Public Perceptions of Biotechnology in South Africa

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PUBLIC UNDERSTANDING OF BIOTECHNOLOGY

Public Perceptions of Biotechnology in South Africa

Conducted for the Public Understanding of Biotechnology Programme of the South African Agency for Science and Technology Advancement

Michael Gastrow*

Ben Roberts

Vijay Reddy

Shameelah Ismail

Education and Skills Development Research Programme
Human Sciences Research Council
*mgastrow@hsrc.ac.za

FINAL REPORT
SUBMITTED 30TH APRIL 2016

EXECUTIVE SUMMARY

Background

Biotechnology is widely seen as one of the critical domains of science and technology for the twenty-first century. It has a growing role, and further enormous potential, in the development and production of new classes of medicine, food, energy, and industrial processes. These areas all offer great opportunities for sustainable human development and economic growth. However, despite this recognition, biotechnology faces several challenges in the public sphere. Firstly, it is an esoteric area of knowledge. The public have a limited understanding of what biotechnology is, how it is governed, how knowledge is produced, and how the benefits are distributed and accrued. This provides fertile ground for reservations about biotechnology's ethical, health, and environmental implications. When the basic structures of living organisms are seen to be interfered with, questions are raised about religion and morality.

The public therefore has attitudes of both promise and reservation about biotechnology. These are well documented by extensive surveys, primarily in Europe and the USA. In some cases, reservations have had material impacts on biotechnology markets, for example the significantly reduced size and scope of the market for GM crops in Europe. Understanding public perceptions of biotechnology is therefore critical for informing national-level policy in the sector. However, relatively little research in this area has been conducted in South Africa.

The Public Understanding of Biotechnology (PUB) programme of the South African Agency for Science and Technology Advancement (SAASTA) has therefore commissioned a research project to undertake a national survey of the South African public's perceptions of biotechnology. This includes perceptions of biotechnology in general, and of specific applications in the fields of food production, medicine, and indigenous knowledge systems. The scope includes knowledge about biotechnology, attitudes towards biotechnology, the use of biotechnology in daily life, sources of information about biotechnology, and perceptions about the governance of biotechnology. The overarching aim of the project is to provide data and analysis that will inform evidence-based policies and strategies related to biotechnology, particularly in terms of public engagement and communication strategies.

Biotechnology, in its broad sense, refers to any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use (US Convention on Biological Diversity, http://www.cbd.int/). In this sense, biotechnology has been evolving along with human civilisation for thousands of years, and is deeply embedded in the indigenous knowledge systems of all cultures. In its contemporary usage, biotechnology is often referred to as specifically related to applications of technologies for manipulating DNA. This usage frames biotechnology as an inherently high-technology and knowledge-intensive activity, closely tied to advanced biological sciences. The juxtaposition between these two usages is particularly evident in South Africa, where indigenous knowledge systems harbour extensive knowledge related to using biological systems, while at the same time genetically modified organisms are commonly produced through commercial agriculture. Research into the public understanding of biotechnology in South Africa needs to encompass this diverse system, and policy interventions should utilise this diversity as a strength.

Public perceptions of biotechnology are commonly studied within the broad theoretical ambit of the 'public understanding of science'. In the South African context, a key source of knowledge about biotechnology and public attitudes is a report which was prepared for the PUB programme on the South African public's perceptions of biotechnology (Rule and Langa, 2004). At the global level, the literature on public perceptions of biotechnology is largely focused on the European public, supported by a number of Eurobarometer studies. This provides a firm foundation for establishing international comparability for the study in relation to *developed* countries. There is also a smaller body of literature on the public understanding of biotechnology in *developing* countries. However, none of these are based on nationally representative samples assessing public opinion, and are instead based on stakeholder interviews. As such, they are not directly comparable to the present study.

Methodology

A survey questionnaire was designed in order to include some questions that are internationally comparable, some that are comparable to 2004 South African data, and some that are customised to provide intelligence according to the current requirements of the PUB programme and the SAASTA. The survey was administered through the South African Social Attitudes Survey (SASAS) in November 2015. This rendered a final sample of 2940 adult South Africans. The results provide nationally representative data for the South African adult population.

Key findings

International comparison

There are no nationally representative studies of public perceptions of biotechnology from other developing countries – extant studies are all stakeholder studies with small samples. This means that international comparisons can only be made with developed country studies, in this case Europe, the US, and Australia. The results clearly show that the South African public can be broadly described as 'less informed, but more positive' about biotechnology, and specifically GM food (which forms the focus of most international studies). South Africans are more than twice as likely as Europeans to believe that GM food is safe to eat, and are also significantly more likely to see GM foods as good for the economy (53% compared to 31%). South Africans are also less likely to see the environmental impact of GM food productions as being higher than conventional farming (42% compared to 52%). However, for each of these questions, South Africans were also more likely to reply with a 'don't know' response, indicating that these generally positive attitudes are formed in a social context that is generally less informed. This supports the thesis that being more informed about biotechnology does not necessarily lead to the formation of positive attitudes. Rather, increased informedness results in greater engagement with the topic and the formation of more clearly defined attitudes. In Europe, these attitudes have tended to be more critical.

It thus appears that the level of knowledge required to meaningfully engage with questions of GM food safety, economic impact, and environmental impact, are lower in South Africa than in developed countries. However, South Africans do have some basic knowledge of GM foods that is at a level that is roughly comparable to a developed country. For example, roughly the same proportions of South Africans and Australians are aware of the country's primary GM crop. 41% of Australians were aware of the farming of GM canola, and 40% of South Africans were aware of the farming of GM maize (see Table 17). Public awareness of the country's secondary GM crop was also similar (9% in Australia, and 7% in South Africa). From these findings we can hypothesise that the South African public's basic knowledge about GM crops is similar to that of a developed country, even though the level of more advanced knowledge might be lower.

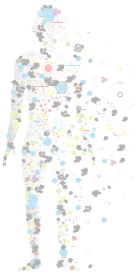
Changes over time: 2004 – 2015

A review of changes in public perceptions of biotechnology between 2004 and 2015 shows, overall, a major increase in public awareness of biotechnology, and a major increase in attitudes that favour the purchasing of GM food (Table 54). Public familiarity with the term 'biotechnology' more than doubled during this period, from 21% of the population to 53%. Public awareness that GM foods form a part of their diet more than tripled, from 13% to 48%. Each of these changes signifies a major shift in public awareness. We can hypothesise that these changes are due to increased levels of education, increased access to information, and greater prominence of biotechnology in the public discourse during this period. It may be the case that the labelling of (some) GM foods has played a role. However, testing these hypotheses would require further research, included qualitative research. Attitudes towards the purchasing of GM foods also changed significantly. The proportion of the public that would purchase GM foods on the basis of health considerations increased from 59% to 77%, on cost considerations increased from 51% to 73%, and on environmental considerations from 50% to 68%. Other aspects have remained more stable – for example the ranking of preferred sources of information about biotechnology has, on the aggregate level, seen little change.

Key findings: 2015

Four dominant themes characterise the latest, 2015 data. Firstly, there is the unique and powerful role of age in determining perceptions of biotechnology. Responses by age were almost in all respects reported on a gradient, with successively younger cohorts being successively more connected to sources of information, successively more knowledgeable, and having generally more positive attitudes towards biotechnology.

The second dominant theme was that of privilege:



educational attainment and living standard were powerful predictors of perceptions of biotechnology. Those with lower levels of education and lower living standards are less connected and have lower levels of knowledge (although their attitudes display a degree of variance).

Thirdly, there is the predominance of polarisation of viewpoints: most indicators of attitudes towards biotechnology reveal a public that is polarised, with substantial proportions being respectively in favour and against a particular issue. Only in the area of food labelling was there any meaningful consensus (a strong public opinion in favour of labelling).

Lastly, the question of 'don't know' responses remains important: significant proportions of the public (generally between 10 and 30 percent) were not able to provide responses to survey questions. This indicates firstly that these sections of the public are disengaged from biotechnology as a topic, and also that the survey results need to be interpreted with this in consideration. This group also represents a strategic public for biotechnology stakeholders – a group where knowledge and attitudes are not yet fully formed, and where preconceptions or inherent biases are not yet present.

South Africa is a highly stratified society, characterised by deep divisions along lines of economic inequality, educational inequality, ethnicity, race, and geographical location, amongst others. The intersections of these strata create distinct South African 'publics', each of which have different perceptions of biotechnology, and each of which may require distinct strategies for engagement. The perceptions of the South African public can be delineated by key demographic indicators: age, education, LSM, race, and geographical location. Other demographic variables, such as gender and religion, did not play as important a role in determining perceptions of biotechnology. Thus we can highlight the key roles of:

- *Age*: younger generations are successively more connected, more knowledgeable, and more positive about biotechnology compared to older generations.
- *Education*: more educated groups are successively more connected, more knowledgeable, and more positive about biotechnology compared to less educated groups. However, those with a tertiary education are more likely than other groups to see biotechnology as risky rather than beneficial.
- *Living standard*: those with higher living standards are successively more connected, more knowledgeable, and more positive about biotechnology than lower living standard groups.
- *Race*: Indian and White groups are more knowledgeable than other groups, but attitudes towards various aspects of GM food are distinct for each group, with neither an overall positive or overall negative viewpoint for a particular race group. Each of the racial groups draws on a distinct set of sources of information about biotechnology.
- *Geographical location*: the different geographical locations have distinct profiles of perceptions of biotechnology. Those in urban areas are more connected and more knowledgeable (in general), but those in rural areas have greater practical knowledge and familiarity with GM crops, and are far more likely to have used IKS applications of biotechnology.

The analysis of survey results was also structured thematically. Some of the key thematic findings are highlighted below:

Knowledge about biotechnology

Most South Africans (73%) report having little or no knowledge about biotechnology. Younger and more privileged groups report greater knowledge than older and less privileged groups. The terms 'genes' and 'DNA' are far more widely understood than 'biotechnology', 'genetic modification' or 'GM food'.

Perceptions of GM food

The public has low levels of knowledge and awareness of GM food, and thus do not have strongly formed opinions. Large proportions of the public did not engage with attitudinal questions about GM food, providing 'don't know' responses instead of defined positions. The main exception is that the South African public are strongly in favour of labelling GM foods. Educational attainment is an important predictor: those with matric or tertiary qualification have a higher likelihood of demonstrating greater knowledge of GM foods compared to those with primary education or no formal schooling. Having previously engaged in traditional farming practices also increases the odds of being more knowledgeable about GM food.

About half of the public are aware that GM crops are legally grown in South Africa. This mostly applies to maize, and awareness of GM cotton and GM soya crops is very low. About half the South African public are aware that their food contains GM products. Higher levels of knowledge about GM food are associated with younger age groups and with social privilege. A large proportion of the public (73%) have

perceived qualitative changes in the maize they eat – a far higher proportion than have substantive knowledge of the causes of these changes. Those who could identify GM maize as a legally grown crop in South Africa were substantially more likely to understand that they eat GM food.

Religion plays a part in forming attitudes towards the ethics of GM food, serving to polarise the public into approximately equal groups that agree or disagree with the notion of GM 'intervening in God's plan'. The public are largely disengaged from assessing the ethics of the international corporations that play a role in the sector.

Most South Africans believe that GM foods are good for the economy, although levels of engagement with the issue are low. Younger South Africans are more positive than older South Africans about the economic benefits of GM food. Farmers are perceived to benefit from GM crops, but commercial farmers are seen to benefit more than subsistence farmers. The environmental impact of GM crops is commonly seen to be higher than traditional farming methods. The overall risk/benefit assessment of GM foods is positive. Younger generations and more educated groups are more likely to see GM foods as a benefit to society.

Perceptions of medical biotechnology
At an aggregated level, knowledge about medical applications of biotechnology is similar to that of GM foods: approximately half of the public have never heard of it, and only 6-7% report a high level of knowledge. As is the case for other knowledge indicators, greater knowledge about medical applications of biotechnology is associated with lower age and higher levels of privilege. Educational attainment appears to exert the strongest positive association with knowledge of medical biotechnology. As levels of education increase, the log odds of possessing greater knowledge rise considerably.

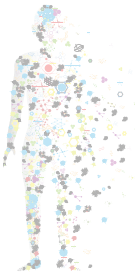
Attitudes towards the ethics of GM medicine are broadly similar to attitudes towards GM food, suggesting that normative judgements among the public cut across specific applications of biotechnology. In the context of a high level of 'don't know' responses, the public were polarised in their views about medical biotechnology 'intervening in God's work' (39% agreed and 33% disagreed) and in their views about whether it is 'ethically wrong' (26% agreed and 43% disagreed). The public is largely disengaged from the issue of corporate ethics in medical biotechnology, with 41% responding 'don't know' to the related question. Only 22% of the public were concerned with the ethics of these corporations.

Governance of biotechnology
The public feel that the governance of biotechnology should be most strongly influenced by commercial farmers, university scientists, and environmental groups/NGOs. The least favoured institutions for this purpose are seen to be international corporations, the general public, the media, and religious organisations. However, the public appear to favour a mode of 'consensus governance', in which all the main stakeholders play a role in governance.

Indigenous Knowledge Systems and biotechnology
Most South Africans have used biotechnology in the context of indigenous knowledge systems and practices. South Africans have a far greater understanding of biotechnology-related traditional practices and knowledge bases than they do of biotechnology in the narrower sense. High levels of awareness and usage in daily life position IKS-based biotechnology as an ideal platform for engagement with the majority of the South African population. Groups with low incomes and low levels of education may find it difficult to engage with concepts of mainstream biotechnology, but harbour rich traditions of knowledge and practice of IKS that may be successfully leveraged to build greater awareness of biotechnology in the more modern sense.

Sources of information
On aggregate, radio and television are the most popular sources of information about biotechnology. Younger age cohorts are more likely to use all sources of information, except for radio. Younger generations are far more likely than older generations to use the internet to obtain information. More educated groups and those with higher living standards are more likely to use the internet and print media, and less likely to use the radio. Those living on rural farms are significantly less likely to use any of the media channels to obtain information about biotechnology.

Overall risk/benefit assessment of biotechnology
Only about half of the public engaged with the question of a general risk/benefit analysis of biotechnology, registering indifference or a 'don't know' response. White and Indian South Africans were more likely to see biotechnology as an overall risk to society compared to Black African and Coloured groups. Increased educational attainment was associated with a more positive risk/benefit assessment, with the exception of those with tertiary education, where this pattern was strongly reversed,



and those in the most highly educated group were most likely to see biotechnology as a risk. Higher living standard was associated with increased likelihood to view biotechnology as a risk. Those living on rural farms and in urban informal areas were substantially more positive in their assessments than those in other areas. An individual with no ethical or religious objections to GM food is much more likely to believe that biotechnology is a benefit rather than a risk. If an individual thinks that government effectively regulates GM food, then he or she will be less likely to view biotechnology with uncertainty, and more likely to rate it as a benefit than a risk.

Biotechnology, public engagement, and policy

The evidence shows us that public engagement by the biotechnology sector takes place in the context of rapidly escalating public awareness of biotechnology. The South African public is also, in comparison to the EU, both more positive and less informed. These factors pave the way for strategic interventions that will build up public knowledge, while at the same time cultivating constructive engagement between the public and the biotechnology sector.

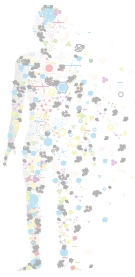
The South Africa public is deeply stratified, and different demographic groups have markedly different perceptions of biotechnology. Policy interventions therefore need to include a strategic approach towards addressing these different publics in different ways, drawing on the evidence related to their levels of knowledge, attitudes, and preferred sources of information.

The suggested generic process for policy interventions is thus to firstly assess which 'publics' require engagement in terms of specific issues as identified in the key themes emerging from this report; for example, knowledge of or attitudes towards biotechnology in general, or of particular aspects of GM food, GM medicine, or IKS and biotechnology. The second stage would be to engage with these 'publics' using the sources of information they are most disposed to using for engaging with biotechnology. The third stage would be to conduct further research into qualitative and quantitative aspects of public perceptions of biotechnology in order to assess changes over time and the impact of engagement interventions.

ACKNOWLEDGEMENTS

This report forms part of the 'Public Perceptions of Biotechnology in South Africa' research project for the Public Understanding of Biotechnology programme of the South African Agency for Science and Technology Advancement. We would like to express our appreciation to the following individuals who contributed to the successful completion of this study on public perceptions of biotechnology in South Africa:

- The 2,940 South Africans who generously gave of their time to participate in the survey and share their views and experiences.
- Prof. Jennifer Thomson for her invaluable technical advice and expertise.
- The South African Agency for Science and Technology Advancement (SAASTA), for their support, guidance, advice and input throughout the study. The comments received from various members of the SAASTA staff at different stages of the research process are also gratefully acknowledged.
- The Human Sciences Research Council (HSRC) provincial supervisors, sub-supervisors and data collectors who traversed the country – often under difficult circumstances – to ensure that high-quality information was collected from all those who were interviewed. Also for their facilitation of the various focus groups that were held in the nine provinces.
- The HSRC's data capturing unit, especially Annemarie Booyens and Joel Makhuvela, for working tirelessly throughout December 2015 to ensure that the data were ready for analysis.
- Thanks are also due to Mercy Ngungu who ensured that the data used for analysis were of high quality, as well as Professor David Stoker for weighting the data.
- The role played by the HSRC project administrator, Busisiwe Mamba, who was an invaluable resource for the study. Her administrative tasks spanned over all field logistics including training and contracts, car rentals and payments. Without her support, this project would not have been possible. We would also like to extend our gratitude to Koshen Govender and Hermien Bolton for their administrative support.



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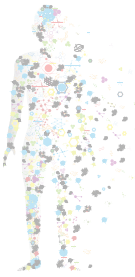

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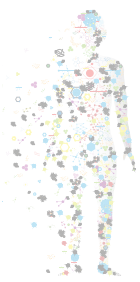

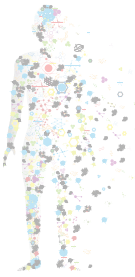

Figures:

1 INTRODUCTION

Biotechnology is widely seen as one of the critical domains of science and technology for the twenty-first century. It has a growing role, and further enormous potential, in the development and production of new classes of medicine, food, energy, and industrial processes. These areas all offer great opportunities for sustainable human development and economic growth. However, despite this recognition, biotechnology faces several challenges in the public sphere. Firstly, it is an esoteric area of knowledge. The public have a limited understanding of what biotechnology is, how it is governed, how knowledge is produced, and how the benefits are distributed and accrued. This provides fertile ground for reservations about biotechnology's ethical, health, and environmental implications. When the basic structures of living organisms are seen to be interfered with, questions are raised about religion and morality.

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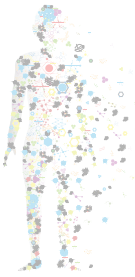
The Public Understanding of Biotechnology (PUB) programme of the South African Agency for Science and Technology Advancement (SAASTA) has therefore commissioned a research project to undertake a national survey of the South African public's perceptions of biotechnology. This includes perceptions of biotechnology in general, and of specific applications in the fields of food production, medicine, and indigenous knowledge systems. The scope includes knowledge about biotechnology, attitudes towards biotechnology, the use of biotechnology in daily life, sources of information about biotechnology, and perceptions about the governance of biotechnology. The overarching aim of the project is to provide data and analysis that will inform evidence-based policies and strategies related to biotechnology, particularly in terms of public engagement and communication strategies.

Chapter Two of this report outlines the mandates of the SAASTA and the PUB programme in the context of national policies related to biotechnology. Chapter Three presents a literature review of South African and international studies of public perceptions of biotechnology. Chapter Four presents the methodology for the study. Chapter Five explores the results of the national survey through a bivariate descriptive analysis of its key findings, including aggregated and demographically disaggregated data, as well as international comparisons and an examination of changes in South African perceptions over time.

Chapters Five and Six are complementary. Chapter Five does not seek to control for other variables in its analysis. In contrast, the multivariate analysis presented in Chapter 6 explicitly sets out to establish the statistical significance of variances across groups, while controlling for other variables. These two analyses thus provide an indication of 1) the de facto knowledge and attitudes of the different demographic groups, and 2) the knowledge and attitudes of these groups when other variables (such as age, race, education, income, etc.) are controlled through a range of multiple regression models.

Chapter Seven reflects on the key findings and implications for SAASTA, the PUB programme, and other stakeholders in the biotechnology sectors who are seeking to engage the public in a more strategic and evidence-based manner.



2 INSTITUTIONAL AND POLICY CONTEXT

2.1 Policy context

The issue of public perceptions of biotechnology, and public engagement with biotechnology, has a rich policy context in South Africa. Public engagement with science is tangentially mentioned in core national policy documents. The White Paper on Science and Technology (1996) notes that the development of the National System of Innovation (NSI) requires a society that values and understands science and technology as social tools. The National Research and Development Strategy (2002) expresses the Department of Science and Technology's aim to invest in science promotion towards making science attractive, accessible and relevant – although further details are not provided. The National Development Plan (2012) aims to 'promote technological advances, developing countries should invest in education for youth, ... and should ensure that knowledge is shared as widely as possible across society', although, again, specifics are not included.

The first detailed policy statements regarding public engagement with biotechnology are made in the National Biotechnology Strategy (2001). This document assessed the following shortfalls in the relationship between biotechnology institutions and the public:

> 'There is a lack of understanding of the scientific basis underlying the potential benefits, risks and ethical and environmental issues of biotechnology and a perception that biotechnology is generally synonymous with genetically modified foods (GMOs). Scientists do not communicate biotechnology issues in a language understood by the public and media reports often do not contain sufficient details to inform the public adequately' (National Biotechnology Strategy, 2001: 36).

The policy objectives suggested to address these perceived problems include promoting a clear understanding of the potential of biotechnology and of the scientific principles that underlie biotechnology. This would require a 'single biotechnology vision for South Africa' – an objective that may require further debate, since visions of biotechnology are inherently diverse and contested. The Strategy also suggests that biotechnology issues should be included in the school curriculum and that the media should be provided with balanced information and encouraged to communicate biotechnology issues responsibly.

These policy objectives contributed to the establishment of the Public Understanding of Biotechnology programme in 2003 – an initiative funded by the Department of Science and Technology (DST), and implemented by the SAASTA, part of the National Research Foundation (NRF). The overall aim of the PUB programme, in line with the Biotechnology Strategy, is to:

> 'promote a clear understanding of the potential of biotechnology and to ensure broad public awareness, dialogue and debate on its current and potential future applications', to 'provide a single biotechnology vision for South Africa', and promote the 'dissemination of accurate and factually correct information accessible to the broad South African public' (http://www.pub.ac.za/).

It is within this ambit that the current study falls.

Biotechnology has remained an ongoing focus area for the DST. The Bio-economy Strategy (2013) represents an advance from the 2001 National Biotechnology Strategy, and also includes support for 'initiatives to promote public understanding of the technologies underpinning the bio-economy', including 'creating and maintaining a South African bioportal that provides information on relevant technology skills, opportunities, products and linkages in the South African bio-economy' (National Bio-economy Strategy, 2013: 23).

An overarching Science Engagement Framework was released by the DST in 2015, with the aim of co-ordinating and aligning national science engagement activities, particularly those of DST

entities. Improved engagement between the public and the institutions of biotechnology would be in line with the main strategic objectives of the Framework, which are expressed as:

- To popularise science, engineering, technology and innovation as attractive, relevant and accessible in order to enhance scientific literacy and awaken interest in relevant careers.
- To develop a critical public that actively engages and participates in the national discourse of science and technology to the benefit of society.
- To promote science communication that will enhance science engagement in South Africa.
- To profile South African science and science achievements domestically and internationally, demonstrating their contribution to national development and global science, thereby enhancing its public standing. (Science Engagement Framework, 2015: 21)

These strategic objectives are well aligned with those of the PUB programme, which has similar objectives, but a specific sectoral scope.

2.2 SAASTA and the PUB programme

The PUB programme is an initiative of the DST, and is implemented by SAASTA's Science Communication Unit. The PUB programme was launched in 2003 with the aim of promoting a clear and balanced understanding of the potential of biotechnology, and to ensure broad public awareness, dialogue and debate on its applications. The target audience includes all facets of the South African society. The PUB programme assists in the translation of academic biotechnology research for the public, industry and policy makers, as a service to these diverse groups of stakeholders. More specifically, the PUB programme aims to achieve improved informed decision making on biotechnology-related life issues, increased numbers of learners and students pursuing biotechnology and related fields as a career, and increased levels of awareness and 'decidedness' by the general public on biotechnology-related issues.

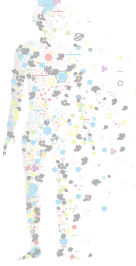
The PUB programme is an initiative that resulted from the publication, in 2001, of the South African National Biotechnology Strategy. Effective communication of developments in the biotechnology sector has been highlighted as a priority area in the DST's Bio-economy Strategy. Amongst the challenges identified in the strategy is the need for the public to understand the significance of biotechnology. Improved communication with the public is one way to meet this challenge, for example by supporting the supply of constructive information, and improving the general understanding of the subject matter.

The strategy advocates the use of basic language and the minimal use of scientific jargon in order to create an environment that is inclusive. It also emphasizes that a single national vision must be followed by all government departments to avoid causing confusion. The public in general, from schools to media organisations, should be provided with information that improves their knowledge base. Campaigns could be used as a tool to convey this message for schools. The PUB programme was launched to target audiences, learners and the general public.

The main stakeholders – the DST, the NRF, SAASTA, and the PUB – aim to gain a comprehensive understanding of the South African public's perceptions of, and attitudes towards, biotechnology and its applications, in order to inform science advancement practices and strategies. This report, which presents an analysis based on a nationally representative household survey, aims to meet this objective.

The broader mandate of SAASTA recognises that science communication requires a sound understanding of public perceptions, in this case towards the field of biotechnology. This understanding is particularly relevant to the critical processes of scientific editing and audience analysis, and hence to the strategic structuring of science communication. It is also of direct relevance to all three of SAASTA's science communication focus areas, namely Science and the Media, Science Promotion, and Science Communication and Capacity Building. Each of these units requires information about public perceptions of science in order to strategically inform their activities.

The overall objective of the report is thus to analyse the results of a national survey investigating the South African public's perceptions of biotechnology, in order to inform evidence-based strategies and policies related to biotechnology, particularly in terms of science advancement, awareness and communication.



3 LITERATURE REVIEW

Biotechnology, in its broad sense, refers to "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use" (US Convention on Biological Diversity, http://www.cbd.int/). In this sense, biotechnology has been evolving along with human civilisation for thousands of years, and is deeply embedded in the indigenous knowledge systems of all cultures. In its contemporary usage, biotechnology is often referred to as specifically related to applications of technologies for manipulating DNA (Bauer, 2005), including in vitro fertilisation, stem cell research, biological weapons, gene therapy, genetically engineered vaccines and other pharmaceuticals, genetically modified plants and animals, and even human cloning (Nisbet & Lewenstein, 2002). This usage frames biotechnology as an inherently high-technology and knowledge-intensive activity, closely tied to advanced biological sciences.

The juxtaposition between these two usages is particularly evident in South Africa, where indigenous knowledge systems harbour extensive knowledge related to using biological systems, while at the same time genetically modified organisms are commonly produced through commercial agriculture, and many research centres practice various forms of genetic manipulation, thus adding to the global biotechnology knowledge frontier. Research into the public understanding of biotechnology in South Africa needs to encompass this diverse system, and utilise this diversity as a strength. In the context of a stratified society with a wide range of economic activities characterised by varying degrees of technological intensity, and a wide range of social and economic strata with distinct attitudes towards and engagements with science (Reddy et al, 2013), understanding public attitudes towards biotechnology is an essential prerequisite for developing evidence-based science engagement policy, and also holds the potential to make a substantive contribution to the related theoretical debates.

It has been in the more restricted contemporary sense that biotechnology has entered global public discourse and generated areas of controversy. The first patent on recombinant DNA techniques was registered in 1973, thus creating the prospect of modifying organisms at the genetic level and using this to economic advantage. This discovery did not at first make a major impact on public discourse (Cantley, 1995; Torgerson et al, 2002). However, when this technology advanced to the point of creating powerful symbols of genetic manipulation, biotechnology emerged as a controversial issue within the public sphere. For example, the birth of Dolly, the cloned sheep, in 1997, prompted debates about the ethics of human cloning for reproductive or therapeutic purposes. Since then, the use of genetically modified crops has prompted debates about food safety, genetic integrity, labelling policies, and traceability of food. These debates have played out in various aspects of the public sphere, including the media, policy making, and in public perceptions and attitudes.

Public perceptions of biotechnology are commonly studied within the broad theoretical ambit of the public understanding of science (for example Bauer, 1997 and Gaskell and Bauer, 2006). At the global level, the literature on public perceptions of biotechnology is largely focused on the European public, supported by a number of Eurobarometer studies, for example Marlier (1992, 1993), European Commission (1997, 2010), Gaskell, Allum, and Stares (2003), Eurobarometer (2005), Gaskell *et al* (2006) and Gaskell *et al* (2010). This provides a firm foundation for establishing international comparability for the study in relation to *developed* countries. There is also a smaller body of literature on the public understanding of biotechnology in *developing* countries, for example Asian Food Information Center (2008), Lü (2006), Macer et al (2000), and Quaye *et al* (2009). However, none of these are based on nationally representative samples assessing public opinion, and are instead based on stakeholder interviews. As such, they are not directly comparable to the present study.

In the South African context, a key source of knowledge about biotechnology and public attitudes is a report which was prepared for the PUB programme on the South African public's perceptions of biotechnology (Rule and Langa, 2004). This report, while based on sound data, offered a limited degree of analysis. The data were moreover constrained by a high proportion of 'don't know' responses, indicating that participants were not familiar with the notions of biotechnology or its applications.

Similarly, a smaller study by Pouris (2003) found very limited understanding of biotechnology – at least to the extent that this concept was made available to survey participants.

This review of the literature positions the objectives of the PUB programme and the national biotechnology survey within the policy context of biotechnology and the public engagement with science. It assesses the field of the public understanding of science, a broad domain of enquiry that seeks to better understand the complex relationships between the institutions of science and the public. We lay out the main theoretical paradigms in this area, and suggest how these could inform research into the public understanding of biotechnology. We also focus on extant research into public perceptions of biotechnology, examining evidence from South Africa in the context of international studies from both developing and developed countries. Finally, we assess the challenges and opportunities that emerge from the literature, and examine how these might inform methodological aspects of the study.

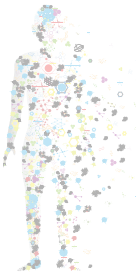
3.1 Science and the public

Fostering a constructive relationship between the public and the institutions of science has many benefits. By making more informed decisions regarding scientific topics, individuals can improve their quality of life, and better contribute to social development. A more engaged public may be better positioned to adapt to changes in the science and technology environment and exploit new technologies (Laugksch, 2000; Stockmayer and Gilbert, 2002). Greater engagement with the sciences can lead to a more highly-skilled workforce and consequent economic development (Laugksch, 2000). A constructive relationship also has implications for citizenship (Reddy *et al*., 2009), as democracy can be consolidated through fostering increased public participation in policy formulation and adoption (Gregory and Lock, 2008; Stockmayer and Gilbert, 2002), particularly by empowering citizens to interrogate and debate science issues with the scientific community in a participatory manner (Durant, 1999). Elam and Bertilsson (2002) frame science engagement as a process of deliberative democracy that requires the establishment of equality between the public and the science establishment in order to create socially sustainable policies. Overall, such engagement makes the government and scientific institutions more accountable to the public, and improves the transparency and legitimacy of the science policy process. There is also an evolving literature exploring possible correlations between attitudes towards science and school achievement in science (Reddy *et al*, 2014).

Theoretical frameworks for understanding the relationship between science, or aspects of science, and the public, have emerged over several decades of international debate. Three central theoretical paradigms have framed this discourse – those of scientific literacy, public understanding of science, and science and society (see Bauer, Allum and Miller, 2007; Gregory and Lock, 2008; Miller, 2004; and Ziman, 1991). The broad trend running through these paradigms is a shift over time from a 'deficit model' which viewed the public as being deficient in science knowledge, and requiring guidance and education, to more participative models which emphasise the agency of citizens to contribute to the relationship between science and society.

Early efforts to promote an improved relationship between the public and science focused on increased levels of knowledge about science, which was framed as inherently beneficial, and likely to improve the capacity of the public to engage with science questions and decisions (Miller, 1998). This was premised on an argument that a lack of scientific knowledge can cause the public to be hostile towards the science community (Allum *et al*, 2008) and create a cognitive barrier that prevents the public from benefiting from science (Miller, 1998). Conversely, a scientifically literate public is more likely to provide public support for science and take advantage of science and innovations (Durant, 1999).

However, the causal relationships that underpin this model came to be critiqued – particularly the assumption that increased scientific knowledge causes more positive attitudes and relationships with science institutions (Evans and Durant, 1995). Questions were also raised about the impact of demographic variables and cultural, social and political contexts. These questions encouraged closer investigation of the links between attitudes, knowledge, and social context. These investigations influenced a seminal report by the Royal Society (1986) in the UK, entitled "Public Understanding of Science", which raised concerns about the political vulnerability of the scientific community in the context of decreasing levels of public support for science (Miller, 2001; Ziman, 1991). The report shifted academic attention to the relationship between knowledge and attitudes (Sturgis and Allum, 2004; Bauer *et al*, 2000) and the role of communication (Gregory & Lock, 2008; Bauer *et al*, 2007). This has remained the



dominant framework for major empirical research projects, such as the Eurobarometer in Europe (see Table 1), the National Science Foundation surveys in the USA (), as well as surveys in India (Shukla, 2005) and South Africa (Reddy *et al*, 2013) It also spurred a substantial body of literature, emerging at first from the UK in the 1980s, and centred on the journal *Public Understanding of Science* (see Bauer, Allum and Miller, 2007; Gregory and Lock, 2008; and Felt and Fochler, 2008 for overviews). This literature focused on public attitudes towards science, public understanding of science content, the public understanding of scientific methods and science institutions, and the field of science communication (see Bauer *et al*., 2007).

However, sustained critique of the 'deficit model', in which the public were perceived as 'deficient' in science knowledge and attitudes towards science, shifted the debate towards the terrain of citizenship and participation, under the rubric of the term 'science in society' (Bauer *et al*, 2007). The notion of 'deficit' was in this case applied to the scientific community itself, highlighting potential opportunities for improving its interaction with the public (Felt and Fochler, 2008, Stockmayer and Gilbert, 2002). The 'science in society' framework also takes into account indigenous scientific knowledge (Sturgis and Allum, 2004), and moves away from the assumption that formal science is superior to indigenous science (Du Plessis and Raza, 2004).

One heuristic commonly used to link the institutions of science, the public, and other social structures into an analytical framework is that of the public sphere, drawing on the work of Habermas (1989), for example Bauer (2002, 2005) and Bauer *et al*, (2007). This application of the notion of the public sphere positions the 'technology movement' at the centre of a systemic analysis of social actors and institutions (see Figure 1). Within the public sphere, technology movements need to mobilise support from social actors, including the general public. A technology movement can create contestation among actors, for example over media representations, public attitudes, and regulatory conditions (Bauer & Gaskell, 1999; Bauer, 2002). Actors can mobilise in three main arenas: 1) regulation and policy making, 2) the mass media, and 3) public attitudes and conversations. These arenas are somewhat autonomous, but can influence one another in terms of what messages are brought to attention. For a 'technology movement' such as biotechnology, the public sphere can provide either support or resistance, or a mixture of these, from the various social actors that play a role in these institutions.

Bauer (2002) developed this heuristic for the analysis of the systemic context of biotechnology as a technology movement, as part of a large comparative research project on public controversies over biotechnology and genetic engineering in sixteen European countries. The notion of the public sphere was used to frame the central concepts of arenas, platforms, and the biotechnology movement, with reference to empirical results comparing the three arenas of regulation, mass media coverage, and public perceptions, and their interrelations in different contexts. The public sphere heuristic provides a critical resource of positioning public attitudes towards biotechnology within their social context, and reflecting on what the social and technological impact of such attitudes might be. It also showcases the central role of biotechnology in the broader public understanding of science literature, where biotechnology features as one of the most controversial and widely studied scientific disciplines and areas of technological application.

