Genetically Modified Food Products in Bangladesh – A Focus on Perceptual Dimensions of Experts and Consumers.

A thesis submitted in fulfillment of the requirement for awarding the degree of Doctor of Philosophy in Marketing.

The University of Dhaka

By

Amir Ahmed

Under the supervision of
Professor Belayet Hossain, PhD
Department of Marketing
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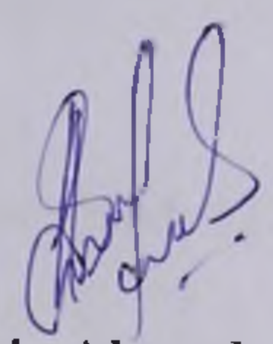
I further affirm that the research work presented in this thesis is original and it has not been submitted earlier either in partly or fully to any other University or Institution for any degree, diploma or any other similar purpose.



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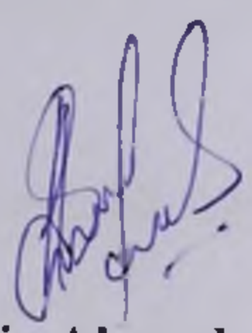

Amir Ahmed

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CERTIFICATE

This is to certify that the thesis titled **Genetically Modified Food Products in Bangladesh- A Focus on Perceptual Dimensions of Experts and Consumers** has been prepared by **Amir Ahmed** under my supervision. The entire thesis comprises the candidate's own work and personal achievement.

It is an original piece of research work and has not been submitted to any other University or Institution for Ph.D. degree or for any other similar purpose.

I recommend the thesis for evaluation for awarding the degree of Doctor of Philosophy in Marketing.

Professor Belayet Hossain, Ph.D.
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DEDICATION

This thesis is dedicated to my eldest brother
Dr. Sarwar Iqbal
for his constant inspiration in my research work.

Acknowledgement

I owe debt of gratitude to Almighty Allah for gracing me with the opportunity to pursue the Ph.D. Program. I am also privileged to undergo the Ph.D. program in the Department of Marketing, Faculty of Business Studies, University of Dhaka.

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I convey my sincere thanks for the invaluable help and cooperation extended to me by the staffs of the Department of Marketing and Department of Biochemistry as well as all the staffs of Dhaka University Central Library; Commerce Faculty Seminar Library, Dhaka University; Institute of Business Administration (IBA) Library, Dhaka University; Bangladesh Institute of Development Studies Library; British Council Library; Wollongong University Library at Sydney, Australia and the United State Information Services Library at Dhaka.

It is a pleasure to pay tribute to Dr. Wahidul Habib, Associate Professor, ASA University, Dhaka for his relentless support in all aspects of my thesis from beginning to end. His involvement with his originality has triggered and nourished my intellectual maturity that I will benefit from for a long time to come. I am grateful to him in every possible way and hope to keep up our collaboration in the future.

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Amir Ahmed

ABSTRACT

This study investigates the perceptual dimensions of experts and consumers about the Genetically Modified Foods (GM foods) in Bangladesh. The first problem addressed is to explore and analyze the perceptual dimensions of the experts about the potential risks and benefits of GM foods as well as to determine from their view points whether the perceived benefit compensates the potential risk or the underlying risk outweigh the benefit of GM foods. The second problem addressed is to explore the awareness level, knowledge and perception of consumers about GM foods as well as to establish a linkage or relationship between consumer's risk/benefit beliefs and their willingness to buy (WTB) GM foods. Two different statistical approaches have been applied in this explorative study for expert and consumer surveys respectively. The expert survey includes both quantitative and qualitative analysis where as the consumer survey comprises only quantitative analysis. The sampling techniques implemented for each survey are also different. Experts' survey includes a judgmental sampling technique where the population is primarily the academicians, researchers, key personnel of multinational companies (GM foods related), activists and persons with direct concern about GM food issues in Bangladesh. Consumers' survey employed a household survey technique in the Dhaka Metropolitan City.

Analysis of the characteristics of experts has shown that experts differ in respect of key cognitive resources that may inform their views of GM foods. Four different groups of experts have been identified based on a two-by-two classification of risk and benefit perceptions. They are designated as "Trade-off" believing that GM foods offer both risk and benefit, "Skeptical" perceiving no benefits and carry only risks in GM foods, "Relaxed" perceiving only benefit and no risk and "Uninterested" that have shown non attitudes towards GM foods. Based on the other qualitative data the characteristics of experts regarding GM foods are further categorized as "Biotech Optimistic" showing very positive attitudes towards GM foods and other food technologies, "Arguably Different" possesses hope for feeding increasing population of the world with GM foods and also concerned about unknown long

term health hazards, "Biotech Pessimistic" possesses a very negative view towards GM foods and other artificial food technology and "Food Neophobic" exhibiting phobia for any new artificially derived food. Ethical and moral concerns, labeling preference, price sensitivity, regulatory issues as well as health, environmental and economical concerns are the best set of predictors that shape the judgment of experts about the encouragement of GM commercialization in Bangladesh.

It is found that various attribute beliefs associated with GM foods are key factors to explain consumers' purchase intentions toward GM foods. The qualitative factors of risk/benefit beliefs significantly influence consumers' acceptance and rejection of GM foods. Depending upon product types consumers showed different levels of risk and benefit perceptions towards GM foods as found in other researches. Consumers hold considerably different sets of risk/benefit perceptions and preferences for buying GM rice and GM soybean oil respectively. In addition, it is revealed that when consumers are willing to buy GM foods, the crucial factor to affect their purchase intention is the food safety and superior nutritional value followed by price benefit and lower production cost. On the other hand, when consumers decide not to buy GM foods, the ethical and moral issues along with concerns over the side effects of GM foods on human health are important factors. The study found that consumers have a strong preference for a mandatory labeling of GM foods as well as a stronger trust on scientist & academicians about the safety information and regulation of those foods as anticipated. Education and age are distinguishing socio-demographic variables which suggest that educated and young consumers are more likely to buy GM foods. The degree of access to information is found significant in the study. The more consumers get access to the authentic information about GM foods the more likely to buy them.

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ABBREVIATIONS & GLOSSARIES

ABSP	Agricultural Biotechnology Support Project
ATC	Australian Trade Commission
ASEAN	Association of Southeast Asian Nations
BMA	British Medical Association
Bt	Bacillus thuringeinsis
BRRI	Bangladesh Rice Research Institute
BST	Bovine Somatotrophin
BSS	Bangladesh Bureau of Statistics
rBST	recombinant Bovine Somatotrophin
CEGMFU	Committee on the Ethics of Genetic Modification and Food Use
CVM	Contingent Valuation Method
CIWF	Compassion in World Farming
DMC	Dhaka Metropolitan City
DNA	Deoxyribonucleic Acid
EFSA	European Food Safety Authority
EU	European Union
FAO	Food and Agriculture Organization
FSANZ	Food Standard Australia New Zealand
FDA	Food and Drug Administration
GEO-PIE	Genetically Engineered Organism- Public Issue Education
GM	Genetically Modified or Genetic Modification
GMO	Genetically Modified Organism
GSA	Genetic Society of America
HIV	Human Immunodeficiency Virus
HMSO	Her Majesty's Stationery Office
IFIC	International Food Information Council
IRRI	International Rice Research Institute
ISAAA	International Service for the Acquisition of Agri-Biotech Applications
ISIS	Institute of Science in Society

JJS	Jagrata Juba Shangha
MNL	Multinomial Logit
NBEC	National Biosafety Expert Committee
NBF	National Biosafety Framework
NGO	Non-government Organization
PBS	Program for Biosafety System
SANFEC	South Asia Network on Food Ecology and Culture
RajUK	Rajdhani Unnayan Kartripokkha
UK	United Kingdom
UNEP	United Nations Environment Program
USA	United States of America
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
UBINIG	Unnayan Bikalper Nitinirdharoni Gobeshona
VEGA	Vegetarian Economy and Green Agriculture
WHO	World Health Organization
WTA	Willingness to Accept
WTB	Willingness to Buy
WTP	Willingness to Pay
WTO	World Trade Organization

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CHAPTER - 1

Introduction

1.1 GM Foods and Genetic Modification Technology

Genetic Modification (GM) refers to the process of modifying plants or animals by adding genes to change the genetic makeup of the original organism. This laboratory procedure involves transfer of the genetic material (the DNA) from one organism to another such as from bacteria to plants, animals to plants and between dissimilar plants. As a consequence it produces plants or animals with desired characteristics faster than classical cross breeding methods. Sometimes the process is called bio-engineering, biotechnology or genetic engineering (Wachenheim and Lesch, 2004).

The term GM foods (Genetically Modified Foods) and GMOs (Genetically Modified Organisms) are most commonly used to refer to crop plants created for human or animal consumption using these latest molecular biology techniques. These plants have been modified in the laboratory to enhance desired traits such as increased resistance to herbicides, tolerance to salinity and drought or to improved nutritional content. Genetic modification attempted to animal has the same basic intention (Scully, 2003). The enhancement of desired traits has traditionally been undertaken through cross breeding but conventional plant breeding methods are very time consuming and often not very accurate. GM technology is different from traditional breeding techniques in three principal ways: i) It reduces the random nature of classical breeding; ii) It accomplishes the desired results much more quickly and predictably; and iii) It makes it possible to cross the intra species barrier (Roller and Harlander, 1998).

For example, plant geneticists can isolate a gene responsible for drought or salinity tolerance and insert that gene into a different plant. The new genetically-modified plant will gain drought or salinity tolerance trait as well. Not only genes are transferred from one plant to another but genes from non-plant organisms can also be used in this process. The best known example of this kind of transformation is the use of Bt. genes in corn and other crops. Bt. (*Bacillus thuringiensis)* is a naturally occurring bacterium which produces crystal proteins that are lethal to insect larvae. Bt. crystal protein genes have been transferred into corn for enabling the corn to produce its own pesticides against insects

such as the "European Corn Borer" (Whitman, 2000). Another classical example is bovine somatotropin (BST) or bovine growth hormone a naturally occurring protein made in the pituitary gland of the cow. Recombinant bovine somatotrophin (rBST) is also a BST produced by a GM bacterium in the laboratory. A cow administered with rBST can increase milk by more than 20%. However, the cow administered with rBST does not carry any GM ingredient in its milk (Aldrich and Blisard, 1998).

1.1.1 The Controversy with GM foods and Research Motivation

Genetically Modified Foods (GM foods) are viewed and positioned in the market as the future of the food system with the potential for enormous economic and social implications (Harrison and Han, 2005). Despite such potential GM foods have so far received mixed regulatory and public acceptance in the United States and elsewhere (Hallman and Metcalfe, 2002). While public debate remains embroil in the controversy about risks and benefits of biotechnology consumer acceptance of GM foods stay behind a critical factor in determining the future of this technology.

However, GM crops have been widely adopted and accepted by farmers as well as agro based industries in many parts of the world. Agribusiness companies such as Monsanto and Syngenta support the application of biotechnology. Among several benefits of GM foods a few are as follows: i) GM crops would be beneficial to health since they lead to foods with less chemical residue; ii) GM crops benefit society because they lower the farmer's production cost; and iii) GM crops benefit consumers because they lower food prices. Experts also argue that biotechnology provides benefits for the environment by allowing farmers to use fewer pesticides and herbicides by leading to adoption of more environment friendly farming systems and by resulting in increased soil moisture retention and decreased soil erosion.

On the other hand, despite the benefits consumer and environmental groups like Greenpeace and Friends of the Earth have a greater interest in food safety and the quality issues associated with GM products. For example, there are concerns that foods with transplanted genes may cause allergic reactions in some consumers and GM foods might have unforeseen harmful effects on human health. Environmental concerns include: i) potential for GM crops to interact with non- GM plants, leading to contamination of organic crops and/or herbicide resistant weeds; ii) GM crops may threaten indigenous

plants and animals; and iii) the herbicides used with some GM crops kill plants that are beneficial to wildlife.

1.1.2 Public Debate of GM foods: A Global Perspective

The controversy regarding the use of biotechnology in food products had been raised soon after the first commercialization of GM foods in the US market back in 1994 while the California company Calgene introduced "Flavr Savr" the 1st ever GM tomato in the world. Flavr Savr was submitted to Food and Drug Administration (FDA) for approval in 1992 for launching in the market. Unfortunately commercial production of the first GM tomato was ceased in 1997 as results of extreme controversy (Belinda, 2001). Calgene has been acquired by biotech giant Monsanto in late 90s. However, commercialization of Recombinant Insulin produced by using the same technology did not encounter any such controversy since its inception in 1983.

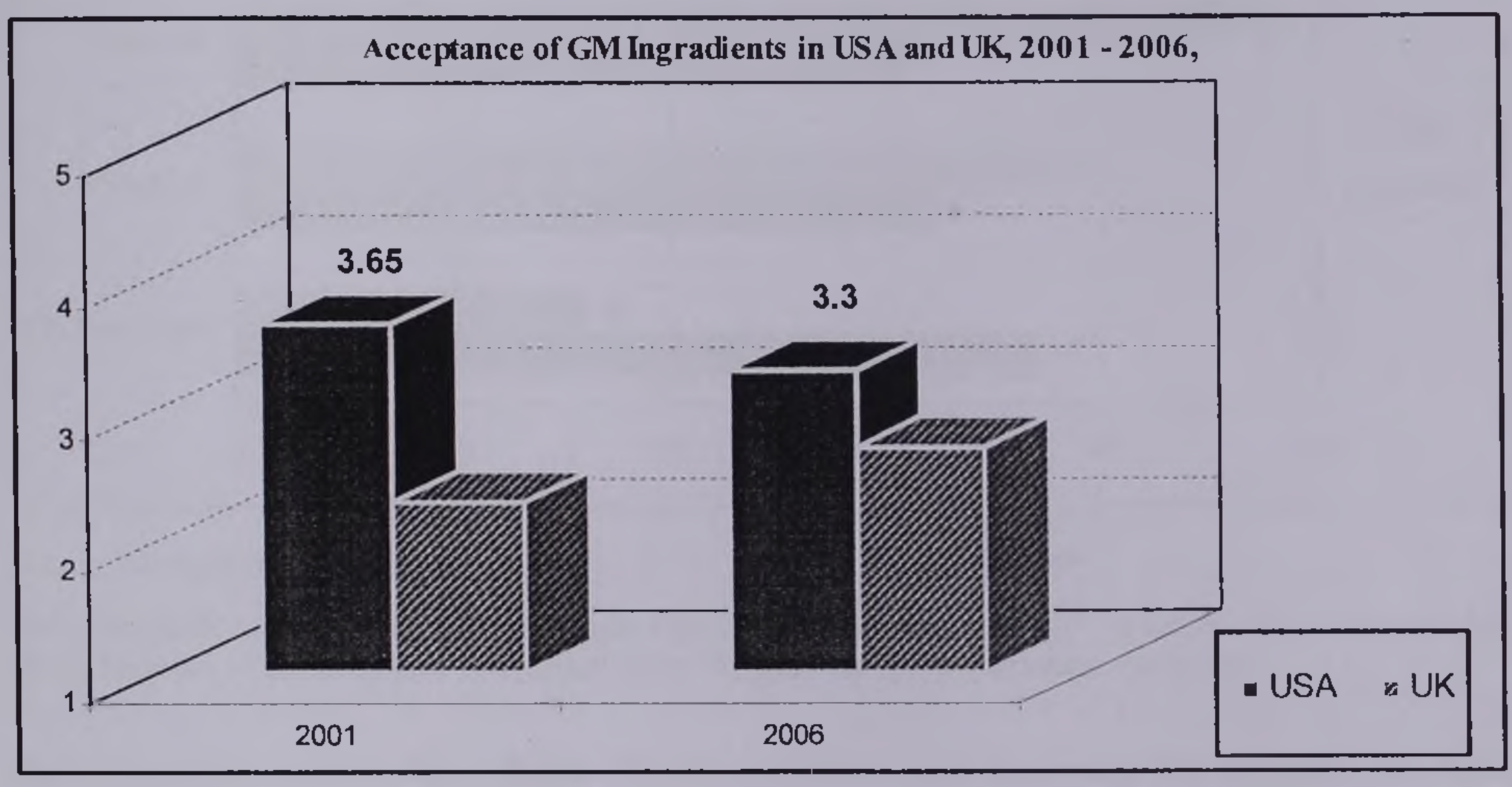
There have been many issues and controversies regarding biotechnology and the public debate about GM foods. Following discussion has been focused only to those issues which have direct concerns with the current study. The technical side of the controversy has not been included intentionally in this discussion as it falls in the specialized area of science and technology and is not a part of consumer perception. However, controversy relating to GM foods and the technology can be categorized into 5 (five) distinctive issues as of a non-scientific perspective: a) Controversy regarding health and environmental risk and benefit, b) Ethical and moral dilemmas, c) Voluntary and mandatory labeling of GM foods, d) Regulatory issues and; finally e) Socioeconomic problems.

It was not until late 2000 when 'Starlink' corn issue surfaced that Americans woke up with an alarm bell. The Washington Post staff writer Mare Kaufman first wrote an article describing how the Starlink (a genetically modified corn variety) released by Aventis got into the food chain though the federal government had permitted it for being marketed as feed only. When 17 Americans complained of allergic problems after consuming Starlink the company withdrew the million dollar stuff off the shelves (Ahmed, 2004). The Starlink has since been referred as a test case and also as an issue that exposed weakness of the US regulatory system believed to be the most conserved and powerful one. Consumer attitudes toward GM food products are largely negative in many developed

countries in the European Union as well as in Japan (Hallman, Hebden, Aquino, Cuite, & Lang, 2003).

Food crises in Europe such as "mad cow" and "dioxin chicken" have led to heightened health and environmental concerns among EU consumers leading to specific and stringent controls of GM products in the European Union (Soregavoli, Boccaletti, & Moro, 2003).

Figure – 1.1: A comparison between USA and UK consumers' attitude towards GM foods.



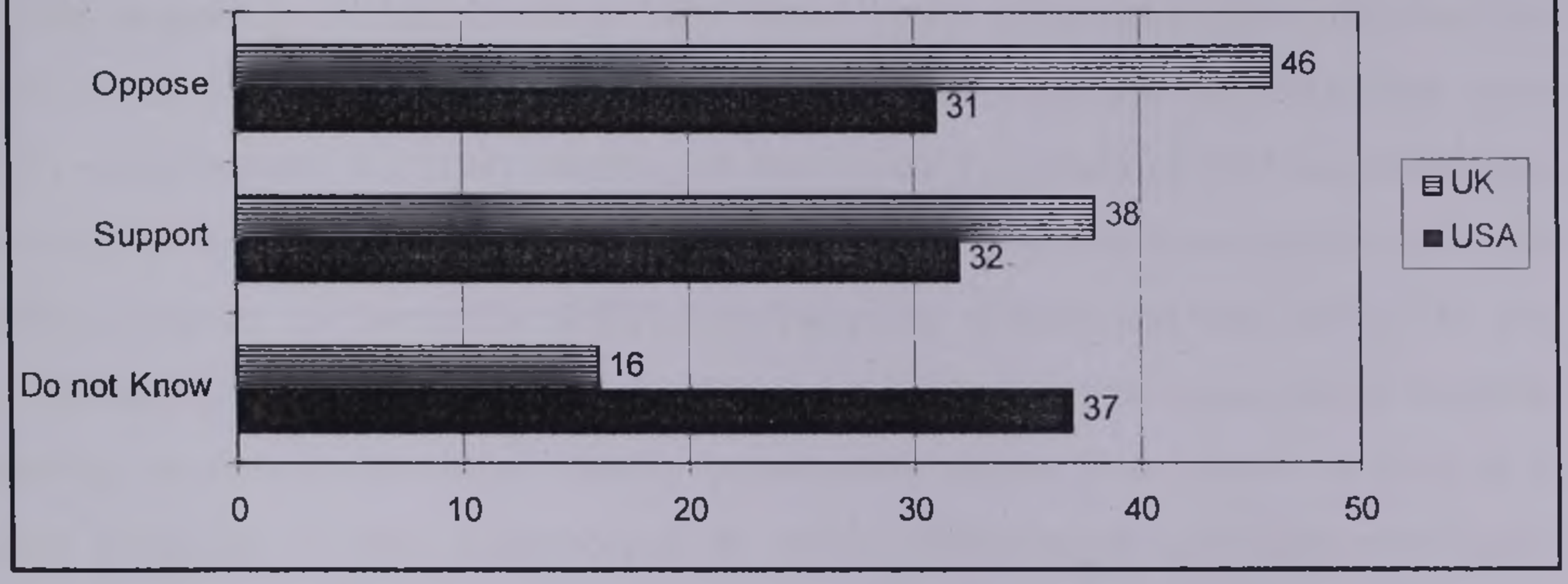
Source: Datamonitor, 2007.

Note: 1 = not accepting – 5 = highly accepting.

For instance, in the middle of 2009 over 40 transgenic events have been approved or close to approval elsewhere but neither been not approved nor even been submitted in the European Union (Alexander and Emilio, 2010). On the other hand USA, Canada and Australia exhibited an encouraging response in acceptance of GM crops and meat products. In general, the United States showed strong public support for biotechnology applications comparing with other European countries. Most U.S. consumers expressed a circumspect optimism about the benefits of biotechnology. They accept GM food products if the price is appropriate and it provides distinct benefits to the society (Hoban, 1999). United States regulatory policies regarding introduction and marketing of GM foods are less stringent because GMOs are regulated under special provisions of the same laws that govern conventional foods. In EU the regulation of GMOs is controlled by a special directive act governed by European Food Safety Authority, EFSA (EFSA, 2004 and GMO-Compass, 2011). Differences in EU and US regulatory policies are determined

by numerous factors. An important factor is the public's perceptions regarding the safety and environmental risks of GMOs (Soregaroli et al., 2003).

Figure – 1.2: A comparison between USA and UK consumers' acceptance level towards GM crops.



Source: Moon and Balasubramanian, 2001.

Note: Six-point scale ranging from "Strongly Oppose" to "Strongly Support". In the bar chart "Oppose" is an aggregation of the first three categories while "Support" is for the last three categories.

However, GM crops have been widely adopted and accepted by farmers in North American countries as well as agribusinesses companies. World's two agribusiness giants Monsanto and Syngenta achieved remarkable contribution in crop science have supported the application of biotechnology for the development of crops. The agro science companies mainly focus into the beneficial side of the technology which directly affect the production economics such as lower production cost for farmers and reduction in production loss due to diseases caused by insects, bacteria, fungus etc. resulting healthier foods for consumers in cheaper price. They also argue that biotechnology provides benefits for the environment by allowing farmers to use fewer pesticides and herbicides, by leading to adoption of more environmentally friendly farming systems and by resulting in increased soil moisture retention as well as decreased soil erosion. On the other hand, despite the benefits consumer and environmental groups like Greenpeace and Friends of the Earth have a greater interest in food safety and the quality issues associated with GM products (Hallman et al., 2003). For example, there are concerns that foods produced with GM technology may cause allergic reactions in some consumers since it contains transplanted genes from other organisms and sometimes overlaps the natural interspecies

genetic barriers. Thus, GM foods might have unforeseen harmful effects on human health. Environmental concerns include chances of interaction of GM crops with non- GM plants, leading to contamination of organic crops and threaten the sovereignty of indigenous plants and animals. Moreover the herbicides used with some GM crops kill plants that are beneficial to wildlife.

Labeling of GM foods is one of the most important issues which shape the global debate of GM technology twisted in many folds. Based on the information from published data as to the labeling requirements of GM foods can be subdivided into two categories, one is FDA recommended voluntary labeling of food products containing GM ingredients and the other is mandatory labeling for all food products containing trace amount of GMOs preferred mostly by the critics of FDA labeling policy (Gruere and Rao, 2007). The cost of labeling involves far more than the paper and ink to print the actual label. Accurate labeling requires an extensive identity preservation system from farmer to elevator to grain processor to food manufacturer to retailer (Maltsbarger and Kalaitzandonakes, 2000). Either testing or detailed record-keeping needs to be done at various steps along the food supply chain. Estimated costs of mandatory labeling vary from a few dollars per person per year to 10 percent of a consumer's food bill (Gruere and Rao, 2007). The choice of labeling policy is different in different parts of the globe. While American scientist and public are satisfied with FDA's voluntary labeling policy Europeans are rigid in implementing the mandatory labeling policy for all GM foods and feeds. These arguments are stretched from ethical ground and consumer's right which focuses mandatory labeling to the economical losses suggests a voluntary labeling (Carter and Gruere, 2003).

In addition, there are concerns regarding the ethics of tampering with the nature via genetic modification. Some consumers argue that GM violates the basic principles regarding the relationship between human and nature, thus GM is like "playing God" (Hallman and Metcalfe, 2002; Hallman et al., 2003). A special committee "Committee on the Ethics of Genetic Modification and Food Use (CEGMFU) has been emerged in September 1992 to address the ethical problems of certain types of modification associated with GM food issue (Her Majesty's Stationery Office, 1993). Since then the issue of trans-gene has become a subject of dietary taboo. In 1993 the Vegetarian Society and Vegetarian Economy & Green Agriculture (VEGA) reported that GM foods

containing a pig gene (as pig is forbidden for Muslim, Jews and vegetarians) should be restricted for vegetarians and certain religious groups. However VEGA finally withdraws the legislation on the ground that a gene which is a microscopic element and have no specific identity while isolated whatsoever the source of isolation (Ellahi, 1994). Animal welfare organization such as Compassion in World Farming (CIWF) has also reported their concerns regarding genetic modification of animal (Friend of the Earth Europe, 2006 and Greenpeace, 2006).

Consumer and environmental groups contend that the unknown risks of biotechnology will outweigh the benefits and the safety of biotechnology is unproven too. Consumers having unfavorable attitudes toward GM argued that have the right to know whether or not products are produced using biotechnology. Greenpeace and Friends of the Earth argue that biotechnology will only benefit big companies but not the consumers (Greenpeace, 2001).

In a study of Italian consumer Mora, Menozzi, Giacomini, Cantoni, Massari & Morelli (2000) reported that people often hear about GM foods and biotechnology probably from the media as these are a topical issue and therefore people think they know about them. But in fact very few people are well informed or correctly informed about GM issue. From the analysis of Mora et al., this is borne out by the fact that all the interviewees in their study know the agro-foodstuff applications of biotechnology (GM foods) which appear most frequently on TV and in the press but few people know about their environmental and medical applications. More than 92% of the respondents have heard about biotechnologies while only 43.4% correctly answered to the question while asked if they really knew what biotechnology is. Food safety has become an important aspect for consumers particularly in the case of genetic modification.

Table – 1.1: Characteristics of Biosafety regulations in selected countries in Asia-Pacific.

Country	Cartagena Bio-safety Protocol	Regulations	Labeling regulation	Approved GM events
Australia	Non-Party	Process-based	Mandatory labeling based on product content(1% threshold)	73
Bangladesh	Party(2005)	Process Based	Proposed legislation for mandatory labeling	7
China	Party(2005)	Process-based	Mandatory for 17 products from com, soybean ,cotton, canola and tomato	34
Hong Kong,	Non-Party	Process-based, GMO Ordinance pending	Voluntary labeling (5% labeling threshold)	n/a
India	Party(2003)	Process-based	Proposed legislation for mandatory labeling	6
Indonesia	Party(2005)	Process-based	Mandatory for pack-aged foods, introduce but implemented (5% threshold)	7
Japan	Party(2004)	Process-based	Mandatory labeling based on product content(5% threshold)	114
Korea	Party(2008)	Process-based	Mandatory labeling based on product content(3% threshold)	72
Malaysia	Party(2003)	Process-based	Mandatory, not yet implemented	5
New Zealand	Party(2005)	Process-based	Mandatory labeling based on product content(1% threshold)	52
Pakistan	Party(2009)	Process-based	No legislation on labeling	1
Philippines	Party(2007)	Product-based	Draft policy for voluntary labeling(5% threshold)	65
Russia	Non-Party	Process-based	Mandatory, includes derived product (0.9%)	20
Singapore	Non-Party	Process-based	Mandatory for pack-aged foods, introduce but implemented (5% threshold)	13
Taiwan	Non-Party	Product-based	Mandatory labeling based on product content(5% threshold)	33
Thailand	Party(2006)	Process-based; bio safety law pending	Mandatory labeling for corn and soybean products content(5% threshold)	2
Viet Nam	Party(2004)	Process-based, bio safety decree pending	Mandatory ,introduced but not implemented (5% threshold)	n/a

Source: Ramessar et al., 2008; James, 2010 and Gruere, 2006.

Overall while the biotech industry has emphasized the positive effects of biotechnology to society some consumers and environmental groups have focused on the negative characteristics of biotechnology.

1.1.3 An Overview of Global GM Food Market

The GM food industry in terms of research, development and market growth had been at the peak in the late nineties even though the market penetration of this special kind of food products started years back in the United States (Isserman, 2001). This is probably the underlying reason that most of the secondary data available about global GM market are estimations of the GM market from the year 1998 and so on. The facts and figures presented in this section are only an effort to provide a fundamental idea about global GM

market. Figures may differ depending on the time of the data collected and published in different academic and non-academic papers.

In 1998 the world market for genetically modified (GM) foods was estimated at US$13 billion (Falvey, 2000). In 1999, food-related GMOs were planted in over 40 million hectares representing an increase of 44 per cent over 1998. Major crops include soybean, maize, cotton, canola, rape seed, potato, squash and papaya. These crops are grown in twelve countries with major players being: USA-72%, Argentina-17%, Canada-10%, China-1% with Australia and South Africa each with approximately 0.3% (Falvey, 2000). The global area devoted to GM crops has increased from 2.8 million hectors in 1996, to 114.3 million hectors in 2007 (James, 1997; 2009). In the same way the number of countries involved in this technological revolution has increased from 6, in 1996 to 23 (James, 2009). It was estimated that between 60% and 70% of processed food products available in the U.S. market contained GM ingredients (Hallman et al., 2003).

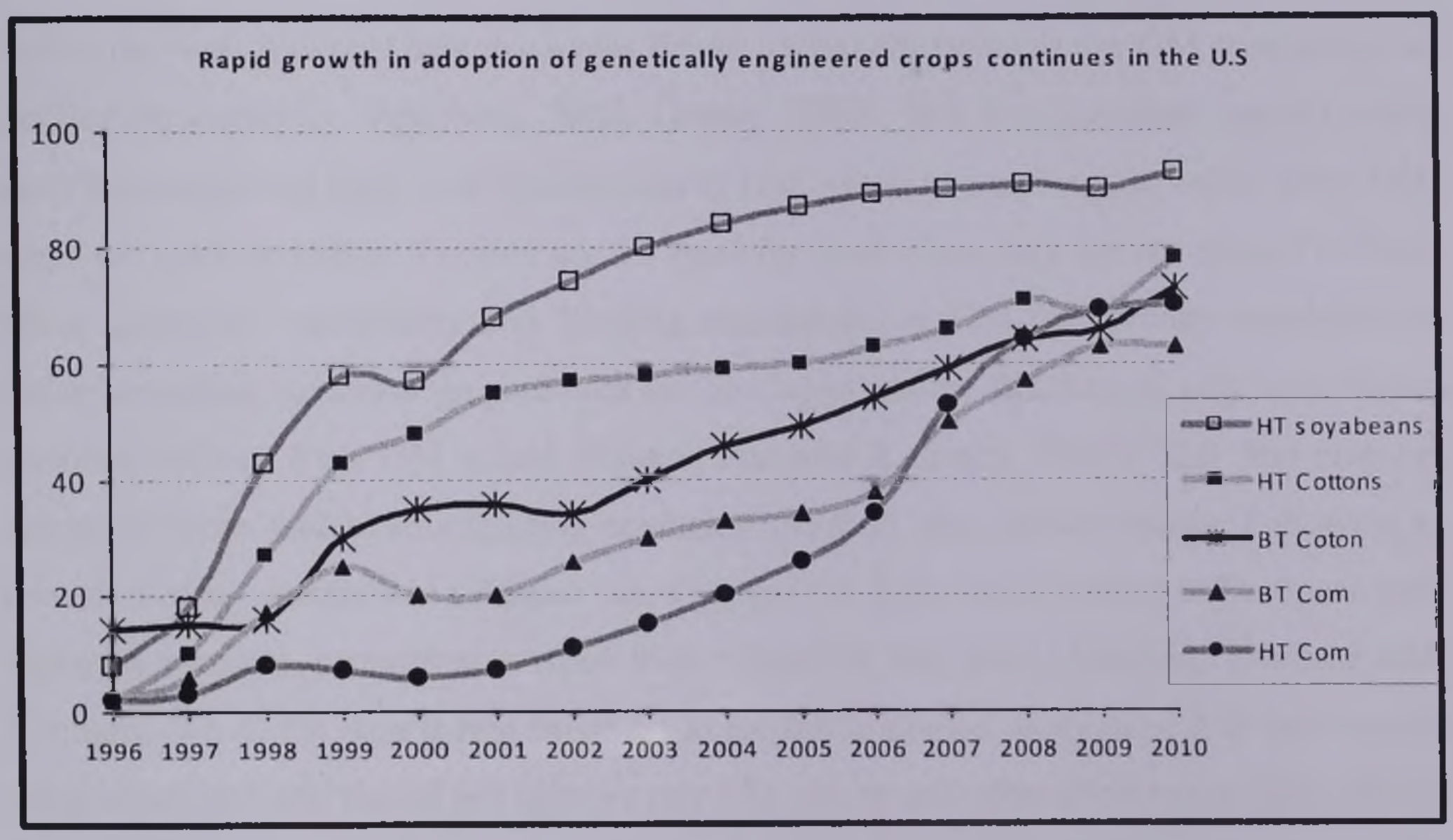
Table - 1.2: Worldwide GM crop are harvested from 1996 to 2007 by Countries (million hectors).

Countries	Area (million hectors)			GM crops
	1996	2005	2007	
USA	1.5	49.8	57.7	Soybean, Maize, Cotton, Squash, Papaya, Alfalfa
Argentina	0.1	17.1	19.1	Soybean, Maize, Cotton
Brazil	....	9.4	15.0	Soybean, Cotton
Canada	0.1	5.8	7.0	Canola, Maize, Soybean
India	....	1.3	6.2	Cotton
China	1.1	3.3	3.8	Cotton, Tomato, Polar, Petunia, Papaya, S.Pepper
Paraguay	....	1.8	2.6	Soybean
South Africa	....	0.5	1.8	Soybean, Maize, Cotton
Uruguay	....	0.3	0.5	Soybean, Maize
Philippines	....	0.1	0.3	Maize
Australia	< 0.1	0.3	0.1	Cotton
Mexico	< 0.1	0.1	0.1	Cotton, Soybean
Spain	....	0.1	0.1	Mize
Romania	....	0.1	<0.1	Soybean
Colombia	....	<0.1	<0.1	Cotton, Carnation
Iran	....	<0.1	....	Rice
Chile	....	....	<0.1	Maize, Soybean, Canola
Honduras	....	<0.1	<0.1	Maize
Portugal	....	....	<0.1	Maize
Germany	....	....	<0.1	Maize
France	....	....	<0.1	Maize
Czech Republic	....	....	<0.1	Maize
Slovakia	....	....	<0.1	Maize
Poland	....	....	<0.1	Maize
World	**2.8**	**90.0**	**114.3**	

Source: James (1997; 2009)

In addition, about 54% of all canola and more than 50% of papayas grown in the United States in 2001 were genetically modified. It was reported that around 70% of processed foods on shelves of US departmental stores have at least traceable GM ingredients (The Pew Initiative on Food and Biotechnology, 2004; GEO-PIE, 2003). In 2006 the global value of biotech crop seeds was estimated at US$ 6.15 billion (James, 2010). International accounting firm, Ernst & Young (2009) reported that US companies invested $9.9 billion into research and development of genetically modified foods, employed 153,000 people and posted total revenues of $18.6 billion.

Figure – 1.3: Growth of Genetically Modified crops in the USA (1996 – 2009).



Source: 1996-1999 data are from Fernandez-Cornejo and McBride (2002). Data for 2000 -2010 are available in ERS data product, Adoption of genetically Engineered Crops in the U.S. (table: 1-3)

Note: Data for each crop category include varieties with HT and Bt (stacked) traits.

1.1.4 GM food Debate in Asia and in the Pacific Region

In contrast to the developed world developing countries have shown a mixed attitude towards GM foods (Baboza, 2003). Some indications have been obtained from different studies which support the idea that acceptance of GM foods is somewhat higher in developing countries (i.e. China, Philippines, Colombia & India) compared to the European countries (Cohen, 2005; Hareau, 2005). However, interestingly while Europe and America are in conflict about the potential long-term health and environmental risk

along with the extra ordinary benefits associated with GM foods the developing countries in Asia and in the pacific region are more concerned about the underlying economic vicious circle of the GM issue relative to other issues outlined in previous section. The prevailing economic dilemmas of GM issue in developing nations are lying between the fear of export loss if adopting GM technology in certain crop varieties especially in the European countries due to their restriction for GMOs and the enormous potential of GM crops to feed the ever increasing large population as well as the promised advantages of GM crops to grow against adverse climatic conditions predominant in this region (Odhimbo, 2007).

In fact the fear of export loss is a major driver in the reluctance to use GM technology in developing countries (Paarlberg, 2002; Gruere, 2006). But two countries namely India and China approved large-scale production of GM cotton in part because unlike other GM crops the main products of cotton are not used for food. Thus they are not subject to food safety approval, traceability and labeling regulations or GM-free private standards in major importing countries. In particular neither Japan nor the EU directly regulates textile products derived from GM cotton (Gruere, Antoine & Simon, 2007). This fear may be driven by large traders in exporting countries afraid to lose market access. Following a detection of an unapproved GM rice variety imported from United States in European and Japanese markets, prompting a rapid import bans of rice from America, Thailand and Vietnam, two of the largest rice exporters to European market announced that they would remain GM free and would not approve any GM rice in their country (Gruere et al., 2007). Rice exporters in India have argued against field-testing of GM rice for similar reasons. As reported in several studies that such fear in many cases are largely exaggerated and based on misinformation or a poor knowledge of the global trade system by biotechnology governing bodies. However this fear has been proved unrealistic in the cases reported by Paarlberg (2006) who revealed that African countries have virtually no export loss from adopting current GM crops. Smythe, Kerr, and Davey (2006) also show that despite claims by GM crop opponents, the major exporters that adopted GM crops in the 1990s have experienced no loss in export value or volume rather their exports have been diverted to other markets. Lastly the fear is also based on the mistaken idea that segregating GM and non-GM crops is infeasible or prohibitively costly. In fact all large GM food or GM feed producing countries (United States, Canada, Argentina, Brazil and

South Africa) produce alternative non-GM crops and even organic crops for domestic and/or international markets (Gruere et al., 2007).

The use of segregation for non-GM crops can help offset some of the relative losses from trade restrictions. Differences between the trade scenario and the hypothetical case with costless segregation provide benchmark values for the opportunity cost of segregation defined as the most a country could spend on segregation to avoid losing compared with trade restrictions with no segregation.

Table - 1.3: Opportunity cost ($ million/yr) of the segregation of non-GM rice for adopting and sensitive countries.

Country	Segregation of non-GM rice for final consumption	Segregation of non-GM rice for final and intermediate consumption
China	3.10	10.09
India	3.60	10.92
Indonesia	- 3.20	3.20
Bangladesh	-0.06	-0.12
Philippines	0.16	0.64
Total	**4.90**	**24.73**

Source: Gruere, Bouet and Mevel (2007)

Table - 1.4: Opportunity cost ($ million/yr) of the segregation of non-GM wheat for adopting and sensitive countries.

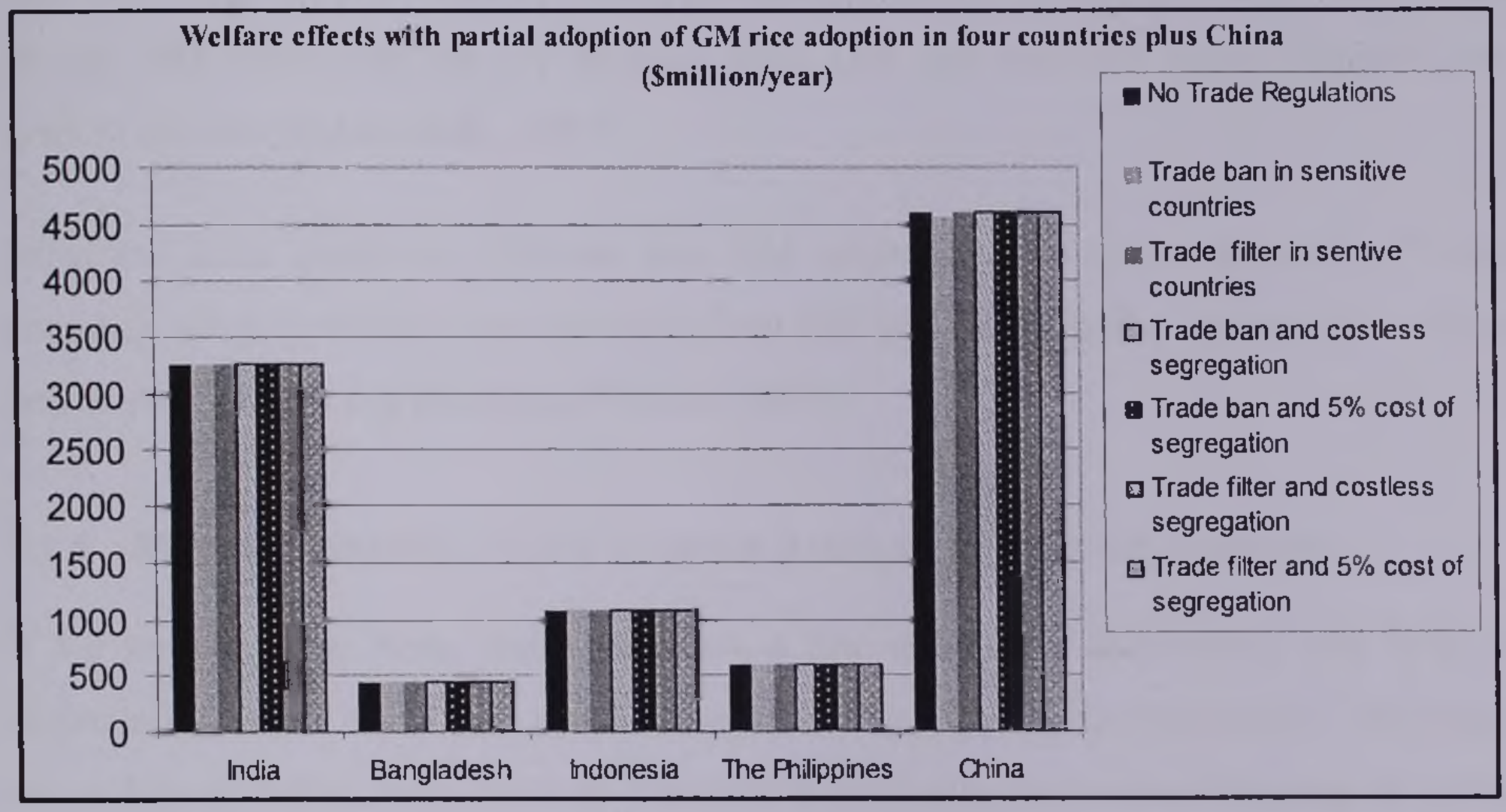
Country	Segregation of non-GM wheat for final consumption	Segregation of non-GM wheat for final and intermediate consumption
China	0.01	2.46
India	0.04	4.14
Bangladesh	0.00	0.17
Argentina	0.08	1.44
Total	**0.13**	**7.87**

Source: Gruere, Bouet and Mevel (2007)

In response to cope with the biotech race in the South East Asian region Pakistan has also constituted a National Biosafety Expert Committee (NBEC) comprising experts from all relevant institutions for updating the relevant laws for GMOs regulation (Ahmed, 2004). However further hindrance the development of GM crops in Asia is occurred by the exaggerated concern over the issue of predominance of few multinational companies in

controlling over GM seed market which may directly affect poor farmers. In usual cases farmers preserved seeds for their next season of harvesting but it is claimed that for GM crops farmers need to buy the same from GM seed producing companies. Interestingly this concern is scientifically not supported (Huffman, Rousu, Shogren & Tegene, 2004).

Figure - 1.4: The derived welfare gains from the adoption of GM rice in four countries and in China in seven scenario.



Source: Gruere, Bouet and Mevel (2007).

Note: GM rice encompasses a combination of traits: drought resistance, salt tolerance, insect resistance and virus resistance.

On the other side critics of GMOs have been exceptionally successful in raising the profile of GM foods and have attracted public support from a wide range of audience including non-governmental organizations (NGOs), religious leaders, politicians, consumers groups, environmental organizations and anti-globalization movements. As NGOs are very active in Asia, for Greenpeace this has been one of its most successful campaigns till date with a petition against GM foods signed by 291 international development agencies. Greenpeace Hong Kong and Greenpeace Thailand have been lobbying government and companies for publishing lists in Hong Kong and Thailand to categorize food as GM and non-GM (Greenpeace, 2001). Friends of the Earth and other environmental groups have also been testing foods for GM traceability. Japan and Korea have already seen strong consumer reaction to GM foods (MacKenzie, 2002).

Nevertheless gigantic potential of GM crops for improving agro-economic situation in Asia has not been overlooked and not even suppressed. High degree research and development for genetic modification on different crop verities has been continued enthusiastically in many Asian countries including Bangladesh. In this context many Asian countries that have already invested millions of dollars in research and regulations on GM food crops confronted with three possible alternatives: (1) allow the production of GM food crops with the risk of losing potential exports; (2) reject the commercialization of any GM food crop; or (3) produce both GM and non-GM crops separately at a marketing cost (Gruere et al., 2007).

However, other evidences indicate that GM crops have a brighter future in 3rd world countries since it offers some extraordinary features and benefits mainly cost-reducing and/or yield-enhancing attributes (Valerie, 2003).

1.1.5 Market Potentials of GM Crops in Asia and Developing Countries

If we turn back to Asia, India has been a late entrant in introducing GM crops for commercial use. While China and Philippines along with US had introduced GM crops in the middle of 1990s, India allowed commercial production of its first GM crop 'Bt cotton' (a variety of GM cotton resistant to insects) only in 2002 (Deodhar, Sankar & Chern, 2007). However, since then, India made a rapid progress in the production of GM cotton. With an area of about 10 million acres under Bt. cotton in 2006 India has surpassed the early entrant China to become the 5th largest country in terms of area under GM crops (ISAAA, 2011).

Table - 1.5: The segments, size and growth of biotech industry in India (in million USD).

	Segments	Number of Companies	2006 – 2007 (million USD)	2005 – 2006 (million UDS)	Growth (%)
1	Biopharma	130 (40)	1453	1145	26.87
2	Bioservice	68 (21)	268	175	53.06
3	Agribiotech	62 (19)	225	145	54.85
4	Bioinformatics	45 (14)	35	29	20.83
5	Bioindustries	20 (06)	96	91	5.33
	All industries	**325 (100)**	**2078**	**1587**	**30.98**

Source: Bioinformatics, 2007

A number of Asian countries have been actively developing research programs on agricultural biotechnology for several years. These researches mainly focus on GM crops with potentially beneficial agronomic traits. Some of these countries had developed Biosafety regulatory frameworks but until middle of 20s only a few approved one or more GM crops (Runge and Ryan, 2004). Recent studies have shown that the introduction of Bt. cotton in India and China has generated revenue gains for farmers overall (Pray, Huang, Hu & Rozelle, 2002; Bennett, Ismael, Kambhampati, & Morse, 2004). Several ex ante simulation models have also shown that China or Sub-Saharan Africa are bound to gain largely from adopting GM food or feed crops even with bans in large importing nations (Huang, Hu, Meijl & Tongeren, 2004; Anderson and Jackson, 2005).

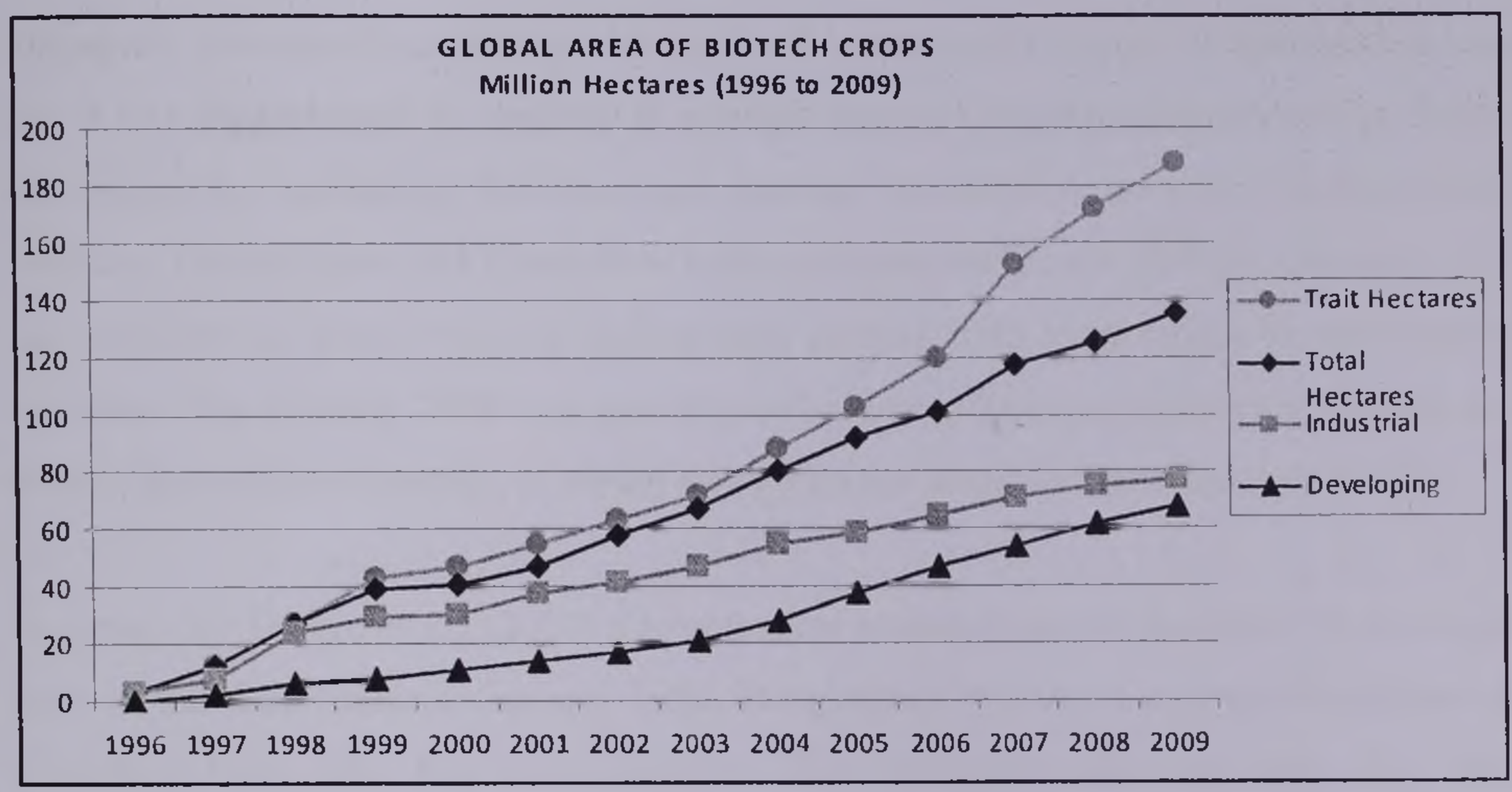
Neilson and Anderson (2000) indicated that if insect resistant (1st generation) GM rice varieties were to be introduced internationally, then India would stand to benefit to the tune of $1178 million and benefit to the world economy would be of $6.2 billion in 1995 dollars. The studies and researches mentioned above have focused on the technology and supply side issues only. The demand side of the Indian market has been more promising (Deodhar et al., 2007)

India planted GM cotton in around 7.6 million hectares of land in 2009 and the Philippines grew GM maize in 0.4 million hectares of land in 2008 (The New Nation, 19 November, 2009:p11). In fact, India has now eliminated customs duty on import of corn due to the pressure from the poultry sector and the starch manufacturing industry (Grainnet, 2007). And, most likely India would receive such imports from countries that produce GM corn. Unfortunately at this situation neither the exporters have explicit GM/non-GM labeling requirement put in place nor does India have an effectively operational GM testing mechanism in place. While one may argue that consumers may be less concerned whether or not their cotton clothes are made up of GM cotton or non-GM cotton (non-food crop), however the same may not be assumed regarding food crops (Deodhar et al., 2007).

However, China is the only country in Asia which grows a significant amount of crops containing GMOs. More than half of its production is cotton crop. Chinese biotech research programs employ 20,000 people in 200 labs. China claims to have developed the world's first genetically modified wheat in 1990. China is now running 10 GM rice field trials and has become the world's largest importer of GM soybeans (Feffer, 2004).

Chinese strains of GM corn and rice that were given safety approvals last year may be market ready by 2013 (Olesen, 2010).

Figure - 1.5: Growth of Genetically Engineered Crops in Industrial and Developing countries from 1996 to 2009.



Source: James, 2009.

Note: A record 14 million farms, in 25 countries, planted 134 million hectares (330 million acers) in 2009, a sustained increase of 7% or 9 million hectares (22 million acers) over 2008.

It is interesting that more than 95 percent of the area devoted to GM crops is located in only four countries: the United States, Argentina, Canada, and China (James, 2007). According to the data available, Asia grew approximately 5 million hectares of biotech crops in 2006.

Three biotech crops (cotton, corn or maize and canola) are currently planted in significant areas in Asia with government regulatory approval. China and India together account for more than a third of the world's population (Geo Hive, 2011). In these two countries over 7 million small farmers are estimated to grow 4.6 million hectares of biotech crops. Studies revealed that within the ASEAN region, the Philippines was the first to approve a biotech crop for food and feed (i.e. Bt. corn) and has developed a strong public institutional capacity for pioneering agro-biotechnology related R&D (Chaturvedi and Rao, 2004). Most Asian countries have guidelines for research on GMOs but the process to obtain commercial approval to grow GM crops is still largely unclear in many countries.

This is the single most important bottleneck to investment by the big players in agro biotechnology market. To some extent the large investments in R&D may generate a pipeline which becomes constipated because no product can be commercialized or released beyond the R&D phase (Teng, 2006).

Singapore has recently enacted guidelines for the commercialization of agro-biotech crops, and it has strengthened its capacity to conduct proof-of-concept research and to develop prototypes for technology licensing and sharing. In addition, countries as Bangladesh, Pakistan, Nepal, Japan and Korea have both upstream (molecular biology, genomics, etc.) and downstream (back-crossing biotech crop parents with local crops) biotech research activities. The ISAAA: 2008 data also shows that over 10 million farmers worldwide now benefit from this technology, of which some 90% are small farmers (ISAAA, 2008).

In a study by Gurere et al., (2007) a hypothetical assumptions for the Major Technologies used in the four countries namely India, Bangladesh, Indonesia and the Philippines for producing GM crops has been analyzed. The assumptions derived from this model process of the study for Bangladesh is presented in absolute terms at the national level (see tables 1.8). The table presented the assumed effects of each technology projected in 2015 as these are the ones used as reference for the simulation model-4 used by the authors.

Table - 1.6: Absolute productivity effects and initial adoption assumed for Bangladesh.

Technology & Crops	% Yield effects			% input effect		% initial adoption		
	Min	ML	Max	Chemical	Labor	IR	RF	Total
DR rice	0.13	1.13	4.89	0.0	0.0	7.8	34.4	9.76
ST rice	0.39	0.57	0.81	0.0	0.0	2.96	1.90	2.88
Bt. rice	0.39	0.82	1.17	-14.62	-2.56	40.0	20.0	36.56
DR wheat	0.25	0.83	1.52	0.0	0.0	8.0	27.4	14.75
Bt. maize	0.0	1.38	2.50	-10.0	-1.88	0.0	25.0	25.0
DR.maize	0.0	1.75	5.25	0.0	0.0	0.0	7.0	7.0
VR.maize	0.0	2.25	5.25	-6.0	-1.13	0.0	15.0	15.0

Source: (Gruere et al., 2007).

Notes: ML = most likely, DR = drought resistant, ST = salt tolerant, VR = virus or disease resistant, IR = irrigated land, RF = rain fed land.

