

**GENETICALLY MODIFIED WHITE MAIZE IN
SOUTH AFRICA:
CONSUMER PERCEPTIONS
AND
MARKET SEGMENTATION**

By

Hester Vermeulen

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Hester Vermeulen

Pretoria

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¹ Department Agricultural Economics, Extension and Rural Development, University of Pretoria

² Department Agricultural Economics, Extension and Rural Development, University of Pretoria & CEO of the Agricultural Business Chamber in South Africa

³ Centre for Nutrition, University of Pretoria & Sensory Analysis and Food Composition, Agricultural Research Council, Irene, South Africa

ABSTRACT

GENETICALLY MODIFIED WHITE MAIZE IN SOUTH AFRICA: CONSUMER PERCEPTIONS AND MARKET SEGMENTATION

by

Hester Vermeulen

Degree: MSc Agric
Department: Agricultural Economics, Extension and Rural Development
Study leader: Prof. J.F. Kirsten
Co-Study leaders: Dr. O.T. Doyer
Prof. H.C. Schönfeldt

Genetically modified food is a reality for many modern-day consumers around the world. With the introduction of GM food to the food market, consumers were faced with a number of new products and also familiar products containing new ingredients. The introduction of genetically modified food products to food markets around the world, led to a lot of controversy. In many cases consumer attitudes and perceptions of GM food products were revealed as fears, concern for, and avoidance of the new technology. Consumer attitudes, perceptions and acceptance towards the use of genetically modified foods or -food ingredients are currently highly relevant issues for role-player such as researchers, government, food companies, biotechnology companies, retailers and farmers all over the world.

The importance of genetically modified food products in South Africa is increasing, even though the debate surrounding genetically modified food products lags behind many other (often more developed) parts of the world. Genetically modified white maize is among the agricultural crops approved for commercial production in South Africa. The production of genetically modified white maize in South Africa increased dramatically from its introduction in the 2001/2002-production season. White maize, especially in the form of super- and special maize meal, is an extremely important staple food source for consumers of all age groups in South Africa. The implication

of the significant increase in the cultivation of genetically modified white maize is that the product is entering the South African food market at an increasing rate. In reality South African consumers are increasingly exposed to food products containing genetically modified white maize. This goes hand in hand with increasing consumer awareness regarding genetically modified food issues.

The general objective of the dissertation is to develop an understanding of the perceptions, attitudes, acceptance and knowledge of South African urban consumers, regarding GM white maize as a staple food product within South Africa. The specific objectives are to identify trade-offs between selected attributes of maize meal and to determine the relative importance of selected GM characteristics within the trade-offs by means of a conjoint experiment, to construct market segments based on the outcomes of a conjoint experiment, to determine the effect of consumer perceptions on the sensory experience of white maize porridge and to determine the knowledge, perceptions and GM food acceptance of the different market segments.

Quota sampling was applied to obtain a random sample of 80 urban white-maize consumers, based on the LSM (Living Standard Measures) market segmentation tool. The respondents participated in sensory evaluation of maize porridge. This was followed by a conjoint experiment designed around three selected product characteristic variables describing a 2.5kg packet of super white maize meal: “Brand variable”, “Genetic modification variable” and “Price variable”. Market segmentation was done through Ward’s hierarchical cluster analysis based on the conjoint results. The final phase of the experimental analysis involved the profiling of the identified clusters based on demographic variables, respondents’ knowledge of genetic modification and respondents’ perceptions, attitudes and acceptance towards genetically modified food.

The limited sample size (80 respondents) could influence the ability of the results to reflect on the population of urban white maize consumers given the presence of GM food in the market. However, the experimental results should be seen in view of general trends in South Africa and available anecdotal evidence supporting the results of the study. The results of this study could go a long way in representing the results

of a more representative sample of urban white maize consumers given the presence of GM food in the market.

The cluster analysis revealed that the sample of urban, white maize consumers could be grouped into three meaningful and distinct market segments, based on their preferences for branded- versus non-branded white-grained maize meal, as well as their preferences for non-GM white maize meal versus GM white maize meal with various types of genetic manipulations. The “Anti-GM” segment (35% of the sample) is particularly negative towards GM food irrelevant of the type of genetic modification applied to the food. The “Pro-GM farmer sympathetic” segment (20% of the sample) is positive towards genetically modified food in cases where the farmer receives the benefit of the genetic modification. The “Pro-GM” segment (45% of the sample) is generally positive towards GM food, but especially when the consumer receives the benefit of the genetic modification. The results indicated that the differences among the cluster groups were more prominent than the differences among the LSM groups. Thus, the clusters were most effective to distinguish between sub-groups in the experimental sample.

The results of the respondents’ knowledge of genetic modification indicated that there is some degree of confusion among respondents regarding the meaning of genetic modification, as well as discrepancies between perceived and actual knowledge levels of genetic modification. In general, the respondents’ knowledge of GM food is relatively low.

A strong positive correlation was observed between the sample respondents’ exposure to GM food related terms and their perceived understanding of these issues, implying that the exposure caused the respondents to learn more about GM food related terms. The balanced GM food information presented to the respondents during the experimental procedure probably influenced their knowledge levels and opinions about GM food as the experiment evolved. Despite these observations the research methodology was still deemed as appropriate. The GM food knowledge gained by the respondents during the experiment could be seen as a simulation of situations where they could receive GM food information from external sources such as television, radio, magazines or newspapers.

The cluster profiling revealed that urban white-grain maize consumers' perceptions and attitudes towards GM food were the strongest distinguishing factors between the various market segments, especially the preferences of the various cluster groups for non-GM maize or maize that was genetically modified for consumer benefit or maize that was genetically modified for producer benefit. Demographic factors and GM knowledge aspects did not really contribute towards distinguishing between the clusters.

The dissertation determined that there is a need for a better understanding of consumer perceptions, attitudes towards and acceptance of GM food products, which could enable producers and scientists to engage in more consumer driven product development and marketing activities. Consumer acceptance is the most critical factor for the success of GM food products within the South African food market place and could shape the future of the agricultural modern biotechnology industry and the agricultural sector in South Africa.

TABLE OF CONTENTS

ACKNOWLEDGEMENTS	I
ABSTRACT.....	III
TABLE OF CONTENTS	VII
LIST OF TABLES	XI
LIST OF FIGURES	XIII
LIST OF APPENDICES	XV
LIST OF ABBREVIATIONS	XVI
CHAPTER 1: INTRODUCTION.....	1
1.1 BACKGROUND	1
1.2 BIOTECHNOLOGY IN THE GLOBAL CONTEXT	2
1.2.1 Technology and the human race.....	2
1.2.2 The historical development of biotechnology	4
1.2.3 A global overview of modern biotechnology in the agricultural sector	7
1.2.4 Consumer reactions to GM food: An international perspective.....	10
1.2.5 Consumer reactions to GM food: An overview of the issues	12
1.3 AGRICULTURAL MODERN BIOTECHNOLOGY IN SOUTH AFRICA	14
1.3.1 The historical development of modern agricultural biotechnology in South Africa.....	14
1.3.2 The role of government in modern biotechnology in South Africa.....	17
1.3.3 Consumer information and GM food in South Africa	18
1.4 MAIZE CONSUMPTION IN SOUTH AFRICA.....	20
1.5 A REVIEW OF CONSUMER STUDIES ON GM FOOD IN SOUTH AFRICA	29
1.5.1 Exposure to GM food products and information.....	30
1.5.2 Understanding of GM food issues.....	31
1.5.3 GM food information and consumer education	31
1.5.4 Regulatory aspects of GM food.....	32
1.5.5 Labelling of GM food.....	32
1.5.6 Consumer reactions to GM food.....	32
1.6 PROBLEM STATEMENT	33

1.7	MOTIVATION AND RESEARCH QUESTION.....	35
1.8	HYPOTHESES.....	37
1.9	OBJECTIVES	38
1.10	OUTLINE	39
CHAPTER 2: RESEARCH METHODOLOGY		40
2.1	INTRODUCTION.....	40
2.2	THEORY OF CONSUMER BEHAVIOUR.....	40
2.3	OVERVIEW OF THE RESEARCH PROCESS	50
2.3.1	Overview of the research activities.....	50
2.3.2	Analytical procedures	51
2.3.3	Sampling procedure.....	53
2.4	SUMMARY	58
CHAPTER 3: MAIZE MEAL PREFERENCES OF SOUTH AFRICAN		
	URBAN CONSUMERS	59
3.1	INTRODUCTION.....	59
3.2	THE APPLICATION OF CONJOINT ANALYSIS WITHIN THE	
	CONTEXT OF CONSUMER RELATED GM FOOD RESEARCH: A	
	LITERATURE REVIEW.....	59
3.3	THEORETICAL OVERVIEW OF CONJOINT ANALYSIS	61
3.4	DESCRIPTION OF THE CONJOINT EXPERIMENT.....	64
3.4.1	Formulating the relevant research objectives	64
3.4.2	Determining the relevant white maize product attributes and attribute	
	levels	65
3.4.3	The scenarios presented to the respondents	69
3.4.4	Presenting the constructed scenarios to the respondents	70
3.4.5	Selecting a measure of consumer preference.....	71
3.4.6	Survey design.....	72
3.4.7	Estimating the model	72
3.4.8	Assessing the reliability and validity of the conjoint results	77
3.5	THE WILLINGNESS-TO-PAY (WTP) CONJOINT MODEL:	
	RESULTS AND DISCUSSION	78
3.6	CHAPTER CONCLUSION	82

CHAPTER 4: MARKET SEGMENTATION.....	83
4.1 INTRODUCTION.....	83
4.2 THEORETICAL OVERVIEW	83
4.3 DESCRIPTION OF THE CLUSTER ANALYSIS.....	85
4.4 MARKET SEGMENTATION BASED ON THE WTP CONJOINT MODEL: RESULTS AND DISCUSSION.....	89
4.5 CHAPTER CONCLUSION	95
CHAPTER 5: PROFILING THE LSM AND CLUSTER GROUPS.....	98
5.1 INTRODUCTION.....	98
5.2 METHODOLOGY.....	99
5.2.1 Survey questionnaire components.....	99
5.2.2 Statistical tests applied in the data analysis.....	103
5.2.2.1 <i>Correlation analysis</i>	103
5.2.2.2 <i>Multivariate statistical analyses: Canonical Variate Analysis</i>	103
5.2.2.3 <i>The analysis of variance (ANOVA) test</i>	104
5.2.2.4 <i>The Chi-square test</i>	105
5.3 AGGREGATE ANALYSIS OF THE KNOWLEDGE LEVELS OF URBAN WHITE MAIZE CONSUMERS REGARDING GENETIC MODIFICATION	107
5.4 PROFILING THE LSM GROUPS	107
5.4.1 LSM group profiling based on knowledge of genetic modification.....	107
5.4.2 LSM group profiling based on perceptions and attitudes towards genetic modification	111
5.5 PROFILING THE CLUSTER GROUPS	115
5.5.1 Demographic profiling of the cluster groups.....	115
5.5.2 Cluster group profiling based on knowledge of genetic modification.....	118
5.5.3 Cluster group profiling based on perceptions and attitudes towards genetic modification	122
5.5.4 Canonical variate analysis for the LSM- and cluster groups.....	126
5.6 CORRELATION ANALYSIS OF THE COMPLETE DATASET	129
5.7 CHAPTER CONCLUSION	131

CHAPTER 6: CONSUMER PERCEPTIONS OF GENETICALLY MODIFIED MAIZE INVESTIGATED WITH SENSORY EVALUATION	135
6.1 INTRODUCTION.....	135
6.2 THE SENSORY EVALUATION EXPERIMENT	136
6.3 RESULTS AND DISCUSSION	140
6.3.1 Sensory evaluation results of the LSM groups.....	140
<i>6.3.1.1 Tasting session 1</i>	<i>140</i>
<i>6.3.1.2 Tasting session 2</i>	<i>142</i>
<i>6.3.1.3 Tasting session 3</i>	<i>142</i>
6.3.2 Sensory evaluation results of the cluster groups	144
<i>6.3.2.1 Tasting session 1</i>	<i>144</i>
<i>6.3.2.2 Tasting session 2</i>	<i>145</i>
<i>6.3.2.3 Tasting session 3</i>	<i>146</i>
6.4 CONCLUSION.....	147
CHAPTER 7: SUMMARY AND CONCLUSIONS	149
7.1 INTRODUCTION.....	149
7.2 SUMMARY OF FINDINGS	150
7.3 RECOMMENDATIONS.....	154
REFERENCES.....	159
APPENDIXES	172
APPENDIX A: CONSUMER PANEL RECRUITMENT QUESTIONNAIRE	172
APPENDIX B: INITIAL PERSONAL INTERVIEW SURVEY	175
APPENDIX C: GENERAL SURVEY QUESTIONNAIRE	177
APPENDIX D: SENSORY EVALUATION QUESTIONNAIRES	182

LIST OF TABLES

Table 1. 1	Areas of technological development from the mid-eighteenth century onwards	3
Table 1. 2	History of biotechnology	6
Table 1. 3	The estimated areas planted to GM maize and soya bean crops in South Africa for the period 1999/2000 to 2002/2003	15
Table 1. 4	The most important events related to modern agricultural biotechnology in South Africa	16
Table 1. 5	Extraction rate of various maize meal types	22
Table 1. 6	The South African technical requirements for super-, special-, sifted- and unsifted maize meal according to the Maize Product Regulations (No. 1739, 17 September 1993).....	23
Table 1. 7	Market share of the major white grain maize millers in South Africa.	24
Table 2. 1	Summary characteristics of the selected LSM groups.....	54
Table 2. 2	Ideal and actual characteristics of the LSM 4 & 5 respondents.....	56
Table 2. 3	Ideal and actual characteristics of the LSM 6 & 7 respondents.....	56
Table 2. 4	Ideal and actual characteristics of the LSM 8, 9 & 10 respondents.....	57
Table 3. 1	Food application examples of conjoint- and cluster analysis	60
Table 3. 2	The selected levels for each of the relevant product attributes.....	68
Table 3. 3	The 9 white maize meal product descriptions within the fractional factorial design.....	70
Table 3. 4	An example of the profile cards used in the conjoint experiment	71
Table 3. 5	Estimated coefficients / part-worth values for the WTP conjoint model (n = 80).....	78
Table 3. 6	Estimated aggregate rescaled WTP values for the WTP conjoint model (n = 80).....	79
Table 4. 1	Average rescaled WTP values and average estimated WTP values for the respondents in Cluster 1	90
Table 4. 2	Average rescaled WTP values and average estimated WTP values for the respondents in Cluster 2.....	91
Table 4. 3	Average rescaled WTP values and average estimated WTP values for the respondents in Cluster 3.....	93

Table 4. 4	Average rescaled WTP values and average estimated WTP values for the respondents in Cluster 4.....	94
Table 5. 1	Characteristics of the three LSM groups in terms of genetic modification knowledge.....	108
Table 5. 2	Characteristics of the three LSM groups in terms of perceptions and – attitudes towards genetic modification	112
Table 5. 3	Demographic profiling characteristics of the four cluster groups	116
Table 5. 4	Characteristics of the four cluster groups in terms of genetic modification knowledge.....	118
Table 5. 5	Characteristics of the four cluster groups in terms of perceptions and – attitudes towards genetic modification	122
Table 5. 6	Characteristics of the LSM groups	132
Table 5. 7	Characteristics of the Cluster groups	133
Table 6. 1	The two-way ANOVA results for tasting session 1 in terms of the LSM groups.....	141
Table 6. 2	The chi-square test results for tasting session 2 for the LSM groups	142
Table 6. 3	The two-way ANOVA results for tasting session 3 for the LSM groups	143
Table 6. 4	The two-way ANOVA results for tasting session 1 for the cluster groups.....	144
Table 6. 5	The chi-square test results for tasting session 2 for the cluster groups	145
Table 6. 6	The two-way ANOVA results for tasting session 3, for the cluster groups.....	146
Table 7. 1	Summary characteristics of the market segments.....	152

LIST OF FIGURES

Figure 1. 1	The global area under GM crops for the period 1996 to 2003.....	9
Figure 1. 2	Cultivation of GM crops in countries planting 100 000 hectares or more during 2003.....	9
Figure 1. 3	Commercial maize consumption (human) 2001/02 to 2004/05.....	21
Figure 1. 4	Commercial maize consumption (animal feed) 2001/02 to 2004/05...	21
Figure 1. 5	Starch food consumption of different age groups within rural areas of South Africa: Percentage of the various age groups consuming the different food items.....	25
Figure 1. 6	Starch food consumption of different age groups within rural areas of South Africa: Average consumption (grams) per person per day of those people consuming the food item.....	25
Figure 1. 7	Starch food consumption of different age groups within urban areas of South Africa: Percentage of the various age groups consuming the different food items.....	26
Figure 1. 8	Starch food consumption of different age groups within urban areas of South Africa: Average consumption (grams) per person per day of those people consuming the food item.....	27
Figure 2. 1	Marketing strategy and consumer behaviour.....	41
Figure 2. 2	The Engel-Blackwell-Miniard (Engel-Kollat-Blackwell) model of consumer behaviour.....	43
Figure 2. 3	The process through which consumer perceptions are formed.....	46
Figure 2. 4	Analytical overview of the research	52
Figure 3. 1	Maize meal preferences of the respondents revealed in the conjoint experiment.....	80
Figure 5. 1	Spider graph illustrating the genetic modification knowledge levels of the LSM groups.....	109
Figure 5. 2	Spider graph illustrating the perceptions and attitudes towards genetic modification in food for the LSM groups	113
Figure 5. 3	Spider graph illustrating the genetic modification knowledge levels of the cluster groups	119

Figure 5. 4	Spider graph illustrating the perceptions and attitudes towards genetic modification in food for the cluster groups.....	124
Figure 5. 5	CVA Plot of mean scores of the 3 LSM groups	127
Figure 5. 6	CVA Plot of mean scores of the 4 cluster groups.....	128

LIST OF APPENDICES

APPENDIX A: CONSUMER PANEL RECRUITMENT QUESTIONNAIRE.....	172
APPENDIX B: INITIAL PERSONAL INTERVIEW SURVEY	175
APPENDIX C: GENERAL SURVEY QUESTIONNAIRE	177
APPENDIX D: SENSORY EVALUATION QUESTIONNAIRES	182

LIST OF ABBREVIATIONS

AMPS	All Media and Products Survey
ANOVA	Analysis of variance
BSE	Bovine Spongiform Encephalopath (Mad cow disease)
CVA	Canonical variate analysis
DNA	Deoxyribonucleic acid
DTI	Department of Trade and Industry
FEST	Foundation for Education, Science and Technology
GE	Genetically engineered
GI	Genetically improved
GM	Genetically modified
GMO	Genetically modified organism
ISAAA	International Service for the Acquisition of Agri-Biotech Applications
LSD	Least Significant Difference
LSM	Living Standard Measures
NDA	National Department of Agriculture
NEMA	National Environmental Management Act
NGO	Non-government organisation
OLS	Ordinary Least Squares
rBST	Bovine Growth Hormone
rDNA	Recombinant deoxyribonucleic acid
SA	South Africa
SAARF	South African Advertising Research Foundation
SAGENE	South African Committee for Genetic Experimentation
SAGIS	South African Grain Information Service
UK	United Kingdom
USA	United States of America
USFDA	United States Food and Drug Administration
WTP	Willingness to pay

CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

Food ... One of the most basic physiological needs of human beings (Maslow, 1970). Initially the basis of the relationship between human beings and food was simple. When hungry, humans (like other animals) gathered food or hunted in order to acquire food for consumption. However, over the centuries the relationship between human beings and food became more complex than the simple elimination of hunger. In modern day society food plays a role in a variety of aspects related to human life, including culture, tradition, security, comfort, status, politics, entertainment, communication, therapy and many other aspects (Schomer, 2004).

Despite the complex nature of the modern day relationship between humans and food, the fact remains that humans need food in order to survive. It is estimated that the world population will reach approximately 9 billion people by the year 2050, with the majority of the population increase expected to occur in urban areas of developing countries in Africa and Asia (Foundation for Education, Science and Technology (FEST), 2002). This implies that agricultural production will have to double to provide food and clothing for this population. Approximately 55% of the additional food will have to come from increased land productivity. There are a number of research initiatives working towards improved land productivity, world food security and addressing food production problems such as pests, diseases, poor soils, droughts, floods and nutritional quality. Examples of these research initiatives include irrigation, agrochemicals, plant breeding and farm management. Biotechnology is an additional tool in this regard (FEST, 2002).

The introduction of modern biotechnology into agricultural production is one of the most prominent advances in the history of agricultural development. The application of genetic modification technology on agricultural crops and the genetically modified organisms (GMOs) that were developed as a result of the technology, are simultaneously considered to be extremely important and controversial (especially

with respect to consumers' reactions to genetically modified (GM) food) within the scope of science and technology developments (FEST, 2002; Thomson, 2002).

This study focuses on consumer perceptions, attitudes and the consequent acceptance or rejection of genetically modified food in South Africa, particularly on GM white maize (a staple food) and urban consumers. Within the general focus of the research, the main objectives of this chapter are to:

- Provide background information on a number of issues relevant within the context of this research project, including the history and development of modern agricultural biotechnology in the international arena, modern agricultural biotechnology in South Africa and the importance of maize within South Africa.
- Discuss the problem statement, hypotheses and objectives of the study.

1.2 BIOTECHNOLOGY IN THE GLOBAL CONTEXT

1.2.1 Technology and the human race

The human race was created as intelligent beings capable of creativity. They have always exhibited certain needs and desires. Maslow (1970) described a hierarchy of human needs including physiological-, safety-, belongingness-, esteem- and self-actualisation needs. McGuire (1974) developed a more specific need classification system, which included needs for consistency, cues, independence, novelty, self-expression, ego-defence, assertion, reinforcement, affiliation and modelling, as well as needs to attribute causation and categorisation. In order to fulfil their needs, human beings used their intelligence and creativity to make discoveries and generate inventions, which ultimately improved their way of life. Therefore the history of mankind was characterised by a vast number of discoveries, inventions and technological developments. Table 1.1 contains a summary of the major technological developments from the mid-eighteenth century onwards.

Table 1.1 Areas of technological development from the mid-eighteenth century onwards

Time period:	Areas of technological development:	Specific examples of new technologies:
1750 to 1845	Water power Textiles Iron Communication	1760's: First successful spinning machines (Derry & Williams, 1960) 1787: Weaving machine patented (Derry & Williams, 1960) 1789: Iron plough (Derry & Williams, 1960) 1807: Commercial steam boat (Derry & Williams, 1960) 1827: Outward flow water turbine (Derry & Williams, 1960) 1844: Telegraph (Derry & Williams, 1960)
1845 to 1900	Steam Rail Steel Communication	1870's: Steel oil pipeline in America and Russia (Derry & Williams, 1960) 1876: Telephone (Derry & Williams, 1960) 1884: First patent for "modern" steam turbine (Derry & Williams, 1960) 1887: First Automobile (Barley, 1998) 1889: Steel construction bridge (Derry & Williams, 1960) 1889: Electric elevator (Barley, 1998) 1889: Electric sewing machine (Barley, 1998) 1890: "Tube" underground railway system in London (Derry & Williams, 1960) 1893: First commercial hydro-electric generators (Derry & Williams, 1960) 1895: X-rays (Barley, 1998)
1900 to 1950	Electricity Chemicals Internal-combustion engine	1903: Airplane (Wright Brothers' first successful flight (Barley, 1998) 1906: Radio broadcast (Barley, 1998) 1908: Model T automobile (PBS, 2000) 1909: Synthetic rubber (Barley, 1998) 1924: Diesel locomotive (Barley, 1998) 1927: Television (PBS, 2000) 1942: Atomic reaction (PBS, 2000) 1950's: Nuclear power (Durant, Bauer & Gaskell, 1998)
1950 to 1990	Petrochemicals, electronics, aviation	1952: Watson and Crick discovered the structure of DNA (Thomson, 2002) 1960: Laser (PBS, 2000) 1969: Moon landing (PBS, 2000) 1970: Optical fibre (PBS, 2000) 1976: Super computer (PBS, 2000) 1981: Reusable space shuttle (PBS, 2000)
1990 onwards	Digital networks, software Modern biotechnology	software (The information era) (PBS, 2000) (Durant <i>et al.</i> , 1998)

According to Durant *et al.* (1998) three strategic technological developments occurred during the post-war period (1950s and onwards). The technologies were considered as strategic technologies due to the observation that they could transform future living standards of the human race. The first strategic technological development was nuclear power in the 1950s and 1960s, followed by information technology in the 1970s and 1980s. Modern biotechnology is considered to be the third strategic technological development (1990's onwards).

1.2.2 The historical development of biotechnology

Section 1.2.1 illustrated the importance of biotechnology and specifically modern biotechnology within the technological development of the human race. The historical developments that lead to the present status of modern biotechnology will be considered in this section. “Biotechnology” is defined as the utilization of biological processes in order to produce products and processes with commercial value (Thomson, 2002). The development of biotechnology involved three overall generations:

- The “first biotechnology generation”.
- The “second / intermediate biotechnology generation”.
- The “third biotechnology generation” or “modern biotechnology”.

The “first biotechnology generation” (New stone age / 7000 BC to 1940s) was characterised by a minimal input of science and engineering (Nef, 1998). Biotechnology applications within the “first biotechnology generation” included the cross breeding of plants and animals, the leavening of bread with yeast and fermentation in order to produce alcohol (Sharp, 1996). Traditional or cross breeding techniques encompasses the selective breeding of plants or animals with desirable attributes, in order to develop new varieties of plants or animals that exhibit the most desirable characteristics of the parent organisms (Schardt, 1994). A cultivar is a plant variety produced by selective breeding techniques (Thomson, 2002). Within this first biotechnology generation, the application of traditional breeding had certain disadvantages (Schardt, 1994), including:

- The randomness and impreciseness of the process.
- The production of a commercially valuable new variety with traditional breeding techniques takes very long (up to 20 years or longer).
- Traditional breeding of two organisms could only be done if the organisms were closely specie related.

During the “second biotechnology generation” or “intermediate biotechnology generation” (1940s to 1980s) science and engineering contributed on an industrial

scale by means of industrial microbiology, biochemistry and industrial engineering. Within this biotechnology generation the production of pharmaceuticals, chemicals and fuels, as well as the processing of residues were done by means of fermentation, bio-conversion and bio-catalysis (Nef, 1998). The first and second biotechnology generations formed part of “traditional biotechnology”. “Traditional biotechnology” includes the processes, products and services that have been developed on the basis of interventions at the level of the cell, tissue or whole organism (Durant *et al.*, 1998).

The “third biotechnology generation” or “modern biotechnology” started in the 1980s and is still developing further. This generation is generally based on molecular biology and the utilisation of genetic engineering techniques to produce organisms with new genetic combinations (Nef, 1998). The term “modern biotechnology” encompasses the processes, products and services that have been developed on the basis of interventions at the level of the gene (Durant *et al.*, 1998). The United States Food and Drug Administration (USFDA) defines “modern biotechnology” as the techniques used by scientists to deliberately modify deoxyribonucleic acid (DNA) or the genetic material of a bacterium, plant or animal in order to produce a desired trait (USFDA, 2001). A transgenic crop is a crop produced by means of modern biotechnology. It is important to note that the techniques applied within the field of modern biotechnology exclude the techniques used in traditional breeding and selection of plants and animals. The terms “genetic modification”, “genetic engineering” and “bioengineering” are synonyms for the term “modern biotechnology”. When dealing with modern biotechnology a number of abbreviations are frequently encountered. The most common of these include GM (genetically modified), GE (genetically engineered), GI (genetically improved) and GMO (genetically modified organism). A genetically modified organism (GMO) is an organism that contains a new or altered gene (University of California San Diego Centre for Molecular Agriculture and AfricaBio, 2002).

A number of biotechnology related terminology were mentioned in the section above on modern biotechnology. A gene is the biological unit of inheritance, made up of DNA that transmits inherited information and controls the appearance of physical, behavioural or biochemical traits of living organisms (Thomson, 2002). DNA is the complex molecule that makes up genes and chromosomes with the function to store

genetic information (Thomson, 2002). A chromosome is a structure composed of a long DNA molecule that carries inherited information (Thomson, 2002).

Within the three biotechnology generations numerous specific events occurred. In the following section, a time line of specific events within the global history of biotechnology is presented (Table 1.2):

Table 1.2 History of biotechnology

± 10 000 years ago	Agricultural revolution began (Thomson, 2002).
± 6 000 to 8 000 years ago	Native Americans in Mexico initiated the domestication and genetic improvement by traditional breeding techniques of teosinte, the ancestor plant of maize (Thomson, 2002).
Early 1900s	Plant breeders and farmers started to engage in more systematic crop improvements, by making simple crosses and producing hybrids from plants of the same species (University of California San Diego Centre for Molecular Agriculture and AfricaBio, 2002).
1922	First application of irradiation breeding to induce DNA changes that might be beneficial to farmers (University of California San Diego Centre for Molecular Agriculture and AfricaBio, 2002).
± 1950	Experiments started in order to cross different species by means of more sophisticated laboratory techniques. A new cereal called triticale was developed with these techniques by combining wheat and rye (University of California San Diego Centre for Molecular Agriculture and AfricaBio, 2002).
1967	The genetically modified potato variety (Lenape potato) was introduced to the USA food market (Uzogara, 2000).
1969	The USFDA removed Lenape potatoes from the US food market, following the discovery of the toxin Solanine in the product (Uzogara, 2000).
1972 – 1973	The development of rDNA techniques (Recombinant deoxyribonucleic acid techniques), which encompasses the manipulation of DNA in various ways and the transferring of the DNA from one organism to another in order to introduce characteristics of almost any organism to another plant, bacteria, virus or animal (Uzogara, 2000). This was considered as the defining breakthrough in modern biotechnology (Durant <i>et al.</i> , 1998).

Table 1.2 History of biotechnology (continued)

Late 1970s	Pharmaceutical and chemical companies got involved in modern biotechnology (Sharp, 1996; Clark, Stokes & Mugabe, 2002). The agricultural potential of modern biotechnology had a strong influence on the involvement of the chemical companies.
1980s	Methods were developed in the USA, West Germany and Belgium to create transgenic plants by means of a pathogenic bacterium (Uzogara, 2000).
1983 to 1989	More sophisticated recombinant DNA techniques were developed for the genetic transformation of plant and animals (Uzogara, 2000).
± 1983 onwards	The first of substantial biotechnology investments by large chemical and pharmaceutical companies (Sharp, 1996).
1990	Genetically modified rennet (used in cheese manufacturing) was approved in the US (Uzogara, 2000).
1993	The USFDA approved rBST (Bovine Growth Hormone) in dairy cows (Uzogara, 2000). RBST is a synthetic growth hormone, which induces increased milk production capacity in dairy cows.
1994	USFDA approved “Flavr Savr TM ” tomatoes in the US (Uzogara, 2000)
1995	“Flavr Savr TM ” tomatoes introduced to the USA market (Durant <i>et al.</i> , 1998)
1995/1996	Commercial introduction of <i>Bt</i> maize, cotton and potatoes (Thomson, 2002).
1996	“Roundup-Ready TM ” soybeans introduced to the USA market (Durant <i>et al.</i> , 1998).
1997	Cloning of Dolly the sheep (Durant <i>et al.</i> , 1998).
1998 to present	A vast number of further developments within the third generation of biotechnology.

1.2.3 A global overview of modern biotechnology in the agricultural sector

Numerous role players with varying roles are involved within the agricultural sector in the modern biotechnology arena. A number of the role players have a direct involvement in the development, implementation and regulation of agricultural modern biotechnology applications, including the scientific community, industry (including farmers), national governments and international institutions (Durant *et al.*, 1998). The public is an additional role player to consider. Public involvement in agricultural modern biotechnology is of an indirect nature as consumers, taxpayers, interest groups and individuals. In the process of biotechnology research the consideration of these role players are often neglected, which is all the more

significant when considering the fact that they will be the final consumers of the product.

There are numerous applications of modern biotechnology, as described in an overview of relevant literature by Engel, Frenzel and Miller (2002) and FEST (2002) including herbicide tolerance; insect resistance; virus, fungi and bacteria resistance; drought resistance; effects of metals; salinity effects; frost tolerance; higher yields; greater crop stability; control and minimisation of post harvest losses; reduction of losses of top soil and biodiversity; development of improved livestock vaccines; as well as improved sensory and nutritional qualities in food. It is evident that different modern biotechnology agricultural applications benefit different role players or combinations of role players.

From a farming perspective numerous farmers acknowledge the agronomic benefits and GM crops. Since the introduction of crops produced through modern biotechnology in the 1990s, the cultivation of GM crops became a worldwide phenomenon. According to the International Service for the Acquisition of Agri-biotech Applications (International Service for the Acquisition of Agri-Biotech Applications (ISAAA), 2004) 7 million farmers in 18 countries planted GM crops in 2003, which represented an increase from 2002 when 6 million farmers in 16 countries planted GM crops. The dramatic and steady increase in the global area under GM crops, for the period 1996 to 2003 can be seen in Figure 1.1.

During 2003, six countries (USA, Argentina, Canada, Brazil, China and South Africa) produced 99% of the total global modern biotechnology crop output (ISAAA, 2004). The GM crop cultivation of countries that planted 100 000 hectares or more during 2003, is displayed in Figure 1.2. The dominant role of the USA and Argentina is evident from Figure 1.2.

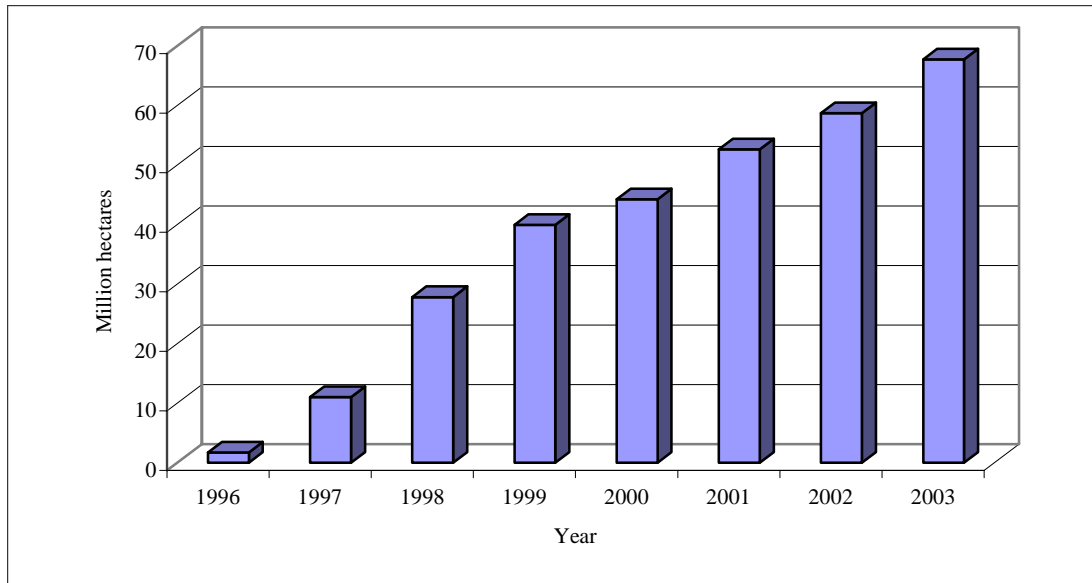


Figure 1.1 The global area under GM crops for the period 1996 to 2003
(James, 2003a, 2003b)

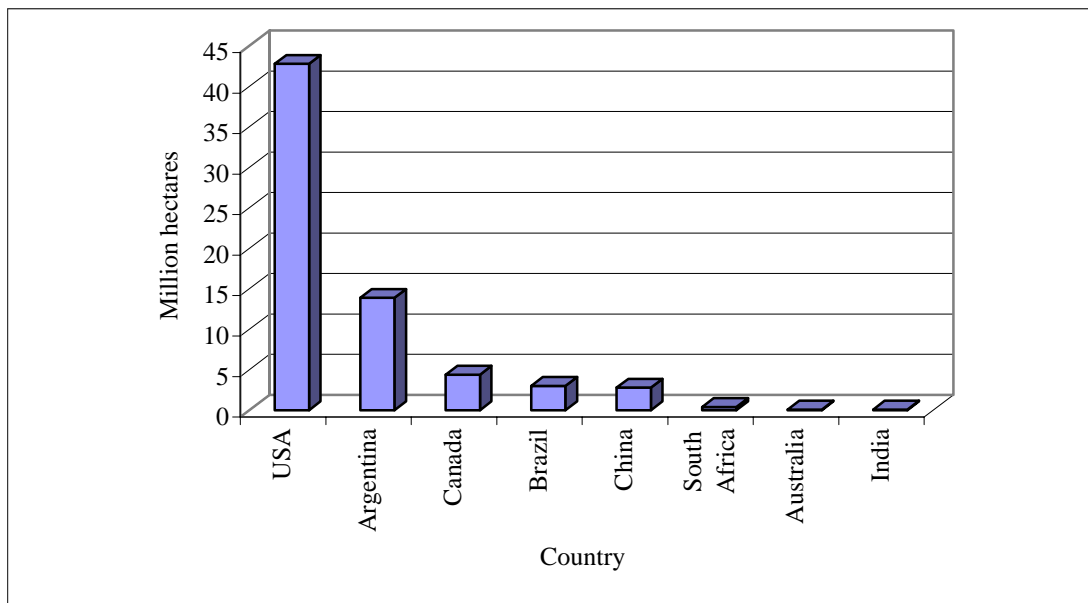


Figure 1.2 Cultivation of GM crops in countries planting 100 000 hectares or more during 2003
(James, 2003b)

1.2.4 Consumer reactions to GM food: An international perspective

The discussion on the global history of modern biotechnology and GM food revealed that, from a production perspective, farmers adopted certain GM crops due to the numerous agronomic benefits. However, consumer acceptance of, and reactions to GM foods varies greatly among countries. Numerous research studies were conducted in countries around the world to investigate various aspects regarding consumers' reactions and behaviour to GM food products. The results from some of these studies are discussed below, in order to present an overview of consumer perceptions and attitudes within different countries around the world.

European consumers react negatively towards GM food. An important contributing factor towards these negative reactions could be the consumers' general distrust in the safety of European food supply after incidents like the BSE (Bovine Spongiform Encephalopath or Mad Cow Disease) crisis and dioxins (Michel, 2003, reporting on a statement by Harry Kuiper a food safety researcher at the University of Wageningen). According to Bredahl (1999) consumers in Denmark, Germany, the United Kingdom and Italy associated the application of genetic modification with unnaturalness and low trustworthiness of the resulting products. Moral considerations were voiced as well. Research by Gaskell (2000) revealed that European consumers, especially those in Greece, Austria and Luxemburg, were opposed to GM foods, even though they were mostly neutral about agricultural biotechnology. Grunert, Bredahl and Scholderer (2003) confirmed the negative attitudes of European consumers towards GM food.

A study in the United Kingdom by Loader and Henson in 1998 indicated that 11% of the respondents would not try GM foods, while 42% indicated that they might still try the products, suggesting that UK consumer might not be so highly opposed to GM foods. However, Lusk, House, Valli, Jaeger, Moore, Morrow and Traill (2002) found that British and French consumers demanded much greater compensation to consume a GM food product than did consumers in the United States. According to research in the United Kingdom (UK) by the Food Standards Agency (FSA) (2003) concern about GM food decreased over the period 2001 to 2003. For many people consumer benefits from GM food remained unclear and unproven. The potential impact of GM

crops on the environment gave rise to most concerns. The safety of GM food was less of an issue, but suspicion and concern were still observed. In 2003, a major government-sponsored public debate in the UK regarding the commercialisation of GM foods and crops concluded that the public did not want genetically modified food and would not buy it (Heller, 2003).