Figure 1: Heuristic for researching science and technology in the public sphere

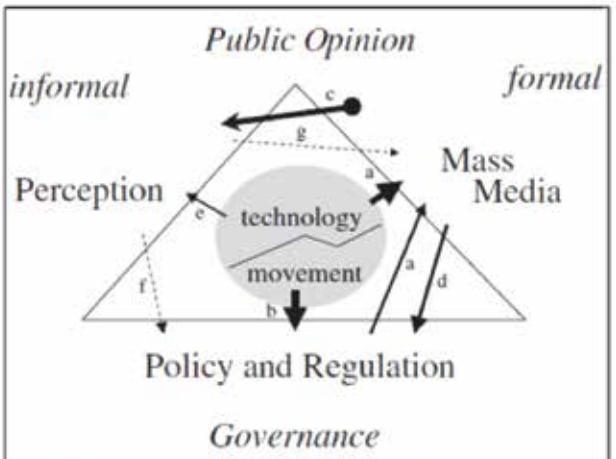


Figure 1: Triangular Model of the Public Sphere of Science and Technology
NOTE: The triangular model of the public sphere of science and technology shows its four main constituencies. The technology movement is at the center, surrounded by the three arenas of the public sphere: regulation and policy making, mass media coverage, and public conversations and perceptions. The triangular model integrates various nonoverlapping distinctions: governance versus public opinion; within public opinion, that between informal and formal public opinion; and the conflicting formations within the biotechnology movements. The arrows suggest principal directions of influence and the hypothetical strength of influences that are subject to empirical testing. The following seven relations can be identified: (a) public relations; (b) lobbying; (c) media effects on public perceptions; (d) media effects on policy making; (e) public lecturing and education; (f) relatively direct contacts with the public, for example, public discussions, consensus conferences, and so on; and (g) feedback effects from audience to mass media production.

Source: Bauer (2002: 150)

3.1.1 Public perceptions of biotechnology

3.1.1.1 International studies

The study of public perceptions of biotechnology is a terrain that is rich in theoretical and empirical research. The field has grown over several decades, in line with the growth of the broader field of the public understanding of science, and in line with the rise of biotechnology as a prominent and controversial new technology. Following the early conceptualisation and application of recombinant DNA technologies in the 1970s and early 1980s, the attention of researchers focused on this particular aspect of biotechnology (Hughes, 2001). Several early studies, such as Krimsky (1982) and Goodell (1986) focused on the social history and social acceptance of recombinant DNA technologies, examining links between media coverage and public attitudes and perceptions.

However, as the scope, prevalence, and public impact of biotechnology grew through the 1980s and 1990s, research imperatives and policy demands spurred a broader theoretical scope and the establishment of both small and large scale surveys. Policy makers increasingly required accurate assessments of public attitudes in order to proceed with biotechnology-related policy decisions, while in the field of the public understanding of science, researchers employed biotechnology as one of the key sectoral lenses for understanding the complexities and causal mechanisms that underlie public perceptions of science. The inherently problematic tensions between notions of scientific progress and anxieties about altering the fundamental DNA structures of life, as well as the tensions between major biotechnology stakeholders (such as producer organisations and international corporations) and anti-GMO lobby groups and activist groups, set a stage for understanding how controversial science and technology are contested in the public sphere (Aerni, 2005).

The increased evidence base supported a wider research scope and the emergence of a variety of theoretical lenses. Bauer (1995) interpreted public perceptions of biotechnology through the lens of 'resistance to new technology'. However, a more common approach, both by Bauer and others, was to seek relationships between media content and public attitudes, drawing on both media content analysis and attitudinal data emerging from surveys – for example Bauer (2002, 2005, 2007), Durant, Bauer and Gaskell (1998), Wagner and Kronberger (2002), Sturgis *et al* (2010) and Ho, Brossard and Scheufele (2008). Other studies have focused on perceptions of risk (Gaskell *et al*, 2004; Legge and Durant, 2010), or specifically on the relationships between knowledge, attitudes, and trust (Roberts *et al*, 2011). A more recent focus has been on drawing attitudinal data into the construction of broader indicators of 'science culture', which also include science input measures, such as research expenditure, and output indicators, such as patents and publications (Bauer *et al*, 2012; Bauer, 2012).

Through the 1990s, and continuing to the present, growing demand for empirical studies of public perceptions of biotechnology led to the establishment of large-scale institutionalised surveys, as well as increasing numbers of smaller scale independent surveys and surveys of stakeholder perceptions (as distinct from the perceptions of the general public). A sample of these surveys is presented in Table 1, Table 2, and Table 3. Table 1 presents a sample of surveys from developing countries, including surveys of stakeholder perceptions (as distinct from surveys of the general public). Table 2 presents an overview of Eurobarometer surveys, and Table 3 presents an overview of National Science Foundation surveys undertaken in the USA.

The research scope of these studies is broad. Items focusing on biotechnology include constructs indicating knowledge about biotechnology, trust in biotechnology institutions, perceptions of benefit and risk, and sources of information about biotechnology. While most of the surveys assessed in this review investigate perceptions of biotechnology in general, there are several studies that focus on specific aspects or applications of biotechnology, such as genetic testing, cloning, pharmacogenetics, gene therapy, industrial biotechnologies, and stem cell research. Research into public perceptions of biotechnology has an overall leaning towards food and agricultural biotechnology, which has proved to be one of the most controversial aspects of the technology. Examples here include Amin *et al* (2010), Cantley et al (1999), Anunda (2014), AFIC (2014a), AFIC (2014b), Curtis *et al* (2004), Gaskell (2000), Hallman and Metcalfe (1994), Legge and Durant (2010), and Torres *et al* (2006). Empirical studies also have a relatively common focus on food and agricultural biotechnology (see Table 1 and Table 2.) This is in line with a long-term academic and policy interest in genetically modified food as a key aspect of biotechnology, particularly with respect to public attitudes and the public sphere, both in developed and developing countries. Studies have shown that the application of genetic modification

for agriculture has lower levels of public acceptance than other applications of biotechnology (Gaskell *et al*, 2003), driven by perceptions that the benefits of such technologies accrue to industry, while the risks are borne by consumers and the environment (Scholderer and Frewer, 2003).

The largest, most regular, most comprehensive, and most methodologically complex surveys of the institutionalised surveys has been the Eurobarometer, which has focused on European countries. These surveys have had samples an order of magnitude larger than other international studies, ranging between 12 000 and 27 000 individuals across a range of European countries. The resultant data are more representative of their populations, and provide for higher levels of disaggregation. Biotechnology items have been included in Eurobarometer surveys since 1991, and have formed an empirical basis for many research efforts to better understand the complexities of perceptions of biotechnology in Europe. For example, Bauer (2007) draws on both media content analysis and public perception surveys to assess the history of genetic engineering in the public sphere in the UK, drawing on multiple Eurobarometer studies. Other examples include Gaskell, Allum and Stares (2003), Gaskell *et al* (2006), INRA (1993, 1997), Legge and Durant (2010), and Sturgis, Brunton-Smith and Fife-Shaw (2010).

Large-scale surveys have also been established in the USA by the National Science Foundation since 2000, on a biennial basis. These surveys, when compared internationally, have had larger sample sizes than most international surveys (typically between 2 000 and 5 000), but smaller than the Eurobarometer surveys. This source of empirical data has also been used for building the field of the public understanding of science (for example, Miller, 2004), but to a lesser extent than is evident for the Eurobarometer surveys. One reason for this is that the NRF research is based on the integration of multiple data sets with varying methodologies, and does not make primary data available to researchers. Moreover, the surveys do provide indications of questionnaire items and aggregated data for comparative research.

In the early years of research into attitudes towards biotechnology, there was a paucity of data emerging from developing countries and newly industrialised economies. From about 2000 onwards there have been several international studies examining perceptions of biotechnology in developing countries, including AFIC (2008b, 2008b), Amin *et al* (2010), Ayanwale *et al* (2004), Macer, Azariah, and Srinives (2000), Quaye *et al* (2009), and Torres *et al* (2006). These have drawn on a growing evidence base that includes surveys from China, India, the Philippines, Thailand, Ghana, Indonesia, Malaysia, Vietnam, Kenya, Mexico, and Nigeria.

However, these studies have had small sample sizes, and therefore low levels of representivity (see Table 1). Only two of the indicated studies included the general public in their sampling frame (AFIC, 2008 and University of Japan, 2000). In all other cases the sampling frame was restricted to a focus on biotechnology stakeholders, rather than the general public. This has the advantage of allowing representivity through smaller samples, due to the smaller population size (and thus reducing research costs – a tangible constraint in developing countries). Another advantage is that attitudes of key actors relevant to biotechnology can be measured, thus informing public sphere analyses and providing value to policy makers. However, these studies do not provide data describing the attitudes of the general public, and therefore can be considered empirically adjacent to the primary objective of assessing the perceptions of the broader public. Nonetheless, this body of research provides indications of perceptions of biotechnology in other developing countries, and makes possible comparative research from a South African perspective.

The methodologies used for empirical surveys of public perceptions of biotechnology are diverse. Data collection methods include online surveys, telephonic surveys, face to face interviews, and focus groups. Most international studies, outside of the Eurobarometer and NSF studies, use small samples and include online self-completed surveys (AFIC, 2008), postal surveys (University of Tsukuba, 2000), and telephone surveys (Rutgers University, 1994). Sampling strategies are also diverse, ranging from purposive sampling of main stakeholders, to random telephone dialling in designated areas. The most common sampling method is random stratified sampling based on reliable population information – for example census data. Instrument design has included structured and semi-structured instruments, which have in some cases been self-completed and in others administered through direct interview methodologies.

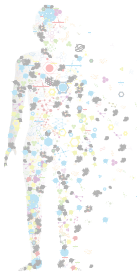
The Eurobarometer surveys, undertaken across multiple countries in the EU, use household interviews based on a multi-stage random probability sample that is proportional to population size and population density. The NSF surveys have employed two main methodologies. From 2000 to 2006 the survey used a disproportionate stratified sampling frame, and

accessed respondents through list-assisted random dialling design within strata to administer structured questionnaires telephonically. From 2008 to 2014 survey interviews were conducted in person, using a random probability sample.

This methodological landscape has positive implications for the measurement of public perceptions of biotechnology in South Africa. The vehicle for the empirical component of the study, the South African Social Attitudes Survey (http://www.hsrc.ac.za/en/departments/sasas), is a nationally representative household survey operated annually by the HSRC. The SASAS employs methods that are broadly aligned with the international best practice methodologies of the Eurobarometer and the National Science Foundation studies - the SASAS also uses random stratified sampling based on reliable population information drawn from census data, and employs a closed structured household interview questionnaire. This alignment increases methodological compatibility, and data comparability, in the international context. Thus, the present PUB study contextualises this internationally standard methodology to the South African context, taking into account the more diverse set of methodologies used in developing countries, and taking into account lessons learned from prior studies that have been undertaken in South Africa.

Table 1: Developing country surveys of public perceptions of biotechnology

Lead organisation	Year	Geographical scope	Methodology	Sample Size	Research Scope
The Asian Food Information Center (AFIC)	2008	Urban areas (capital cities) in China, India, Philippines, Japan, South Korea	Online self-completed survey	1007	Consumer attitudes about food supply and food labelling Awareness and perceptions of GM food biotechnology Opinions on sustainable food production
Institute of Biological Science University of Tsukuba (Japan)	2000	Australia, Hong Kong, India, Israel, Japan, New Zealand, the Philippines, Russia, Singapore, Thailand	Postal survey questionnaire with both open and closed items. Sample included the general public, university students, and high school teachers	2 626	Attitudes Acceptance of genetic engineering Ethics of biotechnology. Teaching and curriculum in bioethics and genetics.
Food Research Institute	2009	Ghana	Interviews with structured questionnaire. Purposive sampling method of biotechnology stakeholders	100	Acceptance of biotechnology/ GM Usefulness of biotechnology in solving development problems Interest in biotechnology debates
University of Illinois at Urban Champagne	2002	Indonesia, Malaysia, Philippines, Thailand, Vietnam	Interviews with structured close-ended survey questionnaires administered to biotechnology stakeholders	385	Knowledge about agricultural biotechnology. Perceptions of the impact and role of biotechnology Sources of information Trust in institutions
Kanyatta University	2014	Kenya	Self-completion questionnaire. Cross-sectional survey design. Administered to biotechnology stakeholders	702	Knowledge Attitudes
The African Technology Development Forum	2000	Mexico	Semi-standardised survey interview questionnaire administered to biotechnology stakeholders	52	Attitudes towards risks and benefits of agricultural biotechnology



Lead organisation	Year	Geographical scope	Methodology	Sample Size	Research Scope
The African Technology Development Forum	1997	Philippines	Semi-standardised survey interview questionnaire administered to biotechnology stakeholders	65	Attitudes towards risks and benefits of agricultural biotechnology
International Institute of Tropical Agriculture (Nigeria)	2004	Nigeria	Survey interviews with structured questionnaire. Sample selected purposively through a multistage random sampling of stakeholder groups	891	Awareness Utility Perception of benefit and risk Willingness to accept GMO products
University of the Philippines	2006	Philippines	Survey questionnairesStructured interview schedule and self-administered questionnaires administered to stakeholders	423	Knowledge about agricultural biotechnologyImpact in daily life Sources of information Trust in biotechnology institutions

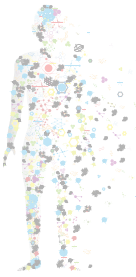
Table 2: Eurobarometer surveys of public perceptions of biotechnology

Euro-barometer	Year	Methodology	Sample Size	Research Scope
35.1	1991	Interview questionnaire Multi-stage random probability sample Sampling points drawn with probability proportional to population size and population density Sample covered 12 member states of the European Community	12 800	Knowledge of biotechnology Attitudes towards biotechnology Sources of information Trust in institutions
39.1	1993	Interview questionnaire Multi-stage random probability sample Sampling points drawn with probability proportional to population size and population density Sample covered 12 member states of the European Community	12 800	Expectations for biotechnology Knowledge of biotechnology Attitudes towards biotechnology Information sources Biotechnology and ethics Public influence on biotechnology development
46.1	1997	Interview questionnaire Multi-stage random probability sample Sampling points drawn with probability proportional to population size and population density Sample covered 15 member states of the EU	15 900	Expectations for biotechnology Knowledge of biotechnology Attitudes towards biotechnology Reliability of information sources
52.1	2000	Interview questionnaire Multi-stage random probability sample Sampling points drawn with probability proportional to population size and population density Sample covered 15 member states of the EU	16 082	Expectations for biotechnology Knowledge of biotechnology Attitudes towards biotechnology Trust in biotechnology institutions

Euro-barom-eter	Year	Methodology	Sample Size	Research Scope
58.0	2002	Interview questionnaire Multi-stage random probability sample Sampling points drawn with probability proportional to population size and population density Sample covered 15 member states of the EU	15 900	*Attitudes towards:* Genetic testing Cloning human tissue GM enzymes for soaps Transgenic animals GM crops and GM foods
64.3	2005	Interview questionnaire Multi-stage random probability sample Sampling points drawn with probability proportional to population size and population density Sample covered 25 member states of the EU	25 000	*Attitudes towards:* Pharmacogenetics Gene therapy GM food Industrial biotechnologies Stem cell research Uses of genetic information Governance of biotechnology Trust in actors involved in biotechnology
73.1	2010	Interview questionnaire Multi-stage random probability sample Sampling points drawn with probability proportional to population size and population density Sample covered 27 member states of the EU	30 800	Knowledge Attitudes Benefits and risks Involvement in biotechnology

Table 3: National Science Foundation surveys of public perceptions of biotechnology

Year	Methodology*	Sample Size**	Research Scope
2000	Disproportionate stratified sampling frame utilising a list-assisted random-digital dial (RDD) design within strata Structured interview questionnaires were administered telephonically	2 807	Usefulness of biotechnology Risks of biotechnology Moral acceptability of biotechnology Attitudes towards medical biotechnology Attitudes towards food and agricultural biotechnology
2002	Disproportionate stratified sampling frame utilising a list-assisted random-digital dial (RDD) design within strata Structured interview questionnaires were administered telephonically	2 812	Attitudes towards biotechnology Sources of information about biotechnology Attitudes towards medical biotechnology Attitudes towards food and agricultural biotechnology
2004	Disproportionate stratified sampling frame utilising a list-assisted random-digital dial (RDD) design within strata Structured interview questionnaires were administered telephonically	2 041	Attitudes towards biotechnology Sources of information about biotechnology Attitudes towards cloning and stem cell research. Attitudes towards medical biotechnology Attitudes towards food and agricultural biotechnology
2006	Survey interviews conducted on a face-to-face basis using a randomly selected probability sample	4 510	Attitudes towards biotechnology Sources of information about biotechnology Attitudes towards cloning and stem cell research. Attitudes towards medical biotechnology Attitudes towards food and agricultural biotechnology



Year	Methodology*	Sample Size**	Research Scope
2008	Survey interviews conducted on a face-to-face basis using a randomly selected probability sample	2 023	Attitudes towards biotechnology Attitudes towards medical biotechnology Attitudes towards food and agricultural biotechnology Knowledge about biotechnology Bioethics
2010	Survey interviews conducted on a face-to-face basis using a randomly selected probability sample	2 044	Attitudes towards biotechnology Sources of information about biotechnology Attitudes towards medical biotechnology Attitudes towards food and agricultural biotechnology
2012	Survey interviews conducted on a face-to-face basis using a randomly selected probability sample	2 044	Attitudes towards biotechnology Sources of information about biotechnology Attitudes towards medical biotechnology Attitudes towards food and agricultural biotechnology
2014	Survey interviews conducted on a face-to-face basis using a randomly selected probability sample	5125	Attitudes towards biotechnology Sources of information about biotechnology Attitudes towards cloning and stem cell research. Attitudes towards medical biotechnology Attitudes towards food and agricultural biotechnology

** Specific methodological details are not provided – data are drawn from multiple studies with varying methodologies as described in annexures to the NSF Science and Engineering Indicators reports*

*** Only approximate sample sizes are made available – upper limits of indicated sample size ranges are indicated here.*

3.1.1.2 South African studies

Three empirical studies of South African public perceptions of biotechnology have been previously conducted (see Table 4); however, only one of these featured a nationally representative sample that is comparable to the present PUB study. Aerni (2005) undertook an assessment of stakeholder perceptions of biotechnology in South Africa, based on a small-sample survey (48 respondents) conducted by the African Technology Development Forum in 2000. The sample consisted of sectoral stakeholders, including government actors, academics, civil society, consumer organisations, and producer firms. Aerni found that most sectoral stakeholders strongly believed in the benefits of GM crops. On the other hand, civil society actors, specifically non-governmental organisations and churches, largely opposed GM crops, placing more emphasis on potential risks. This divergence has established a polarised domestic debate on GMOs. These stakeholder attitudes are similar to those represented in an analysis of biotechnology representations in the South African media (Gastrow, 2010).

Pouris (2003) investigates public attitudes towards biotechnology in South Africa. In a study carried out in 2000 by the former Foundation for Education, Science and Technology (FEST), a survey was conducted among 1 000 households in South Africa's main metropolitan areas. The results are thus indicative of attitudes in these urban areas, but are not representative at the national level. The survey included international benchmark questions for measuring the public understanding of science. The promise-reservation index, an international benchmark set of questions designed to assess attitudes towards various aspects of science, was included, as were questions focused on confidence in science institutions, which are included in several international studies, including studies from developing countries, the Eurobarometer, and the National Science Foundation. These data were used to set a broader context for a set of more detailed biotechnology-related items, which included items about consumer attitudes towards biotechnology, with a focus on GM foods, as well as tests for some basic knowledge constructs related to biotechnology. As has been the case in other South African surveys, there was a large proportion of 'don't know' responses. Only seven percent of respondents indicated familiarity with the term 'biotechnology', and only 26% believed that GM products were sold in South Africa.

A nationally representative survey was conducted by the Human Sciences Research Council (HSRC) for the PUB programme in 2004. This entailed the inclusion of a dedicated module in the 2004 SASAS, which included items for food labelling, biotechnology knowledge constructs, attitudes towards biotechnology, trust in biotechnology institutions, sources of information about biotechnology, and interest in biotechnology (see Appendix A). This survey again highlighted the very limited public understanding of biotechnology, at least in response to the set of questions included in that particular SASAS instrument. Eighty percent of respondents did not have any knowledge of biotechnology. However, as the only nationally representative data describing public perceptions of biotechnology in South Africa, selected results have been used for comparative analysis with the 2015 PUB data.

Lessons from previous surveys highlight a clear need to tailor survey instrument items in order to establish a broader data base – by including items that may elicit more substantive and informed responses from a broader spectrum of South Africans. This suggests that more emphasis should be placed on the vernacular translation of biotechnology terms and concepts into all of South Africa's official languages, the use of proxy items to measure knowledge and attitudes towards biotechnology through the use of more accessible constructs, the use of broader notions of biotechnology, and the inclusion of indigenous knowledge systems as a locus for biotechnology-related questions.

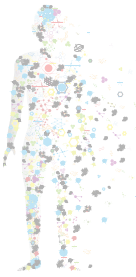
Table 4: South African surveys of public perceptions of biotechnology

Lead organisation	Year	Methodology	Sample Size	Research Scope
African Technology Development Forum	2000	Semi-standardised survey interview questionnaire administered to biotechnology stakeholders	55	Attitudes towards risks and benefits of agricultural biotechnology
FEST	2003	Household surveys in main metropolitan areas using a structured instrument	1 000	Consumer attitudes towards biotechnology Consumer attitudes towards GM Knowledge about biotechnology
HSRC	2004	National household survey using structured instrument Random stratified sample – nationally representative.	7000	Biotechnology knowledge constructs Attitudes towards biotechnology Attitudes towards food labelling Trust in biotechnology institutions Sources of information about biotechnology Interest in biotechnology

3.1.2 Implications for measuring public perceptions of biotechnology in South Africa

The dominant theoretical framework that emerges from the literature is located in the field of the public understanding of science, with its focus on 1) understanding the interplays between knowledge, attitudes, and sources of information about science, 2) demographic analysis to better understand variations across the different 'publics', and 3) a concern for the positioning of science in the public sphere, which frames the investigation in a political economy discourse that can yield valuable insights for policy makers. In this literature, biotechnology has commonly been used as a sectoral lens, rendering a rich set of theoretical and empirical research outputs that investigate the public understanding of biotechnology from range of standpoints, such as 'resistance to new technology', perceptions of risk, science culture, relationships between media content and public attitudes, and relationships between knowledge, attitudes, and trust. These studies provide examples of analytical and empirical tools for investigating these aspects of public perceptions of biotechnology in the South African context.

Two key methodological imperatives emerge along the axes of comparability and contextualisation. Firstly, the methodology for researching public perceptions of biotechnology in South Africa must, to a greater or lesser extent, render data that are comparable to international studies, and should therefore include items from surveys undertaken in other developing countries, items from the Eurobarometer, and items



from the NSF surveys. The methodology should also be comparable with previous South African studies in order to allow for the identification of changes in perceptions over time.

Issues of contextualisation are also critical, and required a carefully constructed response to meet the challenge of measuring South Africa's diverse biotechnology landscape, and utilising this diversity to inform appropriate policy decisions and generate novel contributions to the international literature on public perceptions of biotechnology. The methodology needed to address the challenges that have emerged from prior South African studies. The most significant of these is the issue of 'don't know' responses. It was imperative that research instruments be designed in such a way as to minimise the frequency of such responses. This required greater efforts to make questionnaire items more accessible to a broader South African public. It implied greater attention to issues of translation across all South African official languages. This was part of addressing the broader challenge of designing instruments appropriate for South Africa's highly stratified society – thus being accessible to a broad public while obtaining rich data related to the many 'publics' embedded in the South African population (see Reddy *et al*, 2013).

Related to this was the possibility of exploring and developing constructs for measuring perceptions of biotechnology as manifested in indigenous knowledge systems. Shukla (2005) used biotechnology-related concepts in survey instruments in a manner that is meaningful and accessible to the heterogeneous public of a highly stratified developing country. In some instances, this entailed the inclusion of indigenous knowledge constructs in the survey instrument and in the subsequent analysis. A similar approach was taken in South Africa. This served to (a) benefit from the diversity of biotechnology knowledge, meanings, and applications in the South African context, (b) contribute to the global debate about applications of and attitudes towards indigenous knowledge systems, and (c) make questionnaire items more accessible to broader sections of the South African population.

4. METHODOLOGY

4.1 Questionnaire design

4.1.1 Questionnaire design process

Instrument design followed an iterative and consultative process, drawing initially on the literature review and comparative studies, subsequently on expert and stakeholder comments, and finally on the results of two piloting exercises.

The first round of instrument development was undertaken in April and May 2015, drawing primarily on the review of the literature and from comparative South African and international survey designs. This initial questionnaire was reviewed by a subject specialist, Prof Jennifer Thomson, who has extensive experience as a biotechnology expert and practitioner, both in South Africa and globally. Her insight into the technical specifications and local context aided the research team in developing relevant items. Prof Mogege Mosimege, a subject specialist in the area of indigenous knowledge systems, contributed to the design of the related component of the instrument. The instrument was thereafter reviewed by the internal HSRC team, as well as the SAASTA team and related stakeholders, thus producing a preliminary questionnaire.

This preliminary version formed the basis for an initial small-scale 'pre-piloting' exercise, undertaken in July 2015 at the HSRC in Cape Town, which included three English language and three isiXhosa language interviews. The 2004 SASAS survey had received a high level of 'don't know' responses, and these were the highest among groups with low levels of income and education. As a consequence, the participants in the pre-piloting exercise were chosen from among this group, with the aim of gathering insights that could be used to make the questions more relevant and accessible.

The findings from this exercise informed the evolving instrument. Even though the questionnaire was well understood, the terms used (i.e. biotechnology, genetic modification, GM foods, GM crops, GM organisms, DNA, genes, commercial/subsistence farmers, gene therapy) were somewhat intimidating to participants. However, they understood these terminologies better once their definitions were explained. This informed a question structure in which familiarity with these terms is tested first, following which an explanation is offered, followed by the remainder of the questionnaire.

The pre-pilot also identified several specific questions which were not well understood, and thus prompted a re-design of these questions in order to make them more accessible. Conversely, the questions related to biotechnology and indigenous knowledge systems were well understood, indicating that this newly developed part of the questionnaire was appropriately constructed. Drawing on these lessons, amongst others, lead to the construction of a further iteration of the questionnaire, in this case in preparation for the larger scale and more formalised SASAS piloting exercise.

The SASAS piloting was conducted in September 2015, and entailed the application of the questionnaire to 60 participants. This again rendered lessons about the field suitability for the questionnaire, and some items were further adjusted on this basis. Overall, the effect was to make questions more accessible for participants, while retaining their core construct and therefore their analytical utility.

At each of these stages, further consultation was undertaken with Prof Thomson, as well as the SAASTA team. The process rendered the final questionnaire, as presented in Appendix A: 2015 South African Social Attitudes Survey module: Public Understanding of Biotechnology. Each of the questions that were finally included in the questionnaire served to gather salient data related to one of the following thematic areas that were identified through the literature review:

- Attitudes towards science
- Subjective ratings of knowledge about biotechnology
- Accessibility of biotechnology as a knowledge domain
- Familiarity with core biotechnology concepts
- Sources of information about biotechnology
- Familiarity with the PUB programme
- Knowledge about GM crops in South Africa
- Uses of GM crops
- Attitudes towards GM food
- Knowledge about medical applications of biotechnology

- Attitudes towards medical applications of biotechnology
- Biotechnology and indigenous knowledge systems
- Governance of biotechnology
- Overall risk/benefit assessment of biotechnology

4.1.2 Length of the questionnaire

The average number of questions that a survey respondent can typically complete is 4 per minute. Therefore, in an interview averaging 40 minutes, one would expect that approximately 160 question items could be responded to. Based on the scientific thematic focus of the biotechnology module, one would expect a slightly slower respondent response rate. This has been the experience with other Public Understanding of Science modules included in the SASAS series, including most recently nuclear technology and energy attitudes for the South African Nuclear Energy Corporation (NECSA), fielded in SASAS 2013. Therefore it was expected that the proposed 60-item biotechnology module could take 20 minutes to complete, while the additional background variables, typically around 70 items, would take a further 20 minutes. Based on this estimate, the duration for questionnaire completion should be within the stipulated average of 40 minutes.

4.1.3 Questionnaire translation

As is common practice with the HSRC's SASAS series, the biotechnology questionnaire was compiled in English and then translated into the most commonly spoken official languages in the provinces to ensure that the interview can be conducted in the language respondents are most comfortable with. The research instruments were translated into seven languages, covering each of the major language groups (South Sotho, Northern Sotho, Tsonga, Venda, Zulu, Afrikaans, Ndebele, Tswana, Xhosa, English, and Swazi). This was to ensure that all respondents in different provinces understood the questionnaire and cultural equivalence was retained and consistent across all languages. Fieldworkers carried at least one copy of each translated version. Interviews were then conducted in the interviewees' language of choice.

Table 5 below shows the set of official languages in which the survey was administered, the linguistic subgroup in which each fall, and the corresponding share of the population that speak the different languages based on the Census 2011 results.

Table 5: Questionnaire translation

	Languages fielded	% home language (Census 2011)
European subgroup		*23*
Afrikaans	Yes	14
English	Yes	10
Nguni subgroup		*43*
IsiZulu	Yes	23
IsiXhosa	Yes	16
SiSwati	…	3
IsiNdebele	…	2
Sotho subgroup		*25*
Sepedi	…	9
Setswana	Yes	8
Sesotho	…	8
No subgroup		*7*
Tshivenda	Yes	2
Xitsonga	Yes	5
Other	…	*2*
Total	*7*	*100*

4.2 Ethical considerations and consent

The HSRC subscribes to a strict internal Code of Ethics. Each questionnaire conducted by the HSRC is fielded only if the HSRC ethics committee has approved it. At all times, we kept in mind the confidentiality of information that we may have at our disposal. The study design and research tools (questionnaires, consent and assent forms, training manuals, etc.) were approved by the HSRC's Research Ethics Committee (REC).

4.2.1 Adult respondents and Informed Consent (older than 18 years)

All respondents aged 18 years and older were asked for written informed consent. The consent form explains the purpose of the study; emphasises that participation is voluntary; explains the likely duration of the interview; explains how confidentiality was preserved; offers an earnest appraisal of the risks/discomforts and benefits associated with participation in the study; and provides details of the HSRC's toll free ethics hotline and survey coordinator contacts.

4.2.2 Minors and Written Informed Consent (Persons under the age of 18 years)

The reason for the inclusion of respondents younger than 18 years in the study design is to ensure that there are sufficient numbers of youth (16-24 years) in the survey sample. The SASAS series places a strong emphasis on generational differences in underlying social values and intends to track changes in the cross-sectional data over time. In instances where the selected research participant is a minor aged 16-18 years, the informed consent process we followed adhered to the HSRC's Guidelines on Research with orphans and vulnerable children (OVC). A dual consent process is required, both from the minors and their parent/guardian.

4.3 Research Universe

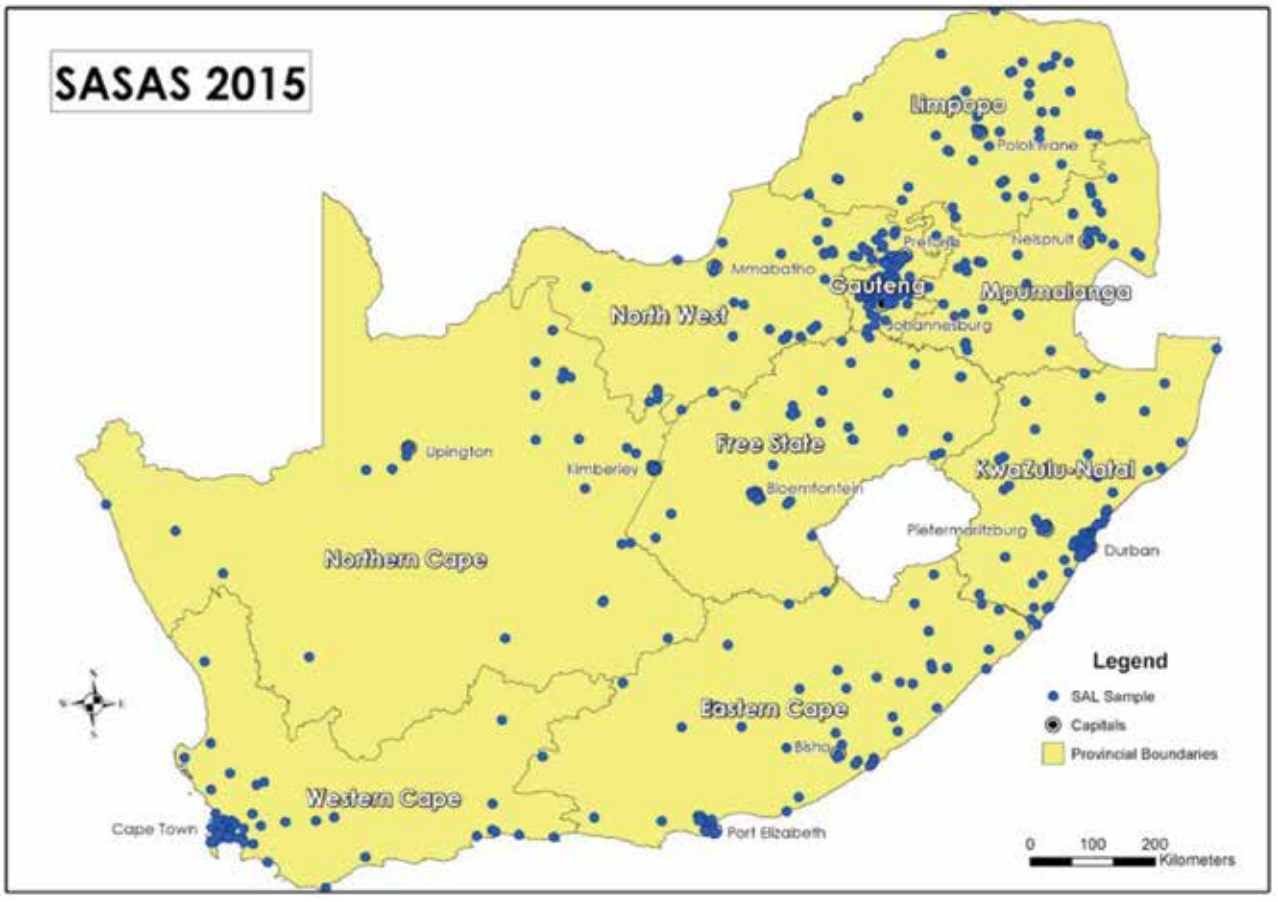
The target population for the South African Social Attitudes Survey is individuals aged 16 and over who live in a private residence in South Africa. Our target population is comprised of people living in households, hostels and other structures. People living in special institutions such as hospitals and prisons were excluded from the sample. We reasoned that the inclusion of people from these institutions would compromise our random selection procedure. Also, past experience has shown that access to people in these institutions is extremely difficult since obtaining permission can be cumbersome and complex.

4.3.1 The sample design

SASAS has been designed to yield a representative sample of 3 500 adult South African citizens aged 16 and older (with no upper age limit), in households geographically spread across the country's nine provinces.

The sampling frame used for the survey is based on the 2011 census and a set of small area layers (SALs). Estimates of the population numbers for various categories of the census variables were obtained per SAL. In this sampling frame special institutions (such as hospitals, military camps, old age homes, schools and university hostels), recreational areas, industrial areas and vacant SALs were excluded prior to the drawing of the sample.