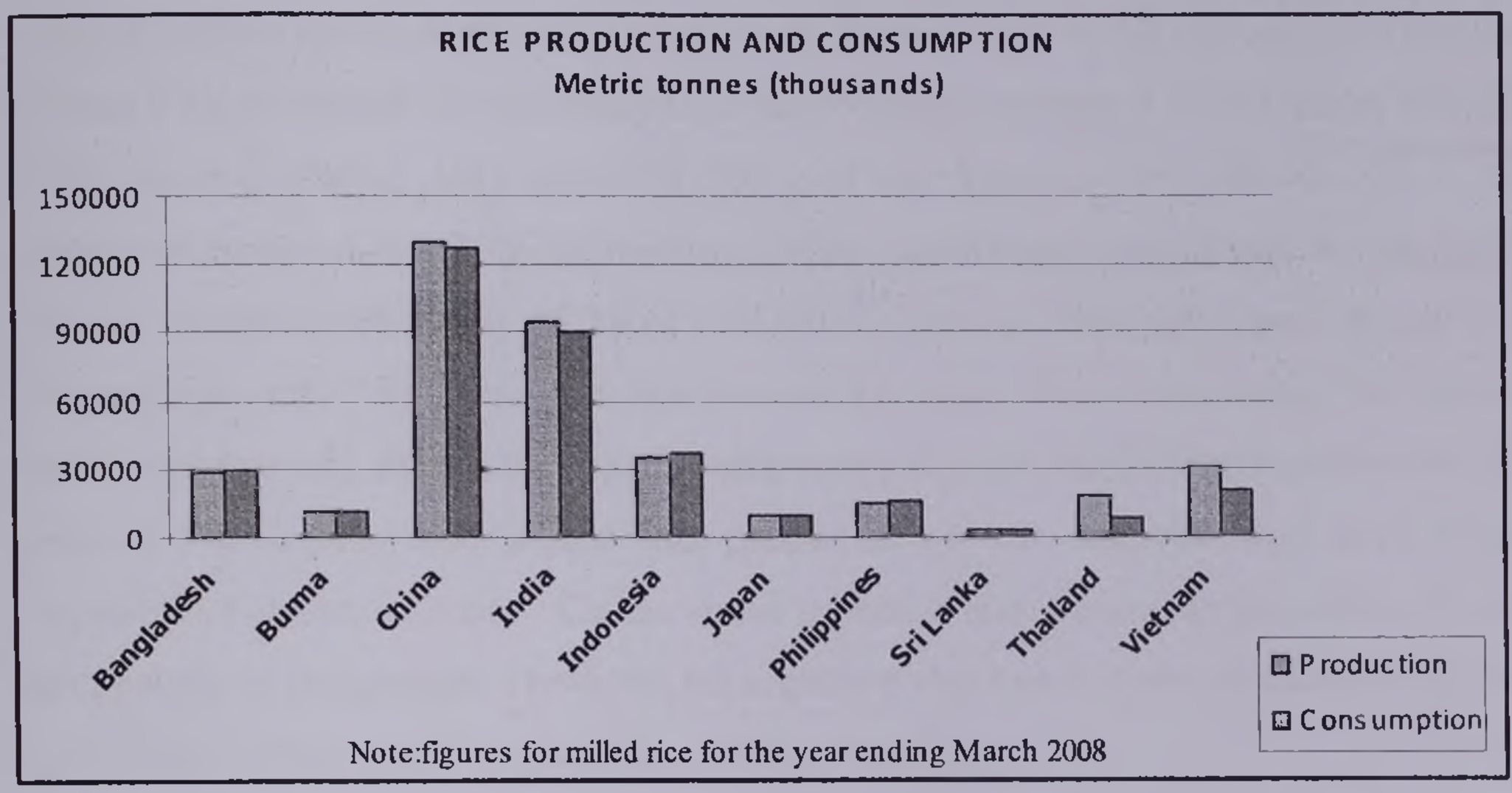
The parameters presented in the tables include minimum, most likely and maximum value of the total yield effect, the total chemical effects and the total labor effects at the national level under the initial adoption rate presented in the last three columns. For instance, the introduction of Bt maize (insect resistant) in Bangladesh (fifth row of Table: 1.8) at an adoption rate of 25 percent only in rain fed areas would result in a most likely 1.38 percent yield increase, a 10 percent reduction of chemicals, and a 1.88 percent labor reduction in maize at the national level

In Asia, food demand is expected to exceed supply by the year 2010, posing huge supply challenges to its agricultural systems. Traditional farming equipment and practices are reaching their limits of effectiveness in increasing agricultural productivity. As countries develop, people are also demanding more and better food. These pressures are multiplied by shrinking farmland, rising labor costs and shortage of farm workers. Scientist and experts claims that all these hurdles can be overcome by the very significant innovation of science, the GM foods.

1.1.6 GM Food Debate in Bangladesh

The global debate on GM issue has also warmed up the media of Bangladesh especially the press. Articles and columns have been published in favor of and against the incorporation of GM crops in the food chain of Bangladesh. Electronic media as well is actively participating in the race of creating awareness about GM foods. It has also been reported that some local NGOs in association with international organizations namely Greenpeace and Friends of the Earth are dominatingly active to pursue the government against the commercialization of GM crops in the country (The Daily Star 8 March, 2004:p8). These activists are also predominant in establishing the GMO free agenda to the field level farmers. Incidentally, Bangladesh Rice Research Institute (BRRI) in collaboration with International Rice Research Institute (IRRI) has successfully introduced Vitamin-A containing gene (popularly known as *Golden Rice*) into BR-29 the widely cultivated rice variety in Bangladesh (Ahmed, 2004). In addition to good yield ability of BR-29 this GM rice variety is claimed to produce Vitamin-A in its seeds which can compensate the Vitamin-A deficiency to poor people who do not take sufficient vegetables. In many of the asian countries rice is the staple food and provides 80% or more of daily calories.

Figure – 1.6: Coparison of porduction and consumtion of rice in few Asian countries in the year 2008.



Source: USDA, 2009.

Polished, white rice the most consumed form of rice contains no beta-carotene or other forms of pro-vitamin-A and is also a very poor source of other micronutrients (iron and zinc). Worldwide, 125 million children particularly those in developing countries suffer from vitamin-A deficiency which causes blindness up to 500,000 children per year and even death (World Health Organisation, 2009).

Box-1.1: Vitamin-A deficiency and Golden Rice

Golden Rice is expected to have a significant impact in reduction of malnutrition and premature death while it is combined with existing dietary sources. Data suggests that Vitamin-A and zinc alone could save 25% of the 12 million children who die annually because of malnutrition worldwide. The Golden Rice Project is being moved forward at various levels. After the Golden Rice prototype obtained in the year 1999 and which accumulated around 1.6 μg/g of β-carotene in the grain scientists generated new lines by using tissue specific promoters in the gene constructs. This led to first Golden Rice-1 (GR1) which produced up to an average of 6 μg/g of β-carotene (Ye et al., 2000). Syngenta scientists have development latest Golden Rice-2 (GR2), which produces 31 μg/g of β-carotene (Paine et al., 2005). However, which line will be used in the end will depend on the final outcome of the ongoing bioavailability studies and regional needs calculated based on the local dietary composition.

Source: Paine et al., 2005.

However, according to Mazhar and Akhter (2005) the main argument against the very need of Golden Rice in a country like Bangladesh is totally baseless. They reasoned that

based on the product developers' own figures Greenpeace calculated that an adult would have to eat at least 12 times the normal intake of 300 g rice to get the daily recommended amount of pro-vitamin-A. An adult would have to eat at least 3.7 kg dry weight of rice, i.e. around 9 kg of cooked rice to satisfy their daily need of vitamin-A from Golden Rice. In other words a normal daily intake of 300 g of rice would at best provide 8% of the vitamin-A needed daily. A breast feeding woman would have to eat at least 6.3 kg in dry weight, converting to nearly 18 kg of cooked rice per day. Whereas a poor family in a village cooks only 2 kg of rice for four persons for two or three meals a day. The authors questioned that why should they spend extra money to cook nearly 4 kg of golden rice per person? The authors also argued that people do not eat only rice they have to eat vegetables, fish etc. with rice. On the above ground it is an expensive proposition for the poor people of Bangladesh. However, the argument was based on the introduction of GR-1, the latest variety GR-2 has overcome this problem.

Therefore, the latest varieties of golden rice are expected to be a new tool in addition to existing ones in helping to overcome vitamin-A deficiency among the poor. It is unfortunate that the commercial launch of this rice variety is still under progress since 2004 (The New Nation, 19 November, 2009:p7). In fact the commercial release of first ever GM crop in Bangladesh has been seriously suffering from the political red-tapism and bureaucratic delay, an obvious consequence of the underlying dilemma of risk and benefit issue of GM foods. However, two new varieties of rice, flood-resistant and saline-resistant, *BR11Sub1* and *Saltol* respectively developed in cooperation with experts in India, the Philippines and the United States, have passed field tests and have been approved by Bangladesh's agriculture ministry for use by farmers, by 2009 (The Economic Times, 2 June, 2008:p10) are yet to be happened. Genetically modified *Egg Plant* and *Potato* were also under scientific and environmental evaluation before its commercial launch expected in 2007 had not taken place. Environmentalists and health experts have already warned the government against introducing any GM rice and food in Bangladesh without testing. They fear that any GM food without proper testing could create severe health problems in a poor country like Bangladesh (BBC News. 18 January, 2005:14.30 GMT). However, it has been reported that imported tomato ketchup, soybean seeds, Soya sauce and canned foods contain GM ingredients are available in the local market but these are not distinctly labeled (Informal interview of the experts and personal observation).

It has been assumed that a significantly low number of consumers are aware of the concept of GM foods.

Although the dilema of health and environmental pros and cons of GM foods are in the place, activist against the introduction of transgenic crops in Bangladesh mostly argue on economic issues and political threat. According to Mazhar and Akhter (2005). The National Biotechnology Policy of last government was essentially to please the USA for soliciting US support in the next election. They argued that it has been passed just a few months before the term of the government is completed and the Caretaker Government steps in to steer the statecraft. The protestant added that it was not a new phenomenon for the regime had been constantly trying to please the USA. But the danger lies in the fact that creating an environment favourable policy to the promotion of the commercial transgenic crop is part and parcel of American foreign policy. This policy is not merely economic in nature to benefit US biotech companies but alarmingly related to security and survival of Bangladesh.

It is evident from above discussion that genetically modified food crops have the potential to raise agricultural productivity in Asian countries. But at the same time they are also associated with the risk of market access losses in sensitive importing countries. It is presumed that GM rice is bound to be the most advantageous crop for the four countries i.e. Bangladesh, India, Indonesia & the Philippines (Gruere et al., 2007).

Although, the Bangladesh government declared a National Biotechnology Policy back in July, 2006 in order to keep pace with the fast advancing field of modern biotechnology and achieve world class competence in the fields of research and innovation in a meeting of the National Taskforce on Biotechnology of Bangladesh (NTFBB) for having final approval of the policy placed to the Ministry of Science, Information and Communication Technology, the formulated policy received its final approval in May, 2011 (ISAAA, 2011). Under this policy immediate action program was promised to be taken for the development of biotechnology in the country in various sectors like agriculture, health, industry and environment. The program reflected the urgent national needs and requirements in terms of funding manpower and equipment. An international biotechnology advisory committee was also formed with internationally recognized experts in different areas of biotechnology to advise the government on priority areas of research and development.

Box- 1.2: Cartagena Protocol on Biosafety.

The Cartagena Protocol on Biosafety is an international agreement on Biosafety, as a supplement to the Convention on Biological Diversity. The Biosafety Protocol seeks to protect biological diversity from the potential risks posed by living modified organisms resulting from modern biotechnology. The Biosafety Protocol makes clear that products from new technologies must be based on the precautionary principle and allow developing nations to balance public health against economic benefits. It will for example let countries ban imports of a living modified organism if they feel there is not enough scientific evidence that the product is safe and requires exporters to label shipments containing genetically altered commodities such as corn or cotton. It was adopted on 29 January 2000 as a supplementary agreement to the Convention on Biological Diversity and entered into force on 11 September 2003.

Source: Secretariat of the Convention on Biological Diversity (2000) & UNEP, 2011.

However, the new policy (formulated in 2006 and finalized in 2011) encouraged the universities to introduce and strengthen biotechnology as well as genetic engineering at the undergraduate and post graduate levels. A separate department named "Genetics and Molecular Biology" was opened in the University of Dhaka in 2006 with a view to provide higher level education in particular field. At the same time attempt had been made to introduce the biotechnological courses at the secondary and higher secondary levels through modification of existing course curricula on biology (Hasan, 2006). Another significant issue focused into the policy draft was the concerns over the protection of intellectual property for innovations in this field beyond legal and ethical questions. In view of the special quality of living organisms the scope of patents has to be clearly defined to find balance between innovation and public interest. Under the policy, legal measures have been taken to achieve a balanced system for protecting the interest of the innovation without compromising public interest. This inconsiderable delay in policy making regarding free movement of GMOs in the country has been criticized not only by the experts but also by the public as well. Some experts argued that Bangladesh is lagging behind in harnessing crop biotech at a time when the country has just been included in the consortium of four south and southeastern countries for a 15- million dollar initiative Program for Biosafety Systems' (PBS) and 'Agricultural Biotechnology Support Project-II' (ABSP-II), both funded by USAID. In this consortium of four comprising Bangladesh, India, Indonesia and the Philippines all but Bangladesh have their Biosafety regulatory bodies set-up (Ahmed, 2004).

Following a memorandum of understanding signed between the government of Bangladesh and the International Rice Research Institute in 2003, the BRRI aimed to develope a variety of golden rice through transfer of gene into the BR-29, the highest yielding BRRI variety with hopes that the yield of the new variety would be much more. It has ben assured by the authority that there is nothing to be worried about if the GM variety is introduced as everything is being done on the basis of scientific research and if it bears any risk it would not be released for farm level production (Ahmed, 2004). The commercial production of Golden Rice was predected in 2010 after a confined trail production in the laboratory. The golden rice variety claims to contain 17 times the amount of vitamin-A present in other high-yielding varieties (Paine et al., 2005). In 2005 BRRI received two grams of seeds from the IRRI to multiply the variety at BRRI laboratory in Bangladesh. The agreement between the BRRI and Singenta (a crop science giant) also raised controversy among many proponets of GM foods. A grass-roots activist working with farmers claimed that the effort of Govt. as piracy and doubted that there was no agronomical value of golden rice since only one per cent of the country's population suffered blindness (Mazhar and Akhter, 2005). UBINIG, a well known NGO in Bangladesh accused the government for sabotaging agriculture by signing the agreement with the multinational company. UBINIG argued that USAID-supported Biotech Activities of the govt. was an attempt to promote fruit and shoot borer-resistant eggplant, late blight-resistant potato and drought and salinity-tolerant rice, while GM papaya is also on the list of import. Environmentalists and health experts also warned the government against introduction any GM rice and food in Bangladesh without proper testing. They fear that any GM food without proper testing could create severe health problems in a poor country like Bangladesh (GRAIN, 2005).

However, addressing this controversy the Agriculture Ministry in 2005 acknowledged that GM foods are controversial worldwide and his government would not take any stand against the technology. Government assured that GM rice would be introduced in Bangladesh after proper testing by in accordance with the national and international rules and regulations (BBC News, Tuesday, 18 January, 2005:14.30 GMT).

A year later, a group of environmentalists and NGO activists expressed concern over gradual introduction of Genetically Modified (GM) foods in Bangladesh at a dialogue on "Genetic Engineering in Food and Agriculture: Threat to Farmers and Human Health"

organized by Jagrata Juba Shangha (JJS) and Action Aid Bangladesh in association with Food Security Network and the European Commission at the city. They reasoned that such foods are harmful to human health and environment and a means to marginalize the small farmers. They also claimed that some companies and NGOs are trying to promote GM foods which pose a threat to Biosafety but the government lacks policy in this regard (The Daily Star,18 July, 2006:p8).

Table – 1.7: List of NGOs active on GM issues in Asia.

Sl	Region/Country	Name of the NGOs
1	Regionally	Friends of the Earth, GRAIN, PAN AP (Pesticide Action Network Asia & Pacific), The Third World Network
2	Bangladesh	UBINIG, Nayakrishi Andolon; SHISUK
3	Hong Kong	Greenpeace,
4	India	SRED, Gene Campaign a grassroots level research and advocacy group, CIKS, PREPARE, Research Foundation for Science, Technology and Ecology (RFSTE), New Delhi, Centre for Sustainable Agreeculture.
5	Japan	NESSFE
6	Korea	CACPK
7	Philippines	KMP – Peasant movement of the Philippines, Masipag, Philippines Greens
8	Thailand	Greenpeace, Bio Thai
9	Sri Lanka	Tamil Nadu Women's Forum

Source: MacKenzie, 2002

The two major proponants of GM foods in the country Nayakrishi Andolon and UBINIG organized a protest meeting in front of the Bangladesh Rice Research Institute against the introduction of Golden Rice on 6 August, 2006 chaired by a farmer along with 100 representative farmers (Mazhar and Akhter, 2005).

It has been reported that although the advanced level research in making GM crops started in the early days of the year 2000 but comprehensive outcomes obtained a decade later. Bangladesh Rice Research Institute (BRRI) reported that Bangladesh would roll out new varieties of flood-resistant and salt-tolerant rice to farmers in 2009 in an effort to boost its staple. Both new types of rice developed in cooperation with experts in India, the Philippines and the United States have passed field tests and have been approved by Bangladesh's agriculture ministry for use by farmers (The Economic Times, 2 June, 2008:10). The research director of BRRI announced that the flood resistant variety uses the Sub1 gene in the domestic high-yielding BR11 rice, which gives an average of 5 tons

of the grain per hectare. In the report he added that this new variety named the 'BR1 ISub1' can survive up to 15 days under water and appears to be the most suitable for areas that suffer flash floods every year. The saline-resistant variety named 'Saltol' will be grown in the country's coastal areas and will yield an additional 1 million tons of rice a year. Reports also uncover the fact that Bangladeshis people are already consuming American soybean oil for many years without knowing that 60 percent of it is genetically modified (The Reuters, 2 June, 2008:.....). However, concerned authority assured that Bangladesh did not need to worry about food sufficiency since the country needed 24 million tons of rice annually to feed its population of roughly 150 million people and the production would suppose to reach nearly 30 million tonnes while the target was to produce 33 million tons annually by 2010 (The Economic Times, 2 June 2008:p.10). It has also been supported by many GM crop experts in the country that new rice varieties hold out the promise of banishing food shortages. Studies revealed that with the cultivation of Sub1, Saltol and the wider spread of GM rice, Bangladesh will probably never run into food deficit even with less cultivated land and food production will outpace population growth.

Addressing the GMOs issue Consumer Association of Bangladesh (CAB) organized a seminar on "GM Foods and Consumers' Right" at Dhaka. In that seminar the speakers focused that although genetically modified food can ensure adequate food supply in an overpopulated country like Bangladesh but the government should be aware that it might be harmful to health of consumers, farmers and environment (The Daily Star, 8 March, 2004:p.11). The speakers also warned that before doing any research on foreign stuff like genetically modified food government should not allow the entrance of GMOs in the country as it has become already controversial.

The agricultural counselor for India, Sri Lanka in Bangladesh admitted that there is a view in some circles that GM technology is a very risky and the US is testing it on the poor populations of developing countries (Gruere et al., 2007). Bangladesh has lower initial adoption rates in certain crops because consumers presume that the technology will take a longer time to spread than in India and other countries.

However addressing the GM issue in Bangladesh a Netherlands based environment organization argued that there can be co-existence of GM, traditional and organic crops as

is there in the European Union but that requires national legislation if it is to be applied in any other countries (The New Nation, 19 November, 2009:p.8).

There have been many issues and controversies regarding biotechnology as discussed, and the public debate about biotechnology continues. Overall, while the biotech industry has emphasized the positive effects of biotechnology to society, some consumers and environmental groups have focused on the negative characteristics of biotechnology. In developed countries the debate about GM foods among various stakeholders has been going on for quite sometime now. The debate surrounding GMOs has been emotive and multi-dimensional as well as attracted a wide range of participants. Conflicting arguments and partial truths have left consumers, farmers, public interest groups and food producers confused.

However one thing is evident from the above discussion that with rapid development of GM food crops in India and around the world, liberalized trade environment, stagnant productivity of green-revolution-era crops and the burgeoning of population, the policy makers of Bangladesh as well as few other countries in this region confront following questions: When (and not if) they should allow production and import of GM food crops in the country? What is the level of awareness among Bangladeshi consumers regarding GM foods? What are their perceptions and attitudes towards consumption of GM foods? What is their willingness to buy for GM foods? These questions need to be addressed first if GM foods are to be introduced commercially in Bangladesh in the near future.

1.2 Research Problem

This section deals with the problems of the present study in details with a brief introduction and background of the problem areas.

1.2.1 Introduction to the Research Problem

In the light of the comprehensive discussion in previous sections it is evident that by adopting GM technology Bangladesh can control the existing gap between rapidly increasing demand of food and shortage of supply. Poor farmers in developing world need better productivity which transgenic (GM foods) crops and foods could eventually provide (Islam, 2005). Studies indicate that the developing countries are one of the prime targets for growing transgenic crops and feed (Hoque, Gruere, Valmonte and Rosegrant, 2006). Agriculture based Bangladesh has immense opportunity to develop specialized human resources in addition to overcome crop scarcity by adopting transgenic crop varieties and utilizing effort in research & development in the genetic engineering sector. As mentioned earlier a GM variety of rice has been recommended for commercial use in Bangladesh. Bangladesh Rice Research Institute (BRRI) has been expecting the first commercial release of GM Rice (The Golden Rice) by 2012 (The New Nation 19 November, 2009:p.8). Like the developed world this GM rice variety has also encountered the controversy and criticism of our expert communities in regards to the risk and benefit issue before its formal incorporation in the food chain of Bangladesh (Mazhar and Akhter, 2005). Many of national scientists and critics have already addressed various significant points in favor of GM crop varieties as well as against the induction of GM crops in the food system of Bangladesh. *"Knowingly or unknowingly we are consuming products derived from crop biotech. Soybean oils that Bangladesh imports from US and Brazil is a glaring example to cite"* (Ahmed, 2004). Against this ground reality Bangladesh now comes to a point where its policy planners require taking an immediate policy decision on GM issue. Whether Bangladeshi farmers should grow GM crops or not, whether Bangladeshi consumers should take GM foods or not - are still big questions to be answered by our government (Ahmed 2004). It is evident that food policy planners of Bangladesh Government alone cannot do the job. The formation process of a National Committee on Bio-safety of Bangladesh (NCBB) remained stalled for several years now. Although, on July 19, 2006 National Taskforce on Biotechnology of Bangladesh (NTFBB) has declared a "National Biotechnology Policy" but by not having this

committee and the policy in place Bangladesh is losing both in terms of non-adherence to research and development in agro-biotechnology. At the same time government is not giving any solid direction to its huge consumer market on the purchase of GM foods. Unless Bangladesh completes the task of preparing necessary frameworks for GM regulation it never can tap the benefit of modern molecular biology in agriculture. In order to make an effective policy for implementing biotechnology in Bangladesh and regulating biotech crops and food stuff for protecting food and environmental safety Bangladesh Government to a great extent depends upon opinion and contribution of experts from all relevant institutions. For instance no attempt has been made till date to study the perceptual dimensions of the experts as well as consumers of Bangladesh about their risk/benefit belief of GM foods. This is a demand of the time and situation to conduct some constructive and structured research in this area; so that it can aid government in making an effective policy for biotechnology in Bangladesh. Study shows that consumers of Bangladesh largely dependent on government agencies and suggestion of the experts from concerned field for making a purchase decision of processed foods and grains (Hoque et al., 2006). Literature review indicates a significant research gap between actual perception of the experts regarding benefit/risk of incorporating GM food products in Bangladesh and the news by print & electronic media have presented so far. It has been reported by many authors that media overstated the potential risk of GM food which does not have any scientific basis which caused causes misleading to European consumers (Gaskell, Allum, Wanger, Kronberger, Torgersen, Hampel & Bardes, 2004). Studies also suggested that this type of partial and imperfect information without supported by any research findings significantly induce wrong perception about GM food in many European and North American consumers (Shanahan et al., 2001). Consumers of Bangladesh will confront new opportunities and challenges about the risk versus benefit issue associated with GM food products once it is incorporated in the national food system. It is assumed that awareness level about risk and benefit of GM food would be significantly low in general consumer. Being member of developing nation Bangladeshi consumers should have the wisdom to accept or reject this modern technology. Thus it is apparent that opinions of experts obtained through a constructive research about risk and benefit perception of GM foods will extensively contribute both in concluding effective policy plans and in developing consumer awareness toward this technology. It has been anticipated that the research finding of the current study will in turn will aid in shaping a

positive or negative attitude towards existing and up coming GM foods in the local market.

The way few GM crops are aggressively taking up shares in the international crop market, days are not so far when consumer would have only two choices while purchasing their staples, cereals, vegetables, fruits and processed food, if it is GM or Non GM? To address this issue the research problem has been subdivided into 2 (two) major segments. The first segment focuses on the expert's views and opinions about GM while the second deals with consumer's awareness, perception and willingness to buy GM products.

1.2.2 Problem Statement One

Research revealed the fact that consumers through out the world have been puzzled with the contradictory information from different experts and regulatory institutions about GM issues (Fernandez and Caswell, 2006). It has also been noticed (researcher's own observation) that experts from different academic and social background in Bangladesh exhibited quite varied opinion in different occasions in favor of and against the induction of GM crops in local food system. In most of the cases these expert's opinions appear as column, report, news etc. in print, electronic and web media. As an obvious consequence consumer often get confused which expert's opinion they should rely on for making their choice for GM foods.

The 1st problem addressed in this study is the need to explore and analyze both qualitatively and quantitatively the perceptual dimension of the experts about the perceived risks and potential benefits of GM food in Bangladesh. In addition it is also necessary to determine from expert's view points that whether the benefit of GM food compensate the potential risk or the perceived risk of this technology outweigh the benefit of GM foods.

1.2.3 Problem Statement Two

It is believed that consumers have little knowledge of GM foods (Hallman et al., 2004). Thus, consumers of Bangladesh cannot assess GM foods by themselves and need awareness or information from GM institutions, government agencies, environmental groups and other reliable sources for decision making. It is assumed that unlike the expert, consumers of Bangladesh are hardly aware of the unbiased risk and benefits perceptions

of GM foods. Some studies showed that a considerably low number of respondents have correctly answered against the questions of GM issue in the Europe and America where as only a fraction of consumers are familiar with the term GM food (Han and Harrison, 2006). However studies also suggest that a segment of educated consumer groups are highly concerned about the risk and benefit issues of GM foods. In last several years GM issue has caught attention of media in Bangladesh (Researcher's self observation). It is evident that educated consumers specifically those residing in urban area (i.e. Dhaka City) are aware of GM foods and crops. In addition consumers with wider internet access are believed to be aware of the potential risk and benefit of GM foods since it is always a topical issue in the web. But as it happened in Europe and North America, consumer widely rejected GM foods due to lack of proper knowledge and overstated possible harmful effect of GM foods by media (Mora et al., 2000). This rejection by the consumers in due course has been narrowing the scope of development of this potentially useful technology. Study shows that acceptance of GM food products is associated with the consumers' perception and beliefs about risk and benefit of GM foods and the biotechnology. When consumers perceive benefits to themselves and society they are expected to be more willing to buy GM foods relative to consumers who perceive few benefits. On the other hand if consumers perceive GM foods as a health risk and also risky for the environment they would be less willing to purchase them. In this regard consumers' risk and benefit beliefs of GM foods are expected to play a significant role in determining their purchasing behavior for those foods. (Harrison and Han, 2005)

The 2nd problem addressed in the study is the need to explore awareness level, knowledge and perception of consumers about GM foods as well as to establish a linkage or relationship between consumer's risk/benefit beliefs and their willingness to buy (WTB) GM foods.

In addition there is also a need to extract out all allied factors (major or minor) in order to examine how these factors such as role of expert's opinion, trust on government agencies, information obtained from media, price sensitivity, ethical/moral concerns etc. influence consumers' attitude and intention to the buy GM foods.

1.3 Research Objective

To date there is no study has been attempted to explore the perception of experts as well as consumers about the risk and benefit belief of GM food in the context of Bangladesh. This study is the first ever attempt of its kind to address a very sensitive issue which has direct apprehension with consumers' health and the environment.

1.3.1 Major Objectives

The study has following 4(four) major objectives:

i) To analyze the perception and belief of experts about the risk and benefit of GM food both in quantitative and qualitative manners.

ii) To determine on the basis of expert's opinion whether GM food is relatively more harmful for the consumers of Bangladesh compared to the claimed benefits or the extraordinary benefits of GM food will compensate associated risk of GM foods.

iii) To obtain an insight about consumer's awareness, knowledge and perception of GM foods.

iv) To examine whether or not consumers' risk/ benefit beliefs of GM food along with other associated factors affect their purchase intention as measured by their willingness to buy (WTB).

1.3.2 Secondary Objectives

The study also has couple of secondary objectives:

i) To isolate particular interest groups in experts' community in terms of their overall attitude towards GM foods.

ii) To identify major factors that directly or indirectly influences consumer's positive or negative attitudes towards GM foods.

1.4 Significance of the Study

'Biotechnologies for food' or 'GM food' debate has become increasingly polarized since last decade. Both proponents and critics of GM technologies have selectively interpreted results of consumer surveys and scientific findings to support their own lines of argument. Meanwhile the media have sensationalized the findings and presented the debate as one of corporate profits versus the importance of public health, freedom of choice and ecological stability. In this debate the moderates have not made the media headlines rather emphasized on heath and environmental factors (Thomas, Nizzari, Cefaloni, Dragos & Has 2009). These biotech crops have shown some impressive double digit growth rates in area planted each year since they were first commercialized in 1996 (James, 2006). Against the many successful examples of biotechnology, it is very important to bear in mind that all technologies bio and non-bio are to serve the ultimate objective of improving the overall welfare of human beings and the nature. Agricultural biotechnology has no exception. Experts' opinion as well as public knowledge, attitudes and perception about biotech products are very important factors which ultimately determine whether biotech crops will become an important contribution to the world's food supply (Teng, 2006).

Based on the timing and types of information available food attributes can be characterized as falling into three categories: search attributes, where consumers can ascertain the quality of a product before they buy and consume it; experience attributes where consumers can judge the characteristics of a product only after they buy and consume it; and credence attributes where consumers cannot accurately determine the quality of a product even after they inspect, buy and consume it (Nelson, 1970; Darby and Karni, 1973). Consumers have considerable difficulties in detecting GM attributes before purchase and after consumption of a GM food. For example, consumers in Bangladesh are exposed to soybean oil extracted from GM soybean (presence of GMOs cannot be detected in oil) or beef from cattle fed GM corn. However, consumers cannot tell which oil is extracted from GM soybean or beef products have been fed GM corn even after consumption (Han and Harrison, 2006).

Consumers are not able to detect the presence of GM ingredients unless the presences of GM ingredients are disclosed through labeling. Therefore, most GM products fall in the credence good category (Isaac and Phillips, 1999). Because of the credence nature of GM

products there is an information gap between consumers and producers. It is also revealed by many studies that consumers depends and rely on experts' suggestion as well as producers' recommendation in case of purchasing products of credence category (Isaac and Phillips, 1999).

As applications of genetic modification get complicated and sophisticated day bt day asymmetric information about GM ingredients seems to be increasing. Some studies found that in general consumers of USA are not informed about GM foods and most consumers are unaware of the prevalence of GM ingredients in food products (Hallman et al., 2003; Hallman et al., 2004). In addition, Hallman et al., (2004) found that more than half of the respondents provided incorrect answers in more than half of the questions in a study of GM foods. Thus, one of the main reasons that some consumers may have an unfavorable attitude toward genetic modification is that they lack information and knowledge about GM foods.

Through the advantage of globalization an event in small part of the world such as the idea of micro financing and its successful implementation brings Bangladesh a noble prize and has become a global interest. In the same way controversy with GM food products in Europe and America is no longer an issue of developed world, it has also caught attention even in the least developed countries where any attempt is yet to be taken to produces GM crops. Hence GM issue is more a global than a regional problem. Therefore it is suggested that constructive research on experts' opinions, consumers' perception and their willingness to buy certain GM products could serve as a useful guideline to the policy planners of GM foods and crops in Bangladesh. At the same time it may provide valuable information to the GM crops researchers and producer companies for particular decision making.

In the light of the above discussion present study has explored the perceptual dimensions of both experts and consumers about GM food in the national food system. The present study has identified and assessed various health risk and benefit factors of GM foods in addition to other significant and insignificant factors that plays vital or partial role in induction and commercialization of GM crops in Bangladesh. In order to deal with above scenario present study has explored and examined the prime factors from expert's view points that lead the ongoing controversy of GM foods in the country. Attempt has also

been made to comprehend from the expert's opinions that whether the risk associated with GM foods is grater or the claimed benefits. In addition the present study focuses on the experts' suggestion that how the risk factors can be eliminated or compensated to tap the maximum benefit of this new technologically derived food products.

Although there has been no official release of any GM food or crop in the market at present but days are not far while government would be compelled to release few of them in the local market which has already passed laboratory and confined field trials successfully in recent years (Financial Express, 3 April, 2011). Thus, it is recommended by many researchers that consumers' knowledge, awareness and perception as well as their willingness to buy certain GM crops in a hypothetical market situation could facilitate a successful market penetration and market establishment of this special type of foods and crops (Hoque et al., 2006). The present study has explored consumers' level of awareness and knowledge about GM foods leading to an empirical model which explains the association of various factors which shaping the consumers decision making of GM foods. Finally the study has explored and assessed the linkage between the identified factors and consumers' willingness to buy the GM food.

1.5 Scope of the Study

The present study was undertaken to explore the perceptual dimension of experts and consumers about GM food in Bangladesh. Extensive literature review was done to identify the benefit and risk factors that may directly or indirectly affect experts' opinion in respect to the commercial approval of this foods and crops in Bangladesh as well as acceptance and rejection of this technologically derived new food by the consumers. The research explores the factors that involves health and environmental risk & benefit, factors for economical opportunities and constrains, factors for regulatory regimes, factors for ethical and moral concerns as well as factors of demographic variables. The role of supporting factors like access to information and hyper activities of media, interrelation between the variables and how these variables contribute to the consumers' food choice were also emphasized. The study also assessed the interrelationship between selected variables and their impact on consumers' willingness to buy (WTB) GM foods. To meet the specific objectives investigations were undertaken into two distinguished area, experts and consumers. The experts' panel comprises different academicians, non-academicians

and personnel from regulatory agencies regarding GM foods and crops, where as consumers of Dhaka Metropolitan City were selected for investigation of consumers' perception about GM foods.

1.6 Limitations of the Study

The study is not free from limitation like most of research. The first limitation of the study is that it covers a small segment of experts actively involved in the field of GM technology in Bangladesh. A wider coverage may produce different results as far as specific issue relating to induction of GM foods in food system is concerned. On the other hand, the present study includes both the academician and non-academician on the same platform. It is anticipated and also revealed from few studies that a group of experts working in the same field but different in academic background differs widely in expressing opinion about specific issues of GM technology (ABSPII, 2005). It would have been better if separate studies can be conducted involving academicians and non-academicians, since the characteristics of these tow groups are not same. The second limitation of the present study is that it is confined to the Dhaka Metropolitan City as far as consumers' knowledge, awareness and perceptions are concerned. Consumer from different geographic locations and socioeconomic status may not possess same type of perception and knowledge about GM food or specific GM issue. As a result generalization of the findings and conclusion of the study in regards to consumers' willingness to buy (WTB) of GM foods may or may not hold good. Last but not the least the conceptual framework of the present study, more specifically the theoretical model used in assessing the consumers' willingness to buy (WTB) was based on the studies mostly conducted in Europe and America. Limited number of research about GM issue involving consumers in the Asian countries and no secondary data support regarding the consumers concern about GM food in Bangladesh constrained few specific area of research methodology of the current study. However limitations discussed above are very common in case of any field study particularly while research enters in a verging study area. Appropriate methodology, proper research design and sophisticated statistical tools and techniques used in the present study are expected to overcome these limitations.

1.7 Structure of the Report

This report is divided in to six chapters in accordance with the objectives of the present study. Chapter 1 deals with the brief introduction to the focus area of study, research problem along with two problem statements, significance of the study, scope and limitations of the study along with a brief background information relevant to the study. Chapter 2 discusses review of literatures. Chapter 3 discusses the methodology of the study, which includes brief descriptions of research design, variables, sampling and collection of data, processing of data and statistical tools used in the study. Chapter 4 presents the conceptual framework, theoretical framework, analysis of results, conclusion and implications of the study on experts. Chapter 5 presents theoretical framework, the empirical model, analysis of results, conclusion and implications of the study on consumers. Chapter 6 deals with the measuring of reliability and validity issue; summary and direction for the future research.

1.8 Background Information

This section serves the purpose of bridging the research problem with the core objectives of the study regarding the GM debate in the world. In order to comprehend the ongoing debate and controversy surrounding GM food and its association with various aspects of the national and global food system a thorough and clear understanding of the present and the past of GM food issues are required. Following section has provided a brief description of the development history of GM food and the technological aspects used in this process in simple text easily understandable for general people.

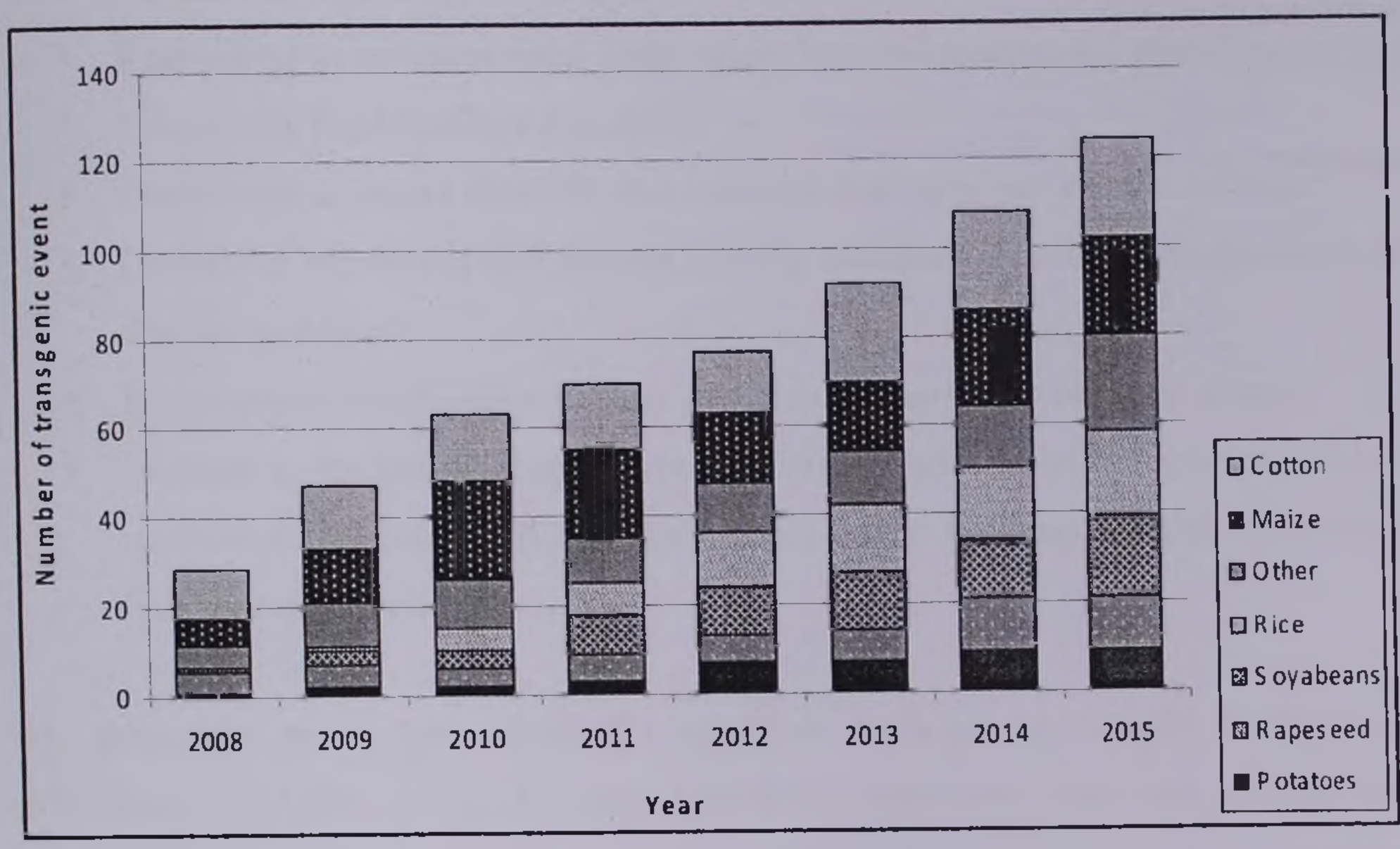
1.8.1 Development History of GM Foods (1993-2010)

Random genetic variation occurs naturally in all living things and it is the basis of evolution of new species through natural selection. Even before the scientific basis of genetic modification was understood, mankind took advantages of this natural variation by selectively breeding wild plants animals and even microorganisms such as yogurt cultures and yeasts to produce domesticated variants better suited to the needs of humans. Such selective breeding involves the transfer of unknown numbers and kinds of genes between individuals of the same species. Before the advent of GM technology so-called 'traditional' or 'conventional' breeding technology involved disruptive gene transfer far more than the foregoing. Over the past half-century it also includes techniques involving

polyploidisation and mutagenesis via x-rays which are far more disruptive of the original plant genes than any GM modification (Chopra, 2005). Genetic modification (GM) has come across a long way since it first came out with the genetically engineered human insulin in 1982 and more than a decade later the first GM tomato sometime during 1994 (Belinda, 2001).

However it is revealed from studies that a genetically modified tomato 'Flavr Savr' was the first commercially grown genetically engineered food to be granted a license for human consumption. It was produced by the Californian Company Calgene and submitted to the U.S. Food and Drug Administration (FDA) in 1992. On May 18, 1994 the FDA completed evaluation of the Flavr Savr tomato and approved for commercial release in the market (Belinda, 2001). A brief 'Time Line' has been presented (ANNEX-IV) in order to give an insight about the gradual development of this remarkable technology as well as its application in food and drug industry in last four decades. The time line includes only few significant events that have led to the current use of GM technology mostly in food and agriculture sectors. It also contains some predictions about future developments in the application of gene technology of food production. However, remarkable development has also been occurred in the clinical sector with the use of genetic modification technology and probably well ahead than what have achieved in the agriculture sector. The largest product area within biomedicine is therapeutics (recombinant medicine) with 49% of core biotech companies focused in this area (Australian Trade Commission, 2011). The use of recombinant gene technology in therapeutic medicine especially in the treatment of some types of cancer, renal disease, vaccination, diagnostic kits and treatment of HIV patients are milestones of this technology in medical science (Avise, 2004). Interestingly the use of genetic or recombinant technology in health care sector is not controversial at all as it does in food and agriculture sector. However, it has been documented that human organ creation in other animal by using almost same technology has already been achieved in the laboratory and on the way to be introduced commercially in transplant therapy in near future (Berg and Mertz, 2010 ; Science Clarified, 2011).

Figure -1.7: Current numbers and estimations of future numbers of transgenic events to produce GM crops worldwide.



Source: Alexander and Emilio, 2010

However, Alexander and Emilio (2010) predicted on the basis of their workshop and subsequent desk research that by 2015 there could be over 120 different transgenic events in commercialized GM crops worldwide compared with around 30 GM events in commercially cultivated GM crops in 2008.

1.8.2 Potential Benefits and Perceived Risk GM foods: A Scientific and Socioeconomic View

Biotechnology advocates emphasize the potential benefits of GM foods to society in terms of improved products that will deliver distinct benefits to mankind. On the other hand opponents often view biotechnology as an unnecessary interference with nature that has unknown and potentially disastrous consequences (Nelson, 2001). However, the following section is an attempt to bring into light the core benefit and major risk factors of GM foods for the purpose of providing a clear idea about GM debate in the later part of this discussion.

Benefits of GM Foods

Advocates of GM foods extracted following environmental and health benefits:

- Increasing yields per unit of land use.
- It is faster in process, lower in cost and improved varieties.

- Decreasing land and water resource usage.
- Decreasing use of fertilizer, chemicals and pesticides.
- Reductions in environmental degradation: less soil erosion and greenhouse effects.
- Decreasing food spoilage and waste.
- Foods with a greater shelf life like tomatoes that taste better and last longer.
- Increasing nutritional and disease fighting qualities of food like crops resistant to disease and insects.
- Less chemical application such as pesticide and herbicide resistant plants.
- Increase in the potential to insert non-allergenic and desired properties, food with medicinal (nutraceutical) benefits such as edible vaccines such as bananas with bacterial or rotavirus antigens.

GM advocates argue that genetically modified foods are potentially better for the environment (FSANZ, 2011). By using genetically engineered crops that are resistant to attack by pests or disease (insect resistant or IR), farmers and primary producers do not have to apply large amounts of pesticides and chemicals to the surrounding environment. Developing crops that are tolerant to particular herbicides (herbicide tolerant or HT) and pesticides may reduce the amount of pesticides used in food production and the residual pesticide levels in the environment.

Risks of GM Foods

Opponents of GM technology like environmentalist, economist, community groups and members of public have identified environmental, health and food security risks that they believe outweigh any potential benefits of GM foods. Perceived risks include:

- Environmental problems including imbalance of biodiversity, potential for cross-breeding between GM crops and surrounding vegetation including weeds. This could result in weeds that are resistant to herbicides and would thus require a greater use of herbicides which could lead to soil and water contamination.
- Health threats and unknown long term risk, new allergens could be inadvertently created and known allergens could be transferred from traditional foods into GM foods and potential for development of antibiotic resistance.
- Domination by a small number of multinational companies with key patents on production systems.

- Threat of losing local indigenous crop variety by continuous cross pollination with GM varieties over a period of times.
- Fear of proper testing and regulation of GM ingredients by the respective agencies.

The safety of GM foods is still being debated as it is impossible to predict all of the potential effects on human health and environment. However, some public health experts advocate a caution for the use of GM foods. They believe that GM foods are at the 'scientific starting line' and it is still undecided whether GM foods are safe or not.

However, a range of second generation GM products with specified benefit have already arrived in the market in mid twenties. Unlike the first generation of GM products which provide benefits mostly to farmers, the second generation GM products will offer tangible and observed benefits to the consumers (Gonzalez, Johnson, & Qaim, 2005). One such crop is Golden Rice has discussed in previous section. Other second-generation GM crops include those that have been modified to produce a whole range of pharmaceutical products, including vaccines and drugs of promised relevance to diseases such as HIV, rabies, diabetes and TB. The use of such crops has been termed 'pharming' (The Open University Learning Space, July 13, 2011). Some second generation crops are promised to be of special benefit to developing countries and the environment. According to International Food Information Council (IFIC, 2001) some examples of second generation GM products with benefits which could be in the market in near future include: i) peanuts with improved protein balance; ii) strawberries with improved freshness, flavor, and texture; iii) peas grown to remain sweeter; iv) higher-protein rice; v) soybean and canola oil to contain more stearate (good cholesterol) making margarine and shortenings more healthful; and vi) vegetables and fruits with higher levels of vitamins. It was anticipated that when the second generation GM products with enhanced attributes outweigh the potential risks, consumers would be more likely to adopt those products (Han and Harrison, 2006).

However a growing demand of 3rd generation GM crops has also been repoıted by many researchers at the beginning of 21st century. Growing pharmaceuticals and industrial products in plants through genetic engineering are the promises of third generation GM products, an area that opens new opportunities to grab the advantages of biotechnology (Niang, 2007). Such crops include plants engineered to produce biodegradable plastics,

fibrous proteins, adhesives and synthetic proteins. For example, tobacco and potato plants have been engineered to produce spider silks (Niang, 2007). The world population has already topped 7 billion people and is predicted to double in the next 50 years (WHO, 2009). Ensuring an adequate food supply for this booming population is going to be a major challenge in the years to come. Alternative farming system and advancement in agriculture system by utilizing modern scientific techniques probably the only way forward. According to Whitman (2000) how GM foods promise to meet this need in a number of ways is described in (ANNEX-V).

CHAPTER - 2

Literature Review

A great deal of literatures has been review for the purpose of this investigation. Unfortunately a comprehensive research gap has been observed in collecting relevant information about GM food controversy in the context of Bangladesh. Very few qualitative data especially newspaper articles only and no quantitative data are available that provides information pertinent to GM issue in Bangladesh. However, it has been revealed from many studies that arguments about genetic modification technique and the barriers against its commercialization are almost similar in nature all over the world. It differs only to the extent of severity and mind set of the institutional as well as in the public level (Hallman et al. 2003). Thus debate surrounding the GM foods is rather a global issue than a national concern. This section mostly discussed the research works conducted in Europe, United States, North American region, Australia, New Zeeland and some studies in Asia along with very limited local information available only as web documents. Considerable effort has been given to correlate global finding with the national scenario which reflects and uncover various domains of the controversy associated with adoption of GM food in Bangladesh. However, literatures only having direct correlation with the major objectives of the study have come in consideration in following discussion. Extensive review of literatures revealed the fact that till date no study has been conducted in Bangladesh that tries to uncover and understand the GM foods issue from consumers' perspective as well as experts' standpoint. Since the present study deals with two distinctive areas experts' opinions and consumers' perceptions about GM foods, the literatures discussed in following section is also presented with appropriate subhead lines.

2.1 Experts' Views about GM foods

While reviewing the literatures about the controversy with GM foods and the applications of biotechnology for altering the food attributes since 1980s one interesting finding is that there was a great deal of controversies existed among the expert groups in different part of the world. Scientist and experts from the same academic area exhibited completely conflicting perception and attitude towards GM food and biotechnology. However, in many cases agro biotechnologist advocate the use of this technology as a risk free

alternative to enhance the quality and quantity of certain food products in particular and for the betterment of agro economics at large. On the other hand few scientist and environmentalist view this application of gene technology in the food crops as a lethal interference between the realm of nature and human (Nelson, 2001). It is also observed that while consumers' debate is concentrated about the risk and benefit of GM foods along with other associated factors like price, product features, tangibility of the benefits etc. the expert's differences of opinions is concentrated mostly in three major areas i) safety issues for both human and environment ii) regulatory issues of GMOs and GM foods and iii) allied economic constrains of commercialization of GMOs (Paarlberg, 2002).

First such incidence of concern over the harmful effect of GM foods revealed from the scientific research has been reported on 17th February in 1999 by World Socialist Web Site captioned "*International scientists raise concerns over genetically modified food : British Labour government rushes to defend biotech industry*". Lee and Tyler (1999) reported that a research by Dr. Pusztai one of the world's leading experts in GM food safety assessments at the Rowett Institute of Scotland involved feeding GM potatoes to rats in an attempt for observing changes in their physiology particularly the gut, metabolic process and immune systems. Dr. Pusztai found that the size of several organs in rats decreased including the brain and their immune system was weakened after the feeding trials. Pusztai appeared on Granada TV's '*World in Action*' program, with the consent of the Rowlett Institute. In the course of the documentary he remarked that he would not eat GM food and that he found it very unfair to use our fellow citizens as guinea pigs (Pusztai, 2000).

Since the early 1990s, Rhetoric from the United States government proclaims that genetically modified (GM) foods are not different from their natural counterparts that have existed for centuries. But this is a political not a scientific assertion (Smith, 2007). However, numerous scientists at the FDA consistently described these newly introduced gene-spliced foods as cause for concern. The very first crop submitted to the FDA's voluntary consultation process the "FlavrSavr" tomato showed evidence of toxins. Out of 20 female rats fed the GM tomato 7 developed stomach lesions (Carl, 1993). As of 2000, 53% of the US soybean crop, 65% of the corn crop and 80% of rennet cheese in United States was genetically modified and the scientist reported that they are not aware of any

confirmed illnesses or other harmful effects resulting from genetically modified foods (Genetic Society of America, 2001).

In July 2003, a report has been documented by GM Science Review Panel of United Kingdom. This independent review requested by British Agriculture Secretary Margaret Beckett found that there is no scientific evidence for ruling out all biotech crops and their products. Additionally, the review found that worldwide there have been no verifiable ill effects reported from the extensive consumption of products improved through biotechnology by humans and livestock.

A group of scientist in Africa has reported that with all the methodologies and scientific tools available to them today, the safety of the products of biotechnology is equal or safer than conventional food products. Decisions made in the advancement of biotechnology events are science based rather than based on emotional decisions (Africa Bio, 2002).

A declaration has been signed by over 3,200 scientists who support the use of biotechnology to improve agriculture in the developing world. In the declaration scientist quoted that "*We, the undersigned members of the scientific community, believe that recombinant DNA techniques used in creating GM foods constitute powerful and safe means for the modification of organisms and can contribute substantially in enhancing quality of life by improving agriculture, health care and the environment*" (Pusztai, 2001).

Comparison between experts' and public perceptions about GM foods has also been analyzed by many researchers. However it is evident that expert perceives risks in a different way than consumers. Hansen, Holm, Frewer, Robinson and Sandoe (2003) attempted to summarize results of two surveys carried on between 2003 and 2005 in Hungary involving both the experts and consumers. The researchers reported that the opinion of consumers and professionals about gene technology is mostly negative as far as 35% of the consumers can recall more negative than positive information about GM foodstuffs and 13% can recall only negative ones. On the other hand risk perceptions among the professionals are stronger than the consumers. Interestingly the dimension of the risk is also different in these two categories. The authors reported that even if Hungarian consumers predominantly refuse GM products this proportion is approximately the same as in Western-Europe. According to 73% of the respondents it is

essential to indicate the GM content on the packaging. Consumers are not sufficiently aware of the concept of biotechnology and often misunderstand it. The results reflect the insufficient information level of the Hungarian consumer and the misunderstanding of biotechnology concept.

Savadori, Savio, Nicotra, Rumiati, Finucane, & Slovic (2004) conducted an interesting and significant survey involving lay persons and experts to examine their attitude and perception towards the use of biotechnology in both food and medical applications. Risk perceptions of a series of biotechnology applications were examined and compared in a public (non-expert) sample and an expert sample. Savadori et al., reported that compared with the experts, the public perceived all biotechnology applications as more risky. In their findings researchers reported that both groups perceived food-related applications to be riskier than medical applications. Compared with the public, experts perceived both food and medical applications as less harmful and more useful. Experts also judged the risks posed from medical biotechnology applications as more familiar and acknowledged by people and science. The concluding remark of the study was that the lay person's estimates of the risk in food applications can be predicted by potential harm, potential benefit, science knowledge and familiarity where as experts' estimates can be predicted only by harm and benefits.

Krystallis (2007) suggested three main changes to current risk analysis processes of Europe about GM foods to improve their transparency, openness, and accountability. The most important is the addition of a formal framing stage would allow interested parties, experts, public and officials to work together as needed to gain an initial shared understanding of the issue, the objectives of regulatory action, and alternative risk management measures. Another is the scope of the risk assessment is expanded to include the assessment of health and environmental benefits as well as risks and the explicit consideration of economic and social impacts of risk management action and their distribution.

Sjoberg (2008) performed a comparative analysis between 469 public and 49 experts to explore the position and impression of GM technology. According to the study result public rated GM technology as the worst of 18 technologies and the respondents also

think that this technology is replaceable. However, experts had a very different view but also saw GM foods as replaceable. Experts were throughout much more positive to GM foods than were members of the public. Sjoberg concluded that the differences between experts and the public are well explained in terms of the models he tested. The attitudes and risk perceptions of experts showed dynamic properties similar to those found in the data from the public.

With all of the controversy around genetically modified (GM) foods people wonder just what doctors think about the technology. For a lot of people in the world especially in Bangladesh doctors have been placed with a great deal of faith and people are keen to understand their assessment of GM foods whether or not these foods truly are safe or if they pose any harm to our health (Smith, 2007). Unfortunately, the controversy extended in the medical field as much as it does to other professional areas. Some doctors believe that there is no risk to consume these foods where as others disagrees and showed concerns about health risks from these products. The British Medical Association (BMA) supports GM foods from the point of view that there is not yet any compelling evidence to prove that they pose a threat to health. Despite the statement of the BMA which does seemingly represent all of the doctors in the UK there are still physicians and medical experts who do not believe that GM foods are safe (Murnaghan, 2010)

However, the second and the most important concern of experts about GM foods are the regulatory issues associated with GMOs. Research revealed the fact the there are large differences in import approval and marketing policies for GM food worldwide. At a macro level, countries can be divided into three groups according to the status or type of the regulations: first countries with a comprehensive and stringent regulatory framework for GM food including mandatory safety approval and mandatory labeling policy; second, countries that have adopted a more pragmatic regulatory approach based on the notion of substantial equivalence with voluntary labeling instead of mandatory labeling and third a large number of developing countries that either do not have any approval or marketing regulations for GM food, are in the process of adopting some or have declared themselves to be GM free (Hoque, 2006). According to this classification of regulatory policy of GMOs Bangladesh has not been fallen in any of these three categories. Although in July 19, 2006 Department of Environment, Ministry of Environment and Forest has declared as by Gadget-Reg. no: D.A.1 "National Biosafety Framework" a complete guideline for

regulating GMOs in Bangladesh (The Daily Star 20 July, 2006:p10). The following discussion has been focused to explore different domains of regulatory issues of GMOs in Bangladesh and around the world.

Anuradha (2007) reported that the principal concerns against use of GM technology in agriculture sector is the controlled use and regulation of potentially hazardous GMOs and the principal players in this debate are the experts of the government, public and private sector organizations engaged in GM research, NGOs and farmers' organizations. However, she brought out lists of some of the most prominent issues at the national and international level regarding the control mechanism of GMOs in her research.

Huppatz and Fitzgerald (2000) reported that transgenic foods cannot be assumed to be safe to humans or the environment. Consumer education is not a major factor in achieving their acceptance. What is needed is independent proof of their safety. This proof should have been obtained long before their commercial release. The researchers pointed out the fact that experts in this special area have the potential to play a vital role to establish the safety aspects GM foods.

Anon (2000) stated that in 2000 American Council on Science and Health expressed that the current regulatory scrutiny along with the excellent track record of GM food safety gives them confidence that GM foods are rigorously scrutinized and that the technology is safe. Consumers and farmers can expect a wide variety of beneficial new products in the not-too-distant future to augment those currently on the market

While American scientist and government have a mixed attitude towards the regulation of GMOs and its derivative products in the market, European countries adopted a very strict regulatory policy for the use of GM ingredients in the EU food market (Gaskell et al. 1999). It is also evident from many studies that the regulatory regime in European Union is the most toughest to control the use of GMOs in the food products than any other nation in the world.

Mora et al., (2000) studied the attitude of Italian consumers towards GM foods. The researchers reported that a fundamental step for European regulation was to introduce

compulsory labeling and traceability for GM food and feed. They described that this was the first move towards citizens' right to be informed, underlying the right to choose what type of food to put on the table.

2.2 Health and Environmental Risk & Benefit Associated with GM foods

A rich body of literature regarding consumer perceptions of biotechnology has emerged in recent years. Consumers' risk and benefit perceptions of biotechnology have been investigated in fifteen developed countries including the United States and France. The number of studies addressing the similar issues about GM foods in the developing countries especially focusing the Asian nations is also very significant.

Hoban and Kendal (1997) examined perceptions regarding the safety of GM foods among U.S. consumers in 1995 and 1997. Their results showed an increasing number of consumers were willing to purchase GM foods. They also found that U.S. consumers expressed the most concern about microbial contamination and pesticides and little concern over the food safety risks of biotechnology. On the other hand, some studies indicate that U.S. consumers are concerned about the safety and environmental risks of GM foods.