A study that revealed more positive attitudes towards GM food in Europe was done by Noussair, Robin and Rufieux (2004) in France. The study revealed that 35% of the respondents were unwilling to purchase products made of GMOs, 23% were indifferent or valued the presence of GMOs and 42% were willing to purchase the products if they were sufficiently inexpensive.

In the Nordic countries (Denmark, Finland, Norway, Sweden) many studies reported negative attitudes toward GM foods (Magnusson & Hursti, 2002; Nordic Industrial Fund, 2000). Grimsrud, McCluskey, Loureiro and Wahl (2002) found that consumers in Norway wanted substantial discounts, like 49.5% for bread and 55.6% for salmon, in order for them to accept GM food products.

In general, numerous studies revealed that USA consumers generally revealed higher acceptance rates towards modern biotechnology and GM foods than consumers in other countries. However, evidence exists that the controversy surrounding GM food increased in recent years, manifested as consumer fears and concerns for the new technology (Lusk, Moore, House & Morrow, 2002). A national survey by the International Food Information Council Foundation (2001) revealed that roughly between 35% to 45% of American consumers were of the opinion that they have heard or read “a lot” or “some” about biotechnology. Hoban (1998) indicated that two-thirds of American consumers were positive about plant biotechnology, especially male respondents and respondents with more formal education. According to research by Hossain, Onyango, Schilling, Hallman and Adelaja (2003) consumer acceptance of food biotechnology increased considerably when the use of the technology brought tangible benefits for the public.

On the other hand a number of studies in the US revealed more negative consumer reactions to GM food. Chen and Chern (2002) found that consumers were willing to

pay a premium for non-GM food. According to research by Huffman, Shogren, Rousu and Tegene (2003) respondents discounted GM labelled food products by approximately 14% relative to their standard-labelled counterparts. In the same line Rousu, Huffman, Shogren and Tegene (2004) found that consumers are willing to pay less for food that contained genetically modified material. Thus, according to these results the consumers would rather pay more for non-GM food in order to avoid GM food, or require a discounted price for GM food in order to consider buying the GM food. It is important to note that despite the general view that USA consumers are more positive towards GM food than European consumers, there seem to be different consumer groups in the USA with varying attitudes towards GM food products.

Japanese consumers seem to have great difficulties in accepting GM products. According to Macer and Ng (2000) only a small majority of Japanese respondents, in the period 1997 to 2000, were in favour of GM technology and considered it as a means of improving the quality of life. Research by Nakamura and Tsuboi (2002) indicated that Japanese consumers revealed negative feelings against GM foods, despite the introduction of a mandatory labelling system. This suggests that the opportunity to make informed decisions about GM food products, did not make the Japanese consumers more positive about the GM food products.

The differences in the reactions of consumers to GM foods in the various countries influenced the reactions of food manufacturers and retailers. Food companies such as Marks and Spencer, McDonalds, Sainsbury and Tesco in the UK, Nestlé in Switzerland and the U.K., Unilever in the U.K., Carrefour in France, McCains in Canada and Frito Lay in the US, have moved towards only accepting and selling non-GM food products (Giannakas & Fulton, 2002; Chua, 2001). However, North American divisions of companies like Nestlé and Unilever have not dropped GM ingredients from their products (Chua, 2001).

1.2.5 Consumer reactions to GM food: An overview of the issues

Within the context of GM food, consumers around the world have expressed numerous fears and concerns. A vast quantity of literature (c.f. Hobbs & Plunkett, 1999; Lindner, 2000; Olubobokunl, Phillips & Hobbs, 2002; FEST, 2002; Food

Standards Agency, 2003) is available on these issues. This section provides a summary of the most important issues related to consumers and GM food:

- GM food safety concerns involve issues of new and enhanced health risks, the potential harmful effects of toxins, allergies, dangers due to nutrition changes, dangers of antibiotic resistance, unknown long-term consumption effects and other unexpected effects. Another component of the food safety issues related to GM food evolves around consumers' confidence in safety measures and trust in regulatory bodies.
- Uncertainty about the benefits of GM foods is problematic for many consumers. In this regard unclear and unproven consumer benefits (regarding aspects such as nutrition, quality and price) are relevant issues.
- Issues related to the environmental impact of GM food include the potential effects of GM crops on other living organisms in the same or near by environment. Examples of more specific environmental impact issues include adverse effects on biodiversity and the creation of invasive species. The unwanted passing of manipulated genes to other species is also considered as a consumer issue due to the effect it could have on choice between GM and non-GM food when dealing with GM "contaminated" food.
- The socio-economic issues related to GM food include consumer choice, consumer information and education, ethical and religious concerns and other socio-economic issues. Consumers want to be able to make informed choices between GM and non-GM food. An important implication of this issue is the need for the labelling of GM food products. Consumers also want easy access to reliable and unbiased information on GM food. This aspect is linked to the issue of consumer choice, since better information could contribute towards improved decision-making. Important ethical concerns include issues such as concerns regarding human beings tampering with genetic material, concerns regarding how far genetic modification might be taken in the future as well as concerns regarding the acceptability of transferring genes from animals to plants. Other socio-economic issues include fears of multinational companies controlling food production in developing countries, globalisation issues, trade issues, income inequality and intellectual property rights.

1.3 AGRICULTURAL MODERN BIOTECHNOLOGY IN SOUTH AFRICA

Within this section the background focus will be narrowed, by considering only South Africa. The discussion within this section starts off with the historical development of agricultural modern biotechnology in South Africa, after which the role of the South African government in GM food issues, as well as the South African situation regarding GM food information are discussed.

1.3.1 The historical development of modern agricultural biotechnology in South Africa

Section 1.2.2 described the history of modern biotechnology within the global context. In order to provide an adequate background for this study, an overview of modern biotechnology in the South African agricultural sector is presented in this section.

According to AfricaBio (2003), a non-governmental organisation (NGO) in favour of modern biotechnology, South African has been involved with biotechnology research and development for more than 25 years. There are more than 500 biotechnology projects in South Africa within various sectors. An estimated 45 South African companies are using biotechnology in food, feed and fibre application. South Africa is heavily dependent on imported modern biotechnology applications.

The importance of GM foods in South Africa is increasing (Aerni, 2002), even though the development of the GMO issue lags behind many other (often more developed) parts of the world. South Africa is the only country in Africa growing legally sanctioned commercial GM crops. Currently the genetically modified crops that have been approved for commercial production in South Africa are herbicide-tolerant soya-beans, cotton and maize, as well as insect-resistant cotton and maize (FEST, 2002; AfricaBio, 2003). The estimated areas planted to GM crops in South Africa are shown in Table 1.3. The increasing importance of genetically modified white maize is evident from the table.

Table 1.3 The estimated areas planted to GM maize and soya bean crops in South Africa for the period 1999/2000 to 2002/2003

	1999/2000 (hectares)	2000/2001 (hectares)	2001/2002 (hectares)	2002/2003 (hectares)
Bt Yellow Maize	50 000	75 000	160 000	197 000
Bt White maize	0	0	6 000	55 000
Roundup Ready Soya Beans	0	0	6 000	15 000

(Gouse, 2004)

No genetically modified fruits and vegetables are available on the South African food market. The fresh produce varieties currently available on the South African food market have been genetically enhanced by means of traditional breeding programs. Currently genetically modified food ingredients could be found in a variety of food products on South African shelves, including chickens, meat, milk, eggs and processed foods containing soya such as ice cream, burgers and fish paste (Burger, 2002). Table 1.4 displays some of the most important events related to modern biotechnology in South Africa.

Table 1.4 The most important events related to modern agricultural biotechnology in South Africa

Date:	Event:
Early 1970s	Establishment of the South African Committee for Genetic Experimentation (South African Committee for Genetic Experimentation (SAGENE)) (Thomson, 2002)
1992	The first field trials with genetically modified crops were approved (Aerni, 2002)
1997	The Genetically Modified Organisms Act (Act 15 of 1997) was passed (AfricaBio, 2003)
1997	The first conditional commercial crop releases commenced in South Africa (Aerni, 2002)
1997	Insect tolerant cotton approved in South Africa (AfricaBio, 2003)
1997/1998 season	Bt cotton production in South Africa commenced
1998	Insect tolerant maize approved in South Africa (AfricaBio, 2003)
1998/1999 season	Bt yellow maize production commenced in South Africa
1 December 1999	The Genetically Modified Organisms Act (Act 15 of 1997) was implemented (AfricaBio, 2003)
2000	Herbicide tolerant cotton approved in South Africa (AfricaBio, 2003)
2001	Herbicide tolerant soya-beans approved in South Africa (AfricaBio, 2003)
2001/2002 season	Herbicide tolerant cotton were distributed for commercial production in South Africa (AfricaBio, 2003)
2001/2002 season	A limited quantity of herbicide tolerant soya-bean seed were released for commercial production in South Africa (AfricaBio, 2003)
2001/2002 season	Bt white maize production commenced in South Africa (AfricaBio, 2003)
2002/2003 season	First season of large-scale Bt white maize production in South Africa (AfricaBio, 2003)
2003/2004 season	A limited quantity of herbicide tolerant maize seed were commercially released in South Africa (Gouse, 2004)
16 January 2004	The regulations related to “The labelling of foodstuffs obtained through certain techniques of genetic modification” were published as G.N. No. R.25 in the Government Gazette No. 25908 (Jansen van Rijssen, 2004)

1.3.2 The role of government in modern biotechnology in South Africa

The strategic intent of the South African government with respect to biotechnology is contained within the National Biotechnology Strategy of South Africa, which was adopted by Cabinet in March 2002 (Patterson, 2004). This followed a number of events including the consideration of the National Biotechnology Strategy by Cabinet in July 2001, the public consultation process from September 2001 to November 2001 and the public consultation review in February 2002. The objectives of the National Biotechnology Strategy relates to the following aspects (Patterson, 2004):

- Stimulating the development of biotechnology skills, capacity and tools.
- The role of Government in the development of biotechnology (legal framework, funding mechanisms, new infrastructure, new institutional arrangements and the development of research capacities).
- Bridging the “Innovation Chasm”.
- Public understanding.
- Responsible use of biotechnology.

The regulation of genetically modified organisms is an important task of government. The National Departments of Agriculture and Health regulate genetically modified organisms in South Africa. The regulation of genetically modified organisms in South African began with the establishment of the South African Committee for Genetic Experimentation (SAGENE) in the early 1970s as an advisory body to develop guidelines for the safe use of GM bacteria in laboratories and for work with all GMOs (Thomson, 2002). Initially the SAGENE handled all requests for permission to carry out laboratory, glasshouse or field trials with GMOs. Due the increased work volumes, SAGENE members started to collaborate with outside experts by means of *ad hoc* sub-committees. SAGENE had no legislative power to enforce compliance with their guidelines. The National Department of Agriculture (NDA) issued permits for GMO work under the Pest Control Act of 1983, enforced and monitored conditions under which GMO trials were conducted.

In South Africa biosafety is overseen under the Genetically Modified Organisms Act, 1997 (Act No. 15 of 1997) together with the GMO Regulations. The Act was passed

in 1997 and implemented on 1 December 1999. The objectives of the GMO Act are to provide safety measures, protect the environment and establish acceptance standards for risk assessment regarding the application of biotechnology in South Africa (AfricaBio, 2003). The GMO Act comprehensively addresses measures to promote the responsible development, production, use and application of GMOs within the country. The combination of the GMO Act, the National Environmental Management Act (NEMA) and other acts, provides the principles for environmental precaution, responsibility and liability (AfricaBio, 2003). According to the GMO Act all facilities involved in the development of GMOs must register with the NDA and obtain permits for greenhouse, industrial scale-up, field and clinical trials, imports, exports and commercial releases of any living GMO. Import and export of commodity grains and animal feeds are also covered in the GMO Act. Under the GMO Act, three South African biosafety structures were formed with the responsibility to regulate all relevant components of GMOs within South Africa (Thomson, 2002), namely the Executive Council, the Registrar and Inspectorate as well as the Scientific Advisory Committee.

1.3.3 Consumer information and GM food in South Africa

The South African Bill of Rights, which is a cornerstone of the Constitution, describes the eight internationally recognised consumer rights of South African citizens (DTI, 2004). The first consumer right is the right to satisfaction of basic needs, according to which consumers should have access to basic goods and services such as adequate food, clothing, housing, health care, education, clean water and sanitation. The second consumer right is the right to safety, stating that consumers should be protected against production processes, products and services that are dangerous to health or life. The third consumer right is the right to information. Thus, consumers must be provided with the facts needed to make informed choices and they have to be protected against dishonest or misleading advertising and labelling. The fourth consumer right involves consumers' right to choice, since consumers should be able to choose from a range of products and services, offered at competitive prices with an assurance of satisfactory quality. The right to representation states that consumers' interests should be represented in the making and execution of government policy, and in the development of products and services. The sixth consumer right is the right

to redress. Consumers must receive a fair settlement of just claims, including compensation for misrepresentation, or unsatisfactory goods or services. The right to consumer education states that consumers need to acquire knowledge and skills needed to make informed and confident choices about goods and services, while being aware of basic consumer rights and responsibilities and how to act on them. The eighth consumer right is the right to a healthy environment, according to which consumers should live and work in an environment that is not threatening to the well being of present and future generations. Many of these consumer rights are relevant to the consumer issues surrounding GM food, as discussed earlier.

Labelling of food obtained through genetic modification techniques is another important regulatory issue. In South Africa labelling issues are generally addressed within the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act No. 54 of 1972), which deals with food safety, nutrition and processed foods. The specific regulation related to “The labelling of foodstuffs obtained through certain techniques of genetic modification” was published as G.N. No. R.25 in the Government Gazette No. 25908 on 16 January 2004. The Act and additional regulations are enforced by the Department of Health. The specific regulation specifies the labelling of foodstuffs obtained through certain techniques of genetic modification:

- Must comply with the general labelling regulations in terms of the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act No. 54 of 1972).
- Is mandatory when there are differences in composition, nutritional value and method of storage or preparation.
- Must indicate the presence of allergens.
- Must indicate human or animal origin of the novel gene.
- May indicate the method of production (modern biotechnology) when foods have enhanced or improved characteristics. (This is subject to validation, certification and wording.)
- Is not required regarding food from animals fed with GM-feed.
- Is not required where there are no significant differences in characteristics of the foods.

(Jansen van Rijssen, 2004)

1.4 MAIZE CONSUMPTION IN SOUTH AFRICA

In the discussion on the history of modern biotechnology in South Africa, the importance of GM maize in the South African context was mentioned. Since GM maize was selected as the focus product within this research, an overview of maize consumption in South Africa is presented in this section.

Maize is the most important grain crop in South Africa due to the importance of the crop as a staple food product and an important feed grain. White- and yellow maize are produced, with the area planted to white maize estimated at 86% of the total maize area of 3 000 410 hectares during the 2003/2004 production season (Crop Estimates Committee, 2004).

Within the South African context white maize is primarily produced for human consumption, while yellow maize is primarily utilised as animal feed. These observations are evident from Figures 1.3 and 1.4 where the commercial maize food and animal feed consumption of white and yellow maize, for the period 2001/2002 to 2004/2005 are presented. During the period 2001/2002 to 2004/2005 the average human white maize consumption was 3.8 million tonnes per annum, while the average yellow maize animal consumption was 3.141 million tonnes per annum. Research by Steyn and Labadarios (2000) found that maize is among the five most commonly consumed foods among children in South Africa (along with white sugar, tea, whole milk and brown bread).

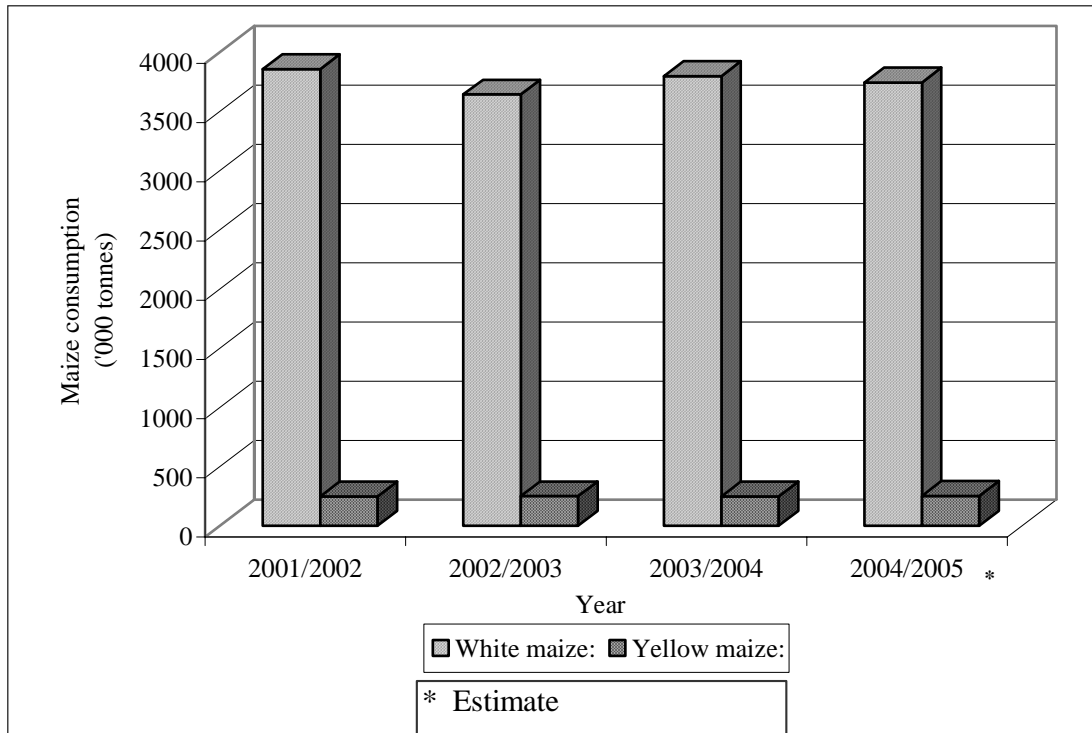


Figure 1.3 Commercial maize consumption (human) 2001/02 to 2004/05
 (Grain South Africa & South African Grain Information Service (SAGIS), as reported by Grain SA, 2004)

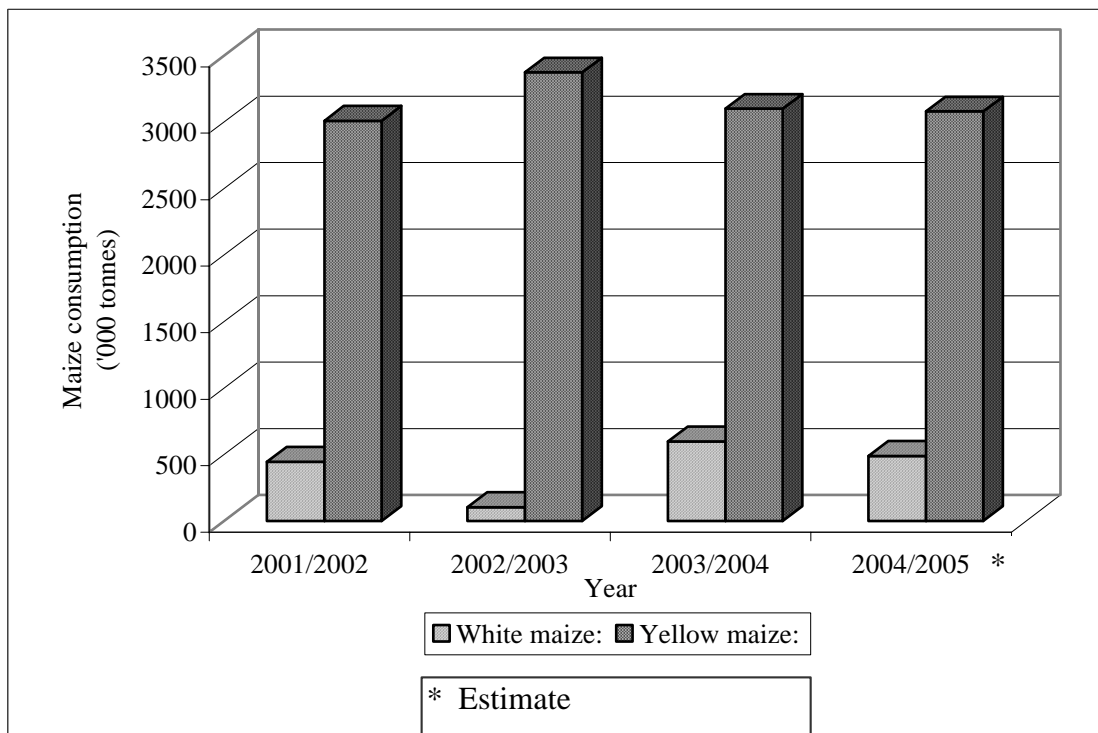


Figure 1.4 Commercial maize consumption (animal feed) 2001/02 to 2004/05
 (Grain SA & SAGIS, as reported by Grain SA, 2004)

In South Africa, white maize is mainly consumed as maize meal based food types. There are four maize meal types dominating the maize meal market: super-, special-, sifted- and unsifted maize meal. According to the National Chamber of Milling estimate that about 40 percent of all the maize meal sold in the SA market is super maize meal and this percentage is increasing, while special maize meal sales make up about 30% of total sales. The choice of super maize meal in the experiment was based on the National Chamber of Milling estimates, due to the more recent nature of the information.

There are different extraction rates for these maize meal types, as indicated in Table 1.5 below. Although an extraction rate of 62.5% is reported for super maize meal, some industry specialists regard this figure as “conservative”.

Table 1.5 Extraction rate of various maize meal types

Maize meal type:	Extraction rate:
Super maize meal	62.5%
Special maize meal	78.7%
Sifted maize meal	88.7%
Unsifted maize meal	98.7%

(National Chamber of Milling, 2003)

The various types of maize meal have to adhere to specific technical regulations according to the Maize Products Regulations (No. 792, 27 April 1984), last revised Regulation No. 1739 of 17 September 1993. The technical requirements for the various maize meal types are summarized in Table 1.6.

Table 1.6 The South African technical requirements for super-, special-, sifted- and unsifted maize meal according to the Maize Product Regulations (No. 1739, 17 September 1993)

	Maize meal type:			
	Super	Special	Sifted	Unsifted
Maximum fat content by mass	< 2.0%	≥2.0% ≤3.0%	≥3.0% ≤4.0%	≥3.5% ≤4.5%
Maximum fibre content by mass	0.8%	1.2%	1.2%	≥1.2% ≤2.5%
% that should pass through 1.4mm sieve	≥90%	≥90%	≥90%	≥90%
% that should pass through 300µm sieve	<90%	Not specified	Not specified	Not specified

On the 7th of October 2003 it became law in South Africa that all maize meal must be fortified as set out in the regulation R7634 dated 7 April 2003 on the fortification of certain foodstuffs as promulgated in the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act no 54 of 1972).

Brand awareness is generally important for maize meal consumers in South Africa. At the national level 89% of the respondents in the National Food Consumption Survey were aware of the brand name of the maize they consumed (MacIntyre & Labadarios, 2000). According to Maunder and Labadarios (2000) and representatives of the National Chamber of Milling (2003), the most important maize meal brands in South Africa is:

- Ace (manufactured by Tiger Brands).
- Iwisa (manufactured by Premier Foods).
- Impala (manufactured by Premier Foods).
- Induna (manufactured by Tiger Brands).
- Super Sun (manufactured by Pioneer Foods – SASKO).
- Tafelberg (manufactured by Ruto Mills).

According to the “Markinor Brands Study” released in October 2003, Premier Foods was strongly positioned in all South African consumers’ minds. Two of Premier

Foods' maize meal brands featured in this study: Iwisa (position number 4) and Impala (position number 9) (Premier Foods, 2004). Table 1.7 shows the market share of the white maize millers in South Africa.

Table 1.7 Market share of the major white grain maize millers in South Africa

Maize miller:	Market share:
Premier	27.0%
Tiger Milling Company	20.0%
Pioneer Foods - (SASKO)	18.0%
OTK	10.0%

(Competition Commission, 2003)

Based on the results of the Markinor study and the information in Table 1.6, Iwisa maize meal was used in this research project.

The Department of Health published a report in 2002, written by J.H. Nel and N.P. Steyn, entitled "Report on South African food consumption studies undertaken amongst different population groups (1983 – 2000): Average intakes of foods most commonly consumed". The research was commissioned by the Directorate: Food Control of the Department of Health and funded by the World Health Organization. Some of the data within the report was used to compile a profile of the most important starch-type food consumption patterns of rural and urban South Africans in terms of various age groups (1 to 5 years, 6 to 9 years and 10 years and older) in order to illustrate the importance of maize. Figures 1.5 and 1.6 relate to rural people in South Africa. Figure 1.5 displays the consumption patterns of the most important starch-type foods by rural South African people, in terms of the percentage of consumers within the sample age group that consumed the starch based food product. Figure 1.6 displays the consumption patterns of the most important starch-type foods by rural South African people, in terms of the average daily consumption quantities for the respondents that consumed the starch based food product.

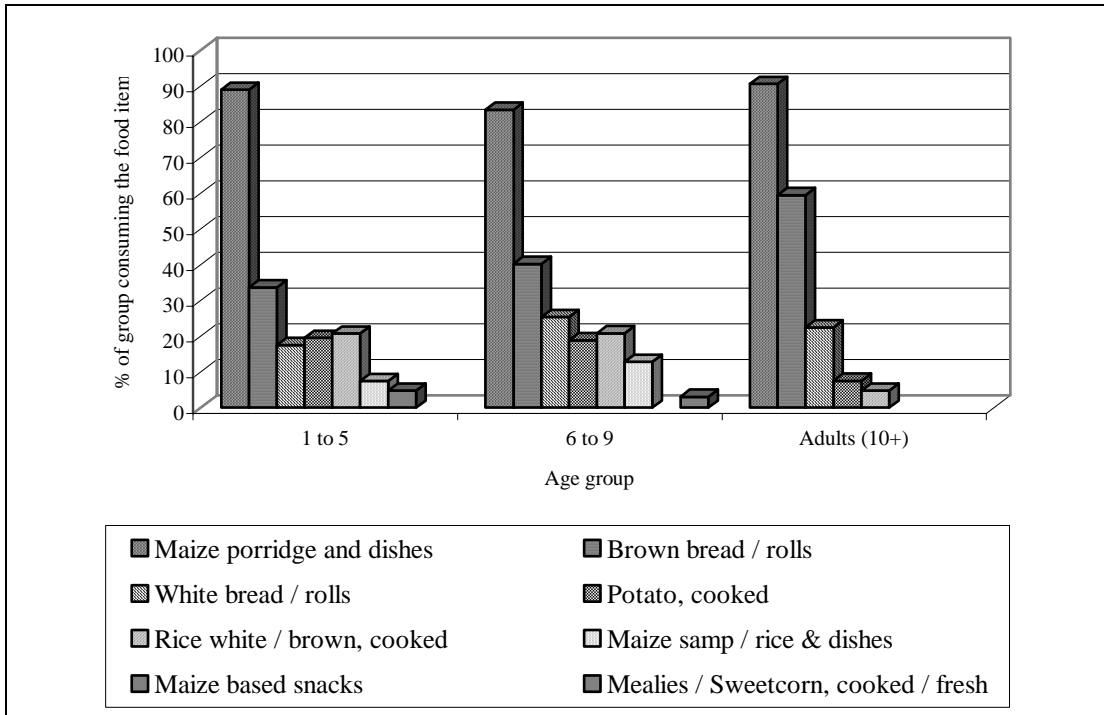


Figure 1.5 Starch food consumption of different age groups within rural areas of South Africa: Percentage of the various age groups consuming the different food items (Nel & Steyn, 2002)

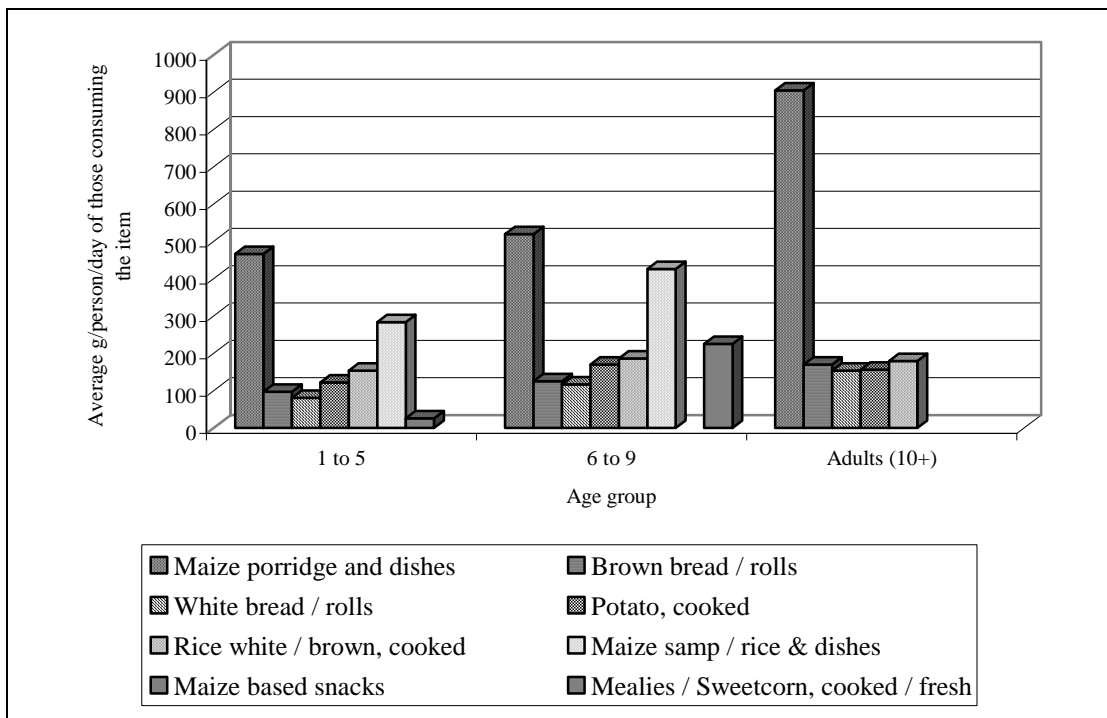


Figure 1.6 Starch food consumption of different age groups within rural areas of South Africa: Average consumption (grams) per person per day of those people consuming the food item (Nel & Steyn, 2002)

Figures 1.7 and 1.8 relate to urban people in South Africa. Figures 1.7 and 1.8 display the consumption patterns of the most important starch-type foods by urban South African people, in terms of the percentage of consumers within the sample age group that consumed the starch based food product and in terms of the average daily consumption quantities for the respondents that consumed the starch based food products.

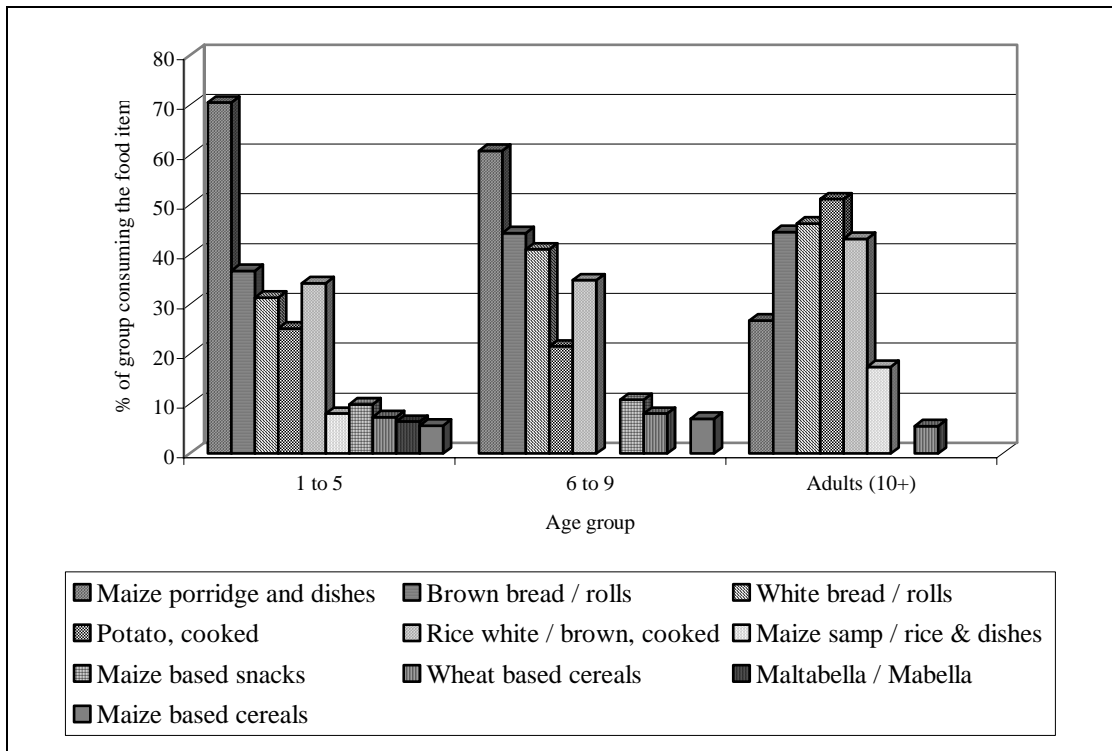


Figure 1.7 Starch food consumption of different age groups within urban areas of South Africa: Percentage of the various age groups consuming the different food items

(Nel & Steyn, 2002)

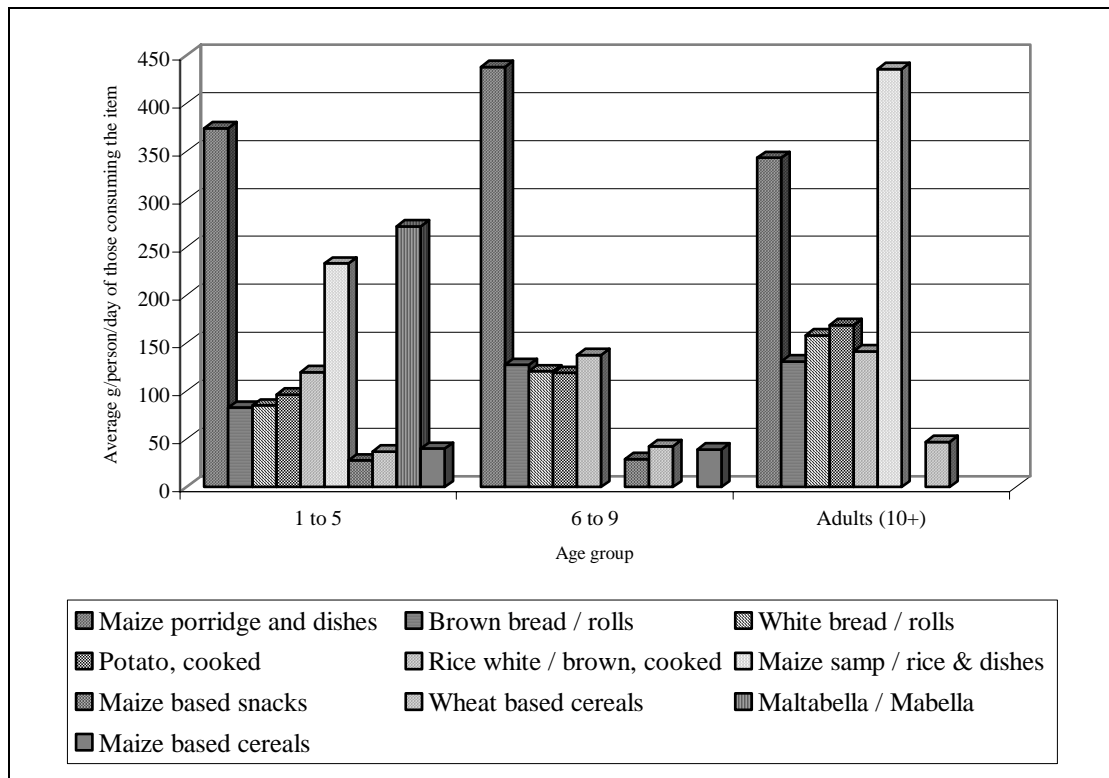


Figure 1.8 Starch food consumption of different age groups within urban areas of South Africa: Average consumption (grams) per person per day of those people consuming the food item
(Nel & Steyn, 2002)

According to the Department of Health report, maize porridge consumption is more prominent in rural areas, compared to urban areas. A large number (98%) of consumers in rural areas consumed maize porridge, compared to 71% of the consumers in the urban areas consumed maize porridge. Portion sizes of maize food types were substantially higher in rural areas. Amongst rural consumers maize porridge and dishes were a dominating food source in all age categories. Other less important starch type foods included brown bread, white bread, cooked potato and rice. It is evident from the graphs that the starch type food consumption patterns of urban consumers are more diverse. For these consumers bread, potatoes and rice are also important food sources.

Makwetla International Communications and Fleishman-Hillard (2002) developed a classification system of South African consumers as part of the communication

strategy for the National Food Fortification Programme. The basis for the classification system was the LSM (Living Standard Measure) classification system developed by the South African Advertising Research Foundation (SAARF). The SAARF LSM is a type of market segmentation tool based on wealth, access and geographic indicators (SAARF, 2004). There are ten market segments within the SAARF LSM classification, with increasing levels of wealth and access as the LSM category number increases. LSM groups 1 to 3 are rural consumers and LSM groups 4 to 10 are urban consumers.

The classification developed by Makwetla International Communications and Fleishman-Hillard identified three groups. The first group was named the “Variety diet users”. They live in urban areas and can be classified within LSM groups 7 to 10 (22.3% of the South African population within the LSM classification according to SAARF, 2004). The consumers within this group have access to a balanced diet and consume maize meal and / or bread as dietary variety. For this group the consumption of maize meal and / or bread is not focused to counter hunger. The second was named the “Staple users”. They live in urban and peri-urban areas and can be classified within LSM groups 4 to 6 (41.9% of the South African population within the LSM classification according to SAARF, 2004). Consumers within this group use maize meal and / or bread as a staple within a reasonably balanced diet. Maize meal and / or bread form the cornerstone of the staple users’ diet. The third group was named the “Survival users”. They live mostly in rural areas, but also in peri-urban and urban areas. They can be classified within LSM groups 1 to 3 (35.8% of the South African population within the LSM classification according to SAARF, 2004). Consumers within this group rely almost entirely on maize meal and / or bread for their survival.

It can be concluded that maize, especially in the form of maize meal, is an extremely important staple food source for rural consumers of all age groups of a very low to middle income in South African consumers. Furthermore it was shown that even for higher income consumers, maize meal forms part of their food consumption as a component of a varied diet.

1.5 A REVIEW OF CONSUMER STUDIES ON GM FOOD IN SOUTH AFRICA

Some research has already been conducted on the subject of consumers' perceptions and acceptance towards GM food products in South Africa. The background to these studies is discussed followed by the main finding.

In 2002 the Pretoria Technicon conducted a survey on behalf of AfricaBio (AfricaBio, 2002). The objectives of this personal interview survey were to assess how much consumers knew about genetically modified foods (gene technology) and to see how they can be informed and educated. The survey targeted 1022 urban respondents in 14 areas within the Pretoria-Sandton area (Gauteng Province) from different age groups, professions, cultures and religions. The results were representative of the Gauteng demographics.

FEST commissioned a survey in October 2001 (Joubert, 2002). The objectives of the study were to determine public knowledge about and understanding of genetically modified foods and to review public attitudes about the usefulness of the technology, its acceptability to consumers and whether or not consumers thought the technology should be encouraged. In total 1000 respondents, aged between 16 and 60 years, living in major metropolitan areas across the country participated in the survey.