Figure 2: A graphical representation of the 500 selected small area layers



Source: SASAS 2015 sample map

In sampling, small area layers (SALs) were used as primary sampling units and the estimated number of dwelling units (taken as visiting points) in the SALs as secondary sampling units. In the first sampling stage, the primary sampling units (SALs) were drawn with probability proportional to size, using the estimated number of dwelling units in an SAL as a measure of size. The dwelling units as secondary sampling units were defined as "separate (non-vacant) residential stands, addresses, structures, flats, homesteads, etc.". In the second sampling stage, predetermined numbers of individual dwelling units (or visiting points) were drawn with equal probability in each of the drawn dwelling units. Finally, in the third sampling stage, a person was drawn with equal probability from all 16 years and older persons in the drawn dwelling units.

Three explicit stratification variables were used, namely province, geographic type and majority population group. As stated earlier, within each stratum, the allocated number of primary sampling units (which could differ between different strata) was drawn, using proportional to size probability sampling with the estimated number of dwelling units in the primary sampling units as a measure of size. In each of these drawn primary sampling units, seven dwelling units were drawn. This resulted in a realised sample of 2 940 individuals.

A list of the 500 SALs was eventually drawn and given to geographic information specialists to map. Maps were generated for each of the 500 areas, indicating certain navigational beacons such as schools, roads churches etc.

4.3.2 Navigation to the selected areas

Once the sample of 500 SALs was selected, a navigational toolkit was developed to assist the field teams in finding the selected SALs. These kits assisted the supervisors and fieldworkers to locate the exact SAL where the interviews were to take place. The navigational kits included:

- Route descriptions, to assist the teams to navigate their way to the selected enumerator areas.
- Maps that, using aerial photographs as a base, identified the exact geographic location of the enumerator areas to be sampled throughout the country.
- More detailed maps that identified the exact area, pinpointing street names and places of interest such as schools, clinics, hospitals, etc. These maps also included latitude-longitude, GPS coordinates indicating the centroid of the SAL.

Figure 3: An example of a SAL map used by the field teams to navigate to the correct areas

Source: sample map, South African Social Attitudes Survey

4.3.3 Introduction of the project to the authorities and communities

A month prior to the fielding of the SASAS study, Agri South Africa (Agri SA), as well as all police commissioners in the nine provinces, was informed of the study. Prior to starting the actual interviewing process, supervisors were also instructed to visit the local police stations, indunas, traditional leaders, or other role players in the various areas to ensure that the authorities were aware of the project and to inform the communities of their intent. Official letters describing the project and its duration and relevant ethical issues were distributed to the authorities. This was done not only as a form of research and ethical protocol but also to ensure the safety of the field teams.

4.3.4 Selecting a household and individual

After driving through the SAL and introducing the project to the local authorities, supervisors had to identify the selected households. A household was selected using a random starting point and counting an interval between households. The interval was calculated using the number of households in the SAL. Once the selected household had been identified, a household member had to be selected randomly as a respondent. This household member (respondent) needed to be 16 years or older. For the purpose of this survey, the KISH grid was used to randomly select the respondent in the household. The KISH Grid method was devised as a basis for selecting members within a household to be interviewed[1].

4.4 Data collection protocol

The following general protocol guidelines for data gathering were implemented:

- Fieldworkers and supervisors were required to notify the relevant local authorities that they would be working in the specific area. The

1 The Kish Grid is a method that was devised by statistician Leslie Kish in 1949 as the basis for selecting members within a household to be interviewed. It uses a pre-assigned table of random numbers (see below the one we use in SASAS) to identify the person to be interviewed.

purpose was twofold: (a) to increase safety protocols for fieldworkers (b) and to reassure respondents, especially the elderly or suspicious, that the survey was official.

- Supervisors were advised to inform the inkosi or induna in a traditional authority area, whilst in urban formal or urban informal areas they had to report to the local police station. In some areas, the local councillor was also met and informed of the study prior to commencing work in the area.
- They were further advised that farms should be entered with caution and that they should report to the local Agri South Africa (Agri SA) offices before doing so. Field supervisors were issued with 'Farm letters' which contained information on the purpose of the study and contact details in case they had queries.
- Consent forms needed to be completed upon successfully finishing each interview. While verbal consent was to be secured from the respondent before the interview, a written consent form had to be signed afterwards.
- Fieldworkers were issued with name tags and letters of introduction to be used in the field. The introduction letter was translated from English into six other languages.
- Fieldworkers had to present their identity cards when introducing themselves.

4.5 Training

Two-day training sessions were held in various provinces. The main training session took place in Pretoria and covered the northern provinces, namely: Gauteng, Limpopo, Mpumalanga and North West. All relevant remarks and instructions discussed during the training session were included in the training manual. Other training sessions were held in East London, Durban, Kimberley and Cape Town.

The training session included sessions on selection and sampling of households; fieldwork operating procedures; research protocol and ethical considerations. The questionnaire was discussed in detail. As far as possible, the training was designed to be participatory, practical and interactive, and gave fieldworkers the opportunity to seek clarification on questions. A training manual was also developed as part of the training toolkit. The fieldwork commenced in October 2015 and ended in December 2015. A network of locally-based fieldwork supervisors in all parts of the country assisted in data collection. Competent fieldworkers with a thorough understanding of the local areas were employed as part of this project.

4.6 Quality control

HSRC researchers conducted random visits to selected areas and worked with the fieldworkers for a certain period to ensure that they adhered to ethical research practices and that they understood the intent of the questions in the questionnaire. HSRC researchers also ensured that the correct selection protocols were followed in order to identify households and respondents in the household. The researchers also checked on procedures followed in administering the research instrument. Field backchecks were also conducted in all nine provinces. Telephonic backchecks were done on 10% of the total sample.

All personal information on the respondent was removed when the data was captured and analysed. Codes to identify respondents were used instead. Information was stored electronically with password-protection at the HSRC. Efforts are also being exerted to secure both the electronic and paper-based survey questionnaires. As part of the ongoing HSRC-wide deliberations around data access protocols, the SASAS team remain emphatic about the need for restricting access to the data only to those subscribing to a pledge of confidentiality and ethical use of the data.

4.7 Data capturing and cleaning

The data-capturing was conducted by the HSRC's Data Capturing Unit. This unit has the capacity to design capturing templates and capture data fast and effectively. All questionnaires were double captured in CSPRO to ensure that no capturing errors occurred. The final dataset was converted into SAS and SPSS and a data manager embarked on a data-cleaning exercise. Data were checked and edited for logical consistency, for permitted ranges, for reliability on derived variables, and for filter instructions.

Table 6: Sample realisation

	Number of replaced SALs	Ideal sample	Realised sample	% Realisation
WC	3	455	383	84
EC	0	455	332	73
NC	0	259	199	77
FS	0	266	237	89
KZN	3	651	571	88
NW	0	259	227	88
GT	3	581	475	82
MP	0	266	240	90
LP	0	308	276	90
Total	9	3 500	2 940	84

After data cleaning, the analytical team received the realisation rates of the survey. As can be seen from the table above, a realisation rate of 84% was achieved. This is a high realisation rate and was partly achieved owing to the fact that communities were well informed about the survey and also because of the data collection methodology – namely face-to-face interviews.

4.8 Data weighting

The data were weighted to take account of the fact that not all units covered in the survey had the same probability of selection. The weighting reflected the relative selection probabilities of the individual at the three main stages of selection: visiting point (address), household and individual. In order to ensure representivity of smaller groups, i.e. Northern Cape residents or Indian/Asian people, weights needed to be applied.

Person and household weights were benchmarked using the SAS CALMAR macro and province, population group, gender and 5 age groups (i.e. 16-24, 25-34, 35-49, 50-59 and 60 and older). These benchmark variables for persons and province and population group of the respondent in the household were selected due to their reliability and validity. The marginal totals for the benchmark variables were obtained from the 2015 mid-year population estimates as published by Statistics South Africa. The estimated South African population was therefore used as the target population. A total of 2 940 people were interviewed during this study. When weighted, this total represents 36 778 675 South Africans of 16 years and older. The final data set (unweighted and weighted) are disaggregated in Table 7 by key demographic variables.

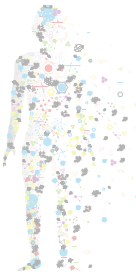


Table 7: Sample (Unweighted and Weighted)

	Unweighted N	Percent	Weighted N	Percent
South Africa	2 940	100	36 778 675	100
Male	1 120	38.1	17 676 294	48
Female	1 820	61.9	19 102 381	52
16-19 years	190	6.46	3 514 223	9.555
20-24 years	319	10.85	5 926 944	16.12
25-34 years	712	24.22	9 044 814	24.59
35-44 years	494	16.8	6 625 039	18.01
45-54 years	429	14.59	5 067 042	13.78
55-64 years	384	13.06	3 601 659	9.793
65+ years	412	14.01	2 998 955	8.154
Black African	1813	61.67	28 680 095	77.98
Coloured	496	16.87	3 387 303	9.21
Indian/Asian	302	10.27	1 031 483	2.805
White	329	11.19	3 679 794	10.01
Upper	157	5.34	1 669 599	4
Middle	1355	46.09	18 464 904	49.8
Lower	1161	39.49	13 396 862	37.2
Missing data	267	9.08	3 247 310	9
Urban formal	2092	71.16	24 602 411	66.89
Urban informal	119	4.05	2 933 218	7.975
Rural trad. auth. areas	593	20.17	8 030 915	21.84
Rural farms	136	4.63	1 212 132	3.296
Western Cape	383	13.03	4 392 147	11.94
Northern Cape	332	11.29	4 268 335	11.61
Eastern Cape	199	6.77	816 935	2.221
Free State	237	8.06	1 933 502	5.257
KwaZulu-Natal	571	19.42	6 807 682	18.51
North West	227	7.72	2 476 410	6.733
Gauteng	475	16.16	9 657 697	26.26
Mpumalanga	240	8.16	2 784 279	7.57
Limpopo	276	9.39	3 641 688	9.902

4.9 Analysis

The analysis seeks to draw out key findings about public perceptions of biotechnology in South Africa, and assess the implications for public engagement with biotechnology. This analysis covers the following interlinked thematic areas:

Knowledge of biotechnology in general: This includes self-rated knowledgeability, perceptions about the accessibility of biotechnology knowledge, and knowledge of core biotechnology concepts. We also examine a cognitive precursor for an understanding of biotechnology – namely belief in human evolution.

Perceptions of GM food: Food derived from genetically modified crops, referred to here by the popular term 'GM food', is the most high-profile application of the biotechnology, both in the public imagination (Gastrow, 2010) and in the economy. The assessment of public perceptions of GM food thus forms a major component of the analysis, and includes aspects related to: knowledge about GM food and their use in South Africa, and attitudes towards their consumer appeal, ethics, safety, labelling, economic benefits, impact on food security, environmental impact, and overall benefits and risks.

Perceptions of medical biotechnology: After GM foods, medical applications of biotechnology have the greatest public prominence. We examine data describing basic knowledge about medical biotechnology, and attitudes towards medical biotechnology, with a focus on ethical aspects.

Governance and institutions: Public perceptions of the governance of biotechnology, in terms of the influence of social institutions, and perceptions of the effectiveness of government regulation.

Biotechnology and indigenous knowledge systems: The use of biotechnology in traditional practices, such as brewing beer, traditional healing, and traditional farming.

The public understanding of biotechnology programme: As South Africa's flagship programme for public engagement related to biotechnology, we review public awareness of the programme.

Sources of information about biotechnology: Preferred channels for obtaining information about biotechnology.

Attitudes towards biotechnology in general: An overall, summative, risk-benefit assessment of biotechnology in general.

The first, descriptive, part of the analysis uses three primary analytical lenses:

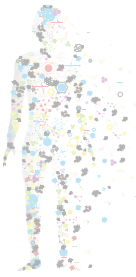
Firstly, level, we look at the basic frequencies in the responses to each question, gaining a high-level perspective that reflects the range of responses at the national level.

Secondly, we look at the bio-demographic distribution of responses, examining differences across and within age, gender, race, educational attainment, living standard, and geolocation. To facilitate this analysis, mean score rankings for demographic groups have been constructed and illustrated in tables or radial diagrams. In some cases, indices have been constructed using the data from several cognate questions, in order to summarise responses to a particular theme. For each of these indices, ANOVA (Analysis of Variance) testing was undertaken to establish more specific markers of statistical significance in the variation among demographic groups. These ANOVA results are presented in Appendix C, and provide details of statistical significance for all the demographic analysis to follow[2].

Finally, we look at comparative data sources. This takes two main forms. Firstly, selected questions are comparable with data from the 2004 Public Understanding of Biotechnology survey undertaken through the SASAS. This provides some points of comparison which allow for an assessment of changes over time. Secondly, there are a variety of data points among the international surveys which are comparable, and this allows us to contrast the South African data with that of other countries.

The second part of our analysis makes use of multivariate analysis and regression methods to examine more closely the relationships that occur within and between these thematic areas, in order to draw out more complex patterns of perceptions of biotechnology, and inform the assessment of their Implications for public engagement with biotechnology.

2 The same significance levels apply as used in Section 6: significance is reported as follows: n.s.=not significant; * $p<0.05$; ** $p<0.01$; *** $p<0.001$



5. PUBLIC PERCEPTIONS OF BIOTECHNOLOGY IN SOUTH AFRICA: DESCRIPTIVE ANALYSIS

5.1 Public attitudes towards science in South Africa

Public perceptions of biotechnology in South Africa are formed in the social context of public attitudes towards science and technology in a broader sense. The standard international measure of public attitudes towards science is the promise-reservation index. Selected items from this index were included in the PUB survey questionnaire[3]. The summary results of these questions are presented in Table 8.

The public are generally positive about the impact of science on daily life. The majority (79%) agreed that science and technology are making our lives healthier, easier, and more comfortable. At the same time, the majority (66%) also believe that we depend too much on science, and not enough on faith. This underscores a theme that recurs in the data describing attitudes towards biotechnology: a public appreciation of the material benefits of science and technology, coupled with scepticism of its impact on our religious and moral selves. The public are divided in their perceptions of the importance of science knowledge, with approximately equal proportions agreeing and disagreeing with the statement, 'It is not important for me to know about science in my daily life'. However, on balance the public perceive the benefits of science to accrue more to the rich than to the poor, highlighting the perceived link between science and social inequality.

Previous research has investigated these attitudes (Reddy *et al*, 2013), drawing on comparable, nationally representative, data sources that also emerged from the SASAS in 2010 and 2013. This allows us to briefly examine changes over time in public attitudes towards science in South Africa (see Table 9). To compare these data sources in a concise manner, we constructed an index for each question that would reflect the overall balance of promise and reservation for each year. For each data source, we assigned the index values to the responses of strongly agree (2), agree (1), neither agree nor disagree (0), disagree (-1), strongly disagree (-2), and do not know (0). We multiplied the responses with the index values, added these together, and divided the total by 200.

3 The full set of items was not included due to space and budgetary constraints.

The results show how attitudes towards science have shifted over the past five years. Perceptions that 'we depend too much on science and not enough on faith' has increased substantially over each period. The perception that 'it is not important for me to know about science in my daily life' has also increased, but at a much slower rate. The perception that 'scientific advances tend to benefit the rich more than they benefit the poor' has also grown from 2013 to 2015.

In order to assess the demographic distribution of these attitudes, we used the same index to assess responses across a range of demographic groups. Perceptions that 'science and technology are making our lives healthier, easier, and more comfortable' are associated with lower age and increased privilege (higher among those who are more educated, who have a higher living standard, and among White South Africans). Those living in urban informal areas are less likely to have this view – perhaps reflecting their disenfranchisement from the benefits of science and technology. The view that 'we depend too much on science and not enough on faith' showed similar overall patterns, again highlighting the juxtaposition between appreciation for the material benefits of science and technology with concern about their non-material implications.

A very different set of responses were recorded to the statement, 'it's not important for me to know about science in my daily life' (see Figure 6). Responses were characterised by very high variances within and between demographic groups, indicating fundamentally differing orientations towards the importance of science knowledge in daily life. There was a stark difference in attitudes between those living in formal urban areas, who largely disagreed with the statement, and those living in rural areas or informal urban areas, who were much more likely to agree. Since this is a negatively phrased statement, this means that those in formal urban areas see science knowledge as being far more important in daily life compared to other groups. Similarly, those with a matric qualification or higher saw science as important, while those with lower educational attainment did not. Responses across age groups revealed a high level of variation, but, unlike other attitudinal indicators, did not reveal a clear trend. The 16-24 and 35-49 years old age groups were

less likely to agree with the statement, while the other age groups were more likely to agree. This underscores the complexities of inter-generational changes in attitudes towards science and its role in daily life.

Perceptions of the (in)equality of benefits from science and technology also did not reveal a clear trend across age groups. However, Whites were significantly more likely to disagree with the statement that the benefits are greater for the rich than for the poor, as did those with a high living standard, and those in urban informal areas (see Figure 7). Perceptions of 'rich' and 'poor' would however differ across the demographic groups.

Table 8: Attitudes towards science in South Africa: promise and reservation (%)

Attitudes towards science	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	(Do not know)
Science and Technology are making our lives healthier, easier, and more comfortable	31	48	9	4	1	7
We depend too much on science and not enough on faith	20	46	14	12	1	6
It is not important for me to know about science in my daily life	12	28	18	29	8	6
Scientific advances tend to benefit the rich more than they benefit the poor	18	39	19	13	3	9

Source: South African Social Attitudes Survey (SASAS) 2015

Table 9: Attitudes towards science in South Africa: promise and reservation, 2010-2015 (%)

	2010	2013	2015
Science and Technology are making our lives healthier, easier, and more comfortable	0.506	0.495	0.528
We depend too much on science and not enough on faith	0.252	0.270	0.362
It is not important for me to know about science in my daily life	-0.068	-0.011	0.041
Scientific advances tend to benefit the rich more than they benefit the poor	0	0.253	0.277

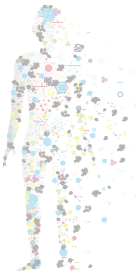
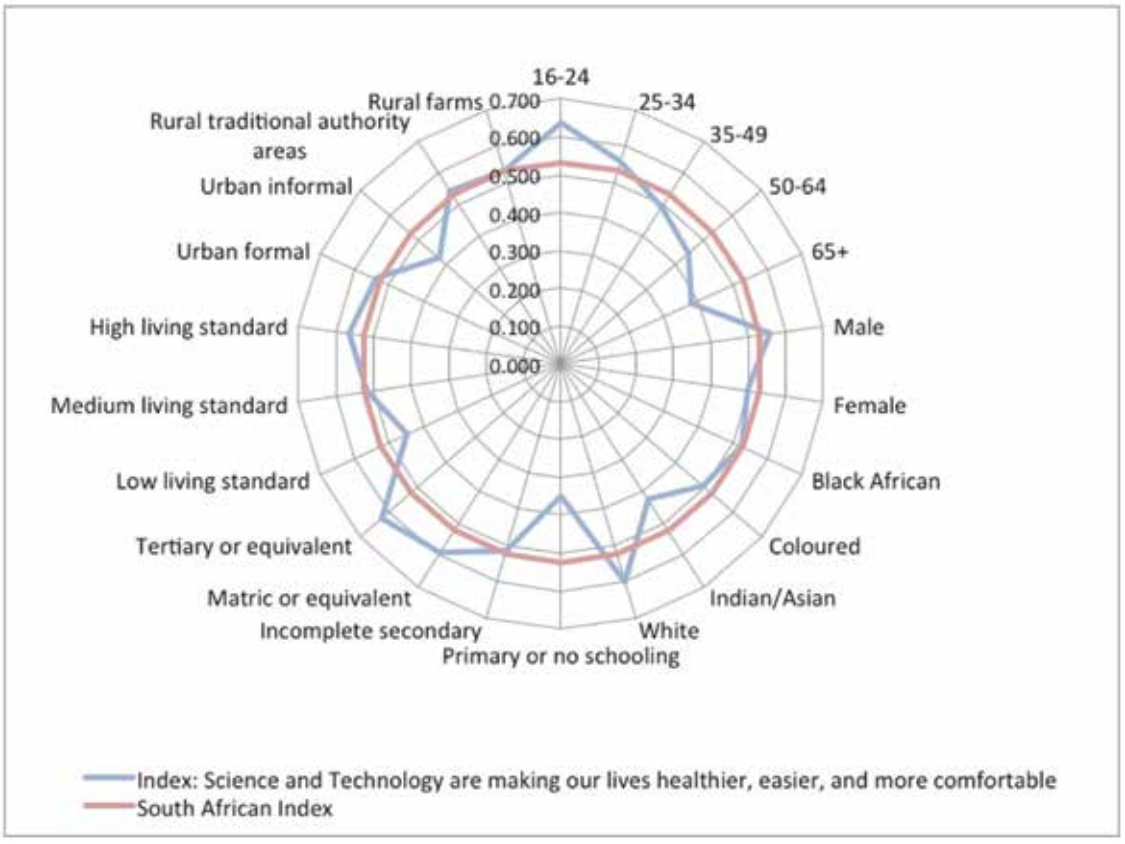
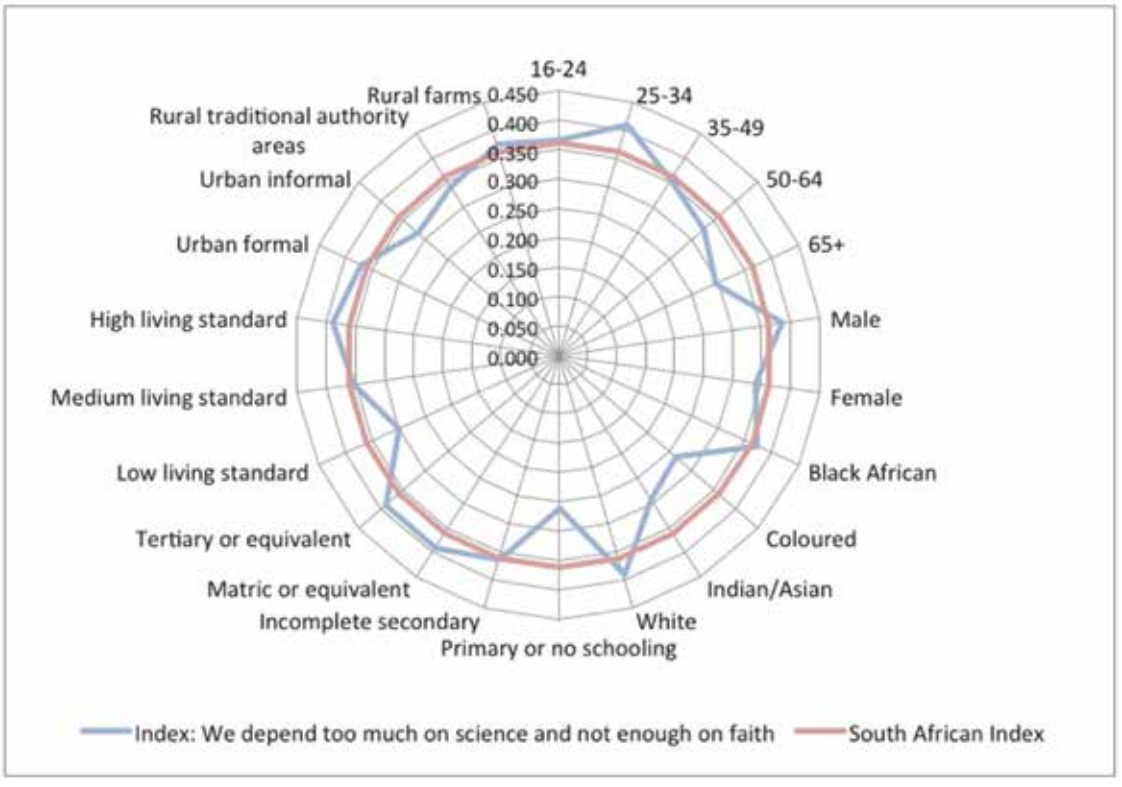


Figure 4: Science and Technology are making our lives healthier, easier, and more comfortable



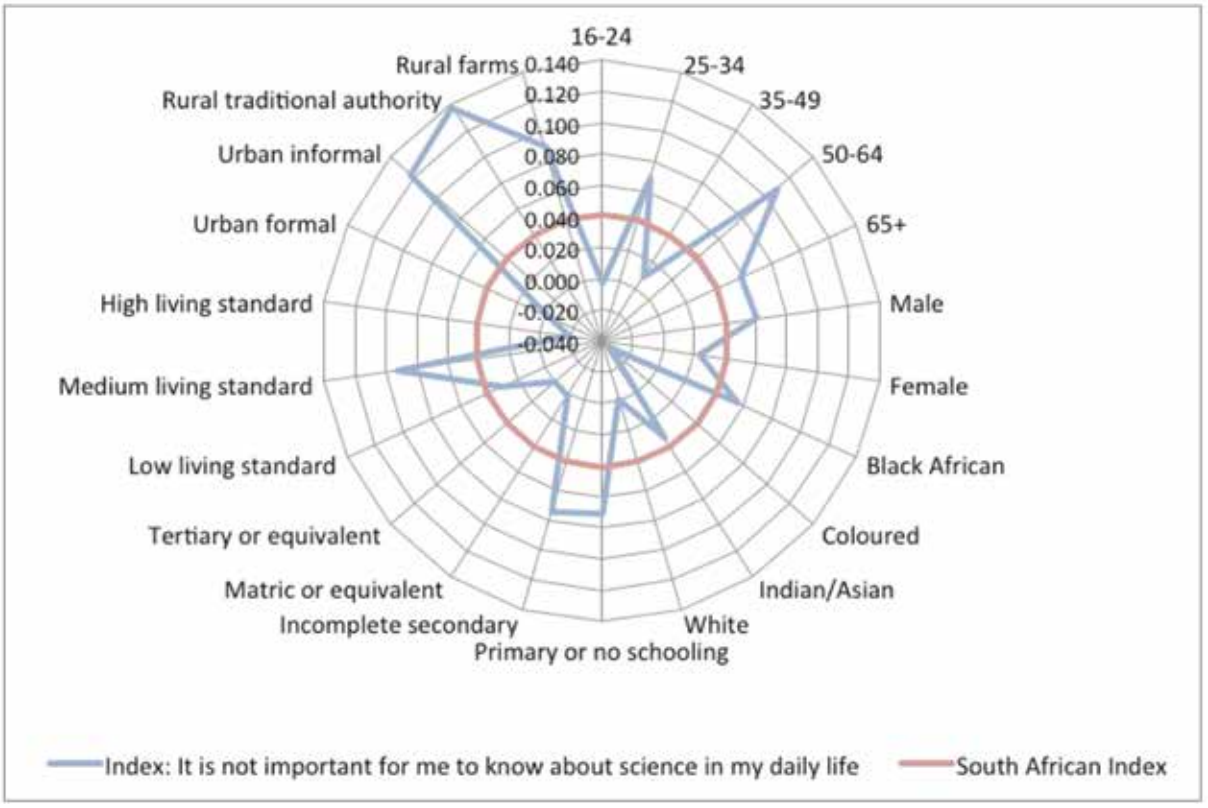
Source: South African Social Attitudes Survey (SASAS) 2015

Figure 5: We depend too much on science and not enough on faith



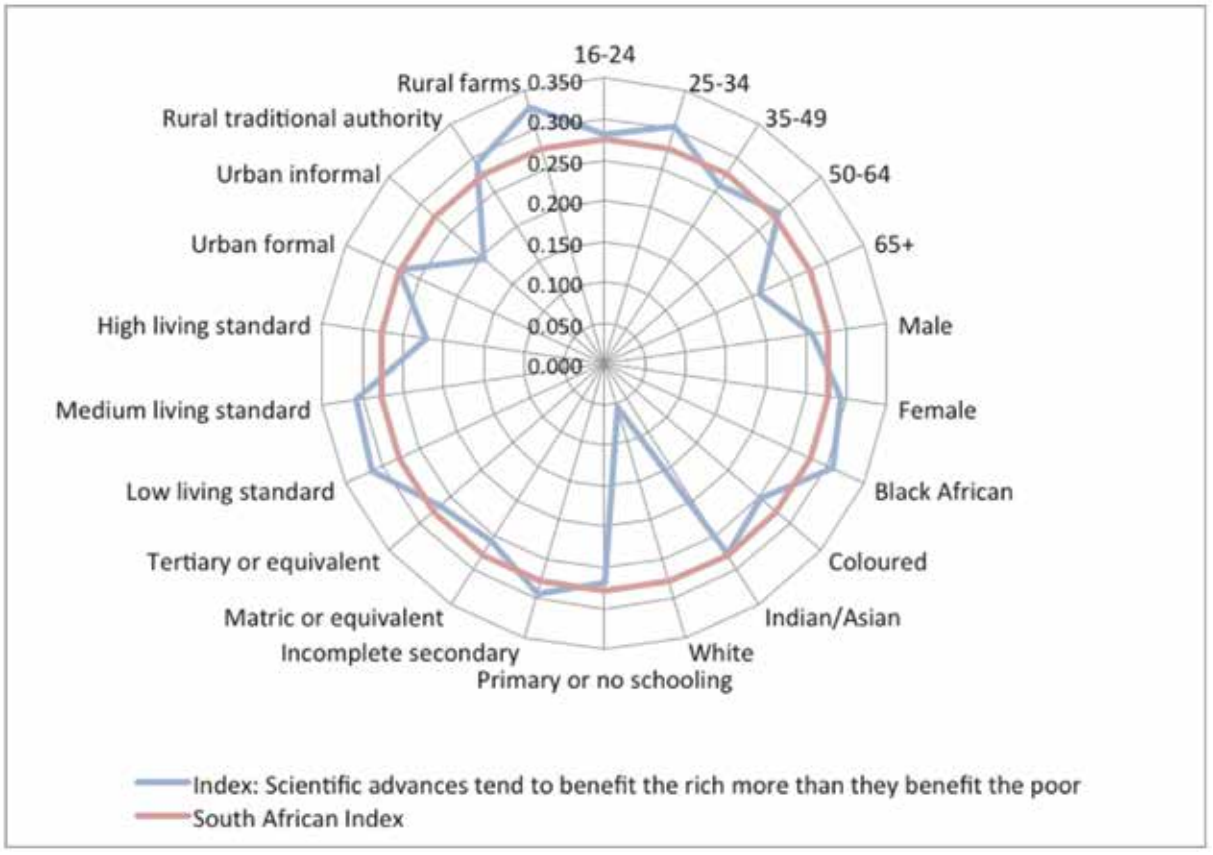
Source: South African Social Attitudes Survey (SASAS) 2015

Figure 6: It is not important for me to know about science in my daily life



Source: South African Social Attitudes Survey (SASAS) 2015

Figure 7: Scientific advances tend to benefit the rich more than they benefit the poor



Source: South African Social Attitudes Survey (SASAS) 2015

Key findings: public attitudes towards science in South Africa

- There is a juxtaposition between the high level of public appreciation of the material benefits of science and technology, and the high level of scepticism of its impact on our religious and moral selves. Both of these (seemingly contradictory) positions have strengthened over time.
- Younger and more privileged groups are more likely to appreciate the benefits of science, but also more likely to be concerned about the balance between science and faith.
- The public are divided in their perceptions of the importance of science knowledge in our daily lives.
- On balance the public perceive the benefits of science to accrue more to the rich than to the poor, highlighting a perceived link between science and social inequality. This view has also grown more common over time.

Implications for public engagement with biotechnology:

- Efforts to engage the public about the benefits of science need to address widespread and growing concerns about the balance between science and faith.
- Groups which see science as being unimportant in their daily lives will require different sets of messages to those who already perceive science to be of material benefit.
- A pro-poor message is required for engagement and communication efforts, particularly with disadvantaged and disenfranchised groups. Such a message would communicate the benefits that biotechnology may have for the low-income sectors of society. Such messages may change perceptions about the distribution of the benefits of science.

5.2 Biotechnology knowledge, access, and core concepts

This section aims to assess the public's awareness of biotechnology as a concept, the accessibility of this concept, and the public understanding of some of the core conceptual constructs related to the general notion of 'biotechnology'. This broad scope is distinct from subsequent and more focused enquiries, which look respectively at knowledge related to biotechnology applications in food production, medicine, and indigenous knowledge systems.

5.2.1 Subjective knowledge assessment

When asked to rate their own knowledge about biotechnology, most of the public reported low levels of knowledge (Table 10). Twenty-seven percent declared themselves to be 'somewhat knowledgeable' or 'very knowledgeable', but the remaining 73% described themselves as 'not very knowledgeable', 'not at all knowledgeable', or were unable to answer the question. Indeed, the majority reported no knowledge at all of biotechnology. This is an important starting point to the remaining analysis – an understanding that biotechnology is poorly understood by the South African public, and that attitudes and awareness of specific aspects of biotechnology are formed in this context. A key challenge for the PUB programme is thus to find other ways to tap into the knowledge base of the public – for example through exploring the role of biotechnology in daily life (see section 5.3.2) or the role of IKS (see section 5.6).

For analytical purposes, indices were constructed to better interpret the demographic distribution of this indicator of 'subjective knowledge', i.e. the extent to which participants subjectively assessed their own knowledge of biotechnology. To this end, a reversed scaling was constructed of question 91 (see Appendix A). Responses of 'don't know' were combined with responses of 'no knowledge of biotechnology', and both given a value of 1. 'Not very knowledgeable' was given a value of 2, 'somewhat knowledgeable' a value of 3, and 'very knowledgeable' a value of 4. The resulting index was converted to a 0-100 scale by subtracting a value of 1 from the reversed scale, dividing by 3, and multiplying by 100. The indexed scores for each demographic category, in relation to the mean, are presented in Figure 8, and the related descriptive statistics in Appendix C[4] (Table 59).

A closer look at the spread of these responses across demographic groupings reveals that subjective levels of knowledge about biotechnology is a function of 1) age and 2) privilege. Privilege is manifested though population group status, educational attainment, and living standard measure. Age is hypothesised to be a key factor because of the greater connectivity

4 The same significance levels apply as used in Section 6: significance is reported as follows: n.s.=not significant; * p<0.05; **p<0.01; ***p<0.001

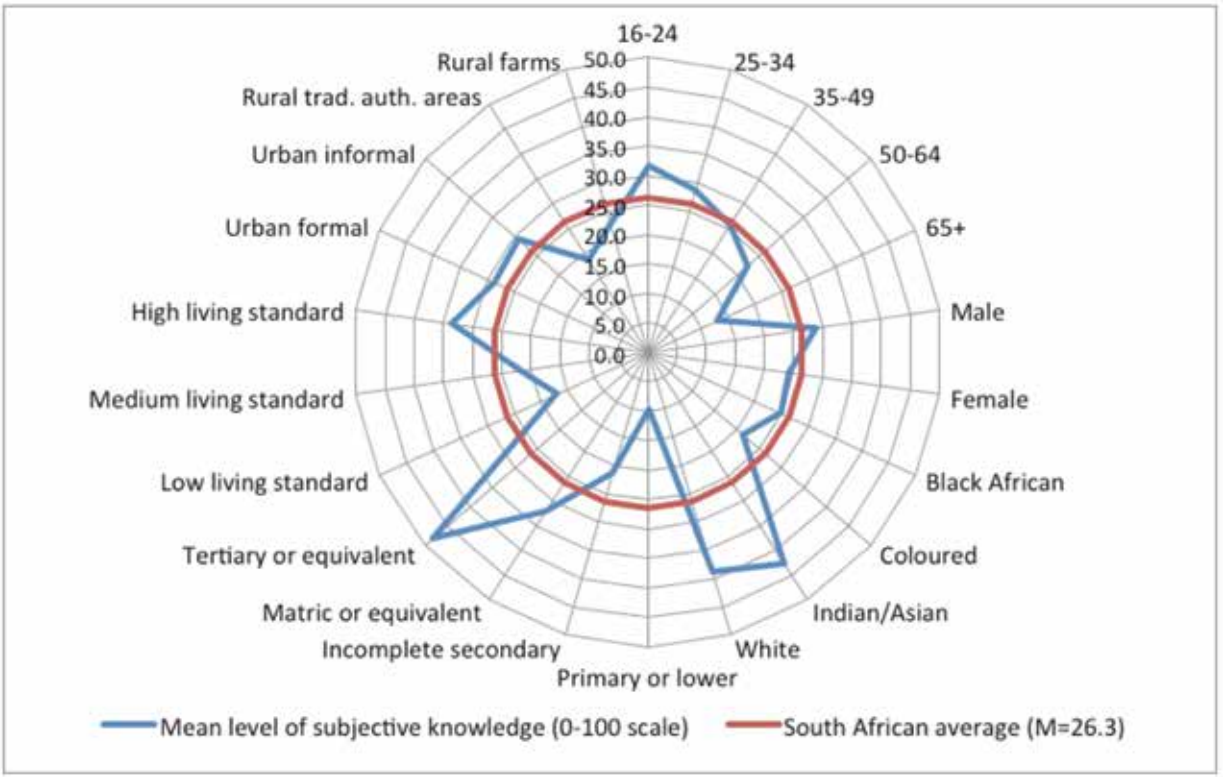
of younger groups to the internet and knowledge cultures that include references to biotechnology. Age is indeed a strong predictor of subjective knowledge, with younger generations successively reporting greater engagement with the question (i.e. lower levels of 'don't know' responses) and higher levels of reported knowledge. Asian and White population groups reported substantially higher levels of engagement and knowledge in comparison to Black African and Coloured groups. As might be expected, increased educational attainment is associated with increased subjective knowledge, as is increased living standard. Religiosity did not have a clear effect on responses, with no statistically significant relationship evident, suggesting that this is a weak predictor of biotechnology knowledge.