Using nationwide consumer survey data Grobe, Douthitt, and Zepeda (1996) studied consumer risk perception associated with the GM product. Recombinant bovine growth hormone (rbGH) which is a food related biotechnology used in milk production to enhance the milk out of cattle. A mixed type of reaction about the risk perception regarding the use of (rbGH) has been identified in their study.

Nelson (2001) aimed at explaining the differences between the United States and Europe in terms of attitudes towards GM foods and concluded that European consumers generally focused on the unknown risks associated with genetically modified products, not the benefits, whereas US consumers generally evaluated neither the risks nor the benefits. A diversified risk perception about GM technology has been shown by consumers with similar information.

Some studies examined consumers' risk preferences toward acceptance of GM food. A study by Lusk and Coble (2005) emphasized the need to elicit both risk perceptions and risk preferences to determine preferences for GM foods. Lusk and Coble showed that risk preferences and risk perceptions are significant predictors of acceptance of GM food, and found that risk perception has a relatively larger influence.

Baker and Burnham (2001) demonstrated that consumers' risk preferences have a great impact on the acceptance of GM product. The study indicated that consumers with higher levels of risk aversion were less likely to be accepting of GM foods.

Teisl, Garner and Vayda (2003) surveyed consumers' attitude towards genetically modified foods in the year 2002 in United States. For instance, this survey indicated that unknown long-term health and environmental effects of GM foods were among the top five concerns by U.S. consumers. Thus, health and environmental concerns as well as moral objections are sources of consumer` concern about food containing GM ingredients. The same phenomenon is also address by Hallman et al., (2003).

A study by Moon and Balasubramanian (2004) investigated the public's attitude toward biotechnology. The study demonstrated that consumer acceptance of biotechnology depends on their cognitive assessment of its risky and beneficial attributes. The study indicated that the adverse effect of negative attributes on overall attitudes outweigh the favorable effects of positive attributes suggesting that consumer sentiment about risk perceptions of biotechnology predominate over benefit perceptions.

In Europe public opinion is generically skeptical towards GM crops, especially for human consumption. According to the Eurobarometer report Gaskell et al., (2006) found that GM food is predominantly perceived negatively. In the study the researchers found that the memory of the "mad cow" disease crisis persisted and the consumers no longer appear to trust anyone. The consumers require increasingly strict controls and accurate analyses of the safety aspects of these foods are also reported by Mora et al., (2000).

Hallman et al. (2002) conducted a comprehensive survey on 1,200 Americans to identify the perceptions about biotechnology and its use in food production. He found that most Americans had very little knowledge about biotechnology and genetic modification

technology in transgenic crop development. Only 41% of Americans were aware that GM foods were available in the local supermarket. They have reported that Americans in general had no clear first image of biotechnology. They also pointed out that biotechnology was supported to a much greater extent for use in crops rather than animals.

In addition, Hallman et al. (2004) found that more than half of the respondents provided incorrect answers in more than half of the questions in their study about GM food. Thus, one of the main reasons that some consumers may have an unfavorable attitude toward genetic modification is they lack information and knowledge about GM foods.

A study by Cummings and Taylor (1999) address the environmental threats allied with GM foods. This study points out number of environmental risk factors affecting consumer purchase decisions of GM foods in the market. Using CVM techniques Cummings and Taylor showed that some environmental factors play vital role in shaping consumers' negative intention to buy GM foods.

A research carried out by Harrison, Boccaletti & House (2004) show that Italian consumers are sensitive to the potential risks that GM food may pose to human health and the environment. In the particular study the researchers emphasized more on the environmental risk than health risk.

Verdurme, Gellynch, and Viaene (2002) attempted to investigate whether or not organic food consumers automatically oppose GM foods. They concluded that this is not the case. Pesticide residues in food, hormones, scandals such as the cases of BSE and dioxin have undermined consumers' confidence in contemporary agricultural practice. Verdurme et al., reported that consumers have become increasingly concerned about health and its link with food in last two decades. Moreover, environmental awareness is growing rapidly and as a consequence some consumers restore to organic agriculture which is perceived as cleaner and delivering healthier food.

2.3 Socioeconomic Risk and Benefits of GM foods

Caswell, Fuglie and Klotz (1994) studied the development of agricultural biotechnology from an economic perspective. They argued that the success of biotech products depends

upon several factors such as public policies, producer expectations, and consumer demand for biotech products. Their study suggested that if profitability of using biotechnology is expected to be high then the demand for the use of this technology by farmers and food processors would be increased too. The study indicated that consumer demand for biotech products would eventually determine the demand for biotechnology in the farm sector.

In a study of global market effects of adopting transgenic rice and cotton, strong assumption has been made by (Neilsen and Anderson, 2000) that the consumers were indifferent between GM and non crops. However, this assumption excluded EU and Japan from their model because of restriction on GM crops in these two countries. The investigator used an empirical model of the global economy to quantify the effects on production, prices, trade patterns and national economic welfare of specific policy as well as consumer responses to GMOs in Western Europe. In addition the researchers discussed the ways in which the emergence of GMOs could lead to trade disputes between Western Europe and the United States.

Ahmed (2004) reported that on May 13, 2003 the US government filed a complaint in the World Trade Organization (WTO) against the European Union's de facto moratorium on genetically modified organisms (GMOs). President Bush went to the extent of accusing Europe for last year's famine in Africa following some of African nations' refusal to take food aid from US on the fear that entry of GM food would hamper their future export to Europe.

However, like some other jurisdictions the European Union also operates a 'zero-tolerance' policy to even the smallest traces of nationally unapproved GM crops (so-called low-level presence). The resultant rejection of agricultural imports has already caused high economic losses and threatens to disrupt global agro-food supply chains. (Alexander & Emilio, 2010)

A study by Neilsen and Anderson (2000) indicated that if insect resistant first generation GM rice varieties were to be introduced internationally, then India would stand to benefit to the tune of $1178 million and benefit to the world economy would be of $6.2 billion in 1995 dollars.

While food technologists have worked on the GM technology per se, economists have also contributed to the related supply-side issues. For example, in the Indian context pros and cons of GM technology and the violations of patent rights by the grower have been studied by Gupta and Chandak (2005). They deal with the case of Bt. cotton in Gujarat in India, as an illustration of how public policy chickens out when large-scale violation of ethical and scientific norms takes place with positive business outcomes. In the study the researchers pointed out several factors that may affect the Indian agronomic situation by the Intellectual Property Rights related to the development of GM crops. Deohar et al., (2007) reported that the studies and researches mentioned above have focused on the positive and negative aspects of GM technology and supply side issues related to GM crops. The demand side of the Indian market has been ignored altogether.

Addressing the economical threats of adopting GM foods in Bangladesh, Mazhar and Akhter (2005) stated that they know through various international and regional networks such as Institute of Science in Society (ISIS), Grain, Third World Network, SANFEC etc. that rice has become a very attractive business interest for the multinational corporations. According to ISIS several major transnational seed corporations such as Aventis, DuPont, Monsanto and Syngenta now have rice program and this programs are mostly focused on genetic modification of rice.

Since rice is self-pollinated and producing hybrid rice seed is costly and very difficult, information reveals that nearly all rice in Asia are still grown with farmer-saved seed. The seed industry believes that the combination of genetic engineering and patents can overcome this hurdle. Thus selling GM rice seed in the Asian block has been increasingly a prime interest of few transnational agro companies (Mazhar and Akhter, 2005). The same author reported that *"Through patents and contractual agreements, seed companies will seek to prohibit farmers from sharing or saving seed, control what pesticides are used and even assert ownership rights over the harvest".*

2.4 Ethical and Moral Concerns Associated with GM foods

Ellahi (1994) studied about religious taboos and other reservations linked with GM food. He reported that there is a gap between the public perception of science and the evidence presented by the biotechnology researchers. However his investigation also focused the

issue of animal welfare, fairness and patenting of GM foods. He concluded that the whole issue of genetic modification program and their use for food is a sensitive area and one that should be handled carefully with as much public debate and discussion as possible.

Rosati and Saba (2000) aimed to quantify some influential factors regarding the acceptance of food biotechnology. The authors conducted a mail survey and obtained 434 complete questionnaires from the respondents of Italy. Many respondents indicated an unfavorable attitude towards the use of genetic engineering in food production. The researchers found that ethical and moral concerns were an important issue regarding the acceptance of food biotechnology. Perceptions of risk and benefit were the major drivers of acceptance too. Uncertainty about possible consequences of genetically modified food and trust in various sources of information were also considered in their report. They concluded that public acceptance of new biotechnology will be the major determinant of its future role in society.

In another study Moon and Balasubramanian (2001) reported that consumer acceptance of biotechnology was significantly related not only to their perceptions of risks and benefits associated with GM products but also to their moral and ethical views. In addition, public views about multinational corporations, knowledge of science and technology, and trust in government were found to have significant influence on consumer acceptance of biotechnology.

2.5 Labeling of GM foods and Regulatory Issues

Economist predicts that markets overestimate or underestimate the value of products with or without labeling. If products are not labeled consumers would not be fully aware of the characteristics and value of the products. Thus, it is believed that labeling plays a significant role as a source of direct consumer information when consumers are concerned about health nutrition, food safety, potential product risks and so on (Lusk and Fox, 2002). Labeling effectively influences consumer demand patterns contributes to their ability to judge product attributes and fundamentally alters the information environment in the market for quality attributes (Harrison and Han, 2005).

A national survey of Australian consumers Kelley (1995) found that 89% of respondents believed genetically engineered tomatoes should be labeled. Only 4% percent of the respondents were against labeling. About 35% percent said labeling GM tomatoes would be a good idea while 65% percent said unlabeled GM tomatoes would be a bad idea

Caswell (1999) stated that the initial direction and speed of market development for foods produced using genetically modified organisms (GMOs) is significantly influenced by the choice of labeling policy. However, Caswell argued that there are good economic reasons for not requiring all information to be disclosed on food labels. For example, those include substantial difficulty in separating biotech ingredients from non-biotech ingredients, increased marketing cost due to segregation of biotech products from non-biotech products, and limits to the amount that can be displayed on a label. The researcher also mentioned that labeling does not significantly affect purchasing behavior of illiterate consumers.

Mora et al., (2000) studied the attitude of Italian consumers towards genetically modified foods. She reported that when asked how respondents can identify a GM food product, almost 60% of them indicated the product label as the best way to get this information. However according to the findings of the survey one fourth of the respondents answered they *"don't know"* and nearly 12% stated they couldn't distinguish these products since *"they are identical"*.

A study by Douthitt (1990) also found that most Americans believed genetically modified foods should be labeled. Surveys in other developed countries report similar results. It is also reported in the study that European consumers are relatively more label concerned. There has been much public debate about consumer acceptability of GM products, if mandatory labeling of GM products were required.

Hine and Loureiro (2002) investigated consumers' knowledge of genetically modified (GM) foods to preferences for mandatory labeling. Various socio-demographic characteristics were also hypothesized to affect consumer preferences for mandatory labeling. Their results indicated that consumers who considered themselves well informed about biotechnology did not appear to be as concerned about mandatory labeling of GM foods as those who were less informed.

Lusk and Fox (2002) studied consumer's willingness to pay for a mandatory labeling by using contingent valuation method (CVM). The result showed that striking 85% respondents preferred a mandatory labeling of beef administered with growth hormones where as 64% respondents favored mandatory labeling of beef from cattle fed GM.

It has been observed that "*Most national labeling systems are still under development and different countries have taken different approaches. The EU has imposed mandatory labeling systems*" (Wen and Kyrre, 2002). According to Hallman and Metcalfe (2002) the respondents supported special labels on biotech products was 84% in their study. Around 60% percent of participants prefer purchasing of GM vegetables with biotech label and 58% said that they would spend time looking at biotech labels while shopping. They have also demonstrated that 42% of respondents reported that they usually search for "not genetically engineered" label. Respondents of the study also stated that if label conveys the information of biotech produce, then they would buy such produce.

According to Harrison and Han (2005) as beliefs regarding potential adverse effects of GM crops on wildlife and the environment increases, consumers are less likely to support the FDA's current labeling policy. The study suggests that consumer beliefs are significant determinants of consumer attitudes toward the current FDA labeling policy.

Food and Drug Administration (FDA) has examined consumers' reaction to various labeling options for biotech foods in four cities in USA. Most of the participants said that all foods should be labeled to tell whether a food is produced using biotechnology (Han & Harrison, 2006). In terms of labeling approach, nearly all participants recognized value in having "more disclosure" labeling. In regard to the practicability of labeling most participants expressed that labeling should be simple and effective which suggests that too wordy and complicated labeling burdens the consumers.

The International Food Information Council (IFIC) has sponsored annual consumer surveys on the topic of biotechnology since the mid 1990s. Approximately 1000 separate telephone interviews of U.S. consumers were conducted between 1997 and 2001(IFIC). These surveys reported that 78% of Americans supported the current FDA voluntary labeling policy in 1997. However, support for the FDA policy had eroded to only about 37% by the 2001 survey.

Some studies investigated the value of practicing a mandatory GM labeling policy. Using laboratory auction experiments Rousu, Huffman, Shogren, & Tegene, (2003) estimated the potential welfare effects of mandatory labeling policy for GM foods in the American market. The researchers showed that average consumers are less likely to pay for the labeled GM foods. The study revealed that mandatory labeling policy brought about welfare losses relative to voluntary labeling policy. Their study suggested that since voluntary labeling policy is inexpensive and consumers are able to correctly decipher signals in non-GM and GM markets, voluntary labeling policy is more efficient in the U.S. market as compared to a mandatory labeling policy.

Deodhar et al., (2007) studied consumers' willingness to pay a premium for GM labeling in Ahmadabad city in India. Their finding showed that more than 85% of respondents from city survey and more than 77% of respondents from internet survey opinioned that labeling is extremely important. Importantly, more than 93% of respondents in both surveys prefer mandatory labeling over voluntary labeling. However, when it comes to paying extra amount for labeling, about 28% of respondents from city survey are against paying any extra money. More than 35 percent of the consumer support labeling if the prices are raised by not more than by 5 percent. In the internet survey only about 5% of respondents are not willing to pay anything extra as labeling cost. In fact about 34% are ready to pay more than 15% of price as labeling cost.

A good number of researches have been conducted in Europe, USA, North American countries and South Africa to address the issue of control mechanism and overall regulation of GM foods.

Moon and Balasubramanian (2004) reported that trust in government regulations, a sense of outrage toward the new technology and selected socio-demographic variables play a significant role in shaping consumer attitudes toward GM crops. In their study the researchers argued that trust in government regulatory agencies is one of the important variables which consists significant correlation with willingness to pay a premium for GM foods.

Huang, Hu, Meijl & Tongeren (2004) analyzed the effects of GM cotton and GM rice introduction in China, based on regional farm-level survey data, adding labeling costs,

loss of demand in export markets and dynamic adoption, but without adoption of these crops in other countries. Their results show that China can continue to benefit from an extended adoption of Bt. cotton but that it would benefit even more from the introduction of GM rice whose formal approval decision has been postponed by regulatory authorities in the last few years.

Meyer (2004) focused on biotech policy of Bangladesh and South East Asian countries. According to him if we turn our eyes to neighbor countries some GM crops including Bt.Cotton have been approved by Genetic Engineering Approval Committee (GEAC) of India in 2005. Pakistan has also constituted a National Bio-safety Expert Committee (NBEC) comprising experts from all relevant institutions for updating the relevant laws. Bangladesh is lagging behind in harnessing of crop biotech at a time when the country has just been included in the consortium of four south and southeastern countries for a 15-million dollar initiative 'Program for Bio-safety Systems' (PBS) and 'Agricultural Biotechnology Support Project-II' (ABSP-II) both funded by USAID. In this consortium of four countries comprising Bangladesh, India, Indonesia and the Philippines - all but Bangladesh had their bio-safety regulatory bodies to set-up (Meyer, 2004). However, Bangladesh has declared the National Biotech Policy lately in the middle of 2006 (The Daily Star 20 July, 2006:p10).

2.6 Consumers' Perception of GM food and their Willingness to Buy (WTB)

Consumers' perceptions of biotechnology have been investigated in fifteen developed countries including the U.S. and France (Han & Harrison, 2006). One of the most convenient statistical ways to explore the consumers' perception towards GM foods is to investigate their willingness to buy (WTB) or willingness to accept (WTA) for a particular object in a hypothetical market situation (Deodhar et al., 2007; Mora et al., 2000).

Contingent Valuation Method (CVM) is often used for valuation of environmental goods in much empirical estimation of welfare measures. CVM is a survey method that depends directly on individual responses in such hypothetical market situation. In CVM studies, WTP and WTA measures are taken as the measure of value. WTP corresponds to maximum amount that individual would be willing to pay to obtain some goods and WTA is the minimum amount that individual would be willing to accept for compensation to

give up the goods. In general, non-market methods can be categorized as attitudinal and behavioral approaches to evaluation. The CVM is an attitudinal approach to non-market valuation.

Weir and Andersen (2003) assessed the attitudes, values, and behavior of organic food users and non-users in Denmark by utilizing the tool Willingness to Buy. Organic buyers were found to be mainly concerned about health. The absence of chemical residues was the most preferred product attribute of organic food. However, in general participants did not see GM food to be as healthy as its traditional counterpart nor did they feel very strongly about the health attributes associated with GM food.

Wachenheim and Lesch (2004) expanded on the work by Hallman et al., (2003). They studied North Dakota shoppers' perceptions of GM foods. Their findings were similar to those of Hallman et al., (2001; 2003) results although the population surveyed by Wachenheim and Lesch was considerably more rural. Wachenheim and Lesch found that awareness and general knowledge about GM food products to be very low even in the largely agrarian state.

Moon and Balasubramanian (2004) also investigated the public's attitude toward biotechnology by measuring their willingness to accept GM food. The findings demonstrated that consumer acceptance of biotechnology depends on their cognitive assessment of its risky and beneficial attributes. The study indicated that the adverse effect of negative attributes on overall attitudes outweigh the favorable effects of positive attributes suggesting that consumer sentiment about risk perceptions of biotechnology predominate over benefit perceptions.

Dhar and Foltz (2005) investigated consumer benefits from the introduction of rBST- free and organic milk. The study found that consumers not only pay significantly more for rBST- free and organic milk but also gain substantial benefits by keeping them both in the market.

Neilson and Anderson (2000) also investigated the effect of adopting transgenic crops in the global market. The study made a strong assumption that the consumers were

indifferent between GM and non-GM crops. The results of the study also indicated that consumers' preference for transgenic rice in not significantly related to their positive belief about this type of foods. However, they excluded EU and Japan from their test model because of restrictions on GM crops in those countries.

The preference of consuming GM or non-GM foods has also been studied in India. One such study has examined the consumers' willingness to pay (WTP) for GM and Non-GM food and feed in a hypothetical market in the city of Ahmadabad, India. One of the notable conclusions of the researchers is that ceteris paribus as the price difference between non-GM and GM food rose, people were more likely to consume GM foods (Deodhar et al., 2007).

2.7 Consumers' Acceptance of GM food and their Willingness to Pay (WTP)

A good number of studies have estimated consumers' willingness to pay for different food products produced with or without biotechnology. Fox, Hayes, Kliebenstein, & Shogren (1994) is one of the pioneers with his initial effort to evaluate willingness to pay (WTP) for a product without biotechnology or any GM ingredients. Employing auction market data consumers' WTP to exchange bST milk (recombinant hormone induced milk) for normal milk was estimated in the study. The researchers showed that more than 50% of consumers would not require any price discount to purchase bST milk. Once consumers who had strong negative bias against bST prior to the experiment received balanced scientific explanation of the product, about 70% of them expressed willingness to buy the product at no or a small discount. In addition, Fox et al., found that if bST milk were available at the same price or at a little lower price than normal milk, then more than 60% would buy the product.

In another study, an experimental auction has been used by Huffman et al., (2002) in order to investigate whether or not consumers were willing to pay more for non-GM foods. The effects of mandatory and voluntary labeling regimes on consumers' willingness to pay for non-GM products were also examined by the investigator in the study.

A year later Huffman et al., (2003) examined how the presence of different labels affects consumer behavior by eliciting consumers' WTP for both GM- labeled and standard-labeled foods. Their results indicated that consumers' WTP for the plain- labeled foods is significantly higher than their willingness to pay for the GM-labeled counterpart.

Loureiro and Bugbee (2005) studied consumers' willingness to pay for GM products with enhanced features. They demonstrated that consumers willing to pay the highest level of premiums for genetic modification of foods which alter the flavor or enhance nutritional value. The study pointed out that attitudinal variables (such as feeling about GM modification) play a statistically significant role in explaining consumer acceptance and WTP for different modifications.

One study investigated the relationship between risk and benefit perceptions about biotechnology and willingness to pay a premium for non-GM foods. Using survey data in the United States (US) and United Kingdom (UK), Moon and Balasubramanian (2001) hypothesized that the decision whether or not to pay a premium for non-GM foods is closely related to risk and benefit perceptions regarding biotechnology. In other words Moon and Balasubramanian assumed that consumers' willingness to pay a premium for non-GM foods can be investigated by examining subjective risk and perceptions about biotechnology. Their study revealed that strong health risk perceptions for both US and UK consumers increases the possibility to pay a premium for non- GM foods, while they are less likely to pay a premium for non-GM foods as they are aware of benefits about biotechnology. In addition, their results indicated that as consumers in both countries are in favor of mandatory labeling policy they are willing to pay more premiums for non-GM foods.

Deodhar, Ganesh and Chern (2007) studied consumers' awareness, acceptance and willingness to pay for GM food in the Indian market. Using a questionnaire developed by Contingent Valuation Method (CVM) they examined the willingness to pay (WTP) for GM foods in the city of Ahmadabad. According to their findings more than 90% of the respondents did not know about GM foods. However, after informing the respondents about pros and cons of GM foods more than 70% were willing to consume even if GM and non-GM foods were available for the same price. According to the findings consumers' willingness to pay premiums were 19.5% and 16.12% for Golden rice and

GM edible oil, respectively. They concluded that GM foods may be acceptable in Indian market. However, consumer education, societies, government ministries and biotech food crop companies may have to create awareness about the GM foods among Indian consumers.

Studies have also been conducted in many countries including Argentina, Australia, China and Italy that try to understand consumers' awareness, acceptance, and willingness to pay for GM foods (Kaneko and Chern, 2005; Zhong, Marchant, Ding & Lu, 2002).

However, while there is an increasing body of literature on acceptance and willingness to pay for food products with particular attributes, it is still relatively limited and is often too general to be of much practical use or is proprietary. More publicly available research is needed on consumer perceptions and behavior about GM and organic foods in order to measure their willingness to buy those foods (Anderson, 2005).

2.8 Demographic Influences on Consumers' Acceptance of GM foods

Consumers' attitude toward GM food and its connection with socioeconomic and demographic influences has also been studied in many different countries since the inception of this food in market (Kaneko and Charn, 2005). These socio-demographic factors range from age, sex, marital status, household patterns, social class, geographic region, education to religion and belongingness to specific race. Among several such factors consumers' age and level of education are the two most considerable variables with specific statistical significance that caught researcher's interest in many studies since mid ninety. However, there is still little information available particularly about the willingness of consumers to purchase GM food products and the influence of socio-demographic factors (Lusk, Danield, Mark & Lusk, 2001).

Hoban (1999) demonstrated that consumers from different areas of the world have quite diverse perceptions about biotechnology. The study found that consumer perceptions about biotech products are very different depending on the type of information provided, government credibility and cultural preferences. For example, the Americans showed strong public support for biotechnology applications in comparison to other European countries.

Burton, Rigby, Young and James (2001) in a study of consumer attitudes toward genetically modified foods in the United Kingdom concluded that male shoppers were willing to pay an extra 26% to avoid animal and plant GM technology whereas female shoppers were willing to pay an extra 49.3% for the same.

Harrison et al., (2004) found a negative relation between Italian consumer's age and willingness to purchase GM foods. He concluded that the greater the age the less likely the Italian consumers will buy GM foods.

Huffman et al., (2004) showed that an individual's personal capitals such as schooling, age, religion as well as social capital significantly affect the preference for GM information sources. Their study reported that educated young consumers have a greater interest to know and understand the risk attributes of GM crops.

Not only demographic factors like regional influence but also choice of product type for genetic modification may affect the acceptance of GM foods in different parts of the world. Hallman et al., (2004) found that consumers in the U.S. are less approving of genetic modification techniques that involve animals and many respondents do not have strong opinions or are unsure of their opinion about GM foods.

Socio-demographic factors can affect the likelihood of GM good consumption in many ways as it is found that the likelihood of GM food consumption seemed to increase as one moved away from the very poor income bracket to middle income brackets as found in Ahmadabad, India. However, moving to the high income bracket does not seem to increase this likelihood. On the other hand a female or a joint family member increased the likelihood of choosing non-GM rice and edible oil (Deodhar et al., 2007).

Demographic influences over the acceptance of GM foods may differ from country to country or within different locations of the same country. Harrison and Han (2005) reported that interestingly the consumers living in the Northwest region of US are less likely to buy GM meats compared to consumers residing in the Southwest. He reasoned that the residence of these two regions have different lifestyle and information source. This finding is also consistent with the study of Lin (1995) which showed that individuals residing in the Northwest have more concerns about food safety. In the similar study

Harrison and Han also tried to correlate the racial distinction of respondents and their preference to GM foods. According to them male white consumers are more likely to buy GM meat than male non-white consumers.

As applications of genetic modification get complicated and sophisticated, asymmetric information about GM ingredients seems to be increasing. Some studies found that in general U.S. consumers are not informed about GM foods and most consumers are unaware of the prevalence of GM ingredients in food products (Hallman et al., 2003; 2004).

Mora et al., (2000) investigated the links between Italia consumers' access to information about GM foods and their willingness to accept GM foods. They found that in general the rejection of GM food is strong and holds for the majority even at lower prices than conventional food and considering the high degree of uncertainty. Thy also reported that in the near future in Italy a growing demand for GM food should not be expected as long as the uncertainty and the lack of information prevails. However, according to their analysis the quota of consumer "opened" to GM food is increasing since 1999. This trend is also confirmed by the Eurobarometer report (Gaskell et al., 2006).

Wier and Andersen (2003) reported that previous purchase decisions and demographics also influenced perceptions of GM foods. Women consumers over 64 years of age and consumers with low levels of education, those who view healthfulness as their primary food value and previous purchase of organic food apparently are less likely to approve the use of GM.

Using conjoint analysis Gath and Alvensleben (1998) showed that the strength of brand does not affect acceptance of GM food and women are less acceptable of GM food than men. Overall, participants' acceptance of GM foods was low and there was no significant change in attitudes toward GM food even if information about biotechnology is offered. Their results suggested that to increase acceptance of GM food, either the prices of GM foods should be lower or there should be tangible consumer benefits from biotechnology.

Stefano and Daniele (2000) assumed that GM foods may provide benefits for consumers such as lower pesticide use, improved nutritional characteristics and improved

organoleptic characteristics and evaluated consumers' WTP for GM foods in Italy. The study showed that income and information about biotechnology are significant determinants that affect WTP for GM foods. Stefano and Daniele (2000) demonstrated that when correct information is provided to consumers they are more likely to pay higher prices to benefit from quality improvements. In addition, the study suggested that consumers' WTP should be different depending upon degrees of risk type and risk avoidance.

Fear appeals concerning GM food frequently appear in the mass media. They have played a crucial role in creating widespread fear of GM food (also known as "Frankenstein food") in a large part of the world. Laros and Steenkamp (2004) presented a report to validate a scale to measure consumers' fear about GM food and shows that Dutch consumers feel significantly more fearful of GM foods than of other new food types. There are no strong relations between consumers' socio-demographic makeup and fear of GM foods indicating that fear of this technologically new type of food is an emotion that cuts across society. Fear of GM food is positively influenced by consumers' concern for the environment and negatively affected by their faith in technology in food production. Consumers who are more fearful of GM food have a more negative attitude toward genetically modified food and toward genetic modification of animals and exhibit a greater interest in information related to food production.

In a study by Shanahan, Scheufele and Lee (2001) addressed which specific values play a significant role in predicting attitudes toward genetically modified food and organically grown food. The research findings support the idea that the relationship between attitudes and values was mediated by beliefs. Their findings also imply a meaningful relationship between specific values, beliefs and food-related attitudes and suggest that values might play a role in explaining attitudes toward genetically modified food and organically modified food products.

Guivant (2006) reported two studies, one carried out by Greenpeace and another by Monsanto. The Greenpeace study claimed that in Northeast Brazil 74% of the population prefer GM-free food while Monsanto study claimed that 80% population would perceive GM crops as a possible way to improve the quality of life.

Teng (2006) studied GMOs and biotechnology in Asian perspective and found that the issues which concern Asian scientists, regulators and the lay public resemble those of other regions are Biosafety, food safety, ethics and social justice, competitiveness and the European Union trade question. He also pointed that in Asia because of the varied cultural issues concerning the use of genes derived from animals arouse much emotion for religious and diet choice reasons. He concluded that even if the religious issue exists because of Asia's growing demand for high volumes of quality food, it is likely that GM crops will become an increasing feature of Asian diet.

CHAPTER - 3

Methodology

This chapter deals with topics related research design including a brief description of dependent and independent variables, sampling methods, measuring instruments, collection and processing of data as well as the statistical tools used for measurement in the research.

3.1 Research Design

This is an explorative research in nature comprising an expert opinion survey and a consumer survey. Two different statistical approaches have been applied to expert survey and consumer survey respectively in order to keep pace with four main objectives of the study as stated in previous chapters. The expert survey includes both quantitative and qualitative analysis where as the consumer survey comprises only quantitative analysis. However two empirical models have been presented in the study. The first model addressed the explanatory process of acceptance and rejection of GM foods by experts and the second model explained the development process of consumers' perception and belief about GM foods and their associations with the attitudes towards purchasing this food.

The concept and design of the expert survey have been adopted from the work of Sjoberg (2008) as well as Han and Harrison (2006) with ample modification relevant to the study; where as the concept, design and theoretical framework of the consumer survey have been adopted from the studies of Deodhar et al., (2007) and Gaskell et al., (2004) as well. However a good number of literatures have been reviewed to craft the conceptual and theoretical framework of both the surveys. In the 1st stage a panel of 5 (five) experts, one from each category: Biotechnologist, Agriculturist, Environmentalists, Nutritionist and Member of Consumers Organization has been chosen for an in-depth interview in order to explore domains of construct of both the surveys through identifying issues and concerns about GM foods in Bangladesh. This group of respondents has been selected on the basis of their active involvement in GM issues in Bangladesh. Another reason is that these five categories of experts usually possess more accurate knowledge and information about

pros and cons of GM foods (Hoque et al., 2006). However experts' suggestion has also been taken to develop the statistical approach to the surveys. Necessary changes suggested by the five respondents have been incorporated in the sampling techniques as well as in theoretical frame work of the study. In the 2nd stage a follow up interview with these experts have also been conducted to restructure the variables identified and the format of questionnaires.

3.2 Sampling

A well-planned sampling design is intended to ensure that the resulting data are adequately representative of the target population and defensible for their intended use. In the process of sampling design the efficient use of time and human resources are critically considered. Two distinctive sampling techniques have been implemented for two different surveys to accomplish the over all objectives of the present study.

3.2.1 Study Population and Sampling Frame

The study population for expert survey is primarily the academicians, researchers, key personnel of multinational companies (GM food related), activists and persons with direct concern about GM food issues in Bangladesh. Sampling units have been selected in accordance with adequate information obtained from reliable sources about their compatibility and expertise in related field. Respondents residing or working in and around Dhaka city have been chosen purposively. The study population for consumer survey is all respondents aged 16+ years residing in the Dhaka Metropolitan City. The sampling unit is a human being in both the cases with good physical and mental health regardless of age, gender, race, religion and political as well as commercial implications.

However to facilitate the decision of selecting sampling units for the experts' survey a complete list of potential respondents has been collected from respective departments of the academicians and researchers. A second list for selecting other respondents of expert group has been prepared with the aid of academic journal records, reports, newspapers, magazines and the internet. Finally experts' suggestions have been taken to finalize respondents from both the lists.

3.2.2 Sampling Technique and Procedure

The research has employed tow different sampling techniques and procedures to accomplish the task in the light of the overall objectives of the study.

Expert Survey: On the basis of the ideas obtained from literature review of similar studies a purposive sampling technique is used for experts' survey in stead of using a probabilistic one. Judgmental sampling is appropriate when statistical results are not needed and/or there is a high degree of certainty that a conclusion can be reached without further sampling (Castillo, 2009). Judgmental sampling technique implemented in the present study has ensured the best possible information about the risk and benefit issues of GM foods in Bangladesh from experts view points. However, according to Neyman (1997) judgmental sampling is recommended in following circumstances:

a) If the purpose is to survey the area in order to determine the necessity for and extent of substantive testing (further transaction testing).
b) If there is a desire to concentrate the survey effort in a specific limited problem area revealed by a previous sample or other source of information.
c) If the population is very small and it would be quicker and easier to review all or most of the items in the subpopulation.
d) If area is very sensitive and there is no room for error or exact results are needed so all of the items in the universe must be reviewed.

Since the overall objective of the experts' survey is the best fit with above circumstances, utilization of judgmental sampling over the statistical sampling technique is well justified in the present study.

On the other hand, instead of following a systematic approach to determine the sample size of the experts' the researcher relied more on the similar studies reviewed in chapter-2 and depended further on the suggestion of the reputed statisticians. Finally a sample size of 64 (sixty four) is determined for the particular survey with the aid of sample size determining formula prescribed by (Castillo, 2009) in similar study based on confidence level at 95% and precision rate 6%. When using judgmental sampling, statistical analysis cannot be used to draw conclusions about the target population. Conclusions can only be drawn on the basis of professional judgment. The usefulness of judgmental sampling will

depend on the study objectives, the study size, scope and the degree of professional judgment available. When judgmental sampling is used quantitative statements about the level of confidence in an estimate (such as confidence intervals) cannot be made (Malhotra, 1999). A list of experts interviewed from different professional streams is outlined in table-3.1

Consumer Survey: A multistage sampling technique adopted from the work of Poortinga (2005) has been designed and implemented successfully for the study. The successive steps are as follows:

Stage-1, *Selection of Areas:* For the purpose of the present study the respondents residing only in the Dhaka Metropolitan City (DMC) has been considered. A detailed area map including a list of all thanas (7 main and 14 auxiliary) under Dhaka Metropolitan City (DMC) along with the number, location and rough estimate of population of each ward under these thanas has been collected from the office of Dhaka City Corporation. Another detailed area map consisting of holding numbers of every house hold in each ward under 21 thanas has been collected from the office of Rajdhani Unnayan Kartripokkha (RajUK). This list is further used in conducting the house hold survey along with a random digit table.

Stage-2, *Determining the Sample Size:* The appropriate sample size for a population-based survey is determined largely by three factors: (i) the estimated prevalence of the variable of interest for instance the n.umber of people aged over 16+ years, (ii) the desired level of confidence and (iii) the acceptable margin of error.

For a survey design based on a simple random sample, the sample size required is calculated according to the following formula.

Formula:

$$n = \frac{t^2 \times p(1-p)}{m^2}$$

Description:

n = required sample size
t = confidence level at 95% (standard value of 1.96)
p = estimated prevalence of information (about GM) in the project area (50%)
m = margin of error at 5% (standard value of 0.05)

Use of the standard values listed above provides the following calculation.

Calculation:

$$n = \frac{1.96^2 \times .5(1-.5)}{.05^2}$$

$$n = \frac{3.8416 \times .25}{.0025}$$

$$n = \frac{.9604}{.0025}$$

$$n = 384.16 \sim \mathbf{384}$$

Note: In the current study the prevalence of estimated population in the project area is unknown. Thus proportion (p) for the calculation is set to 0.50 which correspond to 50% (Liu and Aragon, 2000). However, the number of the Dhaka City's young population is relatively high due to age selective rural-urban migration. About 40% of the total city's population is in the unproductive age groups of 0-14 and 60 and over (Hossain, 2008).This figure has been cross checked with Bangladesh Population Census, 2001(Bangladesh Bureau of Statistics, 2001) and found nearly similar. This presumed that nearly 50% of Dhaka City population is in range of 16+ years to less than 60 years. Thus the figure 0.50 set for proportion is statistically supported.

Design Effect

An anthropometric survey is usually designed as a cluster sample (a representative selection of cluster), in this study stratified sample of cluster is not a simple random sample. To correct for the difference in design the sample size is mostly multiplied by the design effect (**D**). The D value for a cluster survey is 2 where 1.7 is mostly recommended for a stratified random sampling (Liu and Aragon, 2000).

$$n \times D = 384 \times 1.7 = 652.8 \sim \mathbf{653}$$

Contingency

The sample is further increased by 5% to account for contingencies such as non-response or recording error.

$$n + 5\% = 653 \times 1.05 = 685.65 \sim \mathbf{686}$$

Allocation of Sample

Finally, the sample has been distributed in accordance with the proportion of population in each area (cluster) and the calculation result is rounded up to the closest number that matches well with the number of clusters (21thanas) to be surveyed.

Final Sample Size

N = 700 individuals

However, in drawing the sample proportionate stratified random sampling technique has been administered to ensure inclusion and representation of all types of individuals. Prior to drawing samples from different strata (thanas in this study) a matrix containing the number of population under each stratum had been prepared (Table-3.1). Geographic clusters stratified by thanas are used as sample frame.

Table- 3.1: Matrix of the number of population in each stratum (thana) and corresponding sample ratio.

Sl	Thana	Population	Ratio	Sample
1	Dhanmondi	252,519	3.90	27
2	Kotwali	253,558	3.91	27
3	Motijheel	269,628	4.16	29
4	Ramna	257,288	3.97	28
5	Mohammadpur	456,058	7.03	49
6	Sutrapur	352,420	5.44	38
7	Tejgoan	302,109	4.66	33
8	Gulshan	190,590	2.94	21
9	Lalbagh	346,204	5.34	37
10	Mirpur	551,167	8.50	60
11	Pallabi	431,257	6.65	47
12	Sabujbagh	291,207	4.49	31
13	Cantonment	117,464	1.81	13
14	Demra	427,972	6.60	46
15	Hazaribagh	127,370	1.96	14
16	Shyampur	376,545	5.81	41
17	Badda	359,256	5.54	39
18	Kafrul	289,986	4.47	31
19	Kamrangir char	143,208	2.21	15
20	Khilgoan	336,895	5.20	36
21	Uttara	350,176	5.40	38
		6,482,877	**100.00**	**700**

Source: The figures represented the tana wise population number is based on "Population Census 2001" by Bangladesh Bureau of Statistics.

3.2.3 Data Collection Method and Procedure

The data collection method for both the experts' survey and consumers' survey is face to face depth interview. A semi-structured questionnaire (Annex-I) along with a cover letter on university letter head pad written in English and duly signed by the supervisor describing the purpose of the survey has been administered to collect opinions of the experts. Each interview holds for more than an hour and conducted in a confined room free from any noise or other external environmental hazards. Considerable concentration has been given to ensure the comfort of the respondents in providing answers. An additional emphasis is given to record the qualitative data provided by the experts. All 64 (sixty four) interviews have been conducted by the researcher himself.

On the contrary a structured questionnaire written in both English (Annex-II) and Bengali (Annex-III) along with a cover letter on the university letter head pad duly singed by the supervisor and the researcher has been administered to collect the response in the household survey. In addition a single page information sheet describing all the basic information about the GM food, its applications and global controversy as well as risk/benefit idea is also provided. Special emphasis is given to facilitate a clear understanding of the scientific terminologies used in the questionnaire. Each household interview lasts for 30 to 45 minutes on an average.

Consumers' data has been collected by means of house hold visit by the researcher himself and some trained interviewers with prior experience of conducting similar survey. Two female and two male students from the department of Biochemistry, University of Dhaka have been hired to accomplish the task. However the hired interviewers had been trained appropriately and accompanied with the researcher himself for their first five interviews in order to cross check if the interviewers were competent enough for conducting the survey independently.

Table – 3.2: Data Collection Procedure

Data Collection Method	Data Collection Instruments	Target Group(s)/ Respondents	Sample Size/ Numbers
Depth Interview	Semi-structured Questionnaire	1. Biotechnologist	8
		2. Agriculturist	8
		3. Environmentalist	8
		4. GM seed importers	8
		5. Health Professionals	8
		6. Nutritionist	8
		7. Govt. Food (GM) Policy Planners	8
		8. Member, Consumers' Right Protection Agencies	8
			64
Household Survey	Structured Questionnaire	Age : All (16+years) Gender : Male & Female Location : Dhaka Metropolitan City	700

Note: Complete statistical approach to the sample size determination for consumers' survey is detailed in previous section.

3.2.4 Measuring Instrument

A close ended five point Likert scale questionnaire containing 33 statements of 7 broad categories/variables along with 4 open ended questions in 4 dimensions is developed for the experts' survey (Annex-I). In contrast the questionnaire for consumers' survey comprises only close ended five point Likert scale questions containing 44 statements (including few in different scales) of 7 broad categories/variables along with an additional format to collect demographic data of the respondents (Annex-II).

Both the questionnaires are based on extensive literature review, keeping in mind the objectives of the study, feed back from the pilot survey, expert's opinion and advice from two seminars held in the Department of Marketing, University of Dhaka. Each statement of the close ended questionnaires could be replied by checking any one of the five answers 'strongly disagree', 'disagree', 'neutral (neither agree nor disagree)', 'agree' and 'strongly agree'. The scoring weight ranged from 1 to 5 in all cases except some variation in question number (Sec-1: 1b, Sec-4: 1,4 and Sec-5: 1,2 in experts' survey) as well as in question number (2,3,9,16,17-20 & 37-45 in consumers' survey) and thus the highest score, the lowest score and the neutral score under each variable depended on how many statements are there under each variable.

3.3 Variables Studied

An extensive literature review relating to the issues and controversies regarding the induction of GM food in Bangladesh and its regulatory policy implications were conducted to identify the variables for the current study. The objectives of the present study were also in view while identifying the variables. As it is mentioned earlier that there is a scarcity of relevant secondary data relating to the GM issue in the context of Bangladesh, the variables used in the current study are mostly based on the research conducted in America and Europe. While setting the variables seven sequential dimensions were considered for identifying independent and dependent variables for the experts' survey where as six sequential dimensions were considered for independent and dependent variables for the consumers' survey. For example variables for general knowledge, ethical and moral concerns, preference for specific labeling policies, control mechanism and regulatory issues, perception of risk and benefit belief of GM food are always assumed as independent variables over the dependent variables i.e. recommending GM foods for commercial use in Bangladesh used in experts' survey and willingness to buy GM food used in consumers' survey. Demographic variables including access to information used only in consumers' survey is regarded as independent variables as found in many similar researches.

3.3.1 Major Independent Variables

Demographic variables:

Age, Sex, Marital Status, Academic Qualification, Occupation and Income Status.

Access to Information:

- Access to internet
- Access to Newspapers

Variables measuring basic knowledge and awareness of GM foods:

- GM food awareness
- Awareness about sales of GM foods in the market

Note: Variables mentioned above are used only in consumer survey where as variables out lined hereunder are common for both the expert and consumer survey.

Variables measuring ethical and moral concerns regarding:

- GM technology used in plant
- GM technology used in animal
- GM technology used in medicine

Variables measuring labeling preferences:

- Mandatory
- Voluntary
- Frequencies of seeing food labels

Variables measuring control mechanism and regulatory issues:

- Government agencies
- Consumers and environmental groups
- Food and agribusiness companies &
- Scientist and academicians

Variables measuring perception of risk and benefit belief:

- Health
- Environment and wildlife &
- Socioeconomic

3.3.2 Major Dependent Variables

Experts' Survey : The level of encouragement for approving GM foods

Consumers' Survey : Willingness to buy (WTB)

3.4 The Data Collection Period

The data has been colleted for experts' survey during the period of April, 2010 to December, 2010 and consumers' survey from May 2011 to January, 2011.

3.5 Pilot Study

Since a panel of five experts has been used for developing the initial questionnaires the same panel is used in the pilot survey of the expert. However, keeping in mind the reliability and validity issues questionnaire for consumers' survey is administered on a sample of 15 respondents, taking 8 males and 7 females of varied demographic characteristics purposively. The questionnaire is found satisfactory and sound from the pilot study. However, based on the pilot survey following modifications is incorporated:

1. In experts' questionnaire a question regarding the recommended ways of creating awareness about GM food was incorporated in section 6, no-iii, but finally dropped after pilot study.
2. In experts' questionnaire an open ended question regarding the justification of supporting mandatory or voluntary labeling policy was incorporated.
3. In consumers' questionnaire in section-1 an additional question was deleted about the source of information of GM foods.
4. A question regarding the type of GM foods available in the local market under section-1 with reference to the questionnaire of Harrison and Han (2006) has been deleted from both expert and consumer questionnaire.

Moreover, on the basis of the pilot survey the words that seemed ambiguous and/or confusing were replaced with suitable words for easy understanding of the terms. The scientific terminologies which can not be replaced in any way is seemed to be minimized by the Bengali version of the same. The questionnaires are thus refined after several changes and modifications as per the experts' suggestions and input prescribed by the respondents of pilot study. After the changes were made the questionnaire was used for final data collection from the respondents of the household survey.

3.6 Reliability and Validity Issues

The objectives of the pilot study were mainly to ascertain the validity and reliability of the questionnaires. The reliability and validity analysis is an important issue when conducting empirical research.

3.6.1 Reliability

It is an estimate of measurement consistency. It measures the degree in which question items would give consistent or repeatable results. Cronbach's alpha coefficient (1951) has been calculated for each scale to evaluate the reliability. The widely accepted social science cut-off is that alpha should be 0.70. But some use 0.75 or 0.80 while others are lenient as 0.60. (www2.chass.nesu.edu/garson/pa765/standard.html)

3.6.2 Validity

Ensure whether or not question items measures what they are intended to measure. The validity of measurement scales can be tested against *content, construct & external criteria.*

Content validity: An extensive literature review had been undertaken measuring health and environmental factors, factors relating to ethics and morality, factors measuring the labeling preference, regulatory and control mechanism factors, factors measuring the willingness to buy and finally the demographic factors to ensure content validity.

Construct validity: Construct validity had been examined through factor analysis with criteria for example, a minimum Eigenvalue of 1 and item factor loading in excess of 0.4 (Hari, et al., 1992; Onyango et al., 2003).

Criterion related validity: Criterion-related validity measures how closely the measurement instrument is related to the relevant criterion. As the correlations were highly significant, indicated the acceptable degree of the criterion related validity.

3.7 Processing of Data

Data collected for the present study was processed through microcomputer using Statistical Package for Social Science (SPSS), version-16.1. The researcher himself tabulated the data. Before feeding the data into computer, all data were converted into numerical codes and details of this coding were recorded in separate sheets. In addition data cleaning and consistency checking were also done.

3.8 Statistical Tools Used

For the purpose of data analysis the following statistical tools were used:

1. **Descriptive Statistics:** Sample percentages, standard deviation and mean value for each statement measuring the variables and mean value for individual variable were calculated to study the frequency distribution of sample of both the surveys.

2. **Multiple Regression:** Multiple regression were done to find out the relative contribution of some specific independent variables used in the experts' survey, for example individual's risk and benefit perception over one dependent variable

that is overall acceptance and rejection of GM foods for commercial use in the country.

3. **Multinomial Logit:** A special form of regression analysis were done in analyzing the consumers' data to measure the relative association of some in dependent variables with the dependent variables for example Willingness to Buy (WTB) two specific GM foods GM rice and GM Soybean Oil.

4. **Factor Analysis:** As an additional contribution to the present study factor analysis were done. Since the questionnaire contained 26 statements (common in both expert and consumer questionnaires) a useful statistical tool might be used for data reduction to examine the interdependent relationship among variables with their underlying factors. The respondents' ratings of 26 statements were factor analyzed to determine the underlying factors for acceptance and rejection of GM foods. From the factor analysis 11 factors emerged for the present study under the variables of 5.dimensions. This smaller set of 11 factors can be used for any further study in the same field.

CHAPTER - 4

Experts' Perceptions of GM foods in Bangladesh

This chapter deals with the perceptions of experts in Bangladesh about GM foods and crops. The major focus of the discussion has been an attempt to explore the attitudes of the experts toward GM food in terms of various risks and benefits variable along with other related factors. In addition it includes the interpretation of results obtained from the expert's survey. The schema of the presentation in this chapter is as follows:

- Conceptual Framework
- Theoretical Framework
- Analysis of Results
- Conclusion and
- Implications

4.1 Conceptual Framework

One of the essential elements of an innovation, for example a new technological development is that it always offers benefits over and above what is currently available. An innovation without such additional benefit is almost an oxymoron (Gaskell et al., 2004). The nature of the benefit and the category of beneficiary may vary widely and distinctively. Benefits may be seen in lower costs, more functionality or enhanced quality. Agro-food biotechnologies, at least in the minds of the developers are one such leading-edge scientific innovation.

Genetically modified (GM) crops and foods are claimed to offer a range of benefits to a variety of beneficiaries including higher productivity and lower pesticide costs for producers, less environmental pollution from pesticides and herbicides as well as new crop varieties to ameliorate hunger in developing countries. Many western governments have weighed in behind the industry as biotechnology has come to be viewed as an economic opportunity and achieved the status of a strategic technology for the 21st century.

Against these projected benefits and governmental support opposition to agro-food biotechnologies from environmentalists, food policy planners and sections of the wider public comes as a surprise to the promoters of the technology. While environmentalists raise questions about gene drift, super-weeds, biodiversity and the unknown long-term consequences of GM crops the public is concerned about the ethics of genetic modification, the labeling of foods with GM ingredients and the possible health effects of consuming GM foods (Gaskell et al., 2004; Han and Harrison, 2006). Industry experts and regulatory bodies viewed risk assessments point to no unique risks from GMOs, at the same time this opposition is seen as an example of the public's failure to understand risk. Many experts judge that the benefits outweigh the possible risks, if indeed there are any risks at all (Gaskell et al., 2004). And as these experts observe the public opposition they assume that since the benefits are not in dispute then the public must be misperceiving the risks, a view that accords with early research on benefit and risk perception of GM foods.

The two-factor model of risk perception presented by Sjoberg (2000) where he included other characteristics of technologies related to risk perception such as 'interference with nature,' 'unnatural,' and 'immoral.' Siegrist (2000) links risk perceptions to trust, showing that perceptions of the benefits and risks associated with biotechnology are related to levels of trust in companies and scientists. According to Siegrist (2000) worldviews and trust play an important role in perceptions of gene technology. This echoes the pioneering work of Douglas and Wildavsky (1982). These cultural theorists take as a starting point the ways in which people's prior dispositions, group membership and cultural values affect the ways in which social groups attend to some hazards while ignoring others.

Most recently Slovic et al., (2002) emphasizes the role of affective processes in risk perceptions. The widely held assumption is that uncertain outcomes that are attractive will be perceived as less risky while unattractive outcomes will appear as more risky. As a consequence and consistent with cultural theory risk perception can be seen as an expression of already existing values and preferences. Such a formulation runs counter to models of rational choice in which the judgment of a new technology is made on the basis of weighing up independent assessments of risks and benefits. Returning to the case of GM foods, public skepticism has been largely framed as a risk issue as seen in the

literature review in chapter-2. Since it has been established that public perceptions of risk deviate systematically from actuarial and "sound science" based risk assessments, opposition to agro-food biotechnologies is attributed to the public's misperception of risk. Furthermore, it is suggested that this is due in part to the manipulation of public opinion by campaigning groups and amplification by the media (Renn et al., 1992). Hence, a widely proposed and supported solution is the dissemination of accurate risk information by credible and trustworthy sources. This explanation of opposition to agro-food biotechnologies has framed many expert debates and policy initiatives. Essentially, it is based on the assumption that like public the experts themselves use a risk-benefit analysis in the formation of judgments about the new technology but that the former and not the latter assess the risks incorrectly. Both, it is also assumed, agree on the benefits.

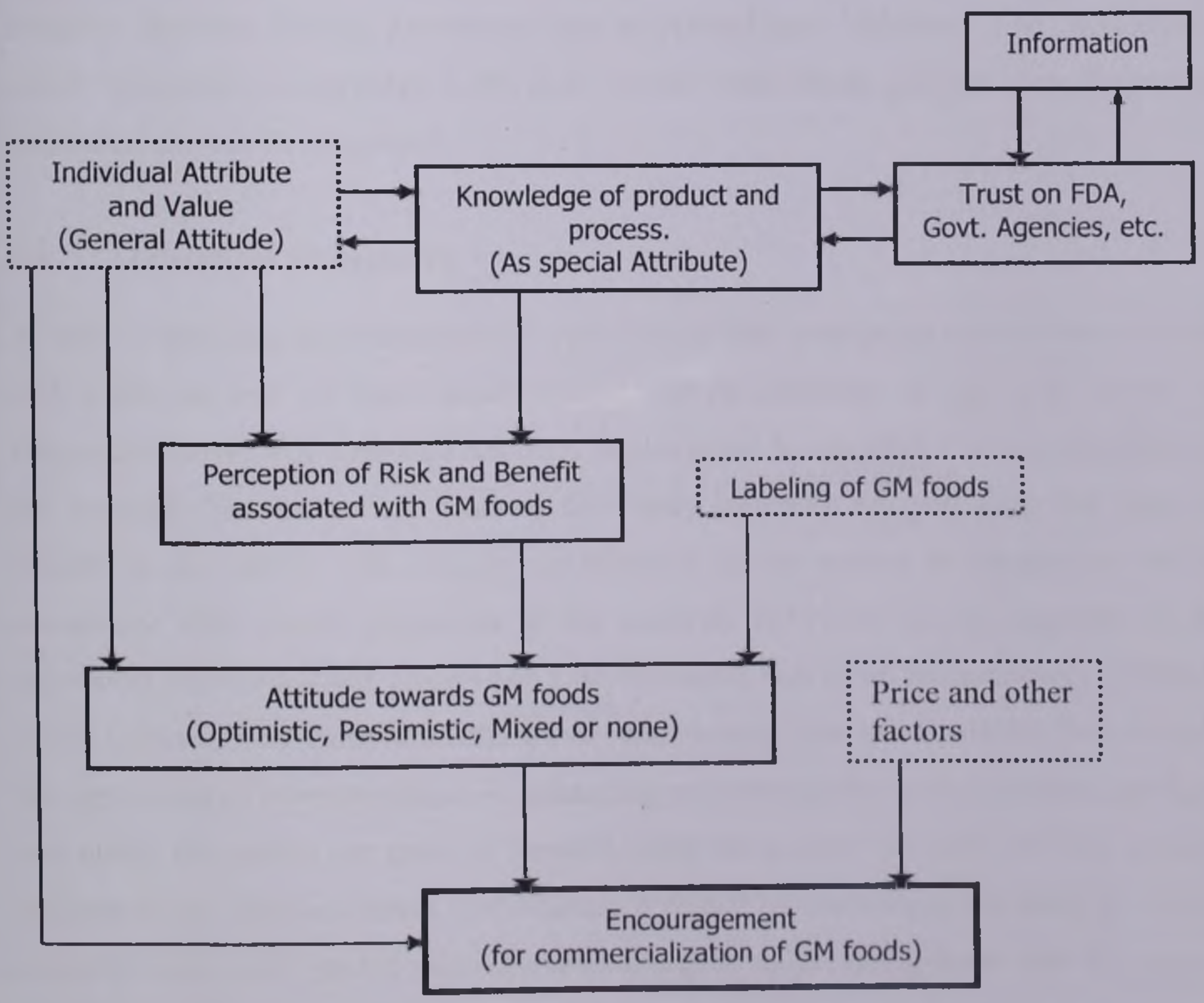
However, the word "risk" in the sense of a scientific definition in relation to probabilities of negative consequences does not feature prominently in lay discourse (Thompson, 1999). Rather, people talk in terms of dangers and in this category there are a wide range of potential problems including what might be deemed moral and democratic hazards (Gaskell & Allum, 2001). On the other hand it is interesting that discourses around medical applications of biotechnology are generally positive as well as to be useful in alleviating pain and curing illnesses. But crucially a strong and critical current of opinion was associated with some biotechnologies including GM food. This concerned the absence of perceived benefits and the possibility of non-GM alternatives to achieve similar ends. People would question the point of genetic modification of food. Was it necessary when there is plenty of food in the shops? Why change the character of food when it is already good and wholesome? Questions of a similar nature were raised around xeno-transplantion. Would it not be easier to get people to carry organ donation cards than to develop transgenic pigs? Arising out of such views people wondered why society should take any risks that might be involved when the claimed benefits appear to be nonexistent or the ends achievable by other "tried and tested" means. Such concerns about the lack of utility of food products produced by biotechnologies were often embedded in other arguments: Is regulation possible for such a fast moving technology? Can government and industry be trusted? Are the longer-term consequences of biotechnology fully understood? Research revealed the fact that in most of such cases the public as well as the policy planners often seek assistance and suggestion from the experts in relevant field (Gaskell et al., 2004).

In accordance with the first objective of the research current study has attempted to model the way in which the experts may come to a decision to encourage or discourage the inception of GM food in Bangladesh.

4.1.2 The Empirical Model

It has been revealed by many studies that the explanatory process of accepting or rejecting GM foods is quite diverse for experts and consumers (Gruer, 2006). Experts use different sets of combination of risk and benefit along with other associated factors than the consumers while judging GM food for commercial use (Gaskell et al., 2004). However, in light of the large array of determinants identified in the previous literatures it can be concluded that the personal attitude of an experts towards the encouragement of GM food is formed by a complex decision-making process which has been attempted to simplify in Figure- 4.1

Figure-4.1: The Empirical Model



Note: An explanatory process of GM food acceptance or rejection.
Source: Adopted from Costa Font et al., (2008)

The concept of the explanatory process of expert judgment of GM food has been adopted from the work of Costa-Font, Gil, Traill, & Bruce, (2008) with considerable modifications relevant to the current study. While most of the revised literature has proposed partial models to explain different aspects of experts' behavior towards GM food the empirical model in Figure-4.1 aims to integrate them into a single one by providing an overall picture of the different stages of the expert decision making process. As can be observed in Figure-4.1, consumer attitudes towards GM food are driven by three main dimensions.