During 2003 the Department of Consumer Sciences at the North West University conducted a focus group research study (Kempen, Scholtz & Jerling, 2004). The objectives of the study were to investigate knowledge and perceptions of GM food and food products in the context of consumers' understanding. The research subjects consisted of men and women, who were academic staff, administration staff, students, contract workers from the North West University's Potchefstroom campus.

CropBiotech (2004) conducted a public phone-in pole during May 2004, to assess the South African public's acceptance of the safety of foods derived from GM crops.

Pouris (2003) conducted a multi-criteria survey to examine among other things, trust in science and technology, the public's opinions of biotechnology and the public's knowledge of the field.

Between August 2003 and January 2004 a survey was conducted under the auspices of the University of Pretoria involving 2000 urban consumers in Pretoria, Johannesburg and Cape Town to assess consumer knowledge of GM foods (AfricaBio, 2004). The survey involved a combination of personal interviews and self-completed questionnaires.

Key findings from these studies will be discussed according to a number of categories: Exposure to GM food products and information, understanding of issues such as GM food and modern biotechnology, consumers and GM food information and education, GM food labelling and consumer reactions to GM food.

1.5.1 Exposure to GM food products and information

Low levels of awareness and exposure to GM food products and information were revealed in most of the studies. According to the 2002 AfricaBio study only 27% of respondents knew about GM food. These low awareness levels were confirmed by Joubert (2002) since he found that only 27.4% of the respondents were familiar with the term "genetically modified foods" and also by Kempen *et al.* (2004). It is interesting to note that the AfricaBio study conducted in 2004, indicated that 55% of the Gauteng respondents have heard about biotechnology, which is much larger than the 27% revealed in the 2002 AfricaBio study. This could suggest that the GM food awareness of the Gauteng urban consumers increased from 2002 to 2004. Furthermore, the 2004 AfricaBio study indicated that 59% of the Gauteng consumers knew about the use of biotechnology for the development of new drugs (versus 64% of the Cape Town consumers), 56% for fibres and plastics (versus 67% of the Cape Town consumers) and 65% for the development of new crop varieties (versus 82% of the Cape Town consumers). Thus, in general the Cape Town consumer revealed higher levels of awareness and exposure to GM food products and information than the Gauteng consumers.

1.5.2 Understanding of GM food issues

Consumers in the various studies generally revealed a lack of understanding and misconceptions regarding GM food issues. Joubert (2002) showed that only 7% of the respondents in the specific survey thought they understood biotechnology or GM, and could explain it to a friend. The 2004 AfricaBio study revealed that 37% of the respondents indicated that “biotechnology” was about the genetic modification of plant genes, while the remaining 63% of the respondents did not know or gave the wrong answer to the question.

1.5.3 GM food information and consumer education

In terms of the availability of information regarding GM food, only 4% of the respondents in the 2002 AfricaBio study felt that enough information was available on the subject. Kempen *et al.* (2004) revealed that a lack of knowledge and understanding caused consumer fears and misconceptions about GM food. The importance of consumer education was identified. AfricaBio (2002) and Joubert (2002) concluded that there was a great need for consumer education regarding biotechnology and that consumer education (with balanced scientific information on the subject of GM food in South Africa), distributed through the correct media, was crucial. However, due to the general absence of balanced scientific information on the subject of GM food in South Africa, Joubert (2002) identified the risk that the public could rapidly turn against genetically modified food, similar to what has happened in Europe.

According to Pouris (2003) the South African public is relatively trusting of television and the press. However, consumers in the 2004 AfricaBio study preferred to get GM food information from the professional biotechnology industry (47%) and dieticians or nutritionists (36%) and considered information from the biotechnology industry as more credible than information coming from biotechnology activists. The respondents in the 2002 AfricaBio study indicated that their preferred GM food information sources were nutritionists (32%), professional biotechnology organisations (31%), government (17%) and industry (15%).

1.5.4 Regulatory aspects of GM food

The 2004 AfricaBio study revealed the 52% of the respondents had trust in the government control systems, while 32% of the respondents were worried about inadequate control.

1.5.5 Labelling of GM food

More than 60% of the respondents in the study by Joubert (2002) agreed that GM foods should be specially and clearly labelled. The study identified the importance of GM food labelling in giving consumers the ability to make informed choices and stated that the labelling of GM food was a critical factor towards establishing consumer trust. Pouris (2003) confirmed that GM food labelling was important for the South African public.

According to the 2004 AfricaBio study 70% of respondents indicated that they would continue to buy GM foods if they were labelled. During the 2002 AfricaBio study only 32% of Gauteng respondents said they would buy labelled GM food. Thus, the willingness of the Gauteng respondents to buy GM food seemed to have increased from 2002 to 2004.

1.5.6 Consumer reactions to GM food

According to Joubert (2002) many South African consumers have not formed opinions yet about whether or not they would buy GM foods and products or if they agree with the use of modern biotechnology to produce food. The study also revealed that many South Africans supported the idea of using modern biotechnology to improve nutritional value and the taste of food, since approximately 40% of the respondents were positive towards the use of modern biotechnology for these purposes, while 41.7% were unsure and only 18.4% disagreed that it should be encouraged.

The general approval of GM foods by South African consumers was also found in other studies. The public phone-in pole (CropBiotech, 2004) revealed that 58% of

South Africans were in favour of GM food. Pouris (2003) indicated that even though South African consumers generally approved the production and consumption of GM foods, less than 25% of the South African public were willing to pay more for non-GM food, while 40% were indecisive.

According to Kempen *et al.* (2004) the consumers in the survey had diverse opinions about GM food, but there were certain fundamental consumer issues and concerns about GM food.

The 2004 AfricaBio study revealed relatively high levels of support for GM food among South African consumers, despite the existence of inadequate knowledge and misconceptions. Sixty five percent of the respondents did not object to the purchase of GM food products. However, 55% of the respondents had ethical and moral objections against the applications of genetic modification to animals, while only 37% revealed these objections regarding GM plants.

1.6 PROBLEM STATEMENT

Consumers make food choices on a daily basis. These choices could lead to either product acceptance or product rejection. From a producer perspective it could be an advantage to have knowledge of consumers' decision-making processes related to food and the factors affecting these processes (Marshall, 1995). Consumer acceptance is a critical factor for the success of products within the market place especially when dealing with new product development and introduction. Consumer acceptance could lead to purchases or even repeat purchases, which could eventually produce profits. A better understanding of consumer perceptions, attitudes towards and acceptance of GM food products, could enable producers and scientists to engage in more consumer driven product development and marketing activities. Consumer perceptions, attitudes and consequently market acceptance could play a more important role in companies' research and development processes worldwide. Increased understanding of consumer behaviour and reactions regarding GM food could assist decision makers in industries and governments towards the development of appropriate market communication strategies.

With the introduction of GM food to the food market, consumers were faced with a number of new products and also familiar products containing new ingredients. The global controversy with regard to consumers' reactions to GM food was discussed earlier. Amongst other things, the discussion revealed the negative nature of consumer perceptions and attitudes towards GM food in many countries. Negative consumer perceptions and attitudes regarding GM foods are often deeply rooted and resistant to change even when consumers are provided with more information regarding the GM foods to enable them to make better-informed decisions (Grunert, Bech-Larsen, Lähteenmäki, Ueland & Åström, 2002). Such negative perceptions and attitudes have been shown to influence the buying intentions of consumers towards GM food products (Heller, 2003; Noussair *et al.*, 2004).

At present consumer attitudes, perceptions and acceptance towards the use of genetically modified foods or -food ingredients are a highly relevant issue all over the world (Grunert *et al.*, 2003). Positive consumer perceptions and attitudes and consequent acceptance of GM products have become fundamental factors influencing the future success of the global market for GM foods, the future course for private and public investments in the development and use of GM technology, the future development of agricultural biotechnology, as well as the returns to all the investment in GM technology up to date.

The specific research problem of this research project evolves around urban consumers of white maize in South Africa. The production of GM food is a relatively recent event within the South African context. As mentioned earlier, the first commercial cultivation of genetically modified white maize only commenced in the 2001/2002 production season (Gouse, 2004). However, the commercial cultivation of genetically modified white maize increased dramatically from 6 000 hectares in the 2001/2002 production season to 55 000 hectares in the 2002/2003 production season (Gouse, 2004). The implication of the drastic increase in the cultivation of genetically modified white maize is that the product is entering the South African food market at an increasing rate. The reality is that South African consumers are increasingly exposed to food products containing genetically modified white maize.

1.7 MOTIVATION AND RESEARCH QUESTION

South African research on consumers and GM food produced a lot of valuable information. The most important results from these studies included the following aspects:

- South African consumers have low levels of knowledge, understanding and awareness regarding GM food issues.
- Fears and misconceptions exist among South African consumers regarding general- and food related issues of genetic modification.
- Many consumers in South Africa have not formed opinions about GM food issues yet.
- South African consumers are generally positive about GM food, especially when consumers receive the benefit from the genetic modification.
- There is a great expectation among South African consumers for labelling of GM food products, as well as information and education on GM food issues.

Despite the fact that valuable information was produced by the research discussed, a vast amount of information is needed in order to understand South African consumers' awareness, perceptions, attitudes and acceptance towards GM food products. Similar to the global situation of consumers and GM food, positive consumer perceptions and attitudes and consequent acceptance of GM food products could be fundamental factors influencing the future success of GM foods in South Africa. Better understanding of consumers' perceptions, attitudes and behaviour regarding GM food could be to the benefit of numerous role-players within the modern biotechnology industry, agricultural industry and food industry in South Africa. Some of the most important role-players who could benefit from information regarding consumer behaviour and GM food include:

- Food companies could use the information to make decisions on whether or not to introduce GM food products and to compile appropriate marketing strategies if these products are chosen.

- Retailers could use the information to make decisions on whether or not to sell GM food products and to compile appropriate marketing strategies if these products are sold.
- Biotechnology companies could use the information when making decisions regarding future investments, so that consumer driven biotechnology could be developed. These companies can also use the consumer information in the formulation of their marketing strategies.
- Farmers could use the information to make decisions on whether or not GM food crops will be planted in order to be a consumer driven producer.
- Government and other relevant role-players could use the information when making decisions on GM food, planning investment, compiling policies and when designing consumer education strategies.

A number of research opportunities were identified after considering the existing research on consumers and GM food in the South African context. Most of the current research considered South African consumers on the aggregate level and consequently a need was identified to identify groups of consumers with similar perceptions, attitudes and behaviour towards GM food. A need was also identified to estimate consumers' willingness to pay within the GM food context. The final research opportunity that was identified, was the need to look specifically at consumers' reactions to GM maize, since maize is such an important staple food product within the South African context.

Within the context of South African GM white maize a number of consumer questions need to be addressed. What is the nature of consumers' knowledge, perceptions, attitudes and acceptance towards GM food products and specifically GM maize? What is South African consumers' willingness to pay for non-GM white maize products? Which market segments exist with respect to South African white maize food products, given the presence of GM white maize in the food market? By studying some of these issues a contribution could be made towards addressing the problem of inadequate information regarding the awareness, perceptions and attitudes of South African consumers towards GM food products. Consequently various industry role-players could use the information towards the accomplishment of consumer-driven research, development and marketing activities.

1.8 HYPOTHESES

The following hypotheses were tested within this study:

- The majority of urban maize meal consumers prefer branded white-grained maize meal to non-branded white-grained maize meal.
- The majority of urban white-grained maize meal consumers prefer maize meal which is free of GM maize, by revealing a willingness to pay a premium for maize meal that is free of GM maize relative to maize meal containing GM maize, especially among higher income consumers.
- When facing a choice between white-grained maize meal containing GM maize that was modified for consumers' benefit versus producers' benefit, the majority of South African urban consumers will prefer maize meal manufactured from maize that was genetically modified for purposes of consumer benefit (such as increased nutritional value) by revealing a willingness to pay a premium for this type of maize meal as opposed to maize that was genetically modified for purposes of producer / farmer benefit.
- The South African urban consumer market for white maize meal can be divided into discreet market segments based on their preferences for branded- versus non-branded white-grained maize meal, as well as their preferences for non-GM white maize meal versus GM white maize meal with various types of genetic manipulations benefiting the consumer and the producer respectively.
- South African urban white maize consumers have relatively low levels of knowledge levels regarding GM food related issues.
- The GM knowledge levels of South African urban consumers would be higher among the wealthier consumers in the higher LSM categories.
- Negative perceptions and attitudes towards GM food will have a negative influence on the sensory experience of urban white maize porridge consumers.
- Wealthier South African consumers in the higher LSM categories, will have more negative perceptions and attitudes towards GM food and will be less accepting of GM technology in food.
- The LSM market segmentation classification can be an appropriate market segmentation tool applied to the South African urban consumer market for white maize meal, given the presence of GM maize in this market.

1.9 OBJECTIVES

Given the problem statement and hypotheses discussed above, the general objective of the study was to develop an understanding of the perceptions, attitudes, acceptance and knowledge of South African urban consumers (consisting of LSM groups 4 to 10), regarding GM white maize meal.

The specific objectives were to:

- Identify the trade-offs between different potential attribute levels of maize meal through the estimation of urban South African consumers' willingness to pay for branded- versus non-branded white-grained maize meal, as well as their willingness to pay for non-GM white maize meal versus GM white maize meal with various types of genetic manipulations benefiting the consumer and the producer respectively.
- To identify market segments based on South African urban maize meal consumers' preferences for and reactions to GM white maize.
- Develop an indication of the existing knowledge levels of South African white maize consumers regarding GM food related issues.
- Determine the effect of perceptions regarding GM food on the sensory experience of urban white maize porridge consumers.
- Develop an indication of the perceptions, attitudes and acceptance of South African urban consumers in relation to GM food.
- Develop profiles of the LSM groups and the identified cluster groups, based on the demographic-, GM knowledge-, GM perception-, GM attitude and GM acceptance data gathered within the study.
- Compare the experimental clusters with the various LSM categories in order to select the most appropriate market segmentation approach for the South African urban consumer market for white maize meal, given the presence of GM maize in this market.

1.10 OUTLINE

Following the introductory chapter, Chapter 2 covers firstly the fundamental aspects of consumer behaviour theory and secondly provides an overview of the research methodology to be used in the study.

The application of conjoint analysis to model consumers' perceptions of genetically modified white maize is covered in Chapter 3. The chapter deals with the application of the conjoint methodology to identify the trade-offs between different potential attribute levels of maize meal through the estimation of urban South African consumers' willingness to pay for branded- versus non-branded white-grained maize meal, as well as their willingness to pay for non-GM white maize meal versus GM white maize meal with various types of genetic manipulations benefiting the consumer and the producer respectively.

Chapter 4 deals with the application of cluster analysis to identify market segments based on the maize meal preferences (WTP values) consumers revealed in the conjoint analysis study.

Within Chapter 5 the profiling of the LSM- and cluster groups is discussed, in terms of demographic characteristics, GM food knowledge, GM food perceptions, attitudes towards GM food and acceptance of GM food.

Chapter 6 covers an investigation of consumer perceptions of genetically modified maize through sensory evaluation, in order to determine the effect of perceptions regarding GM food on the sensory experience of urban white maize porridge consumers.

The study ends with conclusions and recommendations discussed in Chapter 7.

CHAPTER 2: RESEARCH METHODOLOGY

2.1 INTRODUCTION

As mentioned earlier, this study deals with urban consumers' perceptions, attitudes and acceptance of genetically modified white maize in South Africa. Following the background information, problem statement, objectives and hypotheses described in Chapter 1, this chapter provides an overview of the research methodology to be applied in this study.

Due to the strong consumer focus of the research, the first component of this chapter covers some fundamental aspects of consumer behaviour theory. The remainder of the chapter deals with the research methodology.

2.2 THEORY OF CONSUMER BEHAVIOUR

A fundamental purpose of marketing is to influence consumers' behaviour in terms of aspects such as the "what", "when" and "how" of purchase and consumption. This requires an understanding of consumer behaviour. Consumer behaviour is a complex process encompassing many dimensions. According to Hawkins, Best and Coney (1998) the field of consumer behaviour is the study of individuals, groups or organizations and the processes they use to select, use and dispose of products, services, experiences or ideas to satisfy needs and the impacts that these processes have on the consumer and society.

In order to understand consumers' behaviour, organisations have to apply the available information within consumer behaviour theory and possibly also conduct marketing research to gather more specific information. Consumer behaviour theory could assist marketers when formulating appropriate marketing research questions. The combination of the application of consumer behaviour theory, marketing research results and assumptions regarding consumer behaviour could provide the basis for effective marketing strategies that could lead to desirable consumer behaviour (Hawkins *et al.*, 1998).

A simplistic model illustrating the role of consumer behaviour and consumer decision-making within the process of marketing strategy formulation (adopted from Hawkins *et al.*, 1998) is shown in Figure 2.1.

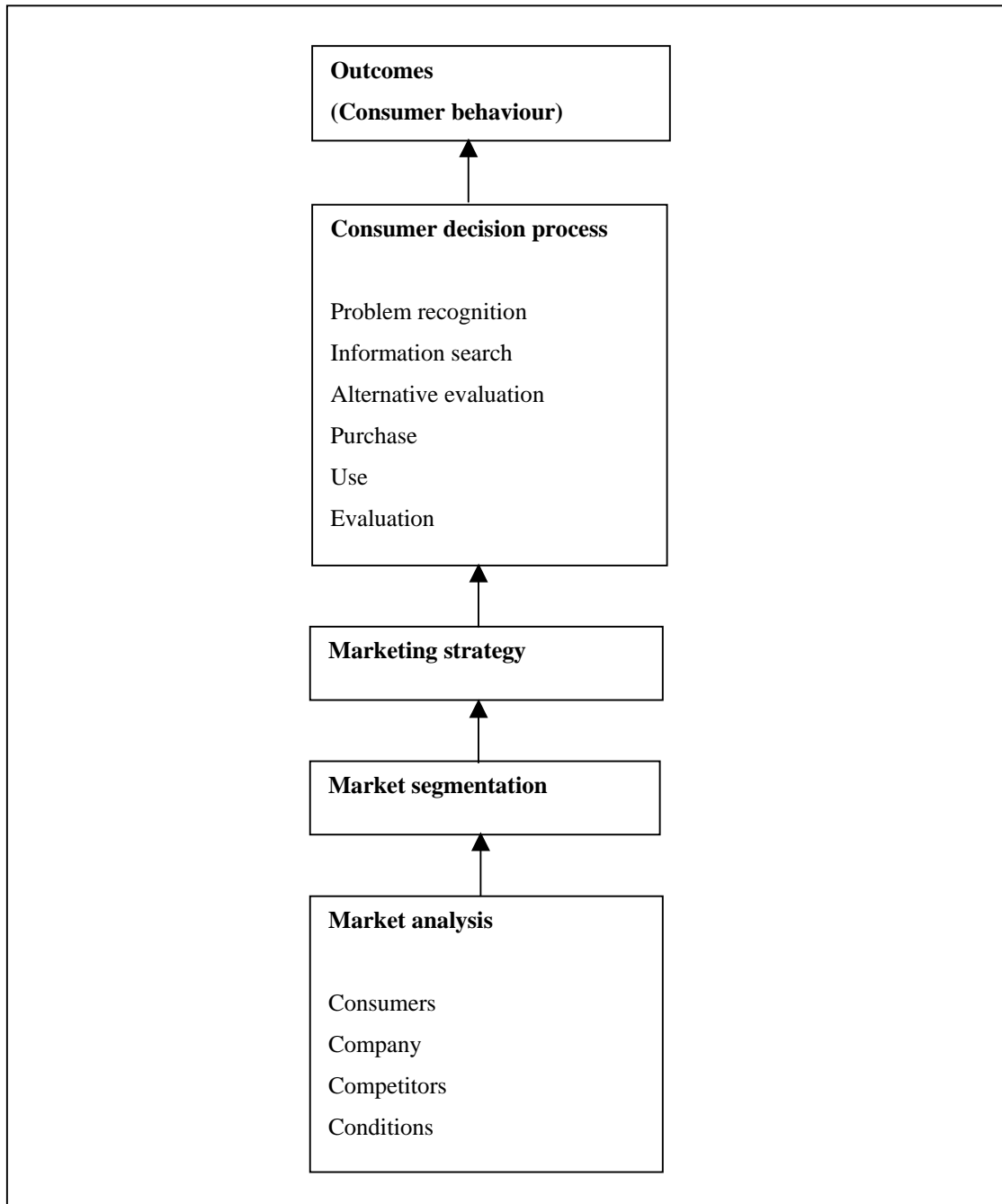


Figure 2.1 Marketing strategy and consumer behaviour

(Adopted from Hawkins *et al.*, 1998)

It is evident from Figure 2.1 that consumer behaviour is a very important component of marketing strategy. The understanding of consumers' current and anticipated

behaviour (within the market analysis aspect) is an important basis of the marketing strategy. Furthermore, the consumer decision process leads to a certain consumer reaction towards the product, which determines the success or failure of the marketing strategy. A proper understanding of consumer behaviour is necessary to anticipate and react to consumers' needs in the marketplace (Hawkins *et al.*, 1998).

A number of models of consumer behaviour exist, within the scope of consumer behaviour theory. The different consumer behaviour models address various focus areas. Some of the focus areas of the models included consumer decision making, family decision making, consumer information processing and consumption values (Schiffman, 1994). Due to the importance of the consumer decision-making process in marketing strategy formulation (as discussed above), the following section will deal with a more detailed consumer behaviour model addressing consumer decision-making, within the context of consumer behaviour.

The Engel, Blackwell and Miniard model of consumer behaviour was developed in 1986, in order to model consumer behaviour with the consumer decision-making process as the focus of the model (Schiffman, 1994). Recently Ragaert, Verbeke, Devlieghere and Debevere (2004) referred to the model as a “classic attitude-behaviour model”. Figure 2.2 displays the Engel-Blackwell-Miniard model of consumer behaviour, also known as the Engel-Kollat-Blackwell model of consumer behaviour.

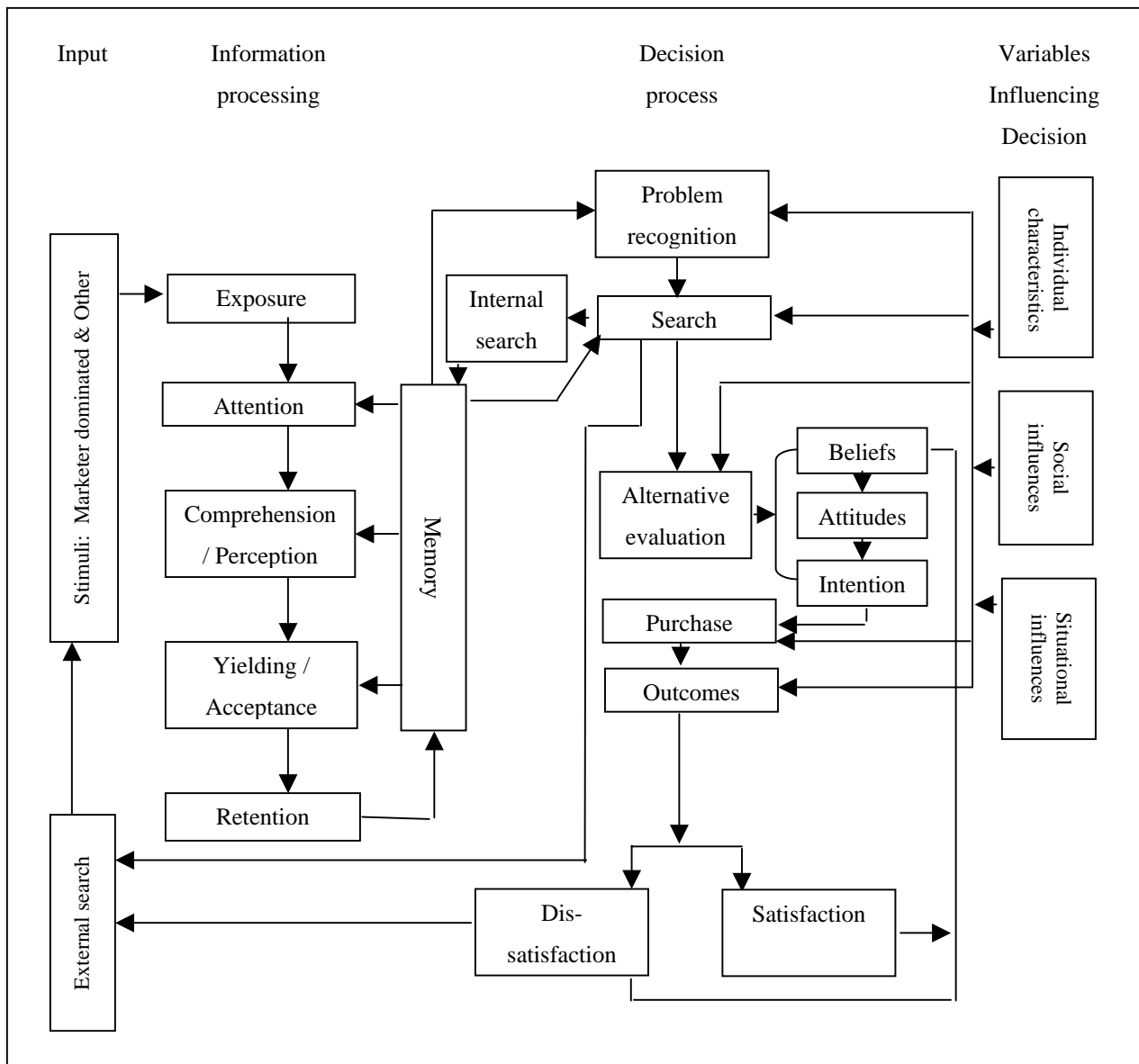


Figure 2.2 The Engel-Blackwell-Miniard (Engel-Kollat-Blackwell) model of consumer behaviour

(Schiffman, 1994)

The focus of the model by Hawkins *et al.* illustrated in Figure 2.1 is on the marketing strategy formulation process and the role of consumer decision-making within that process, while the Engel-Blackwell-Miniard model (Figure 2.2) can be viewed as an elaboration on the “consumer decision process” component of the Hawkins *et al.* model.

The Engel-Blackwell-Miniard model of consumer behaviour will be discussed within the context of food choice by South African consumers, given the presence of GM food in the market. The model consists of four sections. The consumer decision-making process is the central focus of the model. There are five steps within the decision process: problem recognition, search, alternative evaluation, purchase and outcomes. Problem recognition could entail consumer awareness regarding the need to acquire a certain food product. According to Padberg, Ritson and Albisu (1997) typical motives for food demand on the individual, social and situational levels could include nutrition, health, enjoyment, convenience, safety, compliance with the norms of reference groups, prestige, environmental motives and political motives.

The “search” phase involves a search for the information needed in the consumer’s decision-making process. This could include information regarding possible suitable products, prices, product attributes (including GM vs non-GM), purchase outlets, labelling information, packaging, quality attributes and product availability (Padberg *et al.*, 1997). Within the alternative evaluation step, beliefs (e.g. regarding GM food) may lead to the formation of attitudes (e.g. positive or negative attitudes towards GM food), which could then influence the purchase intention of the consumer (e.g. buy GM food product or buy non-GM food product). The outcome of the purchase action and product usage could be satisfaction or dissatisfaction. These outcomes could have an influence on the attitudes of the consumer. If the outcome of the purchase and usage stages is positive, the consumer’s attitude towards GM food could be influenced in a positive way. However, if the purchase and usage outcome is negative it could result stronger negative consumer attitudes (Padberg *et al.*, 1997).

Consumers could engage in either routine- or extended problem solving. When consumers are involved in extended problem solving, they are expected to go through all five stages of the decision process. In routine problem solving consumers are not expected to engage in external search and alternative evaluation. For example, if a consumer has little or no awareness of GM food the consumer could possibly engage in routine problem solving for the food purchase. Higher GM food awareness among consumers might cause extended problem solving, since the consumer is faced with additional aspects to consider in the food purchasing process (Hawkins *et al.*, 1998).

Within the information input section of the model, information from various sources enters the information processing of the consumer. Within the information processing section of the model the steps are exposure, attention, comprehension / perception, yielding / acceptance and retention of incoming information (Schiffman, 1994). Exposure, attention and perception affect what consumers understand, the attitude they have and what they remember, which in turn affects the consumer's decisions. The information is filtered by the consumer's memory, after which it has an initial influence at the problem recognition stage. A need to search for external information could be stimulated due to inadequate available information or if the alternative selected was less satisfactory than expected (Hawkins *et al.*, 1998). Suppose that no GM food information reaches a consumer. The information input process of the consumer could then function as it normally would within the specific food purchasing situation. If information about GM food reaches the consumer (e.g. from a food product label, television, radio or a magazine) the consumer is exposed to the GM information. If the consumer does not give attention to the information the information input process of the consumer could then function as it normally would within the specific food purchasing situation. However, if the attention of the consumer is drawn to the GM food information, the consumer could form perceptions towards GM food products. The GM information could also be filtered through the consumer's memory and consequently influence his / her problem recognition process. The consumer's perceptions could influence:

- The consumer's understanding of GM food.
- The consumer's attitude towards GM food.
- What the consumer remembers about GM food.
- The decision that the consumer could make regarding the purchase of GM food.

The fourth section of the model involves the variables that influence all the stages of the decision process. Social aspects such as culture, reference group and family might influence aspects such as a consumer's exposure to product information, perceptions and attitudes. For example, certain culture groups may be prone towards being more positive or negative towards GM food. The situational influences include aspects such as the financial condition of the consumer. The individual characteristics

include aspects such as age, education, profession, household size, urban / rural, emotions, motives, attitudes, personality and perceptions.

The internal influences / individual characteristics of consumers and the effect of these influences on the consumer decision-making process, are extremely important within the context of consumer behaviour research. Consequently, certain aspects related to emotions, motives, attitudes, and perceptions will be discussed in more detail.

Perception can be defined as the first three steps of information processing, including exposure, attention and interpretation (Schiffman, 1994). Consumer perceptions regarding a product and its attributes affect consumers' attitudes. The process through which consumer perceptions are formed is shown in Figure 2.3.

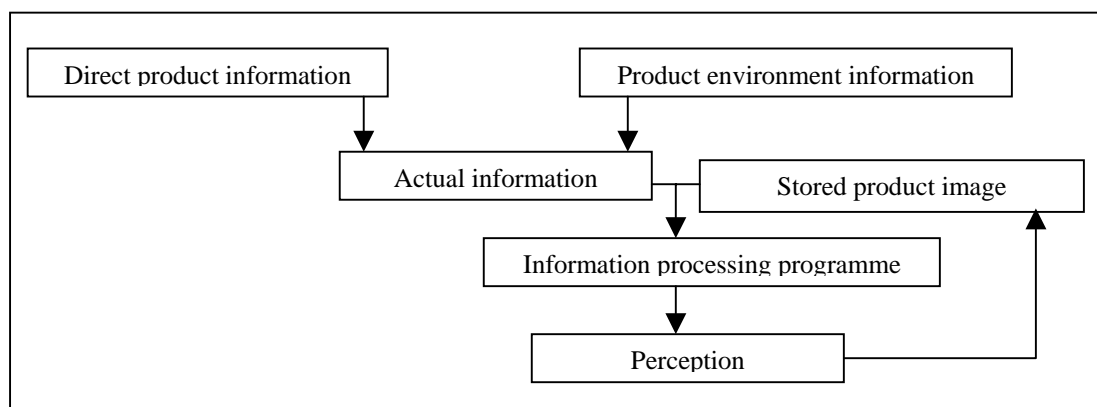


Figure 2.3 The process through which consumer perceptions are formed

(Padberg, Ritson & Albisu, 1997)

According to the information in Figure 2.3, a consumer combines direct product information and product environment information to form actual information. The actual information enters the information processing of the consumer, together with stored information regarding the product image, in order to form the consumer's perception of the product. These perceptions have an influence on the stored product image (Padberg *et al.*, 1997). It is important to note that consumer perceptions are usually distorted, implying that there is an inconsistency between the perceived situation and the real situation facing the consumer. There is a mutual relationship between attitudes and perceived product properties. With a more positive attitude

towards a product and its attributes, the consumer could prefer the selective perception of positive properties of the product. With a more negative attitude towards a product and its attributes, the consumer could prefer the selective perception of negative properties of the product (Padberg *et al.*, 1997).

Emotions can be described as strong, relatively uncontrolled feelings that affect our behaviour (Hawkins *et al.*, 1998) or as pleasant / unpleasant internal tension, which could be more or less conscious to the consumer (Padberg *et al.*, 1997). External events and internal processes can trigger emotions. The literature overview of consumers' reactions to GM food presented in Section 1.2.4 and Section 1.2.5 revealed that emotions play a role in the context of consumers' decision-making processes and reactions to GM food products.

Motives are internal tensions that are combined with a certain activity as objective (Padberg *et al.*, 1997). A motive can also be defined as a construct representing an unobservable inner force that stimulates and compels a behavioural response and provides specific direction to that response (Hawkins *et al.*, 1998). Maslow (1970) developed a model that described a hierarchy of human needs. The model proposed a motive hierarchy, which was shared by all human beings. Within Maslow's model the motive hierarchy included physiological-, safety-, belonging-, esteem- and self-actualisation motives. In the GM food context consumer motives could involve numerous aspects. For example, a consumer with a basic need to acquire food for nutrition, might not really consider GM food issues, since his / her motive is simply to satisfy hunger. Another consumer might have more complex motives associated with food purchasing such as self-actualisation. Such a consumer might avoid GM food if he / she perceives it as being unnatural or as an environmental threat. If a consumer views GM food as a safety risk his / her motive could be linked with the second level of Maslow's motives hierarchy.

According to Padberg *et al.* (1997) attitude can be defined as a willingness of the consumer to react positively or negatively to a stimulus pattern of a product offer. Attitude can also be seen as the consumer's overall evaluation that expresses how much a consumer likes or dislikes an object, issue or action (Olubobokunl *et al.*, 2002). For example, attitudes could guide consumers' thoughts, feelings and behaviour

regarding GM food and could eventually influence consumers' buyer behaviour regarding these products.

Emotions, motives and attitudes are linked and lead to purchasing behaviour (Padberg *et al.*, 1997). Motives have an emotion basis and will lead to the formation of attitudes towards a product, which will finally have an influence on the buying decision of the consumer. The presence of strong emotions could lead to strong motives. Consequently the consumer could develop strong positive (negative) attitudes towards a product, which could then lead to a higher (lower) purchase probability. It is also important to note that there is a mutual relationship between motives, attitudes and consumer behaviour. Thus, even though motives and attitudes determine consumer behaviour, consumption leads to product experience, which could in turn affect the motives and attitudes of consumers (Padberg *et al.*, 1997).

The final part of this section links the Engel-Blackwell-Miniard model of consumer behaviour with the objectives within this study. The attitude- and perception variables influencing consumer decisions together with the consumer decision process (specifically the alternative evaluation and purchase intentions steps) is relevant to the research objectives aimed at developing an idea of the perceptions, attitudes and acceptance of South African urban consumers in relation to GM maize. The following hypotheses of the study fit into these sections of the Engel-Blackwell-Miniard model of consumer behaviour:

- "The South African urban consumer market for white maize meal can be divided into discreet market segments based on their GM perceptions and attitudes, given the presence of white maize meal containing GM white maize, in the South African food market."
- "The majority of urban maize meal consumers would be willing to pay a premium for white maize meal that is free of GM maize."
- "When facing a choice between maize containing GM maize that was modified for consumers' benefit versus producers' benefit, South African urban consumers would be willing to pay a premium for white maize meal manufactured from maize that was genetically modified for purposes of consumer benefit as opposed to maize that was genetically modified for purposes of producer / farmer benefit."

- “Negative GM perceptions and attitudes would have a negative influence on the sensory experience of urban white maize porridge consumers.”
- “South African white maize meal consumers in higher income groups would have more negative perceptions and attitudes towards maize meal containing genetically modified white maize, as opposed to the South African white maize consumers in the lower income groups who would have less negative perceptions and attitudes towards food products containing genetically modified white maize.”

The objective to determine whether the LSM market segmentation classification can be an appropriate market segmentation tool applied to the South African urban consumer market for white maize meal, given the presence of GM maize in this market, fits into the Engel-Blackwell-Miniard model of consumer behaviour by means of certain individual variables influencing consumer decisions, specifically perceptions, attitudes, demographic- and wealth characteristics (since demographic- and wealth characteristics is an important part of the LSM classification).

The input and information processing components of the Engel-Blackwell-Miniard model of consumer behaviour is applicable to the objective to develop an idea of the existing knowledge status of South African white maize consumers regarding GM food related issues.

The alternative evaluation, purchase and outcomes sections of the decision process phase of the model are relevant to the objective addressed by the conjoint- and cluster analyses in the study. The objective aimed at identifying the trade-offs between different attributes of maize meal and the importance of GM maize and type of genetic modification within these trade-offs, involves the alternative evaluation and purchase steps of the decision process. The purchase step is relevant to the objective aimed at identifying market segments based on South African urban maize meal consumers’ preferences for and reactions to GM white maize.

The various variables influencing the consumer decision process as well the input and information procession model stages are applicable to the objective to develop and compare the profiles of the LSM groups and the cluster groups. These model

components include demographic-, perception- and attitude individual characteristics; social influences (e.g. culture) and situational influences (e.g. income).

2.3 OVERVIEW OF THE RESEARCH PROCESS

The purpose of this section is to give an overview of the experimental research process of the thesis. The research process involved a number of marketing research methods, including sensory evaluation, rating questions, conjoint analysis and cluster analysis.

At first the various activities, which were undertaken during the research process, are discussed and then an overview of the analytical procedures are presented. Finally the panel recruitment procedures are discussed.

2.3.1 Overview of the research activities

The activities within the preparation phase were conducted during the period January to November 2003 and involved the following:

- Design of panel requirements and the sampling procedure.
- Design of the sensory evaluation task and questionnaires.
- Design of the conjoint task.
- Design of the main survey questionnaire.
- Questionnaire testing.
- Panel recruitment.
- Other relevant preparation and administration activities.

The main experiment was conducted during November 2003. A total of 83 respondents participated in the data gathering process over six days. Thus, approximately 15 respondents participated on each of the six days. Each data gathering session started with the sensory evaluation sessions (Tasting session 1, 2 and 3), followed by the conjoint experiment, completion of the general survey questionnaire and finally the remuneration of respondents. Data coding and

capturing, data cleaning, statistical analysis and reporting were done during the period December 2003 to July 2004.

2.3.2 Analytical procedures

The analytical overview for the research is shown in Figure 2.4. In Figure 2.4 actions are shown as double border blocks, while results are shown in grey blocks.

All the relevant motivations and detailed discussions regarding the various data gathering- and analyses aspects will be presented in Chapters 4 and 5.