Table 10: Subjective knowledge (%)

Overall, would you say you are very knowledgeable, somewhat knowledgeable, not very knowledgeable or not at all knowledgeable about biotechnology?	
Very knowledgeable	4
Somewhat knowledgeable	23
Not very knowledgeable	21
Not at all knowledgeable	49
(Do not know)	3

Source: South African Social Attitudes Survey (SASAS) 2015

Figure 8: Subjective knowledge: demographics



Source: South African Social Attitudes Survey (SASAS) 2015

5.2.2 Accessibility of knowledge

An analysis of the accessibility of biotechnology as a knowledge domain reinforces that biotechnology is indeed relatively esoteric to much of the South African population. To this end, respondents were asked whether biotechnology was perceived to be 'too specialised for me to understand' (Table 11). Only a minority (16%) perceived biotechnology, as a knowledge domain, to be within reach, while 46% declared that biotechnology was too specialised to understand. Again, this points to biotechnology as an esoteric field that most South African's feel challenged to engage with and understand.

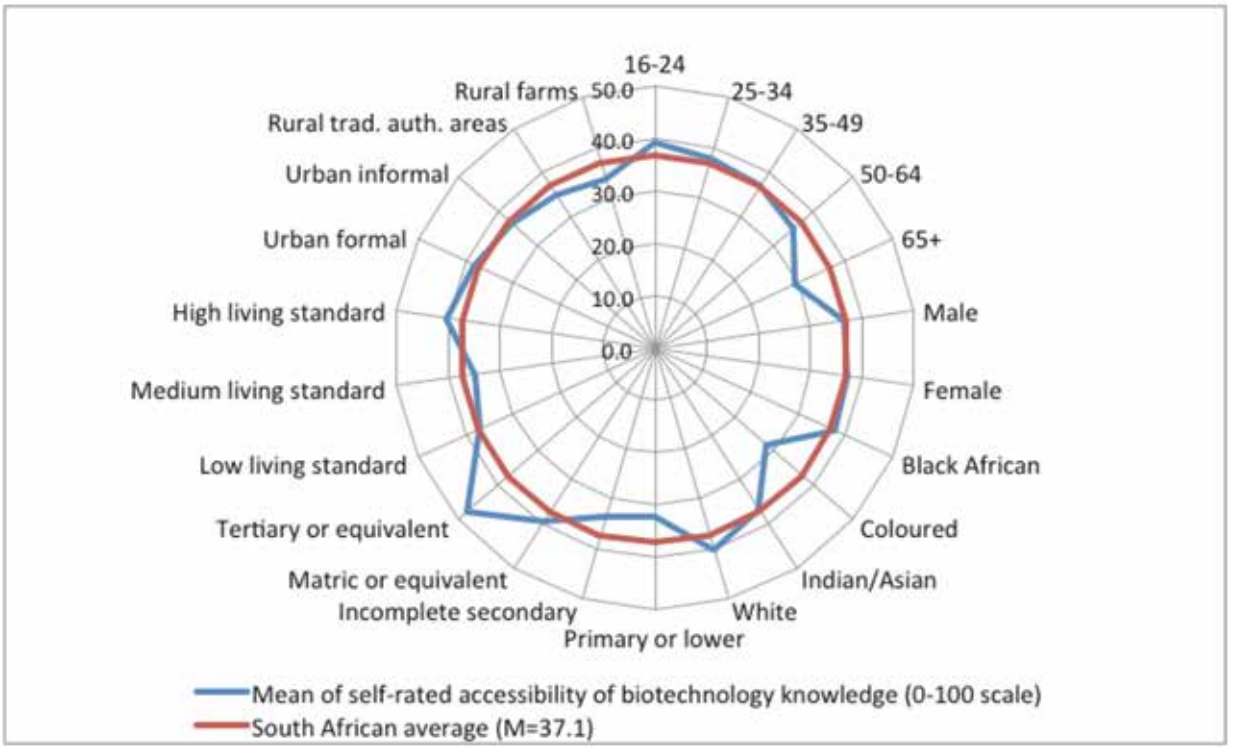
A demographic analysis of perceptions of access to biotechnology knowledge (Figure 9) reveals patterns similar to those of self-rated knowledge of biotechnology, but with lower levels of variation across the demographic groups. Younger generations, more educated groups, and men were more confident in their ability to access biotechnology knowledge.

Table 11: Self-rated accessibility of biotechnology knowledge (%)

To what extent do you agree or disagree that biotechnology is too specialised for me to understand?			
Agree	Neither agree nor disagree	Disagree	(Don't know)
46	21	16	17

Source: South African Social Attitudes Survey (SASAS) 2015

Figure 9: Self-rated accessibility of biotechnology knowledge: demographics



Source: South African Social Attitudes Survey (SASAS) 2015

5.2.3 Knowledge of core biotechnology concepts

Most of the South African public are thus cognitively distant from biotechnology knowledge. This is also reflected in the public's self-rated knowledge about core biotechnology concepts (Table 12). This tested for self-rated knowledge about the terms 'biotechnology', 'DNA', 'genes', 'genetic modification', and 'genetically modified food'. It is worth noting that 'genetically modified food' is not a technically correct term. 'Genetically modified crops' is a technically correct term, and these might in turn be used in the production of food that contains genetically modified ingredients. However, the public discourse does not widely use the technically correct term, and the notion of 'GM food' signifies food that includes, at least to some extent, ingredients sourced from genetically modified crops.

The most commonly understood terms out of this set were 'DNA' and 'genes', terms which have perhaps achieved greater prominence in the public discourse compared to the terms 'biotechnology', 'genetic modification' and 'GM food'. These were reported to be substantially understood by 34% and 29% of the population respectively. The other terms, 'biotechnology, 'genetic modification', and 'GM food' were only understood by 11%, 13%, and 14% of the population respectively, and the majority of the population had never even heard of these terms. This indicated that some of the cognitive building-blocks of an understanding of biotechnology are relatively well developed, while the notion of biotechnology *per se* remains elusive for most South Africans.

This distinction provides useful intelligence for the Public Understanding of Biotechnology programme, illustrating that communication and public engagement efforts might be better premised, initially, on the concepts of DNA and genes, and that the other biotechnology concepts require a basic introduction to most South Africans.

As is the case with other subjective knowledge data, self-rated knowledge of all the key constructs decreases with age. Conversely, this knowledge increases, in an almost linear fashion, with higher levels of education and living standard. Among racial groupings, it is arguably connected with historical privilege, as self-rated knowledge is lowest among the Black African group, and is successively higher for Coloured, Asian, and White groups (see Figure 10, Figure 11, Figure 12, and Figure 13).

A demographic analysis of a constructed 'objective knowledge indicator' (i.e. self-reported knowledge of core biotechnology concepts) again reveals the close relation between social status and knowledge (Figure 14). For this analysis, an index was created in order to synthesise the responses for all five of the biotechnology concepts being tested. To this end, a response of 'have not heard of it' or of 'don't know' was allocated a score of 0, a response of 'Have heard of it, but know very little of it' was allocated a score of 1, and a response of 'know enough about it to explain it to a friend' was allocated a score of 2. These indexed results were then divided by 2 (the maximum possible score) and aggregated across all the data points. This again reveals the two key drivers of knowledge of biotechnology: age and privilege.

The 2004 SASAS survey data make it possible to examine how responses to one of these constructs have changed over time (Table 13). The 2004 survey included a question about familiarity with the term 'biotechnology'. A comparison shows how public awareness and knowledge have increased in the period between these two surveys, with a reduction in 'don't know' responses, a doubling in affirmative responses, and a reduction in negative responses – a positive finding for the PUB programme, indicating that awareness of biotechnology is growing over time, and that it has increasing prominence in the public imagination. It is however not possible to determine, from these data, to what extent these changes are due to the efforts of the PUB programme, and to what extent they may be determined by improvements in general education levels, and greater access to information, over the last decade.

The Eurobarometer also includes a comparable data point, namely the question of whether participants have heard of the term 'GM food' (see Table 14). As might be expected, a higher proportion of Europeans had heard about GM foods (84%) compared to South Africans (49%).

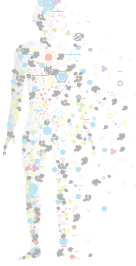
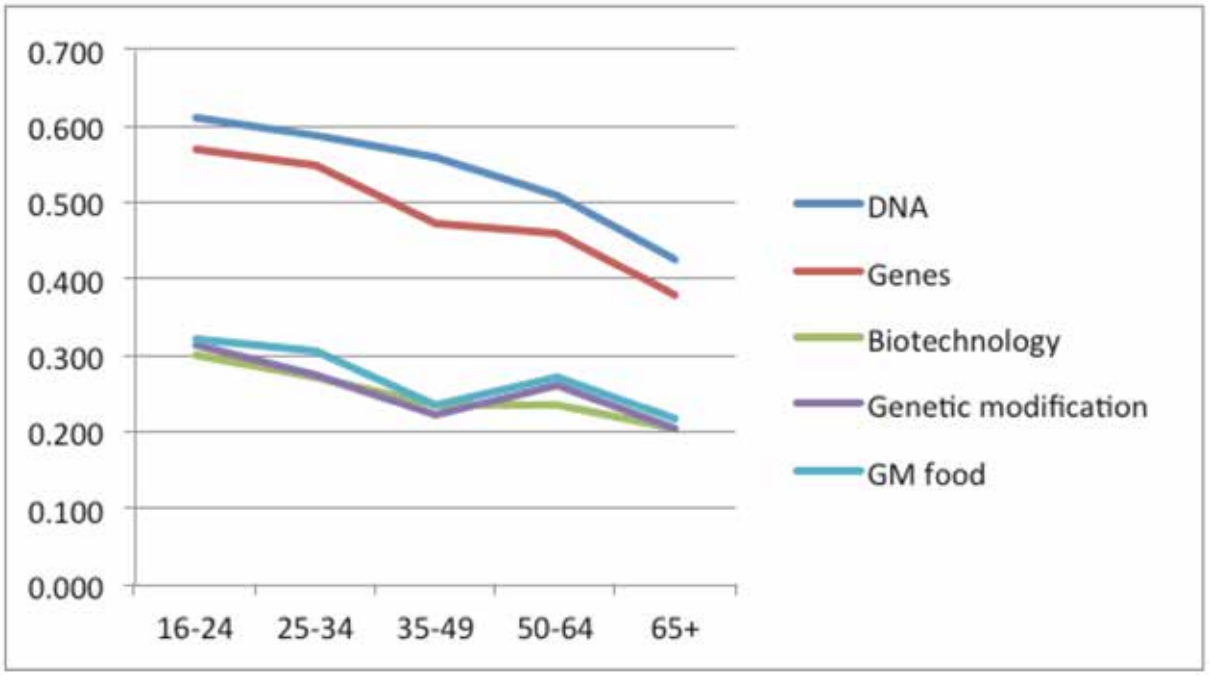


Table 12: Knowledge of core biotechnology concepts (%)

How familiar are you with the following terms?	Have not heard of it	Have heard of it, but know very little or nothing about it	Know enough about it to explain it to a friend	(Do not know)
DNA	19	45	34	3
Genes	25	43	29	4
Biotechnology	53	30	11	7
Genetic modification	53	27	13	7
Genetically modified food or GM food	51	29	14	7

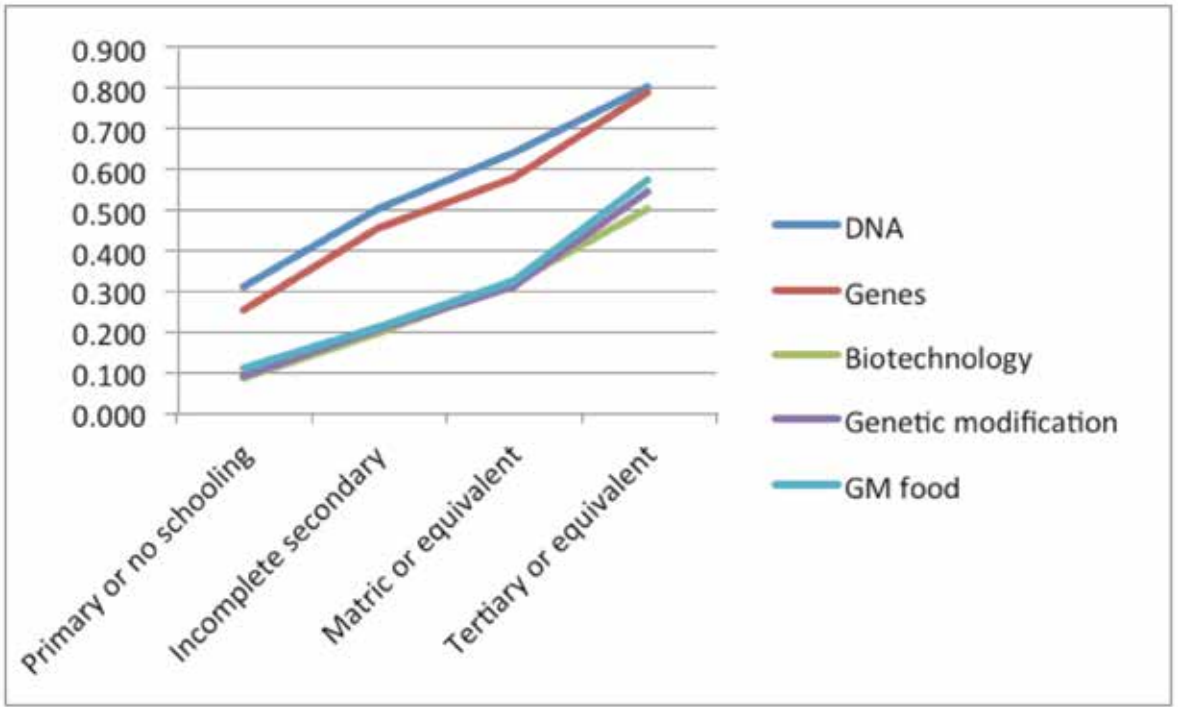
Source: South African Social Attitudes Survey (SASAS) 2015

Figure 10: Knowledge of core biotechnology concepts: age



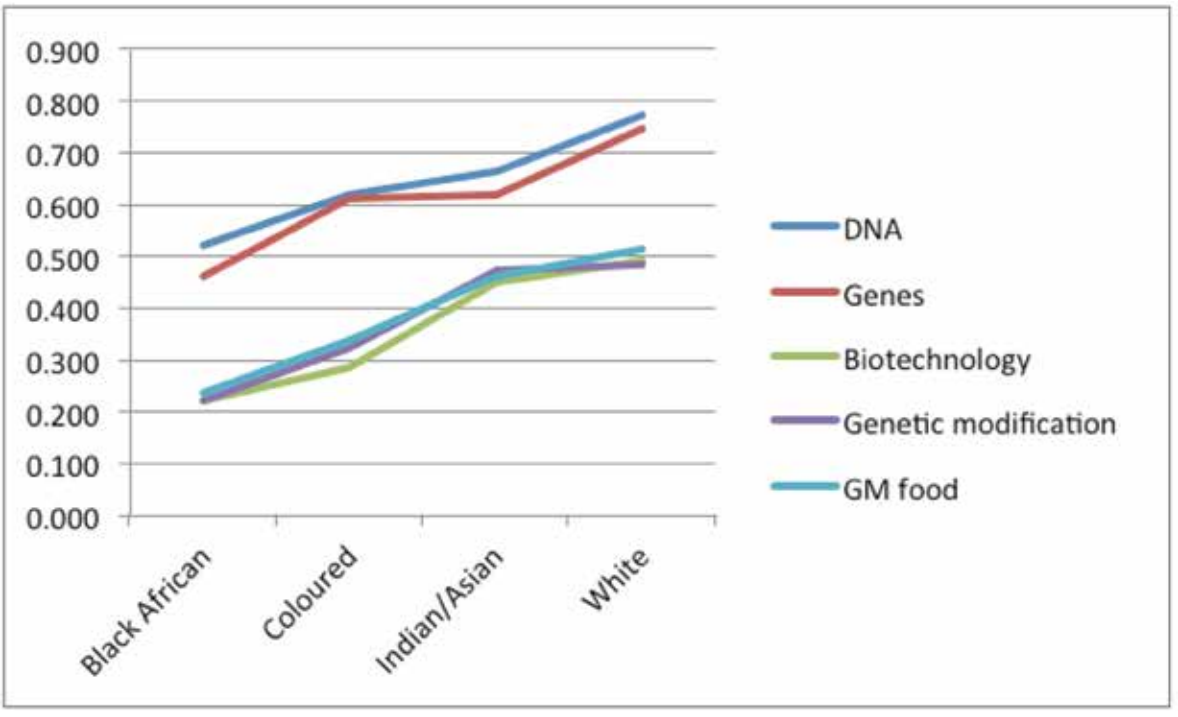
Source: South African Social Attitudes Survey (SASAS) 2015

Figure 11: Knowledge of core biotechnology concepts: education



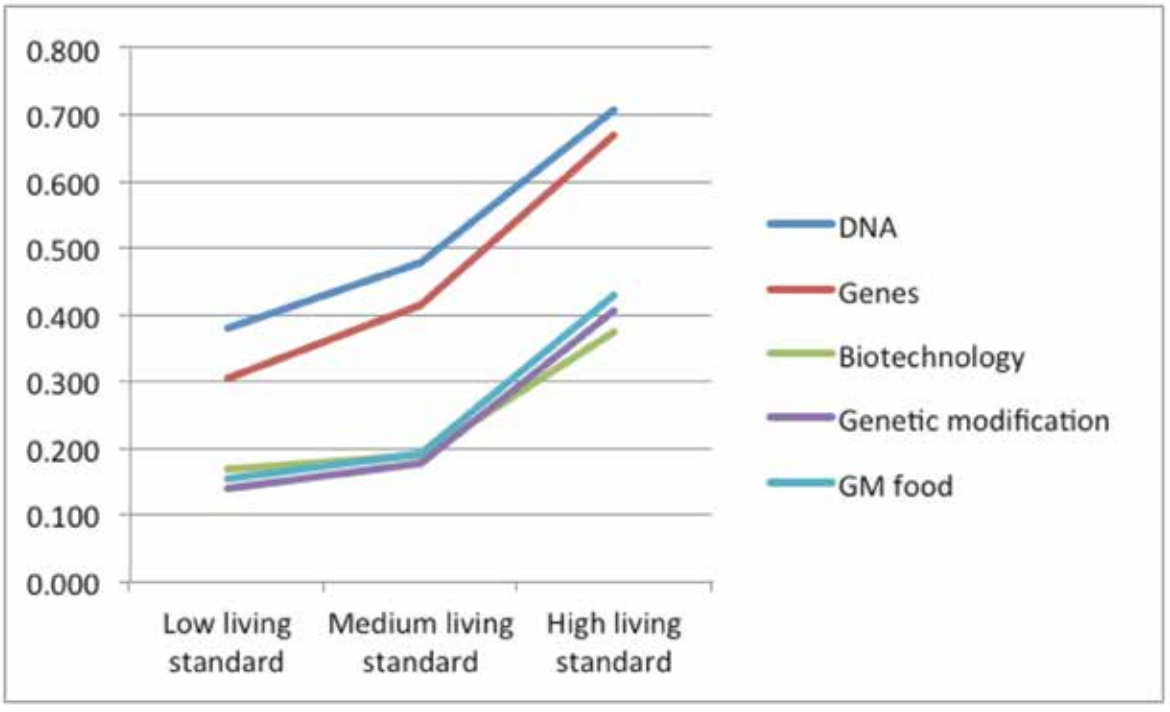
Source: South African Social Attitudes Survey (SASAS) 2015

Figure 12: Knowledge of core biotechnology concepts: race



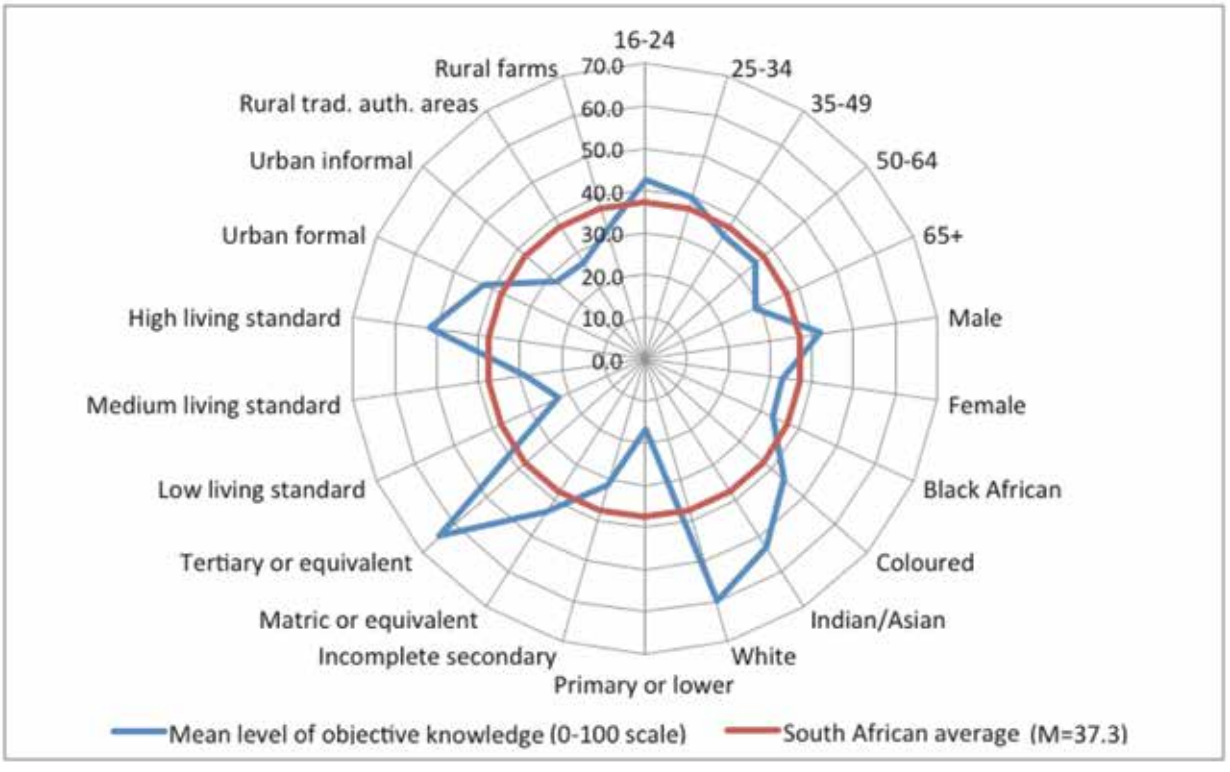
Source: South African Social Attitudes Survey (SASAS) 2015

Figure 13: Knowledge of core biotechnology concepts: living standard



Source: South African Social Attitudes Survey (SASAS) 2015

Figure 14: Knowledge of core biotechnology concepts: summary demographics



Source: South African Social Attitudes Survey (SASAS) 2015

Table 13: Familiarity with the term 'biotechnology', 2004 and 2015 (%)

How familiar are you with the term 'biotechnology'?			
Year	No (have not heard of it)	Yes	(Do not know)
2004 (SASAS)	68	21	11
2015 (SASAS)	53	41	7

Source: South African Social Attitudes Survey (SASAS) 2004 and 2015

Table 14: Knowledge of core concepts: 'GM food' (%)

Comparative studies	Heard	Have not heard	Don't know
South Africa 2015 (SASAS)	49	44	7
Europe 2010 EB 73.1	84	16	-

Source: South African Social Attitudes Survey (SASAS) 2015 and Europe 2010 Eurobarometer 73.1

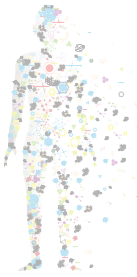
5.2.4 Perceptions of human evolution

An understanding of evolution indicates an awareness that traits of humans and other living organisms are passed on through a hereditary system which may also introduce changes across generations. This forms part of the suite of cognitive requirements for an understanding of biotechnology, which builds on this conception by adding the notions of genes, DNA, and the possibility of the manipulation of inherited traits through genetic modification.

The South African public is polarised in their views about human evolution (Table 15). A significant proportion of the public were not able to provide a clear response to this question, with 29% of respondents reporting either a neutral position or a 'don't know' response. Of those that did provide a clear response, the public were approximately split in half, with 33% agreeing, and 37% disagreeing. This provides an indicator of the public's propensity towards being open to notions of evolutionary biology and the epistemological authority of science.

However, the social distribution of these notions reveals some interesting and surprising results. Firstly, age is a strong predictor of belief in human evolution, and the data reveals a clear gradient of responses, with younger generations successively being more likely to believe in evolution, and also more likely to engage with the question itself, reporting lower levels of 'don't know' responses. Similarly, males are more likely than females to agree with the notion of human evolution, and also report a lower level of 'don't know' responses. The different racial categories each report distinct patterns of response. Firstly, white and Asian populations were more likely to engage with the question, and reported lower levels of 'don't know' responses than Black African and coloured respondents, and also lower levels of neutrality (answering 'neither agree nor disagree'). However, belief in human evolution is unevenly distributed across racial groups. The Black African group has approximately even proportions agreeing and disagreeing with the notion of human evolution (35% vs 34%). In contrast, the Coloured group is substantially more likely to disagree (49%) than agree (23%), and this pattern is even more pronounced among the Asian group (59% vs 16%). Within the white population there is also a greater proportion who do not agree with human evolution (45%) than agree (38%). However, since the White population reported lower levels of don't know responses and lower levels of neutrality (neither agree nor disagree), a greater proportion were able to give positive or negative responses, and thus they also report the highest levels of overall agreement with the notion of human evolution.

The relation between educational attainment and belief in human evolution is particularly interesting. It is not the case that increased education results in a greater propensity to believe in human evolution. Indeed, education had little effect on the propensity to agree with the notion, and also little impact on the propensity to be neutral towards the issue. Instead, education appears to influence engagement with the topic. More educated groups report lower levels of 'don't know' and higher levels of disagreement. It thus appears as if increased education prompts people to



engage with the question of human evolution, and move towards a position of disagreement.

Communication efforts of the PUB programme therefore need to consider that a core mechanism in promoting an understanding of biology, evolution, and biotechnology is the process by which individuals gain education and knowledge, and shift from a status of ignorance or ambivalence to one of sceptical and constructive engagement.

An analysis of responses by economic status reveals a distinct but broadly similar pattern. Those with higher economic status reported lower levels of don't know responses, and also lower levels of neutrality. Again, groups with higher living standards also reported higher levels of disagreement with the notion of human evolution. Groups with a medium or high living standard reported similar levels of agreement with the notion of human evolution (35% and 32%), but those with a low living standard reported lower levels (25%). Overall, however, it seems that as living standards increase, greater engagement with the notion of human evolution shifts opinions from that of non-engagement or neutrality, with a greater proportion moving to disbelief in human evolution than belief.

The PUB programme therefore needs to contend with the situation in which increased education, knowledge, and social status do not necessarily lead to greater levels of belief in human evolution – in other words, that the cognitive substrate of biotechnology may be more culturally determined than socially determined, and that communication and engagement efforts therefore need to be culturally informed and specific.

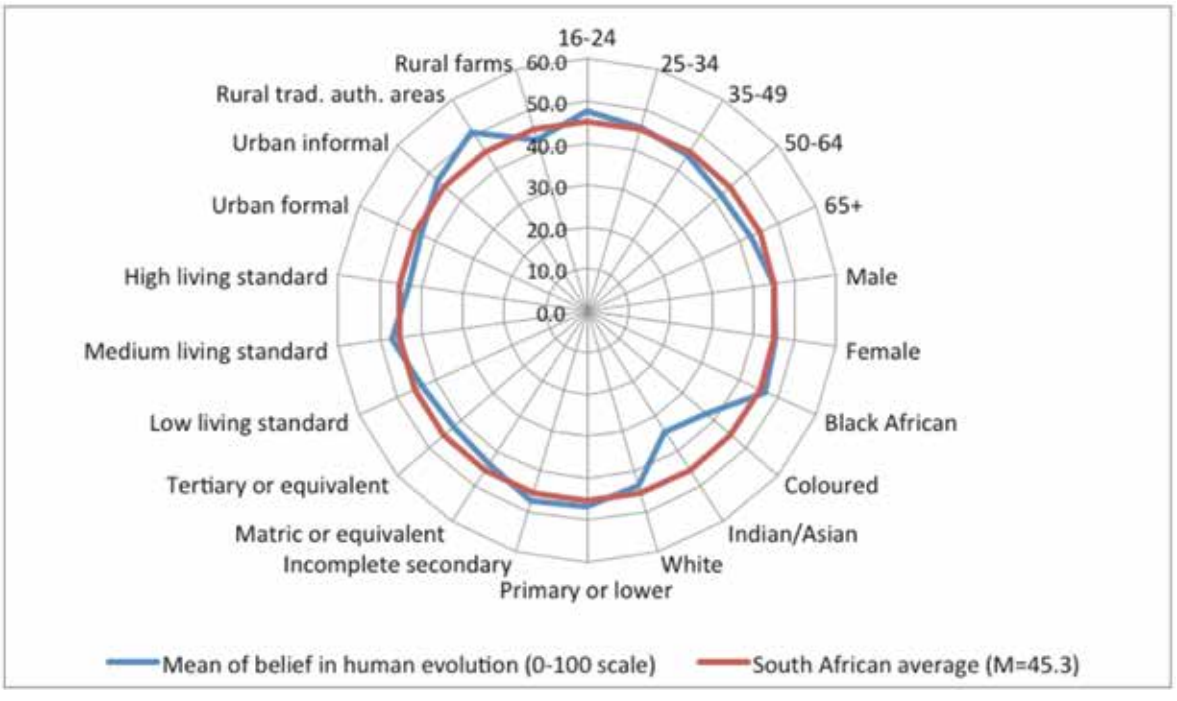
Comparable data from the 2010 SASAS allows us to track changes over time (Table 15). This shows a degree of stability over the five-year period.

Table 15: Belief in human evolution: change over time (%)

Human beings have evolved from other animals				
Year	Agree	Neither agree nor disagree	Disagree	(Do not know)
2015	33	16	38	13
2010	34	-	48	19

Source: South African Social Attitudes Survey (SASAS) 2010 and 2015

Figure 15: Belief in human evolution: demographics



Source: South African Social Attitudes Survey (SASAS) 2015

Key findings: knowledge about biotechnology

- Most South Africans (73%) report having little or no knowledge about biotechnology.
- Younger and more privileged groups report greater knowledge than older and less privileged groups.
- The terms 'genes' and 'DNA' are far more widely understood than 'biotechnology', 'genetic modification' or 'GM food'.
- However, the public understanding of the term 'biotechnology' has increased substantially over the last decade.
- The South African public holds polarised views about human evolution.
- The cognitive substrate of biotechnology may be more culturally determined than socially determined

Implications for public engagement with biotechnology

- A key challenge for the biotechnology sector is to engage with a public who are largely unaware of what biotechnology is.
- Communication and engagement efforts might be better premised, initially, on the concepts of DNA and genes, which are more widely understood than other core biotechnology concepts.
- Public engagement needs to take into account the social and cultural context of knowledge – for example views of human evolution and their relation to perceptions of biotechnology and religious identities.

5.3 Perceptions of genetically modified food

Genetically modified foods are the primary application of biotechnology in terms of the public discourse (Gastrow, 2010). This section therefore forms the largest component of the data analysis. We examine basic knowledge about GM food, the utility of GM food, and an array of attitudes towards GM food.

5.3.1 Knowledge of genetically modified food

5.3.1.1 Growing GM crops

Our first and most basic question aimed to assess to what extent the South African public are aware that GM crops may legally be grown in the country. This simple question indicated that approximately half the population are aware that this is the case, while the remainder are not aware or could not answer the question (Table 16). As can be seen in Figure 16, and in line with subjective knowledge findings, knowledge that GM crops may be legally grown in South Africa is influenced by age and privilege. Knowledge declined consistently with age, and increased consistently with education.

Table 16: Growing GM crops in South Africa (%)

	Yes	No	(Don't know)
As far as you know, are genetically modified crops allowed to be grown in South Africa?	54	13	33

Source: South African Social Attitudes Survey (SASAS) 2015

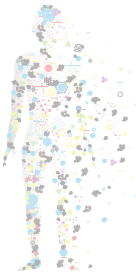
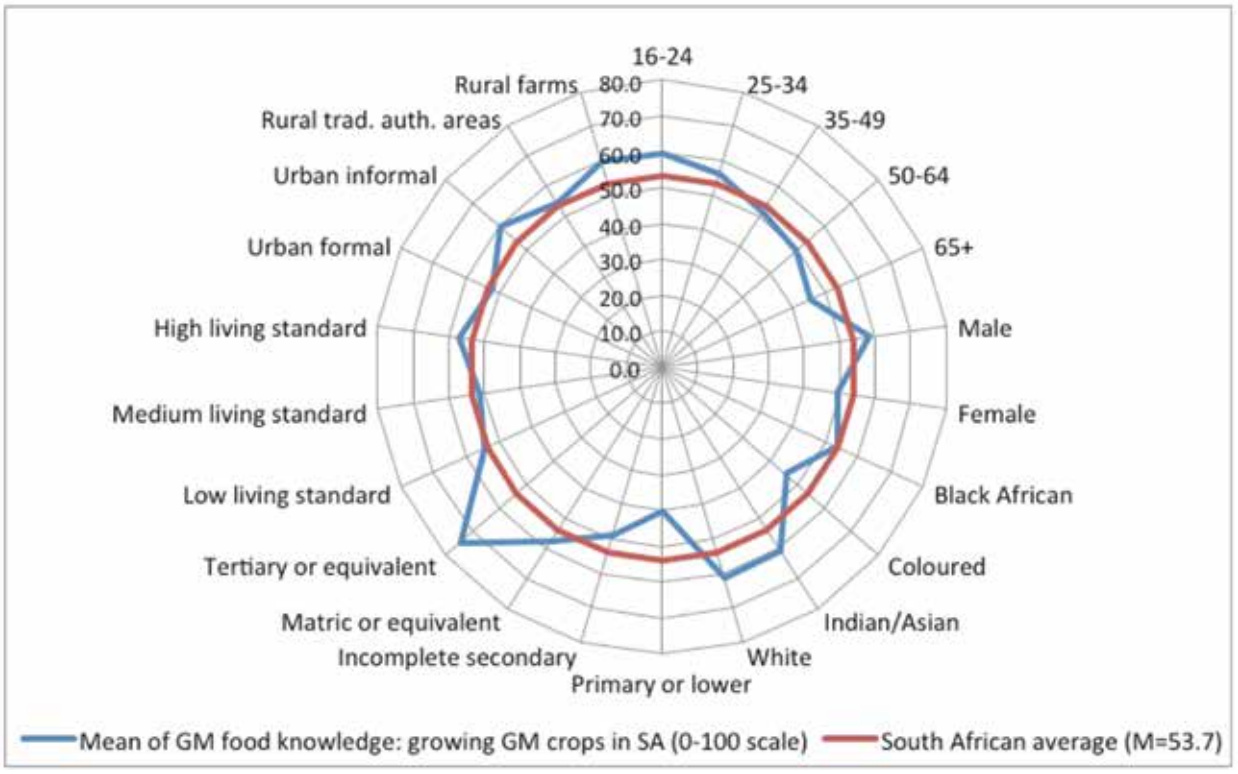


Figure 16: Growing GM crops in South Africa: demographics



Source: South African Social Attitudes Survey (SASAS) 2015

5.3.1.2 Knowledge of GM crops grown in South Africa

Moving beyond the basic knowledge of whether GM crops may be legally grown in South Africa, we aimed to establish the extent of public awareness of the specific crops that fall into this category. In South Africa, cotton, soya and maize are the only GM crops that have received regulatory approval for agricultural production (other categories of regulatory approval include field trials, medicine, and commodities). When asked to identify GM crops legally grown in South Africa, a substantial proportion identified maize, while only 4% and 7% identified cotton and soya respectively. Data from Australia, from the IPSOS study in 2013, provides an international comparison: at that time, 41% of the population were aware of GM canola, and 9% of GM cotton (the only GM crops that had received regulatory approval in Australia at the time).