First, risks and benefit perceptions associated with GM food as well as their weights in determining acceptance and fmal decisions. Second, individual values and attributes appear as key determinants underpinning experts' attitudes. Risk and benefit perceptions towards a GM product are found to be conditioned on what is known as 'individual values' such as environmentalism, conservationism, materialism and equity. Finally, knowledge and its relation with values must be considered as an especially human complex attribute. Indeed, knowledge can be divided into 'objective' and 'subjective'; where 'subjective' knowledge is the most related with values and has more impact on individual attitude development.

4.2 Theoretical Framework

In order to modeling the judgments of experts about their perception and attitudes towards GM foods as well as their encouragement of its inception in the food system of Bangladesh a two way approach has been implemented to meet the first two objectives of the research. The theoretical basis of this study has been adopted from the work of Gaskell et al., (2004) with relevant modification in the context of Bangladesh and in accordance with overall objectives of the research. However the key structure of the theoretical framework was based upon Eurobarometer survey on biotechnology (EB52.1) by the authors. In the Eurobarometer survey respondents were asked whether they thought the application of biotechnologies in enhancing and altering the attribute of food products was useful for society (an index of benefit), risky for society (an index of risk), morally acceptable (an index of ethics) and whether it should be encouraged (an index of overall support).These rather global questions were designed to be intelligible as part of a survey interview with respondents coming from different professional and academic backgrounds in the present study. In the current research few additional variables have

also been included as an index of effect of the relative factors for the application of biotechnologies in the development of agricultural system as deemed necessary for exploring the perceptions of the experts towards GM foods which is previously used in several similar researches (Bredahl, 2001; Ellahi, 1994; Gruere, 2006 & Hallman et. al., 2004). A semi structured questionnaire with few open-ended and approximately 30 (thirty) close ended questions have been developed to accomplish the task. The response alternatives from different academicians and activist for these questions were 5-point scales from strongly disagree to strongly agree keeping neutral response at the middle. However, in section-5 (see Annex-I) 5 point scale was used in different order where 1 indicated "no trust at all" and 5 indicated "high degree of trust". The variables considered in the questionnaire were 1) General information about GM foods, 2) Ethical and moral concerns relating to GM foods, 3) Pricing issue of GM foods, 4) Labeling issue of GM foods, 5) Control mechanism of GMOs in local context and 6) Perception of health, society well being and environmental risk/benefit belief of GM foods.

The initial approach to modeling the structure of judgment of experts' attitude towards GM foods was a typical risk-benefit framework with added attribute of control mechanism and regulatory issues of GM foods. As assumed by Gaskell et al., (2004) the level of public encouragement for a particular application of biotechnology in food products is some combination of its perceived usefulness, riskiness and moral acceptability. However, few current research indicated that while most public use above combination for accepting the GM foods, experts use a different set of combination with significant emphasis on regulatory and economic issues related to this technology (Gaskell et al., 2006). After a brief review of related articles a set of associated variables has been included to inspect the empirical model of expert. The study attempted to explore the fact that whether the experts only consider the heath, economical or environmental risk and benefits to judge the GM food or other associated factors also play significant role in justifying the inception of GM food in the food system.

To test this hypothesis the current study has utilized multiple regression as an appropriate model in which encouragement of this technology and/or recommendation of GM foods for commercial use in the country has been treated as dependent variable and regressed onto the independent variables, the presumed predictors of encouragement such as usefulness, riskiness and moral acceptability in addition to other variables mentioned

above. However, it has also been assumed that results obtained from the regression analysis could not be sufficient enough to understand and express the true perception of experts about their positive and negative attitude towards the commercialization of GM foods in the country. Rather it is also important to isolate distinctive expert groups in terms of their cognitive behavior towards GM food and its local commercialization.

In order to attain this specific objective a second approach has been introduced to modeling judgments of experts where the combinations of dichotomized choices i.e. useful/not useful, risky/not risky, morally acceptable/morally unacceptable and encouragement/not encouragement have been inspected only for the responses relating to experts' overall perceptions about GM foods as outlined in section-6 of the questionnaire (see Annex-I). However, from the analyses of both the qualitative and quantitative data point of the previous studies it is assumed that benefit perception might be more important than risk perception. To explore this hypothesis in more depth the current study has used two further questions from the survey. These questions tap similar concepts of risk and benefit; and have the advantage of being more concrete in their formulation. In the questionnaire benefit is assessed through agreement or disagreement on a 5-point scale with the statement: 'GM food will bring benefits to many people'. Risk is similarly assessed with statement: GM food poses no risk to future generations'. For the purpose of analysis response to the risk question is reverse coded.

In addition to above two models a third approach has also been adopted to analyze the perception of experts about the GM foods and their attitude towards the commercialization of this food products in Bangladesh by using the qualitative data obtained from the respondents.

A detailed analysis and interpretation of both quantitative and qualitative data obtained from experts' survey has been discussed in the following section in the light of appropriate statistical tools.

4.3 Analysis of Results

The analysis of results obtained from the data of expert survey has been presented in following sections:

4.3.1 Regression Analysis

The result presented in table-4.2 expresses the multiple regressions for selected independent variables over the dependent variable which is 'the level of encouragement of experts about the commercialization of GM foods in Bangladesh' in the current study. The result indicates no multi co-linearity among 26 items selected as independent variables. The adjusted $R^2 = 0.529$ is significant at α 0.000 level. This suggest that ethical and moral concern, labeling preference, price sensitivity, regulatory issues as well as health, environmental and economical concerns are the best set of predictors that shape the judgment of experts about the encouragement of GM food commercialization in Bangladesh. The model fitting information has been presented in table- 4.1 which demonstrate the statistical representation of each independent variable with respective β and p value.

Table - 4.1: Model fitting information.

Model Summary[a]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.806[a]	.650	.529	.307	.650	5.348	16	46	.000

b. Dependent Variable: Do you encourage commercial production of GM crops in Bangladesh

As seen in table- 4.2 standardized coefficient of individuals' ethical concern about the transfer of animal genes into plant for genetic modification stands negative (β = -.222 and p = .062) as predicted and evident by Ellahi (1994) in a similar study. According to the data presented in table-4.2 price sensitivity towards the possible GM food in the local market has a considerably stronger impact on respondents' judgment. As predicted in the empirical model (Figure-4.1) fear of increased production cost shows a negative contribution ((β= -.570 and p = .004) where as expectation of high yield against increased

production cost (β = .534 and p = .000) and possible low price of GM crops (β = .692 and p = .000) show a positive contribution on "encouragement". This suggest that few experts perceive higher production cost of GM foods as this would be patented to few multinational companies where as some experts perceive this higher production cost would be compensated by high yield and resultant lower price for the consumers. However, as shown in the figure-4.1 the labeling preferences and respondents' habit of reading food labels of processed foods turns statistically significant as well. These results are also persistent with the findings of Caswell (1999); Hine and Loureiro (2002) and Hallman and Metcalfe (2004). Mandatory labeling of GM foods has the strongest positive impact (β = 1.260 and p = .000) where as respondents' habit of seeing food labels of new food has a negative impact (β = -.531and p = .000). This suggest that experts encouraging GM foods are in favor of a mandatory labeling policy and at the same time experts having a habit of frequently seeing food labels in new food products are sensitive towards the use of selected ingredients and express negative attitude towards GM foods. It is also evident that food labels with inadequate nutritional information may negatively influence (β = -.367 and p = .002) experts' preference of GM foods. This result is also consistent with the findings of Mora et al., (2000).

Incidentally a relatively stronger negative association has been observed for respondents' trust on Government Agencies (β = -.658 and p = .000) as well as the Food and Agribusiness Companies (β = -.338 and p =.007) regarding testing, inspections and regulation of GM crops. This indicates that low level of trust on Govt. agencies and Agribusiness companies negatively influence some experts towards GM foods. However, in contrast respondents' trust on Scientist and Academicians in terms of regulatory issues has positively contributed (β = .446 and p = .003) to the overall support of GM foods in the country. This suggests that experts themselves depend largely on scientists and academicians regarding regulation of GM food products in the country.

A number of variables relating to health, environment and socioeconomic challenges associated with GM foods are found statistically significant. While extra nutritional value (β = .817 and p = .000) and potential disease fighting ability of GM foods (β = .908 and p = .009) contribute positively, the fear of unknown long term risk resulting from this type of foods pose a negative (β = -.336 and p = .031) but relatively weaker impact on encouragement.

Table-4.2: Multiple regressions for selected independent variables over the dependent variable

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.011	.730		.014	.989
	Transfer of genes between different species is unnatural & unnecessary	-.025	.033	-.075	-.760	.453
	The transfer of a forbidden animal's (pigs for Muslim & Jews) genes into a plant / animal will make the resulting GM food forbidden (haram) too	-.078	.041	-.222	-1.932	.062
	High price of GM seeds will increase production cost for the farmers	-.189	.060	-.570	-3.135	.004
	High price of GM seed will outweigh increased cost with high yield	.178	.045	.534	3.949	.000
	Consumer will accept GM variety easily if the price is low	.226	.048	.692	4.676	.000
	Which labeling policy are you most likely to agree with, the FDA's or its critics	1.136	.098	1.206	11.549	.000
	Labels with adequate nutritional information influence my food choice	-.165	.049	-.367	-.363	.002
	How often do you read the nutritional section of food labels before buying a food product (Familiar food)	-.057	.045	-.132	-1.266	.214
	How often do you read the nutritional section of food labels before buying a food product, (New foods)	-.193	.034	-.531	-5.609	.000
	How much do you trust the Government agencies regarding testing, inspections and regulation of GM crops	-.240	.043	-.658	-5.527	.000
	How much do you trust the Consumer and environmental groups regarding testing, inspections and regulation of GM crops	-.151	.112	-.419	-1.345	.188
	How much do you trust the Food and agribusiness companies regarding testing, inspections and regulation of GM crops	-.156	.054	-.338	-2.889	.007
	How much do you trust the Scientist and academicians regarding testing, inspections and regulation of GM crops	.235	.072	.446	3.250	.003
	GM food can have unforeseen harmful affect on human health	-.110	.049	-.336	-2.252	.031
	GM food benefits society because it has extra nutritional features in it	.332	.082	.817	4.043	.000
	GM food can lower your risk of heart disease and some types of cancer	.342	.122	.908	2.788	.009
	GM food may be harmful to people having allergic reactions to particular food	.441	.128	.731	5.095	.388
	GM crops lower the farmer's production cost as well as food price	.489	.075	1.443	6.510	.000
	GM crops may handicap the poor farmers for purchasing GM seeds from MNCs	-.222	.025	-.735	-8.793	.000
	GM crops benefit society to solve food shortage in less developed countries	.701	.078	2.396	8.958	.000
	GM crops are harmful to environment because they can cross pollinate with non-GM crops	-.171	.072	-.860	-3.623	.114
	GM crops are beneficial to environment because they allow farmers to use fewer herbicides and pesticides	.501	.106	.035	.107	.915
	GM crops are beneficial because they lead to adoption of more environmentally friendly farming system	-.513	.108	-0.17	-0.51	.614
	GM crops are harmful for the environment as they kill useful microorganisms in soil	.540	.064	1.740	8.453	.000
	GM crops threaten indigenous plants and animals	-.228	.056	-.664	-4.047	.000

a. Dependent Variable: Do you encourage commercial production of GM crops in Bangladesh

Among several socioeconomic variables the promise of reducing production cost by adopting GM variety (β = 1.443 and p = .000) and prospect of solving foods shortage in developing countries (β = 2.396 and p = .000) indicate a positive impact where as fear of market control by few Multinational Companies having the patent of GM seeds shows a negative (β= -.735 and p= .000) contribution. Among the environmental variable interestingly the fear of environmental imbalance by killing useful microorganisms in the soil found positive (β= 1.740 and p= .000). However, the reason of this inconsistent result is not so clear. Another environmental variable 'the fear of loosing indigenous crop variety' is also statistically significant (β = -.664 and p =.000).

4.3.2 Grouping of Experts on the Basis of their Perception about GM Foods

As discussed in the theoretical framework the response of experts has been extracted out from section 6 of the questionnaire for further analysis. In this approach to modeling judgment the combinations of dichotomized choices useful/not useful; risky/ not risky; morally acceptable/unacceptable and encourage/not encourage were inspected. For instance the applications of food biotechnology that was considered as GM food (in the current study) a set of sixteen possible combinations of these four attributes were figured out of which three 'logics' (patterns of attribute combination) were prototypical. These were the logic of *support* (useful, not risky, morally acceptable and encouraged), of *risk tolerant support* (useful, risky, morally acceptable and encouraged) and of *opposition* (not useful, risky, morally unacceptable and no encouragement). As anticipated from the work of Gaskell et al., (2004) support for biotechnology and commercialization of GM foods is evidenced by some respondents who perceive risk but appear to discount it and in so doing they show support. By the same token there is no evidence of any comparable group that are prepared to express support for GM foods despite considering it to be morally unacceptable or without benefit. However, the sample has been categorized into four distinctive groups in terms of different combinations of risk and benefit perceptions of the experts. The work of Gaskell et al., (2004) has been followed to categorize the sample into groups. The categorization of respondents in to four groups is shown in table-4.3

Cell 1*:** In this group respondents perceive both benefit and risk associated with GM foods. As such, they are potentially confronted by a tradeoff between the two attributes. Hence these respondents refer to as the ***"trade-off" group. Of the total sample this group

comprises 22.64 %, of whom 58.33 % express encouragement for commercialization of GM foods and crops in Bangladesh.

Cell 2*:** In this particular group benefit perception is combined with the absence of risk perception. For these respondents it is a situation of riskless choice. This group, which is referred to as the ***"relaxed" group comprises 52.83 % of the sample of whom 85.71 % express encouragement for approving GM foods and crops in Bangladesh. This is the predominant group as well.

Table- 4.3: Respondents grouped according to risk and benefit perception.

GM food will bring benefit to society	*GM food poses risk for health and environment*	**Agree**		**Disagree**	
		Useful & Risky **"Trade off"**		Useful & Not Risky **"Relaxed"**	
	Agree	**Total**	**Encouragement**	**Total**	**Encouragement**
		22.64 %	58.33 %	52.83 %	85.71 %
	Disagree	Not Useful & Risky **"Skeptical"**		Not Useful & Not Risky **"Uninterested"**	
		Total	**Encouragement**	**Total**	**Encouragement**
		16.98 %	11.11 %	7.54 %	50.00 %

Note: N=53, excluding neutral response

Cell 3: This group does not perceive benefits (challenging a defining characteristic of an innovation) and does perceive only risks. This is designated as the ***"skeptical"*** group comprising 16.98 % respondents. Not unexpectedly a striking 90% respondent express opposition to GM foods. This group takes the same position of some of the focus group respondents in a similar survey who questioned the very need for GM foods (Gaskell et al., 2004).

Cell 4*:** In this group the respondents perceive neither risk nor benefit. This is not a prevalent group and comprises only 7.54 % of the sample. It seems likely that such a view would be associated with non-attitudes, hence they are labeled ***"uninterested." However, 50% of them showed encouragement for GM food production. From this point onward consideration of the "uninterested" group is partially ignored from the analysis.

This categorization raises the question as to whether the different groups are using different decision strategies in the formation of their judgments of encouragement. For the trade-off group there are potentially two relevant attributes, risk and benefit. For the other groups (the "relaxed" and "skeptical") the picture is not so clear. To further understanding of the differences between the four groups of interest other qualitative data from the survey have been used to determine the distinguishing characteristics of the respondents and their resources of information acquisition in terms of prior knowledge and attitudes which they may bring to make the decision about GM foods.

4.3.3 Analysis and Interpretation of Qualitative Data

This section deal with the results and analysis of qualitative data obtained from the expert survey relating to the perception of the respondents about GM foods by using descriptive statistics. This analysis has served the purpose in particular to understand the distinguishing characteristics of different expert groups in more depth in terms their preference to the labeling policy as well as comparative state of risk and benefit perceptions of GMOs.

The questionnaire used in the depth interview of the experts to explore the perception about GM foods and its possible commercialization in the local market contains 4 (four) open ended questions of which 3 (three) have been interpreted and presented statistically. The analysis of the 4th open ended question seeking justification for why or why not respondents recommend commercialization of GM foods in Bangladesh as an additional information has been presented in the form of discussion at the end of this chapter. No demographic profiles have come in consideration for analysis of qualitative data. Incidentally experts are predominantly male: 82 % and aged above 40 years with more than 10 years (82% respondents) of work experiences in their respective field. There are 64 (sixty four) filled out questionnaires obtained from the depth interview selectively

conducted from a list of 80 respondents. There is also about 2% internal data loss since all answers of the respondents could not be coded properly for analysis. However, all 64 respondents have answered the 3 open ended questions and 73% respondents have provided additional information in their response sheet. All the responses have been recorded in writing by the experts themselves. Hence, all data analysis of the open ended questions (qualitative part) is based on 64 responses. Answers collected from the returned questionnaires of the experts have been extracted and coded into a separate sheet in order to categorize the information in several distinctive segments. Unexpectedly only 7.81% multiple answer has been recorded in the data. For the purpose of analysis the multiple responses have not been considered. The percentiles of each category have been analyzed further for presentation as done by Gaskell et al., (2004) in similar study. The responses of 64 experts on 4 open ended questions are presented in the following tables:

Experts' opinion about *"What does the term GM evoke?"*

Results presented in table: 4.4 represent the response summery of the experts' perceptions by the term GM (Genetically Modified). The qualitative data obtained from the respondents have been initially alienated into 6 distinctive categories and further subdivided into 2 broad categories "Hope" and "Fear" respectively.

Table – 4.4: Response summary "What does the term GM evokes?"

Category	Percentile (%)	Broad category
A. Hope among the people of developing country.	**29.68**	
B. New technology for enhancing food quality.	**18.75**	**Hope**
C. Hope for farmers to grow crops in adverse climatic conditions.	**20.32**	**(68.75%)**
D. Fear of unknown health risk.	**12.50**	
E. Fear of environmental risk.	**10.93**	**Fear**
F. Fear of economic risk for farmers imposed by MNCs.	**7.81**	**(31.24%)**
N = 64	**100%**	

(Note: Excluding multiple response)

The former seeing hope in GM foods mostly focus on the enormous scope of this special type of food to feed the ever growing population of the developing countries with its

enhanced nutritional features, high yields and cheaper price advantage. In addition, many of them indicated that GM crop variety will minimize the use of harmful chemicals (pesticides and herbicides) in contemporary faring system. Some of them, accounting around 19% mostly concentrated on the extra-nutritional features of GM crops while a considerably large portion (20%) of experts prioritize the extra-ordinary feature of GM crops to grow in adverse climatic conditions such as during flood, drought, cold, high salinity soil etc. On the other hand, the later seeing fear in GM crop variety are mainly concerned on unknown long term health risk and possible environmental risk (12% and 10%) respectively followed by a small portion (8%) who believe that commercial use of GM variety may handicap the poor farmers of Bangladesh to some multinational companies promoting GM crops in the country. Although this group is smaller in number their proposition against the commercialization of GM crops found very strong as supported by additional information provided in the last part of the questionnaire (Annex-I).

However from the analysis of data it is anticipated the members of relaxed category surely see hope in GM foods. On the contrarily members of skeptical category must perceive risk in GM food at the same time the members of tradeoff category prioritize both hope and risk in different combinations.

Experts' justification about their *"preferred labeling policy"*

The second open ended question seeks justification behind the respondents' preference for a mandatory or voluntary labeling policy for GM food products in Bangladesh. The response summery has been presented in following two tables 4.5 and 4.6 for each labeling preference. However respondents varied in their opinion for quite different reason in support of a mandatory and voluntary labeling policy for GM foods.

Table – 4.5: Experts' justification for FDA recommended voluntary labeling policy.

Category	N	%	Cum. %
A. Trust on FDA	**13**	**20.31**	**34.4**
B. Fear of evoking panic.	**9**	**14.06**	

A remarkable 65.6 % respondent favors a mandatory labeling over 34.4% voluntary labeling of GM foods. Table- 4.5 & 4.6 represents the distribution of respondents in each category according to their key arguments against their preferred labeling policy. Respondents falling under ***category-A*** have ample trust on FDA as they believe that FDA is a trust worthy organization and its recommended voluntary labeling policy for GM foods is the best choice for smooth market orientation of commercialized GM stuffs. They certainly believe that FDA would have never recommended a voluntary labeling policy unless they found this special type of food absolutely safe for human consumption. On the other hand respondent falling under ***category-B*** posses ample trust on FDA and prefer the voluntary labeling policy as well. In addition this later group of respondents believes that mandatory labeling of GM foods may unnecessarily evoke fear or panic among people especially who do not possess awareness and correct knowledge about the use of GM ingredients in the food products. Another argument forced by this group of expert is that highly refined food where the altered DNA or protein is no longer in the food (for example, oil from modified corn or soybean) does not require any GM labeling. They mentioned that there are many foods in the market which contains traceable amount of GM ingredients. Since FDA recommends this foods are safe for human and fed, a voluntary labeling is well justified for GMOs.

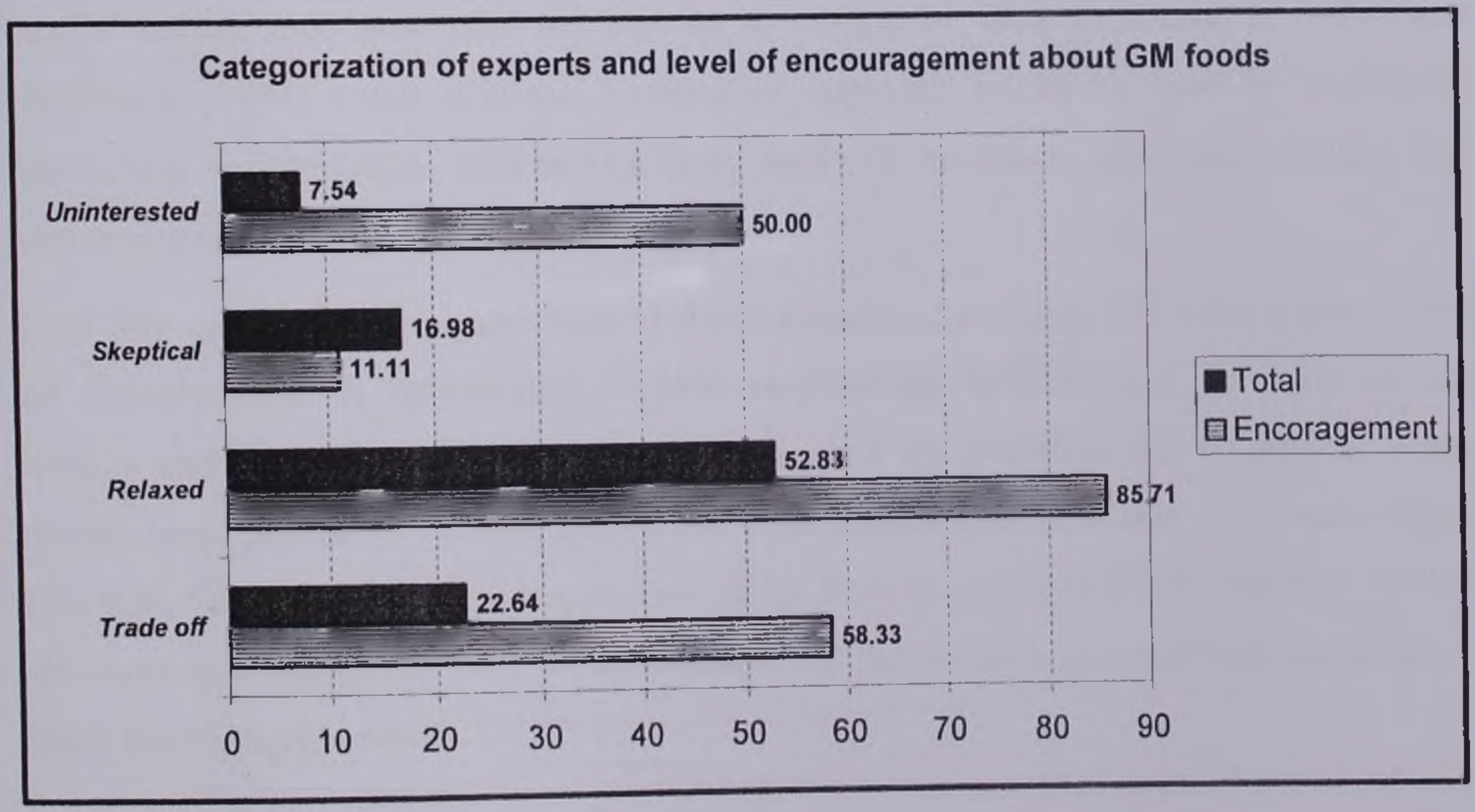
Table – 4.6: Experts' justification for critics recommended mandatory labeling policy.

Category	N	%	Cum. %
C. Limited or distrust on FDA	**12**	**18.75**	**65.6**
D. Consumers' right to know the fact.	**30**	**46.87**	

Table- 4.6 demonstrates that experts falling under ***category-C*** have very limited or no trust on any FDA policy. They believe that many of FDA decisions are partial and fabricated under pressure by special interest groups. They mentioned couple of web documents as examples of fabrication of actual test and inspection result of GM administration in laboratory trail on animal under the pressure of specific interest groups. Thus they recommend a mandatory labeling policy for all food products containing even a trace amount GM ingredients to be safe than sorry.

This result is consistent with the similar study conducted by Bansal and Gruere (2010) in India. At the same time respondents falling under ***category-D*** have neither any distrust on FDA nor any problem with FDA recommended voluntary labeling policy, rather they are concerned about protecting consumers' right to know "what they are eating?" They argued that there should be a discrete segregation of all GM and Non-GM foods available in the market along with the nutritional and ingredient information. Since GM foods are derivatives of laboratory manipulation of natural organism it is ethical and logical to put a mandatory labeling so that consumers can distinguish them easily. This result is also persistent with findings of a study in Europe by Carter and Gruere (2003). The respondents also reasoned that since this food does not possess any harmful consequence on human health and it is same like ordinary food products as claimed by FDA, there is no fear of arising any misconception of health risk from consumers' end. They also prefer a "safe than sorry" approach.

Figure – 4.2: Categorization of Experts and their level of encouragement about GM foods



However, from the above analysis it would not be unlikely to predict that the member of **'relaxed'** group may share the same characteristics as do by the members of **Category-A&B.** From the same token it is also anticipated that members of **'skeptical'** group may share the similar characteristics of members in **Category-C** as far as labeling issue is concerned. No assumptions can be made from this data point in terms of similarities of

characteristics between the members of **'tradeoff'** group and the members of four categories discussed above.

4.3.4 Experts' Opinion about a question on "*Risk and Benefit Tradeoff*"

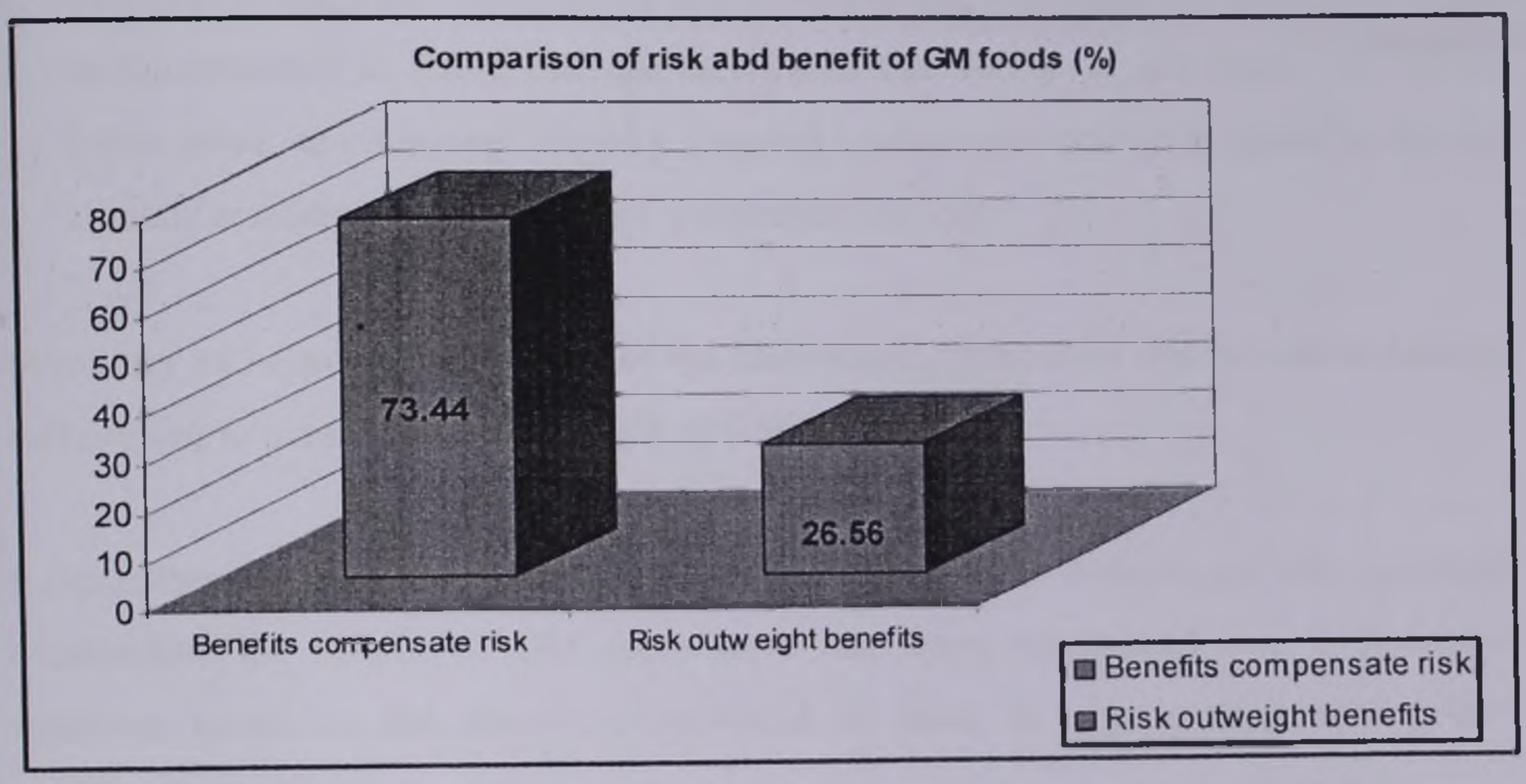
The third open ended question in the expert survey was *"Benefit of GM food will compensate the potential risk or the perceived risk of this technology will outweigh/ overshadow the benefit of GM foods."*

Qualitative researchers choose their analysis methods not only by the research questions and types of data collected but also based on the philosophical approach underlying the study (Miles and Huberman, 1994). In order to outline an interpretation and draw a conclusion from the narrative data obtained from this cognitive testing interviews of experts a special technique has been adopted as recommended by Miles and Huberman (1994). This "interpretive" approach is phenoniological in nature or based on social interactionism. Researchers using this approach would seek to present a holistic view of data rather than a condensed view. The current study seeks to describe a picture of "why this is" rather then generally not choose to categorize data to reduce it. Miles and Huberman (1994) noted that the interpretive approach might be used by qualitative researchers in semiotics, deconstructivism, aesthetic criticism, ethnomethodology and hermeneutics.

Sixty four qualitative responses against above question have been collected and analyzed for interpretation. A remarkably 73.44% respondents believe that the extraordinary features and benefits of GM foods will compensate the potential risk (if any) as it has already been proved to be safe for human consumption except a fear of unknown long term risk. Contrarily 26.56 % respondents differ from the other in a way that they believe perceived risk associated with the GM foods and the technology itself will outweigh or offset the claimed benefits.

However, respondents of both the groups have shown quite varied reasons in favor of their opinion. Based on the data analysis and following the guidelines recommended by Miles and Huberman (1994) the experts have been further categorized into four distinctive segments. A comprehensive interpretation has been outlined in the following paragraphs to distinguish the characteristics of experts in relation to their previous categorization explained earlier in this section.

Figure - 4.3: Percentage of responses for the statement *"Benefit of GM food will compensate the potential risk or the perceived risk of this technology will outweigh/ overshadow the benefit of GM foods."*



Summary of response in support of the statement: "*Benefit of GM food will compensate the potential risk*"

Respondents who believe that the benefit of GM food will compensate the potential risk have been categorized into 2 distinctive segments based on the statements provided by them for justifying their predilections about the benefits GM foods.

a) **Biotech Optimistic:** The respondents of this category have shown a very optimistic view towards the GM technology and the claimed benefits of GM crops. According to the in depth analysis of their views, biotech optimistic respondents do believe that this special type of foods are already proved safe and no risk have been reported so far by any laboratory and biological trial. Thus there is no question about compensation of risk arises. They strongly claimed that GM foods can only bring benefits to the society from many different angles. This group of respondents mostly emphasized health and economic benefits from GM foods. This prevalent group comprises 50.01 % of the total sample of which 82.67 % shows encouragement.

b) **Arguably Different:** This semi-prevalent group comprises 23.43 % of the total respondents of which 54.22 % shows encouragement and perceive GM foods as hope to feed the ever growing population of developing nations. At the same time their long

term risk perception of GM crops is also strong. This group of experts compares the unique features and benefits of GM foods with the unseen long term risk associated with GM technology. They reason that if underlying long term risk issue ever comes in consideration in future then the benefits of GM foods i.e. nutritional enrichment, lower price, environment friendly farming system and ability to grow in adverse climatic condition may or may not compensate the risk.

Summary of response in support of the statement: ***"Perceived risk of GM technology will outweigh/ overshadow the benefit of GM foods"***

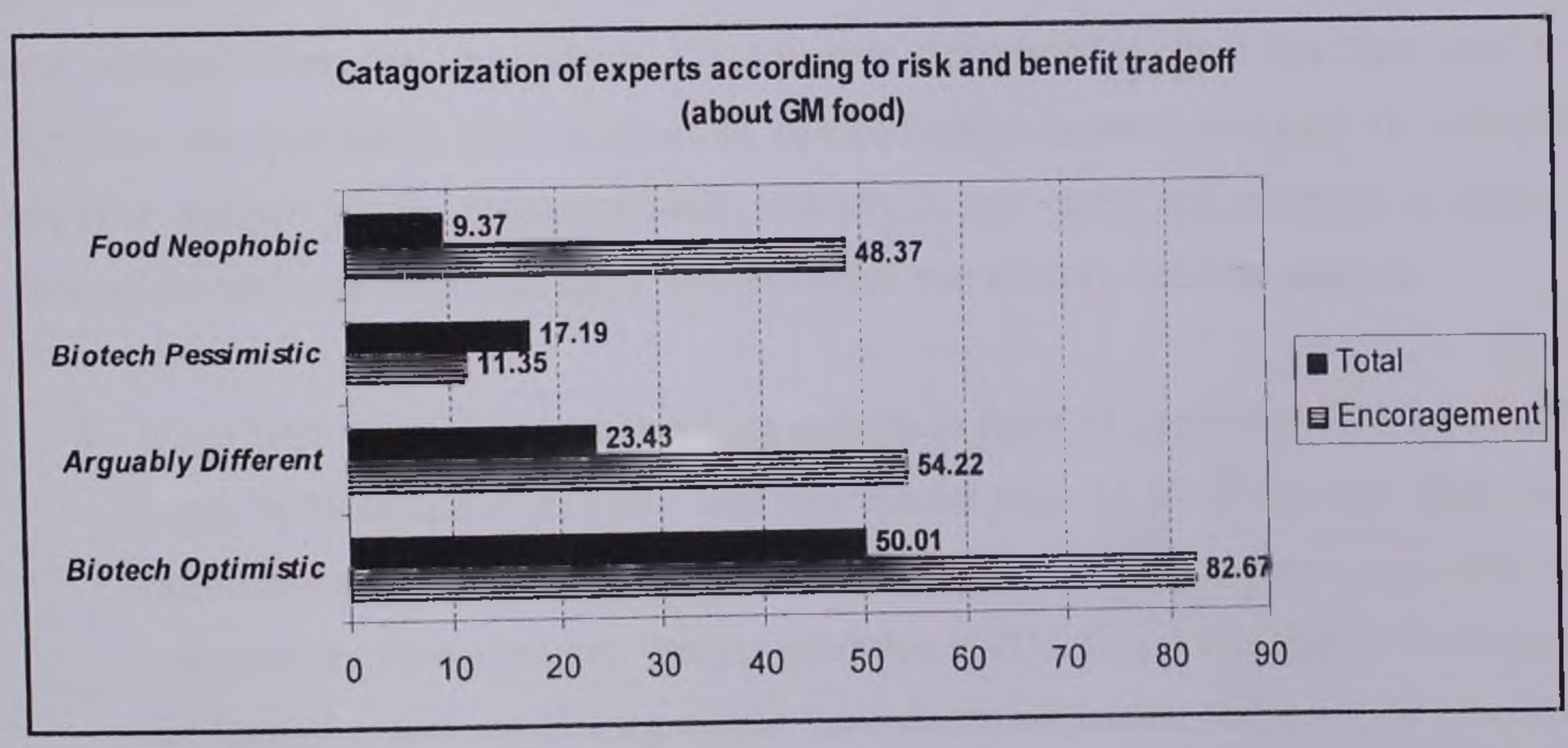
Respondents who believe that the perceived risk of this technology will outweigh/ overshadow the benefit of GM foods have also been categorized into 2 distinctive segments based on the statements provided by them in support of justifying their predilections.

c) **Biotech Pessimistic:** This group of respondents possesses a very negative view towards GM technology. They claimed that this laboratory procedure involving a drastic manipulation of genetic makeup of living organism is full of health and environmental risk. Unfortunately the devastating effect of underlying risk is rather long term than a minor short term health and environmental hazards. They argued that the potential risk of genetic manipulation can only be predicted at this stage but no quantitative data is available to compare with the benefit effect statistically or scientifically. However, they warn consumers and policy planners that while the adverse effect of GM foods comes in motion the claimed benefits of this special food type will be overshadowed. They added that no benefit will be compromised by the consumers at the risk of serious health and environmental hazards. This moderately prevailing group comprises 17.19 % of the total sample of which 11.35 % shows encouragement.

d) **Food neophobic:** This non prevalent group comprises only 9.37 % of the total sample of which 48.37 % shows encouragement and found neither very optimistic nor very pessimistic about biotechnology. This respondent group support GM food as an innovative solution for feeding the growing population of the future world. Interestingly this respondent group possesses a very affirmative view towards the

extraordinary benefits of GM foods. At the same time they are not very confident about the specific benefit and risk perception. According to the analysis and interpretation of their opinions it is evident that the risk perception of the respondents belongs to this category is not very clear to them. Thus they concluded that if any short term and long term risk is associated with this technology then the fear of unknown risk will overshadow the benefits. In addition they support the organic farming system with alternative agriculture techniques which leads to food new phobic attitude a phenomenon called paranoia (Riddell et al., 2001). The experts strongly emphasized on all the causes that usually leads to a phobia towards new food, i.e., over-nutrition, environmental contaminants, natural toxins, agricultural chemicals (including pesticides), and additives (Lee and Tyler, 1999).

Figure - 4.4: Grouping of experts according to the response regarding risk and benefit tradeoff about GM food and rate of encouragement of respective group.



From the above discussion, to a great extent it is predictable that the members of 'Relaxed' group and the members of 'Biotech Optimistic' shares some common characteristics where as the characteristics of 'Tradeoff' and 'Arguably Different' groups may be similar in nature. On the other hand it is also presumed that the probability of characteristic similarities between the 'Skeptical' and 'Biotech Pessimistic' as well as between 'Uninterested' and 'Food Neophobic' are very high. This assumption has been made by considering the holistic view of the respondents regarding GM foods obtained from the qualitative data. Thus a strong statistical conclusion can not be drawn from these results.

4.3.4 Experts' Overall Judgments about GM food Commercialization

The last open ended question in the experts' survey has been designed to explore the fundamental reasons behind a respondent's motivation for recommending or restricting GM foods in Bangladesh. It was hypothesized that there might be few unexplored variables which come in effect spontaneously while experts judge GM foods. In order to uncover the fact in more depth the respondents were further asked "why or why not they recommend GM food or crop in the country". The response summery of this narrative data obtained from the interviews has been discussed in following paragraphs in two broad categories:

1) Respondents' rationalization in favor of approving commercialization of GM crops

An extensive review and analysis have been conducted in order to interpret the qualitative data obtained from the respondents. "Interpretive Approach" method has been used to represent the qualitative data in stead of categorization (content analysis) or multiple response analysis as the responses were multiple in few cases and scattered in nature. Thus minor multiple responses have been excluded purposively from the analysis.

a) It has been revealed that a group of experts in favor of approving GM foods and crops in Bangladesh perceive that this special type of foods are free from any health and environmental risk as it has already been tested and approve by FDA to sell in international market. They argued that if FDA found this type of food risky for human consumption they would have never recommended any GM crop for commercial release in the world market. According to these experts there is no valid reason exist to restrict commercial release of GM foods in Bangladesh. This justification is consistent with the result observed by Ellahi (1994).

b) According to the data obtained from the survey of the experts, the second good reason for approving commercial release of certain GM crops in the country is very case specific. The advocates of GM food commercialization argue that some GM crops having the special features to grow in adverse climatic conditions like drought resistance, salinity and flood tolerant etc. is time demanding. Commercial approval of these crop varieties should be facilitated faster because these varieties

have already come across the laboratory and field trials. According to the experts by approving commercialization of this special food type the country can quickly tap the economic benefits of GM crops. They articulate that GM is the only way out to overcome this static problem of climate on our agriculture system.

The other reasons in favor of commercial approval of GM foods and crops include:

- A better distribution system for reduction of waste. GM crops resistant to certain insects require no pesticides and insecticides. Thus farmers and primary producers do not have to apply large amounts of pesticides and chemicals to the surrounding environment.
- Genetically engineered crops tolerant to particular herbicides, pesticides etc. may reduce the amount of pesticides used in food production and the residual pesticide levels in the environment. This dramatically reduces the primary production cost for the farmers.
- Commercialization of GM crops in Bangladesh will encourage the young scientist to invent new crop verities in our local context and will open new employment opportunities in the country.

2) Respondents' arguments against the commercialization of GM crops

The rationales of experts against the commercialization of certain GM crops in Bangladesh are summarized as follows:

a) According to the opinion of some experts the focal point of argument against the commercialization of GM crops in Bangladesh is its underlying health and environmental risk. Experts argued that GM food and crop have already been proved lethal for both health and environment in many laboratory researches. Until or unless this special variety of artificial food has been proved fully safe for human consumption it should not be recommended for commercialized production. More research on the safety issue of GM crops is need.

b) The second point of argument against the commercial approval of GM crops in the country is its poor regulation system. Experts believe that the country is yet to be well equipped to properly control and regulate GMOs like the developed nations. If commercialization of GMOs is encouraged in the country at this

stage it may turn out with a boomerang effect on the whole agricultural system of the nation. Proper regulation of GMOs is a prerequisite for saving our indigenous crop variety from crosspollinations.

c) The third issue prioritized by the experts against the approval of GM crops in the local market is the strict labeling policy of the products. According to the experts GM variety is distinctively different from the conventional counterpart of the original crop in terms nutritional contents as well as other aspect. A mandatory labeling policy for this type of food is very difficult to maintain in Bangladesh where food regulation policy is very weak and corrupted. The respondents argued that the present food regulation law and the regulating authorities are a complete failure in controlling toxic additives and preservatives in organic and processed foods. If GM crops are allowed for sales in the local market it would face the same consequence. The experts also added that food that is prepared at the point of sale (takeaway and restaurant food) can not be labeled and a consumer can not assess the presence of any GM ingredient in the particular food. Unlabeled restaurant foods have a higher chance of provoking allergic reactions to people having known allergenicity to particular GM ingredients.

d) Last but not the least opponents of GMOs commercialization in the country have extracted out several socioeconomic and ethical issues in support of their arguments. Concerns about the socioeconomic and ethical issues surrounding genetic modification include:

- The possible monopolization of the world food market by large multinational companies that control the distribution of GM seeds.

- Using genes from animals into plant to create foods may pose ethical, philosophical or religious problems. For example, eating traces of genetic material from pork could be a problem for certain religious or cultural groups.

- Animal welfare could be adversely affected. For example, cows administered with more potent GM growth hormones could suffer from health problems related to growth or metabolism.

- New GM organisms could be patented so that 'life' itself could become commercial property through patenting.

4.4 Conclusion

In this analysis of the experts' survey data informed by qualitative interviews and other quantitative analyses four different groups of respondents has been identified initially based on a two-by-two classification of risk and benefit perceptions. It is notable that in the context of GM foods there are a sizeable number of respondents in the group labeled ".trade-off". Around 20% of the sample believes that GM foods offer both risk and benefit. The other two groups of interest were labeled "skeptical" perceiving no benefits and carry only risks and "relaxed" perceiving only benefit and no risk. A small number of respondents labeled "uninterested" have shown non attitudes.

Analysis of the characteristics of these four groups has shown that experts differ in respect of key cognitive resources that may inform their views of GM foods. Furthermore, comparing the "trade-off" group with each of the other two groups indicates that different resources are predictive of both risk perception and of benefit perception. This suggests that the three groups might be making judgments about GM foods in different ways. This hypothesis is confirmed in a set of analyses. First, although risk and benefit perception are prime predictors of encouragement, a significant interaction effect is also found from the analysis of quantitative data by using a multiple regression model. This effect was also found to be robust to the inclusion of a number of relevant background variables as controls in the work of Gaskell et al., (2004). However, the statistically significant background variables are a) Ethical and moral concerns; b) Labeling of GM foods; c) Control mechanism of GMOs and d) pricing of GM s food, fed and seed including control of MNCs over the farmers and GM food market. Second, the current study has utilized other qualitative data in order to understand characteristics of different group members. Considerable similarities have been encountered between the members of different groups. The analysis of both the classification approaches of group members employed in this study suggests that the 'tradeoff' and the 'arguably different' perceive benefits in GM foods at the same time they weight the risk factors of this technology increasingly. On the other hand 'relaxed' and 'tech optimistic' encourage GM foods only weighing the benefits and no risk where as the 'skeptic' and 'tech pessimistic' discourage GM foods

only weighing the risk not benefits. A phenomenon called "Food Neophobia" might be the leading cause behind the non-attitudes of 'uninterested' group.

The analysis of both the qualitative and quantitative data led the current study to the tentative conclusion that perception of benefits, in particular the absence of perceived (visible) benefits as well as underlying health risk factors act as dominant attributes: a unconditional prerequisite of any level of support towards GM foods. However, the findings of a robust interaction between risk and benefit may be interpreted as evidence of different decision making strategies in the three groups. If benefit is perceived then the respondent goes on to think about risk and these two attributes are combined into an overall judgment of encouragement. This is the possible strategy for the 'tradeoff' group. By contrast for the skeptics, either the underlying risk itself or the absence of perceived (visible) benefits acts to truncate their deliberation on the issue. If the absence of benefits is considered alone and not associated with the risk attributes then the attribute of risk is deemed irrelevant and accordingly has less influence on the final judgment of encouragement as found by Gaskell et al., (2004). However, analysis suggests that this is not the case rather the perception of risk acts predominantly for skeptics' decision making strategies. Here the implied decision model is lexicographic. Lexicographic preferences (lexicographical order) based on the order of amount of each good describe comparative preferences where an economic agent infinitely prefers one good (X) to another (Y). Thus if offered several bundles of goods, the agent will choose the bundle that offers the most X, no matter how much Y there is. Only when there is a tie of Xs between bundles the agent will start comparing Ys (Slovic et al., 2002). It is presumed from the analysis that this decision making strategy by 'skeptic' and 'relaxed' groups is possibly based on Slovic's (2002) affect heuristic. The affect heuristic is a heuristic in which current affect influences decisions. In this heuristic decision makers simply put a "rule of thumb" instead of a deliberative decision. It is one of the ways in which human beings show bias in making a decision which may cause them to take action that is contrary to logic or self-interest (Slovic et al., 2002). A heuristic is a mental shortcut that allows people to make decisions and solve problems quickly and efficiently. "Affect" in this context is simply a feeling of fear, pleasure, surprise, etc. In other words, it is a type of heuristic in which emotion plays a lead role. The affect heuristic has been typically used while judging the risks and benefits of something, depending on the positive or negative feelings that a

subject associates with a stimulus (Finucane et al., 2000). It is the equivalent of "going with your gut." If one's feelings towards an activity is positive then subject is more likely to judge the risks as low and the benefits high whereas if his/her feelings towards an activity is negative the subject is more likely perceive the risks as high and benefits low. For the 'relaxed' group the implied heuristic is far from clear. Their perception of benefits may lead them to ignore the risks (lexicographic) or they may deliberate on the risks, judge them to be minimal and combine the two attributes according to the Slovic's (2002) model.

However, these speculations made in the current research are considered with caution not only because they are ex post but also due to the limitations in the data. There have been no independent assessment of the relative importance of benefits and risks as dimensions of judgment as would be required for testing a multi-attribute decision strategy. Here a parsimonious explanation would be that the three groups attach systematically different weights to the two attributes namely risks and benefits and it is the use of different weights that could account for the interaction effects of other associated variables which is not assessed in the current study. Further research might test the generality of these decision-making processes with a range of biotechnologies, including the widely supported medical applications of GM technology.

4.5 Implications

The main implication of the Empirical Model of experts (Figure-4.1) is very clear that is policy makers and firms' decision makers need more research specifically addressed to better understand the full process in order to adopt meaningful and efficient strategies and policies. This is one of the main challenges for social scientists in future research. However, the implications of the conclusion of risk and benefit analysis is that assumptions about the bases of opposition to GM foods need to be reconsidered. From the expert's viewpoint GM food is an innovation with obvious benefits. Opposition is seen as the result of exaggerated risk perception in most cases. Hence, policy responses should have been directed toward allaying public anxieties about any possible risks. For example, the dissemination of "accurate" risk assessments by trusted experts; the making of risk assessment procedures more transparent; and the relativising of the possible risks against other hazardous activities that engage people without apparent concern. Many of these

approaches have been based on, or at least parallel to some of the literatures of risk analysis and risk communication. A recent development in the literature is the concept of mental models of risk. Given the relative failure of risk communication based on scientific conceptions of risk, the idea is to understand lay people's mental models such that messages can be couched in ways that will be more readily understood. Lying behind policy and social scientific thinking on the GM food controversy is a framing of the problem as almost exclusively a risk issue. From a critical point of view it could be argued that it might be "misinformation" about the risks of GM foods stirred up by activists and circulated by the media which led the public to view GM foods as risky. It is possible but if consider the case of another new technology "mobile phones", concerns about the health risks of this technology are frequently aired. The risk of brain damage particularly to children has been discussed in many countries. But at the same time the penetration and use of mobile phones has increased by the year. This is because they are useful and the benefit is visible as such people are prepared to accept the possibility that there may be problems in the future. It is also important to note that using a mobile phone is a voluntary activity in contrast to GM foods for which labeling has been a controversial issue. Thus it can be concluded that the risk issue has been misperceived in the case of GM foods. In some sections of the experts the perception of risks appears to be relevant and this along with the perception of benefits informs experts' attitudes.

CHAPTER - 5

Consumers' Perceptions of GM food & their Willingness to Buy (WTB)

As discussed in the previous chapter consumers' belief regarding risk and benefit of GM foods are expected to play a significant role in shaping the purchase behavior of GM foods. However, in analyzing the purchase behavior of consumers the most crucial problem researchers may confront is that the actual behavior of Bangladeshi consumers towards GM foods cannot be fully observed. This is because consumers of Bangladesh have very limited opportunities to expose their preference for GM foods as these foods are not being sold conventionally. For instance Bangladesh has yet to commercialize any GM food (The New Nation, November 19, 2009. p.8). It is assumptions only that few GM foods or foods containing GM ingredients are available in the local market. As a result consumers still have restricted product experience due to unavailability of many GM foods and they cannot tell which foods have GM ingredients due to a voluntary labeling policy for these types of foods. Instead, researchers rely on consumers' self reporting of behavior or intention to behave towards GM foods. In psychology most behavioral scientists agree that consumers' conscious decision is strongly influenced by their intention which is believed to be the best predictor of consumer behavior (Han & Harrison, 2006). The present study is a unique attempt of its' kind in Bangladesh in terms of exploring consumers' perceptions about GM foods and has considerable similarity with the work of Harrison and Han (2005) as well as Moon and Balasubramanian (2004) reviewed in previous chapter. At the same time this study differs from other studies reviewed in chapter-2 in two ways, one is by exploring and analyzing the links or relationships between consumer risk/benefit beliefs regarding GM foods along with other associated factors and another is by identifying the linkage of the effect of these beliefs on consumer purchase intentions of those foods via attitude. In addition the present study is noteworthy as it explores a conceptual model for explaining the linkage or relationships between beliefs, attitudes, and intentions of consumers' purchase decision regarding GM foods. Moreover it determines which factors make a consumer certain or uncertain regarding the purchase of GM foods. Although a number of studies have already addressed the demographic influences on consumers' purchase intention of GM foods no study has included the factor "Access to Information" specifically for analyzing its influence on purchase intention of GM foods. This study is remarkably different from

other studies in terms of analyzing the effect of consumers' access to information as measured by their habit of reading news paper in general as well as habit of using internet in particular on their willingness to buy GM foods. The reason of inclusion of Newspaper and Internet as studied variables and exclusion of tow other major sources of information i.e. television and radio as variables for examining the effect of "Access to Information" is that; surprisingly the debate and information about GM foods are somewhat absent in television and radio media. In stead most of the general information, updates and controversial discussions about GM foods appear either as newspaper articles or as web documents (Marks & Kalaitzandonakes, 2001). The schema of the presentation in this chapter is as follows:

- Theoretical Framework
- Empirical Model
- Questionnaire and Data Collection
- Analysis of Results
- Conclusion and
- Recommendations

5.1 Theoretical Framework:

When analyzing consumer's purchase intentions an important question is to identify which factors are directly or indirectly related to the step by step development of purchase intention. The presumption is that beliefs are the key elements in forming attitudes, intentions and eventually influencing behavior. Beliefs represent the base set of information that a consumer holds about an object or concept (Fishbein and Ajzen, 1975). Thus, beliefs describe all thoughts that a consumer possess about GM foods in association with various attributes and beliefs play an important role in forming attitude mediating intentions (Moon and Balasubramanian, 2004; Bredahl, 2001; Grove and Douthitt, 1995; Kinnucan and Venkateswaran, 1990).

According to Fishbein's multi-attribute model a person's attitude toward any object is a function of his/her beliefs about the object and the implicit or unspoken evaluative responses (or aspects) associated with those beliefs (Fishbein, 1963). According to Engel, Blackwell, and Kollat (1978) attitude has been defined as "a learned predisposition to

respond consistently in a favorable manner with respect to a given alternative" (p. 388). Thus, attitude refers to consumers' favorable (positive) or unfavorable (negative) evaluation of GM food and attitude formation is closely related to the consumer's evaluation of GM food. Following Fishbein's theory a consumer's attitude toward GM foods is a function of the strength with which a consumer holds the beliefs (i.e., his/her subjective or personal probability that GM foods are related to specific attributes) and of his/her positive or negative evaluation of each attribute. The strength of belief associated with a given attribute is multiplied by the consumers' positive or negative evaluation of the attributes involved. In other words Fishbein's model proposes that attitudes of an individual towards an object is based on the summed set of his/her believes about the object's attribute weighted by the evaluation of these attributes. (Fishbein and Ajzen, 1975).

The belief effects are then summed across all attributes. Algebraically, it is hypothesized that

$$A = \sum_{i-1}^{N} B_i a_i$$

where A = consumer's total attitude toward GM foods, B_i = the consumers' belief (goodness or badness) regarding attribute 'i', a_i = the evaluative aspect (strength) of B_i, and N = the number of beliefs. Beliefs and their evaluative aspects are acquired via a consumer survey in this study. Intention indicating a certain amount of affect toward an object is defined as "the subjective probability that beliefs and attitudes will be acted upon" (Engel, Blackwell, and Kollat, 1978 p.388). While attitude is viewed as a general predisposition that does not prompt the person to perform any specific behavior, intention is related to a specific behavior (Fishbein and Ajzen, 1975).

It has been demonstrated in several past studies that consumer beliefs not only have a major mediating effect in shaping their attitude but also beliefs are significantly influenced by socio economic and demographic characteristics of individuals (Moon and Balasubramanian, 2004; Grove, Douthitt, and Zepeda, 1996; Kinnucan and Venkatcswaran, 1990; Lin, 1995). In addition, a few previous studies suggest that various socio-demographic factors influence information acquisition, consequently attitude and behavior of consumers and in turn it affects individual purchase intention (Nayga, 1996;

Florkowski et al., 1994). Thus, based on the attitude theory and previous research it is hypothesized that individual attitude is affected by both the information available to consumers and consumers' beliefs about GM foods. To accomplish the objectives of the study the choice process model by Engel, Blackwell, and Kollat (1978) is used with adequate modification in the context of Bangladesh as a conceptual basis for developing the model specification.