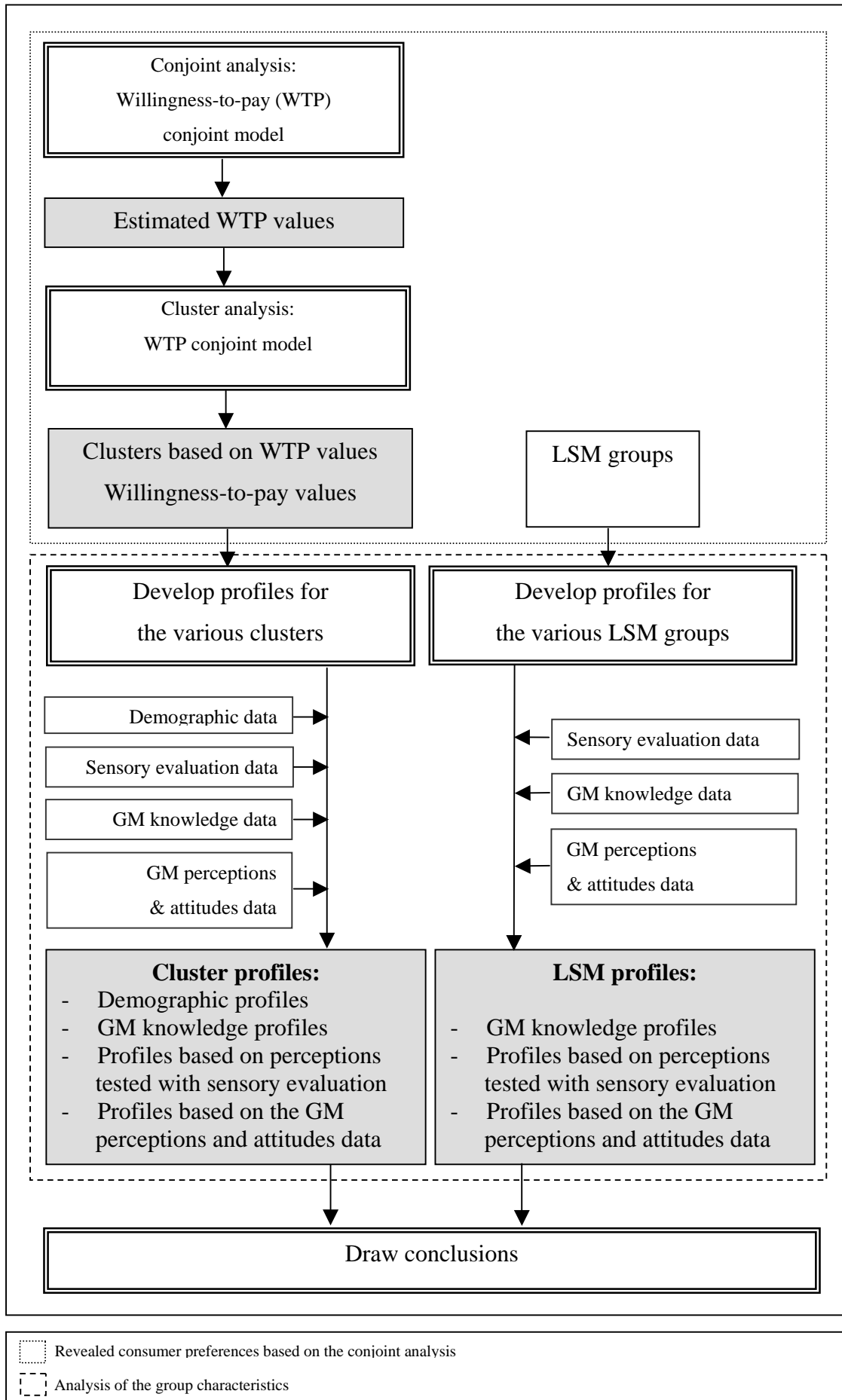


Figure 2.4 Analytical overview of the research

2.3.3 Sampling procedure

Quota sampling was applied to obtain the experimental sample. The “Maize porridge consumer panel recruitment questionnaire” is shown in Appendix A. Quota sampling involves the formations of relatively homogeneous subgroups by applying control characteristics (for which official census or other data of the population is available) (Steyn, Smit, Du Toit & Strasheim, 1994). For this experiment the quotas were based on the LSM (Living Standard Measures) market segmentation tool developed by the South African Advertising Research Foundation (SAARF), based on wealth, access and geographic indicators (SAARF, 2004). The LSM classification divides the population into ten LSM groups with LSM 10 (highest) to LSM 1 (lowest) where urban consumers dominate in LSM groups 4 to 10.

Three subgroups / subpopulation were selected for this study. Group 1 consisted of urban consumers from LSM groups 4 and 5, group 2 of urban consumers from LSM groups 6 and 7 and group 3 of urban consumers from LSM groups 8, 9 and 10.

Table 2.1 displays a summary of the characteristics of the selected LSM groups from the “SAARF Segmentation Handbook Based on the All Media and Products Survey (AMPS) 2003B and 2004” (SAARF, 2004).

The selected control characteristics were age, gender, education level and the results of the SAARF “Do-It-Yourself LSM Classification” tool (SAARF, 2003). The questions of the “Do-It-Yourself LSM Classification” tool can be seen on the second page of the questionnaire in Appendix A.

A total sample size of 90 respondents was decided on. The relatively small sample size was due to the fact that a time-consuming and rather expensive sensory evaluation experiment was also conducted as part of the research project and consequently limited the sample size.

Table 2.1 Summary characteristics of the selected LSM groups

LSM no.	%	Demographics	Media
4&5	29.2	<p><i>Age:</i> 16-34</p> <p><i>Gender:</i> Male & Female</p> <p><i>Education:</i> Some high school up to Gr 12</p> <p><i>Urban</i></p>	<p><i>Radio:</i></p> <p>ALS stations</p> <p>Radio Bop</p> <p>Metro FM</p> <p>KAYA FM</p> <p>YFM</p> <p><i>TV:</i></p> <p>SABC 1, 2 & 3</p> <p>Bop TV</p> <p>E TV</p> <p><i>Other</i></p> <p>Weekly newspapers</p> <p>Magazines</p> <p>Outdoor</p>
6&7	19.0	<p><i>Age & Gender:</i></p> <p>16 – 34 Male & Female</p> <p>35 + Male</p> <p><i>Education:</i> Grade 12 and higher</p> <p><i>Urban</i></p>	<p><i>Radio:</i></p> <p>Wide range of commercial and community radio</p> <p><i>TV:</i></p> <p>SABC 1, 2 & 3</p> <p>E TV</p> <p>M NET</p> <p><i>Other:</i></p> <p>Daily/Weekly Newspapers</p> <p>Magazines</p> <p>Cinema & Outdoor</p>
8, 9 & 10	16.4	<p><i>Age & Gender:</i></p> <p>35 + Male & Female</p> <p><i>Education:</i> Grade 12 and higher</p> <p><i>Urban</i></p>	<p><i>Radio:</i></p> <p>Wide range of commercial and community radio</p> <p><i>TV:</i></p> <p>SABC 1, 2 & 3</p> <p>E TV</p> <p>M NET</p> <p>DSTV</p> <p><i>Other:</i></p> <p>Daily/Weekly Newspapers</p> <p>Magazines</p> <p>Internet</p> <p>Cinema & Outdoor</p>

(Source: SAARF, 2004)

The geographic focus of the study was the Pretoria metropolitan area, within the Gauteng province of South Africa. According to the “SAARF Segmentation Handbook Based on AMPS 2003B and AMPS 2004” (SAARF, 2004):

- 34.0% of the population in Gauteng consists of people from LSM 4 and 5.
- 33.5% of the population in Gauteng consists of people from LSM 6 and 7.
- 32.5% of the population in Gauteng consists of people from LSM 8, 9 and 10.

Thus, each of the experimental LSM subgroups contributed roughly a third of the urban population in the Gauteng province of South Africa. Consequently proportionate sampling was applied and the quota for the sample of 90 respondents was designed to include:

- 30 respondents from LSM 4 and LSM 5.
- 30 respondents from LSM 6 and LSM 7.
- 30 respondents from LSM 8, LSM 9 and LSM 10.

Respondents were randomly selected from urban areas in Pretoria and Johannesburg. The respondents completed the “Maize porridge consumer panel recruitment questionnaire”, which were analysed in order to categorise the respondent into a specific LSM category. A respondent was suitable for recruitment if he / she consumed and / or bought maize meal and if the respondents was able to attend one experimental session during the period 3 to 11 November 2003. Despite the initial sample target of 90 respondents, the final sample size was 83 respondents, since seven of the respondents did not show up during the data gathering process. It is important to note that many of the respondents took leave from work to participate in the data gathering sessions.

As mentioned above the age, gender, education level and “LSM score” characteristics of the respondents were considered, in order to categorise respondents into the appropriate LSM groups. The “ideal” characteristics of the respondents in the three LSM categories refer to the characteristics according to the official demographic data of LSM groups 4 to 10 as shown in Table 2.1. The “actual” characteristics of the respondents in the three LSM categories refer to the actual age, gender and education level characteristics of the experimental group. This section will discuss the “ideal” and “actual” characteristics of the respondents within the various LSM categories.

A summary of the ideal and actual demographic characteristics of the respondents in the group LSM 4 and 5 is shown in Table 2.2.

Table 2.2 Ideal and actual characteristics of the LSM 4 & 5 respondents

Characteristic:	Ideal value¹:	Actual value:
Number of respondents:	30	25
Age distribution:	16 – 34	19 – 48
Average age:	-	30.0
Gender:	Male & Female	13 Male respondents; 12 Female respondents
Education level:	Up to Grade 12	15 Respondent: Gr. 11 or less; 10 Respondents: Gr. 12

(¹ Source: SAARF, 2004)

The actual number of respondents categorised into the LSM 4 & 5 category was 5 respondents less than the targeted 30 respondents, since 5 of the recruited respondents did not show up during the data gathering process. The average age of the respondents in this category was acceptable and within the target age range of 16 to 34 years. Even though 7 of the respondents were older than 34 years they were still placed in the LSM 4 and 5 group, since their other characteristics were most compatible with this category. The gender and education level characteristics of the respondents in the category LSM 4 and 5 adhered to the requirements.

A summary of the ideal and actual characteristics of the respondents in the LSM 6 and 7 category is shown in Table 2.3.

Table 2.3 Ideal and actual characteristics of the LSM 6 & 7 respondents

Characteristic:	Ideal value¹:	Actual value:
Number of respondents:	30	30
Age & gender distribution:	16 – 34 Male & Female 35+ Male	18 Male & Female respondents, aged 18 – 34 6 Male & 6 Female respondents aged 35+
Average age:	-	32.2
Education level:	Up to Grade 12 & Higher	7 Respondents: Gr. 11 or less 10 Respondents: Gr. 12 10 Respondents: Technicon Diploma or Degree 2 Respondents: University Degree

(¹ Source: SAARF, 2004)

The actual number of respondents categorised into the LSM 6 and 7 category was equal to the targeted 30 respondents. The average age of the respondents in this category was acceptable and within the target age range. Even though 12 of the respondents were older than 34 years they were still placed in the LSM 6 and 7 group, since their other characteristics were most compatible with this category. The education level characteristics of the respondents adhered to the requirements.

A summary of the ideal and actual characteristics of the respondents in the LSM 8, 9 and 10 category is shown in Table 2.4.

Table 2.4 Ideal and actual characteristics of the LSM 8, 9 & 10 respondents

Characteristic:	Ideal value¹:	Actual value:
Number of respondents:	30	28
Age distribution:	35+	32 – 65
Average age:	-	46.0
Gender:	Male & Female	5 Male respondents; 23 Female respondents
Education level:	Up to Grade 12 & Higher	1 Respondent: Gr. 11 or less 8 Respondents: Gr. 12 9 Respondents: Technicon Diploma or Degree 10 Respondents: University Degree

(¹ Source: SAARF, 2004)

The actual number of respondents categorised into the LSM 8, 9 and 10 category was 2 respondents less than the targeted 30 respondents, since 2 of the recruited respondents did not show up during the data gathering process. The average age of the respondents in this category was acceptable and within the target age range. Even though 4 of the respondents were younger than 35 years they were still placed in the LSM 8, 9 and 10 group, since their other characteristics were most compatible with this category. Female respondents dominated in this group. The education level characteristics of the respondents in the category adhered to the requirements. In general the actual characteristics of the recruited respondents in the various LSM categories reflected the ideal increased age and education levels associated with higher LSM levels.

2.4 SUMMARY

The first part of this chapter covered some fundamental aspects of consumer behaviour theory. Due to the importance of the consumer decision-making process in formulating a marketing strategy, the discussion was based on the Engel, Blackwell and Miniard model of consumer behaviour, with a specific focus on consumer decision-making within the context of consumer behaviour.

The second part of Chapter 2 dealt with an overview of the research methodology of the study. Quota sampling was applied to obtain a sample of 90 urban white-maize consumers, based on the LSM (Living Standard Measures) market segmentation tool. On arrival the respondents participated in sensory evaluation of maize porridge. This was followed by a conjoint experiment designed around three selected product characteristic variables describing a 2.5kg packet of maize meal: “Brand variable”, “GM variable” and “Price variable”. Market segmentation was done through cluster analysis based on the conjoint results. Finally the respondents completed a survey questionnaire containing a variety of knowledge, perception and attitude questions regarding GM food.

Following the methodology overview, the next chapter will deal with the application of conjoint analysis to model consumers’ perceptions of genetically modified white maize.

CHAPTER 3: MAIZE MEAL PREFERENCES OF SOUTH AFRICAN URBAN CONSUMERS

3.1 INTRODUCTION

The objectives of this chapter are to report on the first component of the study within which conjoint analysis was applied to identify trade-offs between different attributes of maize meal and the importance of GM white maize and type of genetic modification within these trade-offs, as well as to determine urban South African white maize consumers' willingness to pay for non-GM white maize meal and GM white maize meal with various types of genetic modification.

The first section of this chapter presents a literature overview of the application of conjoint analysis within the context of consumer related GM food research. This is followed by a theoretical overview of the conjoint analysis and the specific experimental detail, results and discussion of the applied conjoint analysis.

3.2 THE APPLICATION OF CONJOINT ANALYSIS WITHIN THE CONTEXT OF CONSUMER RELATED GM FOOD RESEARCH: A LITERATURE REVIEW

Conjoint analysis (often in combination with cluster analysis) has been widely used in the evaluation of consumer preferences for hypothetical products and services (Hair, Anderson, Tatham & Black, 1995). There are numerous examples in the academic literature where these techniques were applied within the context of food related marketing research. Some examples of these research studies are summarised in Table 3.1.

Within the context of consumer research related to GM food products, a number of studies were conducted by means of conjoint analysis techniques (often combined with cluster analysis techniques). An overview of some of these studies is discussed below.

Table 3.1 Food application examples of conjoint- and cluster analysis

Reference:	Product:	Country:
Steenkamp (1987)	Ham	The Netherlands
Ness and Gerhardy (1994)	Eggs	UK
Huang and Fu (1995)	Chinese sausages	Taiwan
Van der Pol and Ryan (1996)	Fruit and vegetables	UK
Baker (1999)	Apple products	USA
Murphy, Cowan, Hencion and O'Reilly (2000)	Irish honey	Ireland

Baker and Burnham (2002) conducted a study applying conjoint analysis to determine the effect of GMO content of corn flakes on consumer purchasing decisions in the USA. The product attributes of brand (2 attribute levels) and price (3 attribute levels) were chosen based on focus group results. GMO content (the third attribute with 2 attribute levels) was included to address the goals of the study. A full factorial design was used to compile 12 hypothetical products descriptions. Questionnaires were administered through a mail survey. Data analysis involved the regression of the 12 product ratings on the 3 variables (product attributes) and the calculation of part-worth scores. The part-worth scores were used to calculate the relative factor importance scores. The results revealed that consumer preferences were not dominated by any one factor. Based on the conjoint analysis results, market segments for food products based on information on consumers' concerns for the GMO content of food, were developed through the cluster analysis technique using Ward's minimum variance model. This was done in order to gain understanding on the manner in which consumers' preferences might be revealed in the marketplace. The analysis resulted in the identification of three market segments based on respondents' preferences for branded, low-prices and GMO-free products.

Lusk *et al.* (2002) applied conjoint analysis in the USA, in order to investigate if acceptance of genetically engineered food was dependent upon the type of genetic modification, to estimate the premium that respondents were willing to pay for non-genetically modified corn chips, to determine if brand equity was sufficient to outweigh concern for genetically modified corn chips and to determine if consumers were more accepting of genetically modified corn chips when sold by retailers with high levels of store loyalty. The corn chips were defined in terms of the attributes of price (3 attribute levels), store where purchased (2 attribute levels), brand name (2

attribute levels) and type of corn used to make the chips (3 attribute levels). Thus, the selected attribute levels resulted in 36 possible product descriptions. A fractional factorial design was used to reduce the choice sets to 13 options. Student survey interviews were used to gather the data. A multinomial LOGIT model was estimated to generate the results. The study results revealed that the respondents were more accepting of corn chips that were modified to increase shelf life as opposed to increasing farmer yields. Willingness-to-pay premiums for the value-added corn chips were small relative to corn chips that contained no genetically modified corn. Furthermore, respondents were more accepting of genetically modified foods when sold by agribusinesses with high levels of brand equity or store loyalty.

Grunert *et al.* (2002) conducted research related to cheese in Europe, involving sensory evaluation techniques, a conjoint analysis task and measurement of attitudes towards the use of GMOs in cheese production. The conjoint analysis objective was to investigate the trade-off between a GMO-based starter culture and functional product benefits, which the use of GMO-based starter cultures could allow, in the formation of respondents' purchase intentions. The conjoint task involved the rating of a full-profile reduced design task (16 profile cards) based on six attributes. Aggregated part-worth utilities were calculated. The part-worth utility of GM starter culture was taken as an indicator of attitude towards the use of GMOs in food production. Results revealed that the type of starter culture and price had the largest impact on respondents' purchase intentions. Control group respondents had a more negative attitude to the use of GMOs in food production, compared to the respondents who believed that they had tasted a GMO containing cheese. Overall, the respondents who believed they had tasted a GMO containing cheese (with which they had a positive sensory experience) had a less negative attitude towards GMO in food production. The type of starter culture used also had less impact on their buying intentions regarding cheese, than for the control group.

3.3 THEORETICAL OVERVIEW OF CONJOINT ANALYSIS

Conjoint analysis is a quantitative marketing research technique, originally developed for psychometric research, that is applied in order to measure consumer perceptions and preferences (Anttila, Van Den Heuvel & Möller, 1980; Johnson, 1985). It is a

type of thought experiment, rather than a data analysis procedure (Sudman & Blair, 1998).

Conjoint analysis models the nature of consumer trade-offs amongst multi-attribute products or services (Padberg *et al.*, 1997). The method measures the importance individual consumers attach to various product attributes and the utility that consumers attach to the different levels of the various attributes, based on their valuation of the complete product (Malhotra, 1996; Tull & Hawkins, 1993). Thus, conjoint analysis enables the marketing researcher to identify the attribute combinations that confer the highest level of utility to the consumer and to establish the relative importance of attributes in terms of their contribution to the total utility derived by the specific respondent.

The conjoint analysis method is based on a number of assumptions (Ness & Gerhardy, 1994):

- All products can be defined as a set of attributes.
- Different product variations can be defined by means of a series of predetermined levels of a set of product attributes.
- The total utility derived by a consumer from the consumption of a product is determined by the utilities contributed by each attribute level.
- Consumers evaluate the utility of the different attribute level combinations in order to make a purchase decision.
- When consumers choose between alternative products, they trade off different attribute level combinations.

In a conjoint experiment a set of hypothetical product alternatives is presented to respondents, composed by means of selected product attributes and attribute levels that define the product. The respondents express their overall judgements of these hypothetical product alternatives. The original evaluations of the respondents are then decomposed into separate compatible utility scales, enabling the researcher to gather information regarding the relative importance of various attributes of a product and to provide information about the value of various levels of a single attribute (Green & Wind, 1975).

A number of marketing research questions, could be answered by means of a conjoint experiment, including (Hair, Anderson, Tatham & Black, 1995; Wind, Grashof & Goldhair, 1978):

- What is the utility associated with each product attribute level?
- What is the contribution of each attribute to the consumer's overall evaluation of the product?
- How important is each attribute for the consumer?
- What kind of trade-offs can be made among attributes?

Conjoint analysis offers many advantages and applications to the marketing researcher. According to Anttila *et al.* (1980) the advantages of conjoint analysis include the following:

- Relatively simple data collection procedure.
- Preference ranking could lead to better data reliability than cases where respondents express the magnitude of preference.
- Explicit trade-offs between attributes provide a more realistic approach.
- Part-utilities calculated in conjoint analysis provide a common scale facilitating direct comparisons between different attributes.

The results of conjoint analysis are used for various further analyses and applications, including (Hair *et al.*, 1995; Sudman & Blair, 1998):

- Definition of the product with the optimum combination of attributes.
- Analysis of the variations amongst respondents regarding their conjoint results.
- Cluster analysis could be applied to group conjoint respondents into clusters (market segments) according to similarities and differences in the values they attach to various attribute levels.
- The prediction of market share for new or improved products.
- Measurement of the value of advertising.
- Measurement of price elasticity and willingness to pay (WTP) could be measured if price is included as a variable in the conjoint experiment.

There are some important issues which have to be taken into account when dealing with conjoint analysis. Conjoint analysis is usually administered by means of personal interviews, implying high research costs and / or small sample sizes (Sudman & Blair, 1998). Issues related to the product dealt with in the conjoint experiment include the following (Anttila *et al.*, 1980; Sudman & Blair, 1998; Tull & Hawkins, 1993):

- The product have to be decomposable into a realistic combination of basic product attributes.
- The nature of the product descriptions should allow respondents to visualise the descriptions and reliably choose between the options.
- The product descriptions should be realistic to the respondents.
- The product attribute levels should be selected in such a way that the minimum level of the specific attributes necessary to be considered by the respondent is included in the experiment.

The validity of the utility results is entirely dependent on the chosen product attributes and attribute levels (Anttila *et al.*, 1980). Finally inadequate motivation amongst respondents to complete the conjoint task rationally, could lead to misleading results (Sudman & Blair, 1998). However, this is a potential problem for all research working with individuals.

The steps within the conjoint analysis process will be covered within the next section.

3.4 DESCRIPTION OF THE CONJOINT EXPERIMENT

3.4.1 Formulating the relevant research objectives

The conjoint experiment within this research project was conducted in order to address the following research objectives related to urban white maize meal consumers:

- To identify the trade-offs between different attributes of maize meal within the context of consumer preferences and decision-making.

- To determine the importance of the presence of GM maize in white maize meal, on consumer preferences for the product.
- To determine whether consumer preferences for white maize meal containing GM maize is dependent upon the type of genetic modification.
- To determine white maize meal consumers' willingness to pay (WTP) for:
 - “Specific brand” white maize meal relative to white maize meal with no specific brand attached to the product.
 - Maize meal manufactured from regular (non-GM) maize, relative to maize meal manufactured from maize that was genetically modified to increase shelf life or crop yield.
 - White maize meal manufactured from maize that was genetically modified to increase shelf life, relative to white maize meal manufactured from maize that was genetically modified to increase crop yield or regular (non-GM) maize.
 - Maize meal manufactured from maize that was genetically modified to increase crop yield, relative to maize meal manufactured from maize that was genetically modified to increase shelf life or regular (non-GM) maize.

3.4.2 Determining the relevant white maize product attributes and attribute levels

Two criteria were taken into consideration in order to select the maize meal product attributes for the conjoint experiment. The selected maize meal attributes had to be critical in affecting consumers' preferences and choices regarding the product and the researcher had to be able to influence the selected product attributes according to the research objectives of the conjoint analysis experiment (as suggested by Murphy *et al.*, 1982; Malhotra, 1996).

Relevant product attributes could be identified by means of discussions with managers, discussions with industry experts, analysis of secondary data and qualitative consumer research (Malhotra, 1996). Qualitative consumer research could include methods such as focus groups, personal interviews, telephone surveys or mail surveys. In this conjoint experiment the attributes of maize meal that are critical in

affecting consumers' preferences and choices regarding the product were determined by means of an initial personal interview survey involving 50 consumers, based on the questionnaire shown in Appendix B and by considering possible secondary information sources. According to the pilot survey all the respondents preferred white maize meal to yellow-grain maize meal and all the respondents preferred whiter maize meal to yellow or off-white maize meal. The respondents indicated that brand was an important consideration and that specific maize meal brands were associated with specific quality, taste, colour, texture and nutrition qualities. The importance of brand in the maize meal purchase decision of South African consumers can also be seen in the results of the Food Consumption Survey of 1999, which indicated that 89% of the respondents (on a national level) were aware of the brand name of the maize they consumed (MacIntyre & Labadarios, 2000). In terms of texture, 80% of the respondents preferred fine maize meal to coarse maize meal. Price was also identified as an important factor influencing consumers' purchasing decision regarding white maize meal.

The research objectives of the conjoint experiment necessitated the inclusion of two specific product attributes. As mentioned earlier willingness to pay could be measured if price is included as a variable in the conjoint experiment (Hair *et al.*, 1995; Sudman & Blair, 1998). Thus, price was included in order to be able to determine consumers' willingness to pay for various trade-offs amongst the product attribute levels. Since the main focus of the research project was on consumer perceptions of genetically modified maize, it was also necessary to include the genetic modification factor into the product attributes. This was done by including a factor describing the type of maize used to produce the white maize meal. Thus, the product attributes brand, price and type of maize used to produce the maize meal, were included in the conjoint experiment of white maize meal sold on the South African urban food market.

Following the determination of the relevant attributes for the conjoint experiment, the attribute levels had to be decided on. A number of factors had to be taken into consideration in selecting the attribute levels for the conjoint study, including the levels which the consumers might realistically face in the real market place and the requirements of the study. According to Van Der Pol and Ryan (1996) the selected

attribute levels had to be plausible (reasonable / believable), actionable and capable of being traded off.

The relevant levels for each of the identified attributes of white maize meal were determined by taking the following into consideration:

- The results of the personal interview survey mentioned in step 2.
- The levels that consumers might realistically face in the real market place within South Africa, especially with respect to the price and brand attributes.
- The objectives of the research study.

The preliminary consumer survey suggested two groups of white maize consumers with respect to brand preference. Group 1 was brand aware, while group 2 did not give a lot of attention to brand when selecting maize meal. Based on these observations it was decided to include only two levels for the “Brand name” attribute: “Specific brand, e.g. Ace, Iwisa, Super Sun, etc.” and “Brand not important”. The various specific brand names were included by means of the “Specific brand” level and not as separate levels, due to the wide variety of maize meal brands on the South African market.

As suggested by Lusk *et al.* (2002) and due to the nature of the experiment three price levels were chosen: an inexpensive price, an average price and an expensive price for a 2.5kg packet of super white maize meal. It was also taken into account that the prices had to be realistic for the consumers in the study. Three price levels were calculated: “R6.20”, “R8.10” and “R10.99”. The three price levels were based on an analysis of the price data gathered by means of a survey of the current prices of various maize meal brands sold as 2.5kg packets in October 2004, within 5 grocery stores within the Gauteng urban environment (which were selected to cover a variety of demographic areas). The minimum price (R6.20) was determined by reducing the minimum observed market price by 10%, in order to generate a price level that represented an inexpensive price level. The average price (R8.10) was determined by calculating the average value from all the observed prices. The maximum price (R10.99) was determined by increasing the maximum observed market price by 10%. By selecting the price levels mentioned above, the research objectives could be

attained to determine the premiums that consumers were willing to pay for non-GM maize meal and maize meal with different GM modification types.

Three levels were selected for the attribute “Maize type used to produce the maize meal”, in order to investigate the effects of the type of GM modification applied to the maize, on consumer buying decisions. The levels were “No genetically modified maize”, “Farmer used genetically modified maize to increase crop yield” and “Genetically modified maize used to increase shelf life of maize meal”. The attribute level “Farmer used genetically modified maize to increase crop yield” was included as an example where the genetic modification was to the benefit of the farmer, while the attribute level “Genetically modified maize used to increase shelf life of maize meal” was included as an example where the genetic modification was to the benefit of the consumer. The selection of these attributes was based on a similar study conducted by Lusk *et al.* (2002) with respect to a maize snack food.

Table 3.2 displays a summary of the selected levels for the maize meal product attributes. The chosen white maize meal attribute levels resulted in 18 possible product descriptions.

Table 3.2 The selected levels for each of the relevant product attributes

Attribute:	Number of levels:	Level descriptions:
Brand name	2	“Specific brand, e.g. Ace, Iwisa, Super Sun, etc.”
		“Brand not important”
Price for 2.5kg packet of super white maize meal	3	R6.20
		R8.10
		R10.99
Maize type used to produce the maize meal	3	“No genetically modified maize”
		“Farmer used genetically modified maize to increase crop yield”
		“Genetically modified maize used to increase shelf life of maize meal”

3.4.3 The scenarios presented to the respondents

Based on the identified product attributes and attribute levels, hypothetical scenarios or product descriptions can be compiled (Murphy *et al.*, 2000). The total possible number of scenarios is equal to the product of the number of selected product attributes and the number of selected attribute levels. This can result in numerous possible scenarios.

In cases where the total number of possible product scenarios is manageable for consumers, all possible scenarios can be presented to the respondents by means of a full factorial design. However, in situations where the design of the conjoint experiment results in a large number of possible scenarios, a number of issues are important (Tull & Hawkins, 1993). The respondents within a conjoint experiment could be overwhelmed and experience difficulties if they were presented with a large number of scenarios to consider. It could also lead to a time consuming experimental process. A fractional factorial design could be generated in order to reduce the number of experimental scenarios to be presented to the respondents, in such a manner that the experimental scenarios to be tested are selected to ensure that the independent contributions of all the factors are balanced (Tull & Hawkins, 1993). Thus, by means of the orthogonal array experimental design the total number of scenarios can be reduced to a manageable number, while still maintaining statistical validity. Orthogonal arrays are difficult to design and are usually generated with specialised computer software or manually based on published prototype designs (Tull & Hawkins, 1993).

The second step of the conjoint analysis research process lead to the identification of three product attributes, where two of the attributes had three different attribute levels, while the third attribute had two different attribute levels. Thus the total number of hypothetical scenarios for the experiment was 18 (equal to 3^2 multiplied by 2^1). The 18 possible scenarios were reduced to a smaller number of scenarios, in order to make the conjoint task more manageable for the respondents. A fractional factorial design was generated by means of the “Orthogonal Design” procedure in SPSS 12.0 for Windows. The 9 scenarios of the fractional factorial design are shown in Table 3.3.

Table 3.3 The 9 white maize meal product descriptions within the fractional factorial design

Option:	Brand variable:	Price variable:	Maize type used to produce the maize meal:
Option 1	Specific brand	R 6.20	No genetically modified maize
Option 2	Specific brand	R 6.20	Genetically modified maize used to increase shelf life of maize meal
Option 3	Specific brand	R 8.10	Farmer used genetically modified maize to increase crop yield
Option 4	Specific brand	R 8.10	Genetically modified maize used to increase shelf life of maize meal
Option 5	Specific brand	R 10.99	No genetically modified maize
Option 6	Specific brand	R 10.99	Farmer used genetically modified maize to increase crop yield
Option 7	Brand not important	R 6.20	Farmer used genetically modified maize to increase crop yield
Option 8	Brand not important	R 8.10	No genetically modified maize
Option 9	Brand not important	R 10.99	Genetically modified maize used to increase shelf life of maize meal

3.4.4 Presenting the constructed scenarios to the respondents

The constructed scenarios can be presented to respondents by means of the trade-off approach, pair wise comparisons or the full profile approach (Hair *et al.*, 1995). In the trade-off method of presenting scenarios to respondents, attributes are presented two at a time and respondents rank all combinations of the levels in terms of preference. Pair-wise comparisons involve presenting a pair of scenarios to the respondent for evaluation. According to Hair, Anderson, Tatham and Black (1995) the most popular method is the full-profile approach. The full-profile approach involves the presentation of scenarios to respondents for evaluation that consists of a complete description of the scenario across all attributes. This approach is applicable when the number of attributes will not cause difficulties for the respondents to differentiate between the various hypothetical product descriptions (Murphy *et al.*, 2000). Advantages of the full-profile format include the following (Green & Srinivasan, 1978; Hair *et al.*, 1995):

- Can be used in conjunction with orthogonal arrays to develop fractional factorial designs with fewer scenarios.
- Judgements can be rated or ranked.
- More realistic product descriptions are obtained by defining levels of each factor in the scenario.

The full-profile approach can lead to problems when there are many product attributes in the experiment, causing information overload. In addition, the order in which the product attributes are listed on the stimulus card may have an influence on the consumer's evaluation of the product alternative (Hair *et al.*, 1995).

The full-profile approach was selected for this conjoint experiment. Nine profile cards were created that displayed the nine product scenarios. An example of one of these profile cards is shown in Table 3.4.

Table 3.4 An example of the profile cards used in the conjoint experiment

Brand:	Specific brand
Price for 2.5kg packet of super maize meal:	R8.10
Maize type used to produce the maize meal:	Genetically modified maize used to increase shelf life of maize meal

3.4.5 Selecting a measure of consumer preference

In a conjoint experiment consumer preferences can be measured by rank ordering or rating (Hair *et al.*, 1995). The full-profile and pair wise comparison methods can employ ranking or rating, while the trade-off method employs only ranking data. In the rank order preference measure the respondent rank the profile cards from most preferred to least preferred. When dealing with a relatively small number of scenarios a major advantage of rank ordering is that it is easier than rating and could lead to more reliable results (Hair *et al.*, 1995). A disadvantage of the ranking method is that it usually requires personal interviews to manage the sorting of stimulus cards by respondents. Rating of preferences on a metric scale is the second possibility in order to measure consumers' preferences. The rating scale should be fixed within a certain range (Murphy *et al.*, 2000). Rating could be applied within other survey methods, such as mail surveys. However, respondents could be less discriminating in their evaluations compared to the ranking method (Hair *et al.*, 1995).

The rank order method was selected in this study to measure consumer preferences. The main motivation behind this choice was the fact that some of the respondents, especially those in the lower LSM groups had relatively low education levels and

would benefit from the simplicity of the ranking task. The respondents were asked to rank the 9 product options from most preferred to least preferred.

3.4.6 Survey design

A conjoint experiment can be administered by means of personal interviews, mail surveys, telephone surveys, Internet surveys or combinations of these methods (Tull & Hawkins, 1993). In cases where the complexity of the conjoint experiment is an issue, personal interviews are usually employed to explain the tasks of the experiment.

The nature of the overall experiment suggested that personal interviews were the best way to administer the conjoint experiment. The sensory evaluation component of the research also required personal contact with the respondents. It was anticipated that the low education levels of some of the respondents could make it necessary to explain the conjoint experiment process and guide the respondent through the experiment.

3.4.7 Estimating the model

In conjoint analysis the basic form of the relationship between product attributes and overall judgements has to be specified. The additive model is the most commonly used quantification method to quantify the values assigned to each attribute level. Based on the quantification method a “total worth” score could be assigned to each respondent’s combination of attributes. In the additive model, it is assumed that the consumer’s overall evaluations are formed by the sum of the separate part-worths of the attributes (Steenkamp, 1987). There are other models to quantify the values assigned to each attribute level. However, research indicated that other models seldom have a significantly better fit to the data than the additive model (Emery & Barron, 1979).

The additive model was used to model the basic relationship between the product attributes and the overall judgements of the various maize meal products. Thus, it was assumed that the consumers’ overall evaluations of the maize meal products could be calculated as the sum of the separate part-worth scores of the various

attributes of the maize meal product. An additive model was developed for the conjoint model in this experiment in order to calculate the respondents' willingness to pay values. These models will be discussed below.

On order to estimate the parameters of the conjoint model a variety of approaches are available for the analysis of conjoint data. According to Green and Srinivasan (1978) these approaches can be classified into three categories:

- Non-metric methods that assume the dependent variable has an ordinal scale.
- Metric methods that assume the dependent variable has an interval scale, e.g. ordinary least squares (OLS) regression and minimizing sum of absolute errors.
- Non-metric methods that relate paired-comparison data to a choice probability model.

The non-metric methods are usually applied with rating values, while the metric methods are usually applied with rank order data (Green & Srinivasan, 1978). According to Cattin and Wittink (1982) and Tull and Hawkins (1993), OLS regression is one of the most commonly used procedures used to estimate part-worth scores in a conjoint experiment. Research studies have shown that the application of OLS regression analysis with rank order data produced solutions that had predictive validity close to the predictive validity of the more expensive and more complicated non-metric techniques (Jain, Acito, Malhotra & Mahajan, 1979; Cattin & Wittink, 1982; Carmone, Green & Jain, 1978). However, when regression analysis is applied to rank order data the standard errors and statistical tests are not valid (Green & Srinivasan, 1978). In such cases the fit of the model to the data is normally evaluated in terms of Spearman's rank correlation coefficient between the input values and estimated values of the dependent (rank order) variable (Green & Srinivasan, 1978).

OLS regression was applied in order to estimate the parameters of the conjoint model. In order to apply OLS regression to rank order data, ranking needed to be inverted so that higher numbers represented increasing levels of preference / purchase likelihood (Tull & Hawkins, 1993). Thus, in the first step of the model estimation process the rank order was inverted to (1) "Least preferred option" up to (9) "Most preferred

option”. In the questionnaire the rank order was defined as (1) “Most preferred option” up to (9) “Least preferred option”.

Effects coding was applied in order to code the 9 hypothetical product scenarios, which were presented to the respondents and allowed for the calculation of the coefficient of the “left-out” dummy variable (Lusk *et al.*, 2002). The “Brand” and “Maize source” variables were treated as dummy variables and subjected to effects coding. For each attribute one arbitrarily chosen level of the attribute was omitted from the regression formula (Tull & Hawkins, 1993). These omitted variable levels were “Brand not important” and “GM crop yield”. A code value of (+1) was assigned when the attribute level was present in the product description. A code value of (0) was assigned when the attribute level was not present in the product description, but a level of the attribute was present in the regression formula. A code value of (-1) was assigned when the attribute level was represented by the level not present in the formula (Tull & Hawkins, 1993). In order to calculate willingness to pay values the specific levels (6.20, 8.10, 10.99) of the “Price” variable were used in the regression analysis estimation.

As mentioned earlier, the additive conjoint model was developed in order to investigate the respondents’ preferences and to estimate the respondents’ willingness to pay (WTP) values. According to Van der Pol and Ryan (1996) indirect estimates of the respondents’ WTP values could be acquired if cost is included as an attribute in the conjoint experiment.

The additive WTP conjoint model was specified as:

$$\text{Ranking} = \text{Constant} + B1(\text{Price}) + B2(\text{Specific brand}) + B3(\text{No GM maize}) + B4(\text{GM shelf life})$$

OR

$$Y_n = C + B1(X_1) + B2(X_2) + B3(X_3) + B4(X_4)$$

With:

- C: Constant.
- X1: Price.
- X2: “Specific brand” level of the “Brand” variable.
- X3: “No GM maize” level of the “Maize source” variable.
- X4: “GM shelf life” level of the “Maize source” variable.
- Y_n : Rank order of respondent n, with $n = 1, 2, \dots, 83$.
- B1: Coefficient of Price variable.
- B2: Coefficient of “Specific brand” level of the “Brand” variable.
- B3: Coefficient of “No GM maize” level of the “Maize source” variable.
- B4: Coefficient of “GM shelf life” level of the “Maize source” variable.

OLS regression analysis was done for all 83 respondents individually, based on the conjoint regression model with the software package E-views 3.1. The OLS coefficients of all the respondents were transferred to Microsoft Excel. The OLS regression coefficients formed the basis for the WTP estimations.

In order to generate meaningful results from the OLS estimated coefficients, a number of further analyses were done.

Due to the effects coding the sum of the coefficients / part-worth values of each attribute added up to zero. Thus, the coefficient / part-worth of the omitted level of each attribute was the value that made the sum of all the coefficients / part-worth values equal to zero. The coefficients / part-worth values of the omitted variable levels within the conjoint regression model was calculated for all respondents individually.

The willingness to pay (WTP) values were also calculated for all the respondents individually. A specific WTP value was an estimation of the maximum price a consumer was willing to pay to acquire a certain option (e.g. maize meal containing no GM maize) rather than another option (e.g. maize meal containing maize that was genetically modified for extended shelf life purposes).