Table 17: Public awareness of GM crops grown in South Africa: international comparison (%)

	Comparative studies	Cotton	Canola	Soya	Maize
% of the public who are aware of specific legally grown crops	IPSOS Australia 2013*	9	41	n/a	n/a
	SASAS 2015**	4	n/a	7	40

Source: South African Social Attitudes Survey (SASAS) 2015 and IPSOS Australia 2013

** The only genetically modified crops produced in Australia are canola and cotton*

*** The only genetically modified crops produced in South Africa are cotton, soya, and maize*

5.3.1.3 Eating GM food

Another basic knowledge construct to test was whether the public are aware that they are eating GM food. It is taken as a given that almost the entire South African public consumes at least some proportion of GM food, given the ubiquity of GM products such as maize. However, on aggregate, less than half of the South African public are aware that they are eating GM food. A third felt unable to answer the question, reflecting low levels of the knowledge needed to make such an assessment. Again, correct responses were inversely related to age, and strongly related to educational attainment. Interestingly, traditional authority areas rendered a substantially higher correct response to this question, suggesting a level of awareness of GM food in these areas that is unrelated to the effects of age or education.

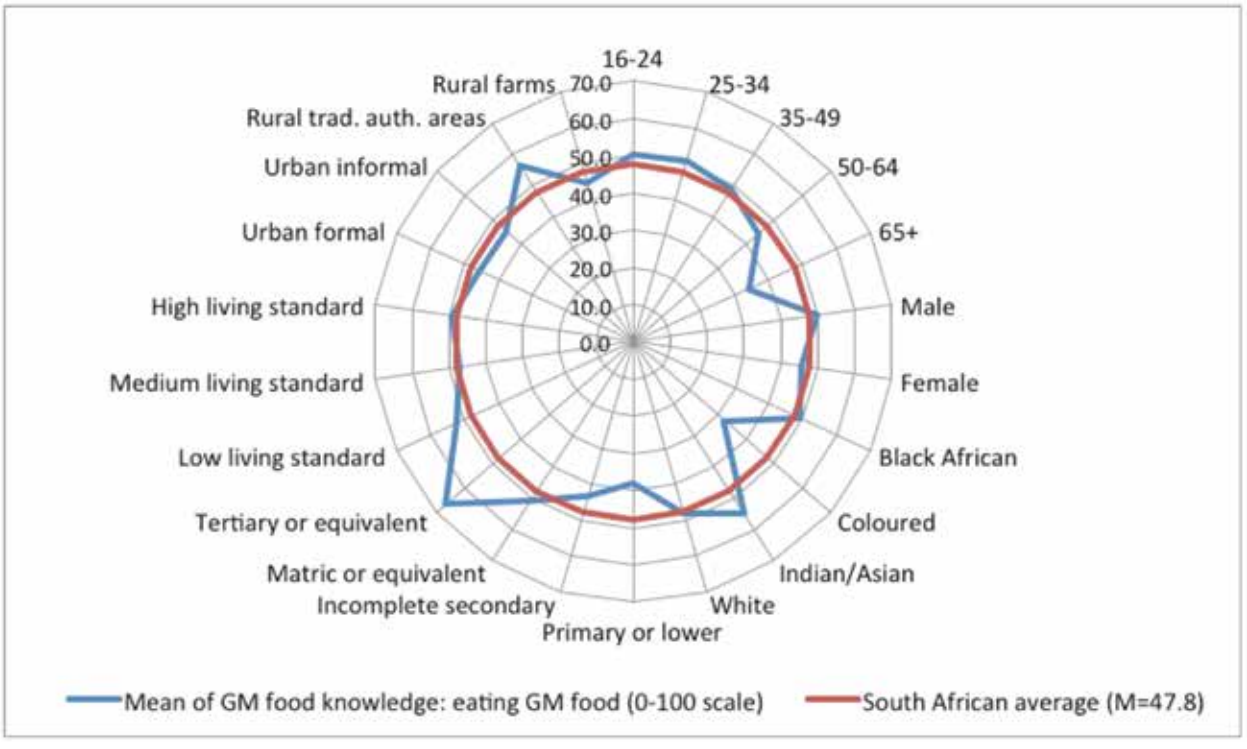
Comparative data are available for South Africa in 2004 from the SASAS (Table 19). This reveals a positive trend, with the proportion of South Africans answering correctly more than tripling, from 13% to 48%, and a reduction in 'don't know' responses from 62% to 36%. This suggests that, on the whole, the South African public has a growing awareness of the presence of GM foods in their diet.

The data also support the hypothesis that an understanding of GM crops influences the public understanding of GM foods. Table 18 shows that the sub-set of the sample who could identify GM maize as a legally grown crop in South Africa were substantially more likely than average to understand that they eat GM food (77% compared to 48%). This highlights that efforts to inform the public about GM foods in their diet could benefit from increased information about the status of GM crops in South Africa.

Table 18: Relationship between knowledge of GM maize crop and knowledge of eating GM food (%)

	Name any GM crops currently grown in SA: Maize		
Have you ever eaten GM food?	Yes	No	Don't know
	77	8	15

Figure 17: Eating GM food: demographics



Source: South African Social Attitudes Survey (SASAS) 2015

Table 19: Eating GM food: changes over time (%)

Have you ever eaten GM food?			
Year	Yes	No	Don't know
SASAS 2004	13	25	62
SASAS 2015	48	17	36

Source: South African Social Attitudes Survey (SASAS) 2004 and 2015

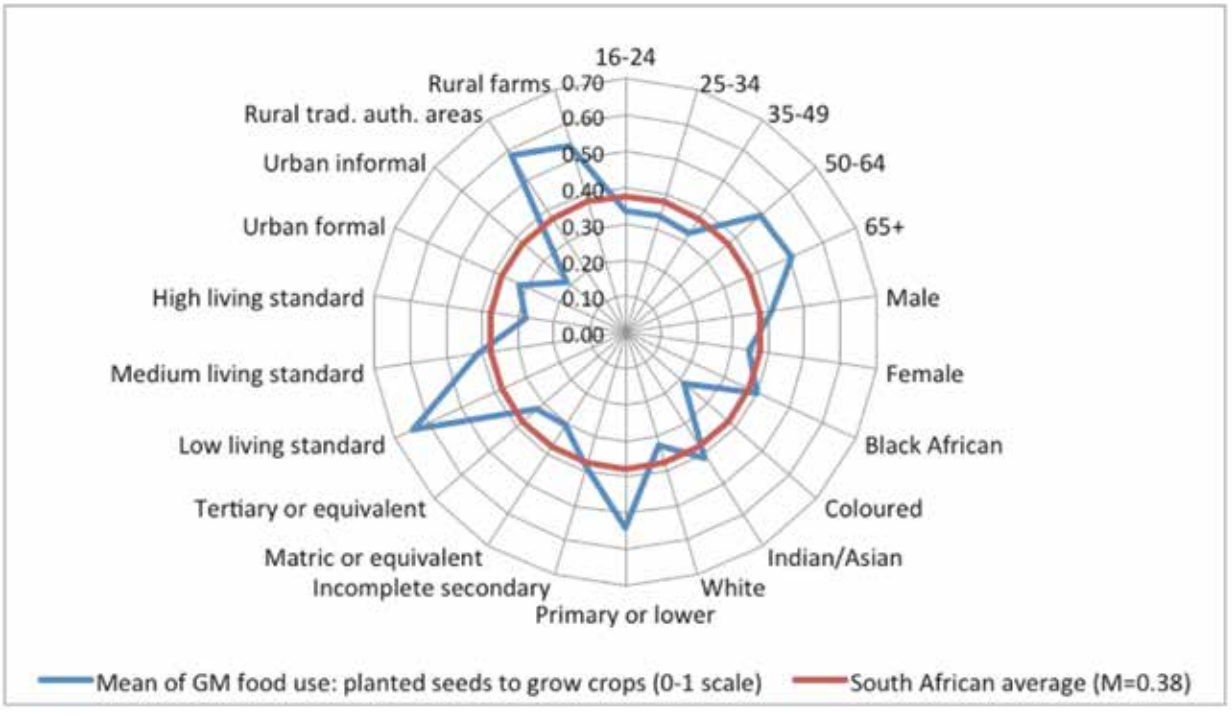
5.3.2 Use of GM food

5.3.2.1 Planting GM crops

Building on the analysis of basic knowledge of GM food, we investigated the ways in which GM crops feature in the everyday life of South Africans. Firstly, we sought to establish which sectors of the South African public are directly involved in planting crops, and then narrow the focus to those who are directly involved in the production of GM crops. Thirty-eight percent of respondents had previously planted seeds to grow crops.

Of this group, only a minority had ever knowingly planted GM crops, amounting to 10% of the sub-group of the sample who had previously planted seeds for growing crops (in other words, 4% of the total sample). The most common source for seeds was the traditional method of saving seeds from previous crops. This is usually not possible with GM seeds, although in some cases reproduction may occur, with an associated loss of 'hybrid vigour'. A substantial proportion (41%) had bought seed without being certain whether they were GM or not. This again highlights the limited awareness of GM crops, even among those who plant seeds.

Figure 18: Planted seeds to grow crops: demographics



Source: South African Social Attitudes Survey (SASAS) 2015

Table 20: Sources of seeds for planting crops (%)**

How were the seeds obtained:	Total*
Saving seeds from previous crops	58
Exchanging seeds with other farmers	14
Buying GM seeds	10
Buying non-GM seeds	8
Buying seeds (but unsure if they are GM or non-GM)	41
(Don't know)	3

Source: South African Social Attitudes Survey (SASAS) 2015

** As a percentage of those who answered positively to question 108 ("108. Have you ever planted seeds to grow crops?")*

*** multiple responses were allowed for this question*

5.3.2.2 Changes in maize

Another means by which to assess awareness of GM food in everyday life was to question the public about the qualities of the maize they eat, with the aim of establishing whether they are aware of some of the changes that have taken place due to the introduction of GM maize varieties (commercially available GM maize has been legally grown in South Africa since 1998). As can be seen in Table 21, there is a fairly broad-based public perception (63%) that maize has changed over recent decades. Specifically, 27% perceive only a change in appearance, 13% a change exclusively in growth patterns, while a further 23% perceive both of these changes. Thus, even if public knowledge about biotechnology is limited, there is some awareness of its impact on our food sources – which offers a potential lever for public engagement to the PUB programme. This may be particularly useful for engaging with specific groups, for example those living in rural areas, and those with medium and lower living standards, were more likely to perceive changes in maize (Figure 19).

Table 21: Perceptions of changes in maize (%)

If you compare the maize you eat today with the maize eaten twenty years ago, would you say it…:	Is the same	14
	Has a different appearance	27
	Grows differently	13
	Has both a different appearance and grows differently	23
	(Don't know)	24

Source: South African Social Attitudes Survey (SASAS) 2015

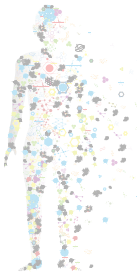
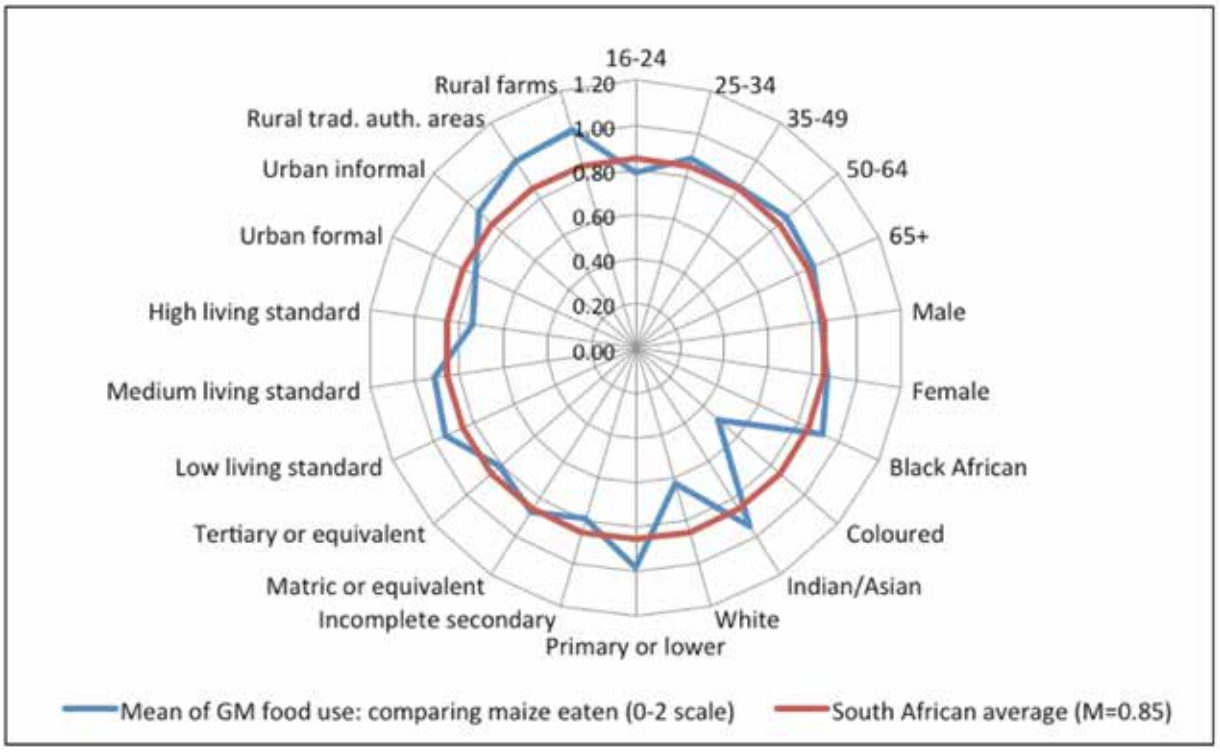


Figure 19: Perceptions of changes in maize: demographics



Source: South African Social Attitudes Survey (SASAS) 2015

5.3.3 Attitudes towards genetically modified food

The assessment of attitudes towards GM food is arguably the most topical and substantive aspect of public perceptions of biotechnology, and this focus takes up a correspondingly large proportion of the survey instrument and analysis. The issue of GM food has been highly polarised in the South African media and the public sphere, and is a site of contestation over issues of regulation and broader political economy. The survey asked questions about a variety of attitudinal aspects, which are summarised in Table 22 below. Similarly, the Eurobarometer, NSF survey, and other international surveys of public perceptions of biotechnology have a significant focus on attitudes towards GM food.

Due to the high level of 'don't know' responses, the construction of indices to guide demographic analysis was seen as sub-optimal for most of these questions (with the exception of composite indices for attitudes towards issues of purchasing GM foods and the ethics of GM foods). Instead, demographic variance is illustrated in basic descriptive tables.

Table 22: Attitudes towards GM food: summary (%)

	Agree	Disagree	Don't know
I would buy GM maize if it were healthier	77	11	12
I would buy GM maize if it cost less than ordinary maize	73	15	12
I would buy GM maize if it were grown in a less damaging way to the environment compared to non-GM maize	68	16	16
The genetic modification of food is interfering in God's Plan	41	36	23
The genetic modification of food is wrong	30	44	26
The international corporations that make GM foods act in an ethical manner	38	24	39
GM foods are safe to eat	49	21	30

	Agree	Disagree	Don't know
The long-term health effects of eating GM food are unknown	52	18	31
Products containing GM foods should be labelled	75	7	18
GM foods are good for the economy	53	16	31
GM foods benefit large-scale commercial farmers	56	13	31
GM foods benefit small-scale subsistence farmers	43	23	34
GM foods provide more secure access to food for my family	47	22	31
The environmental cost of farming GM crops is higher than that of traditional farming methods	45	17	38
Overall, GM foods provide more benefits than risks for society	46	19	36

Source: South African Social Attitudes Survey (SASAS) 2015

5.3.3.1 Consuming GM foods

To test the willingness of the public to consume GM food, as an alternative to non-GM foods, we tested perceptions of GM foods in relation to health aspects, cost aspects, and environmental impact aspects. An overall index of attitudes towards buying GM food was constructed by averaging together the three items (related to health, cost, and environmental impact), and transforming the result into a 0-100 scale by subtracting 1, dividing by 3 and multiplying by 100. This allowed an overall demographic comparison as represented in Figure 20. This reveals that attitudes towards buying GM are fairly consistent across the demographic groups. As such, levels of knowledge appear to have little impact on decisions to purchase GM foods. White and Indian South Africans, those with a tertiary education, and older South Africans (65 years and older) were slightly less likely to (knowingly) purchase GM foods.

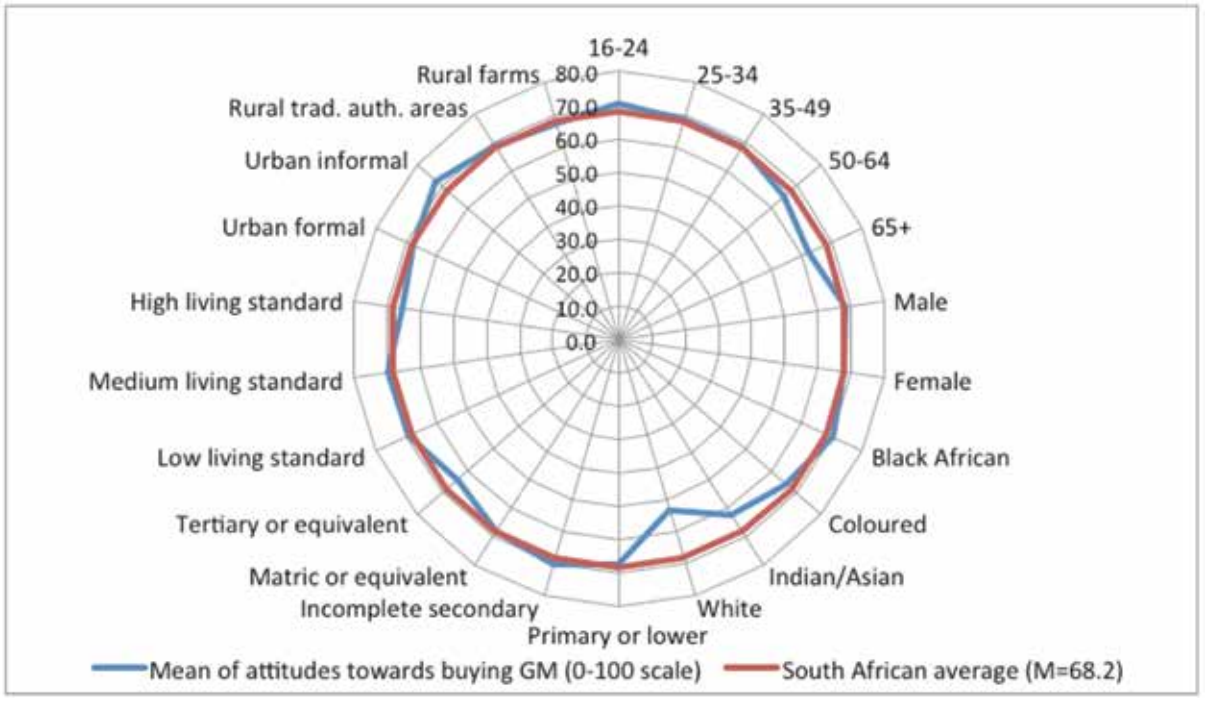
A comparison with 2004 data reveals some interesting changes in public perceptions during this period. Lower levels of 'don't know' responses in 2015 resulted in increased levels of both positive and negative responses. However, on balance, these increases favoured the positive responses, with higher proportions of the public agreeing that they would buy GM foods if they were healthier (59% to 77%), if they cost less (51% to 73%) and if they had a lower environmental impact (50% to 68%). Overall, these data indicate that the South African public have gained increased awareness of GM foods, and are increasingly open to buying GM foods.

Table 23: Attitudes towards buying GM food: changes over time (%)

	Agree		Disagree		Don't know	
	2004	2015	2004	2015	2004	2015
I would buy GM maize if it were healthier	59	77	18	11	22	12
I would buy GM maize if it cost less than ordinary maize	51	73	26	15	23	12
I would buy GM maize if it were grown in a less damaging way to the environment	50	68	24	16	26	16

Source: South African Social Attitudes Survey (SASAS) 2004 and 2015

Figure 20: Attitude towards buying GM: demographics



Source: South African Social Attitudes Survey (SASAS) 2015

5.3.3.2 Ethics

Among the South African public, attitudes towards ethical aspects of GM food are polarised, in the context of low levels of engagement with questions of ethics. Religiosity plays an important part in informing attitudes towards the ethics of GM food. Forty-one percent of the public feel that the genetic modification of food is 'interfering with God's plan'. However, this statement is polarising, as 36% of the public disagree. This indicates that engagement with the public needs to take account of religion – and the nature of the potential conflict between religious views and acceptance of GM foods.

However, the summative ethical assessment of GM foods remains positive, with 30% of the public believing that it is 'wrong', but 44% disagreeing with this statement. Again, however, the polarisation is notable, as is the high level of 'don't know' response, indicating a large proportion of the public that are unwilling or unable to engage in an ethical assessment of GM foods.

Finally, a critical element of the international discourse surrounding GM foods is the role of the international corporations that control GM crop markets. However, in the South African context, this role is not a major concern of the public. The most common response to this question was 'don't know' (39%). Of those that did respond, more felt positively about the ethical actions of corporations (38%) than negative (24%).

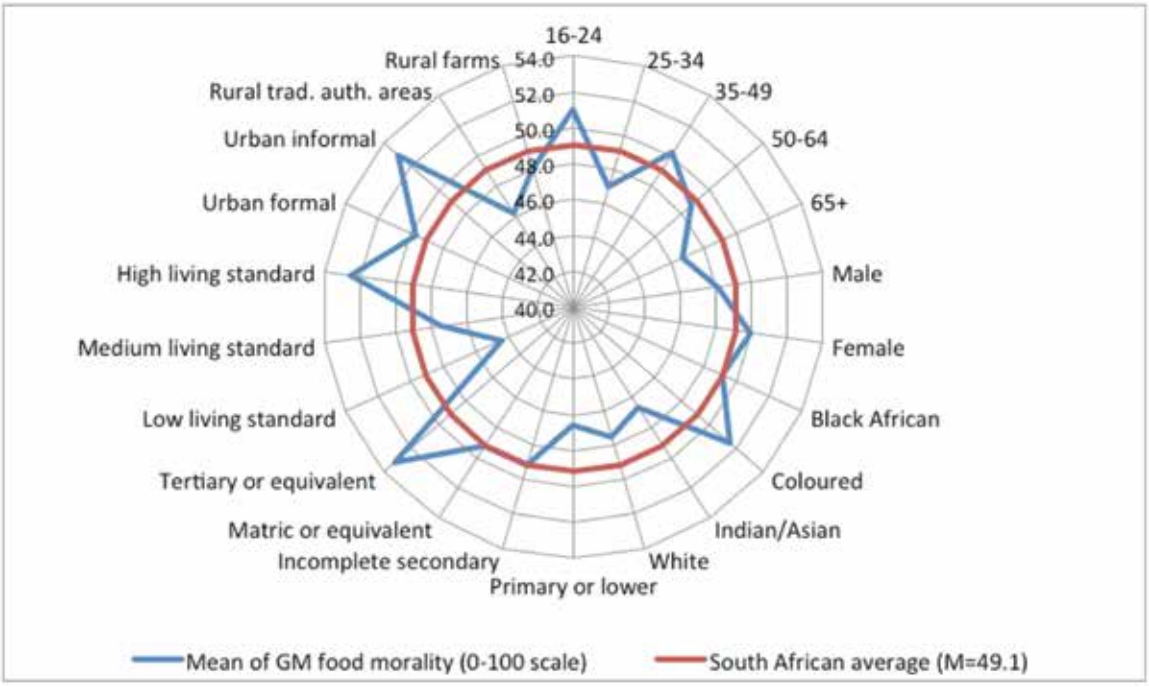
An overall index of moral attitudes towards GM food was created by recoding the responses to questions 115, 116 and 117 (see Appendix A) and removing the values associated with a 'don't know' response. A Cronbach Alpha reliability test for the three items rendered a coefficient of 0.596, indicating that the reliability would be low if all three items were to be combined. As a consequence, responses to question 117 were omitted. The index was therefore constructed using an average of the first two items. This was subsequently transformed into a 0-100 scale by subtracting 1, dividing by 3, and multiplying by 100. This index therefore provides an indication of overall moral and religious acceptance of GM foods, but does not reflect attitudes towards the ethical status of the private corporations in the sector (see Figure 21).

The structure of moral attitudes towards biotechnology reveals some interesting similarities to the structure of knowledge about biotechnology, but also several differences. More positive moral attitudes are associated with higher living standards and higher education levels, and with living in an urban context. By contract, groups in rural areas, and with lower levels of education and living standard, are more likely to be critical of the morality of GM

food production. On the other hand, there is no clear relation between these attitudes and age or population group (see Appendix C[5], Table 75), suggesting that other drivers of attitude formation across different age cohorts and across cultures are influencing these moral attitudes[6].

These findings can inform PUB communication and engagement activities, showing that engagement in rural areas, particularly in traditional authority areas, needs to take into account a higher level of moral resistance to GM foods.

Figure 21: Moral and religious acceptance of GM foods



Source: South African Social Attitudes Survey (SASAS) 2015

5.3.3.3 Safety

A high level of 'don't know' responses to the question of GM food safety illustrates the limited knowledge held by the public, 30% of which felt unable to answer related questions. This presents an opportunity for a PUB communication and engagement programme, as a more informed public would be better able to form opinions in this area. Of those that felt able to engage with the question, more than twice as many viewed GM foods as safe to eat (49%) rather than unsafe (21%). However, there were reservations about our understanding of the long-term health implications of eating GM food, with the majority believing that the nature of these long-term effects are currently unknown.

South Africans are relatively positive about the health aspects of GM, when compared to attitudes in Europe (see Table 28). In Europe, the public are almost three times as likely to see GM food as unsafe: only 21% agree that GM foods are safe to eat, while 58% disagree. Thus, from a communications and engagement point of view, the PUB programme is facing a public with lower levels of knowledge and awareness, but also lower levels of strongly formed opinions, and significantly lower levels of scepticism about the health consequences of GM food.

Within the South African public, views about GM food and health also vary across demographic groups. However, this variation occurs in a manner that contrasts with the structure of knowledge of GM foods, and of knowledge of biotechnology in general (see Table 24 and Table 25), in that age and privilege were not as strongly correlated with attitudes as with knowledge. However, due to the high level of non-response to this question, these data cannot be seen as conclusive, but rather indicative of patterns among the sub-group of the sample that had sufficient knowledge and confidence to engage with the question (i.e. not return a 'don't know' response). Firstly, while age was a significant and consistent predictor of biotechnology knowledge, it does not

5 The same significance levels apply as used in Section 6: significance is reported as follows: n.s.=not significant; * p<0.05; **p<0.01; ***p<0.001

6 These drivers are explored in more detail in the multivariate analysis of this report.

have a significant or consistent effect on views of GM food safety. This suggests that the drivers of higher knowledge levels among the young are not also drivers of attitude formation with regards to safety, or are confounded by other variables. Race appeared to have a minor impact, with Black Africans being more likely to view GM as safe to eat, followed by Coloured, Indian, and White population groups. Living standard appeared to have little impact on responses. Educational attainment had a weak impact, with those with incomplete secondary schooling or less having somewhat lower levels of agreement than those with matric or tertiary education. Thus, another lesson about public attitudes towards GM food safety is that they are not strongly demographically structured, and unlike knowledge of biotechnology, are evidently not a function of privilege or age. This could imply that there remains scope to engage with the broader public with regards to the information that is required to form attitudes about GM food safety, but designing such engagement to look beyond age and privilege as the key drivers of attitude formation, and at reaching the levels of knowledge required to engage with questions of GM food safety.

Table 24: Safety of GM food products: demographics (%)

'GM foods are safe to eat'	Agree	Disagree	(Don't know)
Age group			
16-24	51	22	28
25-34	52	22	26
35-49	49	17	33
50-64	48	20	32
65+	41	22	36
Sex			
Male	49	22	29
Female	50	19	31
Population group			
Black African	51	18	31
Coloured	46	14	41
Indian/Asian	44	31	25
White	42	40	18
Educational attainment			
Primary or no schooling	43	19	38
Incomplete secondary	51	16	33
Matric or equivalent	48	24	28
Tertiary or equivalent	59	26	14
Living standard level			
Low living standard	46	19	36
Medium living standard	52	20	28
High living standard	47	22	31
Geographic location			
Urban formal	47	21	32
Urban informal	57	16	27
Rural traditional authority areas	53	21	26
Rural farms	48	22	30
Total	49	21	30

Source: South African Social Attitudes Survey (SASAS) 2015

Table 25: GM food and long-term health effects: demographics (%)

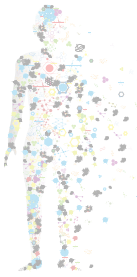
'The long-term health effects of eating GM food are unknown'	Agree	Disagree	(Don't know)
Age group			
16-24	52	19	29
25-34	52	21	27
35-49	53	15	32
50-64	54	14	32
65+	43	15	42
Sex			
Male	53	17	30
Female	50	18	32
Population group			
Black African	52	17	31
Coloured	46	11	42
Indian/Asian	61	14	25
White	55	25	21
Educational attainment			
Primary or no schooling	48	12	40
Incomplete secondary	49	17	35
Matric or equivalent	54	18	28
Tertiary or equivalent	64	23	14
Living standard level			
Low living standard	56	11	34
Medium living standard	54	16	31
High living standard	48	21	31
Geographic location			
Urban formal	49	18	33
Urban informal	52	23	25
Rural traditional authority areas	59	13	27
Rural farms	62	14	23
Total	52	17	31

Source: South African Social Attitudes Survey (SASAS) 2015

Table 26: Attitudes towards GM food safety: international comparison

'GM foods are safe to eat'	Agree	Disagree	Don't know
South Africa 2015 (SASAS)	49	21	30
Europe 2010 (Eurobarometer 73.1)	21	58	20

Source: South African Social Attitudes Survey (SASAS) 2015 and Europe 2010 Eurobarometer 73.1



5.3.3.4 Labelling

Attitudes towards food labelling stand out from the other attitudinal indicators, with a lower level of don't know responses (19%) and a lack of polarisation of views, with a clear majority favouring the labelling of GM foods (75%) versus those not in favour of labelling (7%). This view cuts across all demographic categories, including age. This may have useful policy implications – the South African public is clearly in favour of GM labelling. Greater communication about the current policy requiring the labelling of GM foods (the Consumer Protection Act of 2008), as well as constructive engagement about the limited implementation of this requirement, may have a positive impact on public perceptions.

Table 27: Labelling of GM foods: demographics (%)

'Products containing GM foods should be labelled'	Agree	Disagree	(Don't know)
Age group			
16-24	81	6	12
25-34	79	8	13
35-49	70	7	23
50-64	73	4	22
65+	67	7	26
Sex			
Male	76	7	18
Female	75	7	18
Population group			
Black African	75	7	18
Coloured	76	2	22
Indian/Asian	77	9	14
White	76	12	11
Educational attainment			
Primary or no schooling	67	5	28
Incomplete secondary	73	8	19
Matric or equivalent	79	6	15
Tertiary or equivalent	82	9	8
Living standard level			
Low living standard	71	5	24
Medium living standard	75	7	18
High living standard	76	6	18
Geographic location			
Urban formal	76	6	18
Urban informal	75	9	16
Rural traditional authority areas	73	8	19
Rural farms	79	3	19
Total	75	7	18

Source: South African Social Attitudes Survey (SASAS) 2015

5.3.3.5 Economic benefit

The majority of the public (53%) believe that GM foods are 'good for the economy', while only 16% disagree – although 31% answered 'don't know'. Compared to the European public (Table 28), South Africans are relatively positive about the economic impact of GM foods, although this is in the context of much lower levels of engagement with the question. Again, this highlights that the South African public is, compared to developed countries, both less sceptical of GM foods, and also less informed – which signals an opportunity for the PUB programme to influence attitudes by providing the relevant information and building knowledge among the various publics.

Overall, younger South Africans were more positive about the economic benefits of GM food, and were also more likely to respond to the question. Variation between racial groups was low, although White South Africans were significantly more likely to disagree with the statement that 'GM foods are good for the economy', while at the same time having higher levels of response to the question. This again suggests that attitude formation, based on knowledge, can lead to attitudes that are more sceptical of biotechnology, in this case of GM foods. The effects of educational attainment and living standard are obscured by high levels of non-response. Those with low levels of education were more likely to reply 'don't know', and thus have lower levels of both agreement and disagreement. Conversely, those with a tertiary education were more likely to respond, and registered higher levels of both agreement and disagreement, but with a similar overall ratio of agreement to disagreement as evidenced by less educated groups.

Table 28: Attitudes towards GM food and the economy: international comparison (%)

Attitudes towards the statement 'GM foods are good for the economy'	Agree	Disagree	Don't know
South Africa 2015 (SASAS)	53	16	31
Europe 2010 (Eurobarometer 73.1)	31	50	19

Source: South African Social Attitudes Survey (SASAS) 2015 and Europe 2010 Eurobarometer 73.1

Table 29: GM food and the economy: demographics

'GM foods are good for the economy'	Agree	Disagree	(Don't know)
Age group			
16-24	59	14	27
25-34	57	18	26
35-49	48	19	34
50-64	52	14	34
65+	41	19	39
Sex			
Male	54	17	29
Female	52	16	32
Population group			
Black African	55	14	31
Coloured	46	14	40
Indian/Asian	53	23	24
White	43	37	20
Educational attainment			
Primary or no schooling	43	17	40
Incomplete secondary	52	13	35

'GM foods are good for the economy'	Agree	Disagree	(Don't know)
Matric or equivalent	57	17	26
Tertiary or equivalent	60	21	19
Living standard level			
Low living standard	51	14	35
Medium living standard	55	14	31
High living standard	49	20	31
Geographic location			
Urban formal	50	18	32
Urban informal	59	11	30
Rural traditional authority areas	59	14	27
Rural farms	52	19	28
Total	53	16	31

Source: South African Social Attitudes Survey (SASAS) 2015

5.3.3.6 Benefits for farmers

Farmers are perceived to benefit from GM crops, but this benefit is seen to be greater for large-scale commercial farmers (56%) than subsistence farmers (43%). As is the case for most of the other attitudinal questions related to GM food, a high level of 'don't know' responses obscures the identification of clear patterns among the demographic groups. However, on aggregate, and across most of the demographic categories and scales, large-scale commercial farmers are seen to benefit more than small-scale subsistence farmers. A total of 56% of the public felt that commercial farmers benefit from GM foods, compared to 43% that answered similarly for subsistence farmers.