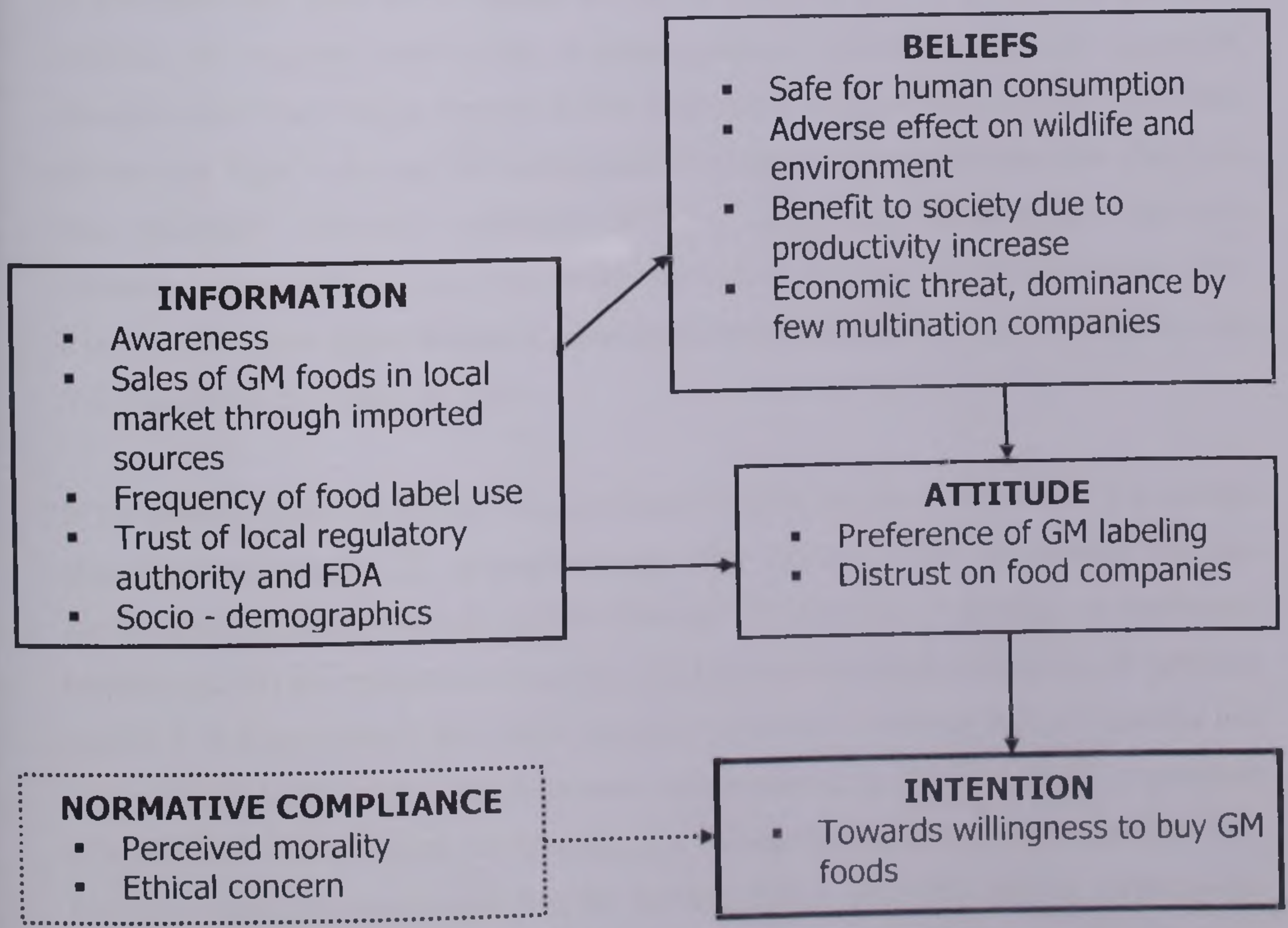
The theoretical framework for the analysis is presented in figure 5.1 in order to demonstrate and explain the step by step cognitive process of developing a consumer's purchase intention of GM foods. A consumer's purchase decision regarding GM foods is determined by his/her intention viewed as the determinant of the behavior. Figure 5.1 illustrates that consumers' purchase intentions for GM foods are affected by various types of information which have a direct effect on consumer attitude and an indirect effect via the belief system. In addition, the model shows a recursive (or sequential) linkage between information, beliefs, attitudes, and intention, where beliefs comprise the consumers' perceptions of risk and benefit regarding GM foods.

In stead of developing research hypothesis this study focus on some presumptions and assumptions to design the theoretical framework adopted from several studies reviewed in chapter-2. Based on those speculations it is hypothesized that when consumers are more informed regarding GM foods and the use of agro-biotechnology in enhancing food quality they are more likely to have a favorable attitude toward the technology and the resulted food products (Brady and Brady, 2003); conversely it is also assume that misleading information may cause a skeptical attitude which leads consumers to stand uncertain about purchasing those foods (Marks & Kalaitzandonakes, 2001).

However it is expected that if consumers believe GM foods have already entered in the local market through imported source, it is assumed that they are somewhat familiar with them, suggesting a more favorable attitude towards GM food. On the other hand this information to the consumers along with some additional negative belief factors may exhibit an unfavorable or skeptical attitude towards GM foods (Moon and Balasubramanian, 2003). In addition, it is predicted that if consumers frequently read food labels while shopping they are believed to be more concerned about health and nutrition than other consumers. Thus, a negative sign is expected between frequency of reading

food label and consumers purchase intentions of GM foods. It is believed that consumers have little knowledge regarding GM foods. To deal with lack of knowledge consumers are more likely to rely on Govt. Institutions, Consumers and Environmental groups as well as Scientist and Academicians for safety information about GM foods (Hallman et al., 2004 and 2003). It is assumed that if consumers have a high degree of trust on all above GM institutions regarding safety of GM foods they are more likely to perceive positive aspects of GM foods than those who have a lower degree of trust in these organizations. In this regard, trust plays the role of substituting for a lack of knowledge. Accordingly, the study proposes that the level of trust in different GM institutions directly affects attitudes and indirectly affects attitudes through beliefs held by consumers. It is also anticipated that if consumers trust the FDA as a regulatory institution they have less concerns about GM food safety suggesting a positive relationship between trust on the FDA and purchase intentions of GM foods.

Figure – 5.1: A conceptual model of explaining purchase intention of GM foods



Note: Adapted (with modifications) from Engel et al., 1978

As discussed earlier consumers' socio-demographic characteristics such as gender, education, age, income and degree of access to information i.e. frequency of reading newspaper and using internet have significant contribution in shaping or building consumers' purchase intention towards GM foods. While some of the signs for socio-demographics are ambiguous, some of them are expected to base upon the previous findings. It is hypothesized that female respondents are more conscious about the safety issue of foods (Gath and Alvensleben, 1998; Hoban and Katic, 1998; Lin, 1995). Thus, a negative relationship is expected between female and the purchase behavior for GM foods. However some studies also indicated that young age group has a higher percentage of willingness to buy GM foods compare to senior citizen (Heiman and Zilberman, 2000). In a similar study Misra and Huang (1991) found that the relationship between age and the perceived risk increases at a decreasing rate. Thus, it is hypothesized that older respondents may be less inclined to learn about new technology and they are more risk averse to the food safety issue than younger respondents. A negative relationship between older respondents and willingness to buy GM foods is anticipated. An individual's level of education may have direct impact on his/her ability to absorb, understand and make decisions on available information. A strong positive relationship between consumers' education level and their preference to GM food is also evident. Harrison and Han (2005) showed that highly educated consumers have 4.12 times higher preference for GM foods than minimally educated consumers. Schultz, (1975) hypothesized that education enhances the individual's ability to process new information into changed behavior. Thus, it is assumed that a higher degree of education increases the probability of purchasing GM foods approved by USDA or FDA.

In the present study consumers' risk and benefit beliefs include 5 factors: (1) perceptions regarding health risk; (2) perceptions regarding adverse effect on wildlife and the environment; (3) the economic risk for farmers; (4) perception regarding the nutritional benefits and (5) the economical benefits of GM crops to society. According to previous studies it is hypothesized that while consumers perceive direct or indirect benefits and believe that GM foods are safe for human consumption they are more likely to purchase GM foods. On the other and, while consumers are not sure about the safety aspects of GM food and more concerned regarding the adverse effects on health and the environment they are less likely to buy them. Few other researches have indicated that while

consumers perceived tangible benefits from GM foods such as lower price and reduced production costs for farmers they are more likely to buy GM crops.

Religious issues often create dilemma in developing purchase intention especially for processed food products in Bangladesh. From previous evidence of "Halal Soap" in Bangladesh it is also hypothesized that perceived social and religious influences may considerably affect the purchase intentions toward any product especially the food stuff (Kotler et al., 2010). For example, in Europe religious groups raise morality concerns about GM foods, saying that humans should not invade the realm of God (Hallman and Metcalfe; Hallman et al., 2002). Some consumers are motivated to either comply with those beliefs or not. A consumer's sensitivity to social pressures is a factor in consumer's personality makeup. That is, consumers' perceived morality about GM foods reveals a personal norm which is explained by the choice model in figure 5.1. In addition, a few past studies examined the impact of moral obligation on behavioral intentions for food related behaviors and towards GM foods (Raats, Shepherd and Sparks 1996; Sparks, Shepherd and Frewer 1995). Thus, based upon the choice model and empirical findings it is hypothesized that perceived morality will negatively influence consumer purchase intention directly and not through attitude. It is assumed that as consumers believe creating GM plants and animals are morally wrong a negative relationship is expected between their purchase intentions of GM foods and the morality. Finally a consumer's willingness to buy GM foods is hypothesized to be a function of the combinations of different types of belief regarding each attribute of GM foods discussed above.

5.2 Empirical Model

A multinomial logit (MNL) model is employed to investigate the significance of selected factors on an individual's purchase intention of GM foods described in the conceptual model in previous section. The MNL is used for three reasons. First, data for the study consist of individual specific characteristics and the MNL is well suited for analysis of characteristics of the individuals especially in the study of social science and genetics (Menard, 2001). Second, the MNL model is very popular as a discrete choice model and recommended while dependent variable are of more than two categories (Borooah, 2003), in this study dependent variables (willingness to buy GM foods) are categorized as Yes, No and Uncertain responses of the consumers. Third, an ordered probit may be used over MNL. The ordered probit model assumes that there is an ordinal nature in the alternatives.

However, the ordering assumption in the ordered probit for the study may be incorrect. Lynch, Hardie, and Parker (2002) showed that an ordered probit assuming uncertain as a middle category does not improve the model's predictive capabilities. Thus, the study doesn't consider the uncertain response to be middle category.

The basic framework for the analysis is provided by the random utility (discrete choice) model where consumers are assumed to choose among a range of discrete or distinct alternatives to maximize their utility. The random utility model is widely adopted in the field of analyzing values of non-market public goods under individual uncertainty about use, illustrating with an assessment of willingness to buy (Cameron and Jeffrey, 1997). The MNL was estimated separately for 2 different types of products, GM rice and GM Soybean oil because consumer's acceptability and willingness to buy GM foods may differ depending on the type of products.

In general MNL model can be expressed in following equation:

$$\Pr[Y_i = j] = \frac{\exp(X_i \beta_j)}{1 + \sum_{k=1}^{J} \exp(X_i \beta_k)}$$

where J is the dependent variable and the number of alternatives in the choice set. Respondents were asked if they were willing to buy GM rice and GM Soybean oil. The model is estimated with three alternatives: j =1 if the respondent indicated they would buy GM foods (Yes); j =2 if the respondent indicated they would not buy GM foods (No); and j =3 if the respondent indicated they are uncertain about buying GM foods (Uncertain). The second alternative, j =2, is used as the reference choice while loading data in SPSS software to estimate MNL.

The independent variables, X_i, is hypothesized to influence the following alternatives (dependent variables): (1) Consumer awareness of GM foods (2) Perceived morality and religious issues; (3) Attitude about specific labeling policy of GM foods and variables in regards to consumers' habit of using food label; (4) Trust in different regulatory authorities about GM foods; (5) Consumers' beliefs toward GM foods that is, consumers'

belief of risk and benefit toward GM foods; and (6) Socio-demographic factors. β_j is a vector of the estimated parameters, and $Pr[Y_i=j]$ is the probability of individual [i] choosing [j] alternative among three alternatives in the choice set namely Yes, No and Uncertain as outlined in equation. The log-likelihood function for the MNL is given by:

$$\ln L = \sum_{i=1}^{n} \sum_{j=0}^{J} d_{ij} \ln \left| \frac{\exp(X_i \beta_j)}{\sum_{k=1}^{J} \exp(X_i \beta_k)} \right.$$

where d_{ij} =1 if the individual i chooses alternative j and d_{ij} = 0 otherwise. In other words the independent variables have been encoded as 1 and 0 in SPSS software for analyzing MNL (see table 5.3 for coding illustration).

In this study results are interpreted using the odds ratio instead of marginal probabilities. Calculating marginal probabilities is not useful for evaluating the magnitudes of β in the MNL (Cropper, Maureen, Deck, Kishor & McConnell, 1993). First of all, discrete change represents the change for a particular set of values of the independent variables. Thus, the changes will not be the same at different levels of the variables. Another problem with marginal probabilities is that the dynamics among the dependent outcomes cannot be captured from measures of discrete change (Long, 1997). The odds ratio is calculated by contrasting each category in this study "Yes" and "Uncertain" groups with the reference category the "No" group. In this study the contrasts represented in the table 3.1 and table 3.2 are limited to YES versus NO response as well as UNCERTAIN versus NO response. The odds ratio shows a multiplicative change in the odds for a unit change in an independent variable.

The odds of outcome of m versus outcome n given x, specified by $\Omega_{m|n}(x)$, is as follows:

$$\Omega_{m/n}(X_i) = \frac{\Pr(y_i = m/x_i)}{\Pr(y_i = n/x_i)} = \frac{\exp(x_i \beta_m)}{\exp(x_i \beta_n)}$$

where m is one of the three alternatives (Yes, No & Uncertain), and n is a reference category.

Taking logs demonstrates the multinomial logit is linear in the logit:

$$\ln \Omega_{m/n}(x_i) = x_i (\beta_m - \beta_n)$$

The difference $\beta_m - \beta_n$ is called a contrast which is the effect of x on the logit of outcome m versus outcome n (Long, 1997). It is interpreted as follows; for a unit change in x, the logit of outcome m versus n is expected to change by $\beta_m - \beta_n$ units, holding other variables constant. Alternatively, the percentage change in the odds can be calculated by subtracting 1 from the odds ratio and multiplying by 100.

5.3 Questionnaire and Data Collection

A questionnaire was developed using Contingent Valuation Method (CVM) primarily adapted from the work of Kaneko and Charn (2005) to study the consumers' perceptions of GM foods in the Dhaka Metropolitan City. CVM has been widely used for analyzing individual characteristics of non-market products (Deodhar, 2007). The questionnaire included questions on i) consumer awareness and knowledge of GM foods; ii) ethical and moral issues; iii) mandatory and voluntary labeling preferences as well as their frequency of reading food labels; iv) trust on different regulatory agencies grading the safety of GM foods; v) consumer perception and belief about risk and benefit of GM foods; vi) willing to buy different GM foods; and lastly vii) consumers' socio-demographics.

In the first part of the questionnaire respondents were asked whether or not they are informed about GM food issues. In addition, their level of knowledge about this special type of foods and the technology involved in producing these foods were also inspected. Subsequently a "Cheap Talk" has been administered along with an information sheet briefing the background information about benefit and risk of GM foods; and the controversy around the world about the use of GM technology in food products. It also contained some specific example of GM foods in addition with a brief description of present and future uses of biotechnology in food, agriculture and medical sectors. The idea of "Cheap Talk" has been highly recommended by many researchers to eliminate the potential bias of "hypothetical evaluation questions" more specifically in the case of assessing Willingness to Pay or in this study Willingness to Buy (Lusk, 2003). Cheap

Talk usually refers to the process of explaining the hypothetical bias to individuals prior to asking a valuation question (Lusk, 2003; Cummings and Taylor, 1999). Since the present study does not investigate consumers' Willingness to Pay a modified type of cheap talk has been administered where individual's hypothetical valuation of GM foods for assessing their willingness to pay is replaced with the hypothetical evaluation of different attributes and amenities of GM foods for measuring their willingness to buy. Another reason of administering cheap talk is to make the respondents comfortable in providing specific response about a non-market object (GM foods) as well as to accelerate the response rate for each question in a precise manner. However the cheap talk was followed by several questions in regards to the respondents' general knowledge and awareness about GM foods. The next section contained several questions focusing the ethical and moral concerns of respondents related with GM food products. In the following section, respondents were asked whether they were in favor of either a voluntary or a mandatory labeling policy for GM products along with several questions to assess their habit or frequency of seeing food labels. The questions in the fourth section were aimed to assess the degree of trust of the respondents on different regulatory organizations about the safety and control of GM foods in the local market. In the fifth section an attempt was taken to uncover the perceptions of respondents about their risk and benefits belief associated with GM foods with equal numbers of question for risk and benefit respectively. The last section poses two questions on consumers' willingness to buy (or purchase) two different types of GM crops, GM rice and GM soybean oil. Finally, information regarding respondents' socioeconomic and demographic characteristics was collected. Since the term GM food itself as well as few other scientific terminologies used in several items in the questionnaire may lead to a non-response error or hypothetical bias; a translated version of each question into National Language (Bangla) in simplified texts that a layperson can understand was incorporated in the questionnaire for the ease of understanding. The respondents were provided a freedom of choice to response in either language. A sample of each questionnaire administered in consumer survey is attached in Annex-II.

The data has been collected from 724 respondents in the Dhaka Metropolitan City by using a household survey technique and finally 648 usable data was encoded and computed for the analysis. The details of the sapling technique and procedure adopted in this study are outlined in Chapter-3, Section- 3.2.2

5.4 Analysis of Results

Frequency distributions for the socio-demographic information of the sample are presented in table 5.1. Sixty three (63%) percent of the respondents were men and 37% were women. Around two third (63.9%) respondents were single or unmarried. A verity of age groups is represented in the sample with the largest percentage (60.2%) representing respondents within the age bracket of 26-35 years, designated as Age Group-2. The second largest (24.1%) designated as Age Group-1 was within the age bracket of 18-24 yrs. Almost 100% percent respondents were moderately educated of which around fifty percent (50.9%) were passed HSC or students studying at undergraduate level. However remaining fifty percent was completed their graduation (24.1%) or possess a post graduate degree (25%) respectively. By profession (occupation) around half of the respondents were private service holders accounting for 47.2% followed by unemployed or probably students comprising 29.1%, self-employed 15.3% and Govt. service holders 6.5% respectively. A very negligible 1.9% was professionals from other stream (unspecified). Remarkably more than 80% percent of the respondents have the habit of reading news dailies of which 60.5% reads newspapers on a regular basis and 21.1% reads more than often respectively. Respondents' use of internet exhibited a mixed result as only 25% have a regular access to the internet while another 25% use internet more than often. A large percentage of respondents (38.9%) have occasional use of internet followed by the limited users account for 7.4% and nonuser 3.7% respectively. Figure-5.2 shows the gender and marital status of the respondents. The ratio of male and female respondents is 60:40. Interestingly the same ratio is prevailing for married and unmarried respondents.

Figure - 5.2: Gender and marital status of the respondents.

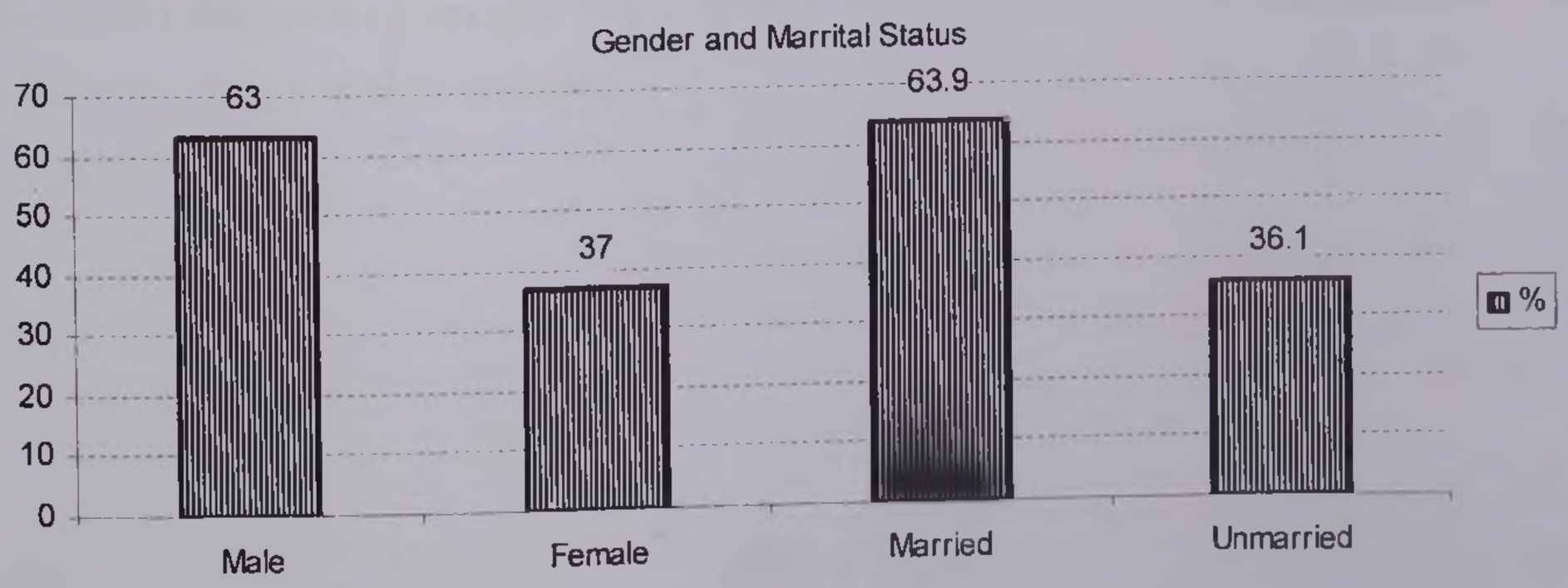


Table-5.1: Demographic profiles of the respondents.

Demographic Profiles	Sample Number (N)	Sample Percentage (%)
Gender		
Male	240	63.0
Female	408	37.0
Marital Status		
Married	414	63.9
Unmarried	234	36.1
Age (years)		
18 – 24	156	24.1
25 – 35	390	60.2
36 – 45	66	10.2
46 – 55	36	5.5
56 – Over	00	0.0
Education		
< HSC	0.0	0.0
HSC / Undergrad Students	330	50.9
Graduate	156	24.1
Postgraduate	162	25.0
Others	00	0.0
Income (taka per month)		
< 10,000 – 10,000	66	10.2
11,000 – 15,000	144	22.1
16,000 – 20,000	108	16.7
21,000 – 25,000	48	7.4
26,000 – 30,000	24	3.7
31,000 – 35,000	48	7.4
36,000 – 40,000	60	9.3
41,000 – 50,000	60	9.3
51,000 – Over	90	13.9
Occupation		
Unemployed / Student	189	29.1
Self-employed	99	15.3
Private service	306	47.2
Govt. service	42	6.5
Others	12	1.9

Table 5.2 reports descriptive statistics (mean and standard deviation) for all items used to construct the theoretical variables and brief descriptions of each question. Additional descriptive statistics of several items of the theoretical variables are presented in Table: 1 to 16 and Chart: 1 to 9 as annexure.

Table-5.2: Summary statistics and variable definition (Consumer Survey)

Sl	Variables	Mean	St. deviation
1	Have you read or heard about the use of biotechnology, genetically engineered or genetically modified ingredients in the production of food.	0.65	0.478
2	How well informed would you say you are about genetically modified food	2.42	1.132
3	Are there any foods produced through genetically modified in your local super market	1.79	0.914
4	Genetic modification violates the basic principle regarding the relationship between human and nature	3.11	1.494
5	Creating GM plants and animals are morally wrong	2.85	1.394
6	Transfer of genes between different species is unnecessary	2.84	1.196
7	The transfer of a forbidden animal's genes into a plant / animal will make the GM food forbidden/haram too	2.83	1.715
8	Use of pig gene in insulin production is acceptable as it is a drug	3.69	1.310
9	Nutritional information influence my food choice	4.09	1.033
10	I see food labels while I purchase processed food	3.82	1.291
11	I see nutritional section in food labels	3.17	1.489
12	I see only expiry dates in food labels	3.57	1.417
13	Presence of GM labels may confuse or negatively affect my choice	3.31	1.297
14	Labeling of GM fruits and vegetable is impossible to maintain in Bangladesh	3.06	1.394
15	How often do you read the nutritional section of Familiar foods	2.74	1.236
16	How often do you read the nutritional section of New foods	1.72	0.891
17	How much you trust Government agencies for testing, inspection & regulation of GM crops	1.79	1.278
18	How much you trust Consumer and environmental groups for inspection & regulation of GM crops	2.49	1.495
19	How much you trust Food and Agribusiness companies for inspection & regulation of GM crops	2.46	1.405
20	How much you trust Scientist and Academicians for testing, inspection & regulation of GM crops	3.47	1.438
21	GM food can have unforeseen harmful effect on human health	3.52	1.252
22	GM food can lower your risk of heart disease and some types of cancer	3.35	1.134
23	GM foods are beneficial to your health because it has enhanced nutritional contents	3.57	1.157
24	GM crops are beneficial to health since they lead to foods with less chemical residue	3.49	1.077
25	GM food may be harmful to people having allergic reactions to particular food	3.60	1.072
26	GM crops are beneficial for society as they lower the farmer's production cost	3.35	1.280
27	GM food should be separated from ordinary food to prevent contamination	3.70	1.031
28	GM crops benefit consumers because they lower food price	3.22	1.243
29	GM crops benefit consumers because they lower food price	3.48	1.143
30	The herbicide used with GM crops kill plants that are beneficial to wildlife	3.75	1.204
31	GM crops threaten indigenous plants and animals	3.38	1.360
32	I have no problem buying GM food	3.57	1.322
33	I avoid buying GM food	2.44	1.287
34	I am afraid of eating GM food	2.85	1.194
35	I would be willing to buy GM food if they are less expansive	3.87	1.285
36	Would you purchase Vitamin A-containing GM rice	1.56	0.843
37	Would you purchase GM Soybean oil with omega-3 fatty acid	1.31	0.660
38	Would you purchase Insect free GM Brinjal	1.33	0.705
39	Would you purchase GM medicine	1.21	0.594
40	Benefits of GM food will compensate the potential risk of the technology	3.65	0.809
41	The perceived risks of this technology will outweigh the benefit of GM food	2.42	1.165
42	I recommend GM food for commercial use in Bangladesh	3.56	1.092
43	I support scientific development as an endeavors for human welfare	3.36	1.085

However for the analysis of MNL regression, computed contrasts obtained from the results of MNL are reported in Tables-5.3 for the GM Vitamin -A Rice model and Table-5.4 for GM Soybean Oil model. The estimated models are statistically different from zero at the $\alpha = 0.01$ significance level as indicated by their respective Chi-square statistics. The magnitudes of the contrasts are obtained from MNL results by testing the null hypothesis that contrasts are equal.

I. Consumers' Willingness to Buy Vitamin-A containing GM Rice

The analysis of consumers' willingness to buy vitamin-A containing GM variety of rice is presented in following two sections:

YES vs. NO response

Results show that consumers' prior knowledge about GM foods and the technology used in making these types foods has a positive impact on their willingness to buy GM rice. The estimated coefficients on statements S1, and S2 are statistically significant at the α = 0.01 significance level. The odds ratios for S1 & S2 are 6.48 and 2.24 respectively. This suggests that consumers more informed about GM technology are 6.48 times more likely to buy GM foods compared to those who are either minimally or not at all informed about GM foods. This result is highly consistent with findings of Harrison and Han (2005). However consumers who believe that GM foods are being sold in the local market have 2.24 times greater likelihood of buying GM rice from those who do not believe that GM foods are available in market.

As expected consumers' perceived morality has a negative effect on their purchase intention of GM foods. The estimated coefficients for both the statements S3 & S4 relating to the morality and ethical issues of GM foods are of negative values (-1.41 & -1.72). According to their respective odds ratio it is evident that consumers who believe "creating GM plants & animals are morally wrong" (S3) are 0.24 times less likely to buy GM rice relative to the respondents who do not believe so and agreed buying GM rice (the "YES" group). However the people who believe that "the transfer of a forbidden animal's gene into other food crops may turned the resultant GM food crops forbidden/haram too" (S4) are only 0.18 times less likely to buy GM foods compared to the consumers who do not agree with the above statement. These results are also consistent with two noteworthy studies by Ellahi (1994) as well as Moon and Balasubramanian (2001; 2007). In addition, the results also support the hypotheses that consumers' choice of specific labeling policy (S5) for GM foods influences their purchase intention. Consumers who require a mandatory labeling of GM foods because of concern over health risk are less likely to buy GM rice. As predicted the estimated coefficient on the statement S5 is statistically significant at the α = 0.01 significance level and has a negative sign which suggests that consumers' preference for a mandatory labeling policy

and their willingness to buy GM foods are negatively associated. The odds ratio that consumers who support FDA recommended voluntary labeling policy will also purchase GM rice is 0.26 times smaller from those who prefer a mandatory labeling for GM foods. Thus consumers supporting a mandatory labeling policy have a lesser possibility to buy GM rice than those who support a voluntary labeling policy. This result signified the fact that consumers concerned over the possible negative impacts of GM foods tend to be more sensitive about a mandatory labeling policy and may have an unfavorable attitude toward GM foods which is also supported by the findings of Douthitt, (1990) and Kelley, (1995).

The results also indicated that consumers' degree of trust regarding the safety of GM foods on Scientists & Academicians (statement S8) also plays significant role on their purchase intention of GM foods. The more they possesses trust on scientists and academicians the more they likely to buy GM foods. The estimated odds ratio for S8 is 3.13, suggests that consumers have shown a relatively greater degree of trust on scientist & academicians regarding the safety issue of GM foods. Consumers who trust the scientist group for the safety of GM foods have 3.13 times greater likelihood of purchasing GM rice in contrast to the respondents having minimum or no trust on this community about food safety.

Four specific statements were presented to the respondents relating to their perceptions of benefit from GM foods, the estimated coefficients of three statements, S13 and S15 are found statistically significant at the $\alpha = 0.01$ significance level followed by S14 which is statistically significant at $\alpha = 0.05$ significance level . Thus it is concluded that the likelihood of purchase intentions of consumers who believe GM foods are safe for human consumption (S13) and also perceived tangible benefit from GM foods as it can be purchased in a comparatively cheaper price (S15) is relatively higher from the respondents not believing these two statements. The odds of a consumer's intention to buy GM rice are 7.50 and 6.64 times greater if the individual agreed with statement S13 and S15. These results are consistent with the finding of Moon and Balasubramanian (2003) that food safety and benefit to society have positive effect on the probability of buying GM foods. On the other hand the odd of a consumer's willingness to buy GM rice is 4.74 times higher if the individual believes GM foods contain higher nutritional value (S14).

According to the results presented in table-5.3; only one amongst four variables associated with consumer's risk perception of GM foods is statistically significant at the $\alpha = 0.01$ significance level. As expected the estimated coefficient (-3.00) on statement S9 has a negative sign. By analyzing the estimated odds ratio it is interpreted that consumers who believe "GM foods may have unforeseen harmful effect on human health" are only 0.05 times less likely to buy GM crops then those who do not think so. This result is also consistent with some studies reviewed in chapter-2. In a study Lusk and Coble (2005) showed that consumers fear about unforeseen harmful effect of GM foods is one of the major mediating factors towards the acceptance and rejection of GM crops. In addition the coefficient on another risk variable S12 is statistically significant at the $\alpha = 0.05$ significance level and has a negative sign too. The odds ratio on S12 suggests that consumers concerned about the possible harmful effect of GM crops on the wildlife and environment are 0.25 times less likely to buy GM rice. This little apprehension of consumers over the environmental issue seems be related with the recent awareness about global worming issues and concern over the possible adverse effect on environment. Table-5.3 shows that other two coefficients on risk perception variables (statement S10 & S11) have expected negative signs but these are not statistically significant and excluded from discussion.

As described in the conceptual model in Figure-5.1 and discussed in the review of literatures in chapter-2 that consumers' socio-demographic characteristics are also significantly associated with their purchase intention of GM foods (Moon & Balasubramanian, 2003). Results indicated that the young age group has greater likelihood of buying GM rice than the older people. The coefficient on age is statistically different from zero at $\alpha = 0.05$ significance level and has a positive sign. The estimated odds for consumers under age bracket (18-35 yrs) is 2.47 times grater than the consumers with age bracket over this range which is consistent with the finding of Hallman et al., (2003). This is probably because young age groups have more awareness and knowledge about current innovations of science and technology and have a positive attitude towards the use of technology for the ease of mankind. Moreover the coefficient on education is also statistically significant at the $\alpha = 0.05$ significance level and consistent with the findings of Heiman, Just, and Zilberman (2000) and Hallman et al., (2003). The estimated odds for consumer having either a graduation degree or studying at undergrad level is 2.47 times higher than the consumers having an education less than that or otherwise.

However this finding is not significant in the context of present study as incidentally 100% respondents are found moderately educated. Thus it is not meaning full to conclude from this result that graduated people or under graduate students have a greater likelihood of purchasing GM rice than respondent having education status otherwise.

From the analysis of data an interesting finding has been revealed that consumers' habit of reading newspaper and their frequency of using internet have strong influence on their attitude towards willingness to buy GM foods. The uniqueness of the present study is that these two variables have not been incorporated in any similar studies before. However, Thomas et al, (2009) have studied the significance of consumers' information acquisition and its correlation of their willingness to buy GM foods. The estimated coefficients for these two variables are statistically significant at the $\alpha = 0.01$ significance level and each has a positive sign, suggesting consumers degree of access to information have significant correlation with their willingness to buy GM rice. The odds ratios for consumers having a habit of reading news paper and using internet on a regular basis or very often are 3.74 and 3.99 times grater respectively than those who read newspapers and use internet very occasionally. This can be interpreted like that consumers having a habit of reading newspaper and using internet more than often or on a regular basis are knowledgeable about the pros and cons of GM foods and the ongoing worldwide debate about GM food and GM technology. It can also be predicted that they have grown positive attitudes as well because initial adverse attitudes towards GM foods are being relaxed day by day and this positive transformation of public attitude in USA and Canada is also widely covered by the media and web (Fernandez and Caswell, 2006).

Table 5.3: Estimation of MNL for Vitamin-A containing GM Rice

	Variables	Yes[1] vs No[2] Response			Uncertain[3] vs No[2] Response		
		Coeff.(Std.Err.)	*Exp(β)*	*Sig.*	*Coeff.(Std.Err.)*	*Exp(β)*	*Sig.*
S1	Level of information about GM foods (1= very well, moderately & somewhat informed, 0= not at all or minimally informed)	2.015 (0.552)	6.484	0.001***	-0.033 (0.543)	0.968	0.952
S2	GM foods are being sold in the local market (1= yes, 0= otherwise)	1.009 (0.459)	2.243	0.000***	-2.721 (0.529)	0.066	0.000***
S3	Creating GM food is morally wrong	-1.410 (1.004)	0.244	0.016**	0.546 (0.495)	1.726	0.270
S4	GM crops transformed with genes of forbidden animal should be forbidden	-1.723 (0.567)	0.179	0.002***	-2.108 (0.592)	0.121	0.000***
S5	Choice of labeling policy (1= Voluntary, 0= Mandatory)	-1.344 (0.505)	0.261	0.008***	0.160 (0.604)	1.174	0.791
S6	Habit of reading labels of new food (1= Always & Often, 0= Otherwise)	0.091 (0.413)	1.096	0.825	0.859 (0,644)	2.360	0.182
S7	Trust on Govt. agencies regarding safety of GM food	0.348 (1.416)	0.433	0.443	-1.549 (0.573)	0.213	0.007 ***
S8	Trust on Scientist & Academicians regarding safety of GM food	1.142 (0.464)	3.134	0.014**	-0.033 (0.543)	0.968	0.952
S9	GM foods may have unforeseen harmful effect on human health	-3.009 (0.500)	0.049	0.000***	2.635 (0.573)	4.524	0.000 ***
S10	GM foods may cause allergic reaction to some individual	-0.562 (0.448)	0.570	0.209	-0.987 (0.448)	0.373	0.028 **
S11	GM foods can affect farmers by overdependence on GM seed companies	-0.362 (0.509)	0.697	0.478	1.509 (0.596)	3.740	0.001***
S12	GM foods may be harmful wildlife and environment	-1.366 (0.551)	0.255	0.013**	0.509 (0.494)	1.663	0.303
S13	GM foods are safe for human consumption	9.805 (0.610)	7.501	0.001***	-0.917 (0.418)	0.373	0.228
S14	GM foods contains higher nutritional contents	1.896 (0.486)	4.747	0.011**	2.251 (0.637)	4.192	0.000***
S15	GM foods can benefit society by reducing food price	9.651 (0.538)	6.644	0.000***	0.000 (0.000)	0.000	0.000
S16	GM foods can help farmers by reducing production cost	1.321 (0.458)	3.423	0.000***	1.730 (0.479)	3.944	0.000***
	* For S6 – S 16 (1= SA & A, 0=Otherwise)						
	Demographics						
	Gender (Male =0, Female = 1)	0.160 (0.604)	1.174	0.791	2.714 (0.607)	5.082	0.001***
	Age (18yrs – 35 yrs =1, Otherwise =0)	1.007 (0.501)	2.737	0.044**	0.503 (1.069)	1.654	0.638
	Education (Students & Graduates =1, Otherwise = 0)	0.905 (0.414)	2.472	0.029**	0.555 (0.450)	1.742	0.217
	Newspaper Reading Habit (1= Regular & Often , 0= otherwise)	1.558 (0.619)	3.749	0.003***	9.854 (0.000)	9.500	0.172
	Use of internet (1= Regular & Often, 0= otherwise)	1.869 (0.336)	3.992	0.000***	9.742 (0.000)	5.641	0.177

, *, indicates estimated coefficient is significant at the 0.05, and 0.01 level, respectively. N = 648; Chi-square (X^2)= 326.595; [1)] means consumers willing to buy GM foods; [2)] means consumers not willing to buy GM foods; [3)] means consumers are not certain about buying GM foods; [4)] is odds ratio. Pseudo R-squared: 0.490.

NO vs. UNCERTAIN response

According to the estimation presented in table 5.3 the coefficient on statements S2 and S4 are statistically significant at $\alpha = 0.01$ significance level and have negative signs which suggest that as consumers consider GM foods are being sold in the local market and transfer of forbidden animal's gene into a crop will result a haram or forbidden food, they are more likely to be uncertain about buying GM rice relative to not buying. The estimated odds for individuals agreeing with statement S2 & S4 and not buying GM crops are 0.06 and 0.12 times lower respectively than the uncertain group.

It is expected that consumers who have very limited trust on the government regulatory agencies regarding the safety of GM foods may exhibit either a negative or an indecisive attitude toward buying GM rice. A negative sign for the statement S7, which is statistically significant at the $\alpha = 0.01$ significance level, support this notion. The estimated odds for statement S7 suggest that the odds for consumers disagreeing with statement S7 (or distrust on Govt. Regulatory Agencies) and uncertain to buy GM rice is 0.21 times greater than consumers certainly not buying.

In the present study one of the risk variables was overdependence of farmers on GM seed producing multinational companies. The estimated coefficient on statement S11 is statistically significant at $\alpha = 0.05$ significance level. The odds on the S11, suggests that consumers who believe that farmers can be negatively affected by overdependence on the GM seeds producing companies are 3.74 times uncertain about buying GM rice relative to consumers who unquestionably do not buy GM rice.

The estimated coefficient on statements S14 and S16 are statistically different from zero at the $\alpha = 0.01$ significance level. Although inconsistent with the expectation, consumers who believe GM foods contain higher nutritional value (S14) and it can reduce production cost for farmers (S16) are more uncertain to buy GM foods. The odds for these two benefit variables are increased by 4.19 & 3.94 times respectively for consumers who uncertain about buying GM rice as contrasted with consumers who are definitely not buying GM rice.

uncertain than male respondents for their willingness to buy GM crops relative to not buying. A possible explanation for this result is that females are more likely to make food choice for married households than males and females are expected to be more concerned about GM issues (Gath and Alvenslebe, 1998; Hoban and Katic, 1998). Thus it is acceptable that female consumers would be more reluctant of buying GM products. However this uncertainty may arise from receiving contradictory information about GM foods.

Table 5.3 indicates that the most crucial factors influencing purchase intention for GM rice are consumers' perception about the safety of GM foods (S13) and its price benefit (S15) to the society respectively. This suggests that consumers have relatively stronger sensitivity to health issues and price advantages of GM foods. In addition it implies that consumers who have prior knowledge about relative level of risk and benefit of GM foods and also perceive some tangible benefits from this special type food like higher nutritional content and reduced production cost for farmers are more likely to buy GM rice. Moreover, results indicated that ethical issues and preference for mandatory labeling of GM foods are also important factors that affect a consumer's intention for not to buy GM crops, respectively. That is, it is interpreted that consumers have greater concerns about violation of morality of GM foods since this technology is tampering the basic principles regarding the relationship between human and nature. An interesting finding is that consumer's trust on the scientist and academicians about the safety of GM foods has appeared as an important mediating factor along with other safety issues. Consumers having a positive intention of buying GM rice have also shown a remarkably greater trust on this community about the safety of GM foods. One of the research hypothesis was that consumers who believe that GM foods contains higher nutritional value and it can reduce production cost for poor farmers will definitely be agreed to buy GM rice. However, somewhat interestingly the research hypothesis is not supported by the findings of the present study since consumers even relying on above two benefit variables are relatively uncertain about purchasing GM rice.

Among demographic variables consumers' habit of reading newspapers and using of internet on a regular basis are found the most important factors in shaping their attitudes towards GM foods. In addition consumers' age and level of education are apparently important factors too for influencing their willingness to buy GM rice. Another

noteworthy finding of the analysis is that female respondents are comparatively more uncertain of purchasing GM foods.

II. Consumers' Willingness to Buy GM Soybean Oil

YES vs. NO response:

Consumers' willingness to buy GM Soybean oil is presented in table 5.4. Interestingly the respondents have exhibited a wide varying attitude towards their willingness to buy GM Soybean Oil than GM Rice. As expected consumers' risk and benefit perceptions in addition to other associated variables regarding GM foods are considerably different while measuring the purchase intention for GM Soybean Oil. In other words consumers have different set of perceptions and preferences about the GM foods for tow different types of GM food products.

Results indicated that consumers having prior information about GM foods exhibited a relatively higher likelihood of purchasing GM Soybean oil than the consumers relatively ignorant about GM foods. The estimated coefficient on statement S1 is statistically significant at the $\alpha = 0.05$ significance level. The odds ratio on SI indicated that the likelihood of consumers purchasing GM soybean oil is 11.28 times greater if the respondents previously informed about GM foods. There could be two probable explanations of this wide variation of odds ratios with rice model regarding this particular variable, one if consumers somehow believe that GM soybean oil is less risky or more beneficial compared to GM rice and the other is if consumers are more interested in buying GM oil than GM rice. As expected and similar with rice model the estimated odds ratio on S2 which is 2.73 in the soybean model indicates that consumers' probability of buying GM soybean oil is also higher if they believe GM foods are being sold in that local market. In addition, statements on ethical and moral concerns over the GM issues and consumers' preference for a specific labeling policy are statistically significant at the $\alpha = 0.05$ and $\alpha = 0.01$ level respectively and both have negative sings. These results support the hypotheses that consumers sensitive towards the ethical and moral issues of GM foods and require a mandatory labeling for this type of foods are less likely to buy GM Soybean Oil. The odds ratio for these two factors are smaller by a multiplicative factor of 0.33 and 0.11 (for S3 and S4) and 0.42 (for S5) respectively.

As found in the rice model consumers' trust on scientists and academicians regarding the safety and control of GM foods is statistically significant at the $\alpha = 0.01$ level suggest that the more consumers trust this community about food safety the greater the likelihood of purchasing GM soybean oil. This is supported by a positive sign and 5.06 odds ratio of consumers who trust scientists and academicians regarding food safety. In addition, the coefficients on consumers' concerns for unforeseen heath risk (S9) and fear for overdependence on GM seed producers (S11) are statistically different from zero at the $\alpha = 0.05$ and $\alpha = 0.01$ significance level and have anticipated negative signs. The odds ratios for purchasing GM soybean oil are about 0.03 and 0.42 times smaller if consumers believe GM foods have potential unknown health risk and may cause overdependence on GM seed producers. However consumers concerned about the harmful effect of GM foods on wildlife and environment are less likely to buy GM soybean oil. This is supported by a negative sign and 0.03 odds ratio for the statement S12. As expected, the estimated odds for benefit variables S13 and S14 are 3.05 and 1.98 indicating that if consumers consider GM foods are safe for human consumption and also contain higher nutritional value; their willingness to buy GM soybean oil is 3.0 and 2.0 times greater respectively from those who do not see these benefits.

Unlike the rice model the socioeconomic and demographic variables are not found statistically significant in the soybean model. However, the two variables regarding consumers' access to information also turned out significant in the GM soybean model at the $\alpha = 0.01$ significance level and have positive signs. The respective odds ratio on information variables suggest that consumer having a regular access to information specifically newspaper and internet have 1.27 and 1.28 times greater likelihood of buying GM soybean oil compared to the consumers having a limited access to those information.

NO vs. UNCERTAIN response

The estimated coefficient on statement S3 is statistically significant at the $\alpha = 0.01$ significance level and has a negative sign. This result supports the research hypothesis that as consumers perceived ethical and moral obligations their probability of not buying GM soybean oil increases. This result is also consistent with findings of Hallman et al., (2004) as well as Moon and Balasubramanian (2004; 2007). The estimated odds for statement S3 suggests that the odds for consumers agreeing with statement S3 and not buying GM soybean oil are 0.25 times smaller than uncertain. Consistent with the

research hypothesis as well as with the results of GM rice model consumers' trust on Govt. Regulatory Agencies for testing the food quality has turned out statistically significant at the $\alpha = 0.01$ significance level with a negative sign on S7 in support of the idea that it is negatively associated with the possibility of purchasing of GM soybean oil. However the estimated odds for statement S7 suggest that the odds for consumers having limited trust on Govt. Food Regulatory Agencies and uncertain to buy GM soybean oil are only 0.07 times greater than consumers certainly not buying.

According to the results in table 5.4 the estimated coefficient on statement S9 and S11 are statistically significant at $\alpha = 0.05$ and $\alpha = 0.01$ significance level. The odds on the statement S7 suggest that consumers' fear about unforeseen harmful effect of GM foods on human life increases the uncertainty of purchasing GM soybean oil around 3.20 times. However the odds on the statement S11 which has a negative sign suggests that consumers who believe that farmers can be negatively affected by overdependence on the GM seeds producing companies are only 0.09 times more certain about not buying GM soybean oil relative to consumers uncertain about buying them. Finally the estimated coefficient on statements S14 has statistically different from zero at the $\alpha = 0.01$ significance level. Although inconsistent with the expectation, consumers who believe GM foods contain higher nutritional value (S14) are more uncertain to buy GM foods than not buying. The odds for this benefit variables is increased as high as 6.32 times respectively for consumers who uncertain about buying GM soybean oil as contrasted with consumers definitely not buying GM soybean. Among the two variables regarding consumers' access to information only the use of internet has revealed statistically significant at the at the $\alpha = 0.01$ significance level and the estimated coefficient has an unexpected negative sign. However the odds on the use of internet variable suggests that consumers' regular access to internet can negatively influence their willingness to buy GM soybean oil. However according to the estimated odds ratio regular internet users are only 0.03 times more certain about not buying GM soybean oil relative to consumers uncertain about buying them. A possible explanation of this could be that the misleading information on internet about the exaggerated potential hazards of GM foods may lead to an uncertainty in few consumers.

Table-5.4: Estimation of MNL for Omega-3 containing GM Soybean Oil

	Variables	Yes[1] vs No[2] Response			Uncertain[3] vs No[2] Response		
		Coeff. (Std.Err.)	*Exp(β)*	*Sig.*	*Coeff. (Std.Err.)*	*Exp(β)*	*Sig.*
S1	Level of information about GM foods (1= very well, moderately & somewhat informed, 0= otherwise)	2.423 (1.149)	11.280	0.035**	0.801 (0.474)	2.228	0.091
S2	GM foods are being sold in the local market (1= yes, 0= otherwise)	1.005 (0.403)	2.732	0.013**	0.215 (0.501)	1.240	0.668
S3	Creating GM food is morally wrong1= Always & Often, 0= Otherwise)	-1.009 (0.429)	0.336	0.011**	-1.374 (0.451)	0.253	0.002***
S4	GM crops transformed with genes of forbidden animal should be forbidden	-2.188 (0.846)	0.112	0.010**	-0.625 (0.455)	0.535	0.169
S5	Choice of labeling policy (1= Voluntary, 0= Mandatory)	-3.172 (0.491)	0.420	0.000***	-0.706 (0.571)	0.493	0.216
S6	Habit of reading labels of new food (processed)	0.055 (0.430)	1.056	0.899	-0.755 (0.497)	0.470	0.128
S7	Trust on Govt. agencies regarding safety of GM food	0.300 (0.463)	1.350	0.517	-2.572 (0.887)	0.076	0.004***
S8	Trust on Scientist & Academicians regarding safety of GM food	1.621 (0.511)	5.060	0.002***	0.417 (0.466)	1.517	0.371
S9	GM foods may have unforeseen harmful effect on human health	-3.372 (1.151)	0.034	0.003***	1.166 (0.464)	3.211	0.012**
S10	GM foods may cause allergic reaction to some individual	-0.465 (0.393)	0.628	0.236	-0.698 (0.488)	0.498	0.153
S11	GM foods can affect farmers by overdependence on GM seed companies	-0.853 (0.385)	0.426	0.026**	-2.409 (0.545)	0.090	0.000***
S12	GM foods may be harmful wildlife and environment	-3.394 (0.641)	0.034	0.000***	0.080 (0.405)	1.084	0.843
S13	GM foods are safe for human consumption	1.118 (0.438)	3.058	0.011**	0.655 (0.520)	1.926	0.208
S14	GM foods contains higher nutritional contents	0.688 (0.399)	1.989	0.085**	1.845 (0.562)	6.328	0.001***
S15	GM foods can benefit society by reducing food price	0.420 (0.387)	1.521	0.278	0.259 (0.584)	0.658	0.195
S16	GM foods can help farmers by reducing production cost	-0.629 (0.357)	0.533	0.078	0.096 (0.479)	1.101	0.841
	* For S6 – S 16 (1= SA & A, 0=Otherwise)						
	Demographics						
	Gender (Male =0, Female = 1)	-0.408 (0.404)	0.665	0.312	0.018 (0.439)	1.018	0.968
	Age (18yrs – 35 yrs =1, Otherwise =0)	sin			0.152 (1.383)	1.164	0.913
	Education (Students & Graduates =1, Otherwise = 0)	-0.722 (0.381)	0.486	0.058	0.047 (0.452)	1.048	0.198
	Newspaper Reading Habit (1= Regular & Often , 0= otherwise)	0.244 (0.422)	1.277	0.004***	-0.071 (0.523)	0.931	0.894
	Use of internet (1= Regular & Often, 0= otherwise)	0.257 (0.479)	1.289	0.000***	-3.440 (1.190)	0.032	0.004***

, *, indicates estimated coefficient is significant at the 0.05, and 0.01 level, respectively. N = 648; Chi-square (X^2)= 205.465; [1)] means consumers willing to buy GM foods; [2)] means consumers not willing to buy GM foods; [3)] means consumers are not certain about buying GM foods; [4)] is odds ratio. Pseudo R -squared: 0.385.

Table 5.4 indicates that the major factors for influencing consumers' willingness to buy GM soybean oil are their prior knowledge about GM foods (S1) and the degree of trust on the scientists and academicians (S8) respectively. At the same time consumers' belief about the safety issues of GM foods (S13) and their awareness about sales of these foods in the local market (S2) have also found significant determinants for buying GM soybean oil. In comparison with the results in table 5.3 for GM rice model almost same variables are also found significant in GM soybean model. However, the important factors that influence consumers not to buy GM soybean are their concerns over the harmful effect of GM foods (S9) which is probably linked to their choice of mandatory labeling of these foods as expressed in the results in table 5.4 which is also same in the GM rice model in table 5.3. One of the research hypotheses was that consumers who consider GM variety of a particular food is different from ordinary variety of the same food and require a mandatory labeling will less likely to buy GM foods is supported by the results shown in both GM soybean and GM rice models.

However some noteworthy findings in the soybean model are that the vital factors which turned consumers undecided for purchasing GM soybean oil are their fear for unforeseen harmful effects of those foods on human health along with the fear of overdependence of farmers on GM seed producing companies. In contrast with the rice model no demographic variables are statistically significant for consumers to stand uncertain about purchasing GM foods in the soybean model.

5.5 Conclusions

This study conducted a household survey in the Dhaka Metropolitan City to investigate the perception and awareness of consumers' about GM foods and to analyze the effects of consumers' risk/benefit beliefs along with other associated factors on their willingness to buy GM foods. Consumers purchase intention for GM foods was hypothesized to be related to their beliefs toward various amenities of GM foods. The study examined that various attribute beliefs associated with GM foods are key factors to explain consumers' purchase intentions toward them and found that the qualitative factors of risk/benefit beliefs significantly influence consumer acceptance and rejection of GM foods.

From the descriptive statistics and multinomial logit (MNL) regression analysis of the collected primary data a few notable conclusions may be drawn. Depending upon product types consumers showed different levels of risk and benefit perceptions towards GM foods. In other wards consumers hold considerably different sets of risk and benefit perceptions and preferences for GM rice and GM soybean oil respectively. However the odds on most of the independent variables are also dissimilar in these two models. Results from four benefit statements demonstrate that when consumers are willing to buy GM foods most of the odds ratios for GM rice are greater than those for GM soybean oil. From this point of view it is interpreted that consumers perceive a wide varying benefits in GM rice than in GM soybean oil. On the other hand, four risk statements have demonstrated that somewhat interestingly when consumers are unwilling to buy GM foods most of the odds ratios for GM rice and GM soybean oil are almost same. This implies that consumers generally perceive more benefit in GM rice relative to GM soybean oil and almost similar type of risk for both GM rice and GM soybean. Thus, the hypothesis that consumers may have different level of risk and benefit perception for different types of food is supported. This finding is consistent with prior studies (Espey, 1993; Frewer et al., 1997; Hallman et al., 2004; Hossain and Onyango, 2004 and Macnaghten, 2004). In addition, the study reveals that when consumers are willing to buy GM foods the crucial factor to affect their purchase intention on both GM rice and GM soybean was the food safety issue and superior nutrition followed by price benefit and lower production cost in the rice model only. On the other hand, when consumers decide not to buy GM foods, the ethical and moral issues along with concerns over the side effects of GM foods on human health were important factors for both GM rice and GM soybean, respectively. However another noteworthy conclusion of the study is that

consumers have a strong preference for a mandatory labeling of GM foods as well as they have shown a stronger trust on scientist and academicians about the safety information and regulation of those foods.

Among several socio-demographic variables, education and age are distinguishing variables. Results of the study of GM rice model suggest that educated and young consumers are more likely to buy GM foods. It is predicted that these particular classes of people might have more knowledge and better understanding about biotechnology and GM foods since they are more likely to be exposed to news or reports on those foods. Thus, well-educated consumers may have a better ability to evaluate media reports of GM foods. The implication of age factor implies that favorable attitude about willingness to buy GM foods has been found from the young age group (Florkowski, Halbrendt, Huang, & Sterling, 1994; Heiman, Just, & Zilberman, 2000).

5.6 Implications

The results of the study conclude that consumers' awareness and prior knowledge along with beliefs regarding health risk and benefits, ethical and moral obligations, adverse effect on wildlife and the environment, preference for specific labeling policy, access to information and trust on scientist and academicians are significant determinants of consumer's purchase intention of GM foods. Based on the findings the study focuses on three important implications for government and policy planners as well as for producers and marketers of GM products in terms of improving consumer acceptance of GM foods. First, it is revealed from the review of literatures and the analysis of data that consumers are being exposed to a mixed type of information about biotechnology and GM foods from various sources such as government, biotech industry, consumer and environmental groups, scientists and academics etc. Consumers' beliefs about GM are formed from diverse sources of information. Among those primary sources of information scientists and academicians without any financial interests in genetic modification technology are regarded as a knowledgeable and reliable independent third-party source of information about GM foods (Huffman et al., 2004). Another famous researcher Huffman (2003) showed that when a respondent acquired information about GM foods and biotechnology from a third-party source such as information supported by scientist and academicians, the likelihood of the consumer not buying GM foods is decreased. This suggests that information from a third-party source reduces the effect of negative information supplied

by consumer and environmental groups. Thus, the study proposes that when information about GM food is offered to consumers from a third-party source their beliefs about GM foods turn positive; ultimately accelerates their positive purchase intention of GM foods.

Second, media is considered as a secondary source of information about GM foods. In this study we bring an argument that the consumers receive a substantial amount of information through media, more specifically newspaper and internet serve as the primary source of information about GM foods and the controversy around the world about this special type of foods. Unfortunately this information is focused more on the negative aspects of GM foods and the potential hazards of GM technology as a whole without any scientific justification. As a result there is a greater likelihood that consumers' beliefs toward biotechnology and GM foods are being shaped from negative information exaggerated in the media (Marks and Kalaitzandonakes, 2001). However result of the present study is inconsistent with above presumption in few areas.

Third consumer having a greater access to information reported a higher likelihood of purchasing GM foods. Consistent with the study of Moon and Balasubramanian (2003) that the negative beliefs concerning biotechnology and GM foods are mitigated by making consumers informed choices. This suggests that as consumers become more knowledgeable about biotechnology and GM foods their perception of risks about this new technology and foods are decreases. Thus, the present study suggests that if consumers are provided balanced and sound information to make informed choices, then their beliefs about GM foods would improve and eventually it will lead to more acceptability of GM foods among consumers.

Like most of the studies this study is not free from limitations. One of the notable limitations of the present study is that only the regions under the Dhaka Metropolitan City of Bangladesh have been surveyed. Purchasing behavior of individuals residing in suburban and rural areas of the Bangladesh may differ from those living in urban areas. Future research should focus on sampling with more diverse groups of consumers as well as considerable spread in the suburban and rural area in order to achieve a better precision level. Another limitation is that in the present study the education level of almost all respondents is either secondary or above. Less educated consumers may show different purchasing behavior relative to the highly educated consumers. In addition, the low

response rate may lead to non-response bias. For example, it is anticipated that consumers responding to the survey are more likely to be interested in GM foods issues relative to the non-respondents and thus they are more sensitive either to the risks or the benefits of biotechnology relative to the general population (Han and Harrison, 2006) This may lead to an upward or downward bias in the estimates of consumer intention toward purchasing decision of GM foods. Finally, it would be worthwhile that future research should investigate in greater depth that how consumer acceptance of GM foods products is influenced by their trust in institutions, perceived benefits and risks on human health as well as the environmental and ethical issues.