The WTP values were calculated with the following formula (Van der Pol & Ryan, 1996):

$$\text{WTP} = [(\text{coefficient of option A} - \text{coefficient of option B}) / |\text{price coefficient}|]$$

Thus, the WTP for option A relative to option B was calculated by dividing the difference between the coefficients of options A and B, with the absolute value of the price coefficient.

Eight WTP values were calculated for every respondent:

- WTP for “Specific brand” maize meal relative to maize meal with no specific brand.
- WTP for maize meal with no specific brand relative to “Specific brand” maize meal.
- WTP for maize meal manufactured from maize that was genetically modified to increase shelf life, relative to maize meal manufactured from maize that was genetically modified to increase crop yield.
- WTP for maize meal manufactured from maize that was genetically modified to increase shelf life, relative to maize meal manufactured from regular (non-GM) maize.
- WTP for maize meal manufactured from maize that was genetically modified to increase crop yield, relative to maize meal manufactured from maize that was genetically modified to increase shelf life.
- WTP for maize meal manufactured from maize that was genetically modified to increase crop yield, relative to maize meal manufactured from regular (non-GM) maize.
- WTP for maize meal manufactured from regular (non-GM) maize, relative to maize meal manufactured from maize that was genetically modified to increase shelf life.
- WTP for maize meal manufactured from regular (non-GM) maize, relative to maize meal manufactured from maize that was genetically modified to increase crop yield.

3.4.8 Assessing the reliability and validity of the conjoint results

According to Green and Srinivasan (1978) the reliability of the conjoint experiment results can be tested with methods such as test-retest reliability of the input preference judgements, as well as alternate forms method with spaced testing.

Validity can be assessed in terms of internal- and external validity. Internal validity encompasses the fit of the model to the data. As mentioned earlier the standard errors and statistical tests are not valid when regression analysis is applied to rank order data. Consequently the fit of the model to the data could be evaluated in terms of the nonparametric Spearman's rank correlation coefficient between the input values and estimated values of the dependent (rank order) variable (Green & Srinivasan, 1978). External validity is achieved when the sample is representative of the population of the research study (Hair *et al.*, 1995).

The results of the sensory evaluation experiment and the responses to some of perception questions in the survey questionnaire were compared with the conjoint results. These aspects will be discussed in Chapter 5.

Spearman's rank correlation coefficient between the input values and estimated values of the dependent (rank order) variable was applied to assess the internal validity of the conjoint results of each individual respondent. The Spearman rank correlation coefficients for all 83 respondents were calculated by means of the statistical package SPSS 12.0 for Windows for the conjoint regression model. Acceptable internal validity was defined by a 5% probability level of significance associated with the Spearman rank correlation coefficient results. The internal validity of the conjoint results of 3 out of the 83 respondents were unacceptable at the 5% probability level of significance. These responses were not taken into consideration. Thus, the sample decreased to 80 respondents based on the internal validity test results.

External validity is achieved when the sample is representative of the population of the research study (Hair *et al.*, 1995). However, the experimental sample was compiled based on six groups within the LSM market segmentation tool in order to make comparisons possible between the various LSM groups. The experimental

sample was not designed to be representative of the population, implying that the external validity was not tested in this experiment.

3.5 THE WILLINGNESS-TO-PAY (WTP) CONJOINT MODEL: RESULTS AND DISCUSSION

Table 3.5 shows the OLS estimated aggregate coefficients for coefficients B1 to B4, as well as the calculated values for the “left-out” variables (“Brand not important” and “Farmer used GM maize to increase crop yield”), regarding the WTP conjoint model.

The estimated aggregate average price coefficient was negative, implying that an increase in the price of the maize meal would result in a decline in the utility derived from the maize meal. Furthermore, on the aggregate level, lower priced maize meal would be preferred to higher priced maize meal, holding all other maize meal attributes constant.

Table 3.5 Estimated coefficients / part-worth values for the WTP conjoint model (n = 80)

Attribute:	Variable / Attribute level:	Coefficient:
Brand name ^a	“Specific brand” (Coefficient B2)	0.788**
	“Brand not important” ^c	-0.788**
Price	Price for 2.5kg packet of super white maize meal (Coefficient B1)	-0.354**
Maize type used to produce the maize meal ^a	“No GM maize” ^b (Coefficient B3)	-0.242**
	“Farmer used GM maize to increase crop yield” ^{b,c}	-0.721**
	“GM maize used to increase shelf life of maize meal” ^b (Coefficient B4)	0.963**

** Statistical significance at a 5% probability level, based on Spearman’s rank correlation coefficient

^a Attributes were effects coded in such a way that the coefficient of the “left-out” attribute level equal the negative sum of the “included” categories.

^b The phrase “genetically modified” was replaced with the acronym “GM”

^c Part-worth utility value was calculated based on the effects coding principle.

WTP values were calculated, based on the coefficients, for each respondent individually. The clustering research objectives related to the WTP conjoint model evolved around the relative importance of a specific maize meal attribute or attribute level to the other maize meal attributes or attribute levels and whether clusters of respondents could be found with similar patterns of importance. Consequently standardization by respondents was applied to prevent size displacements contributing

towards the similarity among respondents. Thus, the estimated WTP values were rescaled so that a rescaled WTP value of (+1) indicated the most preferred trade-off option and a rescaled WTP value of (-1) indicated the least preferred trade-off option for a specific respondent. The estimated aggregate rescaled WTP values are summarised in Table 3.6.

Table 3.6 Estimated aggregate rescaled WTP values for the WTP conjoint model (n = 80)

WTP for ...	Relative to ...	Estimated rescaled WTP value:
Branded maize meal	Non-branded maize meal	0.166
Non-branded maize meal	Branded maize meal	-0.166
“GM shelf life” maize meal	“GM crop yield” maize meal	0.299
“GM shelf life” maize meal	“No GM” maize meal	0.152
“GM crop yield” maize meal	“GM shelf life” maize meal	-0.299
“GM crop yield” maize meal	“No GM” maize meal	-0.146
“No GM” maize meal	“GM shelf life” maize meal	-0.152
“No GM” maize meal	“GM crop yield” maize meal	0.146

Thus, on an aggregate level the respondents preferred:

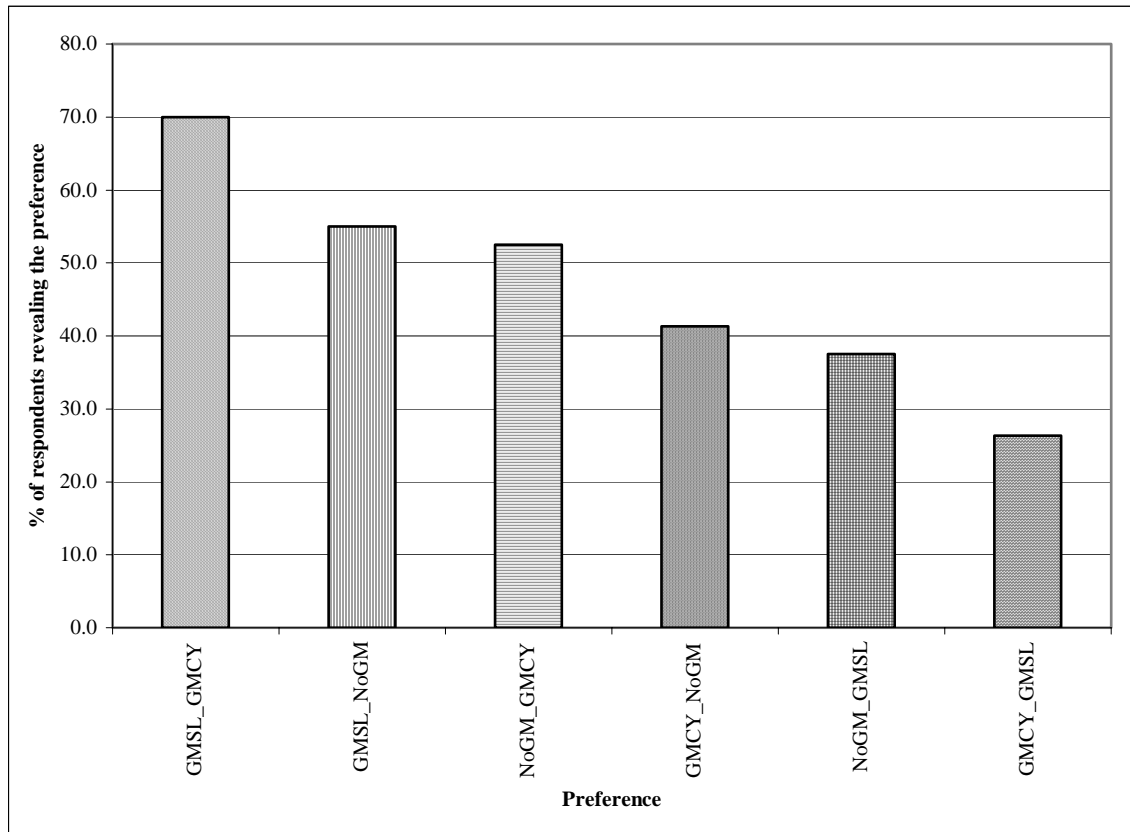
- Branded maize meal to non-branded maize meal.
- Maize meal manufactured from maize that was genetically modified to increase the product’s shelf life to maize meal manufactured from maize that was genetically modified to increase crop yield and also GM-free maize meal.
- GM-free maize meal to maize meal manufactured from maize that was genetically modified to increase crop yield.

Descriptive statistics were calculated in order to analyse the trends revealed by the conjoint analysis results.

The conjoint results indicated that 48.8% of the respondents prefer a specific maize meal brand, while 32.5% do not have a preference for a specific brand. Thus, the majority of the sample respondents prefer branded maize meal. It was mentioned earlier that the experimental pilot survey indicated that brand was an important purchase consideration for maize meal consumers and that 89% of the respondents in the Food Consumption Survey of 1999 (on a national level) were aware of the brand

name of the maize they consumed (MacIntyre & Labadarios, 2000). Thus the trend revealed by the experimental conjoint results confirmed these previous observations.

The maize meal preferences of the respondents are shown in Figure 3.1.



“GMSL” = Maize meal produced from maize, genetically modified to increase maize meal shelf life
 “GMCY” = Maize meal produced from maize, genetically modified to increase maize yield
 “NoGM” = Maize meal produced from non-GM maize
 “GMSL_GMCY” = Preference for “GM shelf life” maize meal above “GM crop yield” maize meal
 “GMSL_NoGM” = Preference for “GM shelf life” maize meal above “No GM” maize meal
 “NoGM_GMCY” = Preference for “No GM” maize meal above “GM crop yield” maize meal
 “GMCY_NoGM” = Preference for “GM crop yield” maize meal above “No GM” maize meal
 “NoGM_GMSL” = Preference for “No GM” maize meal above “GM shelf life” maize meal
 “GMCY_GMSL” = Preference for “GM crop yield” maize meal above “GM shelf life” maize meal

Figure 3.1 Maize meal preferences of the respondents revealed in the conjoint experiment

According to Figure 3.1, 70.0% of the respondents revealed a preference for the use of genetic modification to increase the shelf life of maize meal, compared to the use

of genetic modification to increase maize crop yield. Furthermore, 55.0% of the respondents revealed a preference for the use of genetic modification to increase the shelf life of maize meal, compared to maize meal manufactured from normal (non-genetically modified) maize.

When respondents had to indicate their preferences with regard to maize meal manufactured from normal (non-genetically modified) maize, 52.5% of the respondents revealed a preference for non-GM maize meal rather than the use of genetic modification to increase maize crop yield. Furthermore, 37.5% of the respondents revealed a preference for non-GM maize meal rather than use of genetic modification to increase the shelf life of maize meal.

The results in Figure 3.1 also indicates that 41.3% of the respondents revealed a preference for the use of genetic modification to increase the crop yield of maize, compared to maize meal manufactured from normal (non-genetically modified) maize. Furthermore, 26.3% of the respondents revealed a preference for the use of genetic modification to increase the crop yield of maize, rather than the use of genetic modification to increase the shelf life of maize meal.

According to Figure 3.1 most of respondents prefer maize meal manufactured from maize genetically modified to benefit them as consumers above maize meal manufactured from maize genetically modified to benefit producers. In the second place respondents prefer maize meal manufactured from maize genetically modified to benefit them as consumers above maize meal manufactured from non-GM maize. In the third place the preference is for maize meal manufactured from non-GM maize above maize meal manufactured from maize that is genetically modified to benefit producers. The smallest number of respondents preferred maize meal manufactured from maize that was genetically modified to benefit producers, to maize meal manufactured from maize that was genetically modified to benefit consumers. Thus, the size of the various preference groups suggested that the dominating preference among all the respondents is for maize meal manufactured from maize that is genetically modified to benefit consumers. This suggests a general positive perception toward GM technology provided that they as consumers benefit.

3.6 CHAPTER CONCLUSION

The conjoint analysis results revealed that the largest percentage of the respondents prefer maize meal manufactured from maize that was genetically modified to benefit consumers, followed by non-GM maize meal. There were also a large percentage of respondents who prefer non-GM maize meal to GM maize meal. In terms of brand awareness the majority of respondents revealed a preference for branded maize meal. These results did give an indication of the maize meal preferences of the urban white maize consumers, given the presence of GM maize in the market. However, in order to group consumers with similar preference patterns together to form market segments, it was necessary to conduct cluster analysis based in the conjoint analysis results.

CHAPTER 4: MARKET SEGMENTATION

4.1 INTRODUCTION

The aim of this chapter is to apply cluster analysis, in order to identify market segments among the South African consumers of white maize meal living in urban areas with similar preferences, based on the preferences (WTP values) they revealed in the conjoint analysis presented in Chapter 3.

The first section of this chapter presents a theoretical overview of cluster analysis and the specific experimental detail-, results and discussion of the cluster analysis applied in the study.

4.2 THEORETICAL OVERVIEW

Cluster analysis is a class of techniques used to classify objects into relatively homogeneous groups called clusters, in such a manner that objects within the various clusters tend to be similar to each other and dissimilar to object in the other clusters (Malhotra, 1996). Cluster analysis is applied to group observations based on distances across a series of variables (Sudman & Blair, 1998). The basis for cluster analysis is the rationale that objects, which are closer together, should be allocated to the same group, while objects, which are far apart, should be allocated to different groups. According to Sudman and Blair (1998) the two most common distance measures are the “Euclidean distance” and the “City block distance”. The “Euclidean distance” is calculated as the square root of the sum of the squared differences in values for each variable. The “City block distance” between two objects is the sum of the absolute differences in values for each variable.

According to Malhotra (1996) clustering procedures can be classified as hierarchical or non-hierarchical. Hierarchical clustering (e.g. Ward’s procedure) involves the development of a hierarchy structure. A non-hierarchical / k-means clustering procedure determines cluster centres and then group all observations within a pre-specified threshold value from the specific centre. The choice of a clustering method

and the choice of distance measure are interrelated (Malhotra, 1996). For example, Ward's method and a number of non-hierarchical clustering methods are often applied in conjunction with squared Euclidean distances.

There are a number of advantages and disadvantages associated with the various clustering procedures. The main advantages of non-hierarchical cluster analysis are that it is less time consuming than hierarchical cluster analysis and the results can be less sensitive to outliers in the data, the distance measure used and the inclusion of irrelevant or inappropriate variables if the cluster centers are correctly selected (Malhotra, 1996; Hair *et al.*, 1995). However, there are a number of disadvantages associated with non-hierarchical cluster analysis (Malhotra, 1996; Hair *et al.*, 1995):

- The number of clusters must be pre-specified.
- The selection of cluster centres is random in many statistical packages.
- The clustering results may depend on how the cluster centres are selected.
- The clustering results may depend on the order of observations in the data set.

The main advantages of hierarchical cluster analysis are that it allows for more flexibility in the cluster analysis, application of a wider variety of distance measures and the number of clusters does not have to be specified before the analysis is conducted (Malhotra, 1996; Hair *et al.*, 1995). The disadvantages of hierarchical cluster analysis include the following (Malhotra, 1996; Hair *et al.*, 1995):

- Outliers within the data set can lead to misleading results and when outliers are removed from the data set the results are not representative.
- Not suitable when dealing with very big samples.

A satisfactory clustering solution should be efficient and effective (Malhotra, 1996; Hair *et al.*, 1995). An effective clustering solution will employ as few clusters as possible in order to address the research objectives, while an efficient clustering solution will capture all statistically and commercially important clusters.

Cluster analysis can be used for a number of applications. According to Sudman and Blair (1998) the most important application of cluster analysis within the scope of

marketing research is to form groups of customers for market segmentation purposes. Cluster analysis are often applied to conjoint analysis results to group conjoint respondents into clusters according to similarities and differences in the values they attach to various product attribute levels (Hair *et al.*, 1995; Sudman & Blair, 1998).

The cluster analysis process involves a number of steps (adopted from Malhotra, 1996; Sudman & Blair, 1998): Formulating the problem, selecting a distance measure, selecting a clustering procedure, selecting the number of clusters, interpreting the clusters and assessing the overall significance of the cluster analysis results.

4.3 DESCRIPTION OF THE CLUSTER ANALYSIS

In order to formulate the clustering problem the variables were selected as a basis for clustering. The selected variables had to describe the similarity between objects in a way that were relevant to the marketing research problem (Malhotra, 1996). The selection of relevant variables could be based on past research studies, theory and the consideration of the research objectives and / or hypothesis of the specific research project (Malhotra, 1996).

Within the specific cluster analysis process of this study, variables were selected based on the research objectives and the consideration of information from similar studies by previous researchers. The clustering objective of the WTP conjoint model was to identify homogeneous groups of consumers based on their WTP for the various trade-offs between the levels of the respective maize meal attributes.

The following clustering variables were selected with respect to the WTP conjoint model:

- WTP for “Specific brand” maize meal relative to maize meal with no specific brand.
- WTP for maize meal manufactured from maize that was genetically modified to increase shelf life, relative to maize meal manufactured from maize that was genetically modified to increase crop yield.

- WTP for maize meal manufactured from maize that was genetically modified to increase shelf life, relative to maize meal manufactured from regular (non-GM) maize.
- WTP for maize meal manufactured from maize that was genetically modified to increase crop yield, relative to maize meal manufactured from regular (non-GM) maize.

According to Sudman and Blair (1998) overlapping variables should not be included in the selected clustering variables. The nature of the WTP values was such that the WTP values of the various trade-off pairs were mirror images of each other. For example, the WTP value of a specific respondent for “Specific brand” maize meal relative to maize meal with no specific brand, had the same value but opposite sign than the same respondent’s WTP value for maize meal with no specific brand relative to “Specific brand” maize meal. Thus, in order to prevent the inclusion of overlapping variables, certain variables were not included in the clustering process (even though these variables were included indirectly, by means of their “mirror-image” variables):

- WTP for maize meal with no specific brand relative to “Specific brand” maize meal.
- WTP for maize meal manufactured from maize that was genetically modified to increase crop yield, relative to maize meal manufactured from maize that was genetically modified to increase shelf life.
- WTP for maize meal manufactured from regular (non-GM) maize, relative to maize meal manufactured from maize that was genetically modified to increase shelf life.
- WTP for maize meal manufactured from regular (non-GM) maize, relative to maize meal manufactured from maize that was genetically modified to increase crop yield.

As mentioned earlier, cluster analysis groups observations based on distance across a series of variables (Sudman & Blair, 1998). Within the specific cluster analysis process of the research project the distance measure was selected in conjunction with the selected clustering procedure.

Hierarchical cluster analysis was applied in the study because the number of appropriate clusters was initially unknown. Hierarchical cluster analysis was therefore more suitable, since the number of clusters did not have to be specified before the analysis was conducted. Hierarchical cluster analysis was also selected in order to avoid the problem associated with non-hierarchical cluster analysis that the order of observations in the data set could influence the clustering results.

As mentioned earlier hierarchical cluster analysis is not suitable when dealing with very big samples. In this case with a sample size of only 80 respondents, hierarchical cluster analysis was thus appropriate. Furthermore, when applying hierarchical cluster analysis outliers within the data set can lead to misleading results and when outliers are removed from the data set the results are not representative. In order to address this problem standardization was applied to the WTP dataset, as described below.

Ward's hierarchical cluster analysis with squared Euclidean distances was done within the statistical software package SPSS 12.0. In order to prevent outliers affecting the results standardization was applied to the WTP dataset. The size of the dataset (80 valid respondents in the dataset for the WTP conjoint model) was appropriate for the application of Ward's clustering procedure.

The clustering research objectives related to the WTP conjoint model evolved around the relative importance of a specific maize meal attribute or attribute level to the other maize meal attributes or attribute levels and whether clusters of respondents could be found with similar patterns of importance based on consumers' WTP values. According to Hair, Anderson, Tatham and Black (1995) standardization by respondents is appropriate in such cases. In other words, when the size displacements should not contribute towards the similarity among respondents, column standardizing (standardizing by respondents in this case) could be appropriate (Romesburg, 1984).

The standardised WTP values were calculated by means of the following formula (Romesburg, 1984):

$$Z_{ij} = \frac{X_{ij}}{C_{MAXj}}$$

With:

- Z_{ij} : The standardized value of the i^{th} attribute and the j^{th} respondent.
 X_{ij} : The original data value of the i^{th} attribute and the j^{th} respondent.
 C_{MAXj} : The maximum value observed for the j^{th} respondent.

Given the “mirror-image” nature of the WTP values, the standardised data set contained at least one value of $Z_{ij} = 1.0$ (indicating the strongest preference for that respondent), and one value of $Z_{ij} = -1.0$ (indicating the strongest negative preference for that respondent).

The following guidelines were taken into consideration in order to decide on the number of clusters (Malhotra, 1996; Sudman & Blair, 1998):

- The various clustering solutions were judged in order to establish how meaningful and useful the various clustering solutions were.
- The relative sizes of the clusters within the various clustering solutions had to be meaningful.

A four-cluster solution was selected for the cluster analysis that addressed the objective to identify homogeneous groups of consumers based on their WTP for the various trade-offs between the maize meal attribute levels.

Cluster centroids are defined as the mean values of the objects contained in the cluster on each of the variables used in the clustering process (Hair *et al.*, 1995). The clustering results were interpreted by examining the cluster centroids of the various cluster solutions. These interpretations will be discussed later in this chapter.

Judgement was employed in order to determine whether the analyses were significant (Sudman & Blair, 1998). Thus, a judgement was made on whether the analyses results effectively accomplished the various grouping objectives, by producing meaningful and useful results.

The differences between the respondents within the various clusters, could be investigated further by developing profiles for the clusters in terms of variables that were not used for clustering (Malhotra, 1996). Cluster profiling was done within this study. The relevant procedures and results will be discussed in the next chapter.

4.4 MARKET SEGMENTATION BASED ON THE WTP CONJOINT MODEL: RESULTS AND DISCUSSION

Market segments were developed by means of cluster analysis in order to investigate consumer preferences regarding white maize meal based on the estimated and rescaled WTP values developed by means of the WTP conjoint model. The market segment analysis revealed that the respondents could be grouped into one of four groups, based on the estimated and rescaled WTP values. The average estimated WTP values were an indication of the estimated price increase necessary to offset the positive utility associated with the attribute level trade-off combination.

Cluster 1 included 28 respondents (35% of the sample of 80 respondents). Table 4.1 displays the average rescaled WTP values and average estimated WTP values for the respondents in Cluster 1.

Based on the results in Table 4.1, the respondents in Cluster 1 revealed a strong preference for maize meal manufactured from normal (non-genetically modified) maize relative to maize meal containing GM maize and a weak preference for branded maize meal.

Table 4.1 Average rescaled WTP values and average estimated WTP values for the respondents in Cluster 1

WTP for ...	Relative to ...	Average rescaled WTP value	Average estimated WTP value (Rand)
Branded maize meal	Non-branded maize meal	0.210	R 1.53
Non-branded maize meal	Branded maize meal	-0.210	-R 1.53
“GM shelf life” maize meal	“GM crop yield” maize meal	0.384	R 2.67
“GM shelf life” maize meal	“No GM” maize meal	-0.471	-R 4.64
“GM crop yield” maize meal	“GM shelf life” maize meal	-0.384	-R 2.67
“GM crop yield” maize meal	“No GM” maize meal	-0.855	-R 7.31
“No GM” maize meal	“GM shelf life” maize meal	0.471(b)	R 4.64(b)
“No GM” maize meal	“GM crop yield” maize meal	0.855(a)	R 7.31(a)

(a) Highest estimated value

(b) Second highest estimated value

According to the average estimated WTP values in Table 4.1, the following observations were made regarding Cluster 1:

- The price premium necessary to invoke consumer indifference between GM-free maize meal versus “GM shelf life” maize meal or “GM crop yield” maize meal is R7.31 and R4.64 respectively, for a 2.5kg packet of maize meal. At any premium less than R7.31 (R4.64) the respondents in Cluster 1, on average derives higher utility from GM-free maize meal than from “GM shelf life” and “GM crop yield” maize meal and will probably make their purchase decision based on the preference. However, if GM-free maize meal is priced at a premium greater than R7.31 (R4.64), for a 2.5kg packet of maize meal the average consumer will shift consumption to “GM shelf life” (“GM crop yield”) maize meal.
- The price premium necessary to invoke consumer indifference between branded and non-branded maize meal is R1.53 for a 2.5kg packet of maize meal. At any premium less than R1.53 the respondents in Cluster 1, on average derives higher utility from branded maize meal than from non-branded maize meal and will probably make their purchase decision based on the preference. If branded maize meal is priced at a premium greater than R1.53, for a 2.5kg packet of maize meal the average consumer will shift consumption to non-branded maize meal.

Thus, consumers in Cluster 1 revealed the strongest preference for non-GM maize meal among all the clusters. In general consumers in Cluster 1 are strongly against

maize meal containing genetically modified maize, especially when the maize is genetically modified for the farmers' benefit. These consumers have some brand awareness. Based on these characteristics the consumers in Cluster 1 were named the "Anti-GM" cluster.

Cluster 2 included 16 respondents (20% of the sample of 80 respondents). Table 4.2 displays the average rescaled WTP values and average estimated WTP values for the respondents in Cluster 2.

Table 4.2 Average rescaled WTP values and average estimated WTP values for the respondents in Cluster 2

WTP for ...	Relative to ...	Average rescaled WTP value	Average estimated WTP value (Rand)
Branded maize meal	Non-branded maize meal	-0.581	-R 5.42
Non-branded maize meal	Branded maize meal	0.581(a)	R 5.42(a)
"GM shelf life" maize meal	"GM crop yield" maize meal	-0.443	-R 4.21
"GM shelf life" maize meal	"No GM" maize meal	-0.114	-R 2.12
"GM crop yield" maize meal	"GM shelf life" maize meal	0.443(b)	R 4.21(b)
"GM crop yield" maize meal	"No GM" maize meal	0.328	R 2.09
"No GM" maize meal	"GM shelf life" maize meal	0.114	R 2.12
"No GM" maize meal	"GM crop yield" maize meal	-0.328	-R 2.09

(a) Highest estimated value

(b) Second highest estimated value

Based on the results in Table 4.2, the respondents in Cluster 2 revealed strong preferences for non-branded relative to branded maize meal, as well as for maize meal manufactured from maize that is genetically modified to benefit producers relative to maize meal manufactured from maize that was genetically modified to benefit consumers and maize meal manufactured from normal (non-genetically modified) maize.

According to the average estimated WTP values, the following observations were made regarding Cluster 2:

- The price premium necessary to invoke consumer indifference between non-branded maize meal versus branded maize meal is R5.42, for a 2.5kg packet of maize meal. At any premium less than R5.42 the respondents in Cluster 2, on

average derive higher utility from non-branded maize meal than from branded maize meal and will probably make their purchase decision based on the preference. However, if non-branded maize meal is priced at a premium greater than R5.42 for a 2.5kg packet of maize meal the average consumer will shift consumption to branded maize meal.

- The price premium necessary to invoke consumer indifference between “GM crop yield” maize meal versus “GM shelf life” maize meal or GM-free maize meal is R4.21 and R2.09 respectively, for a 2.5kg packet of maize meal. At any premium less than R4.21 (R2.09) the respondents in Cluster 2, on average derive higher utility from “GM crop yield” maize meal than from “GM shelf life” and GM-free maize meal and will probably make their purchase decision based on the preference. However, if “GM crop yield” maize meal is priced at a premium greater than R4.21 (R2.09) for a 2.5kg packet of maize meal, the average consumer will shift consumption to “GM shelf life” (GM-free) maize meal.

A premium of R5.42 for a 2.5kg packet of non-branded maize meal seems very high. This result should be interpreted with caution, since the WTP value is strongly influenced by the price levels chosen in the conjoint design, as well as the strength of a consumer’s preference for non-branded versus branded maize meal. Thus, the high WTP value should be interpreted as a strong indication of preference and not an actual price premium in monetary terms.

In general, consumers in Cluster 2 revealed the strongest preference for non-branded maize meal amongst all the clusters. The consumers in Cluster 2 are positive about maize meal containing GM maize that was modified to increase crop yield and consequently benefiting the farmers. Based on these characteristics the consumers in Cluster 2 were named the “Pro-GM farmer sympathetic” cluster.

Cluster 3 included 20 respondents (25% of the sample of 80 respondents). Table 4.3 displays the average rescaled WTP values and average estimated WTP values for the respondents in Cluster 3.

Table 4.3 Average rescaled WTP values and average estimated WTP values for the respondents in Cluster 3

WTP for ...	Relative to ...	Average rescaled WTP value	Average estimated WTP value (Rand)
Branded maize meal	Non-branded maize meal	0.126	R 1.19
Non-branded maize meal	Branded maize meal	-0.126	-R 1.19
“GM shelf life” maize meal	“GM crop yield” maize meal	0.831(b)	R 7.35(b)
“GM shelf life” maize meal	“No GM” maize meal	0.862(a)	R 8.02(a)
“GM crop yield” maize meal	“GM shelf life” maize meal	-0.831	-R 7.35
“GM crop yield” maize meal	“No GM” maize meal	0.031	R 0.67
“No GM” maize meal	“GM shelf life” maize meal	-0.862	-R 8.02
“No GM” maize meal	“GM crop yield” maize meal	-0.031	-R 0.67

(a) Highest estimated value

(b) Second highest estimated value

Table 4.3 indicates that the respondents in Cluster 3 revealed strong preferences for maize meal manufactured from maize that was genetically modified to benefit consumers, relative to maize meal manufactured from normal (non-genetically modified) maize and maize meal manufactured from maize that is genetically modified to benefit producers. The respondents also revealed a preference for branded maize meal. According to the average estimated WTP values, the following observations were made regarding Cluster 3:

- The price premium necessary to invoke consumer indifference between “GM shelf life” maize meal versus GM-free or “GM crop yield” maize meal is R8.02 and R7.35 respectively, for a 2.5kg packet of maize meal. At any premium less than R8.02 (R7.35) the respondents in Cluster 3, on average derive higher utility from “GM shelf life” maize meal than from GM-free and “GM crop yield” maize meal and will probably make their purchase decision based on the preference. However, if “GM shelf life” maize meal is priced at a premium greater than R8.02 (R7.35) for a 2.5kg packet of maize meal, the average consumer will shift consumption to GM-free (“GM crop yield”) maize meal.
- The price premium necessary to invoke consumer indifference between branded maize meal versus non-branded maize meal is R1.19, for a 2.5kg packet of maize meal. At any premium less than R1.19 the respondents in Cluster 3, on average derive higher utility from branded maize meal than from non-branded maize meal and will probably make their purchase decision based on the preference.

However, if branded maize meal is priced at a premium greater than R1.19 for a 2.5kg packet of maize meal the average consumer will shift consumption to non-branded maize meal.

Thus, consumers in Cluster 3 generally revealed the strongest preference for maize meal manufactured from maize that was genetically modified to benefit consumers, amongst all the clusters. These consumers have a general preference for maize meal manufactured from GM maize and even prefer maize meal manufactured from maize that is genetically modified to benefit producers to non-GM maize meal. They also have a preference for branded maize meal. Based on these characteristics the consumers in Cluster 3 were named the “Pro-GM consumer benefit” cluster.

Cluster 4 included 16 respondents (20% of the sample of 80 respondents). Table 4.4 displays the average rescaled WTP values and average estimated WTP values for the respondents in Cluster 4.

Table 4.4 Average rescaled WTP values and average estimated WTP values for the respondents in Cluster 4

WTP for ...	Relative to ...	Average rescaled WTP value	Average estimated WTP value (Rand)
Branded maize meal	Non-branded maize meal	0.884(a)	R 6.50(a)
Non-branded maize meal	Branded maize meal	-0.884	-R 6.50
“GM shelf life” maize meal	“GM crop yield” maize meal	0.226	R 2.23
“GM shelf life” maize meal	“No GM” maize meal	0.624(b)	R 6.03(b)
“GM crop yield” maize meal	“GM shelf life” maize meal	-0.226	-R 2.23
“GM crop yield” maize meal	“No GM” maize meal	0.399	R 3.80
“No GM” maize meal	“GM shelf life” maize meal	-0.624	-R 6.03
“No GM” maize meal	“GM crop yield” maize meal	-0.399	-R 3.80

(a) Highest estimated value

(b) Second highest estimated value

Table 4.4 indicates that the respondents in Cluster 4 revealed strong preferences for branded maize meal relative to non-branded maize meal, as well as for genetically modified maize meal relative to non-GM maize meal. According to the average estimated WTP values, the following observations were made regarding Cluster 4:

- The price premium necessary to invoke consumer indifference between branded maize meal versus non-branded maize meal is R6.50, for a 2.5kg packet of maize meal. At any premium less than R6.50 the respondents in Cluster 4, on average derive higher utility from branded maize meal than from non-branded maize meal and will probably make their purchase decision based on the preference. However, if branded maize meal is priced at a premium greater than R6.50 for a 2.5kg packet of maize meal the average consumer will shift consumption to non-branded maize meal.
- The price premium necessary to invoke consumer indifference between “GM shelf life” maize meal versus GM-free or “GM crop yield” maize meal is R6.03 and R2.23 respectively, for a 2.5kg packet of maize meal. At any premium less than R6.03 (R2.23) the respondents in Cluster 4, on average derive higher utility from “GM shelf life” maize meal than from GM-free and “GM crop yield” maize meal and will probably make their purchase decision based on the preference. However, if “GM shelf life” maize meal is priced at a premium greater than R6.03 (R2.23) for a 2.5kg packet of maize meal, the average consumer will shift consumption to GM-free (“GM crop yield”) maize meal.

Thus, consumers in Cluster 4 generally revealed the strongest preference for branded maize meal amongst all the clusters. They have an overall positive attitude towards maize meal manufactured from GM maize (especially when they as consumers received the benefit of the genetic modification, but also when the farmer received the benefit from the genetic modification). Based on these characteristics the consumers in Cluster 4 were named the “Pro-GM” cluster.

4.5 CHAPTER CONCLUSION

This chapter focused on the theory, methodologies and results of the cluster analysis component of the research project. Four clusters (market segments) were developed by means of cluster analysis of the willingness-to-pay (WTP) values generated based on WTP conjoint model, in order to investigate the preferences of urban consumers in Gauteng, regarding white maize meal.

The first cluster (n=28, 35% of the valid responses) was named the “Anti-GM” cluster, since they have the strongest preferences for maize meal manufactured from normal (non-genetically modified) maize, relative to maize meal manufactured from maize that is genetically modified to benefit producers and maize meal manufactured from maize that was genetically modified to benefit consumers. They are particularly negative about maize meal manufactured from maize that is genetically modified to benefit producers.

The second cluster (n=16, 20% of the valid responses) revealed the strongest preferences for maize meal manufactured from maize that is genetically modified to benefit producers relative to maize meal manufactured from maize that is genetically modified to benefit consumers and maize meal manufactured from normal (non-genetically modified) maize. They are particularly negative about maize meal manufactured from maize that is genetically modified to benefit consumers. Thus, this cluster was named the “Pro-GM farmer sympathetic” cluster.

The third cluster (n=20, 25% of the valid responses) was named the “Pro-GM consumer benefit” cluster since they prefer maize meal manufactured from maize that was genetically modified to benefit consumers, to maize meal manufactured from normal (non-genetically modified) maize and maize meal manufactured from maize that is genetically modified to benefit producers. They are particularly negative about maize meal manufactured from normal (non-genetically modified) maize and maize meal manufactured from maize that is genetically modified to benefit producers.

The fourth cluster (n=16, 20% of the valid responses) prefers maize meal manufactured from maize that is genetically modified to benefit consumers and maize meal manufactured from maize that is genetically modified to benefit producers to maize meal manufactured from normal (non-genetically modified) maize. This cluster was named the “Pro-GM” cluster. The “Pro-GM” cluster is particularly negative about maize meal manufactured from normal (non-genetically modified) maize.

A judgement was made on whether the analyses results effectively accomplished the various grouping objectives, by producing meaningful and useful results. The WTP

clusters had unique cluster characteristics and acceptable cluster magnitudes (since no cluster consisted of less than 20.0% of the total sample of respondents). Consequently the WTP clusters were considered to be a good basis for further cluster profiling.

The WTP clusters that were developed within this chapter, based on the conjoint analysis results, were used as a starting point upon which certain components of the rest of the analyses within the research project were built in order to investigate differences between the respondents in the various clusters and to create more extensive descriptions of the various cluster. Thus, the identified clusters were used as a basis to profile the various clusters in terms of selected aspects within the research project that were not used for the clustering procedures. The cluster profiling procedures, results and discussion will be covered in the next chapter.

CHAPTER 5: PROFILING THE LSM AND CLUSTER GROUPS

5.1 INTRODUCTION

Within Chapter 4, four distinct market segments were identified within the sample of Gauteng urban maize meal consumers: The “Anti-GM” segment, the “Pro-GM farmer sympathetic” segment, the “Pro-GM consumer benefit” segment and the “Pro-GM” segment. Furthermore, the sample of respondents consisted of three distinct groups due to the quota sampling based on the LSM classification. As mentioned earlier, one of the applications of conjoint analysis includes the analysis of the variations amongst respondents regarding their conjoint results (Hair *et al.*, 1995; Sudman & Blair, 1998). This application was used in this chapter to investigate the differences between the respondents within the various market segments (clusters) and within the various LSM groups by developing profiles in terms of variables that were not used for clustering. These profiling procedures and results are discussed within this chapter.

The cluster and LSM profiling results discussed within this chapter contributed towards addressing the following objectives within the overall research project:

- To develop profiles of the LSM groups based on the GM knowledge- and GM perception and attitude information gathered within the research project.
- To develop profiles of the identified market segments, based on the demographic-, GM knowledge-, GM perception and attitude information gathered within the research project.
- To compare the profiles of the LSM groups and the cluster groups.
- To develop an idea of the existing knowledge status of South African urban white maize consumers regarding GM food.
- To determine the perceptions and attitudes of South African urban consumers towards GM white maize.

The LSM and cluster profiling is based on a series of survey questions in order to gather information regarding demographic variables, GM knowledge variables and GM perception and -attitude variables.

Some examples will be discussed where researchers used various variables to develop profiles for market segments which were developed based on conjoint analysis results. Baker (1999) used socio-economic characteristics (including gender, age, household size, household income, education level and ethnicity) and value characteristics (e.g. being well-respected, excitement, security, self-respect) to profile market segments for fresh apples in the USA market. Huang and Fu (1995) used socio-economic and demographic characteristics (including age, employment, education, household income, household composition and monthly expenditure) to profile market segments of Taiwanese housewives regarding Chinese sausage attributes. Baker and Burnham (2002) applied cluster profiling within the context of GM food, specifically dealing with the product corn flakes. In order to develop cluster profiles this study employed socio-demographic variables (gender, age, income, marital status, children in home, ethnicity and residence), a biotechnology knowledge variable, risk variables and variables related to respondents perceptions regarding GM foods' effects on food quality and safety.