Table 30: Benefits of GM crops for farmers: demographics (%)

GM foods benefit	Large-scale commercial farmers			Small-scale subsistence farmers		
	Agree	Disagree	(Don't know)	Agree	Disagree	(Don't know)
Age group						
16-24	59	12	29	43	24	33
25-34	62	13	25	51	22	27
35-49	52	14	34	40	23	37
50-64	51	16	34	38	26	36
65+	45	12	43	35	21	44
Sex						
Male	57	13	30	45	23	32
Female	55	13	32	41	24	35
Population group						
Black African	57	12	32	44	22	34
Coloured	48	10	42	36	19	46
Indian/Asian	53	21	26	41	29	29

GM foods benefit	Large-scale commercial farmers			Small-scale subsistence farmers		
	Agree	Disagree	(Don't know)	Agree	Disagree	(Don't know)
White	56	25	18	40	41	19
Educational attainment						
Primary or no schooling	46	11	43	38	18	43
Incomplete secondary	54	11	34	43	22	36
Matric or equivalent	59	13	28	43	24	33
Tertiary or equivalent	62	23	16	47	34	19
Living standard level						
Low living standard	59	9	32	37	27	36
Medium living standard	57	12	31	46	21	34
High living standard	54	16	31	40	27	33
Geographic location						
Urban formal	53	14	33	40	24	36
Urban informal	55	16	29	48	24	28
Rural traditional authority areas	64	9	28	50	21	29
Rural farms	61	9	30	43	23	34
Total	56	13	31	43	23	34

Source: South African Social Attitudes Survey (SASAS) 2015

5.3.3.7 Food security

Again, in the context of low levels of response, more South Africans agreed than disagreed that GM foods provide benefits in terms of food security (Table 31). Younger South Africans were more likely to perceive such a benefit, and were also more likely to provide a response to the question. Black African and Coloured South Africans has higher levels of 'don't know' responses, while Indian and White South Africans had lower levels. However, Indian and White groups were also more likely to disagree with the notion of increased food security. Similarly, those with higher levels of education were both more engaged with the question, and more likely to provide a negative response. This suggests that, to some extent, increased knowledge leads to increased scepticism about the potential of GM food to improve food security conditions for specific groups – hypothetically, this may be the result of increased exposure to public discourses that are critical of GM foods.

Table 31: Food security: demographics (%)

'GM foods provide more secure access to food for my family'	Agree	Disagree	(Don't know)
Age group			
16–24	50	23	27
25–34	53	21	26
35–49	46	20	34
50–64	42	23	36
65+	39	21	40

Sex			
Male	47	23	30
Female	47	20	32
Population group			
Black African	49	19	31
Coloured	38	18	44
Indian/Asian	48	28	24
White	39	42	19
Educational attainment			
Primary or no schooling	45	16	39
Incomplete secondary	47	18	35
Matric or equivalent	49	25	27
Tertiary or equivalent	48	32	20
Living standard level			
Low living standard	52	16	32
Medium living standard	51	19	31
High living standard	42	26	32
Geographic location			
Urban formal	44	22	34
Urban informal	52	23	25
Rural traditional authority areas	55	18	26
Rural farms	50	23	27
Total	47	22	31

Source: South African Social Attitudes Survey (SASAS) 2015

5.3.3.8 Environmental impact

The environmental impact of GM crops is commonly seen to be higher than traditional farming methods, with, on aggregate, 45% of the public holding this view, and 17% disagreeing. The remaining 38% replied 'don't know' (Table 32). This high level of don't know responses is unevenly spread across demographic groups, in a manner similar to the knowledge constructs. Firstly, it is to some extent a function of age, as older generations all report higher levels of 'don't know' responses than younger generations. Secondly, it is a function of privilege, with more educated groups, and those with higher living standards, all reporting lower levels of don't know responses. Black and Coloured groups reported higher levels of 'don't know' than Indian and White groups.

When comparing responses of agreement and disagreement, the patterns are less clear. Age does not have a consistent effect, nor does population group. While more educated groups were more likely to see the environmental cost of GM farming to be higher than traditional methods, the opposite was the case for groups with higher living standards.

Again, in comparison with Europeans, South Africans hold more positive attitudes towards biotechnology, with a lower proportion perceiving GM crops to have a higher environmental cost than traditional farming (see Table 33).

Table 32: Perceived environmental impact of GM crops (%)

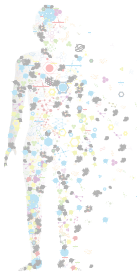
'The environmental cost of farming GM crops is higher than that of traditional farming methods'	Agree	Disagree	(Don't know)
Age group			
16–24	49	19	32
25–34	46	16	37
35–49	43	17	41
50–64	47	14	40
65+	33	19	49
Sex			
Male	46	17	37
Female	44	17	39
Population group			
Black African	47	14	38
Coloured	34	14	52
Indian/Asian	41	28	32
White	38	36	26
Educational attainment			
Primary or no schooling	42	12	46
Incomplete secondary	44	15	41
Matric or equivalent	47	19	34
Tertiary or equivalent	48	23	30
Living standard level			
Low living standard	58	7	36
Medium living standard	49	15	36
High living standard	38	21	41
Geographic location			
Urban formal	39	18	42
Urban informal	61	12	27
Rural traditional authority areas	55	14	31
Rural farms	55	18	28
Total	45	17	38

Source: South African Social Attitudes Survey (SASAS) 2015

Table 33: Attitudes towards GM food and environmental impact: international comparison (%)

The environmental cost of farming GM crops is higher than that of traditional farming methods	Agree	Disagree	Don't know
South Africa 2015 (SASAS)	45	17	38
Europe 2010 (EB 73.1)	52	23	24

Source: South African Social Attitudes Survey (SASAS) 2015 and Europe 2010 Eurobarometer 73.1



5.3.3.9 Overall benefit and risk

The overall assessment of GM foods is positive, with a larger proportion (46%) seeing them as a net benefit to society, and a smaller proportion (18%) as a net risk. As is the case with the other attitudinal questions, there is a high level of 'don't know' responses, which follow similar demographic patterns: higher for older generations, for the less educated, and for Black African and Coloured groups.

Younger generations, and more educated groups, are successively more likely to see GM foods as a benefit to society. However, living standard has a mixed effect, with both low and high living standard groups being less positive about GM food than the medium living standard group. Those in traditional authority areas were the most likely of the geographically defined groups to see GM foods as more of a benefit.

Table 34: GM foods: benefit and risk (%)

'Overall, GM foods provide more benefits than risks for society'	Agree	Disagree	(Don't know)
Age group			
16–24	52	16	32
25–34	47	21	31
35–49	43	20	37
50–64	44	16	40
65+	35	20	45
Sex			
Male	47	18	35
Female	45	19	36
Population group			
Black African	47	16	36
Coloured	38	19	44
Indian/Asian	41	32	27
White	44	32	23
Educational attainment			
Primary or no schooling	37	20	43
Incomplete secondary	45	17	37
Matric or equivalent	49	17	34
Tertiary or equivalent	53	24	24
Living standard level			
Low living standard	38	26	35
Medium living standard	50	17	34
High living standard	42	20	38
Geographic location			
Urban formal	42	19	39
Urban informal	53	19	28
Rural traditional authority areas	56	16	28
Rural farms	40	26	34
Total	46	19	36

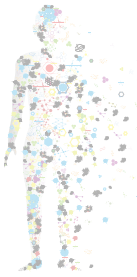
Source: South African Social Attitudes Survey (SASAS) 2015

Key findings: perceptions of GM food

- The public has low levels of knowledge and awareness of GM food, and thus do not have strongly formed opinions. Large proportions of the public did not engage with attitudinal questions about GM food, providing 'don't know' responses instead of defined positions.
- The main exception to the above is that the South African public are strongly in favour of labelling GM foods.
- About half of the public are aware that GM crops are legally grown in South Africa. This mostly applies to maize, and awareness of GM cotton and GM soya crops is very low.
- About half the South African public are aware that their food contains GM products. This awareness has grown substantially over the last decade (from 13% in 2004 to 48% in 2015).
- Higher levels of knowledge about GM food are associated with younger age groups and with social privilege.
- A large proportion of the public (73%) have perceived qualitative changes in the maize they eat – a far higher proportion than have substantive knowledge of the causes of these changes.
- Those who could identify GM maize as a legally grown crop in South Africa were substantially more likely to understand that they eat GM food.
- The South African public are increasingly open to buying GM foods.
- Religion plays an important part in forming attitudes towards the ethics of GM food, serving to polarise the public into approximately equal groups that agree or disagree with the notion of GM 'intervening in God's plan'.
- The public are largely disengaged from assessing the ethics of the international corporations that play a role in the sector.
- Most South Africans believe that GM foods are good for the economy, although levels of engagement with the issue are low. Younger South Africans are more positive than older South Africans about the economic benefits of GM food
- Farmers are perceived to benefit from GM crops, but commercial farmers are seen to benefit more than subsistence farmers.
- The environmental impact of GM crops is commonly seen to be higher than traditional farming methods.
- The overall risk/benefit assessment of GM foods is positive. Younger generations and more educated groups are more likely to see GM foods as a benefit to society.

Implications for public engagement with biotechnology

- Widespread awareness of changes in the qualities of maize in South Africa may provide a point of leverage for communication and engagement – particularly with less privileged groups.
- Efforts to inform the public about GM foods in their diet could benefit from increased information about the status of GM crops in South Africa.
- Advocacy and communication programmes and initiatives need to take account of religion – and the nature of the potential conflict between religious views and the acceptance of GM foods.
- While most of the public are not concerned with the ethics of corporations in the area of GM foods, targeted engagement with the 24% of the public that are concerned here may be required.
- Engagement about the issue of food labelling should be prioritised – South African opinion is at odds with current policy.
- The South African public, compared to the European public, is both less sceptical and less informed about GM foods (in terms of health, safety, and economic benefit). This signals an opportunity for the advocacy and communication programmes and initiatives to influence attitudes by providing accurate and relevant information and building knowledge among the various publics.
- Advocacy and communication programmes and initiatives need to engage with the disjuncture between perceived benefits for commercial and subsistence farmers.
- Advocacy and communication programmes and initiatives need to design messages about the environmental impact of GM crops that take into account the critical public view on this issue.
- However, it needs to recognised that increased knowledge may not necessarily lead to more 'positive' attitudes towards GM foods. In many developed countries, the opposite effect has been observed. More educated groups in South Africa are more critical of issues of environmental impact, labelling, and food security. This requires a clear mandate for enabling 'informed' opinions, which is distinct from cultivating 'positive' opinions.



5.4 Perceptions of medical applications of biotechnology

5.4.1 Knowledge of medical applications of biotechnology

The three knowledge constructs chosen to test knowledge about medical biotechnology were those of genetic testing to treat inherited diseases, gene therapy to treat inherited diseases, and the production of medicine using GM organisms (see Table 35). The aggregated results for the three knowledge constructs are similar, with approximately half of the sample indicating no knowledge, a quarter having heard of it, but not having much more knowledge, and 6% to 7% having substantial knowledge. These results are similar to the proportions of the public that have a basic knowledge of GM food (Table 11), suggesting that unifying factors may be at work in determining overall knowledge of these different aspects of biotechnology. For both GM food and medical biotechnology, the set of approximately 25%-30% of the public who 'have heard of it, but know very little about it' present a group that are well placed for communication and engagement interventions, and could be conceived as a priority 'target group'.

To construct an index from the three questions, they were recoded by subtracting a value of 1 from codes 1 to 3, thus changing the scale from 1-3 to 0-2. 'Don't know' values were recoded to zero (equivalent to 'no knowledge'). A Cronbach Alpha reliability test rendered a coefficient for the 3 items of 0.881, indicating that they would combine reliably into a single measure. An index was constructed by summing together the three items, creating a variable with a 0-6 scale. This was subsequently transformed into a 0-100 scale by dividing by 6 and multiplying by 100. The summary results are presented in Figure 22.

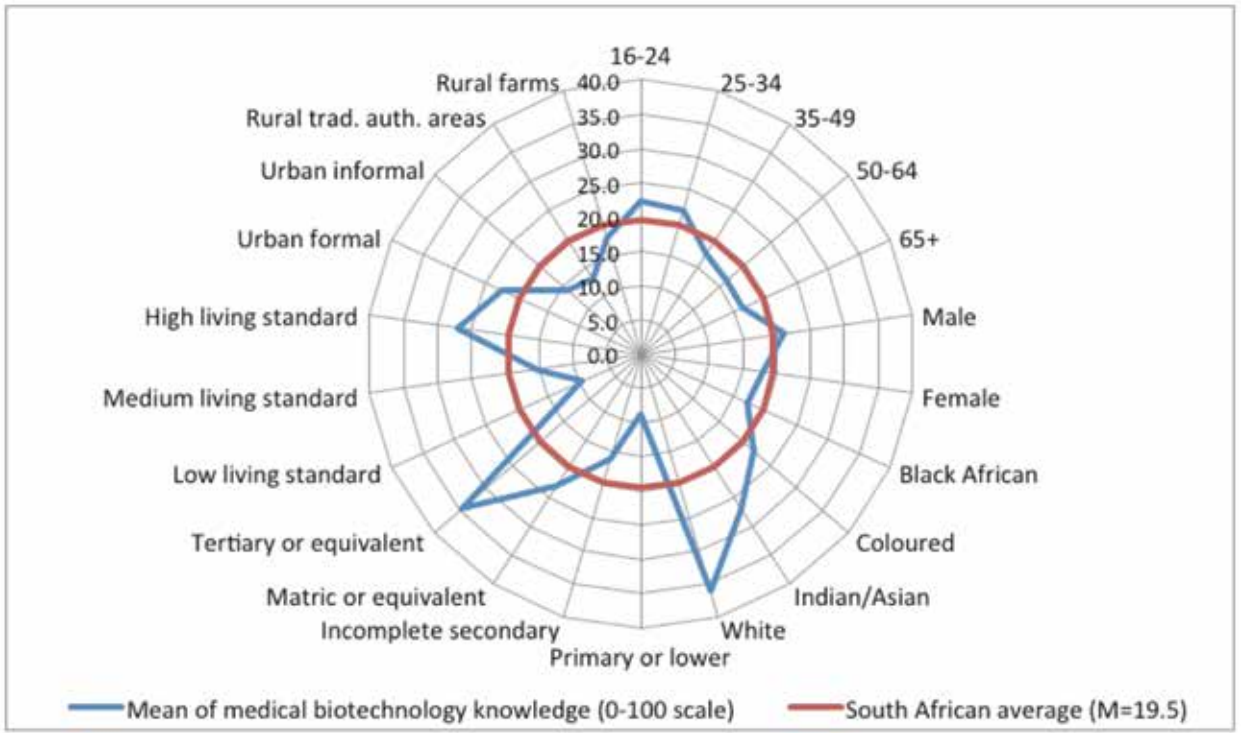
As is the case for other knowledge indicators, responses to these questions are influenced by age and privilege. Younger generations report successively greater knowledge than older generations. More educated groups, and those with higher living standards also report greater knowledge. In terms of race, White South Africans report significantly higher levels of knowledge, followed by Indian, Coloured and Black African groups.

Table 35: Knowledge of medical applications of biotechnology (%)

'Biotechnology is also used in medicine. How familiar are you with the following medical uses of biotechnology?'	Have not heard of it	Have heard of it, but know very little or nothing about it	Know enough about it to explain it to a friend	(Do not know)
Genetic testing to detect inherited diseases	49	28	7	16
Gene therapy to treat genetic conditions	52	25	7	16
Production of medicines using GM organisms	52	23	7	18

Source: South African Social Attitudes Survey (SASAS) 2015

Figure 22: Knowledge of medical biotechnology: summary demographics



Source: South African Social Attitudes Survey (SASAS) 2015

5.4.2 Attitudes towards medical applications of biotechnology

Attitudes towards medical applications of biotechnology were tested in a similar manner to ethical aspects of GM foods (see Table 22 and Table 36) to allow comparison. This shows that, on aggregate, attitudes towards the ethics of GM medicine are similar to attitudes towards GM food production. This suggests that normative judgements among the public cut across specific applications of genetic engineering, and are therefore directed at biotechnology in general. Again, 'don't know' responses were high, particularly for the question related to the ethics of the private corporations that produce medicines using biotechnology. Of those that responded to the question, a larger proportion reported that medical applications of GM are intervening in God's work (39%), compared to those that disagreed with this statement (33%). Conversely, a smaller proportion agreed that GM applications in the production of medicine is ethically wrong (26%) than disagreed (43%).

To create an overall index describing responses to these questions, they were recoded by dropping the 'don't know' values, and reversing the scaling of question 132 (related to the ethics of private corporations) so that greater values represent a more favourable view. A Cronbach Alpha reliability test rendered a coefficient for the three items of 0.574, indicating that the reliability is low if all 3 items were to be combined. However, if item 3 is dropped, then the alpha increases to 0.76. Therefore an index based on the first two items alone was constructed, and item 3 is analysed separately. To construct the final index, the first two items were averaged together, and transformed into a 0-100 scale by subtracting 1, dividing by 3, and multiplying by 100. It must however be noted that this index does not reflect the 'don't know' results, and thus does not reflect the attitudes of the entire public, but rather those that provided responses to the question.

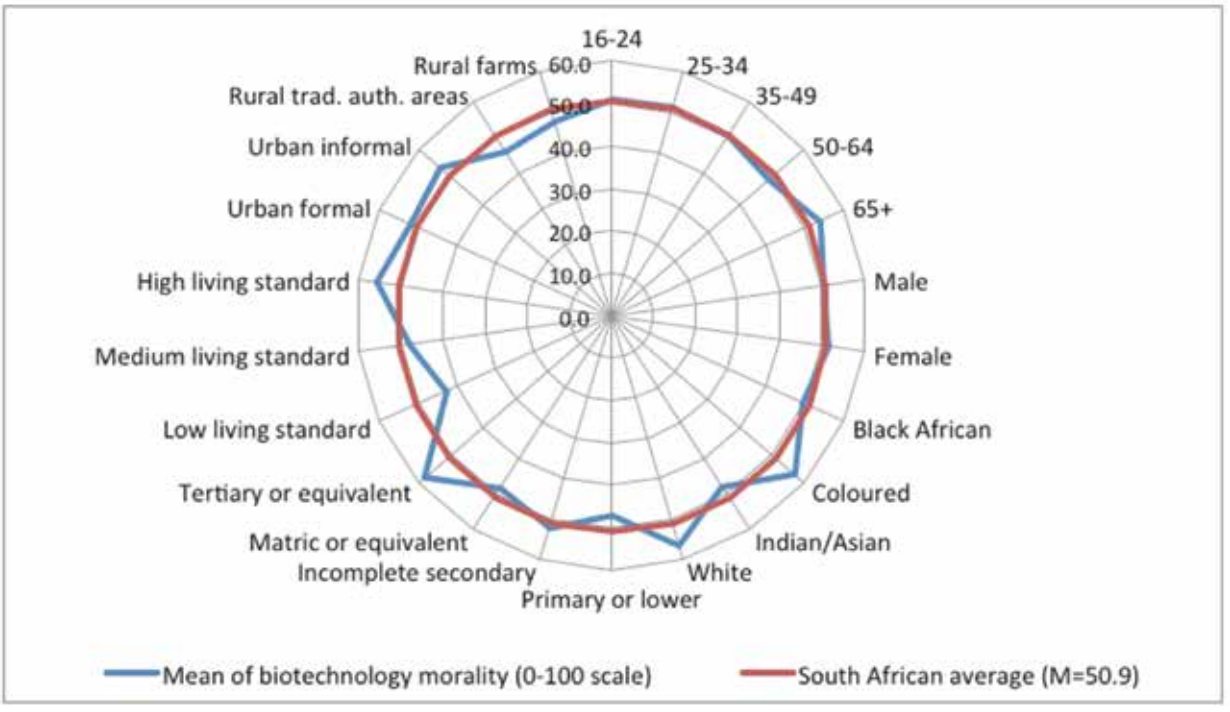
The results reflect a demographic structuring that differs somewhat to the age and privilege based structuring that characterises most public knowledge and attitudes. Age did not have a clear effect on responses. In terms of educational attainment, those with primary school or less were the most critical, with those with a tertiary education were the most positive about the ethics of GM medicine – but the groups in between were close to the mean. Similarly, higher living standard was associated with more positive views. White and Coloured groups were slightly more positive than Black African and Indian groups.

Table 36: Attitudes towards medical biotechnology (%)

	Agree	Disagree	Don't know
Using GM organisms in the production of medicine is intervening in God's work	39	33	28
Using GM organisms in the production of medicine is wrong	26	43	31
The international corporations that use biotechnology to make new medicines act in an ethical manner	38	22	41

Source: South African Social Attitudes Survey (SASAS) 2015

Figure 23: Moral and religious attitudes towards medical biotechnology: summary demographics



Source: South African Social Attitudes Survey (SASAS) 2015

Key findings: perceptions of medical biotechnology

- At an aggregated level, knowledge about medical applications of biotechnology is similar to that of GM foods: approximately half of the public have never heard of it, and only 6-7% have any substantial knowledge.
- As is the case for other knowledge indicators, greater knowledge about medical applications of biotechnology is associated with lower age and higher levels of privilege.
- Attitudes towards the ethics of GM medicine are broadly similar to attitudes towards GM food, suggesting that normative judgements among the public cut across specific applications of biotechnology.
- In the context of a high level of 'don't know' responses, the public were polarised in their views about medical biotechnology 'intervening in God's work' (39% agreed and 33% disagreed) and in their views about whether it is 'ethically wrong' (26% agreed and 43% disagreed).
- The public is largely disengaged from the issue of corporate ethics in medical biotechnology, with 41% responding 'don't know' to the related question. Only 22% of the public were concerned with the ethics of these corporations.

Implications for public engagement with biotechnology

- Due to the high level of variation in knowledge levels across demographic groups, distinct messages and communication strategies would be required for the small part of the public that have some knowledge of medical biotechnology, and for the majority, who have no knowledge at all.
- As is the case for GM foods, the 25%-30% of the public that have heard about medical applications of biotechnology, but do not have much substantial knowledge, present a group that is well placed for communication and engagement interventions, and could be conceived as a priority 'target group'.
- Communication and engagement strategies need to take religion into account, as a substantial portion of the public feel that medical biotechnology is in conflict with their religious views.
- While most of the public are not concerned with the ethics of corporations in the area of medical biotechnology, targeted engagement with the 22% of the public that are concerned here may be required.

5.5 Governance and institutions of biotechnology

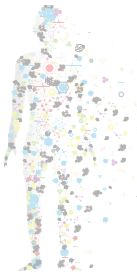
To inform public engagement and communication strategies, the PUB programme may benefit from an enhanced understanding of the trust that the public places in the social institutions that influence and govern biotechnology in South Africa. As such, respondents were asked to indicate the extent to which an array of social institutions should have an influence in the governance and regulation of biotechnology in South Africa (see Table 37). In order to summarise these data, a ranking system was established. The responses 'a great deal of influence' (3), 'a fair amount' (2), 'a little influence' (1), 'none at all' (0) and 'don't know' (0) were each assigned an index number. Aggregated results using these assigned values rendered a ranking in the data from the 'most positive' to the 'least positive'. This ranking has been used to structure Table 37.

The highest ranking was attained by commercial farmers, who received the largest proportion of responses that they should have 'a great deal of influence' in the biotechnology sector. This was followed by university scientists, and environmental groups/NGOs. The lowest rankings were held by the international corporations, the general public, the media, and religious organisations. Interestingly, the results indicate support for a broad range of influence on the governance of biotechnology. For none of the social institutions mentioned did more than 20% of the public feel that no role should be played, and for each institution the majority felt that its role should be to exert a great deal of influence or a fair amount of influence. This suggests that the public favour a mode of consensus governance in which a wide range of social actors and institutions are involved. This could inform the messaging contained in PUB communications and engagement strategies. For example, a potential message may be that governance requires the consensus of commercial farmers, university scientists, environmental groups, and South African businesses, while international corporations, the media, and religious organisations should play an auxiliary role. Such a structure would be a departure from the current political economy of biotechnology, in which international corporations are the most powerful actors, followed by government regulators.

In order to establish comparability with cognate data from international sources, a similar ranking exercise was conducted on data from the NSF (2010) data[7]. In this case, the response categories were each given an index number, 'a great deal' (2), 'some' (1), 'hardly any' (0) and 'don't know' (0). The index number was multiplied with each response (%) and the totals divided by 200, rendering an index that was used to rank the institutions from most to least favoured.

The ranked results are compared in Table 38. The two surveys were structured differently, and presented different sets of social actors in their questions. However, some comparative remarks can be made. Firstly, in the South African case the highest ranked institution was that of commercial farmers, whereas this group was not included in the NSF survey. Conversely, the military was the highest ranked in the NSF, but was not included in the South African survey. However, in both countries, scientists were ranked similarly. In South Africa they were ranked second, and in the NSF case, medical doctors were ranked second, and the 'scientific community' third.

7 The two data sets are cognate, but not identically constructed. NSF data resourced from the US General Social Survey (GSS), in which respondents are asked whether they have a "great deal of confidence, only some confidence, or hardly any confidence at all" in the leadership of various professional communities.



Environmental groups/NGOs were ranked third in South Africa, but were not included in the NSF study. The private sector was ranked higher in South Africa (4th) compared to the USA (7th), and South Africans also ranked the public sector more highly than Americans (6th in comparison to 9th and 11th). However, Americans ranked religious organisations more highly (6th in comparison to 10th). All these results illustrate the distinct structure of the South African public's perceptions of social institutions, and how these should influence the governance of biotechnology.

A separate question was included in the survey to assess public perceptions of the effectiveness of government regulation of the biotechnology sector (see Table 39). Again, this rendered a high proportion of 'don't know' responses, reflecting a public that do not feel sufficiently informed or otherwise able to respond to the question. However, on balance, a larger proportion answered positively (44%) than negatively (19%).

The demographic distribution of these responses is presented in Figure 24. Older generations were successively more critical of government regulation, as were White and Coloured groups in comparison with Black Africans. On the other hand, more educated groups were successively more positive, and living standard did not have a significant impact on responses. In terms of geographical location, those in formal urban areas were the most critical, while those in urban informal areas and on rural farms were more positive. This distribution is a departure from the patterns observed for other attitudinal indicators in the survey, suggesting that these attitudes may possibly be overlaid by attitudes towards government regulation in general.

Table 37: Governance and the institutions of biotechnology: summary (%)

The development and use of biotechnology is governed by various laws and policies. I am going to list a number of groups in society. How much influence to you think they should have in making these laws and policies?					
	A great deal of influence	A fair amount	A little influence	None at all	(Don't know)
Commercial farmers	45	23	7	7	18
University scientists	41	26	8	8	18
Environmental groups/ NGOs	39	28	5	9	18
South African businesses	38	27	9	9	18
Small scale/subsistence farmers	38	26	10	9	18
South African government	39	24	10	10	18
International corporations	29	30	12	10	20
The general public	27	29	13	12	19
Media	23	30	14	15	18
Religious organisations	20	26	17	19	18

Source: South African Social Attitudes Survey (SASAS) 2015

Table 38: Governance and the institutions of biotechnology: international comparison (%)

Institutions	SASAS 2015	NSF 2010
Commercial farmers/farmers or farm groups	1	-
University scientists/professors	2	-
Medical doctors/medicine	-	2
Scientific community	-	3
Environmental groups/NGOs	3	-
South African businesses/major companies	4	7
Small scale/subsistence farmers	5	-
South African government	6	-
Congress	-	11
Executive branch of federal government	-	9
International corporations	7	-
The general public	8	-
Media/press	9	12
Television	-	10
Religious organisations/organised religion	10	6
Military	-	1
U.S Supreme Court	-	4
Education	-	5
Organised labour	-	8
Banks and financial institutions	-	11

Source: South African Social Attitudes Survey (SASAS) 2015 and National Science Foundation (NSF) 2010

Table 39: Perceived effectiveness of government regulation (%)

Do you think that GM foods are effectively regulated by the government in South Africa?	Yes	No	(Don't know)
	44	19	38

Source: South African Social Attitudes Survey (SASAS) 2015

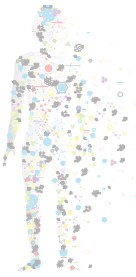
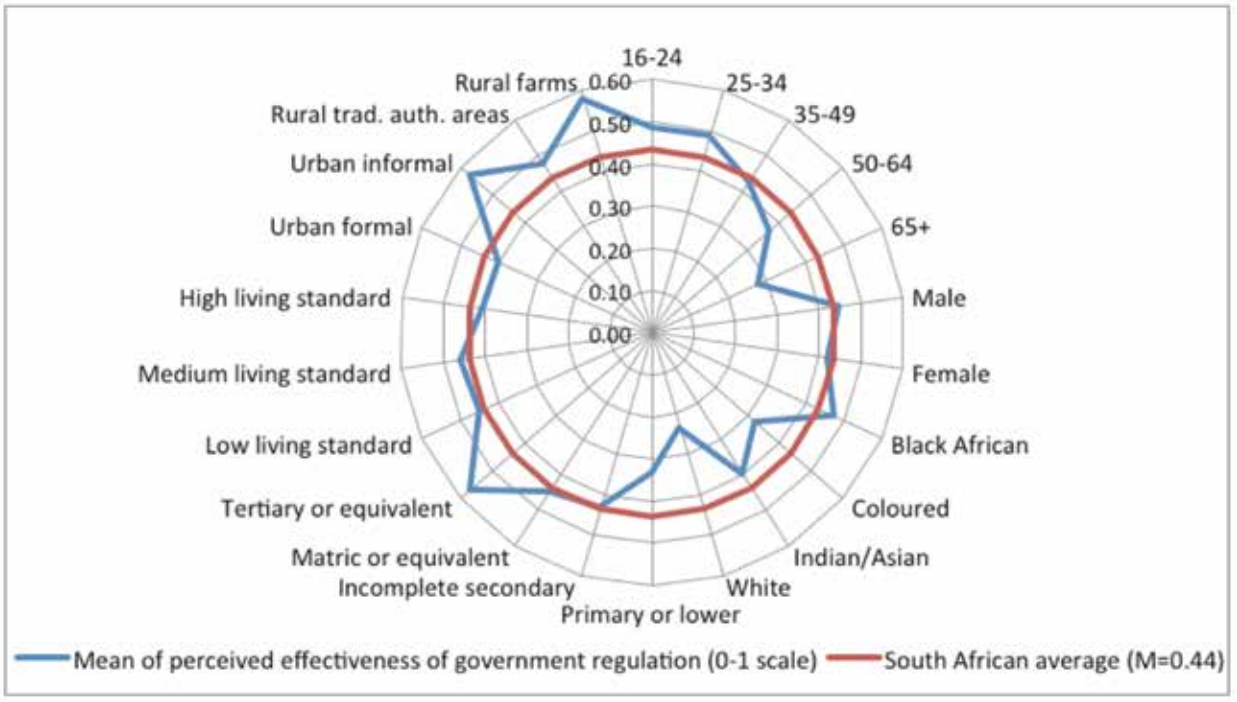


Figure 24: Perceived effectiveness of government regulation: demographics



Source: South African Social Attitudes Survey (SASAS) 2015

Key findings: governance and institutions of biotechnology

- The public feel that the governance of biotechnology should be most strongly influenced by commercial farmers, university scientists, and environmental groups/NGOs. The least favoured institutions for this purpose are seen to be international corporations, the general public, the media, and religious organisations.
- However, the public appear to favour a mode of 'consensus governance', in which all the main stakeholders play a role in governance.

Implications for public engagement with biotechnology

- Advocacy and communication programmes and initiatives may wish to frame messages about the governance of biotechnology in terms of the consensus required to make decisions and determine policy.
- There is a need to reconcile the desired political economy of the public, which favours commercial farmers, academics, and environmental groups, with the current political economy of biotechnology, which is dominated by international corporations and public regulators. This disjuncture may serve to alienate sections of the public if the engagement is not sufficiently constructive and independent.

5.6 Biotechnology and Indigenous Knowledge Systems

The assessment of public perceptions of biotechnology in the context of IKS draws on the broader definition of biotechnology, namely "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use" (US Convention on Biological Diversity, http://www.cbd.int/). In this sense, many of the productive activities in South African society that rely on IKS can also be seen as instances of biotechnology application.

Substantial proportions of South Africans use such biotechnology (see Table 40). To more or less equal degrees, the majority of South Africans have at some point used traditional medicines, made food products using biological processes, and engaged in traditional farming practices. This broad-based use of biotechnology has the potential to play an important part in the science communication and engagement efforts of the PUB programme. The data illustrate that most South Africans are active in the bio-economy, and this makes South Africa distinct from developed-country comparators such as the EU and USA. It also suggests that IKS-based biotech may be a useful entry point for introducing the broader South African public to concepts of biotechnology, since it is already commonly used in daily life. This accessibility is also underscored by the comparatively low levels of 'don't know' responses, which for IKS-related questions varied from 4% to 5%, whereas for other knowledge-based questions, levels of awareness and response were considerably lower, with 'don't know' responses generally ranging from 20% to 40%.

The demographic analysis yields few surprises, but serves to better define the public which may be accessed in such a manner. The use of IKS-based biotechnology is proportionally far higher among Black Africans living in rural areas and urban informal areas, particularly those with low living standards and levels of education. Interestingly, age and gender do not have a significant impact here.

Table 40: Biotechnology and Indigenous Knowledge Systems (%)

How often have you engaged in the following traditional practices?	Often	Sometimes	A few times	Rarely	Never	(Do not know)
Using traditional medicines (such as wild herbs)	12	24	11	11	37	5
Making food that uses biological processes (such as brewing traditional beer or processing sour milk)	11	21	12	10	42	5
Traditional farming practices (such as growing crops using the traditional knowledge of your community)	12	17	9	9	47	6

Source: South African Social Attitudes Survey (SASAS) 2015

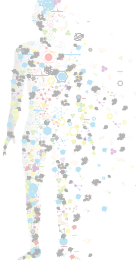
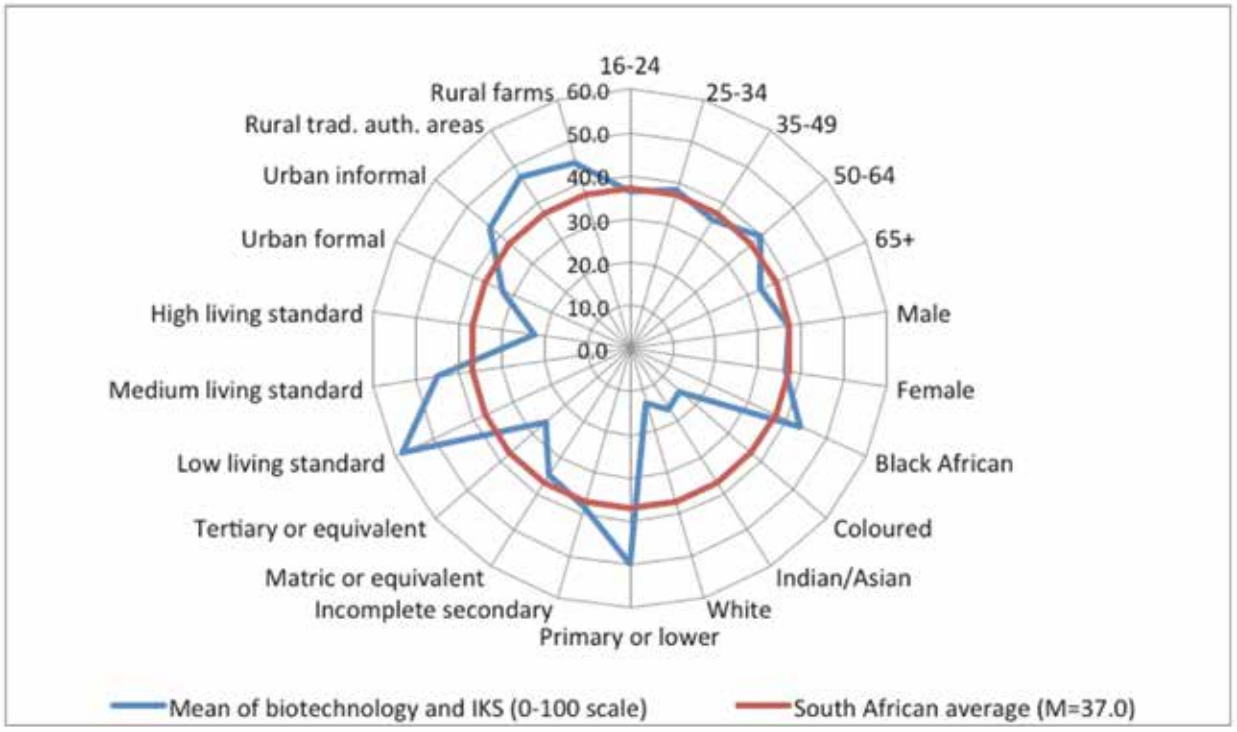


Figure 25: Biotechnology and Indigenous Knowledge Systems: summary demographics



Source: South African Social Attitudes Survey (SASAS) 2015

Key findings: biotechnology and indigenous knowledge systems

- Most South Africans have used biotechnology in the context of indigenous knowledge systems and practices. South Africans have a far greater understanding of biotechnology related traditional practices and knowledge bases than they do of biotechnology in the narrower sense.