CHAPTER - 6

Reliability & Validity Analysis and Summary of the Report

6.1 Reliability and Validity Analysis

The reliability and validity analysis is an important issue when conducting empirical research because it helps the researchers ensure whether or not question items measures what they are intended to measure (validity) and the degree to which question items would give consistent or repeatable results (reliability).

6.1.1 Testing of Reliability

Reliability is an estimate of measurement consistency. It is broadly defined as the degree to which scales are free from error and therefore, consistent. The use of reliable scales provides assurance that the obtained results will be stable. In this research Cornbach's alpha coefficient (1951) was calculated for each scale to evaluate reliability. The widely accepted social science cut-off is that alpha should be 0.70. But some use 0.75 or 0.80 while others are lenient as 0.60.
(www2.chass.nesu.edu/garson/pa765/standard.htm).

Table- 6.1: shows the Cronbach's Alpha Coefficient to test the reliability of the variables. Table- 6.1 demonstrates the high internal consistency of the constructs and their stability (Nunnally and Bernstein, 1994). In each case Cronbach's alpha far exceeded Nunnally and Bernstein's (1994) recommendation of 0.7 and Bagozzi and Yi's (1988) of 0.6.Thus, the scales are sufficiently reliable for data analysis. It is also to be noted that the alpha for all the statements together is 0.73. This reveals that reliability test is highly acceptable.

6.1.2 Testing of Validity

Validity refers to the degree to which scales truly measure the constructs which they are intended to measure. This provides academic and industry users with confidence that the scales measure important constructs which are related to independent measures of the same constructs and that each scale measures a single construct. The validity of measurement scales can be tested against content and construct criteria.

Table-6.1: Reliability analysis of different variables

Variable/Statement	Cronbach's Alpha (α)
1.Knowledge about the use of genetically modified ingredients in the production of food	.727
2.Level of awareness about the genetically modified food	.734
3. Are there any GM food product in your local market or grocery store	.736
4.Genetic modification violates the basic principle regarding the relationship between human and nature	.724
5.Creating GM plants and animal are morally wrong	.731
6. Transfer of genes between different species is unnatural & unnecessary	.722
7.The transfer of a forbidden animal's genes into a plant / animal will make the GM food forbidden or haram too	.728
8. Use of pig gene in insulin production is acceptable as it is a drug	.709
9. Which labeling policy are you most likely to agree with	.713
10.Nutritional information in food label influences my food choice	.725
11.I see food labels while I purchase processed food	.719
12.I see nutritional section in food labels	.725
13.I see only expiry dates in food labels	.751
14. Presence of GM labels may confuse or negatively affect my choice	.778
15. Labeling of GM fruits and vegetable is impossible to maintain in Bangladesh	.743
16. How often do you read the nutritional section of food labels (new foods)	.768
17. Trust on Government agencies for testing, inspection & regulation of GM crops	.730
18. Trust on Consumer & Envt. groups for testing, inspection & regulation of GM crops	.709
19.Trust Food and Agro companies for testing, inspection & regulation of GM crops	.708
20.Trust Scientist and Academicians for testing, inspection & regulation of GM crops	.728
21.GM food can have unforeseen harmful effect on human health	.736
22.GM food can lower your risk of heart disease and some types of cancer	.732
23.GM foods are beneficial to your health because it has enhanced nutritional contents	.728
24.GM crops are beneficial to health since they lead to foods with less chemical residue	.721
25.GM food may be harmful to people having allergic reactions to particular food	.741
26.GM crops are beneficial for society as they lower the farmer's production cost	.728
27.GM crops benefit consumers because they lower food price	.723
28.GM crops benefit society to solve food shortage in less developing countries	.728
29.The herbicide used with GM crops kill plants that are beneficial to wildlife	.729
30.GM foods should be separated from ordinary foods to prevent contamination	.729
31.GM crops threaten indigenous plants and animals	.726
32. GM foods can affect farmers by overdependence on GM seed companies	.731
33.I have no problem buying GM food	.755
34.I avoid buying GM food	.731
35.GM foods are safe for human consumption	.736
36. GM foods are unsafe for human consumption	.729
44. How often you read news paper	.730
45. How often you use internet as a source of information about new events	.723
Overall	**.737**

Content validity

An extensive literature review was undertaken about GM and organic foods to ensure content validity. This research follows the works of Gaskell et al., (2004); Han and Harrison (2006); Deodhar et al., (2007) and Sjoberg, et al. (2008) which developed a set of measurement scales for GM food.

Construct validity

Construct validity is examined through factor analysis with the following criteria: 1) a minimum eigenvalue of 1, and 2) item factor loadings in excess of 0.4. Table 6.2 and Table 6.3 present the results of construct validity for GM foods. The eigenvalue for each of these scales are all more than 1 for all the factors. All the item loadings are more than 0.4, mostly ranged between 0.4 and 0.8. These results show that all scales have good construct validity.

Criterion Related validity

Criterion-related validity measures how closely the measurement instrument is related to relevant criterion. As the correlations had been highly significant this indicated the acceptable degree of criterion related validity.

In this connection it is to be noted that all the factors under each variable are given a label or title as per the statement has got the highest factor loading or coefficient in each group and considering the relevance with the other statements in the group as in the case.

Table 6.2: Eigenvalue of different factors

Component/Factor	***Initial Eigenvalue***		
	Total	% of Variance	Cumulative %
F-1	4.438	14.317	14.317
F-2	2.532	8.169	22.486
F-3	2.319	7.481	29.967
F-4	1.798	5.800	35.766
F-5	1.715	5.532	41.299
F-6	1.427	4.603	45.902
F-7	1.362	4.393	50.295
F-8	1.294	4.173	54.468
F-9	1.214	3.916	58.384
F-10	1.138	3.671	62.055
F-11	1.001	3.228	65.283

Varimax Rotated Factor Matrix

Principal component factor analysis with rotated factor loadings (Table 6.3) was performed on the surveyed data. Principal Component Analysis (PCA) is the commonly used method for grouping the variables under few unrelated factors. Variables with a factor loading of higher than 0.5 are grouped under a factor. A factor loading is the

correlation between the original variable with the specific factor and the key to understanding the nature of that particular factor. Table- 6.3 provides the rotated factor loadings against the 26 variables. Moreover, factor analysis using Varimax rotation finds 11 derived factors.

Table- 6.3: reveals that the varimax rotated factor loadings against the 26 variables. Factor-1 consisted of four variables. The variables are Knowledge about GM foods (0.797), level of awareness about GM food (0.768), trust on scientist and academicians (0.624) and habit of reading newspaper (-0.594). Factor-2 is constituted by four variables including belief of lowering food price (0.722), enhanced nutritional contents (0.635), safe for human consumption (0.582) and lowering production cost for farmers (0.571). Factor-3 is formed by 3 variables. The variables are labeling policy (0.705), ethical / moral concerns (0.674) appeared as the transfer of forbidden animal genes into plant makes the crops forbidden too and trust on consumer and environmental groups (0.539). Factor-4 consists of 2 variables. The variables are nutritional information on food label influence food choice (0.784) and habit of seeing food labels (0.497). Factor-5 included 3 item scales. This factor is measured by lower risk of heart disease and cancer (0.724), less chemical residues (0.613) and solve food shortage problem in less developing countries (0.540). Factor-6 is formed by 2 variables. The variables are belief of having allergic reactions (0.810) and trust on Government agencies (-0.553). Factor-7 includes 2 variables. The variables are unforeseen harmful affect (0.783) and threaten indigenous plants and animal (0.641). Factor-8 also includes two item scales. This factor is measured by the belief that GM food is unsafe for human consumption (0.798) and should be avoided to prevent contamination (0.552). Factor-9 is formed by only one variable- trust on food and agro companies for testing and inspection of GM food with factor loading of 0.723. Factor-10 consists of 2 variables. The variables are habit of using internet (0.759) and habit of seeing only expiry dates in food labels (0.708). Factor-11 is formed by only one variable- the sense that creating GM plants and animals is unnecessary with factor loading of 0.674.

Table-6.3: Factor Analysis with Varimax Rotation for variables in a survey about GM food

Variable	Factor										
	1	2	3	4	5	6	7	8	9	10	11
Knowledge about GM ingredients in food production	**.797**	.155	.155	.179	.078	-.011	-.046	-.096	.068	.111	-.009
Level of awareness about the GM food	**.768**	.058	-.041	.012	-.195	-.266	-.114	-.077	.030	.036	-.031
Trust on scientist and academicians.	**.624**	.037	.257	-.182	.134	.082	-.087	.150	-.325	.054	.097
Habit of reading newspaper	**-.594**	.130	.159	-.073	-.035	-.114	-.152	-.109	-.269	.184	.082
GM crop is beneficial because they lower food price	.149	**.722**	-.071	.055	.102	.074	.026	.257	-.023	-.193	.044
GM food has enhanced nutritional contents	.072	**.635**	.187	-.215	.196	-.056	-.166	-.098	.226	.187	-.334
Belief that GM foods are safe for human consumption	-.009	**.582**	.030	.202	-.074	.282	-.123	-.089	.188	.106	.282
GM crops lower the farmer's production cost	.117	**.571**	.015	-.004	.159	-.071	.242	.141	-.038	-.022	.287
Labeling policy	-.219	-.173	**.705**	.083	.154	.167	.135	.073	.181	-.080	.013
The transfer of a forbidden animal's genes makes a GM food forbidden or haram	.265	.092	**.674**	-.143	-.092	-.101	.122	-.041	.087	-.046	.068
Trust on consumer and environmental groups	.177	.063	**.539**	.249	.053	.161	-.173	-.027	-.138	.094	.413
Nutritional information in food label influences my food choice	051	.005	-.005	**.784**	.106	.006	.028	.026	.159	.042	.029
I see food labels while I purchase processed food	.278	.141	.445	**.497**	.092	.035	.062	.084	-.366	-.026	.176
GM foods lower the risk of heart disease and some cancers	-.207	.184	-.072	-.040	**.724**	.073	.041	.023	.015	.064	.192
GM crops are healthy as it leads to less chemical residue	.244	-.022	.221	.192	**.613**	.094	-.049	-.176	.182	.086	-.162
GM crops can solve food shortage problem in less developing countries	.239	-.063	-.014	.388	**.540**	.031	.167	.101	-.019	.042	-.022
GM food may harmful for people having allergic reactions to particular food	-.104	.144	.074	-.059	.013	**.810**	.020	-.013	-.059	.179	-.109
Trust on Government agencies	-.009	.203	-.095	-.305	-.213	**-.553**	-.287	.248	-.030	.185	-.081
GM food can have unforeseen harmful effect on human health	.115	.042	.015	.069	.132	.149	**.783**	-.099	-.014	.197	.073
GM crops threaten indigenous plants and animals	-.215	.096	.380	.055	-.024	.041	**.641**	.312	.089	-.097	.008
GM foods are unsafe for human consuption	-.058	.062	-.030	.142	-.107	-.041	-.044	**.798**	.152	.094	.082
GM foods should be separated from ordinary foods to prevent contamination	.088	.188	.145	-.156	.434	-.108	.162	**.552**	-.050	-.060	.103
Trust Food and Agro companies	.182	.050	.129	.063	.072	-.033	.004	.154	**.723**	.046	.060
Habit of using internet	.143	.024	-.168	-.141	.033	.038	.079	-.017	-.116	**.759**	.217
I see only expiry dates in food labels	-.046	-.047	.086	.244	.098	.111	.074	.102	.223	**.708**	-.154
Transfer of genes between different species is unnecessary	.018	.100	.154	-.004	.055	-.079	.089	.127	.066	.046	**.674**

6.2 Summery of the Study

The summery of the study has been outlined in following headlines.

6.2.1 Research Problems

This study aims to explore the perceptual dimensions of experts and consumers about the Genetically Modified Foods (GM foods) in Bangladesh. In order to explore the perceptual dimensions of experts and consumers the current study addresses two main research problems. First, the need to explore and analyze the perceptual dimension of the experts about the potential risks and benefits of GM foods in Bangladesh as well as to determine from expert's view points that whether the benefit of GM foods compensate the potential risk or the perceived risk of this technology outweigh the benefit of GM foods. Second, the need to explore the awareness level, knowledge and perception of consumers about GM food as well as to establish a linkage or relationship between consumer's risk/benefit beliefs and their willingness to buy (WTB) GM food.

6.2.2 Objectives

This study has following 4 (four) major objectives:

i) Analyzing the perception and belief of experts about the risk and benefit of GM foods.

ii) Determining primarily on the basis of expert's opinion whether this new food is more harmful for the consumers of Bangladesh compared to the claimed benefits or the extraordinary benefits of GM food will compensate the potential risk.

iii) Obtaining an insight about consumer's awareness, knowledge and perception of GM foods.

iv) Examining whether or not consumers' risk/ benefit beliefs of GM food along with other associated factors affect their purchase intention as measured by their willingness to buy (WTB).

6.2.3 Significance of the study

'GM food' debate has become increasingly polarized since last decade all over the world. Both proponents and opponents of GM technologies have selectively interpreted results of consumer surveys and scientific findings to support their own lines of argument for and

against the benefits and risk of this special type of foods and underlying technology. The media meanwhile have sensationalized the findings and presented the debate as one of corporate profits versus the importance of public health, freedom of choice and ecological stability. These biotech crops have shown some impressive double digit growth rates in area planted each year since they were first commercialized in 1996. Experts' opinion as well as public knowledge, attitudes, and perception about biotech products are very important factors which ultimately determine whether or not biotech crops will become an important contribution to the world's food supply. The present study has identified and assessed various health risk and benefit factors of GM foods in addition to other significant and insignificant factors that play vital or partial role in induction and commercialization of GM crops in Bangladesh from two different angles of experts and consumers. In order to provide a clear view about the risk and benefits of GM food to the policy planner present study has explored and examined the prime factors from expert's view points that lead the ongoing controversy of GM foods in the country and abroad. Attempt has also been made to comprehend from the expert's opinions that whether the risk associated with GM foods is grater or the claimed benefits. In addition the present study focuses on the experts' suggestion that how the risk factors can be eliminated or compensated to tap the maximum benefit of this new technologically derived food products. The present study has also explored consumers' awareness level and knowledge about GM foods and brought out an empirical model which explains the association of various factors which shapes the consumers decision making of GM foods. Finally the study has explored and assessed the linkage between the identified factors and consumers' willingness to buy the GM foods. Therefore the current study will significantly contribute to policy planning of GM foods in Bangladesh as well as helps all concerns regarding the commercialization of this food in the country in near future.

6.2.4 Research Design and Sampling

The present study is an explorative research in nature comprising an expert opinion survey and a consumer survey. Two different statistical approaches have been applied to expert survey and consumer survey respectively in order to keep pace with four main objectives of the study as stated in Chapter-3. The expert survey includes both quantitative and qualitative analysis where as the consumer survey comprises only quantitative analysis. However two empirical models one for describing the explanatory

process of accepting and rejecting GM foods by experts and the other for explaining consumers' perception and belief about GM foods and its association with the attitudes towards purchasing this food have been presented in the study. The concept and design of the expert survey have been adopted from the work of Sjoberg (2008) as well as Han and Harrison (2006) with ample modification relevant to the study; where as the concept, design and theoretical framework of the consumer survey have been adopted from the studies of Deodhar et al., (2007) as well as Han and Harrison (2005).

Two different sampling techniques have been implemented for the two distinctive surveys (experts and consumers) to accomplish the over all objectives of the present study. Experts' survey includes a judgmental sampling technique where the population is primarily the academicians, researchers, key personnel of multinational companies (GM foods related), activists and persons with direct concern about GM food issues in Bangladesh. Data has been collected from 64 (sixty four) respondents by means of depth interview with the aid of a semi structured questionnaire. Five point Likert Scale has been used in the questionnaire to obtain the quantitative data in most cases.

In consumers' survey a multistage sampling technique has been adopted from the work of Poortinga (2005). However, the sampling technique is stratified random sampling in nature with minor modification. The sampling frame is the individual aged above 18 years and residing in the Dhaka Metropolitan City. Data has been collected from more than 700 individuals by means of household survey using a structured questionnaire designed with 5-point Likert Scale. Data has been presented for 624 usable respondents.

6.2.5 Major Findings of the Study

Following major findings have been revealed from the experts' survey

Expert's opinions have been analyzed both quantitatively and qualitatively. Analysis of the characteristics of respondents has shown that experts differ in respect of key cognitive resources that may inform their views of GM foods.

1. Analysis of the experts' survey data informed by qualitative interviews and other quantitative analyses, four different groups of respondents have been identified initially based on a two-by-two classification of risk and benefit perceptions. They are labeled as "trade-off" believing that GM foods offer

both risk and benefit, "skeptical" perceiving no benefits and carry only risks in GM foods, "relaxed" perceiving only benefit and no risk and "uninterested" that have shown non attitudes towards GM foods.

2. Based on the qualitative data obtained from the experts' survey the characteristics of respondents regarding GM foods are further categorized as "Biotech Optimistic" showing very positive attitudes towards GM foods and GM plus other food technologies, "Arguable Different" possess hope for feeding increasing population of the world and also concerned about unknown long term health hazards, "Biotech Pessimistic" possesses a very negative view towards GM foods and other artificial food technology and "Food Newphobic" exhibiting phobia for any new artificially derived food.
3. Regression results suggest that ethical and moral concern, labeling preference, price sensitivity, regulatory issues as well as health, environmental and economical concerns are the best set of predictors that shape the judgment of experts about the encouragement of GM commercialization in Bangladesh.
4. Analysis of experts' data demonstrated that perceptions of benefits, in particular the absence of perceived (visible) benefits and underlying health risk factors act as dominant attributes. However, a robust interaction between risk and benefit is found as evidence of different decision making strategies in the different group of experts. It is also explained in the current study that experts' judgment about GM foods are more emotional than logical. Individual views and attitudes towards GM food and GM technology predominantly influence their judgment for encouraging or discouraging commercialization of GM foods in Bangladesh.

Following major findings are revealed from the consumers' survey in current study

Results from the analysis of Multinomial Regression reveal few notable findings.

1. Various attribute beliefs associated with GM foods are key factors to explain consumers' purchase intentions toward them. It is also found that the qualitative factors of risk/benefit beliefs significantly influence consumers' acceptance and rejection of GM foods.
2. Depending upon product types consumers showed different levels of risk and benefit perceptions towards GM foods. Consumers hold considerably different

sets of risk and benefit perceptions as well as preferences for GM rice and GM soybean oil respectively. The odds on most of the independent variables are also dissimilar in these two models. Results from four benefit statements demonstrate that when consumers are willing to buy GM foods most of the odds ratios against significant variables for GM rice are greater than those for GM soybean oil. From this point of view it is interpreted that consumers perceive a wide varying benefits in GM rice than in GM soybean oil.

3. In addition, the study reveals that when consumers are willing to buy GM foods, the crucial factor to affect their purchase intention on both GM rice and GM soybean was the food safety issue and superior nutrition followed by price benefit and lower production cost (in the rice model only). On the other hand, when consumers decide not to buy GM food, the ethical and moral issues along with concerns over the side effects of GM foods on human health were important factors for both GM rice and GM soybean, respectively.
4. It is revealed that consumers have a strong preference for a mandatory labeling of GM foods as well as they have shown a stronger trust on scientist and academicians about the safety information and regulation of those foods.
5. Among several socio-demographic variables education and age are distinguishing variables. Results of the study of GM rice model suggest that educated and young consumers are more likely to buy GM foods.
6. The degree of access to information is found significant. The more consumers get access to the information about GM foods the more likely to buy them.

6.2.6 Direction for Future Research

In future study regarding GM foods can be done on many different aspects. The current study has included a small segment of experts in the relevant field. To attain a more generalized and reliable results study involving a larger segment of experts is recommended. On the other hand the present study has involved both the academician and non-academician as experts on the same platform. It is anticipated and also revealed from few studies that a group of experts working in the same field but different in academic background differs widely in opinion about specific issues of GM technology (ABSPII, 2005). It would have been better if studies can be conducted involving academicians and non-academicians separately, since the characteristics of these tow groups are not similar.

Studies relating to case specific issues of GM food can also be conducted with the experts in relevant fields. The consumers' survey in the current study is confined to the Dhaka Metropolitan City as far as consumers' knowledge, awareness and perceptions are concerned. Consumers from different geographic locations and socioeconomic status may not possess same type of perception and knowledge about GM foods or about specific GM issue. Study may be conducted involving a larger sample which covers entire country or major metropolitan cities in the country. Studies attempting to uncover the consumers' willingness to pay (WTP) for GM foods is also recommended for advanced research in this area. Last but not the least comparative studies are also recommended regarding GM issues in home and abroad in both experts' and consumers' perspective.

Annex-I

Sample of Cover Letter and Questionnaire used in the Expert Survey

Department of Marketing
Faculty of Business Studies
University of Dhaka

Dear Sir / Madam,

We are writing to seek your help in a study of Genetically Modified Foods. Being an expert in this field you are aware that GM foods and crops have raised controversy among the consumers, scientists and expert communities all over the world. A GM variety of rice is under progress for commercial approval in Bangladesh. Knowingly or unknowingly people of Bangladesh has been consuming few GM stuff available in local market from imported sources. As we know from different sources that GM foods have claimed some extra ordinary benefits along with some disastrous health and environmental risk, it is important to know what experts in this area of Bangladesh actually think about this new technology. Nevertheless, consumers and Govt. food policy planners to a great extent depend on experts' opinion about any food safety issue.

To better understand your concerns, the Department of Marketing, University of Dhaka is conducting a study of GM foods. You are selected as an important participant in this study. The survey is intended to collect information about your perceptions, beliefs and attitudes about GM foods, and its associated risks and benefits to incorporate this new type of food in the food system of Bangladesh.

The survey will help us; the food industry and the Govt. policy planner to better understand how experts perceive GM foods. Your answers are ***completely confidential*** and will be released only as summaries in which no individual's answers can be identified. When you return your completed questionnaire, your name will be deleted from the list and never connected to your answers in any way. This survey is voluntary, but your response is very important. You can help us exceptionally by taking a few minutes to share your opinions about GM foods. Please take a few minutes to fill out the questionnaire and return it to the researcher.

If you have any questions or comments regarding the survey, we would be happy to talk with you. Our number is **01715524048** (Dr. Belayet Hossain) or **01920066684** (Amir Ahmed). Or email us at **prof_belayet@yahoo.com** or **aaff73@yahoo.com.**

Thank you very much for helping with this important study.

Sincerely,

Dr. Belayet Hossain.
Professor
Department of Marketing
University of Dhaka

Amir Ahmed
Research Student (PhD Program)
Department of Marketing
University of Dhaka

Name: _____

Specialization: _____ Institute: _____

E-Mail: _____ Phone: _____

Section – 1: General information about GM foods.

a) What does the term GM evoke?

b) Which of the following terms are you most familiar with? [please circle {O} one]

1. Biotech Food
2. Genetically Engineered Foods (GE)
3. Genetically Modified Foods (GM)
4. Genetically Modified Organism (GMO)
5. Bioengineered Foods

Section – 2 : Ethical and moral concerns related with GM food products.

Genetic modification raises moral and ethical concerns for some people. Please, tell us the extent you (agree or disagree with each of the following statements)

[Please circle {O} *one, where SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree]*

	SD	D	N	A	SA
1. Genetic Modification violates the basic principle regarding the relationship between human and nature	1	2	3	4	5
2. Transfer of genes between different species is unnatural & unnecessary	1	2	3	4	5
3. The transfer of a forbidden animal's (pigs for Muslim & Jews) genes into a plant / animal will make the resulting GM food forbidden (haram) too	1	2	3	4	5
4. Use of pig gene in insulin production is acceptable as it is a drug	1	2	3	4	5

Section – 3: Pricing of GM food products.

Pricing of genetically modified food is a big concern in countries where it is being sold predominantly. Please tell us to what extent you believe following statements

[Please circle {O} one, where SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree]

	SD	D	N	A	SA
1. High price of GM seeds will increase production cost for the farmers	1	2	3	4	5
2. High price of GM seed will outweigh increased cost with high yield	1	2	3	4	5
3. Consumer will accept GM variety easily if the price is low	1	2	3	4	5

Section – 4: Labeling of GM food (mandatory or voluntary labeling).

The present policy of the U.S. Food and Drug Administration (FDA) is that labeling of biotech foods should be voluntary; since it has been determined that these foods have the same safety and nutritional contents as other foods. FDA argues that mandatory labeling could unnecessarily raise the health concerns about biotech foods. However, critics of this policy say that any food produced through biotechnology should be labeled, even if the safety aspect of the food has not been altered. They argue it is the consumer's right to know.

1. Which labeling policy are you most likely to agree with, the FDA's or its critics? [*circle* {O} *one*]

a) FDA – voluntary labeling of biotech foods
b) Critics – mandatory labeling of biotech foods

What is your justification?

Please, tell us the extent you (agree or disagree with each of the following statements)
[Please circle {O} *one, where SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree]*

	SD	D	N	A	SA
2. Food labels are needed to show the presence of biotech ingredients, since consumer could face unknown health risk.....	1	2	3	4	5
3. Labels with adequate nutritional information influence my food choice.....	1	2	3	4	5

4. How often do you read the ingredients section of food labels before buying a food product:
[*Please circle* {O} *one* for each]

a) Familiar food : 1) Always 2) Often 3) Sometimes 4) Rarely 5) Never

b) New foods : 1) Always 2) Often 3) Sometimes 4) Rarely 5) Never

Section – 5: Control mechanism and regulatory issues of GM foods.

GM food raises concerns about the trust regarding the control and regulation of genetic modification for food safety. *Please answer the following questions using a scale from 1 to 5 where 1indicates (no trust at all) and 5 indicates (high degree of trust).* [*Please circle* {O} *one* for each]

1. How much do you trust the following institutions to protect health and environment from the potential harmful effects of GM crops

Government agencies.....	1	2	3	4	5
Consumer and environmental groups.....	1	2	3	4	5
Food and agribusiness companies.....	1	2	3	4	5
Scientist and academicians.....	1	2	3	4	5

2. How much do you trust the following institutions regarding testing, inspections and regulation of GM crops

Government agencies.....	1	2	3	4	5
Consumer and environmental groups.....	1	2	3	4	5
Food and agribusiness companies.....	1	2	3	4	5
Scientist and academicians.....	1	2	3	4	5

Section – 6: Perception of benefit and risk belief of GM food.

(in terms of health, society's well being, effects on wildlife and the environment)

i) **Please tell the extent you believe genetically modified (GM) food (i.e. crops, vegetables, fruits and animal feeds affect your health and society's well being.** *[Please circle {O} one where SD = Strongly Disagree, D = Disagree, N = Normal, A = Agree, SA = Strongly Agree]*

	SD	D	N	A	SA
1. GM food can have unforeseen harmful affect on human health.....	1	2	3	4	5
2. GM food benefits society because it has extra nutritional features in it.....	1	2	3	4	5
3. GM food can lower the risk of heart disease and some types of cancer.....	1	2	3	4	5
4. GM food may be harmful to people having allergic reactions to particular food.....	1	2	3	4	5
5. GM crops lower the farmer's production cost as well as food price.....	1	2	3	4	5
6. GM crops may handicap the poor farmers for purchasing GM seeds from MNCs.....	1	2	3	4	5
7. GM crops benefit society to solve food shortage in less developed countries.....	1	2	3	4	5

ii) **Please tell the extent you believe genetically modified (GM) food (i.e. crops, fruits, vegetable and animal feeds affect wildlife and the environment.** *[Please circle {O} one, where SD = Strongly Disagree, D = Disagree, N = Normal, A = Agree, SA = Strongly Agree]*

	SD	D	N	A	SA
8. GM crops are harmful to the environment because they can cross pollinate with non GM crops.....	1	2	3	4	5
9. GM crops are beneficial to the environment because they allow farmers to use fewer herbicides and pesticides.....	1	2	3	4	5
10. GM crops are beneficial because they lead to adoption of more environmentally friendly farming system.....	1	2	3	4	5
11. GM crops are harmful for the environment as they kill useful microorganisms in soil..	1	2	3	4	5
12. GM crops threaten indigenous plants and animals.....	1	2	3	4	5

Section – 7: Overall opinion about GM issue.

13. According to your overall judgment of risk and benefits viewpoints about GM foods, circle one from each of the following statement.

a)	GM foods is	O Beneficial	O Not beneficial
b)	GM food is	O Risky	O Not risky
c)	GM food is ethically	O Acceptable	O Not acceptable
d)	GM food is	O Encouraged	O Not encouraged

SD	D	N	A	SA

14. I personally encourage commercial production of GM food and crops in Bangladesh. *[Please circle {O} one, where SD = Strongly Disagree, D = Disagree, N = Normal, A = Agree, SA = Strongly Agree]*

Please summarize your benefit and risk assessment about GM foods by circling one from each of the following:

[Please circle {O} one. where SD = Strongly Disagree, D = Disagree, N = Normal, A = Agree, SA = Strongly Agree]

	SD	D	N	A	SA
a) GM food will bring benefits to many people.....	1	2	3	4	5
b) GM food poses no risk for to future generation.....	1	2	3	4	5

16. Please give us your expert opinion about following statement in the blank box below

"Benefits of GM food will compensate the potential risk or the perceived risks of this technology will outweigh/ overshadow the benefit of GM foods."

17. Please use the space below to provide your justification that why or why not you recommend GM foods:

Thank you for your time and cooperation in helping to make this a successful study.

Annex-II

Sample of Cover Letter, Questionnaire and Information Sheet used in the Consumer Survey (English version)

Department of Marketing
Faculty of Business Studies
University of Dhaka

Dear Sir / Madam,

We are writing to seek your help in a study of Genetically Modified Food products in Bangladesh. We assume that you are aware of GM foods and crops have raised controversy among the consumers, scientists and expert communities all over the world. If you are not aware, enclosed "General Information about GM Foods" will help you to get a basic idea about GM foods. Incidentally a GM variety of rice along with couple of GM vegetables is under progress for commercial approval in Bangladesh. It is assumed that knowingly or unknowingly people of Bangladesh have been consuming few GM stuff available in local market from imported sources. It is also predicted that consumers of Bangladesh will be exposed to GM food stuffs in near future. As we know from different sources that GM foods have claimed some extra ordinary benefits along with some disastrous health and environmental risk, it is important to know what consumers of Bangladesh actually think about this new technology. Nevertheless, the success of GM foods and this new technology depend to a grate extent on consumer perception and their willingness to buy.

To better understand your concerns the Marketing Department of Dhaka University has been conducting a study of GM foods. You are selected as an important participant in this study. The survey is intended to collect information about your perceptions, beliefs and attitudes towards GM foods and underlying risks & benefits of GM foods to incorporate this new type of food in the food system of Bangladesh.

The survey will help us; the food industry and the Govt. policy planner to better understand how consumers perceive GM foods. Your answers are ***completely confidential*** and will be released only as summaries in which no individual's answers can be identified. When you return your completed questionnaire your name will be deleted from the list and never connected to your answers in any way. This survey is voluntary, but your response is very important. You can help us exceptionally by taking a few minutes to share your opinions about GM foods. Please take a few minutes to fill out the questionnaire and return it to the researcher.

If you have any questions or comments regarding the survey, we would be happy to talk with you. Our number is **01715524048** (Dr. Belayet Hossain) & **01920066684** (Amir Ahmed) or e-mail us at **prof_belayet@yahoo.com / aaff73@yahoo.com**

Thank you very much for helping us with this important study.

Sincerely,

Dr. Belayet Hossain.
Professor
Department of Marketing
University of Dhaka

Amir Ahmed
Research Scholar (PhD Program)
Department of Marketing
University of Dhaka

General information about GM foods worldwide

The term GM (Genetically Modified) refers to a laboratory procedure witch involves insertion of foreign genes from different species into a plant or animal to alter the original genetic make up in order to enhance the nutritional quality and other traits of a particular food. In simple terms, the gene technologist uses a "cutting-copying-pasting" approach to transfer genes from one organism to another. GM technology has also been used in pharmaceutical industries. The first major GM (Genetically Modified) food was tomato introduced on the market in mid - 1990s. However the production of GM crops has increased significantly over the last decade. It has been reported that in 1999 world production GM crops utilized an area of 30 million hectors which has been increased around 115 million hectors by 2007.

The major GM food producers are United State (57.7) Million Hector, Argentina (19.1) Million Hector, Brazil (15.0) Million Hector, Canada (7.0) Million Hector, India (6.2) Million Hector, China (2.8) Million Hector and South Africa (1.8) Million Hector respectively. For instance a GM variety of rice (Golden Rice) containing Vitamin-A, has been in progress for commercial release in Bangladesh, some other GM crops and vegetable are under trail production in laboratory.

The overall state of public attitudes in the world towards food biotechnology (GM food) is best described as an ongoing tension between optimism of the benefits and fear of unforeseen risks from its use in plants and animals. GM foods are already banned in European Union and in some countries of Asia including Myanmar.

The major benefit claims of GM foods are economical, environmental and society well being. In general GM food increases yields per unit of land use, faster in process, lower in cost and improved varieties. It also decreases land and water usage as well as limits usage of fertilizer, chemical and pesticides. Decreasing food spoilage, waste and increasing nutritional as well as disease fighting qualities of food are common tangible benefits of GM foods. On the other hand major risks associated with this GM technology are health threats and unknown long term risk including allergic reactions, environmental problems like imbalance of biodiversity and domination by a small number of companies with key patents on production system. Ethical and moral issues also raised concern in some communities of the world.

Some of GM foods prevailing in the world market are rice, corn, maize, wheat etc.(all with improved nutritional quality), disease free cotton, slow ripening and nutritionally rich tomato, insect free egg plant and potato, broccoli with anti cancer element, apple, grape, cherry and strawberry with improved texture, sweet peas with different taste, oil seeds with low cholesterol and high oleic acid content, milk and dairy products produced by rBST, GM tuna fish in the major protein produced through GM technology, GM canola used as preservative in canned food etc. Commercially available Insulin and a variety of drugs used in chemotherapy of cancer are also produced by genetic modification.

You are kindly requested to visit the web *http://www.disabled-world.com/fitness/gm-foods.php* for more information about GM foods.

Section – 1: Consumer knowledge about GM food.

1. Have you read or heard about the use of biotechnology, genetically engineered (GE), genetically modified (GM) genetically modified organism (GMO) or bioengineered ingredients in the production of food? *{Please circle (O) one}*

   a) Yes, I have read or heard about biotech foods.

   b) No, I have not read or heard anything about biotech foods.

<u>[If your answer is no please see the enclosed general information about GM foods and switch to Section -2]</u>

2. Using a 5 point scale, how well informed would you say you are about biotechnology, where ***one means you are not at all informed*** and ***5 means you are very informed.*** *{Please circle (O) one}*

   5 - very informed
   4 - moderately informed
   3 - somewhat informed
   2 - minimally informed
   1 - not at all informed

3. Are there any foods produced through biotechnology in your local super market or in grocery store? *{Please circle (O) one}*

   a) Yes b) No c) Don't k now

Section – 2: Ethical and moral concerns related with GM food products.

GM foods are not naturally occurring. It involves a laboratory procedure to alter the natural structure of gene, thus genetic modification raises moral and ethical concerns for some people. Please, tell us the extent you (agree or disagree with each of the following statements). [Please circle (O) one}, where SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree]

	SD	D	N	A	SA
4. Genetic Modification violates the basic principle regarding the relationship between human and nature.....	1	2	3	4	5
5. Creating GM plants and animals are morally wrong.....	1	2	3	4	5
6. Transfer of genes between different species is unnatural & unnecessary.....	1	2	3	4	5
7. The transfer of a forbidden animal's (pigs for Muslim & Jews) genes into a plant / animal will make the GM food forbidden (haram) too.....	1	2	3	4	5
8. Use of pig gene in insulin production is acceptable as it is a drug.....	1	2	3	4	5

Section – 3: Labeling of GM food (mandatory or voluntary labeling).

The present policy of the U.S. Food and Drug Administration (FDA) is that labeling of biotech foods should be voluntary; since it has been determined these foods have the same safety and nutritional contents as other foods. FDA argues that mandatory labeling could unnecessarily raise the health concerns about biotech foods. However, critics of this policy say that any food produced through biotechnology should be labeled , even if the safety aspect of the food has not been altered. They argue it is the consumer 's right to know.

9. Which labeling policy are you most likely to agree with, the FDA's or its critics? *[Please circle {O} one]*

   a) FDA – voluntary labeling of biotech foods
   b) Critics – mandatory labeling of biotech foods

Please, tell us the extent you agree or disagree with each of the following statements
[Please circle {O} one, where SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree]

	SD	D	N	A	SA
10. Labels with adequate nutritional information influence my food choice.....	1	2	3	4	5
11. I see food labels while I purchase processed food.....	1	2	3	4	5
12. I see nutritional section in food labels.....	1	2	3	4	5
13. I see only expiry dates in food labels.....	1	2	3	4	5
14. Presence of GM labels may confuse or negatively affect my choice.....	1	2	3	4	5
15. Labeling of GM fruits and vegetable is impossible to maintain in Bangladesh.....	1	2	3	4	5

16. How often do you read the nutritional section of food labels before buying a food product:
[*{Please circle (O) one}*]

a) Familiar food : 1) Always 2) Often 3) Sometimes 4) Rarely 5) Never

b) New foods : 1) Always 2) Often 3) Sometimes 4) Rarely 5) Never

Section – 4: Control mechanism and regulatory issues of GM foods.

GM food raises concerns about the trust regarding the control and regulation of genetic modification for food safety. Please answer the following questions using a scale from 1 to 5 where 1 indicates (no trust at all) and 5 indicate (high degree of trust). [Please circle {O} one]

How much do you trust the following institutions regarding testing, inspections and regulation of GM crops

17. Government agencies.....	1	2	3	4	5
18. Consumer and environmental groups.....	1	2	3	4	5
19. Food and agribusiness companies.....	1	2	3	4	5
20. Scientist and academicians.....	1	2	3	4	5

Section – 5: Perception of risk and benefit belief of GM food.

(In terms of health, society's well being, effects on wildlife and the environment)

Please tell the extent you believe genetically modified (GM) food (i.e. crops, vegetables, fruits and animal feeds affect your health, society's well being, wild life and environment.
[*Please circle {O} one,* where SD = Strongly Disagree, D = Disagree, N = Normal, A = Agree, SA = Strongly Agree]

	SD	D	N	A	SA
21. GM food can have unforeseen harmful effect on human health.....	1	2	3	4	5
22. GM food can lower your risk of heart disease and some types of cancer.....	1	2	3	4	5
23. GM food are beneficial to your health because it has enhanced nutritional contents....	1	2	3	4	5
24. GM crops are beneficial to health since they lead to foods with less chemical residue.	1	2	3	4	5
25. GM food may be harmful to people having allergic reactions to particular food.....	1	2	3	4	5
26. GM crops are beneficial for society as they lower the farmer's production cost.....	1	2	3	4	5
27. GM crops benefit consumers because they lower food price.....	1	2	3	4	5
28. GM crops benefit society to solve food shortage in less developing countries.....	1	2	3	4	5

	SD	D	N	A	SA
29. The herbicides used with GM crops kill plants that are beneficial to wildlife.....	1	2	3	4	5
30. GM crops should be separated from ordinary foods to prevent contamination.....	1	2	3	4	5
31. GM crops may affect farmers by overdependence on GM seed producing companies..	1	2	3	4	5
32. GM crops threaten indigenous plants and animals.....	1	2	3	4	5

Section – 6: Acceptance of and willingness to buy GM food.

	SD	D	N	A	SA
33. I have no problem with buying GM foods.....	1	2	3	4	5
34. I avoid buying GM foods.....	1	2	3	4	5
35. GM foods are safe for human consumption.....	1	2	3	4	5
36. GM foods are unsafe for human consumption.....	1	2	3	4	5

37. Would you purchase a food product that has been produced using biotechnology?

a) **Vitamin -A containing GM Rice** (normal rice does not contain Vitamin – A, this vitamin protects childhood blindness)

1) Yes 2) No 3) Uncertain

b) **Omega -3 fatty acid rich GM Soybean Oil** (derived from GM soy)

1) Yes 2) No 3) Uncertain

Section – 7: Socio-demographics.

38. What is your gender? [Circle (O) one]

a) Male b) Female

39. What is your marital status? [Circle (O) one]

a) Single b) Married

40. Which of the following best describes your age category in years? [Circle (O) one|

a) 18 – 24; b) 25 – 34 ; c) 35 – 44; d) 45 – 54; e) 55 – 59; f) 60 – 64; g) 65 or older

41. Please indicate your highest level of education attained. [Circle (O) one]

i) Under graduate students; ii) Graduate; iii) Post graduate; iv) Advanced degree; v) Others

42. Which of the following best describe your profession? [Circle (O) one|

i) Student; ii) Govt. service; iii) Private Service; iv) Business v) Engineer
vi) Physician; vii) Teacher; viii) Lawyer; ix) Technical; x) House wife

Others (please specify.....)

42. Which of the following best describe your monthly income? [Circle {O} one] for no income please mark {X} on right side of the numbers.

a.	5,000 – 10,000	f.	31,000 – 35,000
b.	11,000 – 15,000	g.	36,000 – 40,000
c.	16,000 – 20,000	h.	41,000 – 50,000
d.	21,000 – 25,000	i.	51,000 – 60,000
e.	26,000 – 30,000	j.	61,000 – above

43. How often you read news paper?

a) Regular b) Most of the time c) Sometime d) Rare e) Not at all

44. How often you use internet as a source of information about new events?

a) Regular b) Most of the time c) Sometime d) Rare e) Not at all

Please use the space bellow to make any additional comments or question

Thank you for your time and cooperation in helping to make this a successful study

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Signature and date

Annex-III

Sample of Cover Letter, Questionnaire and Information Sheet used in the Consumer Survey (Bengali version)

মার্কেটিং বিভাগ
ব্যবসা শিক্ষা অনুষদ
ঢাকা বিশ্ববিদ্যালয়

শ্রদ্ধেয় মহোদয়/ মহোদয়া,

সবিনয় নিবেদন এই যে, আমরা কৌলগতভাবে (জেনেটিক্যালি মডিফাইড) জি এম খাদ্যের উপর গবেষণার জন্য আপনার সাহায্য প্রার্থনা করছি। আমরা মনে করি যে, জিএম খাদ্য ও ফসল নিয়ে যে বিতর্ক ভোক্তা, বিজ্ঞানী ও গবেষক মহলের মধ্যে সৃষ্টি হয়েছে আপনি সে সম্পর্কে অবগত। যদি আপনি অবগত না হয়ে থাকেন তবে প্রশ্নের সাথে সংযুক্ত জিএম খাদ্য সম্পর্কিত সাধারন তথ্য আপনাকে জিএম খাদ্য সম্পর্কে মৌলিক ধারনা পেতে সাহায্য করবে। বর্তমানে বিভিন্ন ধরনের জিএম চাউল এবং সেই সাথে কিছু সংখ্যক জিএম শাক সবজি বর্তমানে বাংলাদেশের বাণিজ্যিক অনুমোদন প্রক্রিয়ার অধীনে রয়েছে। জ্ঞাতসারে বা অজ্ঞাতসারে বাংলাদেশের মানুষজন বাহিরের দেশ থেকে আমদানীকৃত বাজারে সহজলভ্য কিছু জিএম পণ্য বর্তমানে ভোগ করছে। যেহেতু আমরা বিভিন্ন উৎস থেকে জেনেছি যে, জিএম খাদ্য কিছু অনন্যসাধারন উপকারীতার দাবিদার কিন্তু সেই সাথে স্বাস্থ্যের জন্য ক্ষতিকর এবং পরিবেশের জন্য ঝুঁজিপূর্ণ হরে পারে। তাই এটা জানা জরুরী যে, বাংলাদেশের ভোক্তারা এই নতুন প্রযুক্তি সম্পর্কে মূলত কি ধারণা পোষন করে। উল্লেখ্য যে এই নতুন বৈজ্ঞানিক পদ্ধতি ও জি এম খাদ্যের সফলতা অনেক আংশে ভোক্তার মনোভাব ও ক্রয় করার ইচ্ছার উপর নির্ভরশিল।

আপনার অবগতির জন্য জানানো যাচ্ছে যে, ঢাকা বিশ্ববিদ্যালয়ের মার্কেটিং বিভাগ জিএম খাদ্যের উপর এই গবেষণা পরিচালনা করছে। আপনি এই গবেষণার জন্য একজন গুত্বপূর্ণ অংশগ্রহণকারী হিসেবে মনোনীত হয়েছেন। এই জরিপের মুখ্য উদ্দেশ্য হলো, জিএম খাদ্য সম্পর্কে আপনার উপলব্ধি, বিশ্বাস, মনোভাব ও এর সম্পর্কিত ঝুঁজি ও উপকারিতা এবং সেই সাথে এই নতুন ধরনের খাদ্য বাংলাদেশের খাদ্য শৃংখলের মধ্যে সংযুক্ত করার অভিপ্রায় সম্পর্কিত তথ্য সংগ্রহ করা।

এই জরিপটি খাদ্য শিল্প ও সরকারকে সহযোগিতা করবে। সেই সাথে খাদ্য শিল্পের কর্মপন্থা পরিকল্পনাকারীদের জন্য জি. এম. খাদ্য সম্পর্কিত ভোক্তাদের উপলব্ধি বুঝতে সাহায্য করবে। আপনার মতামত গুলো সম্পূর্ণ গোপনীয় এবং এগুলো শুধুমাত্র সারমর্ম আকারে প্রকাশ করা হবে যাতে কোন ব্যক্ত বিশেষের উত্তর সনাক্ত করা না যায়। যখন আপনার লিখিত প্রশ্নাবলী শেষ হবে আপনার নাম তালিকা থেকে মুছে দেয়া হবে এবং আপনার নাম উত্তরের সাথে অন্য কোন পন্থায় সংযুক্ত করা হবে না। এই জরিপটি ঐচ্ছিক কিন্তু আপনার অংশগ্রহণ খুবই গুরুত্বপূর্ণ। কিছু সময় ব্যয় করে জি. এম. খাদ্য সম্পর্কিত আপনার অভিমত আমাদের জানিয়ে আপনি আমাদের ব্যতিক্রমীভাবে সহযোগিতা করতে পারেন। দয়া করে কিছু সময় নিয়ে লিখিত প্রশ্নাবলী পূরণ করে গবেষণা সহায়কদের কাছে তা ফেরত দিন।

যদি এই জরিপ সম্পর্কে আপনার কোন প্রশ্ন বা মতামত থাকে তবে আমরা আপনার সাথে কথা বলে খুশী হব। আমাদের নম্বর- ০১৭১৫৫২৮০৪৮ (ড. বেলায়েত হোসেন) অথবা ০১৯২০০৬৬৬৮৪ (আমির আহমেদ) অথবা আমাদের ই-মেইল করতে পারেন prof_belayet@yahoo.com অথবা aff73@yahoo.com

আমাদের এই গুরুত্বপূর্ণ গবেষণায় সাহায্য করার জন্য আপনাকে অনেক ধন্যবাদ।

বিনীত

ড. বেলায়েত হোসেন
অধ্যাপক
মার্কেটিং শাখা/বিভাগ
ঢাকা বিশ্ববিদ্যালয়

আমির আহমেদ
গবেষণা শিক্ষার্থী (পি. এই. ডি প্রোগ্রাম)
মার্কেটিং শাখা/বিভাগ
ঢাকা বিশ্ববিদ্যালয়

জি এম ফুড সংক্রান্ত সাধারণ তথ্য

সাধারনভাবে জ্বীন গবেষকরা যে বিশেষ পদ্ধতিতে কোন সজীব পদার্থের জ্বীন ভিন্ন ধরনের কোন সজীব উদ্ভিদ বা প্রাণীর জৈব কোষে হ্যানান্তর করে তাই জি এম প্রযুক্তিবিদ্যা। জি এম প্রযুক্তি ঔষধশিল্পে ব্যাপকভাবে ব্যবহৃত হয়। সর্বপ্রথম জি এম প্রযুক্তিতে উৎপাদিত খাদ্য ছিল টমেটো যা ১৯৯০ সালে বাজারে আসে। তবে জি এম শস্যের উৎপাদন বিগত দশকে উল্লেখযোগ্যভাবে বৃদ্ধি পেয়েছে। সাম্প্রতিক রিপোর্ট থেকে জানা যায়, ১৯৯৯ সালে জি এম শস্যের উৎপাদন ছিল ৩০ মিলিয়ন হেক্টর। যা ২০০৭ সালে বেড়ে দাড়িয়েছে ১১৬ মিলিয়ন হেক্টরে।

প্রধান জি এম শষ্য উৎপাদনকারী দেশগুলোব নাম যথাক্রমে আমেরিকা যুক্তরাষ্ট্র (৫৭.৭) যা হেক্টর আর্জেন্টিনা (১৯.১) যা হেক; ব্রাজিল (১৬.০) যা হেক; কানাডা (৭.৩) যা হেক; ভারত (৬.২)যা, হেক; চীন (২.৮) যা হেক; এবং দক্ষিণ আফ্রিকা (১.৮) যা হেক;। উদাহরণস্বরূপ জি এম প্রযুক্তিতে উৎপাদিত ধানে রয়েছে ভিটামিন এ যা বাংলাদেশে খুব শ্রীঘ্রই বাণিজ্যিকভাবে উৎপাদন করা হবে। এছাড়াও জি এম প্রযুক্তিতে উৎপাদিত বিভিন্ন শস্য এবং শাকসবজি গবেষণাগারে নির্মাণাধীন রয়েছে।

সারা বিশ্বের জনগণের মাঝেই জি এম প্রযুক্তিতে খাদ্যের উৎপাদন নিয়ে মিশ্র প্রতিক্রিয়া রয়েছে। অনেকেই পশুপাখি ও গাছপালা নিয়ে জি এম গবেষণা কতটুকু সফল হবে তা নিয়ে সন্দিহান। তারা এর মধ্যে অনেক ঝুঁকি ও দেখতে পাচ্ছেন। ইতিমধ্যে জি এম খাদ্যের উৎপাদন ইউরোপিয় ইউনিয়ন এবং এশিয়ার কিছু দেশে (মায়ানমার) নিষিদ্ধ করা হয়েছিল।

জি এম ফুড এর প্রধান সুবিধা হল দামে তা সাশ্রয়ী, পরিবেশবান্ধব এবং সমাজের জন্য কল্যানকর। সাধারনভাবে জি এম ফুড প্রতি একর জমিতে শস্যের উৎপাদন বাড়ায়, দ্রবত ফলন হয়, দামে সাশ্রয়ী হয়, এবং বিভিন্ন জাতের ফলন হয়। এটা যেমন জমি ও পানির ব্যবহার হ্রাস করে তেমনি অতিরিক্ত সারের ওষুধ ও কীটনাশকের ব্যবহারও হ্রাস করে। খাদ্যের পঁচন রোধ করা। অপচয় কমানো, পুষ্টির গুন বাড়ানো এবং রোগ জীবানু প্রতিরোধে সাহায্য করা জি এম ফুড এর প্রধান বৈশিষ্ট্য। আবার, জি এম প্রযুক্তি কখনও কখনও স্বাস্থ্যের জন্য ঝুঁকিকরও হয়ে উঠতে পারে। অ্যালার্জি, পরিবেশের ভারসাম্যহানী তা imbalance of biodiversity এবং কতিপয় ব্যবসায়ী প্রতিষ্ঠানের একক প্রভাব বিস্তার জি এম প্রযুক্তির মূল সমস্যা। এছাড়া নৈতিক ও সামাজিক ইস্যুর কারণেও বিভিন্ন দেশের বিভিন্ন সংস্থা জিএম প্রযুক্তির বিরুদ্ধে অবস্থান নেওয়ার কারনে জিএম খাদ্য হুমকির মধ্যে অবস্থান করছে।

বর্তমানে বিশ্বের বাজারে যে সকল জি এম ফুড বিদ্যামন তা হল ধান, গম, ভুট্টা (অতি উচ্চ পুষ্টিমানের), রোগমুক্ত তুলা, উচ্চ পুষ্টিমানের টমেটো, পোকা যুক্ত বমম ঢ়ষধহঃ এবং আলু, ফুলকপি, ক্যানসাররোধী খাদ্য, আপেল, আঙ্গুর, চেরী এবং স্ট্রবেরী যা মানে এবং স্বাদে অতুলনীয়, তৈল বীজ (low cholesterol & high oleic acid content), দুধ, জাতীয় সামগ্রী (rBST), জি এম টুনা মাছ যা প্রচুর পরিমাণে প্রোটিন সমৃদ্ধ, জি এম ক্যানোলা টিনজাত খাবারে প্রিজারভেটিভ হিসেবে ব্যবহৃত হয়। এছাড়া বাণিজ্যিকভাবে ইনসুলিন, বিভিন্ন ঔষধ এবং ক্যানসারে কোমাথেরাপি ও জি এম প্রযুক্তিতে জ্বীনের উন্নয়নের মাধ্যমে উৎপাদিত হচ্ছে।

আরও বিস্তারিত তথ্যের জন্য নিম্নোক্ত ওয়েব অ্যাড্রেসে ভিসিট করুন:

http://www.disabled-world.com/fitness/gm-foods.php

বিভাগ- ১: জি এম ফুড সংক্রান্ত ভোক্তার সাধারন জ্ঞান

ক) আপনি কি কৃত্রিম খাদ্য উৎপাদনে বায়োটেকনোলজি, জেনেটি ইঞ্জিনিয়ারিং, জেনেটিক্যালি মডিফিকেশন (জে এম), জেনেটিক্যালি মডিফাইড অরগ্যানিসমের ব্যবহারের কথা শুনেছেন বা পড়েছেন. (আপনার নির্বাচিত উত্তরে গোল চিহ্ন দিন)

১) হ্যা, আমি বায়োটেক ফুড সম্পর্কে পড়েছি বা শুনেছি।
২) না, আমি বায়োটেক ফুড সম্পর্কে পড়েনি বা শুনেনি।

যদি আপনার উত্তর না হয় তবে এই পরিসংখ্যানের সাথে সংযুক্ত জি এম ফুড সংক্রান্ত সাধারন তথ্য অংশটি পড়ুন এবং পরিবর্তি প্রশ্নের উত্তর দিন

খ) বায়োটিকনোলীজ বা জিএম ফুড সম্পর্কে আপনি কতটুকু জানেন নিম্নের অপশনগুলোর সাহায্যে নিজেকে যাচাই করুন।

জিএম ফুড
৫) খুবই ভালো
৪) মোটামুটি
৩) কিছু পরিমাণে
২) অল্প পরিমাণে
১) কিছুই না।

গ) আপনার এলাকার কোন দোকানে বা স্থানীয় বাজারে কি জি এম ফুড পাওয়া যায়?

১) হ্যা (২) না (৩) জানা নেই।

বিভাগ-২: জি. এম. খাদ্য সংক্রান্ত নৈতিকতা

জি. এম. খাদ্য স্বাভাবিকভাবে তৈরি হয় না। এই খাদ্য পরীক্ষাগারে কৃত্রিমভাবে জিনের জৈবিক গঠনে পরিবর্তন করে উৎপাদন করা হয়। এজন্য সমাজের অনেক জনগণের কাছেই এর নৈতিকতা ধর্ম ও ভাবমূর্তি নিয়ে প্রশ্ন উঠেছে। অনুগ্রহ করে আপনার মতামতে গোল চিহ্ন দিন

১ = সম্পূর্ন দ্বিমত, ২ = দ্বিমত, ৩ = নিরপেক্ষ, ৪ = একমত, ৫ = সম্পূর্ণ একমত।

১)	জিনের উন্নয়ন প্রকৃতি ও মানুষের সম্পর্কের সাধারন ধর্মকে লঙ্ঘন করে।	১	২	৩	৪	৫
২)	জি. এম. শস্য এবং পশুপাখি সৃষ্টি করা নৈতিকভাবে অনুচিত	১	২	৩	৪	৫
৩)	বিভিন্ন প্রজাতি বা শ্রেণীর জীবের মধ্যে জিনের উৎপাদনে স্থানান্তর করা অপ্রাকৃতিক ও অপ্রয়োজনীয়....	১	২	৩	৪	৫
৪)	হারাম প্রাণী বা শস্যের জিন অন্য কোন প্রাণী বা শস্যে স্থানান্তর করলে তাও হারাম হয়ে যায়।	১	২	৩	৪	৫
৫)	শূকরের জিন কৃতিম ইনসুলিন সংক্রান্ত দ্রব্যে ব্যবহার করা যাবে কারণ তা ঔষধ।	১	২	৩	৪	৫

বিভাগ-৩: জি. এম. খাদ্যের লেবেলিং (বাধ্যতামূলক বা ঐচ্ছিক)

যুক্তরাষ্ট্রের খাদ্য এবং ঔষধ মন্ত্রণালয়ের FDA আইন অনুযায়ী বায়োটেক খাবার লেবেলিং করা ঐচ্ছিক। যেহেতু এসব খাদ্য দ্রব্য অন্য সাধারন খাদ্য দ্রব্যের মতই নিরাপদ এবং এরূপ খাদ্য দ্রব্যের উপাদান সমূহও নিরাপদ। ঐচ্ছিক লেবেলিং এর ফলে বায়োটেক খাবারের মান সম্পর্কে প্রশ্ন উঠবে এই বক্তব্যের সাথে FDA একমত নয়। তবে সমালোচকদের মতে বায়োটেকনলজিতে উৎপাদিত খাবার অবশ্যই লেবেলিং করা উচিৎ যদিও এসব খাবার নিরাপদ। তারা বলেন ভোক্তাদের এটা জানার অধিকার রয়েছে।

১) কোন লেবেলিং পদ্ধতির সাথে আপনি একমত? (FDA অথবা সমালোচকদের?)
ক। FDA অথবা সমালোচকদের
খ। সমালোচক- বাধ্যতামূলক লেবেলিং
অনুগ্রহ করে আপনার মতামত দিন

১ = সম্পূর্ন দ্বিমত, ২ = দ্বিমত, ৩ = নিরপেক্ষ, ৪ = একমত, ৫ = সম্পূর্ণ একমত।

২)	লেবেলের পুষ্টি সংক্রান্ত তথ্য খাবার কেনার ক্ষেত্রে আমার সিদ্ধান্তকে প্রভাবিত করে	১	২	৩	৪	৫
৩)	প্রক্রিয়াজাত খাবার কিনার সময় আমি খাবারের লেবেল দেখি	১	২	৩	৪	৫
৪)	আমি খাবারের লেবেলের পুষ্টিগত তথ্যের অংশটুকু দেখি	১	২	৩	৪	৫
৫)	আমি শুধুমাত্র খাবারের মেয়াদউত্তীর্নের তারিখ দেখি	১	২	৩	৪	৫
৬)	জি. এম. খাদ্যের লেবৈলিং আমাকে বিভ্রান্ত করতে পারে অথবা আমার সিদ্ধান্তকে ভুল দিকে প্রভাবিত করতে পারে..	১	২	৩	৪	৫
৭)	জি. এম. ফলমূল এবং শাকসবজির লেবেল করা বাংলাদেশে অসম্ভব	১	২	৩	৪	৫

৮) আপনি প্রায়ই খাবার কেনার সময় খাবারের লেবেলের পুষ্টিগত অংশ পড়ে দেখেন কি?