5.2 METHODOLOGY

The discussion of the experimental method related to the cluster profiling consists of two sections. The first section covers the components that were addressed within the survey questionnaire, including the demographic questions, GM knowledge questions and GM perception and –attitude questions. These discussions cover the relevant aspects of data gathering and data analysis. The second section covers the statistical analysis techniques applied, in more detail.

5.2.1 Survey questionnaire components

After completing the sensory evaluation experiment, the respondents completed the conjoint task, followed by completion of the survey questionnaire by means of a personal interview with an enumerator. The survey questionnaire contained all the

other questions used in the cluster profiling process. The various questions can be seen in the survey questionnaire in Appendix C. The survey questionnaire contained all the demographic-, GM knowledge and GM perception and -attitude questions that were used in the cluster profiling process. These profiling questions were partially based on and adopted from similar studies by other researchers (Baker and Burnham, 2002; Verdurme and Viaene, 2002; Wolf, Bertolini and Parker-Garcia, 2002).

Data analysis involved the following. The LSM membership characteristics of the various cluster groups were analysed by means of chi-square tests. The demographic questions included gender, respondent's age, household size, number of children in household 18 years and younger, ethnic group, residence area type (rural / urban), highest education level completed and citizenship country. The demographic variables were coded and captured in SPSS 12.0.

The gender-, ethnic group- and education level variables were analysed by means of chi-square tests. The age-, household size- and number of children in household variables were analysed by means of one-way analysis of variance (ANOVA) tests. The residence area type variable (rural or urban) were simply analysed with a frequency distribution, in order to make sure that all the respondents were from urban areas.

Respondents' knowledge on GM food related issues were measured by means of two sets of questions. In the first set of questions respondents expressed their own opinion regarding:

- The amount they have read and heard of GM food related terms on a 4 point

Likert interval scale:

(1) A lot	(2) Some	(3) A little	(4) Nothing at all
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- Their understanding and ability to explain GM food related terms, on a 4 point

Likert interval scale:

(1) Very well	(2) Relatively well	(3) A little	(4) Not at all
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In the second set of true or false type questions, the respondents were presented with some statements to evaluate their GM knowledge, which they had to evaluate in terms of their level of agreement on a 5 point Likert interval scale:

(1) Strongly disagree	(2) Disagree	(3) Neutral	(4) Agree	(4) Strongly agree
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These questions included the following:

- Statement: “Animal characteristics cannot be transferred to plants through genetic modification”. The statement was false, implying that the “correct” answer was “Strongly disagree”.
- Statement: “Conventional food does not contain genes, but genetically modified food do contain genes”. The statement was false. Thus, “Strongly disagree” was the “correct” answer.
- Statement: “Genetic modification can be used to make agricultural crops such as maize resistant to pests and diseases”. The statement was true. Thus, “Strongly agree” was the “correct” answer.

The responses to these GM knowledge questions were coded and captured in SPSS 12.0. One-way ANOVA tests were applied to the data, in order to investigate whether there were significant differences in the mean response values for the various GM knowledge questions, across the various LSM and cluster groups.

Respondents’ perceptions and attitudes towards GM food were investigated by presenting respondents with a number of statements, which they had to evaluate based on their level of agreement on a 5 point Likert interval scale:

(1) Strongly disagree	(2) Disagree	(3) Neutral	(4) Agree	(5) Strongly agree
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These questions included the following:

- Statement: “Genetically modified crops can be a threat to the environment”. Thus, a higher rating value represented a more negative GM perception and attitude of a respondent.

- Statement: “Genetically modified food can be beneficial for consumers”. Thus, a higher rating value represented a more positive GM perception and attitude of a respondent.
- Statement: “Genetically modified food is not safe”. Thus, a higher rating value represented a more negative GM perception and attitude of a respondent.
- Statement: “Genetically modified food is not natural”. Thus, a higher rating value represented a more negative GM perception and attitude of a respondent.
- Statement: “The quality of genetically modified food is lower than the quality of conventionally produced food”. Thus, a higher rating value represented a more negative GM perception and attitude of a respondent.
- Statement: “Eating genetically modified food is a health risk”. Thus, a higher rating value represented a more negative GM perception and attitude of a respondent.
- Statement: “Genetically modified should be cheaper than normal food”. Thus, a higher rating value represented a perception that GM food should be cheaper than non-GM food and thus a higher price sensitivity in terms of GM food products.

In order to form an idea of the overall attitude of the respondents towards GM food products the respondents also expressed their opinion regarding their likelihood of buying GM food, on a 5 point Likert interval scale:

(1) Will definitely buy	(2) Will probably buy	(3) Will maybe buy	(4) Will probably not buy	(5) Will definitely not buy
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The responses to these GM perception and -attitude questions were coded and captured in SPSS 12.0. One-way ANOVA tests were applied to the data, in order to investigate whether there were significant differences in the mean response values for the various GM perception and -attitude questions, across the various LSM and cluster groups.

5.2.2 Statistical tests applied in the data analysis

5.2.2.1 Correlation analysis

Correlation analysis investigates the relationship between two variables by indicating how the change in one attribute will result in a change in a correlating attribute (Johnson, 1994). Generally, a coefficient of approximately (+ / -) 0.700 is regarded as indicating a fairly strong correlation.

5.2.2.2 Multivariate statistical analyses: Canonical Variate Analysis

Canonical Variate Analysis (CVA) was used to determine which variables discriminate most between the LSM and the cluster groups. CVA, also better known as linear discriminant analysis, is used when it is of more interest to show differences between groups (such as LSM / cluster groups) than between individuals (Krzanowski, 1988). The variability in a large number of variables is firstly reduced to a smaller set of variables that account for most of the variability. The new set of variables, called canonical variates, is linear combinations of the original measurements, and is thus given as vectors of loadings for the original measurements. The scores found for each of the canonical variates are then correlated with the original variates to find those that are the most important in discriminating between the groups. With this approach a set of directions are obtained in such a way that the ratio of between group variability to within group variability in each direction is maximised (Krzanowski, 1988). In this study the variates were the demographic-, sensory evaluation results-, GM knowledge- and GM perceptions/attitudes characteristics of the respondents in the sample.

Plots of the canonical variate means for each group show the group positions relative to one-another. In such a plot, points closer together are similar and points further apart are dissimilar with respect to the variates that discriminate between them. The 95% confidence region of the group means is calculated as circle radius' about the means (Krzanowski, 1988) and when these circles overlap, the groups do not differ at the 5% level (Krzanowski, 1988).

5.2.2.3 *The analysis of variance (ANOVA) test*

The two-way between group analysis of variance (ANOVA) test was applied in this study to explore the impact of “Cluster group”, “LSM group” and “Tasting sample number” on the tasting ratings of the respondents in tasting sessions 1 and 3. The dependent variable in the analyses was “Tasting rating”, while the independent variables were “Cluster group”, “LSM group” and “Tasting sample number”.

The one-way between group ANOVA test was applied to investigate whether there were significant differences in the mean values of a dependent variable (e.g. some rating response), across 3 or more independent groups. In order to conduct the one-way between groups ANOVA test it was necessary to have one independent variable consisting of 3 or more levels (groups) and one dependent continuous variable (Pallant, 2001). The independent variable could for example be LSM group or cluster group, while the dependent continuous variable could be age, household size or a rating response for a specific question. An example of typical questions, which was answered in this research, project by means of the one-way between groups ANOVA was: “Is there a difference in the age characteristics of the different cluster groups?”

The assumptions of the ANOVA test include the following (Pallant, 2001; Tull and Hawkins, 1993):

- The independent variable should be an interval scaled or continuous scaled variable.
- The results should be obtained by means of random sampling from the normally distributed population. The ANOVA tests are however relatively tolerant of violations of the normality assumption, but the data should be symmetric.
- The observations should be independent of each other.
- Samples should be obtained from populations of equal variances. Thus, cell variances should be the same. The ANOVA tests are however relatively tolerant of violations of the homogeneity of variance assumption, but the size of the groups should be relatively similar.
- Data should be normally distributed.

These assumptions were taken into consideration during the data analysis process.

All ANOVA tests were performed with the statistical package SPSS 12.0 for Windows. The Levene test for equality of variances was performed in SPSS 12.0 to test the homogeneity of variances assumption. A significance level of greater than $p=0.0500$ indicated that the homogeneity of variances assumption was not violated. If the homogeneity of variances assumption was violated a more stringent significance probability level ($p=0.0100$) was applied for evaluating the results of the two-way between-group ANOVA analysis, as suggested by Pallant (2001). The ANOVA table displayed the calculated F-value and the associated significance level of the F-value. A significance value of 0.10 or less indicated a significant difference in the compared mean values. The results of the Least Significant Differences (LSD) test in the multiple comparisons table were only interpreted if the F-value indicated significant differences between the group means. The LSD test results indicated whether significant differences existed between the group means, when compared two at a time. Significant differences between two groups were present if the calculated LSD significance values were $p \leq 0.100$.

5.2.2.4 The Chi-square test

The Chi-square test was applied in this study to determine whether two categorical variables (each with two or more categories) were related. The two categorical variables could for example be cluster group and gender classification. An example of a typical question which were answered in this research project by means of the Chi-square test, was whether the ratio of males to females was the same for the four cluster category groups.

All Chi-square analyses in the research were done by means of the “Chi-square test for independence” in the statistical package SPSS 12.0 for Windows. The procedure required the specification of the row variable (e.g. cluster category group), the column variable (e.g. gender classification) and the options to calculate observed cell values, expected cell values, row percentages, column percentages and total percentages.

For tables larger than 2 by 2 proportions the Chi-square test results table contained the Pearson Chi-square value, two-sided probability value, number of degrees of freedom, the number of valid cases and a footnote indicating the number and percentage of cells with expected cell frequencies of less than 5. For 2 by 2 tables the Chi-square test results table contained the Continuity Corrected Chi-square value, the two-sided probability value, the number of degrees of freedom, the number of valid cases and a footnote indicating the number and percentage of cells with expected cell frequencies of less than 5.

A two-sided probability value of 0.100 or lower indicates a significant result, with the implication that there are significant differences in the proportions of the independent groups. A two-sided probability value of more than 0.0500 indicates a non-significant result, with the implication that there are no significant differences in the proportions associated with the independent groups (Pallant, 2001). For 2 by 2 tables the Yates' Continuity Corrected Chi-square value with the associated two-sided probability value was interpreted. The Yates' Continuity Correction compensated for the overestimation of the Chi-square value when used with a 2 by 2 table. The Pearson Chi-square value with its associated two-sided probability value was interpreted for larger tables (Pallant, 2001).

Even though a significant result (i.e. two-sided probability of 0.10 or less) indicates that there are significant differences in the proportions of the independent groups at a 10% probability level, the result does not give an indication of exactly where the differences among the groups occur. If the results indicate that there are overall significant differences, further analyses need to be done to determine where the significant differences were between the group pairs. These analyses had to cover all possible combinations of the groups that were compared. For example, three groups led to three possible combinations in total, while four groups led to six possible combinations in total. These results were evaluated at a probability level calculated by dividing the original probability level by the number of possible combinations, given the number of groups to be compared. For example, with three groups compared, the results were evaluated at the 1.67% probability level (calculated by dividing 5.00% by 3). In such a case two groups were significantly different if the associated probability value was 1.67% or less.

5.3 AGGREGATE ANALYSIS OF THE KNOWLEDGE LEVELS OF URBAN WHITE MAIZE CONSUMERS REGARDING GENETIC MODIFICATION

The first two questions related to consumers' knowledge of genetic modification allowed respondents to express their own opinions regarding their exposure and knowledge regarding genetic modification. The respondents' perceived exposure to genetic modification was relatively low, since 63.8% of the respondents indicated an exposure level of "A little" or "Nothing at all". The respondents' perceived understanding of genetic modification terms was also low since 65.0% of the respondents indicated that their ability to explain genetic modification terms varied between "A little" and "Not at all".

The other questions related to consumers' knowledge of genetic modification tested the respondents' knowledge of genetic modification with three statements, which they had to evaluate in terms of their level of agreement. For the first statement "Animal characteristics cannot be transferred to plants through genetic modification" relatively low knowledge levels was observed since 40.2% of the respondents responded to the question with a "somewhat wrong" to "don't know" answer. The same observation was made for the statement "Conventional food does not contain genes, but genetically modified food do contain genes" where 48.8% of the respondents responded to the question with a "somewhat wrong" to "don't know" answer. In total 62.2% of the respondents responded correctly to the third statement "Genetic modification can be used to make agricultural crops such as maize resistant to pests and diseases", possibly due to the fact that this statement was less scientifically complex than the first two statements and that fact that the respondents encountered this statement in the conjoint experiment.

5.4 PROFILING THE LSM GROUPS

5.4.1 LSM group profiling based on knowledge of genetic modification

The profiling results of the LSM groups based on the respondents' knowledge of genetic modification are shown in Table 5.1. In order to facilitate the interpretation of

these results for the LSM groups, a spider graph (Figure 5.1) was constructed of the results in Table 5.1.

Table 5.1 Characteristics of the three LSM groups in terms of genetic modification knowledge

Characteristic:	LSM category			Specific significant differences between:
	Rating: LSM 4, 5 (n=25)	Rating: LSM 6, 7 (n=29)	Rating: LSM 8, 9, 10 (n=28)	
Perceived GM exposure ^{a b ***} (Mean rating)	3.16	2.76	2.11	LSM 4,5 and LSM8,9,10 LSM 6,7 and LSM8,9,10
Perceived GM understanding ^{a c **} (Mean rating)	3.16	2.79	2.50	LSM 4,5 and LSM 6,7 LSM 4,5 and LSM8,9,10
Statement to test GM knowledge 1 ^{a d g} (Mean rating)	3.36	3.10	3.29	None
Statement to test GM knowledge 2 ^{a e g ***} (Mean rating)	3.12	2.76	1.86	LSM 4,5 and LSM8,9,10 LSM 6,7 and LSM8,9,10
Statement to test GM knowledge 3 ^{a f g} (Mean rating)	3.96	4.45	4.43	None

*** Significant differences at the 1% probability level.

** Significant differences at the 5% probability level.

^a The one-way ANOVA test was applied.

^b Respondents expressed their opinion on the amount read / heard of GM food related terms.

Scale (1) "A lot", (2) "Some", (3) "A little" and (4) "Nothing at all".

Interpretation: Larger value implies a higher perceived exposure to GM food related terms.

^c Respondents expressed their opinion regarding their understanding of GM food related terms.

Scale (1) "Very well", (2) "Relatively well", (3) "A little" and (4) "Not at all".

Interpretation: Larger value implies a higher perceived understanding of GM food related terms.

^d Respondents expressed their level of agreement with the statement: "Animal characteristics cannot be transferred to plants through genetic modification".

Interpretation: The statement was false, thus (1) "Strongly disagree" was the correct answer.

^e Respondents expressed their level of agreement with the statement: "Conventional food does not contain genes, but genetically modified food do contain genes".

Interpretation: The statement was false, thus (1) "Strongly disagree" was the "correct" answer.

^f Respondents expressed their level of agreement with the statement: "Genetic modification can be used to make agricultural crops such as maize resistant to pests and diseases".

Interpretation: The statement was true, thus (5) "Strongly agree" was the "correct" answer to the question.

^g Scale: (1) "Strongly disagree", (2) "Disagree", (3) "Neutral/Don't know", (4) "Agree", (5) "Strongly agree".

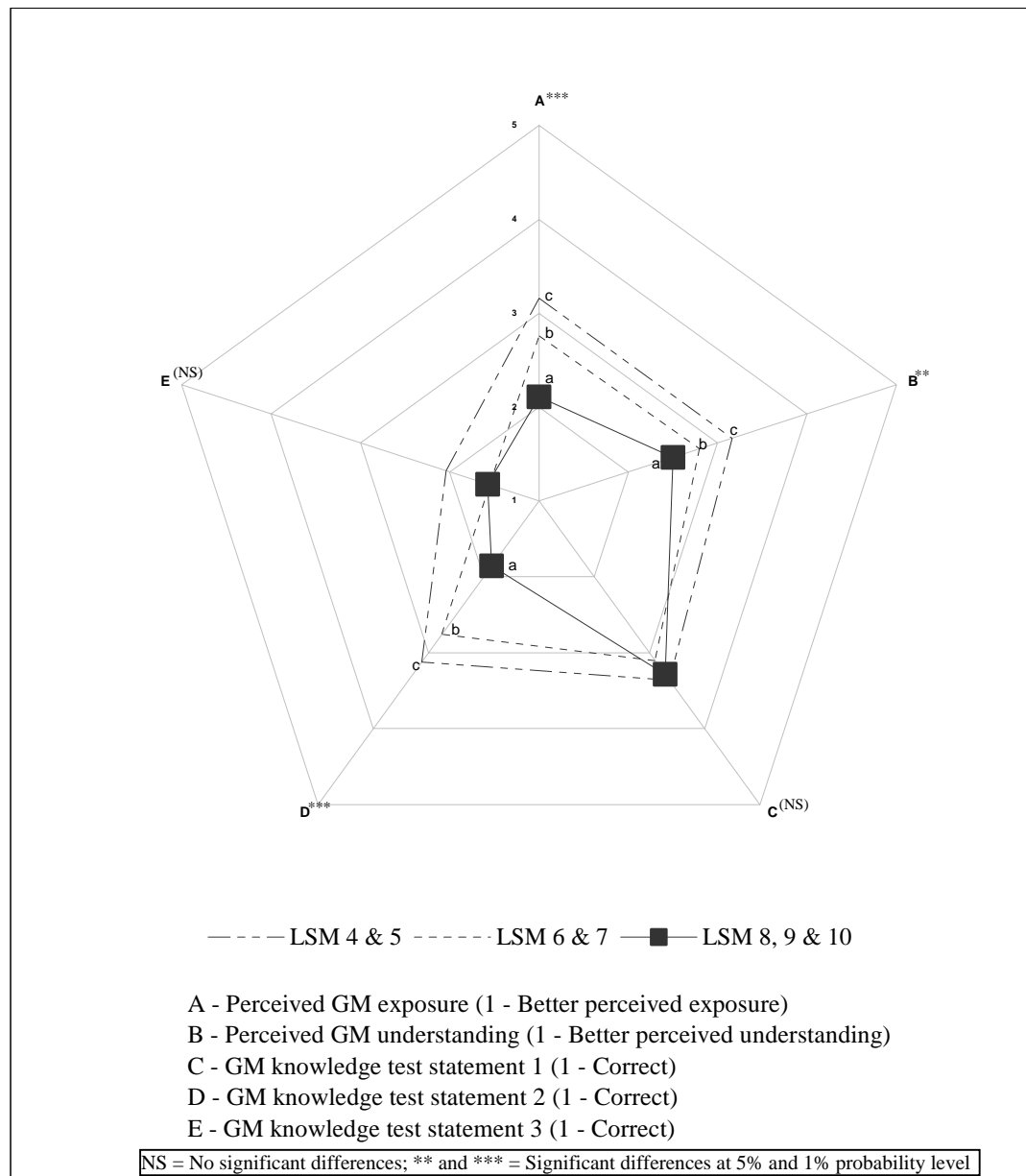


Figure 5.1 Spider graph illustrating the genetic modification knowledge levels of the LSM groups

The first two questions related to consumers' knowledge of genetic modification allowed respondents to express their own opinions regarding their exposure and knowledge regarding genetic modification (A and B on graph in Figure 5.1). The F-statistics were significant at a 1% and 5% probability level respectively ([F=10.8, df=2, $p \leq 0.00100$] and [F=4.45, df=2, $p = 0.0147$]). For both these questions the Levene test statistic [$p > 0.05$], indicated that the homogeneity of variances assumption was not violated. In terms of perceived exposure to genetic modification, significant

differences were observed between LSM 4, 5 and LSM 8, 9, 10 as well as between LSM 6, 7 and LSM 8, 9, 10. In terms of perceived understanding of genetic modification significant differences were observed between LSM 4, 5 and LSM 6, 7 as well as between LSM 4, 5 and LSM 8, 9, 10. It is evident from Figure 5.1 that the perceived exposure to genetic modification and knowledge levels of genetic modification is the highest for LSM 8, 9 and 10, followed by LSM 6,7. LSM 4,5 has the worst perceived levels of exposure and –knowledge of genetic modification.

The perceived exposure of the respondents to genetic modification is relatively low, since none of the average exposure ratings of the LSM groups is close to “A lot”. The average rating for LSM 8, 9, 10 is close to “Some” while the exposure ratings of the other two LSM groups are lower and close to “A little”. The perceived understanding of genetic modification for the respondents is also relatively low, since none of the average ratings of the LSM groups is close to “Very well”. For LSM 8, 9, 10 the average rating of their understanding of genetic modification is between “Relatively well” and “A little”, while the understanding ratings of the other two LSM groups are lower and close to “A little”.

The other questions related to consumers’ knowledge of genetic modification (C, D and E on graph in Figure 5.1) tested the knowledge of respondents with three statements, which they had to evaluate in terms of their level of agreement, in order to test their knowledge of genetic modification. For the statement “Animal characteristics cannot be transferred to plants through genetic modification” no significant differences were observed between the LSM groups [$F=0.231$, $df=2$, $p=0.795$]. Figure 5.1 illustrates that LSM groups 6, 7 reveals the most correct understanding of the statement, followed by LSM 8, 9, 10. LSM 4, 5 reveals the least correct understanding regarding this statement. For this statement all the LSM categories reveal responses that are close to the “Neutral / Don’t know” position on the rating scale.

The second statement presented to the respondents was “Conventional food does not contain genes, but genetically modified food do contain genes”. The F-statistic generated by means of the one-way ANOVA procedure, indicated the presence of overall significant differences at a 1% probability level between the various LSM

groups [$F=8.55$, $df=2$, $p=0.0004$] in terms of their responses to this question. Significant differences were observed between LSM 4, 5 and LSM 8, 9, 10 as well as between LSM 6, 7 and LSM 8, 9, 10. According to Figure 5.1 LSM groups 8, 9, 10 has the most correct understanding of the statement, while LSM 4, 5 has the least correct understanding. LSM 8, 9, 10 is relatively sure about the fact that the statement is false, however the average ratings of the other two LSM groups are close to the “Neutral / Don’t know” position on the rating scale.

For the statement “Genetic modification can be used to make agricultural crops such as maize resistant to pests and diseases” no significant differences were observed between the LSM groups [$F=1.66$, $df=2$, $p=0.197$]. LSM groups 6, 7 has the most correct understanding of the statement, while LSM 4, 5 has the least correct understanding. The respondents in all the LSM groups revealed a very high level of correct understanding regarding this statement. This could be attributed to the fact that this aspect was included in the conjoint experiment. Thus, the respondents were exposed to this fact statement earlier on during the experimental session.

These results generally revealed increasing levels of exposure and understanding towards genetic modification, as the LSM category increases. As discussed earlier, some of the fundamental characteristics of the LSM groups are that education levels and income increase as the LSM category increases. Thus, the increased levels of exposure and understanding towards genetic modification among higher LSM consumers could probably be explained by their higher education levels, as well as their higher income levels (giving them access to more opportunities to be exposed to and learn about issues related to genetically modified food).

5.4.2 LSM group profiling based on perceptions and attitudes towards genetic modification

The analyses of the results of all the questions testing the respondents’ perceptions and -attitudes towards genetic modification were done for the LSM groups. These results for the various LSM categories are shown in Table 5.2.

Table 5.2 Characteristics of the three LSM groups in terms of perceptions and –attitudes towards genetic modification

Statement:	LSM category			Specific Significant differences between:
	Mean rating LSM 4,5 (n=25)	Mean rating LSM 6, 7 (n=29)	Mean rating LSM 8,9,10 (n=28)	
Perceived likelihood of buying GM food ^{a b k}	1.80	2.07	2.36	None
“Genetically modified crops can be an environmental threat” ^{a c j k}	2.68	2.76	2.18	None
“Genetically modified food can be beneficial for consumers” ^{a d j}	4.60	4.28	4.04	None
“Genetically modified food is not safe” ^{a e j k}	2.12	2.52	2.04	None
“Genetically modified food is not natural” ^{a f j k}	2.92	3.38	2.96	None
“The quality of genetically modified food is lower than the quality of conventionally produced food” ^{a g j k **}	3.00	2.79	2.00	LSM 4,5 & 8,9,10 LSM 6,7 & 8,9,10
“Eating genetically modified food is a health risk” ^{a h j k}	2.32	2.24	2.07	None

** Significant differences at the 5% probability level

^a The one-way ANOVA test was applied

^b Respondents expressed their own opinion regarding their likelihood of buying GM food.

Scale: (1) “Will definitely buy”, (2) “Will probably buy”, (3) “Will maybe buy”, (4) “Will probably not buy” and (5) “Will definitely not buy”.

^c Respondents expressed their level of agreement with the statement: “Genetically modified crops can be a threat to the environment”.

^d Respondents expressed their level of agreement with the statement: “Genetically modified food can be beneficial for consumers”.

Interpretation: A higher rating value represented a more positive GM attitude of a respondent.

^e Respondents expressed their level of agreement with the statement: “Genetically modified food is not safe”.

^f Respondents expressed their level of agreement with the statement: “Genetically modified food is not natural”.

^g Respondents expressed their level of agreement with the statement: “The quality of genetically modified food is lower than the quality of conventionally produced food”.

^h Respondents expressed their level of agreement with the statement: “Eating genetically modified food is a health risk”.

ⁱ Respondents expressed their level of agreement with the statement: “Genetically modified should be cheaper than normal food”.

^j Scale: (1) “Strongly disagree”, (2) “Disagree”, (3) “Neutral/Don’t know”, (4) “Agree”, (5) “Strongly agree”.

^k Interpretation: A higher rating value represented a more negative GM attitude of a respondent.

In order to facilitate the interpretation of these results, a spider graph (Figure 5.2) was constructed of the data contained in Table 5.2.

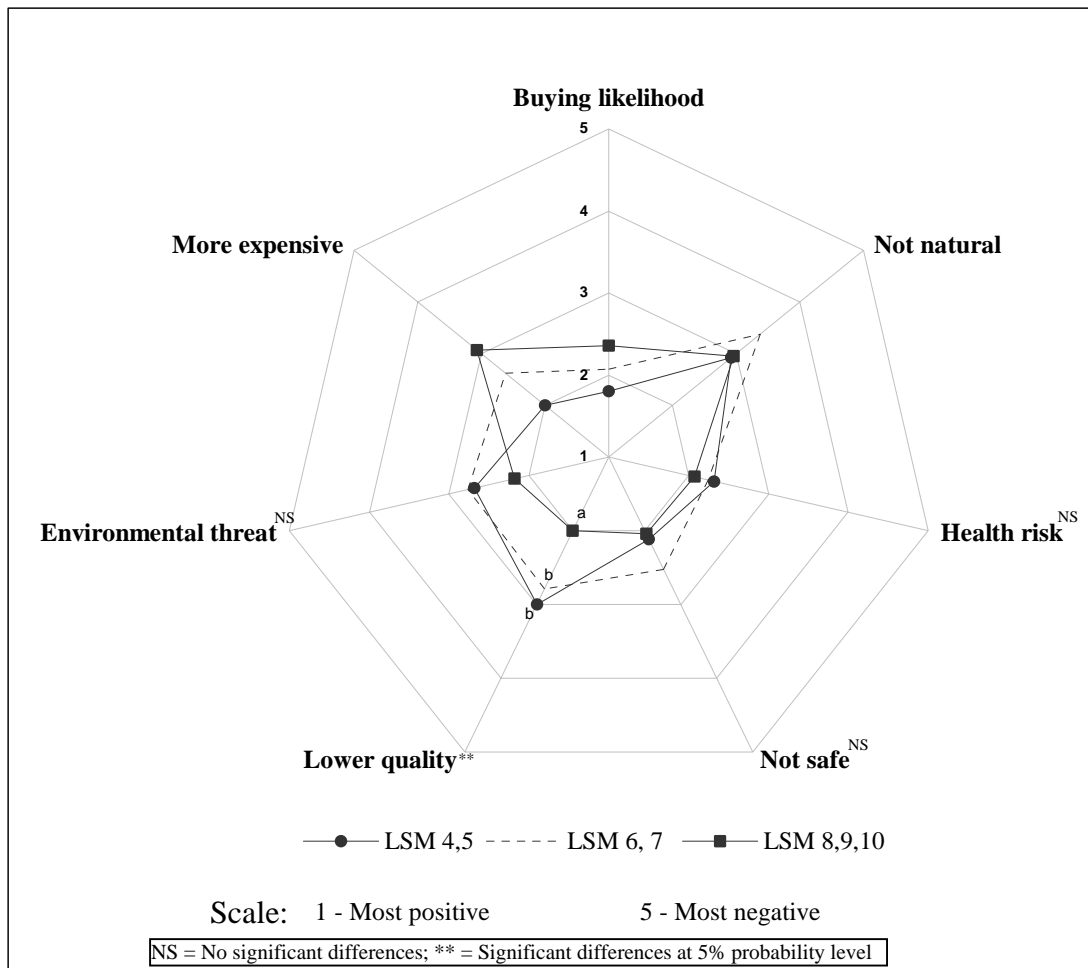


Figure 5.2 Spider graph illustrating the perceptions and attitudes towards genetic modification in food for the LSM groups

The results displayed in Table 5.2 reveal the absence of significant differences in terms of the respondents' willingness to buy GM food, GM food being unnatural, GM food presenting a health risk, GM food being unsafe and GM food presenting an environmental threat.

Despite the absence of significant difference in terms of these statements a number of trends were observed in Figure 5.2:

- The respondents' willingness to buy GM food increases towards the lower LSM groups and is around the "Will probably buy" level for the various LSM groups. Thus, in general the respondents' willingness to buy GM food is relatively high.

- The lower LSM categories (LSM 4, 5, 6 and 7) are more negative towards GM food in terms of GM food presenting a health risk. However, none of the LSM groups are extremely negative in this regard.
- The lower LSM categories (LSM 4, 5, 6, 7) are more negative towards GM food in terms of GM food presenting an environmental threat. However, none of the LSM groups are extremely negative in this regard.
- In terms of GM food being unnatural the respondents revealed some of the strongest negative perceptions / attitudes among the various statements that were evaluated. In terms of this statement LSM 6, 7 revealed the most negative perception / attitude.
- The lowest and highest LSM categories (LSM 4, 5, 8, 9, 10) are more positive towards GM food in terms of GM being unsafe. However, none of the LSM groups are extremely negative in this regard.

Only two of the GM perception statements revealed significant differences at a 5% probability level:

- “The quality of GM food lower than the quality of conventionally produced food” [F=3.35, df=7, p=0.0400], with significant differences between:
 - LSM 4, 5 (more negative about the quality of GM food) and LSM 8, 9, 10 (more positive about the quality of GM food).
 - LSM 6, 7 (more negative about the quality of GM food) and LSM 8, 9, 10 (more positive about the quality of GM food).
- “GM food should be cheaper than normal food” [F=4.82, df=7, p=0.0110], with significant differences between:
 - LSM 4, 5 (strongest agreement with the statement among all the LSM groups) and LSM 8, 9, 10 (weakest agreement with the statement among all the LSM groups, close to “Neutral / Don’t know”).
 - LSM 4,5 (strongest agreement with the statement among all the LSM groups) and LSM 6,7 (agreement level between “Neutral / Don’t know” and “Agree”).

- LSM 6, 7 (level of agreement between “Neutral / Don’t know” and “Agree”) and LSM 8, 9, 10 (weakest agreement with the statement among all the LSM groups, close to “Neutral / Don’t know”).

Thus, the lower LSM groups differed significantly from the higher LSM groups in terms of their quality and price sensitivity regarding GM food products. The lower LSM groups generally perceived the quality of GM food as being lower than the quality of other food and they felt that GM food had to be cheaper than normal food.

It is interesting to note that the highest LSM groups (LSM 8, 9, 10) revealed a “Neutral / Don’t know” attitude and not a disagreement towards the GM food price statement. This seems to suggest that even the wealthier consumers in the sample would not want to pay more for GM food than for other food products.

5.5 PROFILING THE CLUSTER GROUPS

5.5.1 Demographic profiling of the cluster groups

The demographic profiles of the various clusters are shown in Table 5.3.

The Chi-square test indicated significant differences between the various cluster groups in terms of their LSM membership characteristics, at a 5% probability level of significance ($\chi^2=15.9$, $df=6$, $p=0.0144$). The *post-hoc* test indicated overall significant differences between the “Anti-GM” cluster and “Pro-GM farmer sympathetic” cluster, as well as between the “Anti-GM” cluster and “Pro-GM” cluster.

In general LSM groups 6 and 7 (followed by LSM 8, 9 and 10) dominate in the “Anti-GM” cluster. For the “Pro-GM farmer sympathetic” cluster LSM groups 4, 5, 8, 9 and 10 dominate, while LSM groups 4 and 5 (followed by LSM 6 and 7) dominate in the “Pro-GM” cluster. Finally, LSM groups 4, 5, 8, 9 and 10 dominate in the “Pro-GM consumer benefit” cluster.

Table 5.3 Demographic profiling characteristics of the four cluster groups

Characteristic:	Cluster 1: Anti-GM cluster	Cluster 2: Pro-GM farmer sympathetic cluster	Cluster 3: Pro-GM consumer benefit cluster	Cluster 4: Pro-GM cluster	Specific significant differences between:
	(n=28)	(n=16)	(n=20)	(n=16)	
LSM characteristics ^{a **}					
% LSM 4 & 5	7.14	43.8	40.0	50.0	
% LSM 6 & 7	53.6	12.5	25.0	31.3	Clusters 1 & 4
% LSM 8, 9 & 10	39.3	43.8	35.0	18.8	Clusters 1 & 2
Gender ^a					
% Male	32.1	50.0	30.0	37.5	
% Female	67.9	50.0	70.0	62.5	None
Ethnicity ^{a ***}					
% Black	25.0	50.0	50.0	81.3	
% White	75.0	50.0	50.0	18.8	Clusters 1 & 4
Education ^a					
% Up to grade 12	57.1	62.5	60.0	68.8	
% Higher than grade 12	42.9	37.5	40.0	31.3	None
Respondents' mean age ^b	35.8	40.9	34.9	34.5	None
Respondents' mean household size ^b	4.21	4.13	4.45	4.81	None
Mean number of children in household ^b	1.25	1.38	1.30	2.06	None

*** Significant differences at the 1% probability level

** Significant differences at the 5% probability level

^a The Chi-square test was applied.

^b The one-way ANOVA test was applied.

In terms of the gender characteristics of the cluster groups, the Chi-square test indicated the absence of overall significant differences between the various cluster groups [$\chi^2=1.86$, $df=3$, $p=0.602$] in terms of their gender characteristics.

The Chi-square test indicated overall significant differences between the various cluster groups at the 1% probability levels of significance [$\chi^2=13.1$, $df=3$, $p=0.00450$] in terms of their ethnic characteristics. The *post-hoc* test indicated overall significant differences between the “Anti-GM” cluster (dominated by white respondents) and the “Pro-GM” cluster (dominated by black respondents). Within the “Pro-GM farmer sympathetic” cluster and the “Pro-GM consumer benefit” cluster black and white respondents were represented in equal proportions.

For the education level characteristics of the cluster groups, the chi-square test indicated the absence of overall significant differences between the various cluster groups [$\chi^2=0.602$, $df=3$, $p=0.896$]. The lower education levels dominate in all the clusters, especially in the “Pro-GM farmer sympathetic”- and the “Pro-GM” clusters. These observations are probably linked with the fact that the “Pro-GM farmer sympathetic” cluster and the “Pro-GM” cluster contained the highest proportions of respondents from LSM 4 and 5 among all the cluster groups.

The F-statistic generated by means of the one-way ANOVA procedure, indicated the absence of overall significant differences between the various cluster groups [$F=0.866$, $df=3$, $p=0.463$] in terms of their age characteristics.

The F-statistic generated by means of the one-way ANOVA procedure, indicated the absence of overall significant differences between the various cluster groups in terms of their household size characteristics [$F=0.575$, $df=3$, $p=0.633$] and number of children in the household [$F=1.54$, $df=3$, $p=0.211$]. The Levene test statistics [$p>0.05$], indicated that the homogeneity of variances assumption was not violated. The average household sizes of respondents in the various clusters were very similar. The average household size and number of children in the household of respondents within the “Pro-GM” cluster are the highest. Once again this observations are probably linked with the fact that the “Pro-GM” cluster contains the highest proportion of respondents from LSM 4 and 5 among all the cluster groups.

Thus, in terms of the demographic characteristics of the four cluster groups no significant differences were observed between the clusters (at the 10% probability level) in terms of gender, education level, age, household size and number of children in the household. However, the observed trends for education level, household size and number of children in the household did reflect the typical characteristics of the LSM groups that dominated in the various clusters. Significant differences regarding the socio-demographic characteristics were observed between the “Anti-GM” cluster and the “Pro-GM” cluster in terms of their ethnicity characteristics (at a 1% probability level) since the “Anti-GM” cluster consisted of mainly white respondents, while the “Pro-GM” cluster consisted mainly of black respondents.

5.5.2 Cluster group profiling based on knowledge of genetic modification

The profiling results of the cluster groups based on the respondents' knowledge of genetic modification are shown in Table 5.4. In order to facilitate the interpretation of these results for the cluster groups, a spider graph (Figure 5.3) was constructed of the results in Table 5.4.

Table 5.4 Characteristics of the four cluster groups in terms of genetic modification knowledge

Characteristic:	Average rating: Cluster 1: Anti-GM	Average rating: Cluster 2: Pro-GM farmer sympathetic	Average rating: Cluster 3: Pro-GM consumer benefit	Average rating: Cluster 4: Pro-GM	Specific significant differences between:
Perceived GM exposure ^{a b} (Mean rating)	2.43	2.63	2.60	3.13	None
Perceived GM understanding ^{a c} (Mean rating)	2.68	2.75	2.80	3.00	None
Statement to test GM knowledge 1 ^{a d e} (Mean rating)	3.46	3.31	2.95	3.31	None
Statement to test GM knowledge 2 ^{a e g *} (Mean rating)	2.39	2.13	2.60	3.19	Clusters 1 & 4 Clusters 2 & 4
Statement to test GM knowledge 3 ^{a f g} (Mean rating)	1.54	1.87	1.75	1.75	None

* Significant difference at the 10% probability level

^a The one-way ANOVA test was applied.

^b Respondents expressed their opinion on the amount read / heard of GM food related terms.
Scale (1) "A lot", (2) "Some", (3) "A little" and (4) "Nothing at all".

Interpretation: Larger value implies a higher perceived exposure to GM food related terms.

^c Respondents expressed their opinion regarding their understanding of GM food related terms.
Scale (1) "Very well", (2) "Relatively well", (3) "A little" and (4) "Not at all".

Interpretation: Larger value implies a higher perceived understanding of GM food related terms.

^d Respondents expressed their level of agreement with the statement: "Animal characteristics cannot be transferred to plants through genetic modification".

Interpretation: The statement was false, thus (1) "Strongly disagree" was the correct answer.

^e Respondents expressed their level of agreement with the statement: "Conventional food does not contain genes, but genetically modified food do contain genes".

Interpretation: The statement was false, thus (1) "Strongly disagree" was the "correct" answer.

^f Respondents expressed their level of agreement with the statement: "Genetic modification cannot be used to make agricultural crops such as maize resistant to pests and diseases".