Implications for public engagement with biotechnology

- High levels of awareness and usage in daily life position IKS-based biotechnology as an ideal platform for engagement with the majority of the South African population. Groups with low incomes and low levels of education may find it difficult to engage with concepts of mainstream biotechnology, but harbour rich traditions of knowledge and practice of IKS that may be successfully leveraged to build greater awareness of biotechnology in the more modern sense.

5.7 Awareness of the PUB programme

The PUB survey included a question about awareness of the PUB programme. This rendered unexpectedly high results (see Table 41), with 12% of the public reporting that they had heard 'quite a bit' or 'a lot' about the programme. It may be the case that participants were overestimating their knowledge in this instance. Several factors may be underlying this: (i) the question is positioned approximately a third of the way through the module, and after a read out description of key biotechnology related terms. This may have influenced reporting on the PUB programme (i.e. recognition of the term 'biotech'). There may also be an influence of name recognition of the Department of Science and Technology, rather than the PUB programme itself. Finally, there is the possibility of responding in line with social desirability – and actively trying to avoid seeming unaware about the programme. In such cases those reporting 'a little' knowledge of the programme may not really know it at all.

These effects can be assessed by overlaying the data for subjective knowledge of biotechnology with knowledge of the PUB programme using a ranked line graph, in order to provide a sense of who possibly is overestimating their familiarity with the programme. From the subjective graph below (Figure 26), we can infer that those who described themselves as 'not at all knowledgeable', 'not very knowledge' and even

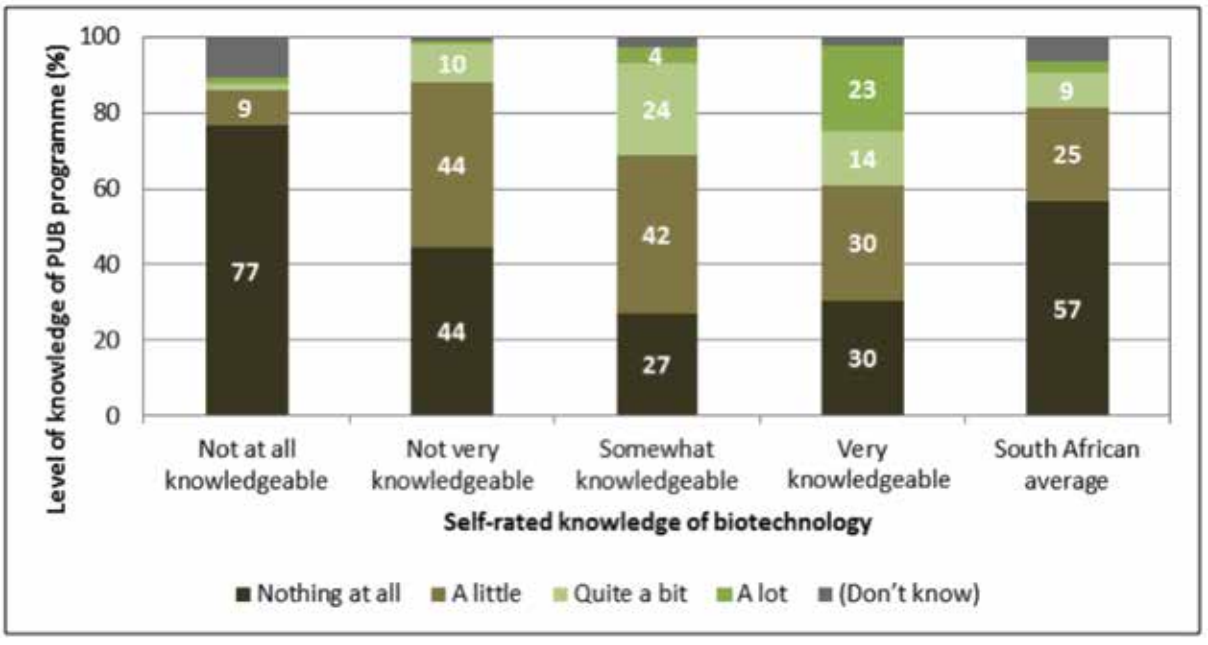
'somewhat knowledgeable' are overestimating their knowledge about the PUB programme, since without a meaningful understanding of biotechnology, it is unlikely that individuals can gain familiarity with the PUB programme. These groups represent the large majority of the South African public, and results need to be interpreted accordingly.

Table 41: Awareness of the PUB programme (%)

How much have you heard about the Public Understanding of Biotechnology programme of South Africa's Department of Science and Technology?	Nothing at all	57
	A little	25
	Quite a bit	9
	A lot	3
	(Don't know)	7

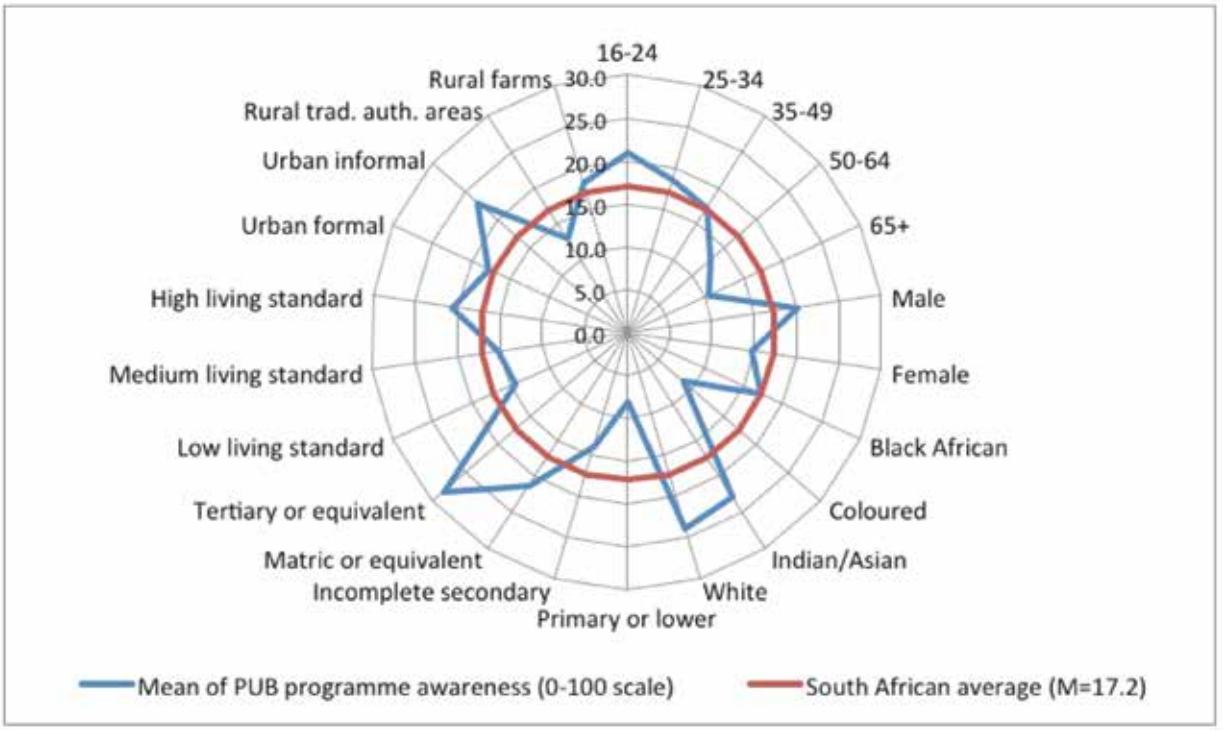
Source: South African Social Attitudes Survey (SASAS) 2015

Figure 26: Knowledge of PUB programme by subjective knowledge (%)



Source: South African Social Attitudes Survey (SASAS) 2015

Figure 27: Awareness of the PUB programme: demographics



Source: South African Social Attitudes Survey (SASAS) 2015

Key findings: awareness of the PUB programme

- Survey data indicate a relatively high level of public awareness of the PUB programme. However, these data require further interrogation in terms of the knowledge base that would be required to have an accurate understanding of the PUB.

Implications for public engagement with biotechnology

- It is possible that the PUB programme has achieved greater public awareness than previously recognised. However, the challenge remains to generate more customised data to identify the extent to which the knowledge base of the public allows for meaningful understanding of the PUB programme and its purpose.

5.8 Sources of information about biotechnology

Understanding the public's sources of information about biotechnology forms a key component of research to inform communication and engagement strategies. Respondents were asked to indicate the extent to which selected sources of information they might use to learn about biotechnology. It must be noted that these questions are not backward looking – they do not ask what sources have been or currently are being used. As such, the responses are to some degree hypothetical: indicating which channels would be used if such an information search were to be undertaken. For example, 45% of the public would be 'very likely' or 'somewhat likely' to visit a science centre to learn about biotechnology: the data do not suggest that this group has in fact visited science centres, rather that these would be a chosen route for obtaining information.

The summary results are presented in Table 42. This shows that, on aggregate, television and radio are the most popular sources of information. Moreover, the overall ranking of sources of information has remained relatively stable over time (see Table 43). In order to rank the results, responses to the 2015 survey were weighted by assigning values to 'very likely' (3), 'somewhat likely' (2), 'not very likely' (1), 'not likely at all' (0) and 'don't know' (0). The responses were then weighted and the totals divided by 200. The resultant figures were used to rank the overall relative preference for each source of information. The ranked responses from the SASAS 2015 were then compared against the ranked list of SASAS 2004. The latter was drawn directly from the SASAS

2004 results, which requested that respondents select the source they were most likely to use to obtain information about biotechnology. Only one response was allowed. This shows that the overall ranking of the four most commonly used sources of information has not changed.

However, the use of these channels varies considerably across demographic groups (Figure 28 to Figure 33). Figure 28 reveals the differences across age groups. For each channel, younger age cohorts were successively more likely to use each source of information, with the exception of radio. This trend is particularly pronounced for the use of the internet, and school/college. This again underscores age as a key determinant, not only of knowledge and attitudes, but also of the use of sources of information.

Gender differences are illustrated in Figure 29, showing that males are somewhat more likely to access each of the sources, with exception of friends or family. However, these differences are relatively minor, and not of statistical significance. In terms of race, each racial group exhibited a distinct pattern of information resource use. Black Africans were more likely than other groups to use television and radio, as well as school/college and science centres. Indians were the most likely to use the internet and print media. Whites were the least likely to use television, radio, or print media, but reported a higher use of the internet than Black African or Coloured groups.

More distinct trends emerge in relation to educational attainment and living standard. The use of the internet increased sharply in line with educational attainment and increased living standard, as did the use of print media. By contrast, the use of the radio decreased with higher educational attainment, with the exception of those with primary or no schooling. The use of television increased with higher educational attainment, except for those with tertiary education, for whom this figure dropped slightly. Similarly, higher levels of living standard were associated with higher levels of access to the print media and the internet. For the use of television, radio, school/college, and friends or family, usage was highest for the medium living standard group, indicating that, on the one hand, these are not the preferred sources of information for high living standard groups, while lower living standard groups may have greater difficulty accessing these sources.

The differences across geographical location show that those living on rural farms have significantly lower usage of all sources of information – indicating the challenge that exists in reaching this group. Since these are also important stakeholders in the area of GM crops, these findings identify a key challenge for the PUB programme. Across all the sources of information, with the exception of school/college, those living in urban informal areas indicated the greatest use of media channels. This highlights an opportunity for the PUB programme, showing that those who live in disadvantaged urban areas nonetheless are active media citizens.

Table 42: Sources of information (%)

If you wanted to learn more about biotechnology, how likely would you be to get your information from the following sources?	Very likely	Somewhat likely	Not very likely	Not likely at all	(Do not know)
TV	51	21	12	12	4
Radio	35	25	17	18	5
Print media (books, newspapers, and magazines)	27	29	19	20	5
Internet	34	20	12	29	5
School or college	26	20	15	34	5
Science centre	29	16	14	36	6
Friends or family	23	23	19	30	5

Source: South African Social Attitudes Survey (SASAS) 2015

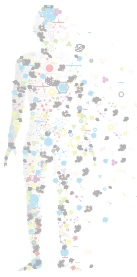
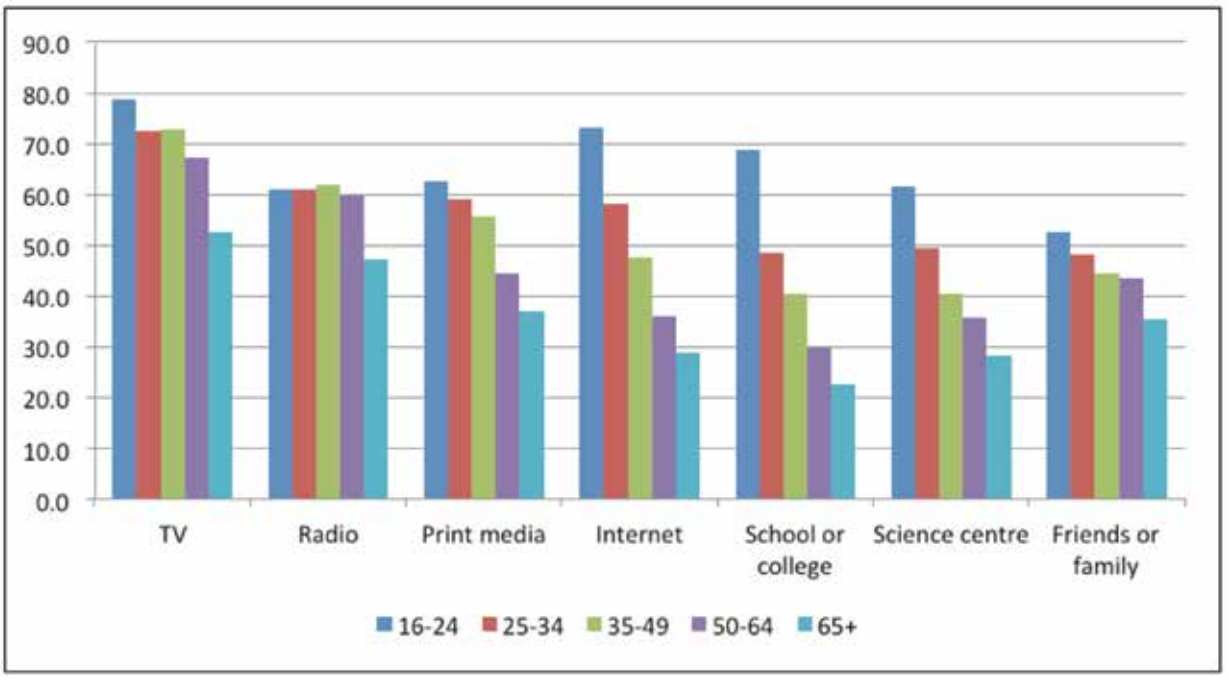


Table 43: Sources of information: change over time (%)

	Channels	SASAS 2004 ranking	SASAS 2015 ranking (using index)
Sources of information	TV	1	1
	Radio	2	2
	Print media	3	3
	Internet	4	4
	Friends or family	-	5
	School or college	-	6
	Science centre	-	7

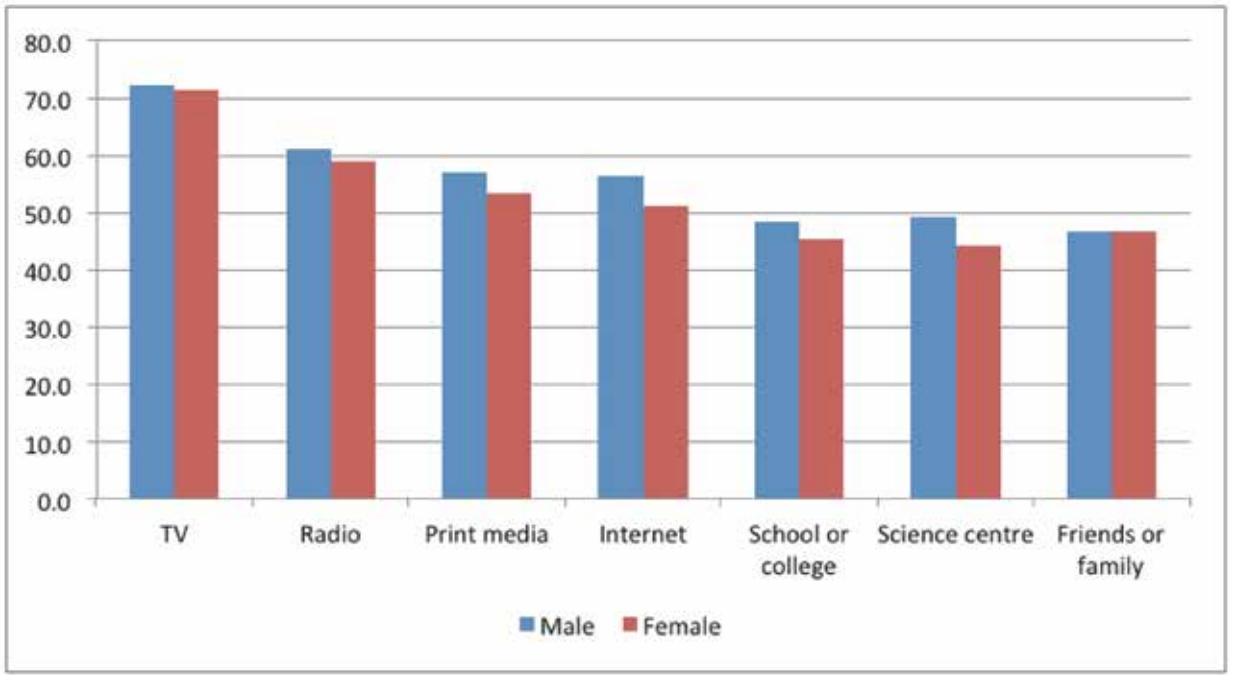
Source: South African Social Attitudes Survey (SASAS) 2004 and 2015

Figure 28: Sources of information by age group (%)



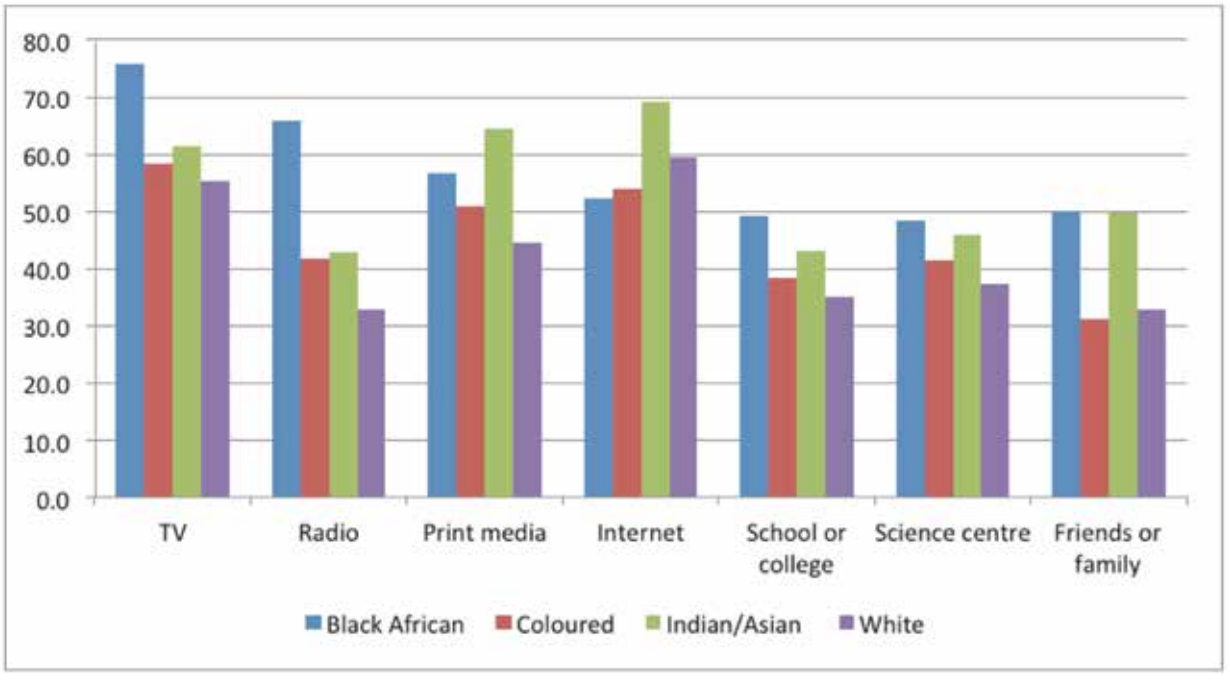
Source: South African Social Attitudes Survey (SASAS) 2015

Figure 29: Sources of information by sex (%)



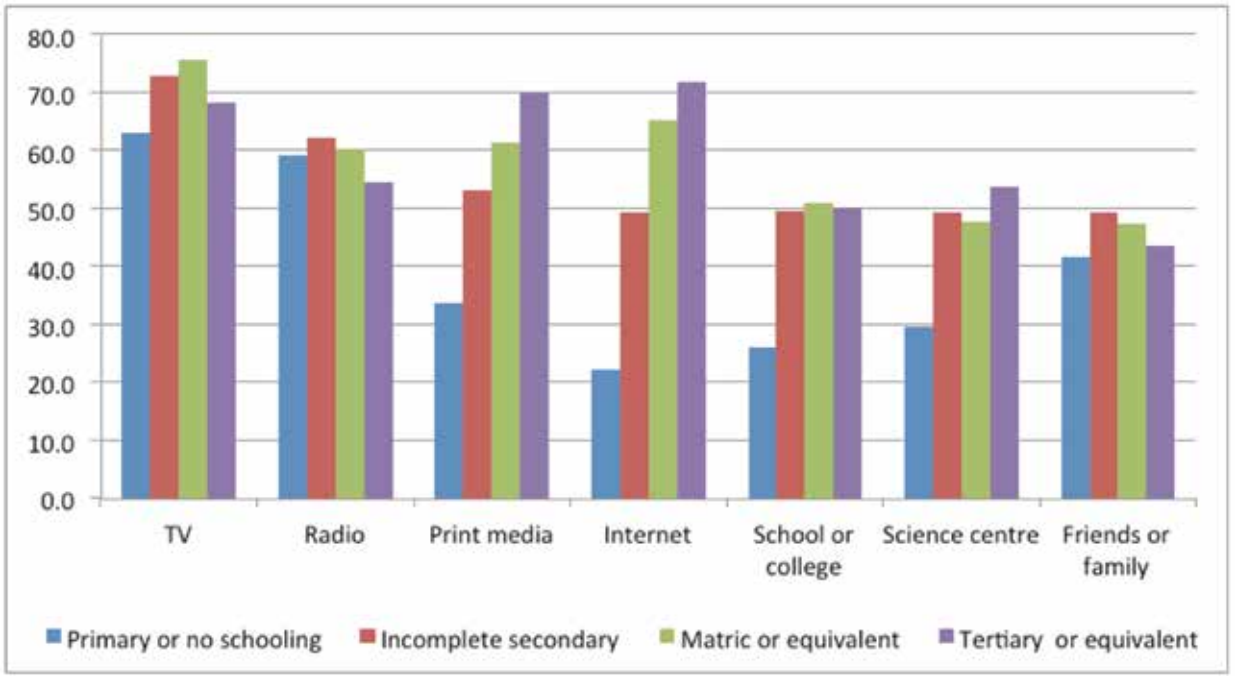
Source: South African Social Attitudes Survey (SASAS) 2015

Figure 30: Sources of information by population group (%)



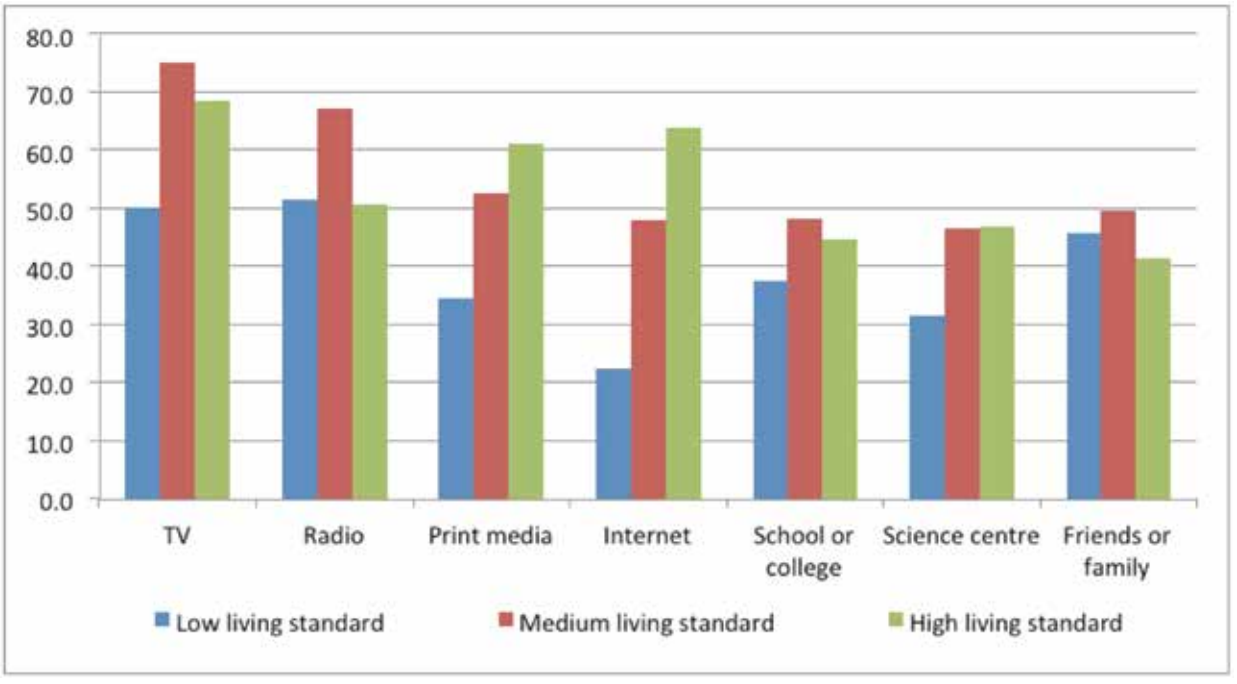
Source: South African Social Attitudes Survey (SASAS) 2015

Figure 31: Sources of information by educational attainment (%)



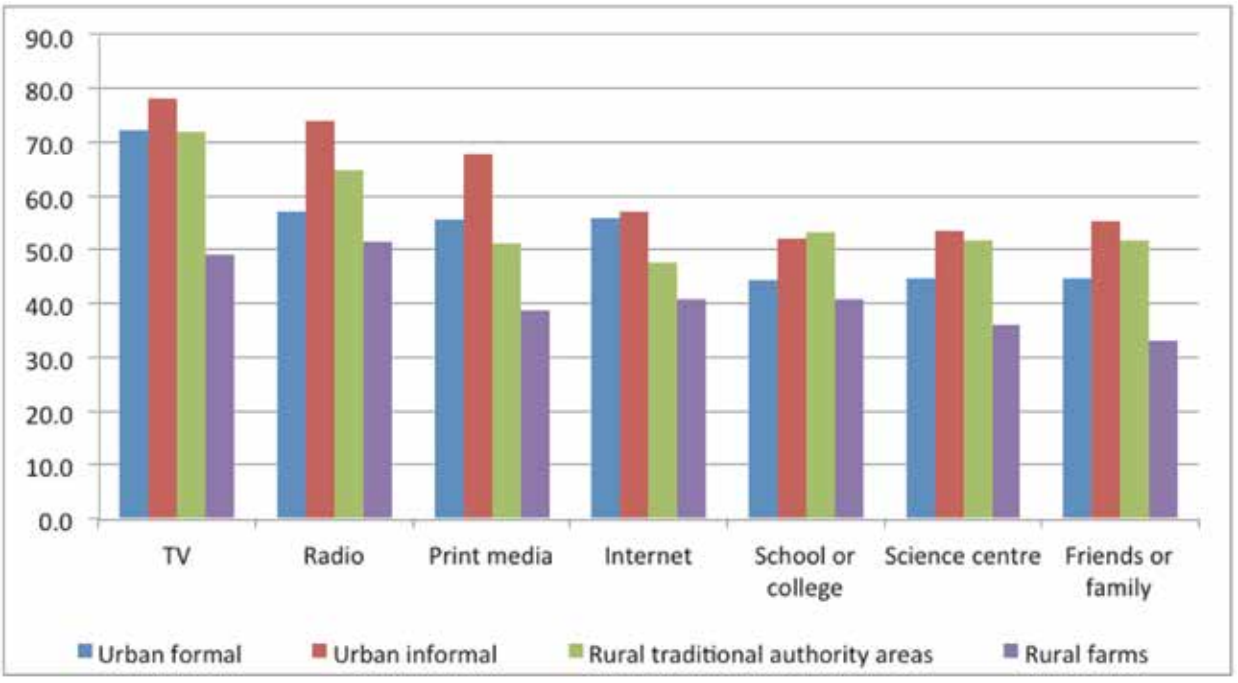
Source: South African Social Attitudes Survey (SASAS) 2015

Figure 32: Sources of information by living standard (%)



Source: South African Social Attitudes Survey (SASAS) 2015

Figure 33: Sources of information by geographic location (%)



Source: South African Social Attitudes Survey (SASAS) 2015

Key findings: sources of information about biotechnology

- On aggregate, radio and television are the most popular sources of information about biotechnology.
- Younger age cohorts are more likely to use all sources of information, except for radio. Younger generations are far more likely than older generations to use the internet to obtain information.
- More educated groups and those with higher living standards are more likely to use the internet and print media, and less likely to use the radio.
- Those living on rural farms are significantly less likely to use any of the media channels to obtain information about biotechnology.
- Those living in urban informal areas indicated a higher propensity to use each of the media channels that those living in other geographical contexts.

Implications for public engagement with biotechnology

- An understanding of which groups hold particular knowledge and views of biotechnology needs to be integrated with an understanding of which media channels each group is more likely to use, thus making it possible to strategically target specific groups with specific messages, delivered through specific channels, on a basis that is informed by evidence.
- Reaching those living in rural areas is a key challenge for the PUB programme, in that limited access to information must be overcome.
- Since disadvantaged groups in urban areas have considerably greater propensity to access sources of information, they represent a public that is ready for increased engagement.

5.9 General risk/benefit assessment of biotechnology

A summative question, positioned at the end of the fieldwork instrument, provides a useful anchor for framing the overall public perception of biotechnology. This asked whether biotechnology was generally seen more as a benefit or more as a risk (Table 44). The results again reveal that only about half of the South African public are engaged with the question, with 47% responding with indifference or a 'don't know' response. Of the remaining 53%, there was a slightly larger proportion that saw biotechnology more as a benefit.

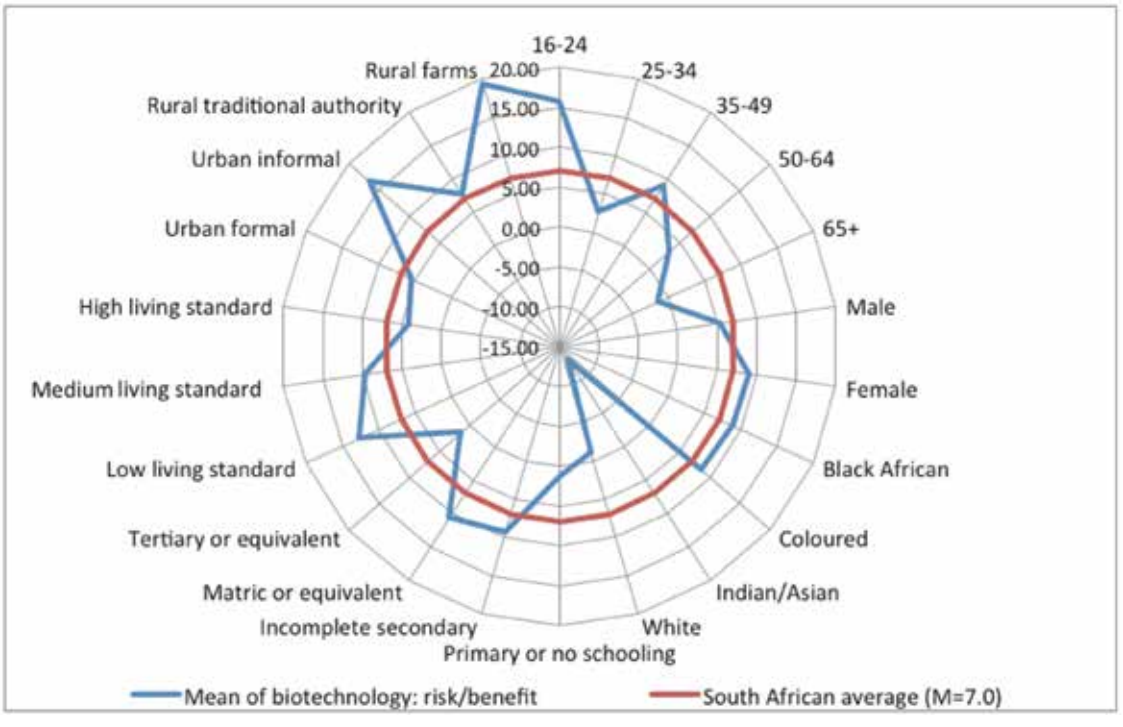
However, these views vary greatly among demographic groups. To calculate an index for these data, responses of 'more of a benefit' were given a +1 weighting, and 'more as a risk' a -1 weighting. The means derived from these weightings were then used to create Figure 34. This reveals some demographic outliers: Indian South Africans were relatively negative, and significantly more likely than any other demographic group to see biotechnology as a risk. White South Africans were also more likely to have this view in comparison to Black African and Coloured groups. Older generations of South Africans were successively more likely to see biotechnology as a risk, with the exception of the 35-49 years old group, who were more positive. Increased education attainment was also associated with a more positive risk/benefit assessment, with the exception of those with tertiary education, where this pattern was reversed; this group reported the lowest index score, and hence most likely to see biotechnology as a risk. This again highlights that knowledge and education do not have a linear relationship with attitudes towards biotechnology, including the overall risk/benefit assessment. In terms of living standard, higher living standard was associated with increased likelihood to view biotechnology as a risk. Finally, in terms of geographical location, those living on rural farms and in urban informal areas were substantially more positive in their assessments.