ক) পরিচিত খাদ্যদ্রব্য- ১। সবসময় ২। প্রায়ই ৩। মাঝে মাঝে ৪। কদাচিৎ ৫। কখনই না।

খ) নতুন খাদ্যদ্রব্য- ১। সবসময় ২। প্রায়ই ৩। মাঝে মাঝে ৪। কদাচিৎ ৫। কখনই না।

বিভাগ-৪: জি. এম. খাবারের পরিচালনা এবং নিয়ন্ত্রণ সংক্রান্ত বিষয়াদিঃ

জি. এম. খাদ্যের নিয়ন্ত্রণ ও পরিচালনা পদ্ধতির নিরাপত্তার ব্যাপারে নিম্নের কোন কোন সংস্থাকে আপনি বিশ্বাস করেন? আপনার

মতামত ১-৫ অপশনের মধ্যে গোল চিহ্ন দিয়ে প্রকাশ করুন। অপশন-১ (মোটেই বিশ্বাস করি না) থেকে অপশন-৫ (অনেক বিশ্বাস করি)

ক- সরকারী সংস্থা.....	১	২	৩	৪	৫
খ-ভোক্তা এবং পরিবেশবাদী দল.....	১	২	৩	৪	৫
গ- খাদ্য এবং কৃষি ব্যবসায়ী	১	২	৩	৪	৫
ঘ- বৈজ্ঞানিক এবং একাডেমীক সদস্যরা.....	১	২	৩	৪	৫

বিভাগ-৫: জি এম ফুড এর সুবিধা ও ঝুঁকি সংক্রান্ত সাধারণ ধারণা।

১ = সম্পূর্ন দ্বিমত, ২ = দ্বিমত, ৩ = নিরপেক্ষ, ৪ = একমত, ৫ = সম্পূর্ণ একমত।

(শারীরিক ও আর্থ- সামাজিক প্রেক্ষাপট)

ক) দয়া করে জি এম ফুড সম্পর্কে আপনার বিশ্বাসও মতামতকে গোল চিহ্ন দিন

১) জি এম ফুড মানুষের স্বাস্থ্যের জন্য ক্ষতিকর	১	২	৩	৪	৫
২) জি এম ফুড হৃদরোগ ও ক্যানসারের ঝুঁকি হ্রাস করে	১	২	৩	৪	৫
৩) জি এম ফুড স্বাস্থের জন্য উপযোগী কারণ এতে অনেক পুষ্টিকর উপাদান যাবে	১	২	৩	৪	৫
৪) জি এম স্বাস্থ্যসম্মত কারণ এতে রাসায়নিক পদার্থের সীমিত ব্যবহার হয়	১	২	৩	৪	৫
৫) জি এম ফুড ক্ষতিকর কারণ কতিপয় জি এম ফুড এ্যালার্জির সৃষ্টি করে	১	২	৩	৪	৫
৬) জি এম ফুড সমাজের জন্য উপকারী ও লাভজনক কারণ এটা কৃষকের উৎপাদন ব্যয় কমায়..... ..	১	২	৩	৪	৫
৭) জি এম ফুডের কলুষিতকরণ এড়াতে সাধারন খাবার থেকে একে আলাদা করা উচিত	১	২	৩	৪	৫
৮) জি এম ফুড ভোক্তাদের লাভবান করে কারণ তা সাশ্রয়ী	১	২	৩	৪	৫

১ = সম্পূর্ন দ্বিমত, ২ = দ্বিমত, ৩ = নিরপেক্ষ, ৪ = একমত, ৫ = সম্পূর্ণ একমত।

(পরিবেশ ও বনের উপর প্রভাব)

৯) উন্নয়নশীল দেশে খাদ্য মজুদের সমস্যা এড়াতে জি এবং ফুড অত্যন্ত উপযোগী.....	১	২	৩	৪	৫
১০) জি এম শষ্যে ব্যবহৃত জীবজগতের গুরুত্বপূর্ণ উদ্ভিদ ধক্ষংস করে.....	১	২	৩	৪	৫
১১) জি এম শস্য লাভজনক কারণ.....	১	২	৩	৪	৫
১২) জি এম শস্য পরিবেশবান্ধব কৃষিব্যবস্থার সহায়ক	১	২	৩	৪	৫
১৩) জি এম শস্য কতিপয় পশুপাখি ও উদ্ভিদের জন্য হুমকিস্বরূপ.....	১	২	৩	৪	৫
১৪) জি এম শস্য ক্ষতিকর কারণ.....	১	২	৩	৪	৫

বিভাগ- ৬: জি এম ফুড এর গ্রহণযোগ্যতা এবং জি এম ফুড ক্রয়ে ভোক্তার আগ্রহ।

১ = সম্পূর্ন দ্বিমত, ২ = দ্বিমত, ৩ = নিরপেক্ষ, ৪ = একমত, ৫ = সম্পূর্ণ একমত।

আপনার মতামতে গোল চিহ্ন দিন

১) জি এম ফুড কিনতে আমার কোন সমস্যা নেই	১	২	৩	৪	৫
২) আমি জি এম ফুড কিনতে চাই না	১	২	৩	৪	৫
৩) জি এম ফুড মানুষের খাদ্য হিসাবে নিরাপদ	১	২	৩	৪	৫
৪) জি এম ফুড মানুষের খাদ্য হিসাবে নিরাপদ নয়.....	১	২	৩	৪	৫

ক) ভিটামিন এ সমৃদ্ধ চাল (সাধারন চালে ভিটামিন থাকে না)

১) হ্যা ২) না ৩) নিশ্চিত নই।

খ) ওমেগা ৩ ফ্যাটি এসিড যুক্ত সয়াবিন তেল যা স্বাস্থ্যের জন্য উপকারী। (সাধারন সয়াবিন তেল এ ওমেগা ৩ ফ্যাটি এসিড খুবই অল্পপরিমাণে থাকে)

১) হ্যা ২) না ৩) নিশ্চিত নই।

১) বিভাগ- ৮ ঃ সামাজিক- ডেমোগ্রাফস

ক) আপনার লিঙ্গ কি?

১। পুরুষ ২। মহিলা

খ) আপনার বৈবাহিক অবস্থা কি?

১। অবিবাহিত ২। বিবাহিত ৩। অন্যান্য

গ) আপনার সম্ভাব্য বয়স?

১। ১৮-২৪ ২। ২৫-৩৪ ৩। ৩৫-৪৪ ৪। ৪৫-৫৪ ৫। ৫৫-৫৯ ৬।৬০-৬৪ ৭। ৬৫ বা তার বেশি

ঘ) দয়া করে আপনার সর্বোচ্চ শিক্ষাগত যোগ্যতা উল্লেখ করুন

১। স্নাতকের শিক্ষার্থী ২। স্নাতক ৩। স্নাতকোউত্তর ৪। এডভান্সড ডিগ্রী ৫। অন্যান্য

ঙ) নিচের কোন অংশে আপনার পেশা সবচেয়ে ভালোভাবে মিলে?

১। ছাত্র ২। সরকারী চাকুরীজীবি ৩। বেসরকারী চাকুরীজীবি ৪। ব্যবসা ৫।প্রকৌশলী ৬) চিকিৎসক ৭। শিক্ষক ৮।আইনজীবি ৯। টেকনিকাল
১০। গৃহিনী ১১। অন্যান্য (দয়া করে উল্লেখ করুন)

চ) নিচের কোনটির সাথে আপনার মাসিক আয় সবচেয়ে বেশি মিলে?

১) ৫০০০-১০০০০ ২) ১১০০০-১৫০০০ ৩) ১৬০০০-২০০০০ ৪)২১০০০-২৫০০০
৫) ২৬০০০-৩০০০০ ৬) ৩১০০০-৩৫০০০ ৭) ৩৬০০০-৪০০০০
৮)৪১০০০-৫০০০০ ৯) ৫১০০০-৬০০০০ ১০) ৬১০০০- তার বেশি

ছ) আপনি খবরের কাগজ কেমন পড়েন?

১) নিয়মিত ২) বেশিরভাগ সময় ৩) মাঝে মাঝে ৪) খুব কম ৫) একেবারেই কম

জ) নতুন কিছু জানার জন্য আপনি কখন ইন্টারনেট ব্যবহার করেন?

১) সব সময় ২) বেশির ভাগ সময় ৩) মাঝে মাঝে ৪) খুব কম ৫) একেবারেই কম।

আপনার আরো কোন প্রশ্ন বা মতামত থাকলে নিচের অংশে লিখুন।

আপনার মূল্যবান সময় এবং সহযোগিতা দিয়ে এই গবেষণাকে সফল করার জন্য আন্তরিক ধন্যবাদ।

Annex - IV

Year wise chronological list of major events took place in gradual development of Genetic Modification technology.

List of major events took place in gradual development of Genetic Modification technology

Year	Major events
1973	Boyer and Cohen create the first recombinant organism (GMO).
1980	First biotechnology patent granted. US researchers awarded a US patent that allows them to make human insulin from genetically modified bacteria. GM crop plants started being developed in laboratory with useful characteristics such as herbicide tolerance and insect & virus resistance.
1982	Insulin produced by GM technology approves for sale by the US Food and Drug Administration.
1983	Four separate groups of scientists create GM plants, three groups insert bacterial genes into plants and one inserts a gene into a sunflower plant. Scientists genetically modify a tobacco plant to have antibiotic resistance.
1987	China first to put GM crops on sale, namely a virus-resistant tobacco and a tomato.
1990	GM technology used to make chymosin, an enzyme used in making hard cheese.
1993	Monsanto used GM technology to make recombinant bovine somatotropin protein (rBST) supplement to increase cows' milk yields.
1994	Marking the start of widespread use of genetically modified crop plants in the USA, the FlavrSavr tomato is first introduced in the US market.
1995	Bt. corn (modified with a bacterium gene to give in insect resistance) goes in the market in the USA. Australian Genetic Manipulation Advisory Committee (GMAC) allows unrestricted commercial release of a GM blue carnation in Australia.
1996	Ingard® insect resistant (*Bt*) cotton is grown commercially in Australia. GM tomato arrives in Britain, prompting backlash from Greenpeace and Friends of the Earth Herbicide-tolerant GM Soybean available in the US market. Roundup Ready Soybeans (soybeans resistant to Roundup herbicide) introduced in the USA. UK experience with BSE (Bovine Spongiform Encephalopathy) food crisis 'mad cow disease' linked to human brain disease. First GM herbicide tolerant soybean (Roundup Ready Soybeans) and insect protected maize approved in the EU.
1997	Dolly, the first ever cloned sheep born in Scotland in 1996, is revealed to the world. EC Novel Roods Regulation (258/97) comes into effect, requiring a safety assessment for novel and GM foods before they go on sale.
1998	40 million hectares of GM crops are planted globally: predominantly soy, cotton, canola & corn. Arpad Pusztai claims on TV show that GM potatoes harm rats in his laboratory .study.
1999	Downing Street confirms that Tony Blair has eaten GM food and regards it as safe. Losey, et al., report of laboratory study indicating monarch butterflies could be potentially harmed by GM corn pollen, subsequent field level findings showed minimal, if any harm.
2000	Intermingling of Starlink corn with approved GM varieties; recalls relating to potential allergic responses. Biosafety Protocol requiring of bio-engineered crops is agreed by 130 countries in Montreal, Canada
2001	EU imposed mandatory labeling for trace amount of GM ingredients.
2003	African nations affected by drought and famine reject U.S. food aid of GM corn. U.S. sues the EU in the WTO regarding GM issue.
2004	GM maize is approved for planting in Britain and Australia, despite regulatory approval for GM canola, most state governments place moratoria on growing GM canola in response to consumer concerns. Golden rice: Rice that can make beta-carotene (which our bodies make into vitamin A) is grown in parts of the world where people are deficient in vitamin A. Potatoes that contain extra protein go on sale. EU rules go into effect.
2007	Government backs industry call to bring GM to Britain. United States Food and Drug Administration conclude that food and food products derived from cloned animals or their offspring are as safe to eat as that from non-cloned animals.
2008	GM canola approved for commercial release in NSW. Japanese researchers successfully develop the world's first GM blue rose.
2009 and Beyond	Within the next twenty years, a second generation of GM crops is expected with properties that have more direct consumer benefit such as elimination of allergens in food, increased nutritional content, and lower fat & oil levels. Third generation GM crops may have properties like salt tolerance and drought resistance, or produce pharmaceutical products, oral vaccines, and specialty products such as plastic starter chemicals to create bioplastics.

Source: The Guardian, Feb 16, 2008 & Berg and Mertz, 2010

Annex -V

A comprehensive overview of the technologies used in creating GM crops and their corresponding consumers' benefits.

Technologies used in creating GM crops and their corresponding benefits.

Pest resistance: Crops loss from insect pests can result in devastating financial loss for farmers in developing countries. Farmers typically use many tons of chemical pesticides annually to get rid of this problem. On the other hand eating of food that has been treated with pesticides can cause potential health hazards. Moreover, run-off of agricultural wastes from excessive use of pesticides and fertilizers can poison the supplied water and cause harm to the environment. Growing GM foods such as Bt. corn can help eliminate the application of chemical pesticides and reduce the cost of bringing a crop to market.

Herbicide tolerance: Removing weeds by physical means such as tilling is a time consuming procedure. As an easy alternative farmers often spray large quantities of different herbicides (weed-killer) to destroy weeds which is an expensive process and requires extra care to protect the crop plant and the environment. Genetically modified crop plants resistant to one very powerful herbicide could help prevent environmental damage by reducing the amount of herbicides needed.

Disease resistance: There are many viruses, fungi and bacteria that cause plant diseases. Papaya and Squash in international market are examples of GM variety which is resistant to certain viral disease.

Cold tolerance: An antifreeze gene from cold water fish has been introduced into plants such as tobacco, potato and tomato in 2002. With this antifreeze gene, these plants are able to tolerate cold temperatures lethal for normal growth of those plants.

Drought and salinity tolerance: As the world population grows and more land is utilized for housing instead of food production, there will be a need to grow crops in locations previously unsuited for plant cultivation. In some country creating plants that can withstand long periods of drought or high salt content in soil, a GM variety with drought and salinity resistant trait can help farmer to grow crops in formerly inhospitable places.

Nutrition: Malnutrition is common in third world countries where impoverished peoples rely on a single crop such as rice for the main staple of their diet. However, rice does not contain adequate amounts of all necessary nutrients to prevent malnutrition. Rice has been genetically modified to contain additional vitamins and minerals.

Pharmaceuticals: Medicines and vaccines often are costly to produce and sometimes require special storage conditions not readily available in third world countries. Researchers are working to develop edible vaccines in tomatoes and potatoes. These vaccines will be much easier to ship, store and administer than traditional injectable vaccines.

Phytoremediation: Not all GM plants are grown as crops. Soil and groundwater pollution continues to be a problem in all parts of the world. Plants such as poplar trees have been genetically engineered to clean up heavy metal pollution from contaminated soil. Phytoremediation is a great hope to the scientist to fight against global warming

List of Statistical Tables and Figures
(Expert Survey)

Table – 1: Percentage of Frequency Distribution, Mean Value and Standard Deviation Regarding Responses on Ethical and Moral Concerns with GM Foods.

Sl. No.	Statements for Measuring Ethical and Moral Concerns Regarding GM Foods	Percentages of Score Value						
		SD	D	N	A	SA	Mean Value	Standard Deviation
1.	Genetic Modification violates the basic principle regarding the relationship between human and nature	38.1	36.5	9.5	3.2	12.7	2.16	1.322
2.	Transfer of genes between different species is unnatural & unnecessary	36.5	22.2	14.3	20.6	6.3	2.38	1.337
3.	The transfer of a forbidden animal's (pigs for Muslim & Jews) genes into a plant / animal will make the GM food forbidden (haram) too	25.4	19.0	25.4	23.8	6.3	2.67	1.270
4.	Use of pig gene in insulin production is acceptable as it is a drug	7.9	20.6	3.2	42.9	25.4	3.57	1.292
Overall Mean Value Score and Standard Deviation							**2.70**	**1.305**

Note: SD = *Strongly Disagree*, D = *Disagree*, N = *Neutral*, A = *Agree*, SA = *Strongly Agree*

Table – 2: Percentage of Frequency Distribution, Mean Value and Standard Deviation Regarding Responses on Pricing Issues of GM Foods.

Sl.No.	Statements for Measuring Pricing Issues Regarding GM foods	Percentages of Score Value						
		SD	D	N	A	SA	Mean Value	Standard Deviation
1.	High price of GM seeds will increase production cost for the farmers	7.9	34.9	12.7	20.6	23.8	3.17	1.351
2.	High price of GM seed will outweigh increased cost with high yield	11.1	27.0	6.3	36.5	19.0	3.25	1.344
3.	Consumer will accept GM variety easily if the price is low	14.3	22.2	3.2	42.9	17.5	3.27	1.370
Overall Mean Value Score and Standard Deviation							**3.23**	**1.355**

Note: SD = *Strongly Disagree*, D = *Disagree*, N = *Neutral*, A = *Agree*, SA = *Strongly Agree*

Table – 3: Percentage of Frequency Distribution, Mean Value and Standard Deviation Regarding Responses on Labeling Issues of GM Foods.

Sl.No.	Statements for Measuring Labeling Issues Regarding GM Foods	Percentages of Score Value						
		SD	D	N	A	SA	Mean Value	Standard Deviation
1.	Food labels are needed to show the presence of biotech ingredients, since consumer	7.9	9.5	14.3	49.2	19.0	3.62	1.142
2.	Labels with adequate nutritional information influence my food choice	3.2	9.5	3.2	49.2	34.9	4.03	1.031
3.	Most BD consumers only see expiry dates in food labels	19.0	14.3	17.5	34.9	14.3	3.11	1.357
4.	How often do you read the nutritional section of food labels before buying a food product, familiar food.	9.5	22.2	47.6	14.3	6.3	3.14	.998
5.	How often do you read the nutritional section of food labels before buying a food product, New foods	4.8	31.7	28.6	12.7	22.2	2.84	1.234
6.	How often do you read the ingredients section of food labels before buying a food product, Familiar food	9.5	39.7	14.3	25.4	11.1	3.11	1.220
7.	How often do you read the ingredients section of food labels before buying a food product, New foods	17.5	12.7	27.0	15.9	27.0	2.78	1.431
Overall Mean Value Score and Standard Deviation							**3.23**	**1.202**

Note: **SD** = ***Strongly Disagree***, **D** = ***Disagree***, **N** = ***Neutral***, **A** = ***Agree***, **SA** = ***Strongly Agree***

Table – 4: Percentage of Frequency Distribution, Mean Value and Standard Deviation Regarding Responses on Labeling preference of GM Foods.

Sl.No.	Statements for Measuring Labeling Preference Regarding GM foods	Percentages of Score Value		
		Agreement	Mean Value	Standard Deviation
1.	FDA – voluntary labeling of GM foods	33.3	1.67	0.475
2.	Critics – mandatory labeling of GM foods	66.7		
Overall Mean Value Score and Standard Deviation			**1.67**	**0.475**

Note: **SD** = ***Strongly Disagree***, **D** = ***Disagree***, **N** = ***Neutral***, **A** = ***Agree***, **SA** = ***Strongly Agree***

Table – 5: Percentage of Frequency Distribution, Mean Value and Standard Deviation Regarding Responses of Trust on Different Regulatory Organization of GM Foods.

Sl.No.	Statements for Measuring Trust on Different Agencies Regarding GM Foods	Percentages of Score Value						
		1	2	3	4	5	Mean Value	Standard Deviation
1.	How much do you trust the Government agencies to protect wildlife and environment from the potential harmful effects of GM crops	23.8	7.5	27.0	28.6	3.2	2.70	1.213
2.	How much do you trust the Consumer and environmental groups to protect wildlife and environment from the potential harmful effects of GM crops	9.5	15.9	30.2	28.6	15.9	3.25	1.191
3.	How much do you trust the Food and agribusiness companies to protect wildlife and environment from the potential harmful effects of GM crops	23.8	46.0	20.6	9.5	0.0	2.16	.902
4.	How much do you trust the Scientist and academicians to protect wildlife and environment from the potential harmful effects of GM crops	0.0	6.3	20.6	36.5	36.5	4.03	.915
5.	How much do you trust the Government agencies regarding testing, inspections and regulation of GM crops	22.2	19.0	33.3	17.5	7.9	2.70	1.227
6.	How much do you trust the Consumer and environmental groups regarding testing, inspections and regulation of GM crops	11.1	33.3	23.8	17.5	14.3	2.90	1.241
7.	How much do you trust the Food and agribusiness companies regarding testing, inspections and regulation of GM crops	9.5	41.3	23.8	25.4	0.0	2.65	.970
8.	How much do you trust the Scientist and academicians regarding testing, inspections and regulation of GM crops	0	4.8	25.4	42.9	27.0	3.92	.848
Overall Mean Value Score and Standard Deviation							**3.04**	**1.063**

Note: 1 = *No trust* to 5 = *High degree of trust*

Table – 6: Percentage of Frequency Distribution, Mean Value and Standard Deviation Regarding Responses on Health and Social Well Beings issues of GM foods.

Sl.No.	Statements for Measuring Health and Social Well Being Regarding GM Foods	Percentages of Score Value						
		SD	D	N	A	SA	Mean Value	Standard Deviation
1.	GM food can have unforeseen harmful affect on human health	27.0	17.5	30.2	11.1	14.3	2.68	1.366
2.	GM food benefits society because it has extra nutritional features in it	4.8	19.0	20.6	31.7	23.8	3.51	1.190
3.	GM food can lower your risk of heart disease and some types of cancer	4.8	17.5	38.1	22.2	17.5	3.30	1.102
4.	GM crops may handicap the poor farmers for purchasing GM seeds from MNCs	12.7	7.9	7.9	42.9	28.6	3.67	1.320
5.	GM food may be harmful to people having allergic reactions to particular food	4.8	17.5	34.9	20.6	22.2	3.38	1.156
6.	GM crops are beneficial for society because they lower the farmer's production cost and food price	27.0	11.1	3.2	46.0	12.7	3.06	1.480
7.	GM crops benefit society to solve food shortage in less developed countries	7.9	17.5	19.0	38.1	17.5	3.40	1.199
Overall Mean Value Score and Standard Deviation							**3.29**	**1.184**

Note: **SD** = ***Strongly Disagree***, **D** = ***Disagree***, **N** = ***Neutral***, **A** = ***Agree***, **SA** = ***Strongly Agree***

Table – 7: Percentage of Frequency Distribution, Mean Value and Standard Deviation Regarding Responses on Wildlife and Environmental issues of GM foods.

Sl.No.	Statements for Measuring Wildlife and Environmental Issues Regarding GM Foods	Percentages of Score Value						
		SD	D	N	A	SA	Mean Value	Standard Deviation
1.	GM crops are harmful to the environment because they can cross pollinate with non GM crops	6.3	34.9	15.9	14.3	28.6	3.24	1.364
2.	GM crops are beneficial to the environment because they allow farmers to use fewer herbicides and pesticides	9.5	14.3	7.9	39.7	28.6	3.63	1.299
3.	GM crops are beneficial because they lead to adoption of more environmentally friendly farming system	20.6	3.2	9.5	49.2	17.5	3.40	1.386
4.	GM crops are harmful for the environment as they kill useful microorganisms in soil	19.0	20.6	23.8	12.7	23.8	3.02	1.442
5.	GM crops threaten indigenous plants and animals	3.2	46.0	12.7	14.3	23.8	3.10	1.304
Overall Mean Value Score and Standard Deviation							**3.20**	**1.308**

Note: SD = *Strongly Disagree*, D = *Disagree*, N = *Neutral*, A = *Agree*, SA = *Strongly Agree*

Table – 8: Percentage of Frequency Distribution, Mean Value and Standard Deviation Regarding Responses on level of encouragement of commercial production of GM of GM Foods.

Sl. No.	Statements for Measuring Level of Encouragement Regarding GM foods	Percentages of Score Value						
		SD	D	N	A	SA	Mean Value	Standard Deviation
1.	I personally encourage commercial production of GM food and crops in Bangladesh.	12.50	17.50	17.50	21.28	31.23	2.62	1.213
Overall Mean Value Score and Standard Deviation							**3.23**	**1.213**

Note: SD = *Strongly Disagree*, D = *Disagree*, N = *Neutral*, A = *Agree*, SA = *Strongly Agree*

Figure – 1: Percentage of experts' response about "what does the term GM evoke?"

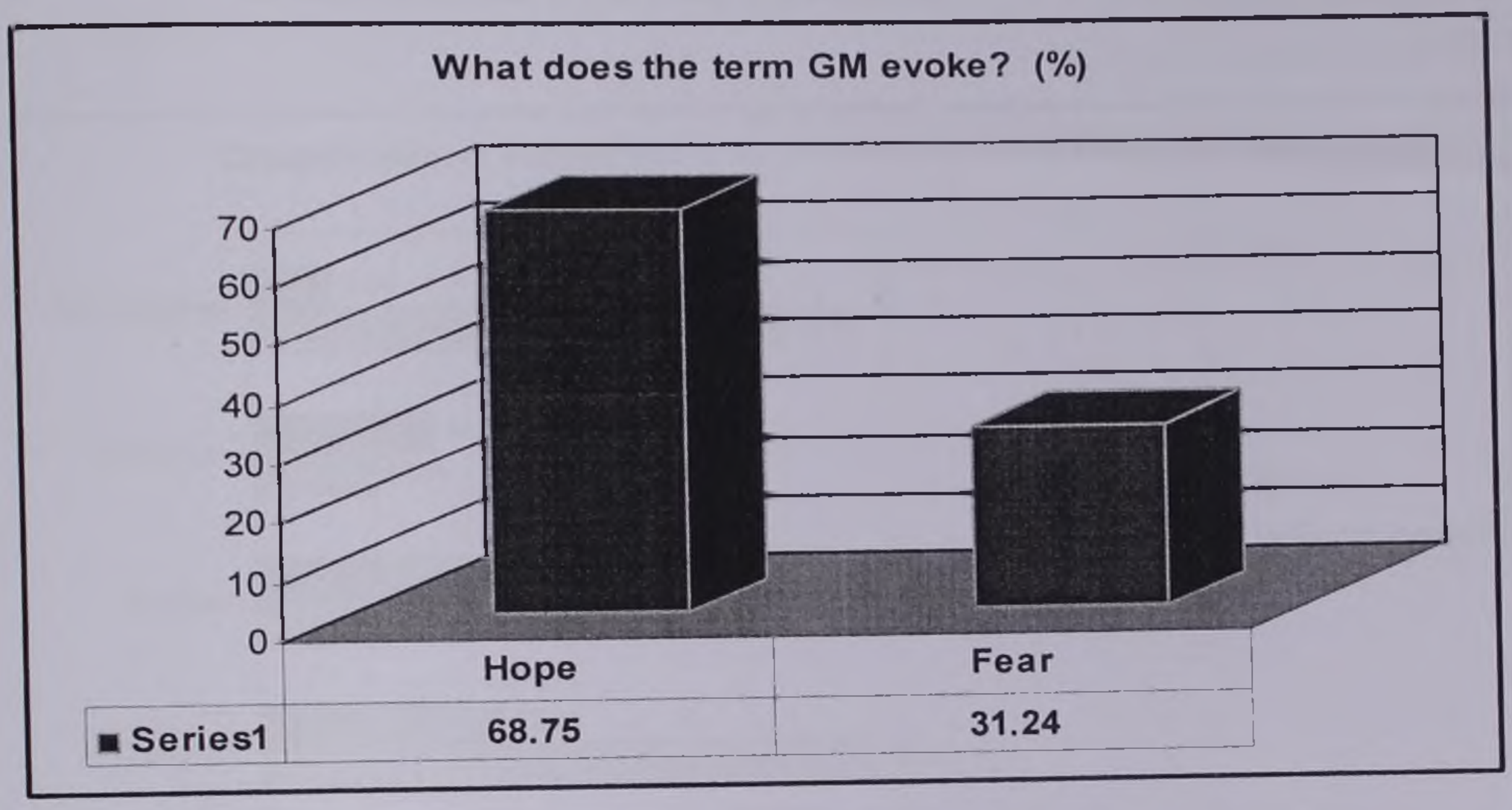


Figure - 2: Percentage of experts' response about preference of specific labeling policy of GM foods

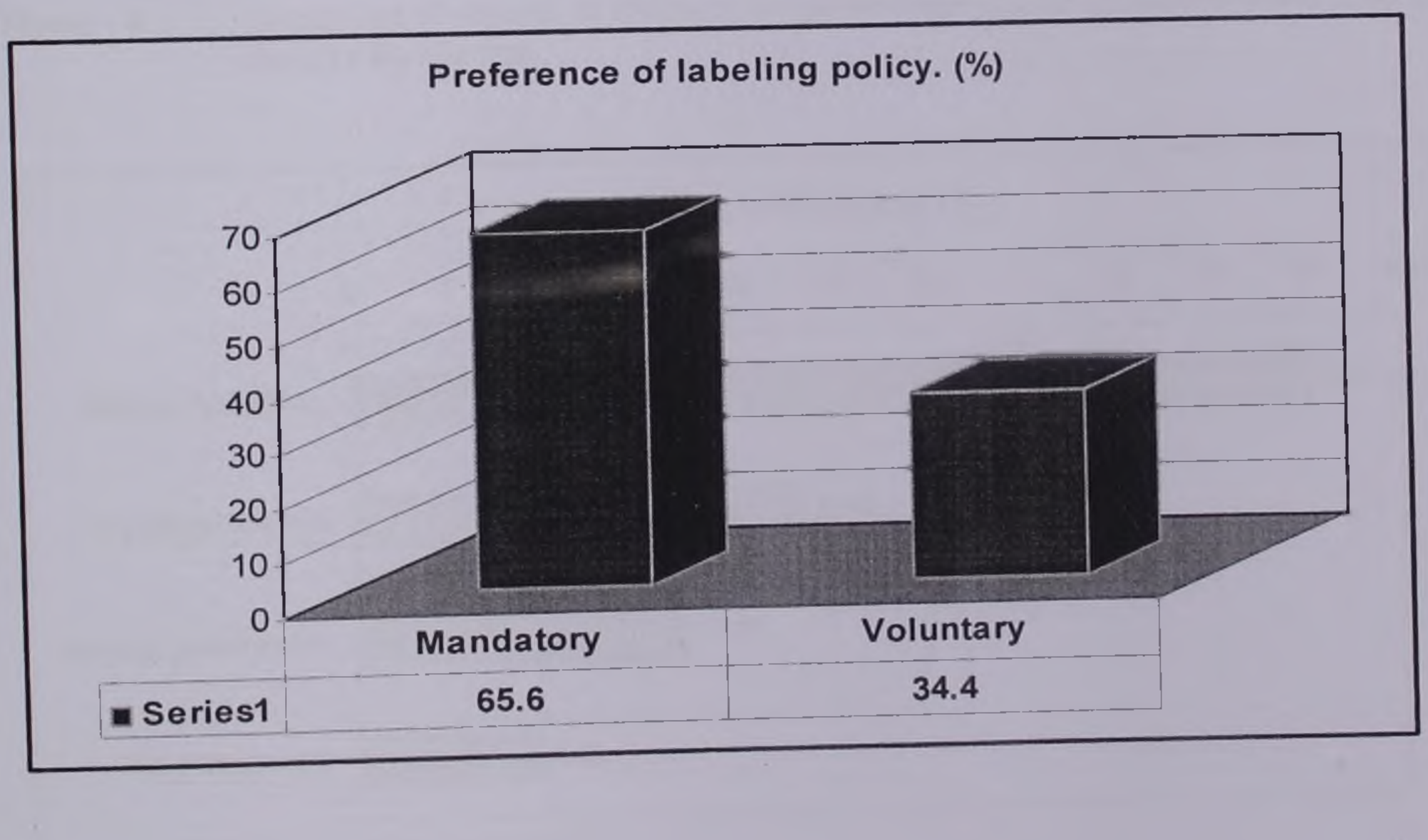


Figure - 3: **Percentage of experts' in different categories and their level of encouragement for commercialization of GM foods in Bangladesh**

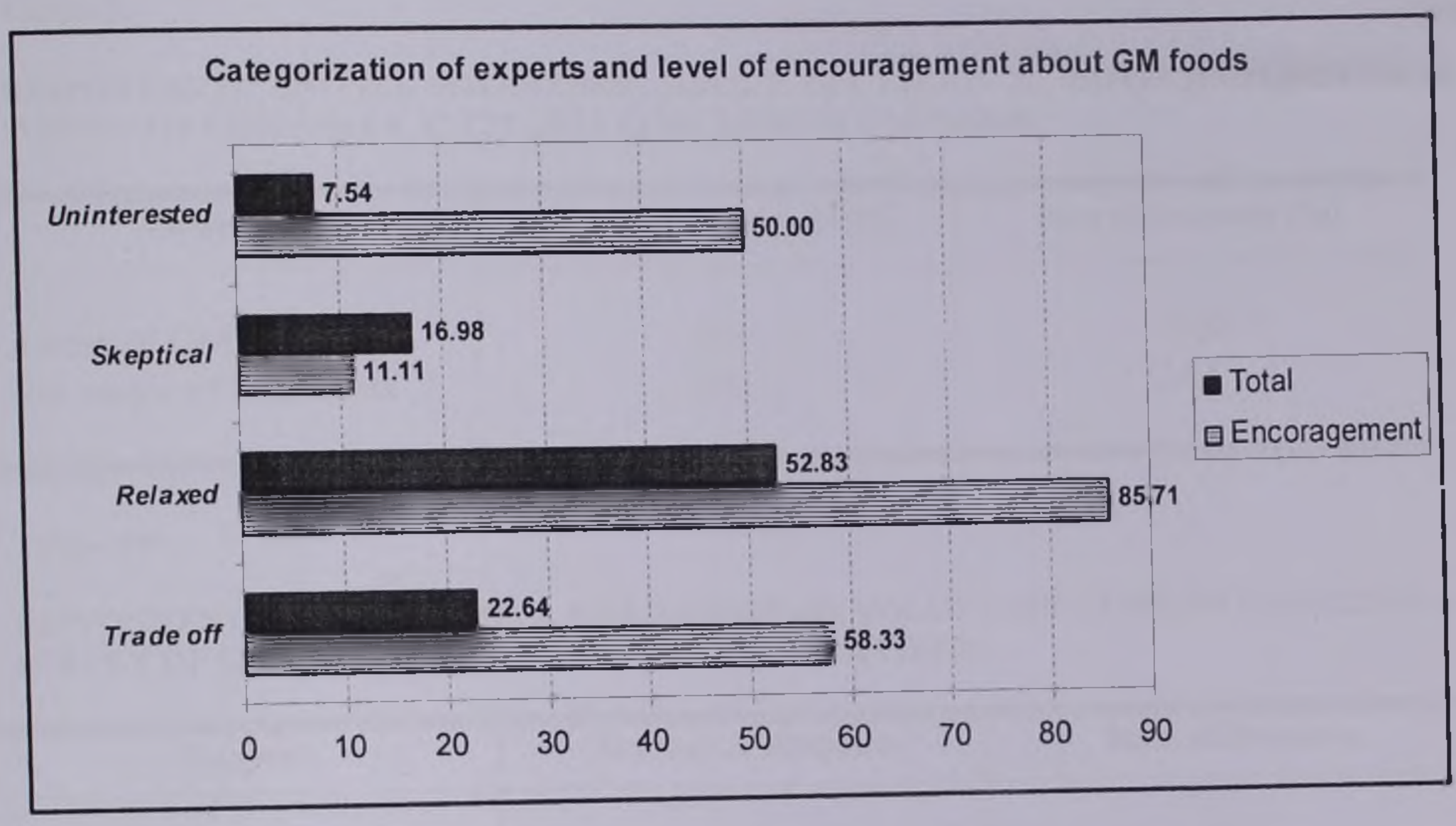
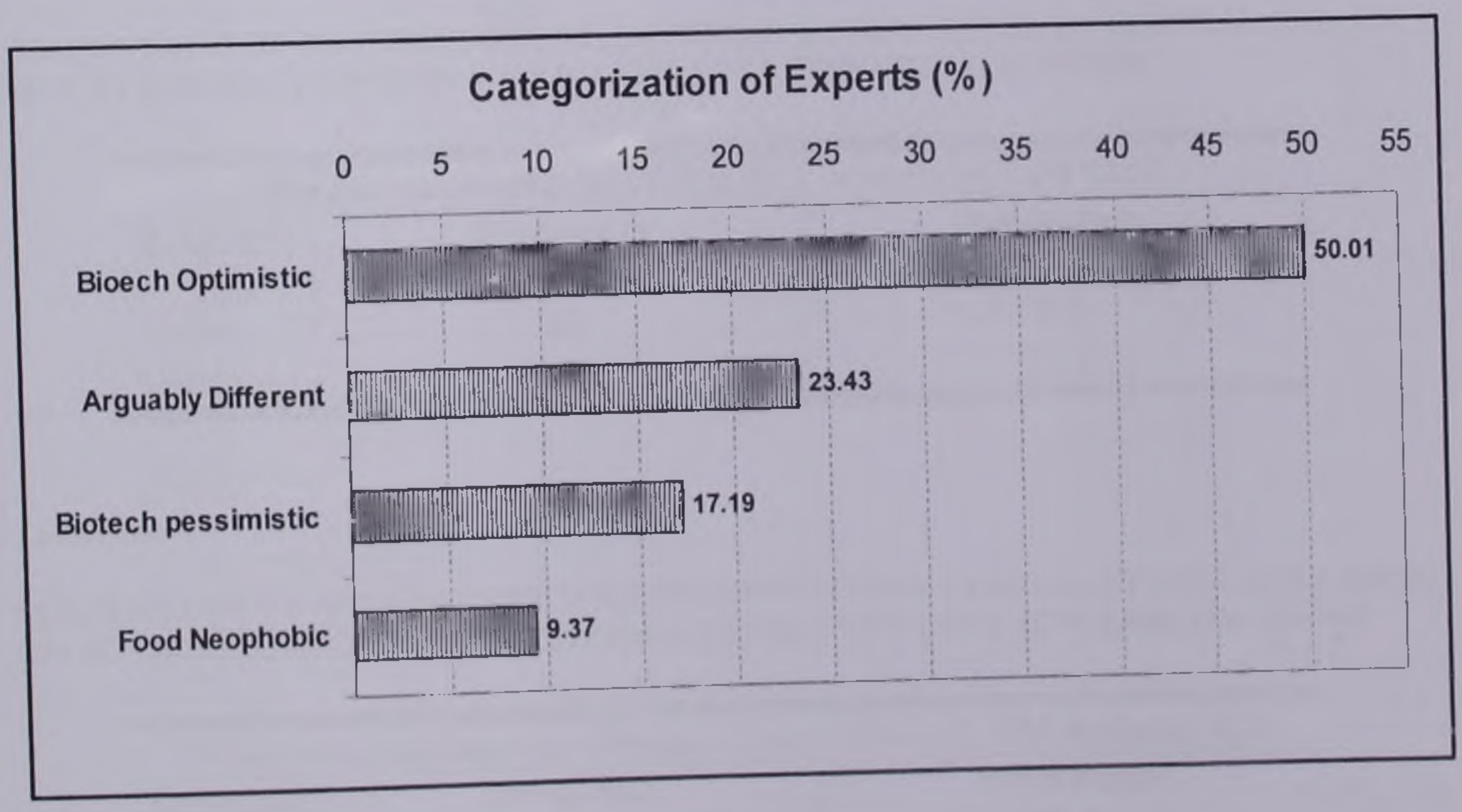


Figure - 4: **Percentage of experts' in different categories based on the qualitative about GM foods in Bangladesh**



List of Statistical Tables
(Consumers' Survey)

Table- 9:

RESPONDENTS' INITIAL AWARENESS ABOUT GM FOODS & BIOTECHNOLOGY IN A SURVEY OF CONSUMER ATTITUDES CONCERNING GM FOODS

Awareness	Number of Response (N)	Rate of Response (%)
Aware of GM foods	492	75.9
Not aware of GM foods	156	24.1

Table- 10:

RESPONDENTS' REPONSES TO A MANDATORY OR VOLUNTARY LEBELING POLICY IN A SURVEY OF CONSUMER ATTITUDES TOWARDS GM FOODS

Support	Number of Response	Rate of Response
Voluntary Labeling	312	48.9
Mandatory Labeling	336	51.9

Table- 11:

PERCENTAGE OF RESPODENTS' WILLINGNESS TO BUY (VITAMIN-A) COTAINING GM RICE IN A SURVEY OF CONSUMER ATTITUDES TOWARDS GM FOODS

Would you purchase a Vitamin-A containing GM rice?		
Response	**Frequency**	**Percentage**
Yes	438	67.6
No	60	9.3
Uncertain	150	23.1

Table- 12:

PERCENTAGE OF RESPODENTS' WILLINGNESS TO BUY (OMEGA -3 FATTY ACID RICH) GM SOYBEAN OIL IN A SURVEY OF CONSUMER ATTITUDES TOWARDS GM FOODS

Would you purchase an Omega-3 Fatty Acid rich GM soybean oil?		
Response	**Frequency**	**Percentage**
Yes	470	72.5
No	54	8.3
Uncertain	124	9.2

Table- 13:

CROSS TABULATION OF AWARENESS LEVEL AND SOCIO-ECONOMIC & DEMOGRAPHIC MAKE-UP OF SAMPLE IN A SURVEY OF CONSUMER ATTITUDES TOWARDS GM FOODS

Demographics	% Total Response Aware	Percentage Level of Awareness				
		Not at all informed	Minimally informed	Somewhat informed	Moderately informed	Very informed
ender						
Male	42.6	20.4	22.2	9.3	9.3	1.9
Female	33.3	3.7	11.1	14.8	4.6	2.8
			sd			
Marital Status						
Single	63.9	13.0	19.4	15.7	11.1	4.6
Married	36.1	11.1	13.9	8.3	2.8	0.0
Age (yrs)						
18 – 25	24.1	5.6	5.6	8.3	3.7	0.9
26 – 35	60.2	14.8	22.2	11.1	8.3	3.7
36 – 45	10.2	3.7	3.7	1.9	0.9	0.0
46 – 55	5.6	0.0	1.9	2.8	0.9	0.0
56 – 65						
Education						
Under Grad. Student	24.1	0.0	8.3	10.2	4.6	0.9
Graduate	25.0	5.6	9.3	5.6	3.7	0.9
Post Graduate	50.9	18.9	15.7	8.3	5.6	2.8
Others						
Profession						
Student	42.6	9.3	15.7	8.3	8.3	0.9
Govt. service	6.5	1.9	0.9	2.8	0.9	0.0
Pvt. Service	47.2	13.0	14.8	11.1	4.6	3.7
Business	1.9	0.0	0.9	0.9	0.0	0.0
Others	1.9	0.0	0.9	0.9	0.0	0.0
Income (Per annum)						
<10,000 – 10,000	38.9	10.2	12.0	11.1	2.8	2.8
11,000 - 20,000	10.2	0.9	3.7	1.9	3.7	0.0
21,000 - 30,000	11.2	4.7	2.8	2.8	0.0	0.9
31,000 - 40,000	15.8	0.9	5.6	6.5	2.8	0.0
41,000 - 50,000	9.3	0.0	5.6	1.9	0.9	0.9
51,000 - 60,000	9.3	4.6	2.8	0.0	1.9	0.0
61,000 - Over	4.6	2.8	0.9	0.0	0.9	0.0

Table-14:

RESPONDENTS' PERCEPTIONS OF BENEFITS (PERCENTAGE) IN A SURVEY OF CONSUMER ATTITUDES TOWARDS GM FOODS

Variables	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
GM foods contain higher nutritional content	18.5	49.1	11.1	13.9	7.4
GM foods benefit society by reducing food price	16.7	27.8	29.6	13.0	13.0
GM foods benefit society by reducing farmer's production cost	18.5	36.1	21.3	10.2	13.9
GM foods can lower the risk of heart disease and cancer	13.9	39.8	20.4	19.4	6.5
GM foods can provide high yield, improved quality & features	14.8	49.1	13.0	15.7	7.4

Table-15:

RESPONDENTS' PERCEPTIONS OF RISK (PERCENTAGE) IN A SURVEY OF CONSUMER ATTITUDES TOWARDS GM FOODS

Variables	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
GM foods may have unforeseen harmful effect on human health	23.1	37.0	19.4	9.3	11.1
GM foods may cause allergic reactions to some people	23.1	31.5	32.4	8.3	4.6
GM foods affects farmers by overdependence on MNCs for seed	21.3	44.4	22.2	7.4	4.6
GM foods may be harmful to wild life and environment	34.3	28.7	21.3	9.3	6.5
GM foods may cause contamination to non GM varieties	26.9	25.9	17.6	17.6	12.0

Table-16:

RESPODENTS' PERCEPTION OF ETHICAL AND MORAL CONCERS (PERCENTAGE) IN A SURVEY OF CONSUMER ATTITUDES TOWARDS GM FOODS

Variables	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
GM violates basic principle between human and nature	22.2	26.9	14.8	12.0	24.1
Creating GM plants and animals is morally wrong	14.5	22.5	20.4	18.5	24.1
Transfer of forbidden animal's gene into plants is haram	09.3	22.6	26.7	26.9	14.6

Figure-5:

RESPONDENT'S CHOICE ON PURCHASING GM RICE VERSUS GM SOYBEAN OIL IN A SURVEY OF CONSUMER ATTITUES TOWARDS GM FOODS

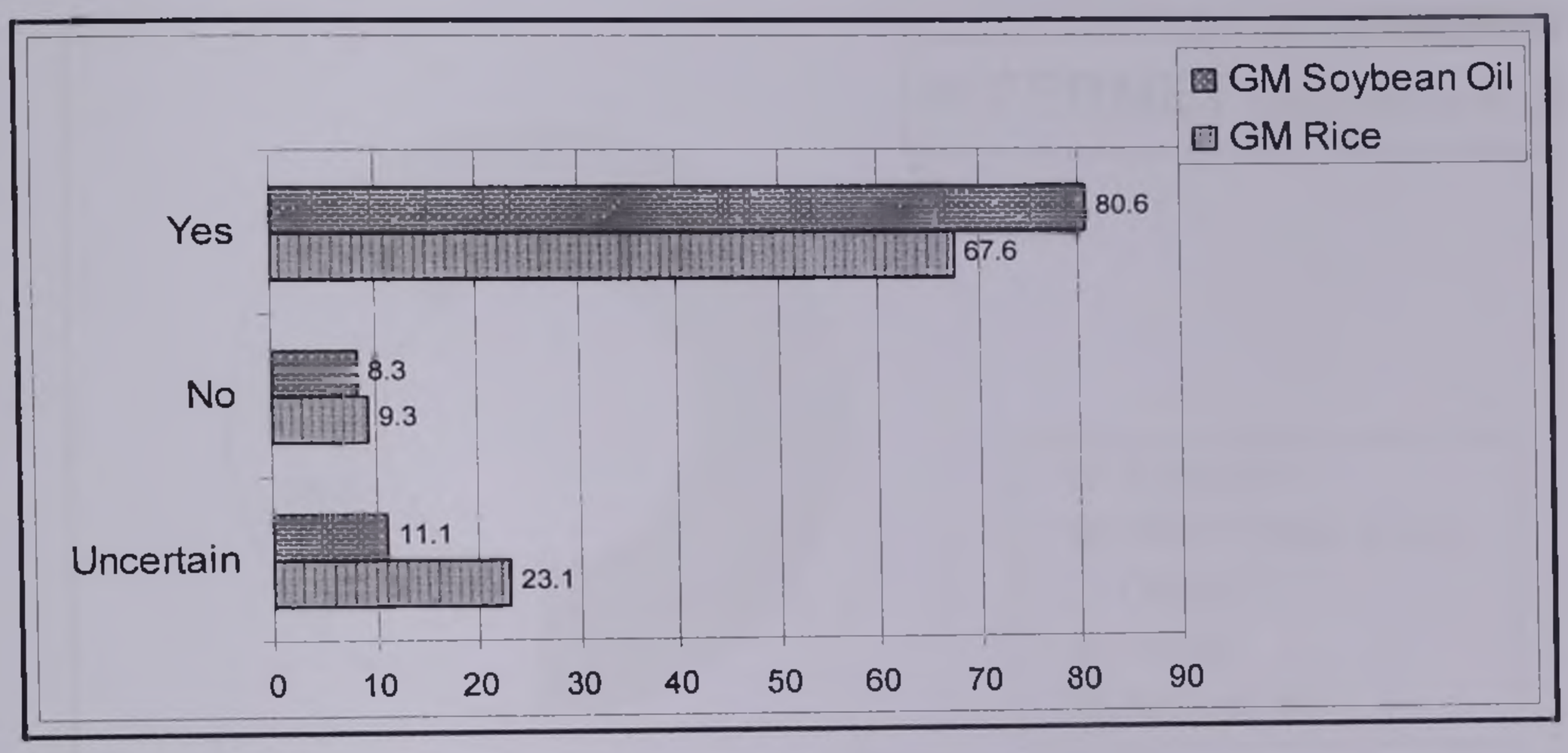


Figure-6:

REEPONDENTS' TRUST ON DIFFERENT AGENCIES REGARDING SAFETY INSPECTION AND REGULATION OF GM FOODS IN A SURVEY OF CONSUMER ATTITUES TOWARDS GM FOODS

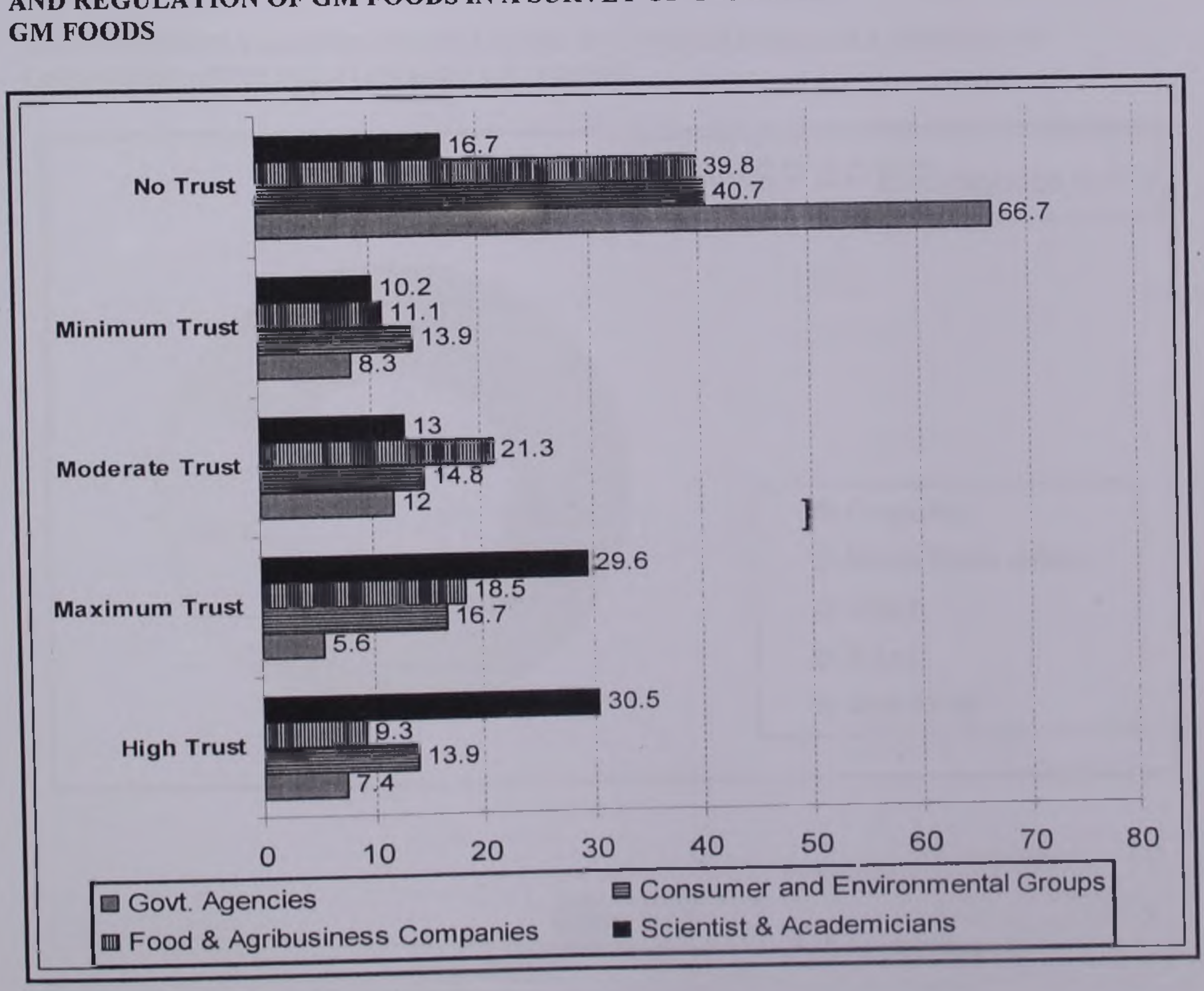


Figure-7:

RESPONDENT'S FREQUENCY OF ACCESS TO INFORMATION IN A SURVEY OF CONSUMER ATTITUES TOWARDS GM FOODS

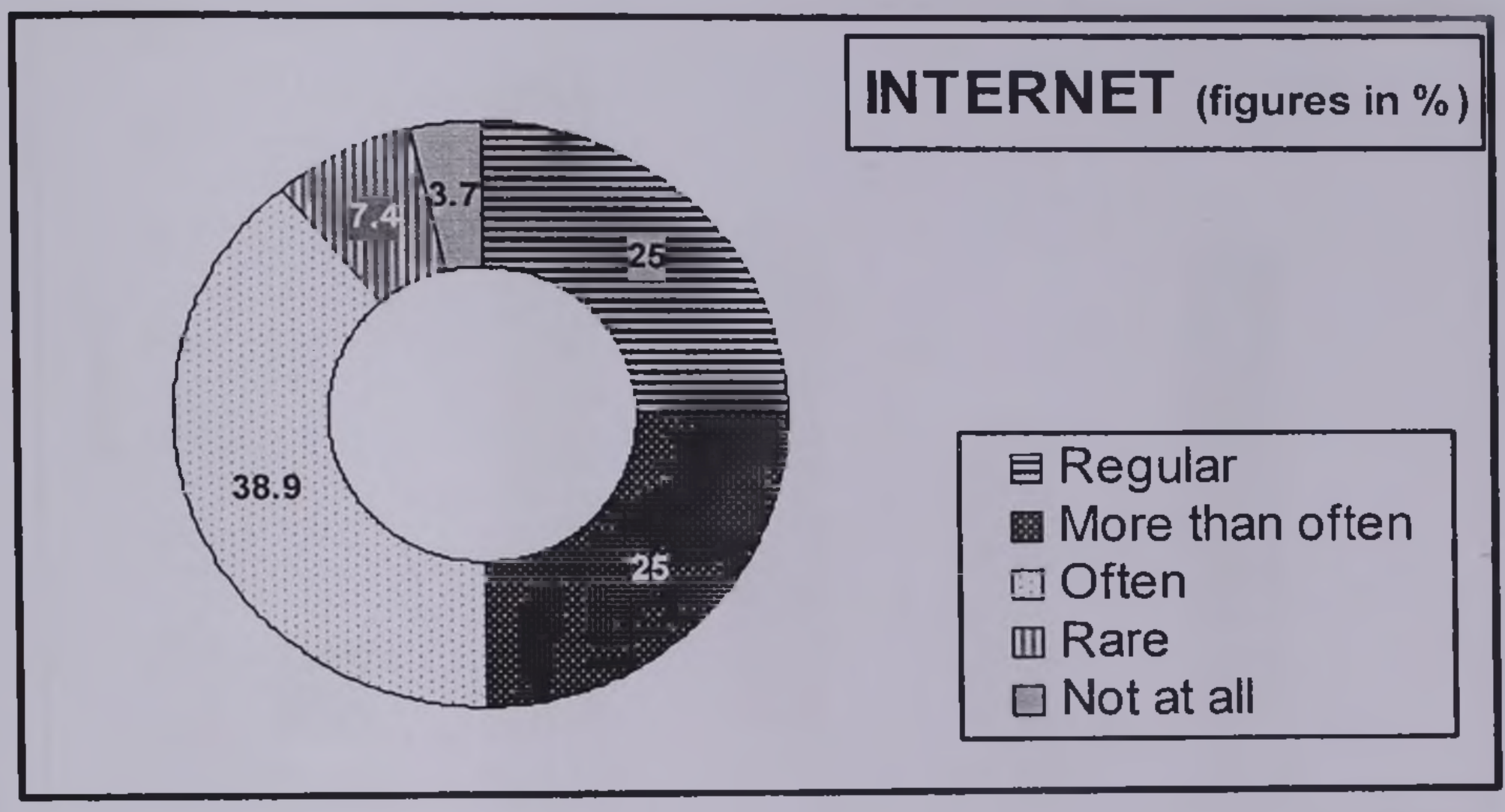


Figure-8:

RESPONDENT'S FREQUENCY OF ACCESS TO INFORMATION IN A SURVEY OF CONSUMER ATTITUES TOWARDS GM FOODS

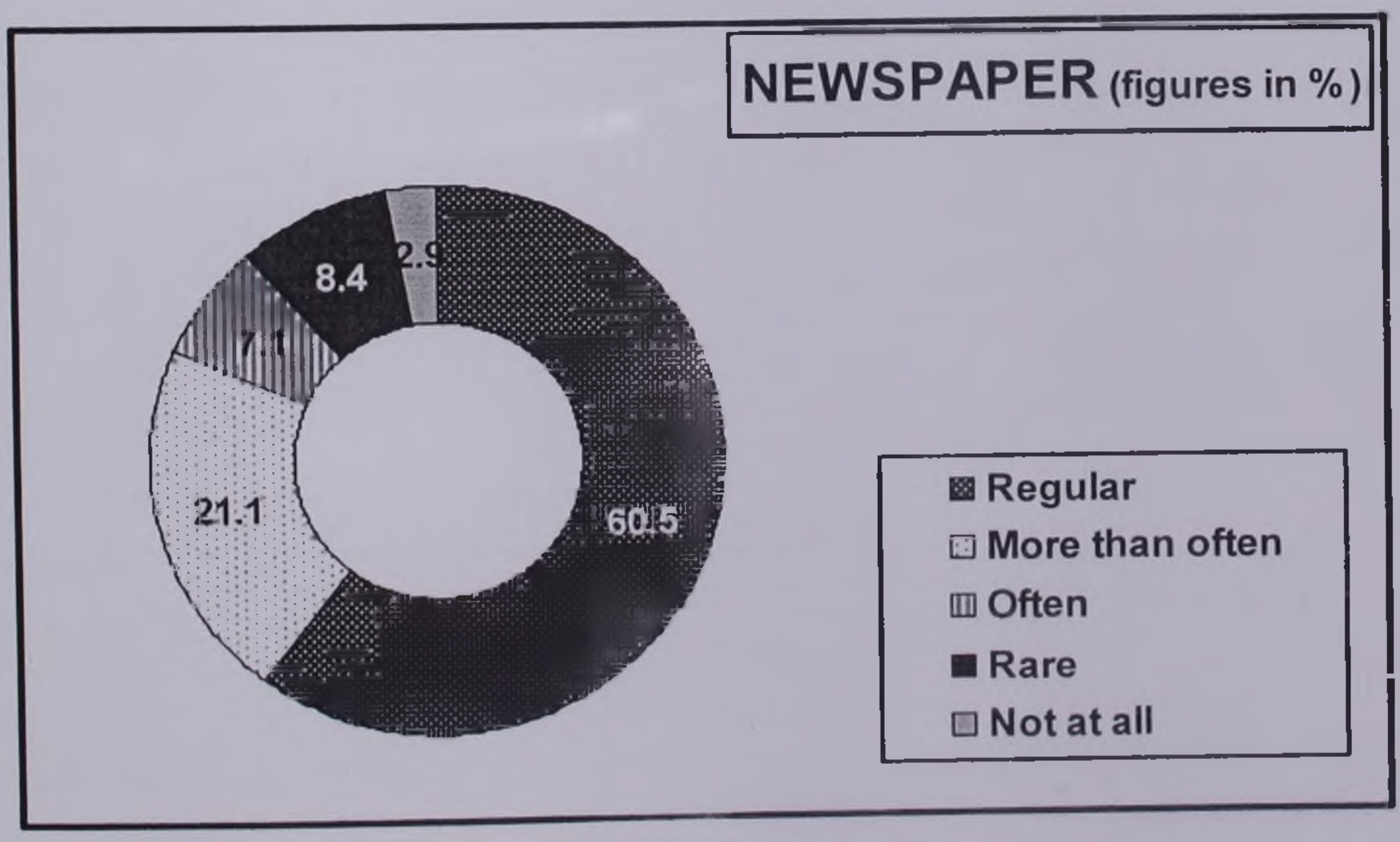
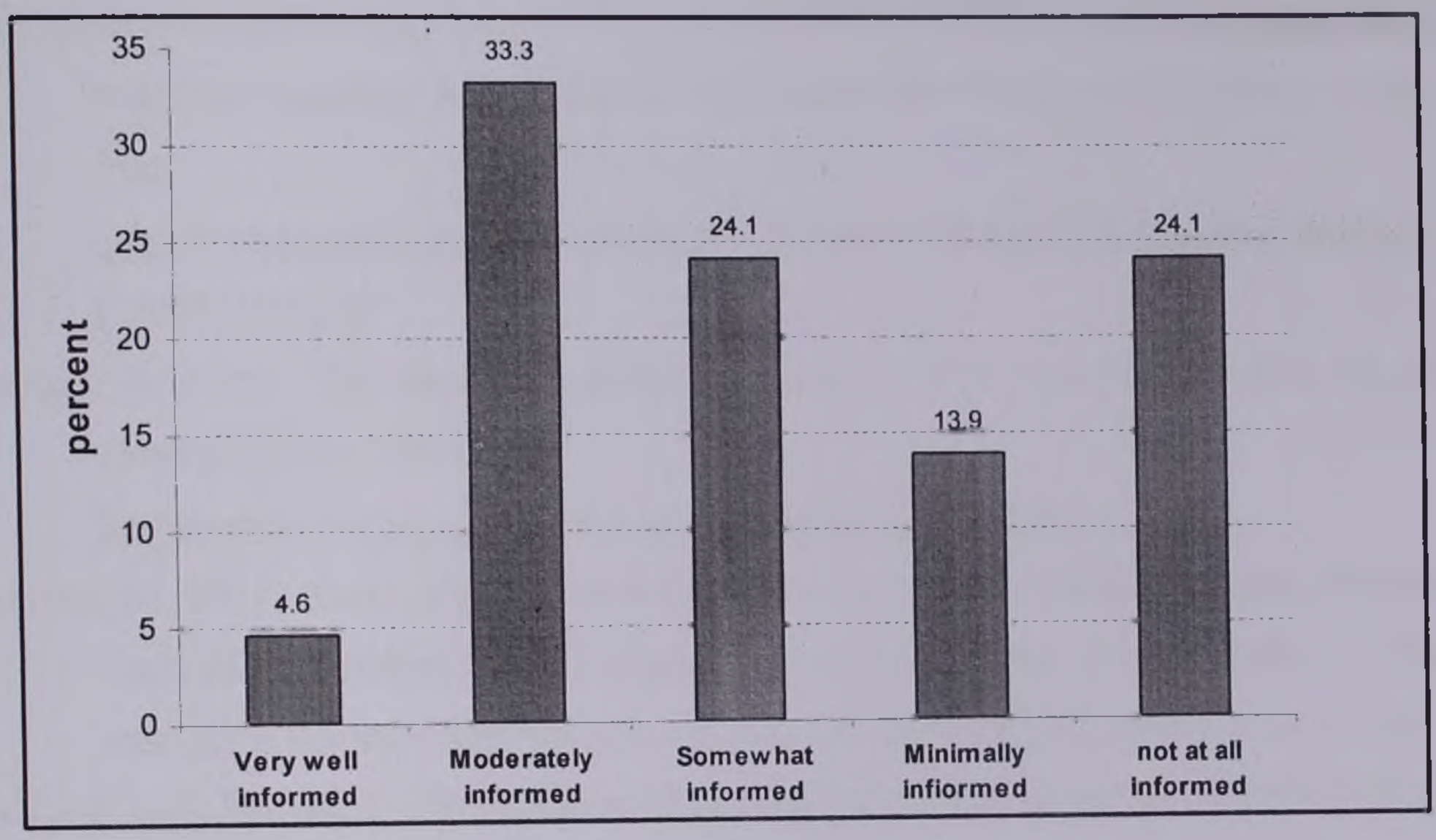


Figure – 9:

PERCENTAGE OF RESPODENTS' INDICATING LEVELS OF AWARENESS IN A SURVEY OF CONSUMER ATTITUDES TOWARDS GM FOODS



REFERENCES

Africa Bio, 2002, '*Position on the impact of genetic modification on biosafety'*, viewed 31 August 2008, from http://www.croplifeasia.org/biotechnology-quotes.html

Agricultural Biotechnology Support Project II (ABSPII), 2005, 'Fruit and Shoot Borer-Resistant Eggplant' *Ithaca,* Cornell University New York, viewed 17 July 2010, from http://www.absp2.cornell.edu/resources/factsheets/documents/eggplant_factshee t_20051100.pdf.