Interpretation: The statement was false, thus (1) "Strongly disagree" was the "correct" answer to the question.

^g Scale: (1) "Strongly disagree", (2) "Disagree", (3) "Neutral/Don't know", (4) "Agree", (5) "Strongly agree".

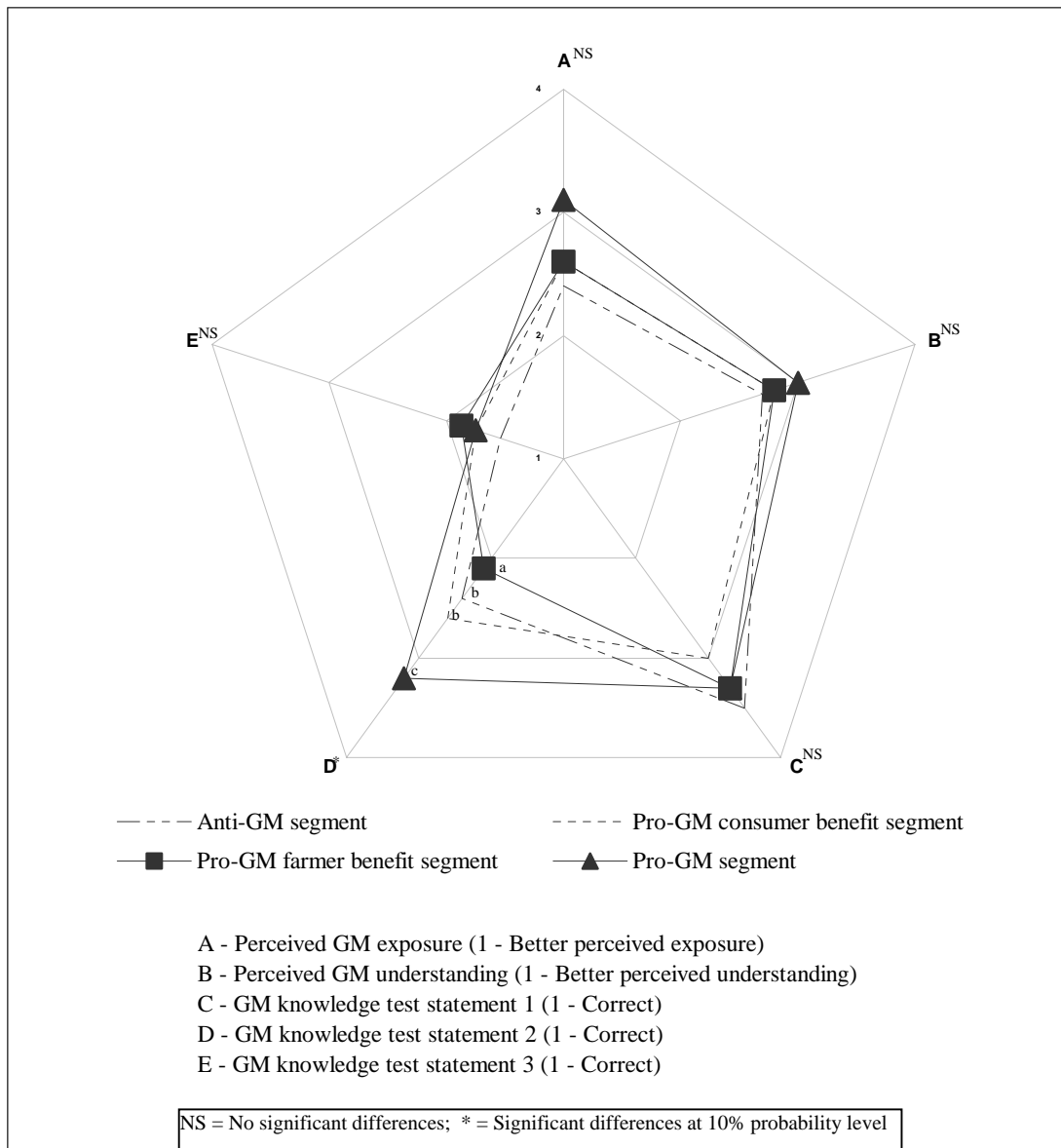


Figure 5.3 Spider graph illustrating the genetic modification knowledge levels of the cluster groups

The first two questions related to consumers' knowledge of genetic modification allowed respondents to express their own opinions regarding their exposure and knowledge regarding genetic modification (A and B in Figure 5.3). The F-statistics were not significant for these questions ($[F=1.96, df=3, p=0.127]$ and $[F=0.504, df=3, p=0.681]$ respectively).

It is evident from Figure 5.4 that the perceived exposure to genetic modification and knowledge levels of genetic modification is the lowest for the “Pro-GM” cluster, while the “Anti-GM” cluster has the highest levels of exposure and –knowledge of genetic modification. The perceived exposure of the respondents to genetic modification is relatively low, and ranged between “Some” / “Relatively well” and “A little”.

The other questions related to consumers’ knowledge of genetic modification (C, D and E on graph in Figure 5.3) tested the knowledge of respondents with three statements, which they had to evaluate in terms of their level of agreement, in order to test their knowledge of genetic modification. For the statement “Animal characteristics cannot be transferred to plants through genetic modification” (C in Figure 5.3) no significant differences were observed between the cluster groups [$F=0.511$, $df=3$, $p=0.676$]. Figure 5.3 illustrates that the respondents in the “Pro-GM consumer benefit” cluster revealed the most correct response, while the “Anti-GM” cluster revealed the least correct understanding of the statement. However, for this question all the clusters’ responses are close to the “Neutral / Don’t know” position and do not reveal definite tendencies towards strong correct or wrong understanding of the statement.

The second statement presented to the respondents was “Conventional food does not contain genes, but genetically modified food do contain genes” (D in Figure 5.3). The F-statistic generated by means of the one-way ANOVA procedure, indicated the presence of overall significant differences (at the 10% probability level) between the various cluster groups [$F=2.18$, $df=3$, $p=0.0971$] in terms of their responses to this question. The LSC *post-hoc* test revealed significant differences between the responses of the “Anti-GM” cluster and the “Pro-GM” cluster, as well as between the “Pro-GM farmer sympathetic” cluster and the “Pro-GM” cluster. According to Figure 5.3 the “Pro-GM” cluster revealed the most incorrect understanding of the statement, while the “Anti-GM”- and “Pro-GM farmer sympathetic” clusters revealed the most correct understanding of the statement among the various clusters. The respondents in the various cluster groups revealed a better understanding of this statement compared with the previous statement, since the responses varied between “Somewhat correct” and “Neutral / Don’t know / Not sure”.

For the statement “Genetic modification can be used to make agricultural crops such as maize resistant to pests and diseases” (E in Figure 5.3), no significant differences were observed between the cluster groups [$F=0.355$, $df=3$, $p=0.786$]. The respondents in the “Anti-GM” cluster revealed the most correct understanding of this statement. In general the respondents revealed the highest levels of GM knowledge in this question compared with the previous two statements. This could be attributed to the fact that the respondents were exposed to this fact statement earlier on during the experimental session in the conjoint experiment.

The GM knowledge results of the cluster groups generally suggest a degree of confusion within the various clusters regarding GM issues, due to the following observations:

- The “Anti-GM” cluster (dominated by the higher LSM groups) perceives that they have the highest levels of GM exposure and understanding among all the clusters. However, in terms of the statement “Animal characteristics cannot be transferred to plants through genetic modification” the respondents in this cluster revealed the most incorrect understanding among all the clusters, while they revealed only the second best understanding of the “Conventional food does not contain genes, ...” statement.
- The “Pro-GM” cluster (dominated by the lower LSM groups) perceives that they have the lowest levels of GM exposure and understanding among all the clusters. However, they only revealed the most incorrect understanding regarding the statement “Conventional food does not contain genes, but genetically modified food do contain genes”.
- Compared to the other clusters the “Pro-GM farmer sympathetic” cluster revealed the best knowledge regarding the “Conventional food does not contain genes, ...” statement and the most incorrect understanding of the statement “Genetic modification can be used to make agricultural crops such as maize resistant to pests and diseases”.
- The “Pro-GM consumer benefit” cluster revealed the best knowledge among all the clusters regarding the statement “Animal characteristics cannot be transferred to plants through genetic modification”.

5.5.3 Cluster group profiling based on perceptions and attitudes towards genetic modification

The analyses of the results of all the questions testing the respondents' perceptions and -attitudes towards genetic modification were done for the cluster groups. These results for the various cluster groups are shown in Table 5.5.

Table 5.5 Characteristics of the four cluster groups in terms of perceptions and –attitudes towards genetic modification

Characteristic:	Average rating: Cluster 1: Anti-GM cluster	Average rating: Cluster 2: Pro-GM farmer sympathetic cluster	Average rating: Cluster 3: Pro-GM consumer benefit cluster	Average rating: Cluster 4: Pro-GM cluster	Specific significant differences between:
Perceived likelihood of buying GM food ^{a b k **}	2.54	1.81	1.75	2.00	Clusters 1 & 2 Clusters 1 & 3
“Genetically modified crops can be a threat to the environment” ^{a c j k *}	2.93	2.75	1.85	2.44	Clusters 1 & 3
“Genetically modified food can be beneficial for consumers” ^{a d j}	3.93	4.50	4.35	4.56	None
“Genetically modified food is not safe” ^{a e j k **}	2.64	2.31	1.60	2.25	Clusters 1 & 3
“Genetically modified food is not natural” ^{a f j k **}	3.68	2.81	2.35	3.19	Clusters 1 & 3
“The quality of genetically modified food is lower than the quality of conventionally produced food” ^{a g j k **}	2.54	2.81	1.85	3.25	Clusters 3 & 4
“Eating genetically modified food is a health risk” ^{a h j k}	2.61	2.00	1.75	2.31	None
“Genetically modified should be cheaper than normal food” ^{a i j}	3.25	3.13	3.40	3.88	None

** Significant differences at the 5% probability level

* Significant differences at the 10% probability level

^a The one-way ANOVA test was applied

^b Respondents expressed their own opinion regarding their likelihood of buying GM food. Scale: (1) “Will definitely buy”, (2) “Will probably buy”, (3) “Will maybe buy”, (4) “Will probably not buy” and (5) “Will definitely not buy”.

^c Respondents expressed their level of agreement with the statement: “Genetically modified crops can be a threat to the environment”.

^d Respondents expressed their level of agreement with the statement: “Genetically modified food can be beneficial for consumers”.

Interpretation: A higher rating value represented a more positive GM attitude of a respondent.

^e Respondents expressed their level of agreement with the statement: “Genetically modified food is not safe”.

^f Respondents expressed their level of agreement with the statement: “Genetically modified food is not natural”.

- ^g Respondents expressed their level of agreement with the statement: “The quality of genetically modified food is lower than the quality of conventionally produced food”.
- ^h Respondents expressed their level of agreement with the statement: “Eating genetically modified food is a health risk”.
- ⁱ Respondents expressed their level of agreement with the statement: “Genetically modified should be cheaper than normal food”.
- ^j Scale: (1) “Strongly disagree”, (2) “Disagree”, (3) “Neutral/Don’t know”, (4) “Agree”, (5) “Strongly agree”.
- ^k Interpretation: A higher rating value represented a more negative GM attitude of a respondent.

In order to facilitate the interpretation of these results, a spider graph (Figure 5.4) was constructed of the data contained in Table 5.5.

The analysis of the respondents’ perceptions and attitudes towards GM food related issues revealed a number of significant differences between the various cluster groups. In terms of the respondents’ willingness to buy GM food, overall significant differences were present at the 5% probability level of significance [$F=3.03$, $df=3$, $p=0.0343$]. Among the cluster pairs significant differences were observed between the “Anti-GM” and “Pro-GM farmer sympathetic” clusters, as well as between the “Anti-GM” and “Pro-GM consumer benefit” clusters. The “Anti-GM” cluster revealed the lowest likelihood of buying GM food and thus the most negative attitude towards GM food. The other clusters revealed a higher likelihood of buying GM food implying a more positive attitude towards GM food. In general the rating values of the respondents indicated relatively good willingness to buy GM food products.

In response to the statement “GM food is not safe” overall significant differences were present at the 5% significance level [$F=3.54$, $df=3$, $p=0.0185$], with specific significant differences between the “Anti-GM” cluster (most negative) and the “Pro-GM consumer benefit” cluster (most positive). In general the respondents in the various cluster groups are relatively positive about this statement and rating values varied between “Disagree” and “Neutral”.

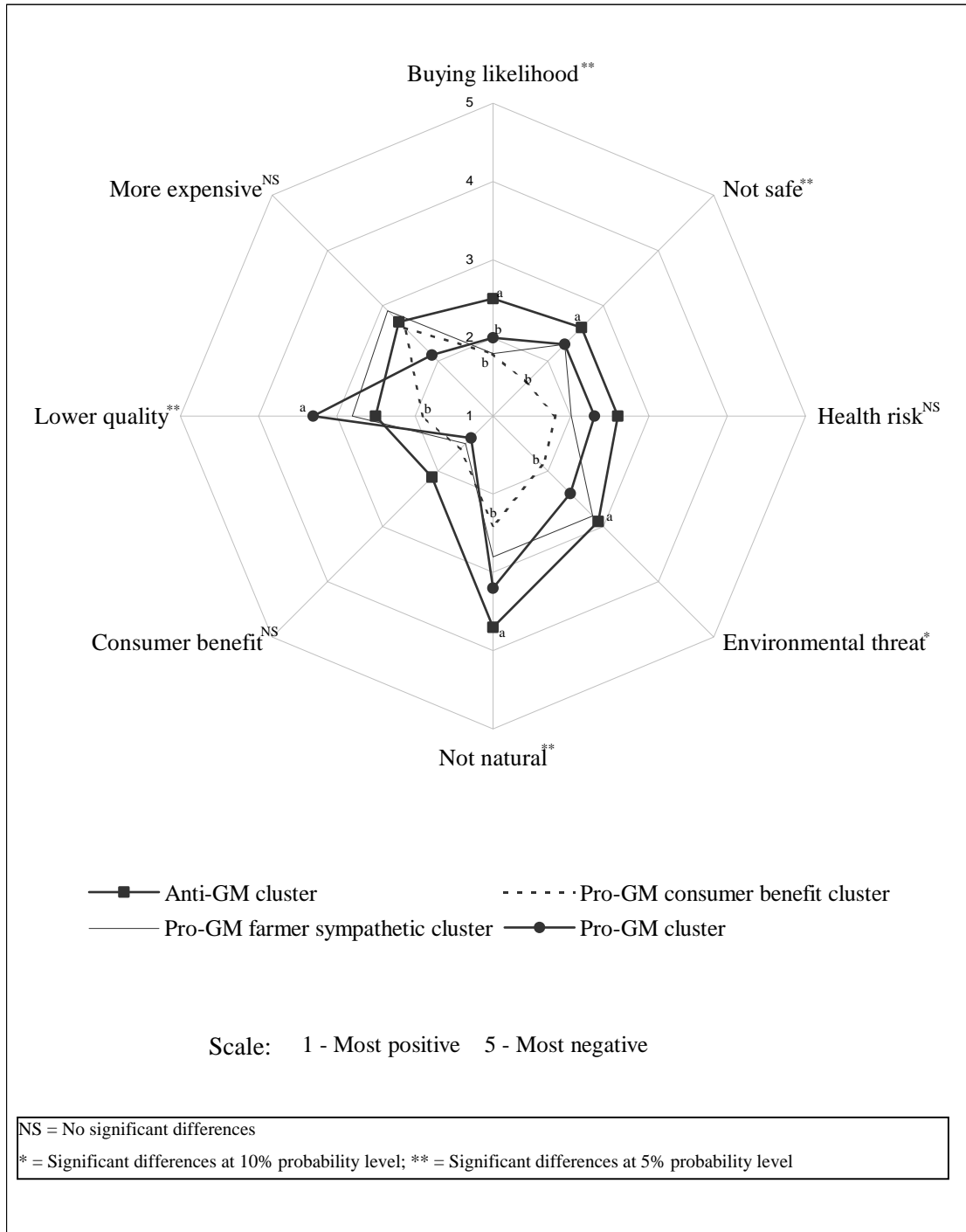


Figure 5.4 Spider graph illustrating the perceptions and attitudes towards genetic modification in food for the cluster groups

For the statement “Eating GM food is a health risk” no significant differences were observed ([F=1.98, df=3, p=0.124]. The “Anti-GM” and “Pro-GM farmer sympathetic” clusters revealed the most negative responses to this statement (close to “Neutral”, while the “Pro-GM consumer benefit” cluster revealed the most positive

response (close to “Disagree”). In general the respondents in the various cluster groups are relatively positive about this statement since the responses of the cluster groups varied between “Disagree” and “Neutral”.

In response to the statement “GM crops can be a threat to the environment” overall significant differences were present at the 10% probability level [$F=2.35$, $df=3$, $p=0.0789$], with specific significant differences between the “Anti-GM” cluster (most negative among all the clusters) and the “Pro-GM consumer benefit” cluster (most positive among all the clusters). In general the respondents in the various cluster groups are relatively positive about this statement and do not consider GM crops as a serious environmental threat since the responses of the cluster groups varied between “Disagree” and “Neutral”.

Overall significant differences at the 5% probability level were observed for the statement “GM food is not natural” [$F=3.55$, $df=3$, $p=0.0190$], with specific significant differences between “Anti-GM” cluster (most negative, close to “Agree”) and the “Pro-GM consumer benefit” cluster (most positive, close to “Disagree”).

No overall significant differences were found regarding the statement “GM food can be beneficial for consumers” [$F=1.96$, $df=3$, $p=0.127$]. All the clusters are relatively positive about this statement even though the “Anti-GM” cluster is the most negative response among all the clusters regarding this statement.

In response to the statement “The quality of GM food is lower than the quality of conventionally produced food” overall significant differences occurred at the 5% probability level [$F=2.81$, $df=3$, $p=0.0451$], with specific significant differences between the “Pro-GM consumer benefit” cluster (most positive, “Disagree” agreement level) and the “Pro-GM” cluster (most negative, agreement level of between “Neutral” and “Agree”).

For the statement “GM food should be cheaper than normal food” no significant differences were observed [$F=1.05$, $df=3$, $p=0.377$]. The “Pro-GM” cluster revealed the strongest perception that GM food should be cheaper than normal food, while the responses of the other clusters were close to “Neutral”.

Thus, some of the GM food perception and attitude statements related to various risks or problems associated with GM food, including environmental threats-, safety, naturalness- and health risk aspects. For all four these statements the “Pro-GM consumer benefit” cluster has the most positive perceptions and attitude towards GM food, while the “Anti-GM” cluster has the most negative perceptions and attitude towards GM food. These observations are consistent with the cluster characteristics based on the conjoint analysis results. In general the “not natural” statement had the most negative evaluation, followed by the “environmental threat” statement, among the various clusters. Thus, it seemed that naturalness and environmental concerns are stronger among the consumers than safety and health concerns related to GM food. Furthermore, significant differences (at the 1% significance level) were observed between the “Pro-GM consumer benefit” cluster and the “Pro-GM” cluster regarding their opinion on the quality of GM food relative to food is lower than the quality of conventionally produced food since the “Pro-GM” cluster revealed the most negative attitude towards the quality of GM food, while the “Pro-GM consumer benefit” cluster revealed the most positive attitude in this regard.

5.5.4 Canonical variate analysis for the LSM- and cluster groups

The canonical variate analysis (CVA) for the complete data set in terms of the three LSM groups revealed meaningful results for the first latent root, since the root was larger than 1. However, the second latent root did not reveal significant results. According to the results 93.1% of the variation of the data was explained by the x-axis. Figure 5.5 displays a plot of the mean scores of the three LSM groups.

On the horizontal axis the greatest variation was found between LSM group 1 (LSM 4 and 5) compared to LSM group 3 (LSM 8, 9 and 10) (see Figure 5.5).

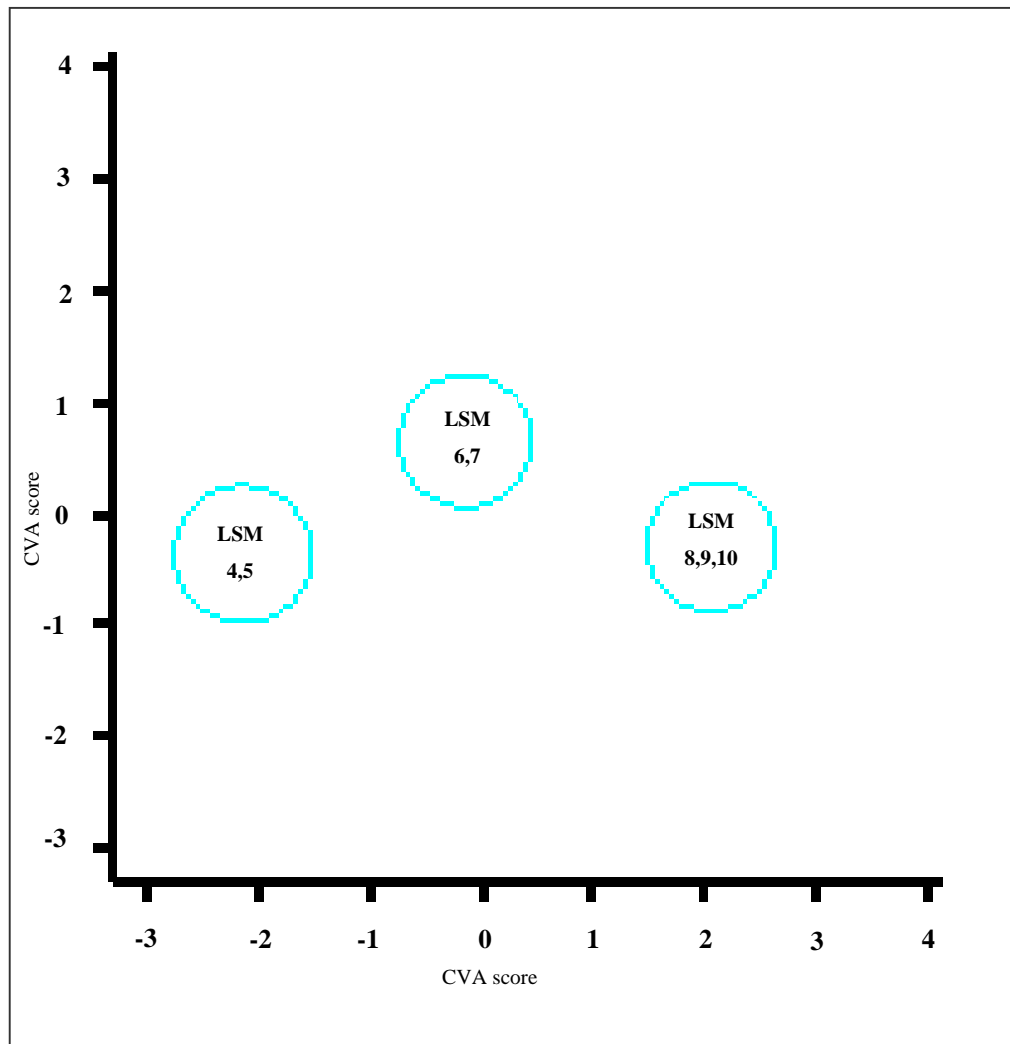


Figure 5.5 CVA Plot of mean scores of the 3 LSM groups

The greatest amount of observed variability between these LSM groups on the horizontal axis was explained mainly by:

- The ethnic group variable ($r = 0.899$) (since LSM 4 and 5 consisted of more black respondents while LSM 8, 9 and 10 consisted of more white respondents).
- The education level variable ($r = 0.622$) (since LSM 4 & 5 have lower education levels than LSM 8, 9 and 10).
- The age variable ($r = 0.603$) (since LSM 4 & 5 were younger and LSM 8, 9 and 10 older).

These observations are meaningful given the basic characteristics of the LSM groups as discussed earlier.

The canonical variate analysis (CVA) for the complete data set in terms of the four cluster groups revealed meaningful results, since the roots were larger than 1. According to the results 97.25% of the variation of the data was explained by the x- and y-axes. Figure 5.6 displays a plot of the mean scores of the four cluster groups.

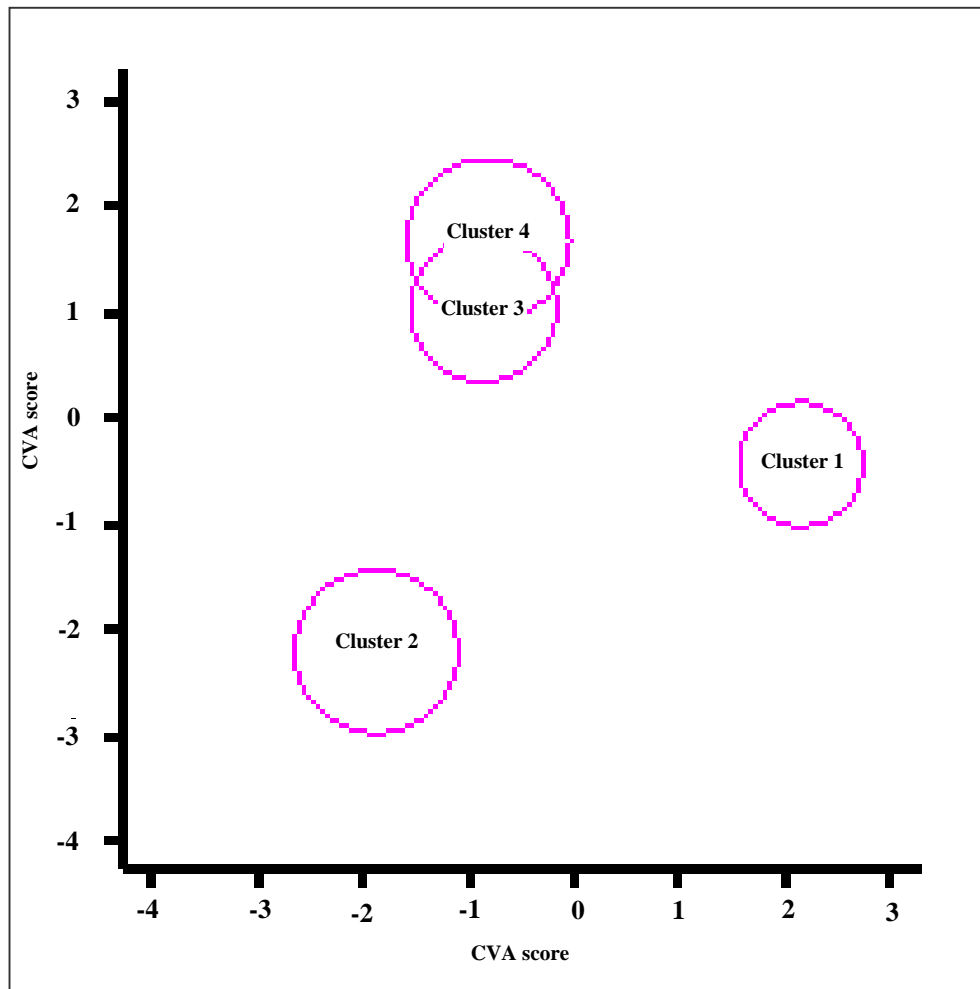


Figure 5.6 CVA Plot of mean scores of the 4 cluster groups

On the horizontal axis the greatest variation was found between the “Anti-GM” cluster (Cluster 1) and the “Pro-GM farmer sympathetic” cluster (Cluster 2) (See Figure 5.6). The greatest amount of observed variability between these clusters on the horizontal axis was explained mainly by the respondents’ willingness to pay for maize meal containing maize that was genetically modified for better crop yield versus non-GM maize meal ($r = 0.943$). This result makes sense in the light of the fact that the key characteristic of the “Anti-GM” cluster (according to the cluster analysis in Chapter 4) is a preference for non-GM maize and thus a higher WTP for non-GM

maize meal than for GM maize meal (especially GM maize benefiting the farmer). On the other hand the key characteristic of the “Pro-GM farmer sympathetic” cluster (according to the cluster analysis in Chapter 4) is a preference for maize meal manufactured from maize that was genetically modified to benefit the farmer.

On the vertical axis the greatest variation was found between the “Pro-GM farmer sympathetic” cluster (Cluster 2) versus the “Pro-GM consumer benefit” cluster (Cluster 3) and the “Pro-GM” cluster (Cluster 4) (See Figure 5.6). The greatest amount of observed variability between these Cluster groups on the vertical axis was explained by the respondents’ willingness to pay for branded maize meal versus non-branded maize meal ($r = 0.831$). It was shown in Chapter 4 that the “Pro-GM farmer sympathetic” cluster prefers non-branded maize meal, while the other clusters preferred branded maize meal.

The respondents’ willingness to pay for maize meal containing maize that was genetically modified for better shelf life versus non-GM maize meal also explained a significant amount of the observed variability ($r = 0.718$). The “Pro-GM consumer benefit” cluster and the “Pro-GM” cluster both prefer maize meal produced from maize that was genetically modified to benefit the consumer to non-GM maize meal and GM maize meal benefiting the producer (refer to Chapter 4).

The CVA analysis indicated that the cluster groups revealed more prominent differences than the three LSM groups. However, according to the CVA results, Clusters 3 and 4 did not differ significantly from each other.

5.6 CORRELATION ANALYSIS OF THE COMPLETE DATASET

No strong correlations ($r \geq 0.700$) were observed in terms of the results of the various sensory evaluation sessions and the demographic characteristics of the sample respondents.

In terms of demographics some weaker correlations were observed between:

- Number of children in the household and household size (correlation coefficient of 0.654). Larger households had more children in the household.
- Ethnic group and education level (correlation coefficient of -0.501). The white respondents in the sample generally had higher education levels while the black respondents in the sample generally had lower education levels.
- Ethnic group and household size (correlation coefficient of 0.494). The white respondents in the sample were generally part of smaller households than the black respondents in the sample.

These demographic trends associated with the selected respondents correspond with the demographic characteristics of the South African population.

A strong positive correlation (correlation coefficient of 0.738) was observed between the sample respondents' exposure to GM food related terms and their perceived understanding of these issues, implying that the exposure caused the respondents to learn more about GM food related terms. In terms of GM knowledge aspects some correlations were observed between:

- Perceived GM exposure / understanding and the education level of the respondents (correlation coefficients of -0.464 and -0.418 respectively). Respondents with higher education levels revealed higher levels of exposure to GM food related terms.
- Perceived GM exposure and ethnic group (correlation coefficient of 0.416). The white respondents revealed higher exposure levels to GM food related terms than the black respondents in the sample.

No strong correlations (≥ 0.700) were observed in terms of the GM perceptions and attitudes of the respondents.

Some correlations were observed between:

- Perceived GM exposure / understanding and the GM food quality perception of the respondents (correlation coefficients of 0.480 and 0.429 respectively). Respondents with lower exposure levels revealed stronger perceptions that the quality of GM food is lower than the quality of ordinary food products.
- Positive correlations were observed between respondents who revealed the perception that GM food is not safe and respondents who perceived GM food as presenting a health risk and environmental threat (correlation coefficients of 0.531 and 0.478 respectively).
- A positive correlation was observed between respondents who revealed the perception that GM food is not natural and respondents who perceived GM food as presenting a health risk (correlation coefficient of 0.539).
- Black consumers revealed a perception that GM food had to be cheaper than other food (correlation coefficient of 0.455).

5.7 CHAPTER CONCLUSION

Chapter 5 dealt with the profiles of the three LSM groups and the four cluster groups based on the respondents' demographic characteristics, GM food knowledge characteristics and perceptions and attitudes toward GM food, investigated through a series of survey questions. Summaries of the characteristics of the LSM- and cluster groups are presented in Tables 5.6 and 5.7 respectively.

The LSM profiling information contained in this chapter as summarised in Table 5.6, revealed that the perceived and actual GM knowledge levels of respondents in the different LSM categories increased as the LSM category increased, while the GM food buying likelihood decreased as the LSM category increased. The actual GM knowledge of the respondents was revealed as relatively low, especially for the more technical GM knowledge test statements. According to the LSM profiles GM knowledge seemed to be an important distinguishing factor between the various LSM groups. However, very few significant differences were observed with respect to the GM perceptions and attitudes of the various LSM groups.

Table 5.6 Characteristics of the LSM groups

Profiling dimension:	Significant differences:	LSM 4 & 5:	LSM 6 & 7:	LSM 8, 9 & 10:
Demographics:				
Age distribution	Not applicable	19-48	18-57	32-65
Average age	Not applicable	30.0	32.2	46.0
% Male	Not applicable	52.0	41.4	17.9
% Female	Not applicable	48.0	58.6	82.1
Education	Not applicable			
% ≤ Grade 11		37.5	24.1	3.60
% Grade 12		62.5	34.5	28.6
% Technicon			34.5	32.1
% University			6.90	35.7
GM knowledge:				
Perceived GM exposure	Yes, 1% sign level LSM 4,5 & 8,9,10 LSM 6,7 & 8,9,10	Lowest	2 nd highest	Highest
Perceived GM knowledge	Yes, 5% sign level LSM 4,5 & 6,7 LSM 6,7 & 8,9,10	Lowest	2 nd highest	Highest
GM knowledge test statement 1: “Animal ...”	None	Least correct	Most correct”	2 nd most correct
GM knowledge test statement 2: “Conventional ...”	Yes, 1% sign level LSM 4,5 & 8,9,10 LSM 6,7 & 8,9,10	Least correct	2 nd most correct	Most correct
GM knowledge test statement 3: “Genetic ...”	None	Least correct	Most correct	2 nd most correct
GM perceptions & attitudes:				
% recognising “GM” maize sample	None	72.0 2 nd Highest	72.4 Highest	50.0 Lowest
Sensory preference	None	Non-GM maize	“GM” maize	Non-GM maize
Buying likelihood	None	Lowest	2 nd highest	Highest
GM food health risk	None	More negative	More negative	More positive
GM food unsafe	None	More positive	More negative	More positive
GM food unnatural	None	More positive	More negative	More positive
GM food environmental threat	None	More negative	More negative	More positive
GM food quality	Yes, 5% sign level LSM 4,5 & 8,9,10 LSM 6,7 & 8,9,10	More negative	More positive	More positive
GM food lower priced	Yes, 5% sign level LSM 4,5 & 8,9,10 LSM 4,5 & 6,7 LSM 6,7 & 8,9,10	Most price sensitive	Less price sensitive	Least price sensitive

Table 5.7 Characteristics of the Cluster groups

Profiling dimension:	Significant differences?	Cluster 1: Anti-GM cluster	Cluster 2: Pro-GM farmer sympathetic cluster	Cluster 3: Pro-GM consumer benefit cluster	Cluster 4: Pro-GM cluster
Demographics:					
LSM characteristics	Yes, 5% sign level				
% LSM 4 & 5	Clusters 1 & 4	7.14	43.8	40.0	50.0
% LSM 6 & 7	Clusters 1 & 2	53.6	12.5	25.0	31.3
% LSM 8, 9 & 10		39.3	43.8	35.0	18.8
Gender	None				
% Male		32.1	50.0	30.0	37.5
% Female		67.9	50.0	70.0	62.5
Ethnicity	Yes, 10% sign level				
% Black	Clusters 1 & 4	25.0	50.0	50.0	81.3
% White		75.0	50.0	50.0	18.8
Education	None				
% Up to grade 12		57.1	62.5	60.0	68.8
% Higher than grade 12		42.9	37.5	40.0	31.3
Mean age	None	35.8	40.9	34.9	34.5
Mean household size	None	4.21	4.13	4.45	4.81
Mean number of children in household	None	1.25	1.38	1.30	2.06
GM knowledge:					
Perceived GM exposure	None	Highest	In between	In between	Lowest
Perceived GM knowledge	None	Highest	In between	In between	Lowest
GM knowledge test statement 1: "Animal ..."	Yes, 10% sign level Clusters 1 & 4 Clusters 2 & 4	Least correct	In between	Most correct	In between
GM knowledge test statement 2: "Conventional ..."	None	Most correct	Most correct	In between	Least correct
GM knowledge test statement 3: "Genetic ..."	None	Most correct	Least correct	In between	In between
GM perceptions/ attitudes:					
% recognising "GM" maize sample	None	67.9 Highest	62.5 Lowest	65.0 In between	62.5 Lowest
Sensory preference	None	Non-GM maize	Non-GM maize	GM maize	GM maize
Buying likelihood	Yes, 5% sign level Clusters 1 & 2 Clusters 1 & 3	Lowest	In between	In between	Highest
GM food health risk	None	Most negative	Most negative	In between	Most positive
GM food unsafe	Yes, 5% sign level Clusters 1 & 3	Most negative	In between	Most positive	In between
GM food unnatural	Yes, 5% sign level Clusters 1 & 3	Most negative	In between	Most positive	In between
GM food environmental threat	Yes, 10% Clusters 1 & 3	Most negative	In between	Most positive	In between
GM food quality	Yes, 5% sign level Clusters 3 & 4	In between	In between	Most positive	Most negative
GM food lower priced	None	Less price sensitive	Less price sensitive	Less price sensitive	Most price sensitive

One of the objectives of the research project that was addressed within this chapter was to develop an idea of the existing knowledge of South African urban white maize consumers regarding GM food. In general, the perceived GM food knowledge levels of the clusters are relatively low. The results of the perceived GM knowledge levels and the actual GM knowledge (as tested by the various statements) revealed some

degree of confusion among respondents regarding the meaning of genetic modification, as well as discrepancies between perceived and actual knowledge levels of genetic modification.

The cluster profiling information contained in this chapter (as summarised in Table 5.7) revealed that the profiling results of the perception and attitude questions were generally consistent with the cluster characteristics based on the conjoint analysis results. The profiling results generally supported the anti-GM preferences of “Anti-GM” cluster and the pro-GM preferences of the other clusters. The profiling results also revealed that the respondents in the various clusters revealed the strongest negative perceptions towards GM food being unnatural and presenting an environmental threat.

An important result from the CVA analyses in this chapter was that the differences among the cluster groups were more prominent than the differences among the LSM groups. Thus, this result suggests that the clusters were more effective to distinguish between sub-groups in the experimental sample.

According to the profile of the cluster groups, urban white maize consumers’ perceptions and attitudes towards GM food are the strongest distinguishing factors between the various clusters (market segments), especially the preferences of the various cluster groups for non-GM maize or maize that are genetically modified for consumer benefit or maize that are genetically modified for producer benefit (as revealed by the CVA analysis). Demographic factors and GM knowledge aspects do not really contribute towards distinguishing between the clusters.

Initially the cluster analysis was done based on the maize preferences of the respondents as revealed by their WTP values. This resulted in the identification of four clusters. However, the CVA analysis revealed that the “Pro-GM consumer benefit” cluster and the “Pro-GM” cluster did not differ significantly from each other. Thus, when taking the whole dataset into consideration (and not only the WTP results) a three-cluster solution (containing the “Anti-GM”-, “Pro-GM farmer sympathetic” and “Pro-GM” clusters) seem to be a more appropriate cluster solution.

CHAPTER 6: CONSUMER PERCEPTIONS OF GENETICALLY MODIFIED MAIZE INVESTIGATED WITH SENSORY EVALUATION

6.1 INTRODUCTION

Chapter 5 developed profiles for the three LSM groups and the four cluster groups based on a number of variables that were not used as a basis for the initial clustering procedure. These variables included demographic variables, GM knowledge variables and GM perceptions and attitudes variables and the data was gathered with a survey questionnaire. Within this chapter the perceptions of South African white maize consumers towards GM maize are further investigated through a sensory evaluation process.

The objectives of the sensory evaluation session were to determine the effect of consumer perceptions on the sensory experience of white maize porridge consumers and also to develop the profiles of the LSM groups and cluster groups further based on the sensory evaluation results.