Ahmed, R. 2004, '*GM food: Bangladesh's position'*, The New Nation, Mar 18, p.8, viewed 12 May 2010, from http://nation.ittefaq.com/artman/publish/article_7624.shtml

Ahmed, M. 2011, 'Govt. plans to approve GM crops', The Financial Express, National Daily of Bangladesh, April 3, vol.18, no.145, pp.8, viewed 3 April 2010, from http://www.thefinancialexpress-bd.com/more.php?news_id=131248&date=2011-04-03

Aldrich, L. & Blisard, N. 1998, 'Consumer acceptance of biotechnology: Lessons from the rbST Experience', *Current Issues in Economics of Food Markets,* December Bulletin, no.747.01.

Alexander J.S & Emilio R.C. 2010, 'International Trade and the Global Pipeline of New GM Crops', *Nature*, vol. 28, no.1, pp. 23-25.

Anderson, J.C., 2005, 'North Dakota collage students' perceptions of GM and Organic foods', working paper, *North Dakota State University Journal,* Fargo.

Anderson, K. & Jackson L.A., 2005, 'Some Implications of GM food Technology Policies for Sub-Saharan Africa', *Journal of African Economies,* vol.14, pp.385–410.

Anon, D. 2000, 'Caution Required With the Precautionary Principle', *Lancet,* September 30, vol. 365, pp. 265-268.

Anuradha, R.V. 2007, 'Regulatory and Governance Issues Relating to Genetically Modified Crops and Foods: an Indian Case Study', *The New York University Project on International Governance and Genetically Modified Organisms*, September, viewed 16 May 2010, from http://www.fda.gov/newsevents/testimony/ucm115032.html

Australian Trade Commission, 2011, Biotechnology: Human Therapeutics, viewed 30 January 2012, from http://www.scienceclarified.com/scitech/Genetics/Genetic-Engineering.html

Avise, J.C. 2004, *'The hope, hype & reality of genetic engineering: Remarkable stories from agriculture, industry, medicine and the environment.* Oxford University Press, Oxford, pp. 22

Baboza, D. 2003, 'Development of biotech crops is booming in Asia', *Yale Global Online,* viewed 19 September 2007, from http://yaleglobal.com/GM/Chaina.html

Bagozzi Richard, P. & Youjae, Yi.1988, 'On the Evaluation of Structural Equation Models', *Journal of the Academy of Marketing Science*, vol.16 (1), pp.74-95.

Baker, G.A. & Burnham, T.A.2001, 'Consumer Response to Genetically Modified Foods: Market Segment Analysis and Implications for Producers and Policy Makers', *Journal of Agricultural and Resource Economics,* vol.26 (2), pp.387-403.

'Bangladesh to grow GM rice by 2012', The New Nation, November 19, 2009, p.7.

Bangladesh Bureau of Statistics (BBS), 2003, *'Population Census 2001',* National Report (Provisional), Dhaka: BBS

Bansal, S. & Gruere, G. 2010, 'Labeling of Genetically Modified Food in India: Economic Consequences in Four Marketing Channel,' *International Food Policy Research Institute,* viewed 13 November 2008, from http://ideas.repec.org/p/fpr/ifprid/946.html

Beecher, N., Harrison, E., Goldstein, N., McDaniel, M., Field, P. & Susskind, L. 2005, 'Risk Perception, Risk Communication and Stakeholder Involvement for Biosolids Management & Research', *Journal of Environmental Quality,* vol.34, no.I.

Belinda, M. 2001, '*First Fruit: the creation of Flavr Savr tomato and the birth of Biotech Food'*, McGraw Hill. pp.34.

Bennett, R.M., Ismael,Y., Kambhampati, U. & Morse, S. 2004, 'Economic Impact of Genetically Modified Cotton in India', *AgBio Forum,* vol.7 (3), pp.96–100.

Berg, P. & Mert, J., 2010, 'Personal Reflections on the Origins and Emergence of Recombinant DNA technology'. *Genetics*, vol. 1, no. 184, pp. 9-17.

Bioinformatics, 2007, *Indian Biotech Industry Segment (2004-2007)*, exhibit: 18, viewed 12 December 2010, from www.bioinformatics2007.conf.umu.se/

Biotechnology Industry Organization, 2011. viewed 17 August 2011, from http://www.bio.org/speeches/pubs/er/timeline.asp

Borooah, V.K. 2003, 'Logit and Probit: Ordered and Multinomial Model', *Journal of the American Statistical Association,* January, vol.98, pp.775-776.

Brady, J.T. & Brady, P.L.2003, 'Consumers and Genetically Modified Foods', *Journal of Family and Consumer Sciences,* vol.95, pp.12-18.

Bredahl, L. 2001, 'Determinants of Consumer Attitudes and Purchase Intentions with Regard to Genetically Modified Foods: Results of a Cross-National Survey,' *Journal of Consumer Policy, vol.* 24, no.1, 23-61.

Burtom, M., Rigby, D., Young, T. & James, S. 2001, 'Consumer Attitudes to Genetically Modified Organism in Food in the UK. European Review of Agriculture Economics, vol.28, pp. 479-498.

Cameron, T.A. & Jeffrey, E. 1997, 'Welfare Effects of Changes in Environmental Quality under Individual Uncertainty about Use', *RAND-Journal-of-Economic,* vol. 28(0), no. Special Issue 1997, page. 45-70.

Carter, C.A. & Gruere, G.P. 2003, 'Mandatory labeling of genetically modified foods: Does it really provide consumer choice'? *AgBio Forum*, vol. 6, no. 18, viewed 16 September 2008, from www.agbioforum.org/.

Carl, B.J. 1993, 'Flavr Savr Tomato: Significance of Pending DHEE Question,' Alliance for Bio-Integrity, December (7).

Castillo, J. J. 2009, 'Non-probability Sampling', viewed 17 March 2010, from http://www.experiment-resources.com/non-probability-sampling.html

Caswell, M.F., Fuglie, K.O. & Klotz, C.A. 1994, 'Agricultural Biotechnology: An Economic Perspective', Economic Research Service, U.S. Dept. of Agriculture, *Agricultural Economic Report*, May, no. 687.

Caswell, J.A. 1999, 'An evaluation of risk analysis as applied to agricultural biotechnology (with a case study of GMO labeling),' *Proceedings of NE-165 Conference,* Washington D. C., 24-25 June.

Chaturvedi, S. & Rao, S. R. (eds.), 2004, 'Biotechnology and Development Challenges and Opportunities for Asia', *Research and Information System for Developing Countries.* New Delhi.

Chopra, V.L. 2005, 'Mutagenesis: Investigating the Process and Processing the Outcome for Crops Improvement', *Current Science*, July 25, vol.89, no.2, pp. 353-359.

Cohen, J.I. 2005, 'Poorer Nations Turn to Publiely Developed GM crops', *Nature Biotech*, vol. 23(1), pp.27-33

Compassion in world farming, 2011, viewed 12 December 2011, from http://www.ciwf.co.uk/gm

Costa-Font, M., Gil Jose, M., Traill, M. & Bruce, W. 2008, 'Consumer acceptance, valuation of and attitudes towards genetically modified food: Review and implications for food policy', *Food Policy*, vol.33, pp.99-111.

Cropper, D., Maureen L., Deck L., Kishor N & McConnell, K. 1993, 'Valuing Product Attributes Using Single Market Data: A Comparison of Hedonic and Discrete Choice Approaches', *The Review of Economics and Statistics*, vol.75, no.2, pp.225-232.

Cummings, R.G. & Taylor, L.O.1999, 'Unbiased Value Estimates for Environmental Goods: A Cheap Talk Design for the Contingent Valuation Method', *The American Economic Review*, June, pp. 649-665.

Darby, M.R. & Karni, E.1973, 'Free Competition and the Optimal Amount of Fraud', *Journal of Law and Economics*, vol.16, pp.67-88.

Datamonitor Knowledge Centre, 2010, 'Global GM database', May (2010), viewed 18 August 2010, from http://about.datamonitor.com/delivery/kc.htm

Deodhar, S.Y., Sankar, G. & Chern, W.S. 2007, 'Emerging Markets for GM Foods: An Indian Perspective on Consumer Understanding and Willingness to Pay', *Indian Institute of Management, India, Research and Publications*, Working Paper, June, no. 2007-08-06.

Dhar, T. & Foltz, J.D. 2005, 'Milk by Any Other Name: Consumer Benefits from Labeled Milk', *American Journal of Agricultural Economics*, February, vol. 87, no.1, pp. 214-228.

Douglas, M. & Wildavsky, A. 1982, 'Risk and Culture: An Essay on the Selection of Technical and Environmental Dangers', Berkeley University of California Press, pp.123-125.

Douthitt, R. 1990, 'Biotechnology and consumer choice in the market place: Should there be mandatory labeling? a case study of bovine somatotropin and Wisconsin dairy products', Paper presented at the second international conference on Research in the Consumer Interest, Snowbird, UT, August 9-11.

European Food Safety Authority (EFSA) scientific advice, 2004, 'On the use of Antibiotic Resistance Marker Genes in Genetically Modified Plants', Press release 19/04/2004, viewed 18 June 2006, from http://www.efsa.eu.int/press_room/press_release/386_en.html

European Food Safety Authority, 2004, 'Opinion of the scientific panel on genetically modified organisms on the use of antibiotic resistance genes as marker genes in genetically modified plants', (Question No. EFSA-Q-2003-109). 04/2004, viewed 11 January 2009, from http://www.efsa.eu.int/science/gmo/gmo_opinions/384_en.html

Ellahi, B. 1994, 'Genetic Engineering for Food Production – What Is it All About'? *British Food Journal*, vol.96, no.8, pp.13-23.

Engel, J.F., Blackwell, R.D. & Kollat, D.T. 1978, 'Consumer Behavior, 3rd. ed. The Dryden Press.

Ernst & Young, 2009, International Accounting Firm, viewed 23 February 2010, from http://www.ey.com/GL/en/Industries/Insurance/International-Accounting-Standards-Board-Exposure

Espey, J. 1993, 'Canadian institute of biotechnology report on attitude towards biotechnology', Ontario, Canada.

Evenson, R.E., Herdt, R.W. & Hossain, M. 1996, 'Rice research in Asia: Progress and priorities', *CAB International,* Wallington, U.K.

Falvey, J.L. 2000, 'GMOs and GFN: Genetically Modified Organism and Global Food Need', *ATSE Focus*, November-December, vol. 114.

Fernandez, C. J & Caswell M. 2006, 'The first decade of genetically engineered crops in the United State', *Economic Information Bulletin*, April, viewed 19 October 2008, from http://www.ers.usda.gov/publications/eib11/eib11.pdf

Feffer, J. 2004, 'Asia holds the key to the future of GM food', *Yale Global*, viewed 2 December 2008, from http://valeglobal.yale.edu/

Finucane, M.L.; Alhakami, A., Slovic, P. & Johnson, S.M. 2000, 'The Affect Heuristic in Judgment of Risks and Benefits', *Journal of Behavioral Decision Making,* January, vol.13, no. 1, pp.1-17.

Fishbein, M. 1963, 'An Investigation of the Relationship between Beliefs about an Object and the Attitude toward That Object', *Human Relations*, vol.16, pp.233-240.

Fishbein, M., Ajzen, I. & Addison, W. 1975, 'Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research', Addison, Wesley.

Florkowski, W., Halbrendt, C., Huang, C.L. & Sterling, L. 1994, 'Socioeconomic Determinants of Attitude toward Bioengineered Products' *Review of Agricultural Economics,* vol.16, pp.125-132.

'Food Standard Australia New Zealand (FSANZ)', 2011, viewed 30 June 2011, from http://www.foodstandards.gov.au/consumerinformation/gmfoods/

'Food and Agricultural Organization of the United Nations (FAO) 2003', Rome, Italy, vol.56, pp.115-116.

Fox, J.A., Hayes, D.J., Kliebenstein, J.B. & Shogren. J. F. 1994, 'Consumer Acceptability of Milk from Cows Treated with Bovine Somatotropin,' *Journal of Dairy Science,* vol.77, pp.703-707.

Frewer, L.J., Hedderley, D.; Howard, C. & Shepherd, R. 1997, 'Objection Mapping in Determining Group and Individual Concerns Regarding Genetic Engineering,' *Agriculture and Human Value,* vol. 14, pp. 67-79.

Food Standards Agency, 2005, '*GM Material in Animal Feed',* viewed 17 October2009, from http://www.foodstandards.gov.uk/gmfoods/gm-animal

Friends of the Earth Europe, 2004, '*Throwing Caution to the Wind: A review of the European Food Safety Authority and its work on genetically modified foods and crops,'* November, viewed 17 October 2009, from http://www.foeeurope.org/GMOs/publications/EFSAreport.pdf

Friends of the Earth Europe 2004, *'Comments on 1507 maize: Response to EFSA GMO Panel Opinions for Commission Questions'*, EFSA-Q-2004-072 and EFSA-Q-2004-087, viewed 17 October 2009, from http://www.foeeurope.org/GMOs/pending/FOEE%20comments%20-507%20maize.pdf

Friends of the Earth Europe, 2004, '*Questions remaining over Monsanto's NK603 maize*', viewed 17 October 2009, from http://www.foeeurope.org/GMOs/pending/nk603briefing.pdf

Friends of the Earth Europe, 2003, '*Provisional comments by Friends of the Earth Europe to the Notification by Monsanto for the Placing on the EU market of Roundup Ready (glyphosate tolerant) oilseed rape',* event GT73 (notification numberC/NL/98/11), viewed 17 October 2009, from http://www.foeeurope.org/GMOs/pending/MonsantoGMO_oil_seed_GT73.pdf

Friends of the Earth Europe, 2003, *'Provisional comments by Friends of the Earth Europe to the Notification by Monsanto for the placing on the EU Market of Maize Grains Derived From Insect-protected Maize Lines',* MON863 and MON863 x MON810. (C/DE/02/9 is the notification no), viewed 17 October 2009, from http://ww.foeeurope.org/GMOs/pending/MonsantoGM_Maize863.p

Gath, M. & Alvensleben, R.V. 1998, 'The Potential Effects of Labeling GM Foods on the Consumer Decision-Preliminary Results of Conjoint Measurement Experiments in Germany', AIR-CAT 5th Plenary Meeting. *Effective Communication and GM Foods as Norwegian,* vol. 4, no. 3, pp.18-28.

Gaskell,G. & Allum, N.C. 2001, 'Sound science, problematic publics? Contrasting Representations of risk and uncertainty,' *Politei*, vol. 63, pp.13-25.

Gaskell, G., Allum, N., Wanger, W., Kronberger, N., Torgersen, H., Hampel, J. & Bardes, J. 2004, 'GM Foods and the Misperception of Risk Perception', *Society of Risk Analysis*, vol.24, pp.185-194

Gaskell, G., Stares,S, Allansdottir, A., Allum. N., Corchero, C., Fischler, C., Hampel, J., Jackson, J., Kronberger, N., Mejlgaard, N., Revuelta, G., Schreiner, C., Torgersen, H. & Wagner, W. 2006, 'Europeans and Biotechnology in 2005: Patterns and Trends', *Final report on Euro barometer*, vol. 64.3.

Gaskell, G. & Bauer, M. 2001, *'Biotechnology 1996-2000: The Years of Controversy,'* Science Museum Press, London.

Gaskell, G.; Bauer, M.; Durant, J. & Allum, N. 1999, 'Worlds Apart: The Reception of GM foods in the United States and Europe,' *Science*, July 16.

GEO-PIE, 2003, *'Genetically Engineered Organisms Public Issues Education (GEO-PIE) Project: GE Foods in the Market, Cornell Cooperative Extension'*, viewed 19 September 2008, from http://www.geo-pie.cornell.edu.

Geo Hive, 2011, *'Global Statistics and Population Statistics'*. January, viewed 3 June 2011, from, http://www.geohive.com/

Genetics Society of America (GSA), 2001, *'Statement on Genetically Modified Organism'*, November, viewed 19 September 2008, from http://www.genetics-gsa.org/pages/pp_benefits.shtml

'GM Foods pose threat to health, environment' The Daily Star, 18 July 2006, p. 9.

'GM Food should not be allowed before test', The Daily Star, 8 March 2004, p.9

GM Science Review Panel Report, 2003, July, viewed 7 October 2008, from http://www.gmsciencedebate.org.uk/

GMO Compass, 2011, 'Genetic Engineering, Plants and Food: The European Regulatory System, June 2, viewed 7 December 2008, from http://www.gmocompass.org/eng/regulation/regulatory_process/156.european gulatory_system_genetic_engineering.html/

Gonzalez, C., Johnson, N. & Qaim, M. 2005, 'Consumer Acceptance of Second Generation GM Foods: The Case of Biofortified Cassava in the northeast of Brazil." *International Centre for Tropical Agriculture'*, Cali, vol.--, pp.--.

Grainnet, 2007, *'GM Food Debate Heats up with Global Warming',* May, viewed 19 June 2007, from http://www.grainnet.com/articles/GM_Food_Debate_Heats_up_with_Global_Warming-44122.html

Greenpeace, 2003, *'Genetic Engineering Retrieved'*, viewed 20 September 2007, from http://www.greenpeace.org/interantional_en/campaigns/intro?campaign%5fid=3942.

Greenpeace, 2001, *'Greenpeace Stages Protest Against Nestle: Stop GMO Contamination,'* May 28, viewed 19 September 2008, from http://www.greenpeace.org/seasia/ph/press/releases/greenpeace-stages-protest-agai/

Greenpeace, 2004, *'GM and dairy cow feed: steps to a GM-free future for the UK dairy industry',* viewed 19 September 2008, from http://www.greenpeace.org.uk/GM-dairy//

Greenpeace, 2006, *'Eating up the Amazon',* viewed 19 September 2008, from http://www.greenpeace.org.uk/MultimediaFiles/Live/FullReport/7555.pdf

Grove, D. & Douthitt, R. 1995, 'Consumer Acceptance of Recombinant Bovine Growth Hormone: Interplay between Beliefs and Perceived Risks', *The journal of Consumer Affairs*, vol.29, no.1, pp. 128-143.

Grove, D., Douthitt, R. & Zepeda, L. 1996, 'Consumer Risk Perception Profiles for the Food-Related Biotechnology, Recombinant Bovine Growth Hormone (rbGH)', *Proceedings of NE-165 Conference,* Washington D. C., June 20-21.

Gruere, G.P., 2006, '*An analysis of trade related international regulations of genetically modified food and their effects on developing countries*'. EPTD Discussion Paper 147, International Food Policy Research Institute, Washington, D.C.:

Gruere, G.P. 2006, 'International Trade Related Regulations of GM Foods – What Policies for Developing Countries?' *International Food Policy Research Institute (IFPRI),* viewed 21 September 2008, from http://www.ifpri.org/divs/eptd/dp/papers/eptdp147.pdf

Gruere G., Antoine, B. & Simon, M. 2007, 'Genetically Modified Food and International Trade, the Case of India, Bangladesh, Indonesia and the Philippines', *International Food Policy Research Institute (IFPRI).* Discussion Paper -00740.

Gruere, G.P., & Rao, S.R. 2007, 'A review of international labeling policies of genetically modified food to evaluate India's propose rule', *AgBio Forum*, vol. 10, no.1.

Guivant, J. 2006, 'Transgenicose percepcao publica ed a ciencia no Brasil,' Ambiente & Sociedade, vol. 9, pp. 81-105.

Gupta, A. & Chandak, V. 2005, 'Agricultural Biotechnology in India: Ethics, Business and Politics,' *International Journal of Biotechnology*, vol. 7, no. 1/2/3, pp. 212-227.

Hallman, W.K. & Metcalfe, J. 2002, 'Public Perceptions of Agricultural Biotechnology: A Survey of New Jersey Residents', *Ecosystem Policy Research Center*, Rutgers, The *State University of New Jersey, Retrieved,* November 11, viewed 17 December 2008, from http://www.nal.usda.gov/bic/Pubpercep/

Hallman, W.K. & Metcalfe, J. 1995, '*Public Perceptions of Agricultural Biotechnology: A Survey of New Jersey Residents*', Ecosystem Policy Research Center, Rutgers, the State University of New Jersey.

Hallman, W., Hebden, W.C., Aquino, H., Cuite, C. & Lang, J. 2003, *'Public Perceptions of Genetically Modified Foods: A National Study of American Knowledge and Opinion,'* Food Policy Institute, Rutgers University, New Brunswick, New Jersey.

Hallman, W.K., Hebden, W.C., Cuite, C.L., Aquino, H.L. & Lang. J.T. 2004, *'Americans and GM Foods: Knowledge, Opinion and Interests in 2004.'* Publication Number RR 1104-007, Food Policy Institute, Cook College, Rutgers-The State University of New Jersey.

Han, J.H., & Harrison, R.W. 2006, 'Consumers evaluation of second generation of genetically modified (GM) foods with benefit discloser', *Paper presented at*

Southern Agriculture Economics Association Annual Meetings, Orlando, Florida, pp. 124-140.

Hareau, G., Norton, G.W., Mills, B.F. & Peterson, E. 2005, 'Potential Benefits of Transgenic Rice in Asia: A General Equilibrium Analysis', *Quarterly Journal of International Agriculture* vol.44, pp. 205-21.

Hari, J., Anderson, R., Tatham, W. & Black,. 1992, '*Multivariate Data Analysis*,' Macmillan, New York.

Harrison, R.W., Boccaletti, S. & House L. 2004,'Risk perceptions of urban and United States Consumers for Genetically Modified Foods,' *AgBio Forum*, vol.7, no.4, pp. 95-201.

Harrison, R.W. & Han, J.H. 2005, 'The Effects of Urban Consumer Perceptions on Attitudes for Labeling of Genetically Modified Foods.' *Journal of Food Distribution Research,* vol.36, no.2, pp.29-38.

Hasan, R. 2006, 'Biotech Policy Declared in Bangladesh, 'The Daily Star 20 July, pp. 10.

Hansen, J., Holm, L., Frewer, L. J., Robinson, P. and Sandoe, P. 2003, 'Beyond the Knowledge Deficit: Recent Research into Lay and Expert Attitudes to Food Risks', *Appetite* .vol. 41 , no. 2 , pp. 111-121.

Heiman, A., Just, D.R. & Zilberman, D. 2000, 'The Role of Socioeconomic Factors and Lifestyle Variables in Attitude and the Demand for Genetically Modified Foods', *Journal of Agriculture,* vol.18, pp.249-260.

Her Majesty's Stationery Office (HMSO), 1993, '*On the Ethics of Genetic Modification and Food Use',* Report of the Committee,1993, Ministry of Agriculture, Fisheries and Food, London.

Hill, R., Stanisstreet, M., Boyes, E. & Sullivan, H.O. 1998, 'Reactions to a New Technology: Student's Ideas about Genetically Engineered Foodstuffs', *Research in Science, Technology and Education,* vol. 16, pp.203-216.

Hine, S. & Loureiro, M.L. 2002, 'Understanding consumers' perceptions toward biotechnology and labeling', paper presented at the *American Agricultural Economics Association Annual Meeting,* Long Beach, CA, July 28-31.

Hoban, T.J.1999, 'Public Perceptions and Understanding of Agricultural Biotechnology', *North Carolina State University, Raleigh*, NC, viewed 21 May 2010, from http://usinfo.state.gov/journals/ites/1099/ijee/bio-hoban.htm

Hoban, T.J. & Katic, L.D. 1998, 'American Consumer View on Biotechnology', *Cereal*

Foods World, vol.43, no.1, pp.20-22.

Hoban, T.J. & Kendal, P.A.1997, 'Consumer Attitudes about the Use of Biotechnology in Agriculture and Food Production,' *North Carolina State University, Raleigh,* NC.

Hoque, I., Gruere, G. P., Valmonte-S. R., Rosegrant M. W. 2006, 'Potential of Transgenic Crops in Bangladesh: Findings from a Consultation of Bangladeshi Scientific Experts', *Plant Cell, Tissue and Organ Culture,* vol. *86* (3), pp. 411-415.

Hossain, F. & Onyango, B. 2004, 'Product Attributes and Consumer Acceptance of Nutritionally Enhanced Genetically Modified Foods', *International Journal of Consumer Studies,* vol. 28, no.3, pp.255-267.

Hossain, F., B. Onyango, A. Adelaja, B. Schilling, and W. Hallman, 2002, 'Consumer acceptance of food biotechnology: willingness to buy genetically modified food products', *Food Policy Institute*, working paper no-0602-001, 2002.

Hossain, S. 2008, 'Rapid Urban Growth and Poverty in Dhaka City', Bangladesh Journal of Sociology, January, vol.5, no.1.

Huang, J., Hu, R., Meijl, H. & Tongeren, F. 2004, 'Biotechnology Boosts to Crop Productivity in China: Trade and Welfare Implications', *Journal of Development Economics*, vol. 75, pp.27-54.

Huffman, W.E., Rousu, M., Shogren, J.F. & Tegene, A. 2002, 'Should the United States Regulate Mandatory Labeling for Genetically Modified Foods?' *Staff* working paper 02013: *Iowa State University, Department of Economics*, Ames, IA

Huffman, W.E., Shogren, J.F., Rousu, M. & Tegene, A., 2003 'Consumer Willingness to Pay for Genetically Modified Food Labels in a Market with Diverse Information: Evidence from Experimental Auctions', *Journal of Agricultural and Resource Economics,* December, vol. 28, pp. 481-502.

Huffman, W.E., Rousu, M., Shogren, J.F. & Tegene, A., 2004, 'Who Do Consumers Trust for Information: The Case of Genetically Modified Food?' *American Journal of Agricultural Economics,* vol. 86, no. 5, pp. 1222-1229.

Huppatz, J. & Fitzgerald, P. A. 2000, 'Genetically modified foods-safety and regulatory issues', *Medical Journal of Australia,* vol. 172, pp. 170-173.

International Food Information Council (IFIC), 2001, *'U.S. Consumer Attitudes Toward Food Biotechnology'*, Writhing Group Quorum Surveys, viewed 21 November 2007, from http://www.ific.org/writhing/group/quoram/survy/default./html

International Policy Services for the Acquisition of Agri-Biotech Application (ISAAA), 2011, July 15, viewed 18 August 2010, from http://www.isaaa.org/kc/cropbiotechupdate/article/default.asp?ID=8159

International Service for the Acquisition of Agri-Biotech Application (ISAAA), 2003, GM Crop Update, 2002, viewed 21 May 2010, from http: mvw.isaaa.org

Isserman, A.M. 2001, 'Genetically Modified Food: Understanding the Social Dilemma', *American Behavioral Scientist,* vol. 44, pp. 1225-1232.

Islam, S. 2005, 'Challenges of bio-tech crops', The Daily Ittefaq, 19 October, pp.16.

Issac, G.E. & Phillips. P.W.B. 1999, 'Market Access and Market Acceptance for Genetically Modified Products', *Proceedings of NE-165 Conference,* Washington D.C., June 24-25.

James, C. 1997, 'Global Status of Transgenic Crops in 1997.' *ISAAA*: Briefs No. 5, ISAAA: Ithaca, NY. pp.31

James, C. 2009, 'Global Status of Commercialized Biotech/GM Crops: 2009: The first fourteen years 1996 to 2009', *ISAAA* Brief No. 41-2009, ISAAA: Ithaca, NY.

James, C. 2010, 'Global Status of Commercialized Biotech/GM Crops: 2010', *ISAAA Brief No. 42*, ISAAA: Ithaca, NY.

Kaneko, N. & Chern, W. 2005, 'Willingness to Pay for Genetically Modified Oil, Cornflakes, and Salmon: Evidence from a U.S. Telephone Survey,' *Journal of Agricultural and Applied Economics*, vol. 37, pp. 701-719.

Kelley, J. 1995, 'Public Perceptions of Genetic Engineering: Australia, 1994', Working Paper, *Department of Industry, Science, and Technology,* Commonwealth of Australia, 1995.

Kinnucan, H.W. & Venkateswaran, M., 1990, 'Effects of Generic Advertising on Perceptions and Behavior: The Case of Catfish'. *Southern Journal of Agricultural Economics*, December, pp.137-151.

Kotler, P. & Anderson, A. 1991, '*Strategic Marketing for Nonprofit Organizations,* 4th ed., Prentice-Hall, Englewood Cliffs, New Jersey.

Kotler, P., Armstrong, G., Agnihotri, P.Y. & Haque, E. 2010, *'Principles of Marketing'* 13th Ed. Pearson Education, Prentice Hall, New Delhi.

Krystallis, A., Frewer, L. J., Rowe, G., Houghton, J., Kehagia, O. & Perrea, T. 2007, 'A Perceptual Divide? Consumer and Expert Attitudes to Food Risk Management in Europe,' *Health Risk & Society,* vol. 9, no. 4, pp.407-424.

Laros, F .J. & Steenkamp, J. 2004, 'Importance of Fear in the Case of Genetically Modified Food' *Psychology & Marketing,* vol. 21, no. 11, pp. 889-908.

Lee, K. & Tyler, R. 1999, 'International Scientists Raise Concerns over Genetically Modified Food', *World Society Web Site*, February, viewed 14 February 2007, fromhttp://www.wsws.org/aricles/1999/food-f17.shtml

Lin, C.T.J. 1995, 'Demographic and Socioeconomic Influence on the Importance of Food Safety in Food Shopping', *Agricultural and Resource Economics Review*, October, vol.24, no.2, pp.190-198.

Liu, J. & Aragon, E. 2000, 'Sub sampling strategies in longitudinal surveys' *Proceedings of the American Statistical Association, Section of Survey Research Methods,* Atlanta, pp.307-312.

Long, J.S. 1997, *'Regression Models for Categorical and Limited Dependent Variables'*, Sage Publications, Inc., NY.

Loureiro, M.L. & Bugbee. M. 2005, 'Enhanced GM Foods: Are Consumer Ready to Pay for the Potential Benefits of Biotechnology?' *The Journal of Consumer Affairs,* vol. 39, no.1, pp. 52-70.

Lusk, J.L., Danield, M.S., Mark D.R. & Lusk, C.L. 2001, 'Alternative Calibration and Auction Institutions for Predicting Consumer Willingness to Pay for Nongenetically Modified Corn Chips,' *Journal of Agricultural and Resource Economic,* vol. 26, pp.40-57.

Lusk, J.L. & Fox, J.A. 2002, 'Consumer Demand for Mandatory Labeling of Beef from Cattle Administered Growth Hormones or Fed Genetically Modified Corn', *Journal of Agricultural and Applied Economics,* April, vol.34, no.1, pp.27-38.

Lusk, J.L. 2003, 'Effects of Cheap Talk on Consumer Willingness-To-Pay for Golden Rice', *American Journal of Agricultural Economics, November,* vol.85, no.4, pp.840-856.

Lusk, J.L. & Coble, K.H. 2005, 'Risk Perceptions, Risk Preference, and Acceptance of Risky Food', *American Journal of Agricultural Economics,* May, vol.87, no.2, pp.393-405.

Lynch, L., Hardie, I. & Parker, D. 2002, *'Analyzing Agricultural Landowners' Willingness to Install Streamside Buffers'*, Working Paper 02-01, January, The University of Marlyland, College Park.

MacKenzie, V. 2002, 'GM Foods: will their fate be decided in Asia? The Association for Sustainable and Responsible Investment in Asia (ASRIA),' May, viewed 14 February 2007, from http://www.asria.org/publications/lib/GMFoodsReport.pdf

Macnaghten. P. 2004, 'Animals in Their Nature: A Case Study on Public Attitudes to Animals, Genetic Modification and Nature', *Sociology*, vol. 38, no.3, pp.533-551.

Malhotra, N.K. 1999, Marketing Research, *'An Applied Orientation'*, International Edition (3rd), Prentice Hall, London.

Maltsbarger, R. & Kalaitzandonakes, N. 2000, 'Direct and Hidden Costs in Identity Preserved Supply Chains', *AgBio Forum*, vol. 3, no. 4.

Marks, L.A. & Kalaitzandonakes, N. 2001, 'Mass Media Communications about Agrobiotechnology', *AgBio Forum*, vol. 4, no.3&4, pp.199-208.

Martineau, B. 2001, *'First Fruit: The Creation of the Flavr Savr Tomato and the Birth of Biotech Food'*, McGraw-Hill, NY.

Mazhar, F. & Akhter, F. 2005, 'Farmers are not day-blind. They can see the harmful effect of Golden Rice', Information and analysis for the resistance to hybrid rice, *Grain Resources*, viewed 7 February 2007, www.grainresoureces.com

Menard, S., 2001, '*Applied Logistic Regression Analysis: Sage University Papers Series on Quantitative Applications in the Social Science'*, Series no 07 -106. Thousand Oaks, CA: Sage Publications.

Meyer, H. 2004, 'GENET- European NGO Network on Genetic Engineering', viewed 8 February 2007, from http://www.genet-info.org/

Miles, M.B., & Huberman, A.M., 1984, '*Qualitative Data Analysis, 16*', Newbury Park, CA: Sage Publications.

Miles, M.B. & Huberman, A.M. (1994). *Qualitative Data Analysis,* 2nd Ed., p.10-12. Newbury Park, CA: Sage Publications.

Misra, S.K. & Huang, C.L. 1991, 'Measuring Consumer Risk Perception of Pesticide Residues in Fresh Produce', *Proceedings of the 37th Annual Conference of the American Council on Consumer Interests*, ed. V. Haldeman, Columbia, Mo: ACCI, pp.110-116.

Moon, W. & Balasubramanian, S.K. 2001, 'Public Perceptions and Willingness to Pay a Premium for Non-Genetically Modified Foods in the US and UK', *AgBio Forum,* vol.4, no.3&4, pp.221-231.

Moon, W. & Balasubramanian, S.K.2003, 'Willingness-to-pay for Nonbiotech Foods in the US and UK', *Journal of Consumer Affairs*, vol.37, pp.317-339.

Moon, W. & Balasubramanian, S.K. 2004, 'Public Attitudes toward Arobiotechnology: The Mediating Role of Risk Perceptions on the Impact of Trust, Awareness and Outrage', *Review of Agricultural Economic*, vl.26, no.2, pp.186-208.

Moon, W., Balasubramanian S.K. & Rimal, A. 2007, 'Willingness-to-Pay (WTP) a Premium for Non-GM foods versus Willingness-to-Accept (WTA) a Discount for GM foods,' *Journal of Agricultural and Resource Economics*, vol.32, no.2, pp. 363-382.

Mora, C., Menozzi, D., Giacomini, C., Cantoni, C., Massari, M. & Morelli G. 2000, 'The Attitude of Italian Consumers Towards GM foods', *paper presented at 17th Annual forum and Symposium, IAMA Conference,* Parma, Italy, June 23-26.

Murnaghan, I. 2010, 'The Professional Views of Doctors on GM Foods', *Genetically Modified Foods* November 27, viewed 8 February 2007, from http://www.geneticallymodifiedfoods.co.uk/ views-doctors-gm-foods.html

Murphy, J.. Stevens, T. & Weatherhead, D. 2005, 'Is Cheap Talk Effective at Eliminating Hypothetical Bias in a Provision Point Mechanism?' *Environmental and Resource Economics*, vol.30, no.3, pp. 327-343.

Natasa, R., Stipcevic V.B., 2003, 'Attitudes of Croatian Population towards GM Food', Research Paper: *British Food Journal*, vol.105, no. 03, pp.148-161.

Nayga, R.M. 1996, 'Socio-demographic Influences on the Consumer Concern for Food Safety: The Case of Irradiation, Antibiotics, Hormones and Pesticides,' *Review of Agricultural Economics,* vol.18, pp.467-475.

Nelson, P. 1970, 'Information and Consumer Behavior,' *Journal of Political Economy*, vol.78, pp.311- 329.

Nelson, C.H. 2001, 'Risk perception, behavior, and consumer response to genetically modified organism: towards understanding American and European public reaction', *The American Behavioral Scientist,* vol. 44, no.8, pp.1371-1388

Neilson, C. & Anderson, K. 2000, 'Global Market Effects of Adopting Transgenic Rice and Cotton,' Mimeo, Centre for International Economic Studies, University of Adelaide, July.

Nelson, G.C., De Pinto, A., Bullock, D., Nitsi, E.I., Rosegrant, M., Josling, T., Babinard, J., Cunningham, C., Unnevehr, L. & Hill, L. 1999, 'The Economics and Politics of Genetically Modified Organisms in Agriculture: Implications for WTO 2000', Bulletin 809, University of Illinois.

Neyman, J. 1997, 'On the two different aspects of the representative method: the method of stratified sampling and the method of purposive selection', *Journal of the Royal Statistical Society*, vol.97, pp.558-606.

Neyman, M. R., Zidenberg-Cherr, S. & McDonald, R. B. 1996, 'Effect of Participation in Congregate-site Meal Programs on Nutritional Status of the Healthy Elderly. *Journal of American Detritions Association,* vol. 96, pp. 475-483.

Niang, I.S. 2007, 'Third generation GM crops: an opportunity for Africa', Science and Development Network (Scidev.Net), June 12, 2007.

Nunnally, J.C. & Bernstein, I.H., 1994, *Psychometric Theory*, McGraw-Hill, New York.

Odhimbo, Z. 2007, 'Commercializing Biotech Crops-the Global Picture', *New Agriculturist*, March, vol.1, no--.

Olesen, A. 2010, 'Expert: China GM Rice May be Market Ready by 2013', *Business Week,* 24 February, no.8, p. S23.

Onyango, B, Hossain, F., Hallman, W., Schilling, B., & Adelaja, A, 2003, 'Public Perception of Food Biotechnology Uncovering Factors Driving Consumers' Acceptance of Genetically Modified Foods', *Journal of Food Distribution Research*, March, vol. 34, no. 1.

Paarlberg, R.L. 2002, 'The Real Threat to GM crops in Poor Countries: Consumer and Policy Resistance in Rich Countries', *Food Policy,* vol. 27, pp. 247-250.

Pusztai, A. 2001, 'Genetically Modified Foods: Are they a Risk to Human/Animal health', *an Action Bioscience,* viewed 17 April 2009, from http://www.actionbioscience.org/biotech/pusztai.html

Paarlberg, R.L. 2006, 'Are Genetically Modified (GM) Crops a Commercial Risk for Africa'? *International Journal of Technology and Globalization*, vol.2, no. 1-2, pp.81-92.

Paine, J. A., Shipton, C. A., Chaggar, S., Howells, R. M., Kennedy, M. K., Vernon, G., Wright, S. Y., Edward H.E., Jessica L. A., Silverstone, A.L. & Drake, A. 2005. 'Improving the nutritional value of Golden Rice through increased pro-vitamin A content', *Nature Biotechnology*, March, vol. 23, pp. 482-487.

Poortinga, W. 2005, 'The Use of Multi-level Modeling in Risk Research. A Secondary Analysis of a Study of Public Perceptions of Genetically Modified Food,' October, *Journal of Risk Research*, vol.08, no.7-8, pp.583-597

Pray, C., Huang, J., Hu, R. & Rozelle, S. 2002, 'Five Years of Bt. cotton in China-the Benefits Continue', *The Plant Journal*, vol. 31, pp. 423-430.

Raats, M.M., Shepherd, R. & Sparks, P. 1995, 'Including Moral Dimensions of Choice within the Structure of the Theory of Planned Behavior,' *Journal of Applied Social Psychology*, vol. 25, pp. 484-494.

Ramessar, K., Capell, T., Twuman, R.M., Quemada, H. & Christou, P., 2008, 'Trace and Traceability - a Call for Regulatory Harmony', *Nature Biotechnology,* vol. 26, pp. 975-978.

Ready, R.C., Navrud, S. & Dubourg, W.R. 2001, 'How Do Respondents with Uncertain Willingness to Pay Answer Contingent Valuation Question?', *Land Economics*, August, vol.77, no.3, pp. 315-326.

Renn, O., Burns, W. J., Kasperson, J. X., Foundations and Empirical Applications', *Journal of Social Issues*, vol. 48, no. 4, pp.137-160.

Roller, S. & Harlander, S. 1998, 'Genetic Modification in the Food Industry: A Strategy for Food Quality Improvement', Aspen Publishers, Gaithersburg, pp.5-26.

Rosati, S. & Saba, A. 2000, 'Factors Influencing the Acceptance of Food Biotechnology', *Italian Journal of Food Science*, vol.12, no. 4, pp. 425-434.

Rousu, M., Huffman, W.E., Shogren, J.F. & Tegene, A. 2003, 'Should the United States Regulate Mandatory Labeling for Genetically Modified Food? Evidence from Experimental Auctions,' RTI International, *Experimental Economics,* Working Paper, January 20.

Runge, C.F. & Ryan, B. 2004, 'The global diffusion of plant biotechnology: International Adoption and Research', University of Minnesota, Minneapolis, Minn.: Center for International Food and Agricultural Policy.

Rice Projections, 2008, 'United State Department of Agriculture (USDA): Economic Research Service', viewed 23 September 2010, from http://starphoenixbase.com/?p=522

Riddell J., Lynnette, B.A., Russell S., Keast, J. & Hunter, W., 2011, 'Impact of Living Arrangements and Nationality on Food Habits and Nutrient Intakes Among Young Adults', *Appetite*, vol. 56, no. 6, pp. --

Savadori, L., Savio, S., Nicotra, E., Rumiati, R., Finucane, M. L. & Slovic, P. 2004, 'Expert and Public Perception of Risks from Biotechnology', *Risk Analysis,* vol. 24, no. 5, pp.1289-1299.

Schultz, T.W. 1975, 'The Value of the Ability to Deal with Disequilibria.' *Journal of Economic Literature,* vol. 13, pp. 827-846.

Scully, J. 2003, 'Genetic Engineering and Perceived Levels of Risk', *British Food Journal*, vol.105, no.1/2, pp.59-77.

Secretariat of the Convention on Biological Diversity, 2000, '*Cartagena Protocol on Biosafety to the Convention on Biological Diversity: text and annexes*. Montreal, Canada.

Science Clarified, 2011, *Chapter 13, Genetic Engineering,* viewed 15 August2012, from http://www.scienceclarified.com/scitech/Genetics/Genetic-Engineering.html

Shanahan, J., Scheufele, D. & Lee, E. 2001, 'Trends: Attitudes About Agricultural Biotechnology and Genetically Modified Organisms', *Public Opinion Quarterly,* vol. 65, pp. 261-281.

Siegrist, M. 2000, 'The Influence of Trust and Perceptions of Risks and Bbenefits on the Acceptance of Gene Technology', *Risk Analysis*, vol. 20, no.2, pp.195-204

Sjöberg, L . 2000, 'Factors in risk perception', *Risk Analysis,* vol. 20, pp. 1-11.

Sjöberg, L . 2008, 'Genetically Modified Food in the Eye of Public and Experts' *Risk Management: An International Journal,* vol. 10 , no. 1 , pp. 168-193.

Slovic, P., Finucane,M. L., Peters, E. & MacGregor,D. 2002, 'Risk as analysis and risk as feelings: Some thoughts about affect reason, risk, and rationality. Paper presented at the Annual Meeting of the Society for Risk Analysis. New Orleans, LA.

Smith, M. J., 2007, '*Genetic Roulette: The Documented Health Risks of Genetically Engineered Foods, Seeds of Deceptions',* Yes! Books, Fairfield, IA.USA.

Smythe, S., Kerr, W.A. & Davey, K.A. 2006, 'Closing Markets to Biotechnology: Does It Pose an Economic Risk if Markets are Globalized'? *International Journal of Technology and Globalizations,* vol.2, no.3-4, pp.377-389.

Soregavoli, C., Boccaletti, S.&Moro, D. 2003, 'Consumer's Attitude towards Labeled and Unlabeled GM Food Products in Italy', *International Food and Agribusiness Management Review,* vol. 6, no. 2, pp.111-127.

Sparks, P., R. Shepherd, R. & Frewer, L.J. 1995, 'Assessing and Structuring Attitudes toward the Use of Gene Technology in Food Production: The Role of Perceive Ethical Obligation', *Basic and Applied Social Psychology,* vol.16, pp. 267-285.

Springer, A.E., Queen, A.M., Quintanilla, G., Arrivillaga, M. & Ross, M.W. 2009, 'Reliability and Validity of the Student Perceptions of School Cohesion Scale in a Sample of Salvadoram Secondary School Student,' BMC International Health and Human Rights, viewed 13 January 2010, from http.//www.biomedcentral.com/1472-698x/9/30

Stefano, B. & Daniele, M. 2000, 'Consumer Willingness-to-Pay for GM Food Products in Italy', *AgBio Forum*, vol. 3, no. 4, pp.259-267.

Teisl, M.F., Garner, L., Roe, B. & Vayda, M.E. 2003, 'Labeling Genetically Modified Foods: How Do US Consumers Want to See It Done?' *AgBio Forum,* vol.6, no.3&4, pp.48-54.

Teng, P.S. 2006, 'Where Does Asia Stand in Accepting Agribiotechnology Crops?' *Asia Pacific Biotech,* vol. 10, pp.838-845.

The Guardian, *Timeline: GM crops*, Feb 16, 2008, viewed 10 October 2009, from http://www.guardian.co.uk/environment/2008/feb/16/gmcrops.food1

The Open University Learning Space, 2011, 'The Social Issues and GM Crops,' July 13, viewed 13 September 2012, from http:/openlearn.open.ac.uk/mod/oucontent/view.php?id=398604&section=2.4.1

The Pew Initiative on Bio-technology, 2004, 'This Food Contains GM Ingredients: Useful or Useless Info?', viewed 29 September 2009, from http://pewagbiotech.org/buzz/display.php3?StoryID=72

The Pew Initiative on Bio-technology, 2006, 'Report: State Legislatures Continue to Be Active in Addressing Challenges Associated with Agricultural Biotechnology', Jun 22, viewed 29 September 2009, from http://www.pewtrusts.org/work_report_detail.aspx?id=20040&category=442

The Pew Initiative on Food and Biotechnology, 2006, 'Genetically Modified Crops in the United States', August, viewed 29 September 2009, from http://pewagbiotech.org/resources/factsheets/display.php3?FactsheetID=2

Thompson, P. 1999, 'The Ethics of Truth-telling and the Problem of 'Risk', *Science and Engineering Ethics*, vol.5 no. 4, pp. 489-510.

Thomas, C., Nizzari, D., Cefaloni, V., Dragos, C., Has, E.C. 2009, 'Role of Media in Forming Public Opinion about GM Crops Programme Intensive', Paper presented at *Bioéthique en Sciences de la vie et de l'environnement,* Lublin, 22 March-5 April.

United Nations Environment Program (UNEP), 2011, Green Economy Repot, viewed 19 December 2011 from http://www.unep.org/greeneconomy/greeneconomyreport/tabid/29846/dfault.aspx

U.S. Food and Drug Administration, 2000, 'Report on Consumer Focus Group on Biotechnology', October, viewed 19 January 2009, from http://www.cfsan.fda.gov/~comm/biorpt.html

USDA Foreign Agricultural Service, 2003, GRAIN Report #JA3002, 'Update on Japan's Biotechnology Safety Approval and Labeling Policies', January 13.

USDA, 2009, '*Rice Situation and Outlook Yearbook/ RCS-2008*, Economic Research Service, USDA

U.S. Food and Drug Administration 2000, '*Report on Consumer Focus Group on Biotechnology'*, October, viewed 13 January 2007, from http://www.cfsan.fda.gov/~comm/biorpt.html

Valerie, K. 2003, 'Global Anti-GM Sentiment Slows China's Biotech Agenda', *Yale Global*, September 26, viewed 25 June 2007, from http://yaleglobal.com/GM/Chaina.html

Verdurme, A., Gellynch, X. & Viaene, J. 2002, 'Are Organic Food Consumers Opposed to GM Food Consumers', *British Food Journal*, vol.104, no.8, p.610-623.

Wachenheim, C. & Lesch, W. 2004, *Global prevalence of vitamin A deficiency in populations at risk 1995–2005: WHO global database on vitamin-A deficiency*, World Health Organization, 2009, viewed 24 July 2010, from http://whqlibdoc.who.int/publications/2009/9789241598019_eng.pdf

Wei, J.Z., Hale, K., Carta, L., Platzer, E., Wong, C., Fang, S.C & Aroian, R.V. 2003, *Bacillus thuringiensis* crystal proteins that target nematodes. Proceedings of the National Academy of Sciences, vol.100, pp. 2760-2765.

Wen, S.C & Kyrre, R. 'Consumer Acceptance of GMOs: Survey Result from Japan, Norway, Taiwan and United State', Dept. of Agriculture, Environment & Development Economics, The Ohio State University, Working paper: *AEDE-WP*-0026-02.

'What the Experts Say about Agricultural Biotechnology', 2009, viewed 14 December 2010, fromhttp://www.agbioworld.org/declaration/petition/petition.phtml

Whitman D.B. 2000, 'Genetically Modified Foods: Harmful or Helpful', April, viewed 22 September 2007, from http://www.csa.com/discoveryguides/gmfood/gloss_f.php

Wier, M & Andersen, L. M 2003, 'Consumer Demand for Organic Foods: Attitudes, Values and Purchasing Behavior'. *Newsletter from Danish Research Centre for Organic Farming (2), viewed 12 April 200, from* http://www.darcof.dk/enews/jun03/consum.html

Wirthgen, A. & Fabe, A. 2005, 'Consumers' View and Awareness of Genetically Modified food', paper presented at the *EAAE Seminar: Quality Management and Quality Assurance in Food Chains,* Gottingen, Germany.

World Health Organization, 2009, 'Global prevalence of vitamin A deficiency in populations at risk 1995–2005: WHO global database on vitamin-A deficiency, viewed 23 July 2010, from http://whqlibdoc.who.int/publications/2009/9789241598019_eng.pdf

Ye, X., Al-Balili. S., kloti. A., Zhang. J., Lucca. P., Beyer, P. & Portykus, 2008, 'Engineering the Provitamin A (β-Carotene) Biosynthetic Pathway into (Carotenoid-Free) Rice', *Endosperm Science*, January 14, vol. 287, no. 5451, pp. 303-305.

Zhong, F., Marchant, M.A., Ding, Y. & Lu, K. 2002, 'GM foods: A Nanjing case study of Chinese Consumers' Awareness and Potential Attitudes', *AgBio Forum*, vol.5, pp. 36-144.