Sensory evaluation can be defined as a scientific method used to evoke, measure, analyse and interpret product responses as perceived through the various human senses (sight, smell, touch, taste and hearing) (Lawless and Heymann, 1998). According to Lawless and Heymann (1998) there are three main types of sensory testing, including discrimination tests, descriptive tests and affective tests. Discrimination tests examine whether there are differences between two types of products. Descriptive tests examine how products differ in specific sensory characteristics and are normally conducted by trained panels. Trained panels consist of panel members who have been trained in specialised sensory evaluation techniques. Affective / hedonic tests examine how well products are liked or which products are preferred. These tests often employ a hedonic scale. Untrained panels normally conduct descriptive tests (Lawless and Heymann, 1998). Untrained panels usually consist of consumers who do not have any specialised sensory evaluation skills and could normally only indicate their liking of the product.

Sensory evaluation has been applied in the context of consumer perceptions regarding GM food, in this study. Similarly, a study was conducted by Grunert *et al.* (2002) with the objective to investigate the effect of sensory experience with a (supposedly) GMO-based food product on consumers' attitudes towards the use of GMOs in food production and on the way these attitudes affect purchase intentions for GMO-based food products. The research involved sensory evaluation techniques, a conjoint analysis task and measurement of attitudes towards the use of GMOs in food production.

6.2 THE SENSORY EVALUATION EXPERIMENT

As mentioned in Chapter 2, the sensory evaluation experiment (consisting of 3 tasting sessions) was the first activity that respondents completed during the data gathering process. The sensory evaluation experiment was done at a sensory evaluation facility that was constructed according to the ASTM design guidelines for sensory facilities with all the elements necessary for an efficient sensory program. Samples were served in the tasting booths under white light conditions. The sensory evaluation experiment was done over a period of 6 days and ± 15 respondents participated every day. The overall purpose was to determine the effect of perceptions regarding GM food on the sensory experience of urban white maize consumers. It is extremely important to note that all the maize porridge samples tasted by the respondents were identical and in fact were served from the same source. All maize porridge samples were prepared utilizing one of the leading maize meal brands on the South African food market according to a standard recipe and served at an average temperature of 60 °C. No salt or condiments was added. Thus, in reality the respondents did not really consume any GM maize, they were only made to believe that they consumed GM maize (in order to test their perceptions). Another important aspect to take note of is that no mention was made to GM food during the panel recruitment process. Respondents were only told that they would participate in a research project involving maize porridge. The GM aspect of the research was deliberately kept from respondents so that in tasting session 1, their sensory opinions could be captured, without necessarily having GM aspects in mind. The GM aspect was only mentioned at the beginning of tasting session 2.

The experimental flow for the complete sensory evaluation experiment involved a number of activities. Upon arrival the respondents were welcomed and given an outline of the research activities they would participate in. The sensory evaluation experiment involved 3 tasting sessions in individual booths, 30 minutes apart with an instruction session prior to each session in the seminar room. Before the first tasting session the procedure for this session was explained to the respondents:

“You will receive the following items in your allocated tasting booth: a tray containing 3 maize porridge samples with numbers written on the foil lids, a glass of water, carrot pieces, a questionnaire and a pencil. Before you start, please eat some carrot and drink some water (in order to clean your palate). The numbers on the lids of the maize porridge samples will correspond to the numbers on your questionnaire. Now, taste the maize porridge samples on your tray and rate the samples according to the scale on the questionnaire, with “0” representing “Dislike” up to “9” representing “Like a lot”. Return to the seminar room when you completed the tasting session.”

After the first tasting session the procedure for the second tasting session was then explained to the respondents:

“You will receive the following items in your allocated tasting booth: a tray containing 3 maize porridge samples with numbers written on the foil lids, a glass of water, carrot pieces, a questionnaire and a pencil. Before you start, please eat some carrot and drink some water (in order to clean your palate). The numbers on the lids of the maize porridge samples will correspond to the numbers on your questionnaire. Please note, one of the maize porridge samples might contain genetically modified maize. Whom of you are familiar with genetically modified food?”

If some of the respondents were not familiar with GM food, a short introduction was given to the basic concepts, after which the procedure description for tasting session 2 was continued.

“Now, please taste the three maize porridge samples on your tray in the order given to you. Complete the first question, asking whether you can identify which one of the samples is different from the others (due to the presence of GM maize). If your

answer to this question is “Yes”, please complete the second question by indicating the number of the sample that you think contain the GM maize. Please return to the seminar room when you completed the second tasting session.”

After the second tasting session the procedure for the third tasting session was then explained to the respondents:

“You will receive the following items in your tasting booth: a tray containing 3 maize porridge samples with randomly selected 3 digit numbers written on the foil lids, a glass of water, carrot pieces, a questionnaire and a pencil. Before you start, please eat some carrot and drink some water (in order to clean your palate). The numbers / letters on the lids of the maize porridge samples will correspond to the numbers / letters on your questionnaire. One sample contains genetically modified maize. This sample is marked “GM”. Now, taste the maize porridge samples on your tray and rate the samples according to the scale on the questionnaire, with “0” representing “Dislike” up to “9” representing “Like a lot”. Please return to the seminar room when you completed the third tasting session.”

The questionnaires used in the three tasting sessions are shown in Appendix C. Random numbers were selected to identify the samples in the various tasting sessions. In tasting session 1 the random numbers were 256, 437 and 911. In tasting session 2 the random numbers were 652, 734 and 819. In tasting session 3 the random numbers were 156 and 337. The order of the samples on the respondents’ tasting trays was also randomised within each of the various tasting sessions.

The three tasting sessions contributed towards the overall objective of the sensory evaluation experiment. The objective of tasting session 1 was to test the respondents’ ability to recognise that the 3 maize porridge samples were identical. Thus, significant differences in the tasting ratings within a specific LSM group or cluster group would indicate that respondents did not recognise the similarity of the tasting samples. Tasting session 1 was an affective / hedonic sensory test since respondents indicated their degree of product liking for the various samples. The objective of the second tasting session was to test the respondents’ ability to recognise a (supposedly) GM sample among 3 maize porridge samples in a situation of information

uncertainty. This tasting session attempted to simulate the current situation in South Africa, where consumers are uncertain whether they are or are not consuming GM maize when consuming maize porridge. Thus, if respondents were able to identify the GM maize porridge samples, the implication would be that their GM perceptions influenced their sensory experience of the maize porridge. Tasting session 2 was a discrimination sensory test since respondents indicated whether the samples differed from each other. The objective of tasting session 3 was to test consumers' sensory reaction when they were told that a certain sample contained GM maize. This tasting session attempted to simulate a situation where consumers would know for certain when GM maize was present in a food product, due to the use of GM product labelling. Thus, the results indicated whether respondents' GM perceptions had a positive or negative or no influence on their sensory experience of the maize porridge. Tasting session 3 was an affective / hedonic sensory test since respondents indicated their degree of product liking for the various samples.

Data analysis was done in the following manner. For tasting session 1 each respondent's tasting rating values for the three samples were captured in SPSS 12.0. A two-way between group analysis of variance (ANOVA) was conducted to explore the impact of "Cluster group", "LSM group" and "Tasting sample number" on the tasting ratings of the respondents. The dependent variable in the analysis was "Tasting rating", while the independent variables were "Cluster group", "LSM group" and "Tasting sample number". The "Cluster group" variable had four levels (Cluster 1, Cluster 2, Cluster 3, Cluster 4), the "LSM group" variable had three levels (LSM 4 and 5; LSM 6 and 7; LSM 8, 9 and 10) and the "Tasting sample number" had three levels (Sample number 256, 437 and 911).

In order to analyse the data of tasting session 2 the first question was captured in SPSS 12.0 as a code, with "1" representing "Yes" and "2" representing "No". Chi-square tests were used to examine the differences in the various clusters and LSM groups' ability to "recognise" the GM maize porridge sample. The Chi-square test investigated whether significant differences were present in terms of the "Yes" to "No" proportions for the various cluster groups and LSM groups.

For tasting session 3 each respondent's tasting rating values for the three samples were captured in SPSS 12.0. A new variable was generated by calculating the average rating for each respondent of the two non-GM maize porridge samples. A two-way between group analysis of variance (ANOVA) was conducted to explore the impact of "Cluster group", "LSM group" and "Tasting sample number" on the tasting ratings of the respondents. The dependent variable in the analysis was "Tasting rating", while the independent variables were "Cluster group", "LSM group" and "Tasting sample number". The "Cluster group" variable had four levels ("Anti-GM" cluster, "Pro-GM farmer sympathetic" cluster, "Pro-GM consumer benefit" cluster and "Pro-GM" cluster), the "LSM group" variable had three levels (LSM 4 and 5; LSM 6 and 7; LSM 8, 9 and 10) and the "Tasting sample number" had two levels (Average rating for the two non-GM samples and tasting rating of the pseudo-GM sample).

6.3 RESULTS AND DISCUSSION

6.3.1 Sensory evaluation results of the LSM groups

6.3.1.1 Tasting session 1

The two-way ANOVA results for tasting session 1 analysed with respect to the three LSM groups is shown in Table 6.1.

The average rating values of the three LSM groups over all three the samples, were 5.64, 5.67 and 6.02 respectively. This indicated that the various LSM groups had a weak positive sensory experience of the maize porridge, since these average ratings were above the mean value (4.5) of the rating scale towards the "Like a lot" end of the scale. These average ratings also indicated that LSM groups 8, 9 and 10 revealed a more positive sensory experience than the other LSM groups.

Table 6.1 The two-way ANOVA results for tasting session 1 in terms of the LSM groups

		Average Rating ¹ LSM 4 & 5	Average Rating ¹ LSM 6 & 7	Average Rating ¹ LSM 8, 9 & 10	Average rating ¹ for specific sample
Average rating ¹ per tasting sample	256	5.32	5.69	5.78	5.60
	437	6.88	5.62	6.03	6.18
	911	4.72	5.69	6.25	5.55
Average Rating ¹ LSM group		5.64	5.67	6.02	
LSM group	F = 0.904			p = 0.406	
Tasting samples	F = 2.37			p = 0.0955	
Interaction effect	F = 2.91			p = 0.0223	

¹The Likert scale varied between “0” for “Dislike” to “9” for “Like a lot”

Levene’s test for equality of error variances indicated a significant result ($p \leq 0.05$), which implied that the homogeneity of variances assumption was violated. To compensate for this problem a more stringent probability level ($p = 0.01$) was applied for evaluating the results of the two-way between-group ANOVA analysis. According to the results in Table 6.1 the main effect for “LSM group” [$F = 0.904$, $p = 0.406$] did not reach statistical significance at a 1% probability level. Thus, the three LSM groups did not differ significantly (at a 1% probability level) in terms of their mean tasting rating scores. The main effect for “Sample number” [$F = 2.37$, $p = 0.0955$] did not reach statistical significance at a 1% probability level. Thus, the three samples did not differ significantly (at a 1% probability level) in terms of their mean tasting rating scores. The interaction effect [$F = 2.91$, $p = 0.0223$] did not reach statistical significance at a 1% probability level. Thus, there was no significant effect of “LSM group” on average tasting rating for the three samples tasted by the respondents at a 1% probability level.

The results of tasting session 1 analysed for the various LSM groups, indicated that the respondents in the three LSM groups revealed an acceptable ability to recognise that the three maize porridge samples were similar.

6.3.1.2 Tasting session 2

Table 6.2 displays the chi-square test results for tasting session 2 analysed with respect to the three LSM groups.

Table 6.2 The chi-square test results for tasting session 2 for the LSM groups

Group	Observed frequencies				Total
	“Yes” # of respondents in LSM group	“Yes”% of respondents in LSM group	“No” # of respondents in LSM group	“No”% of respondents in LSM group	
LSM 4 & LSM 5	18	72.0%	7	28.0%	25
LSM 6 & LSM 7	21	72.4%	8	27.6%	29
LSM 8, LSM 9, LSM 10	14	50.0%	14	50.0%	28
Total	53		29		82

Chi-Square value	3.99
df	2
p	0.136

The results in Table 6.2 indicated that the Chi-square test was not significant ($\chi^2=3.99$, $p=0.136$, $df=2$) indicating that the “Yes”/”No” proportions were not significantly different at a 10% probability level. Thus the three LSM groups did not differ significantly with respect to their ability to recognise the “GM” sample.

Despite the absence of significant differences, the results revealed that among the respondents in LSM groups 4, 5, 6 and 7, more than 70% of the respondents identified the “GM” sample, while only 50% of the respondents in LSM groups 8, 9 and 10 identified the “GM” sample.

6.3.1.3 Tasting session 3

Table 6.3 displays the two-way ANOVA results for tasting session 3 analysed with respect to the three LSM groups.

Table 6.3 The two-way ANOVA results for tasting session 3 for the LSM groups

	Average rating ¹ LSM 4 & 5	Average rating ¹ LSM 6 & 7	Average Rating ¹ LSM 8, 9 &10	Average rating ¹ for specific sample
Non-GM samples (average rating ¹)	6.46	5.48	6.43	6.12
GM sample rating¹	6.40	6.07	5.93	6.13
Average rating ¹ LSM group	6.43	5.78	6.18	
LSM group	F = 3.66		p = 0.0272	
Tasting samples	F = 0.00330		p = 0.997	
Interaction effect	F = 0.901		p = 0.464	

¹The Likert scale varied between “0” for “Dislike”, “4.5” for “Neutral” to “9” for “Like a lot”

Levene’s test for equality of error variances indicated a significant result ($p \leq 0.05$), which implied that the homogeneity of variances assumption was violated. To compensate for this problem a more stringent probability level ($p = 0.01$) was applied for evaluating the results of the two-way between-group ANOVA analysis. According to the results in Table 6.3 the main effect for “LSM group” [$F = 3.66$, $p = 0.0272$] did not reach statistical significance at a 1% probability level. Thus, the three LSM groups did not differ significantly (at a 1% probability level) in terms of their mean tasting rating scores. The main effect for “Sample number” [$F = 0.00330$, $p = 0.997$] did not reach statistical significance at a 1% probability level. Thus, the samples did not differ significantly (at a 1% probability level) in terms of their mean taste rating scores. The interaction effect [$F = 0.901$, $p = 0.464$] did not reach statistical significance at a 1% probability level, indicating that there was no significant effect of “LSM group” on average taste rating for the pseudo-GM sample versus the average rating of the two non-GM samples at a 1% probability level.

Thus the three LSM groups did not differ significantly with respect to their ratings of the pseudo-GM sample versus the non-GM samples. The mean taste rating values revealed that LSM groups 4, 5, 8, 9 and 10, revealed a preference for non-GM maize porridge, while LSM 6 and 7 revealed a preference for GM maize.

6.3.2 Sensory evaluation results of the cluster groups

6.3.2.1 Tasting session 1

Table 6.4 displays the two-way ANOVA results for tasting session 1 analysed with respect to the four cluster groups.

Table 6.4 The two-way ANOVA results for tasting session 1 for the cluster groups

		Average Rating ¹ Cluster 1: Anti-GM	Average Rating ¹ Cluster 2: Pro-GM farmer sympathetic	Average Rating ¹ Cluster 3: Pro-GM consumer benefit	Average Rating ¹ Cluster 4: Pro-GM	Average rating ¹ for specific sample
Average rating ¹ per tasting sample	256	5.82	5.68	5.70	5.06	5.57
	437	5.53	6.25	6.85	6.00	6.16
	911	5.96	5.31	5.75	4.69	5.43
Average rating ¹ for cluster group		5.77	5.75	6.10	5.25	

Cluster group	F = 1.50	$p = 0.215$
Tasting sample	F = 2.66	$p = 0.0725^*$
Interaction effect	F = 1.01	$p = 0.422$

* Statistically significant differences at the 10% probability level

¹ The Likert scale varied between “0” for “Dislike” to “9” for “Like a lot”

The average rating values of the three LSM groups over all three the samples, was 5.25, 5.75, 5.77 and 6.10 respectively. This indicated that the various cluster groups had a weak positive sensory experience of the maize porridge, since these average ratings were above the mean value (4.5) of the rating scale towards the “Like a lot” end of the scale. These average ratings also indicated that “Pro-GM, consumer benefit” cluster revealed a more positive sensory maize meal experience than the other LSM groups, while the “Pro-GM” cluster revealed the least positive sensory maize meal experience among all the clusters.

Levene’s test for equality of error variances indicated a non-significant result ($p > 0.05$), which implied that the homogeneity of variances assumption was not violated. According to the results in Table 6.4 the main effect for “Cluster group” [$F = 1.50$, $p = 0.215$] did not reach statistical significance at a 10% probability level.

Thus, the four cluster groups did not differ significantly (at a 10% probability level) in terms of their mean taste rating scores. The main effect for “Sample number” [F=2.66, p=0.0725] reached statistical significance at a 10% probability level. Thus, the three samples differed significantly (at a 10% probability level) in terms of their mean taste rating scores. The interaction effect [F=1.01, p=0.422] did not reach statistical significance at a 10% probability level. Thus, there was no significant effect of “Cluster group” on average taste rating for the three samples tasted by the respondents at a 10% probability level.

The results of tasting session 1 analysed for the various cluster groups indicated that the respondents in the four cluster groups had a good ability to recognise that the three maize porridge samples were similar.

6.3.2.2 Tasting session 2

Table 6.5 displays the chi-square test results for tasting session 2 analysed with respect to the four cluster groups.

Table 6.5 The chi-square test results for tasting session 2 for the cluster groups

Group	Observed frequencies				Total
	“Yes” # of respondents in cluster group	“Yes”% of respondents in cluster group	“No” # of respondents in cluster group	“No”% of respondents in cluster group	
Cluster 1: Anti-GM,	19	67.9%	9	32.1%	28
Cluster 2: Pro-GM farmer sympathetic	10	62.5%	6	37.5%	16
Cluster 3: Pro-GM consumer benefit	13	65.0%	7	35.0%	20
Cluster 4: Pro-GM	10	62.5%	6	37.5%	16
Total	52		28		80

Pearson Chi-Square	0.188
df	3
Approximate probability	0.979

The assumption of the Chi-square test that the minimum expected cell frequency should be 5 or greater, was not violated in the analysis. The Chi-square test was not significant ($\chi^2=0.188$, p=0.979, df=3) indicating that the frequencies were not significantly different at a 10% probability level.

Thus the four cluster groups did not differ significantly with respect to their ability to recognise the “GM” sample, even though 65% of all the respondents identified a sample in tasting session 2 as the “GM” sample. The “Anti-GM”- and the “Pro-GM consumer benefit” clusters revealed the highest percentage of respondents that recognised the “GM” sample within tasting session 2.

6.3.2.3 Tasting session 3

Table 6.6 displays the two-way ANOVA results for tasting session 3 analysed with respect to the four cluster groups.

Table 6.6 The two-way ANOVA results for tasting session 3, for the cluster groups

	Average rating ¹ Cluster 1: Anti-GM,	Average rating ¹ Cluster 2: Pro-GM farmer sympathetic	Average rating ¹ Cluster 3: Pro-GM consumer benefit	Average rating ¹ Cluster 4: Pro_GM	Average rating ¹ for specific sample
Non-GM samples (average rating ¹)	6.13	6.31	6.48	5.47	6.10
GM sample rating ¹	6.00	6.13	6.60	5.69	6.10
Average rating ¹ for cluster group	6.06	6.22	6.54	5.58	

Cluster group	F = 1.82	p = 0.147
Tasting sample	F = 0.000748	p = 0.978
Interaction effect	F = 0.112	p = 0.953

¹ The Likert scale varied between “0” for “Dislike” to “9” for “Like a lot”

Levene’s test for equality of error variances indicated a non-significant result ($p > 0.05$), which implied that the homogeneity of variances assumption was not violated. The results in Table 6.4 indicated that the main effect for “Cluster group” [$F = 1.82$, $p = 0.147$] did not reach statistical significance at a 10% probability level. Thus, the four cluster groups did not differ significantly (at a 10% probability level) in terms of their mean taste rating scores for the pseudo-GM sample versus the average for the two non-GM samples. The main effect for “Sample number” [$F = 0.000748$, $p = 0.978$] did not reach statistical significance at a 10% probability level. Thus, the pseudo-GM sample and the non-GM samples did not differ significantly (at a 10%

probability level) in terms of their mean taste rating scores. The interaction effect [$F=0.112$, $p=0.953$] did not reach statistical significance at a 10% probability level. Thus, there was no significant effect of “Cluster group” on average taste rating for the samples tasted by the respondents at a 10% probability level.

The mean taste ratings revealed that the “Anti-GM” cluster and the “Pro-GM farmer sympathetic” cluster preferred the non-GM samples to the pseudo-GM sample. The “Pro-GM consumer benefit” and “Pro-GM” clusters preferred the pseudo-GM sample to the non-GM samples. The “Pro-GM” cluster revealed the greatest difference between ratings assigned to the pseudo-GM sample and the average of the non-GM samples.

6.4 CONCLUSION

The investigation of the effect of perceptions regarding GM food on the sensory experience of white maize porridge consumers revealed a number of important observations.

The results of tasting session 1 indicated that initially before the respondents were given any information about the nature of the maize porridge samples, the respondents revealed an acceptable ability to recognise that the three maize porridge samples were identical.

The various LSM groups and cluster groups did not reveal significant differences in their ability to recognise the “GM” sample in tasting session 2. However, the results revealed that in a situation of information uncertainty the GM food perceptions of the respondents in the lower and middle LSM groups, the “Anti-GM” cluster and the “Pro-GM” consumer benefit cluster seemed to have a greater influence on their sensory maize porridge experience, since a larger number of these respondents recognised the “supposedly” GM sample.

In a situation where consumers were informed when GM maize was present in a maize porridge sample, there were no significant differences observed between the sensory evaluations of the various LSM groups and cluster groups. The observed

results indicated that in such a situation LSM 6 and 7, the “Pro-GM consumer benefit” cluster and the “Pro-GM” cluster preferred the “GM” maize porridge sample to the “non-GM” maize porridge sample. For these consumers their GM food perceptions seemed to have a positive influence on their sensory experience of “GM” maize porridge. On the other hand LSM groups 4, 5, 8, 9 and 10, the “Anti-GM” cluster and the “Pro-GM farmer benefit” cluster preferred the “non-GM” samples to the “GM” sample. Thus, these consumers’ GM food perceptions had a negative influence on their sensory experience of “GM” maize porridge.

The results of the sensory evaluation experiment revealed that the sensory experience of the maize porridge consumers, were relatively consistent with their perceptions and attitudes towards GM food as discussed in Chapter 5. The “Anti-GM” cluster revealed a sensory preference for non-GM maize porridge, while the “Pro-GM” cluster and the “Pro-GM consumer benefit clusters revealed a sensory preference for GM maize porridge. The “Pro-GM farmer benefit” cluster revealed a sensory preference for non-GM maize porridge even though their general GM food attitude was positive. This could be seen as a discrepancy, but could also be explained by the fact that these consumers might be sympathetic towards the plea of farmers to such an extent that they would be willing to tolerate GM food even though they did reveal a degree of negativity towards GM food (as observed in the sensory evaluation experiment).

CHAPTER 7: SUMMARY AND CONCLUSIONS

7.1 INTRODUCTION

The overall objective of the study was to develop an understanding of the perceptions, attitudes, acceptance and knowledge of South African urban consumers, regarding GM white maize meal. In order to address this objective the research methodology consisted of a number of techniques including conjoint analysis, cluster analysis and cluster profiling analysis. Conjoint analysis was applied to identify the trade-offs between different potential attribute levels of maize meal through the estimation of consumers' willingness to pay for branded- versus non-branded white-grained maize meal, as well as their willingness to pay for non-GM white maize meal versus GM white maize meal with various types of genetic manipulations benefiting the consumer and the producer respectively.

The consumer preferences revealed in the conjoint experiment was used as a basis to identify market segments within the urban consumer market of white-grained maize meal by applying cluster analysis. A set of questions was used to develop an idea of the existing knowledge status of South African white maize consumers regarding GM food related issues. The perceptions of urban maize porridge consumers were investigated by means of two difference approaches. Sensory evaluation was applied to determine the effect of consumers' perceptions regarding GM food on the sensory experience of urban white maize porridge consumers. Furthermore a series of questions investigated the perceptions, attitudes and acceptance of South African urban consumers in relation to GM food. The final objective of the study was to develop and compare profiles for the LSM groups and the identified cluster groups (market segments), based on demographic-, GM knowledge-, GM perception-, GM attitude and GM acceptance data gathered within the study.

7.2 SUMMARY OF FINDINGS

The limited sample size (80 respondents) could influence the ability of the results to reflect on the population of urban white maize consumers given the presence of GM food in the market. Given the limited sample size, the verification of the hypotheses should be seen in view of general trends in South Africa and available anecdotal evidence supporting the results of the study. The results of this study could go a long way in representing the results of a more representative sample of urban white maize consumers given the presence of GM food in the market.

The main findings of the study are discussed in line with the hypotheses stated at the beginning of the study:

The first hypothesis stated that the majority of urban maize meal consumers would prefer branded white-grained maize meal to non-branded white-grained maize meal. The hypothesis was proven as true, since the conjoint analysis results indicated that 48.8% of the respondents preferred a specific maize meal brand, versus 32.5% that did not have a preference for a specific brand.

The second hypothesis stated that the majority of urban white-grained maize meal consumers would prefer maize meal that is free of GM maize, by revealing a willingness to pay a premium for maize meal that is free of GM maize relative to maize meal containing GM maize. This hypothesis was proven as being false in situations where consumers faced a choice between maize meal manufactured from normal (non-genetically modified) maize and maize meal manufactured from maize that was genetically modified to benefit consumers. The descriptive statistical analysis of the conjoint experiment revealed that 55% of the respondents preferred maize meal manufactured from maize that was genetically modified to benefit consumers to maize meal manufactured from normal (non-genetically modified) maize, while only 37.5% preferred maize meal manufactured from normal (non-genetically modified) maize to maize meal manufactured from maize that was genetically modified to benefit consumers. Thus, given this trade-off pair more respondents preferred maize meal manufactured from maize that was genetically modified to benefit consumers than maize meal manufactured from normal (non-

genetically modified) maize. However, the descriptive statistical analysis of the conjoint experiment also indicated that 52.5% of the respondents preferred maize meal manufactured from normal (non-genetically modified) maize to maize meal manufactured from maize that is genetically modified to benefit producers, while only 41.3% of the respondents preferred maize meal manufactured from maize that is genetically modified to benefit producers to GM free maize meal. This indicates that the second hypothesis was also be partly true in a situation where consumers could choose between GM free maize meal and maize meal manufactured from maize that is genetically modified to benefit producers.

The third hypothesis was that when facing a choice between white-grained maize meal containing GM maize that was modified for consumers' benefit versus producers' benefit, the majority of South African urban consumers will prefer maize meal manufactured from maize that was genetically modified for purposes of consumer benefit by revealing a willingness to pay a premium for this type of maize meal as opposed to maize that was genetically modified for purposes of producer / farmer benefit. According to the descriptive statistical analysis of the conjoint experiment this hypothesis was true, since 70.0% of the respondents preferred maize meal manufactured from maize that was genetically modified to increase the shelf life of the maize meal, to maize meal manufactured from maize that is genetically modified to increase crop yield. Only 26.3% of the respondents preferred meal manufactured from maize that is genetically modified to increase crop yield to maize meal manufactured from maize that was genetically modified to increase the shelf life of the maize meal.

The cluster analysis revealed that the sample of urban, white maize consumers could be grouped into three meaningful and distinct market segment, based on their preferences for branded- versus non-branded white-grained maize meal, as well as their preferences for non-GM white maize meal versus GM white maize meal with various types of genetic manipulations. The three clusters (market segments) are summarised in Table 7.1.

Table 7.1 Summary characteristics of the market segments

Market segment number	% of sample	Maize meal GM preference	Maize meal brand preference	Summary description
1	35%	Non-GM food	Branded	“Anti-GM” cluster
2	20%	Genetic modification for farmers’ benefit	Non-branded	“Pro-GM farmer sympathetic” cluster
3	45%	All GM food, but especially Genetic modification for consumers’ benefit	Branded	“Pro-GM” cluster

This analysis confirms the fourth hypothesis that the South African urban consumer market for white maize meal can be divided into discreet market segments based on their preferences for branded- versus non-branded white-grained maize meal, as well as their preferences for non-GM white maize meal versus GM white maize meal with various types of genetic manipulations benefiting the consumer and the producer respectively. It is important to note that the CVA analysis revealed that the “Pro-GM consumer benefit” cluster and the “Pro-GM” cluster did not differ significantly from each other. Thus, when taking the whole dataset into consideration (and not only the WTP results) a three-cluster solution (containing the “Anti-GM”-, “Pro-GM farmer sympathetic”- and “Pro-GM” clusters) seem to be a more appropriate cluster solution for the study.

The fifth hypothesis was that South African urban white maize consumers have limited knowledge regarding GM food related issues. This hypothesis was proven as true since the descriptive statistical analysis confirmed the relatively low levels of GM information exposure, perceived understanding and actual understanding of South African urban consumers. Only 63.8% of the respondents indicated an exposure level of “A little” or “Nothing at all”, while 65.0% indicated that their ability to explain GM terms varied between “A little” and “Not at all”. The respondents’ actual GM understanding regarding the more technical GM statements also confirmed the low understanding levels, since 40.2% and 48.8% of the sample responded to these questions with a “somewhat wrong” to “don’t know” answer.

The analysis of the GM knowledge of the LSM groups indicated that in terms of perceived GM exposure significant differences (at a 1% probability level) were observed between LSM 4, 5 and LSM 8, 9, 10 as well as between LSM 6, 7 and LSM

8, 9, 10. In terms of perceived GM understanding significant differences (at a 5% probability level) were observed between LSM 4, 5 and LSM 6, 7 as well as between LSM 4, 5 and LSM 8, 9, 10. The perceived GM exposure and GM knowledge levels of LSM 8, 9, 10 was the highest, followed by LSM 6,7. LSM 4,5 revealed the worst perceived levels of GM exposure and –knowledge. Thus, the sixth hypothesis that the GM knowledge levels of South African urban consumers would be higher among the wealthier consumers in the higher LSM categories was proven to be true.

The results of the sensory evaluation experiment confirmed the hypothesis that consumers' negative perceptions and attitudes towards GM food will have a negative influence on their sensory experience. The "Anti-GM" cluster revealed a sensory preference for non-GM maize porridge, while the "Pro-GM" cluster and the "Pro-GM consumer benefit clusters revealed a sensory preference for GM maize porridge despite the fact that they all tasted the same "normal" (non-GM) maize porridge.

The results suggested that the hypothesis stating that wealthier South African consumers in the higher LSM categories will have more negative perceptions and attitudes towards GM food and will be less accepting of GM technology in food was proven as false. The analysis of the GM food perceptions and attitudes of the different LSM groups revealed that LSM groups 8, 9 and 10 have the highest buying likelihood among all the LSM groups. Some of the more positive perceptions / attitudes for a number of GM risk aspects including GM food presenting a health risk, being unsafe, being unnatural and presenting an environmental threat. Furthermore the lowest LSM groups (LSM 4 and 5) revealed the most negative perceptions / attitudes among all the cluster groups in terms of GM food being a health risk, an environmental threat and having a lower quality than conventional food.

A comparison of the characteristics of the LSM groups and the cluster group revealed that the cluster groups represented a more appropriate market segmentation approach than the LSM groups. Even though the LSM profiles revealed that GM knowledge was an important distinguishing factor among the various LSM groups, very few significant differences were observed with respect to the GM perceptions and attitudes of the various LSM groups. On the other hand the cluster profiling analyses revealed that urban white maize consumers' perceptions and attitudes towards GM

food were the strongest distinguishing factors between the various clusters (market segments), especially the preferences of the various cluster groups for non-GM maize or maize that was genetically modified for consumer benefit or maize that was genetically modified for producer benefit (as revealed by the CVA analysis). Demographic factors and GM knowledge aspects did not really contribute towards distinguishing between the clusters. The CVA analyses indicated that the differences among the cluster groups were more prominent than the differences among the LSM groups leading to the conclusion that the clusters groups were more effective to distinguish between sub-groups in the experimental sample. Thus, the hypothesis “The LSM market segmentation can be an appropriate market segmentation tool applied to the South African urban consumer market for white maize meal, given the presence of GM maize in this market” was proven as false.

7.3 RECOMMENDATIONS

This study had a number of limitations that should be mentioned along with certain recommendations for further research flowing from these limitations:

The geographical focus of the sampling procedure only included urban maize meal consumers in the Pretoria and Johannesburg areas within the Gauteng Province of South Africa. Thus, no rural consumers and no urban consumers from other geographical parts of South Africa were included in the sample. The implication of these two limitations could be that the results do not give an indication of rural South African consumers' reactions to GM food and the results might not be representative of all urban consumers in South Africa. The GM behaviour and -acceptance of urban white maize consumers in other urban areas within South Africa (such as Cape Town, Polokwane, Durban and Bloemfontein) should be investigated further and compared with the Gauteng results. There is also a great need for research on the GM behaviour and -acceptance of rural white maize consumers from different cultural groups and geographical areas in South Africa.

Another limitation evolved around the participation of the respondents with low education levels (such as LSM groups 4 and 5) in the conjoint experiment. Even

though these respondents were able to complete the conjoint experiment, it was a very time consuming procedure to guide them through the whole process of the thought experiment. Thus, appropriate research techniques will have to be developed and applied for rural GM studies in order to accommodate the low education levels of these rural consumers. Suitable techniques could include qualitative techniques such as focus group discussions.

The sample size of 80 respondents also represented a limitation, since it is relatively small for a consumer survey. The small sample size could be seen as a limitation of the sample design, having an influence on the ability of the results to reflect on the population of urban white maize consumers given the presence of GM food in the market. Further research in this field should consider much larger sample sizes.

The results within Chapter 5 indicated that in general, the respondents' knowledge of GM food is relatively low. The balanced GM food information gained by the respondents during the experimental procedure probably influenced their opinions about GM food as the experiment evolved. Despite these observations the research methodology was still deemed as appropriate. The GM food knowledge gained by the respondents during the experiment could be seen as a simulation of situations where they could receive GM food information from external sources such as television, radio, magazines or newspapers.

The maize product focus of the study could also present potential limitation. Maize porridge (prepared from maize meal) was selected as the product in the sensory evaluation experiment, while maize meal was the selected product for the conjoint experiment. It could be argued that maize consumption is more important in rural areas than in urban areas and that another product should have been chosen for the urban study. However, since GM maize is a reality in the South African food market and since maize is widely consumed in South Africa among all income groups (even just as part of a variety diet by wealthier consumers), maize was considered as an appropriate food product for this study. Further research could include studies of the behaviour and acceptance of South African urban and rural consumers regarding genetically modified non-staple food products for everyday use, as well as genetically modified luxury food products.

The main findings of this study were used to formulate recommendations related to GM food marketing and consumer education. A summary of the key findings along with recommendations is discussed. The market segmentation (cluster analysis) based on the consumer preferences revealed the existence of three significantly different market segments within the urban consumer market of white-grained maize meal. The market segments developed within the cluster analysis procedure yielded better results than the three LSM categories, in terms of the respondents' perceptions and attitudes towards GM food. Black respondents from the middle and lower LSM groups dominated in the "Pro-GM" segment (45% of the sample respondents). These respondents revealed the lowest education levels among all the clusters. In terms of their GM preferences these consumers revealed a sensory preference for GM maize porridge, had the highest GM food buying likelihood and the most positive perceptions and attitudes towards GM food among all the clusters. The "Anti-GM" segment (35% of the sample respondents) mainly consisted of the middle and higher LSM groups (92.9%), white respondents and revealed the highest education levels among all the respondents. The consumers in this market segment revealed a sensory preference for non-GM maize porridge, had the lowest GM food buying likelihood and most negative perceptions and attitudes towards GM food among all the clusters. The third market segment, the "Pro-GM farmer sympathetic" segment was the smallest (only 20% of the sample respondents), consisted of equal proportions of black and white respondents and also had some of the lowest education levels. They had a sensory preference for non-GM maize porridge, but revealed relatively positive perceptions and attitudes towards GM food.

In order to use these market segment characteristics for marketing strategy formulation it is recommended that only the "Pro-GM" segment and the "Anti-GM" segments could be targeted, instead of all three the market segments. By targeting these two segments 80% of the market could be covered. It is very important to note that the largest market segment was positive towards GM food, especially when they received the benefit of the genetic modification. This suggests therefore that in order to achieve better consumer acceptance of GM food technology the product development efforts of food related GMOs should rather be driven towards genetic manipulations benefiting consumers and not necessarily benefiting the producers. The GM food marketing message for the "Pro-GM" segment could be targeted at

black consumers in the lower LSM groups, while white consumers in the higher LSM groups could be targeted with the marketing message for the “Anti-GM” segment.

The GM knowledge status of the sample respondents revealed a number of valuable observations when designing communication strategies for GM food. In general the survey revealed relatively low levels of GM information exposure, perceived- and actual understanding. These observations confirmed the observations of other South African GM consumer research studies mentioned in section 1.5.2. It was also found that the GM knowledge levels of South African consumers were higher among wealthier consumers (in higher LSM groups) than among poorer consumers (in the lower LSM groups).

According to Kotler (2000) inadequate marketing communication could contribute towards the failure of new products. This could be very relevant within the context of GM food products. The low level of GM food knowledge of South African consumers could result in a situation where they could rapidly turn against GM food in the absence or inadequate supply of balanced, scientific information on the topic. This could be especially applicable to the lower LSM groups who seem to be relatively positive about GM food, but revealed the lowest levels of GM knowledge among all the wealth groups.

The difference in the GM knowledge levels of the various LSM- and cluster groups suggest that GM food communication campaigns will have to be designed in such a manner that the communication messages and –channels fit the profiles of the market segments. Thus, the “Pro-GM” segments could be targeted with GM food communication containing balanced, scientific information presented in such a way that they can understand the message (given their lower education levels) and structured in such a way that they could be persuaded to remain positive about GM food products. On the other hand the “Anti-GM” segment could be targeted with balanced, scientific GM food communications structured to suit their higher education levels and attempting to persuade them to develop a positive GM food attitude. Since the study revealed that the “Anti-GM” segment was particularly negative about GM food presenting an environmental threat and being unnatural, these aspects could also be addressed in their GM food communication strategy.

Properly designed and executed GM food communication campaigns could reduce the gap between consumers' current (often distorted) perceptions and the perceptions that could lead to informed decision-making regarding GM food in the South African market. When dealing specifically with GM maize communication strategies, it might be feasible to focus marketing efforts mainly on the lower LSM consumers in the "Pro-GM" group, since poorer consumers consume the largest quantities of maize meal as a staple food product. Thus, such a focussed strategy could achieve high coverage in terms of product volumes despite the narrower population coverage. However, in this scenario it would probably still be crucial to present consumers with GM food products that was modified to the consumers' benefit as well and not only for the producers' benefit.

According to Kotler (2000) a major factor that could contribute towards the failure of new products could be when a powerful role-player pushes a new product through to the market, despite negative market research findings such as product consumer rejection, safety concerns and environmental concerns among consumers. Thus, when dealing with new product introduction in the context of GM food, this risk factor could possibly be avoided by a number of role-players operating in the GM food market. Farmers, seed companies, food processors, government and NGO's could learn valuable lessons from these results, that could contribute towards consumer-driven research, product development and marketing activities, instead of engaging in a technology push approach and ignoring the importance of consumers' behaviour towards GM food.

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APPENDIXES

APPENDIX A: CONSUMER PANEL RECRUITMENT QUESTIONNAIRE