Table 44: Overall risk/benefit assessment of biotechnology (%)

Taking into account all that you know about this topic and thinking about you and your family, do you see biotechnology more as a benefit or more as a risk?	More as a benefit	30
	More as a risk	23
	Neither/indifferent	25
	(Do not know)	22

Source: South African Social Attitudes Survey (SASAS) 2015

Figure 34: General attitudes towards biotechnology: demographics



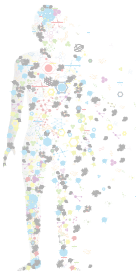
Source: South African Social Attitudes Survey (SASAS) 2015

Key findings: risk/benefit assessment of biotechnology

- Only about half of the public engaged with the question of a general risk/benefit analysis of biotechnology, registering indifference or a 'don't know' response.
- White and Indian South Africans were more likely to see biotechnology as an overall risk to society compared to Black African and Coloured groups.
- Increased educational attainment was associated with a more positive risk/benefit assessment, with the exception of those with tertiary education, where this pattern was strongly reversed, and the most highly educated group were most likely to see biotechnology as a risk
- Higher living standard was associated with increased likelihood to view biotechnology as a risk.
- Those living on rural farms and in urban informal areas were substantially more positive in their assessments.

Implications for public engagement with biotechnology

- The fact that most South Africans do not feel themselves to be in a position to assess the risks and benefits of biotechnology signals an opportunity for advocacy and communication initiatives to engage with citizens to enable them to establish informed opinions.
- Knowledge and education do not have a linear relationship with risk/benefit assessments of biotechnology, and this needs to be taken into account by advocacy and communication initiatives. The most educated and economically well-off groups, holding the highest levels of knowledge, are also the most critical, and the most likely to see biotechnology as a risky technology. These groups therefore require a distinct and focused engagement and communication strategy. Again, such engagement should have as its objective the constructive participation of the public, rather aiming an outcome of 'positive' attitudes towards all aspects of biotechnology.



6. MULTIVARIATE ANALYSIS

In this section of the report we present select results from a multivariate analysis that explores the SASAS data using more sophisticated statistical tools. This aims to complement the descriptive univariate and bivariate analyses by deepening the quantitative basis of the overall findings, by further exploring the core analytical themes, and by undertaking more detailed analysis of key findings.

Eight sets of modelling were undertaken in order to examine the relative strength of different predictors on the following conceptual constructs that constitute the main themes for analysis:

- Self-rated (subjective) knowledge of biotechnology;
- 'Objective' evaluations of biotechnology knowledge;
- Knowledge of genetically modified food;
- Views on the role of health, cost and environmental factors in encouraging the purchasing of GM food;
- The perceived effectiveness of government's regulation of GM food;
- Knowledge of medical biotechnology;
- Support for the view that GM food provides more benefits than risks to society;
- The overall evaluation of the benefits and risks of biotechnology.

The regression analysis is complicated by the nature of the dependent variables involved, as well as differential patterns of item non-response across both dependent and independent variables. This ultimately informed the choice of methods employed, as well as the manner in which variables were combined or recoded. An outline of the measures is presented in Appendix D: Indicators used for multivariate modelling.

6.1.1 Subjective knowledge of biotechnology

The first of the models presented relates to the single-item self-rated knowledge of biotechnology variable included in the module. The explicit phrasing of the question is, "Overall, would you say that you are very knowledgeable, somewhat knowledgeable, not very knowledgeable or not at all knowledgeable about biotechnology?" Given that the data corresponding to this dependent variable are ordinal in character, ranging from low to high stocks of perceived knowledge, the preferred multivariate method that will be employed is an ordered logistic regression model. This multivariate method is specifically designed for analysing ordered categorical variables, thereby allowing one to determine the probability of choosing one outcome category on an ordered variable over the probability of choosing another. For analytical purpose, the four-point scale has been reversed, so that higher values represent more knowledge, and 'do not know' responses were combined with those answering 'not at all knowledgeable'. Table 45 shows the coefficients and odds ratios from the ordered logistic regression model, which estimates the association between the dependent and individual characteristics and attitudes. There are two models in the table, the first of which is a base model containing only basic socio-demographic variables. The second model introduces three knowledge variables, namely knowledge of genetically modified food, medical biotechnology and the Department of Science and Technology's PUB programme. In addition, two variables capturing attitudes towards science more generally are included, the first addressing level of agreement with the statement that "we depend too much on science and not enough on faith" and the second level's agreement with the view that "it is not important for me to know about science in my daily life". In the modelling, these two promise-reservation items are scaled so that higher values represent a pro-science perspective.

Table 45: Ordered logistic regression predicting subjective knowledge of biotechnology

	Model I			Model II		
	Coeff.	Odds Ratio	Sig.	Coeff.	Odds Ratio	Sig.
Female (ref. = male)	-0.20	0.82		-0.06	0.94	
Age	0.00	1.00		0.00	1.00	
Age^2	0.00	1.00		0.00		
Population group (ref. = black African)						
Coloured	-0.34	0.71		0.06	1.06	
Indian/Asian	0.55	1.73	*	0.55	1.73	*
White	0.26	1.29		0.02	1.02	
Education (ref. = primary/no schooling)						
Incomplete secondary	0.58	1.79	**	0.44	1.55	*
Matric	1.10	3.00	***	0.73	2.07	**
Tertiary	2.01	7.50	***	1.25	3.49	***
Subjective poverty status (ref. = poor)						
Non-poor	0.86	2.36	***	0.57	1.77	**
Just getting by	0.47	1.60	**	0.25	1.29	
Religiosity (Ref. highly religious 8-10)						
Not very religious (0-4)	0.03	1.03		-0.07	0.93	
Moderately religious (5-7)	-0.20	0.82		-0.14	0.87	
Geographic type (ref. = trad. auth. area)						
Urban formal	0.27	1.31		0.05	1.06	
Urban informal	0.59	1.81		0.27	1.30	
Rural farms	0.26	1.29		-0.16	0.85	
Disagree that we over-rely on science	…	…		0.00	1.00	
Importance of science in daily life	…	…		0.03	1.03	
Knowledge of GM food	…	…		0.02	1.02	***
Knowledge of medical biotechnology	…	…		0.27	1.31	***
Knowledge of PUB programme	…	…		0.93	2.53	***
Number of obs.	2 852			2 476		
/cut1	1.05			3.05		
/cut2	2.13			4.49		
/cut3	4.45			7.32		

Source: South African Social Attitudes Survey (SASAS) 2015

*Notes: 1. Data is weighted to be nationally representative of the adult South Africans. 2. A positive coefficient indicates a higher level of subjective knowledge about biotechnology 3. The regression model controlled for an individual's province of residence. 4. Significance is reported as follows: * p<0.05; **p<0.01; ***p<0.001.*

From Model I, it is apparent that sex, age, religiosity and geographic location are not statistically significant predictors of self-assessed knowledge of biotechnology. There is also little sign of population group differences, with only Indian adults emerging as more likely to report higher knowledge scores than Black African adults. As one might anticipate, there is a distinct relationship between educational attainment and reported knowledge. Having a better education substantially increases the log odds of having a high level of subjective knowledge about biotechnology. If an individual is a tertiary-educated, for example, we discern a 2.01 increase in the log odds relative to having primary or no formal education, holding constant all other variables in the model. Economic status also seems to play a statistically significant role in predicting knowledge of biotechnology in South Africa. Using a subjective measure of economic status, the non-poor were found to be significantly more likely to report greater knowledge of biotechnology. It may be that wealthy individuals are more exposed to information concerning biotechnology because their media consumption habits are so different from the poor or those who are just getting by.

In Model II, it is evident that, even after controlling for attitudes towards science and levels of knowledge of GM food, medical biotechnology and the PUB programme, educational attainment remains a significant predictor of subjective knowledge of biotechnology. The size of the observed associations for the different educational categories does however decline somewhat between Models I and II, though the general pattern remains unchanged. All three of the knowledge indicators were found to be significantly associated with subjective knowledge of biotechnology. A one-unit increase in the knowledge of GM food measure increases log odds of self-rated knowledge of biotechnology by 0.02. Knowledge of medical biotechnology has a considerably stronger association with the dependent variable. For a one-unit increase in this indicator, the log odds of self-rated biotechnology knowledge increase by 0.27, which is an appreciably higher ratio than for knowledge of GM food. Of the three knowledge variables included as independent variables in Model II, knowledge of the PUB programme has the largest influence on self-rated biotechnology knowledge. A one-unit increment in this indicator raises the log odds in the dependent variable by 0.93 – a considerably higher ratio than any other knowledge indicator in Model II, and the second largest effect overall after being tertiary educated. The two general attitudes to science measures both failed to achieve statistical significance, suggesting that views on the promise versus reservation attached to science do not exert much influence on the evaluations of the South African public of their own level of biotechnology awareness, controlling for other variables in the model. Similarly, sex, age, population group, religiosity and geographic location continue to be insignificant predictors, other factors being held constant. In sum, while there are apparent points of convergence between the determinants of both subjective and objective knowledge, especially in relation to the robust class (especially educational) and domain specific knowledge effects present in both sets of modelling, the most prominent discrepancy lies in the significance of sex and race in driving levels of knowledge of biotechnology based on more objective evaluations.

Multivariate Key lessons: Subjective Knowledge of Biotechnology

Key trends and findings

- Educational status seems to play a statistically significant role in predicting self-rated knowledge of biotechnology in South Africa.
- Wealthier individuals report significantly higher levels of knowledge about biotechnology than poorer individuals. This may possibly be attributable to socio-economic differences in media consumption patterns.
- Knowledge of the PUB programme was strongly associated with self-rated biotechnology knowledge. Those who were knowledgeable about the programme tended on average to report higher levels of knowledge about biotechnology.
- Knowledge of the medical applications of biotechnology and GM food are also positively associated with overall knowledge of biotechnology.
- Age, race, religiosity and geographic location were *not* statistically significant predictors of self-assessed knowledge of biotechnology.

Implications for public engagement with biotechnology

- The data suggest that continuing efforts to promote the PUB programme will have the desired effect of promoting a general awareness and understanding of biotechnology.
- There is, however, considerable science communication work yet to be done to further improve basic levels of knowledge of biotechnology, especially if one recognises that only 27% reported that they were somewhat or very knowledgeable about biotechnology.
- Given the educational gradient underlying knowledge, continued efforts to ensure exposure to scientific concepts such as biotechnology at secondary schools and tertiary institutions remains an important priority.

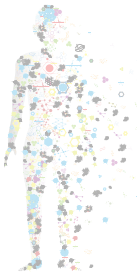
6.1.2 Objective knowledge of biotechnology

In a similar manner to the modelling of subjective evaluations of knowledge about biotechnology, there is also an interest in better understanding the correlates of more 'objective' measures of such knowledge and whether the predictors remain relatively consistent irrespective of whether subjective or objective indicators are employed. The objective measure used as the dependent variable for this analysis is the index that was constructed based on five questions concerning the level of familiarity with the terms DNA, genes, biotechnology, genetic modification and GM food. Three pre-coded responses were provided to respondents, namely 'have not heard of it', 'have heard of it, but know little or nothing about it' and 'know enough about it to explain it to a friend'. To create an objective knowledge index, these responses were assigned values of 0, 1 and 2 respectively, while 'do not know' responses were also assigned a value of zero, thus effectively combining these responses with those answering 'have not heard about it'. An additive scale was constructed based on the five items, ranging between a 0 (no knowledge) and 10 (maximum knowledge). The resulting index achieves good levels of reliability, with a Cronbach alpha coefficient for the five items of 0.8788, and no indicators suggested for exclusion.

Given the ordinal nature of the objective knowledge index, use is again made of an ordered logistic regression model. Table 46 shows the coefficients and standard errors from the ordered logistic regression logit model and from these we can assess the relationships between the dependent and individual characteristics and attitudes. The structuring of the models is identical to the subjective knowledge analysis, with a base model firstly presented that contains basic socio-demographic variables, followed by a second model that rotates in three knowledge indicators (GM food, medical biotechnology, and the PUB programme) and the two attitudes towards science variables.

Table 46: Ordered logistic regression predicting objective knowledge of biotechnology

	Model I			Model II		
	Coeff.	Odds Ratio	Sig.	Coeff.	Odds Ratio	Sig.
Female (ref. male)	-0.38	0.69	***	-0.36	0.70	***
Age	-0.02	0.98		-0.01	0.99	
Age^2	0.00	1.00		0.00	1.00	
Population group (ref. black African)						
Coloured	0.65	1.92	***	0.84	2.32	***
Indian/Asian	0.60	1.82	*	0.48	1.61	
White	0.69	1.99	*	0.44	1.55	



	Model I			Model II		
	Coeff.	Odds Ratio	Sig.	Coeff.	Odds Ratio	Sig.
Educational (ref. primary/no schooling)						
Incomplete secondary	0.65	1.92	***	0.55	1.74	**
Matric	1.34	3.82	***	1.12	3.08	***
Tertiary	2.59	13.39	***	1.94	6.93	***
Subjective Poverty (ref. poor)						
Non-poor	0.86	2.37	***	0.72	2.05	***
Just getting by	0.28	1.32	*	0.27	1.31	
Religiosity Scale (ref. highly religious 8-10)						
Not very religious (0-4)	0.17	1.18		0.28	1.32	
Moderately religious (5-7)	0.10	1.11		0.28	1.19	
Geographic type (ref. trad. auth. area)						
Urban formal	0.43	1.54	**	0.32	1.38	
Urban informal	-0.03	0.97		-0.22	0.80	
Rural farms	0.17	1.19		0.05	1.05	
Disagree that we over-rely on science	…	…		0.01	1.01	
Importance of science in daily life	…	…		0.06	1.06	
Knowledge of GM food	…	…		0.01	1.01	***
Knowledge of medical biotechnology	…	…		0.39	1.48	***
Knowledge of PUB programme	…	…		0.35	1.41	***
Number of obs.	2845			2463		
Prob > chi^2	0.00			0.00		
Pseudo R^2	0.08			0.13		

Source: South African Social Attitudes Survey (SASAS) 2015

*Notes: 1. Data is weighted to be nationally representative of the adult South Africans. 2. A positive coefficient indicates a higher level of objective knowledge about biotechnology. 3. The regression model controlled for an individual's province of residence. 4. Significance is reported as follows: * p<0.05; **p<0.01; ***p<0.001.*

In Model 1, educational attainment again emerges as a statistically significant predictor of knowledge of biotechnology, with higher levels of education translating into the likelihood of better objective knowledge scores. Subjective evaluations of economic status also matter, with the non-poor possessing higher objective knowledge about biotechnology than the non-poor. Therefore, economic status is a notable predictor of both subjective and objective knowledge. In common with the subjective knowledge modelling, age, religiosity and geographic location are not significant determinants of levels of knowledge. By contrast, however, there are distinct sex and population group differences that were not evident in the previous modelling. In terms of gender-based variation, we find that women were generally less knowledgeable than men, based on the objective biotechnology knowledge scale, even after controlling for education, economic status and other socio-demographic attributes. Model I also reveals that coloured, Indian and white adults were also significantly more likely to exhibit higher objective knowledge scores than black African adults, even after controlling for other socio-demographic variables.

What difference does adding in other attitudinal and knowledge variables to the model make with respect to these basic patterns? While the inclusion of the other variables does not diminish the observed gender differences in objective knowledge, there is a discernible weakening in race as a predictor. Indian and white adults are no longer statistically different from black African

adults in their objective knowledge scores, though coloured adults continue to remain appreciably more knowledgeable than black African adults. This indicates that the initially observed variation among Indian and white adults was mainly attributable to differences in specific knowledge domains. The effect of educational attainment on objective knowledge ratings also weakens between Models I and II, though education remains a significant predictor overall.

As anticipated, the three knowledge indicators all display statistically significant relationships with objective knowledge of biotechnology. Of the three variables, knowledge of GM food has the weakest association, which is consistent with the models of subjective knowledge. However, the findings are discrepant in the relative influence of knowledge of medical biotechnology and knowledge of the PUB programme. In the case of objective knowledge, the size of the coefficients is roughly equivalent, while for subjective knowledge the latter clearly predominated. Lastly, the general attitudes to science variables were not statistically significant predictors in Model II, which is another element of correspondence with the subjective knowledge analysis, as is the lack of salience of factors such as age, religiosity and geographic location.

Multivariate Key lessons: Objective Knowledge of Biotechnology

Key trends and findings

- Having a better education substantially increases the odds of having a high level of objective knowledge about biotechnology.
- Evaluations of economic status also influence the likelihood of having knowledge of biotechnology, with the non-poor possessing higher objective knowledge about biotechnology than the non-poor.
- Women were generally less knowledgeable than men based on the objective biotechnology knowledge scale.

Implications for public engagement with biotechnology

- Communications strategies should target specific groups in South Africa according to their knowledge profiles. For example, strategies for communicating introductory and basic knowledge must prioritise the poor and the less educated.

6.1.3 Knowledge of genetically modified (GM) food

A third dependent used in the multivariate modelling for the study again addresses levels of knowledge, but in this instance the focus is more specifically on GM food. This serves as a good introduction to the models on different components of attitudes to GM food that is to follow. The knowledge measure used derives from three variables in the module. The first of these is a dummy variable based on whether respondents believe that 'genetically modified crops are allowed to be grown in South Africa'. A value of one represents a positive response, while a zero value signifies a negative or uncertain response. The second variable is an index of how many of the three crops that contain GM genes that are legally allowed in South Africa (white and yellow maize, soya and cotton), respondents are able to identify correctly. As such is scaled from 0 to 3, with zero indicating that none of the crops were identified and three denoting that all were mentioned by the respondent. The third indicator is another dichotomous variable focusing on whether the respondent reports ever having eaten GM food. The Cronbach alpha coefficient for the three items is 0.7297, which is within an acceptable reliability range. In constructing the final knowledge of GM food measure, the three items were first transformed into 0-100 scores and then averaged together to produce a final index that also employs a 0-100 scale. In common with the previous two knowledge dependent variables, the knowledge of GM food measure is an ordinal index ranging from limited to high knowledge, which again favours the use of an ordered logistic regression model.

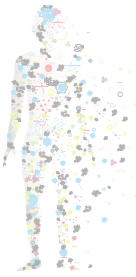


Table 47: Ordered logistic regression predicting knowledge of GM food

	Model I			Model II		
	Coeff.	Odds Ratio	Sig.	Coeff.	Odds Ratio	Sig.
Female (ref. male)	-0.091	0.913		0.030	1.031	
Age	-0.007	0.993		-0.008	0.992	
Age^2	0.000	1.000		0.000	1.000	
Population group ref. black African)						
Coloured	-0.444	0.641	*	-0.018	0.982	
Indian/Asian	0.211	1.234		0.128	1.137	
White	-0.043	0.958		0.015	1.016	
Education (ref. primary/no schooling)						
Incomplete secondary	0.318	1.374		0.152	1.164	
Matric	0.715	2.043	***	0.316	1.371	
Tertiary	1.506	4.510	***	0.817	2.263	*
Subjective poverty (ref. poor)						
Non-poor	0.502	1.651	**	0.219	1.245	
Just getting by	0.208	1.232		0.145	1.156	
Religiosity scale (ref. highly religious 8-10)						
Not very religious (0-4)	0.043	1.044		0.120	1.128	
Moderately religious (5-7)	-0.051	0.950		0.034	1.034	
Geographic type (ref. trad. auth. area)						
Urban formal	-0.045	0.956		-0.141	0.869	
Urban informal	0.483	1.621		0.326	1.385	
Rural farms	0.176	1.193		-0.005	0.995	
Planted seeds for crops	…	…		0.171	1.186	
Engaged in traditional farming practices	…	…		0.134	1.144	**
Identified change in maize	…	…		0.502	1.652	***
Disagree that we over-rely on science	…	…		0.074	1.076	
Importance of science in daily life	…	…		-0.057	0.944	
Subjective knowledge of biotechnology	…	…		0.404	1.498	***
Knowledge of medical biotechnology	…	…		0.183	1.201	***
Knowledge of PUB programme	…	…		0.594	1.810	***
Number of obs.	2756			2438		
/cut1	-0.647	0.502		1.435	0.681	
/cut2	-0.548	0.500		1.568	0.678	
/cut3	-0.518	0.501		1.600	0.679	
/cut4	0.001	0.499		2.272	0.678	
/cut5	0.436	0.499		2.779	0.679	
/cut6	0.497	0.499		2.856	0.679	

	Model I			Model II		
	Coeff.	Odds Ratio	Sig.	Coeff.	Odds Ratio	Sig.
/cut7	1.045	0.496		3.525	0.679	
/cut8	3.298	0.500		6.057	0.668	
/cut9	5.213	0.557		8.025	0.759	
Prob > chi^2	0.00			0.00		
Pseudo R^2	0.04			0.11		

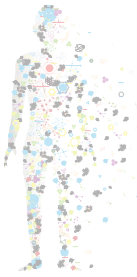
Source: South African Social Attitudes Survey (SASAS) 2015

*Notes: 1. Data is weighted to be nationally representative of the adult South Africans. 2. A positive coefficient indicates a higher level of knowledge about GM food. 3. The regression model controls for an individual's province of residence. 4. Significance is reported as follows: * p<0.05; **p<0.01; ***p<0.001.*

Results from the modelling based on the knowledge of GM food measure are presented in Table 47. The first of the two models presented is the base model containing only basic socio-demographic variables. The second model introduces a cluster of additional variables, consisting of a mix of behavioural, knowledge and attitudinal indicators. The behavioural measures include engagement in some form of agricultural activity, whether by having previously planted seeds for crops or having experience with traditional farming practices. A measure concerning the respondent's ability to discern changes in the appearance and manner in which maize grows is also included. The knowledge items included are the subjective knowledge of biotechnology measure, knowledge of medical biotechnology and knowledge of the government's PUB programme. Lastly, the two general attitudes to science items are included, as one might expect that knowledge of GM food would be related to the level of promise or reservation vested in science overall.

From Model I, it is apparent that educational attainment is again a statistically significant predictor of knowledge, controlling for other factors. Those with matric or tertiary qualification have higher likelihood of demonstrating greater knowledge of GM foods compared to those with primary education or no formal schooling. To some degree, economic status seems to be a significant determinant of knowledge of GM food. Based on subjective poverty status, the non-poor are found to be significantly more likely to possess knowledge about GM food than those classifying themselves as poor. Coloured adults appear less knowledgeable about GM food than black African adults, though no other population group differences are significant, and this effect falls away once other knowledge, attitudinal and experiential measures are included in Model II. Levels of GM knowledge were not influenced by the sex, age, religiosity and geographic location of survey respondents.

With the inclusion of the additional variables in Model II, the race and economic status effects on GM food knowledge fall away altogether, while the educational effect diminishes substantially. The main educational effect remaining is a distinction in knowledge between the tertiary educated and those with primary or no formal education. All three knowledge variables that are added in the model are statistically significant, implying that knowledge of GM foods is positively influenced by overall subjective knowledge of biotechnology, as well as more specifically knowledge of medical biotechnology and knowledge of the PUB programme. Having previously engaged in traditional farming practices also increases the odds of being more knowledgeable about GM food, though having planted seeds is not a significant predictor controlling for other factors. If one were to exclude the traditional farming practices variable from the model (not shown), the experience of having planted seeds for crops does become significant at the 95% confidence level (p=0.024), though it is not as strong a determinant of knowledge of GM food as experience of traditional farming practices. Being able to identify a change in the appearance and growth pattern of maize is also positively associated with levels of knowledge. Finally, the general attitudes towards science do not have a significant bearing on GM food knowledge, which is a finding common to the previous two knowledge models.



Multivariate Key lessons: Knowledge of genetically modified (GM) food

Key trends and findings

- Educational attainment is an important predictor. Those with matric or tertiary qualification have a higher likelihood of demonstrating greater knowledge of GM foods compared to those with primary education or no formal schooling.
- Levels of GM knowledge were *not* influenced by the sex, age, race, religiosity and geographic location of survey respondents.
- Having previously engaged in traditional farming practices also increases the odds of being more knowledgeable about GM food.
- Being able to identify a change in the appearance and growth pattern of maize is associated with greater levels of knowledge of GM food.
- Subjective knowledge of biotechnology, as well as knowledge of medical biotechnology and the PUB programme, are all significant predictors of knowledge of GM food.

Implications for public engagement with biotechnology

- Efforts at educating the public about biotechnology should make use of basic examples such as changes in the appearance and growth pattern of maize as a way of further promoting awareness and dialogue regarding GM food.

6.1.4 Factors encouraging the purchasing of GM food

The next part of the multivariate analysis examines the determinants of one specific set of attitudinal measures included in the survey module, namely whether health, cost and environmental gains would predispose South Africans towards purchasing genetically modified food. For the modelling, an index was produced by combining responses to the following three statements:

> 'I would buy GM maize if it were healthier.'
> 'I would buy GM maize if it cost less than ordinary maize.'
> 'I would buy GM maize if it were grown in a less damaging way to the environment compared to non-GM maize.'

The original scaling on these three items was a four-point agreement scale, ranging from strongly agree to strongly disagree, with no neutral midpoint category offered. In order to try and preserve the sample size for the modelling, taking into account moderate levels of non-response (12-16% 'don't know' values), three dichotomous variables were constructed, based on whether or not survey participants voiced agreement with the statements or not. A value of 1 was assigned to those answering 'strongly agree' or 'agree', while a value of 0 was given to 'disagree', 'strongly disagree' and 'don't know' responses. Having constructed these three dummy variables, a simple 0-3 index was derived through an additive process, with higher scores representing a greater tendency towards expressing a willingness to purchase GM food if it offers clear benefits. The Cronbach alpha for the three dummy variables constituting the final index is 0.8726, with no variables suggested for dropping. This indicates that the items provide the basis for a reliable measure.

As with the modelling of the knowledge questions already performed, the ordinal nature of the index on the factors encouraging the purchasing of GM food outlined above lends itself to an ordered logistic regression modelling approach. In Table 48, the coefficients and significance levels for each of four models that were undertaken is presented. The first of the four models is the base model containing the by now familiar set of basic socio-demographic attributes. The second model adds in one additional indicator, namely subjective knowledge of biotechnology. Attitudes towards GM food and their regulation are inserted in the third model, while the final model includes all these independent variables together with the two variables capturing general attitudes towards science.

In Model I, the only relationship achieving statistical significance is the association between the population group of respondents and levels of support for purchasing GM food if it offered specific personal and societal benefits (health, cost and environmental). Relative to black African adults, and controlling for socio-economic characteristics, belonging to a racial minority was associated with greater circumspection regarding the purchasing of GM food even if it was healthier, cheaper and environmentally friendly. Unlike the knowledge

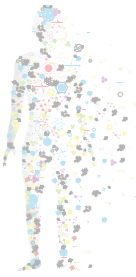
variables modelled previously, there is no sign of class-based variance in support for the purchasing of GM food even if specific gains are evident.

The inclusion of subjective knowledge of biotechnology in Model II does little to alter the picture. Race remains a salient predictor, with no other socio-demographic variables becoming significant. A positive association can be observed between subjective knowledge and the dependent variable. The odds of purchasing GM food if presented with specific benefits thus increase as one's (self-rated) knowledge of biotechnology grows. The same finding emerges if one substitutes subjective knowledge for the objective knowledge scale.

In Model III, three attitudinal variables are introduced. The first is a composite measure of attitudes towards GM food. It is based on an index that was constructed by adding together responses from a set of five dichotomous variables that represented whether respondents believed that GM food is safe to eat, good for the economy, benefits commercial farmers as well as small scale or subsistence farmers, and provides improved food access for one's family. The resulting index of GM food benefits consists of a 0 to 5 scale, where zero represents none of the aforementioned benefits being cited and five indicates that all benefits were mentioned by survey respondents. The second variable is the absence of ethical objections to GM food. This is a 0-2 index, based on whether respondents report that they disagree that the genetic modification of food is 'interfering in God's plan' and 'is (morally) wrong'. A score of 5 indicates that the respondent does not believe that GM food is ethically wrong based on disagreement with both statements, while a value a zero implies that the respondent either supported or was uncertain about their position on both statements. The third attitudinal measure is based on a single item that asks whether the respondent thinks that 'GM foods are effectively regulated by the government in South Africa'. A dichotomous variable was created, where 0 represents a negative or uncertain response and 1 indicates an affirmative response.

Table 48: Ordered logistic regression estimates predicting factors encouraging purchasing of GM food

	Model I		Model II		Model III		Model IV	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Female (ref. male)	-0.10		-0.07		-0.04		-0.04	
Age	-0.02		-0.02		-0.02		-0.02	
Age^2	0.00		0.00		0.00		0.00	
Population group ref. black African)								
Coloured	-0.51	*	-0.48	*	-0.20		-0.20	
Indian/Asian	-0.57	*	-0.69	**	-0.57	*	-0.47	*
White	-0.94	**	-1.02	***	-0.90	**	-0.90	**
Education (ref. primary/no schooling)								
Incomplete secondary	-0.04		-0.09		-0.23		-0.30	
Matric	0.04		-0.08		-0.24		-0.32	
Tertiary	0.21		-0.07		-0.46		-0.51	
Subjective poverty (ref. poor)								
Non-poor	0.00		-0.11		-0.16		-0.33	
Just getting by	0.00		-0.04		-0.03		-0.14	
Religiosity scale (ref. highly religious 8-10)								
Not very religious (0-4)	0.00		0.01		0.17		0.24	
Moderately religious (5-7)	0.20		0.25		0.25		0.26	



	Model I		Model II		Model III		Model IV	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Geographic type (ref. trad. auth. area)								
Urban formal	-0.14		-0.18		-0.15		-0.13	
Urban informal	0.04		-0.01		-0.12		-0.15	
Rural farms	0.41		0.39		0.45		0.34	
Subjective knowledge of biotechnology	…		0.36	***	0.14		0.14	
Disagree that we over-rely on science	…		…		…		-0.16	*
Importance of science in daily life	…		…		…		-0.05	
Index of perceived benefits of GM food	…		…		0.38	***	0.35	***
Absence of ethical objections to GM food	…		…		0.46	***	0.48	***
Perceived effectiveness of GM food governance	…		…		0.50	**	0.46	**
Number of obs.	2845		2840		2798		2532	
/cut1	-2.67		-2.09		-1.45		-2.13	
/cut2	-2.32		-1.73		-1.02		-1.68	
/cut3	-1.62		-1.02		-0.19		-0.84	

Source: South African Social Attitudes Survey (SASAS) 2015

*Notes: 1. Data is weighted to be nationally representative of the adult South Africans. 2. A positive coefficient indicates a greater inclination towards the purchasing of GM food in the presence of specific benefits (health, cost and environmental). 3. The regression model controlled for an individual's province of residence. 4. Significance is reported as follows: * p<0.05; **p<0.01; ***p<0.001.*

Following the introduction of these GM food attitudes measures in Model III, the general patterning on the socio-demographic measures remains largely unchanged. The race-based association weakens slightly, with coloured adults no longer significantly different from black African adults in their predisposition towards the purchasing of GM food, though Indian and white adults continue to display greater wariness. Interestingly, the effect of subjective knowledge of biotechnology on the dependent variable in Model II falls away. This washing-out effect may be attributable to the fact that self-rated knowledge of biotechnology may be associated with the promotion of specific attitudes towards GM food, including greater recognition of the benefits that may be secured, a rejection that it violates religious or moral norms, and a general sense that the state is performing well in regulating such scientific developments. All three attitudinal variables that were included in Model III are statistically significant predictors that encourage the reported intention to purchase GM food if it brings specific gains. Therefore, believing in a range of benefits of GM food, not objecting to GM food on ethical grounds, and having a positive view of the governance of biotechnology all yield a positive bearing on the odds of buying GM food.

Lastly, the insertion in Model IV of the two general attitudes towards science variables does not alter much the patterns evident in Model III. The racial effect is still unchanged, the three attitudes towards GM variables remain strong predictors, and subjective knowledge does not return as a significant predictor. In terms of the scientific promise-reservation items, disagreement with the statement that 'we depend too much on science and not enough on faith' is inversely associated with the dependent variable, controlling for other factors. This is an unanticipated finding, for it suggests that those who are more inclined to report tensions between science and religion are somewhat more inclined to support the purchasing of GM food if it provides demonstrable benefits than those who more unequivocally favour science. By contrast, disagreement with the statement "it is not important for me to know about science in my daily life" is not a significant predictor of preferences for purchasing GM food.

Multivariate Key lessons: Factors encouraging the purchasing of GM food

Key trends and findings

- Unlike the models predicting different forms of knowledge about biotechnology, there is no sign of class-based variance in support for the purchasing of GM food even if specific gains are evident.
- The likelihood of purchasing GM food if presented with specific benefits increases as one's knowledge of biotechnology grows.
- Believing in a range of benefits of GM food, not objecting to GM food on ethical grounds, and having a positive view of the governance of biotechnology all yield a positive bearing on the odds of buying GM food.
- Those who are more inclined to report tensions between science and religion are somewhat more inclined to support the purchasing of GM food if it provides demonstrable benefits than those who more unequivocally favour science.

Implications for public engagement with biotechnology

- The provision of information on biotechnology through a variety of means, including an open, factual communication about the benefits and risks of GM food, will help people make informed decisions about buying GM food and may even encourage people to buy GM food.

6.1.5 Perceived effectiveness of Government's regulation of GM food

Having examined the determinants of knowledge of GM food, the focus now moves to attitudes and evaluations of GM food. One notable variable of this nature included in the module is the perceived effectiveness of the governance of genetically modified food. The question is explicitly phrased as follows: 'Do you think that GM foods are effectively regulated by the government in South Africa', which answers were captured using a simple dichotomous 'yes'/'no' coding scheme. As already described, for analytical purposes this variable was recoded so that 0 represents a negative or uncertain response and 1 indicates an affirmative response to the question. This was partly due to the fact that close to two-fifths (38%) provided 'don't know' responses. As such, the dichotomous dependent variable represents those who were definitively able to state that the government was effectively regulating GM food compared to those expressing either negative or ambivalent views. Given the binary nature of the coding of the dependent variable, a logistic regression model was undertaken, since this multivariate method is specifically designed for dichotomous outcome variables. In Table 49, the coefficients and odds ratios from the logistic regression model are presented. Four models are shown, the first again being the base model with basic socio-demographic variables. The second model adds in subjective knowledge of biotechnology, while attitudes towards GM food are added in the third model. The final model retains all these independent variables and supplements them with the two general attitudes towards science variables.

In Model I, there are distinct race, educational and to a certain degree geographic effects that inform evaluations of the perceived effectiveness of the government's efforts at regulating GM food. Compared to black African adults, coloured, Indian and especially white adults are less inclined to believe that GM foods are being effectively regulated. This may reflect differential views on governance in the country in general, and warrants further exploration. With respect to education, those with a matric or tertiary education are respectively 1.6 and 3.8 times as likely as those a primary level or no formal schooling to report effective governance. As for geographic location, those in informal urban settlements and living on rural farms offered significantly more favourable views than those living in rural traditional authority areas. There are no discernible sex, age economic status or religiosity effects, an outcome that holds true even after adding in additional variables in Models II through IV.

From Model II, it is apparent that possessing subjective knowledge of biotechnology increases the odds of rating the governance of biotechnology favourably. The same applies if one substitutes subjective for objective knowledge (results not shown). After adding in this variable, the race effect remains unchanged while the educational effect has washed out slightly. Those with a matric education are no longer statistically different in their ratings of the effectiveness of governance from those with primary or no formal schooling, though the strong effect of having a tertiary qualification remains. The geographic location associations also remain virtually indistinguishable from those in Model I.

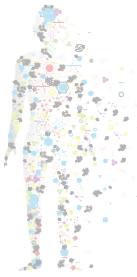


Table 49: Logistic regression estimates predicting the perceived effectiveness of the governance of GM foods

	Model I		Model II		Model III		Model IV	
	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.	Coeff.	Sig.
Female (ref. male)	-0.11	0.90	-0.07	0.93	-0.10	0.90	-0.09	0.91
Age	-0.02	0.98	-0.02	0.98	-0.01	0.99	-0.02	0.98
Age^2	0.00	1.00	0.00	1.00	0.00	1.00	0.00	1.00
Population group ref. black African)								
Coloured	-0.57*	0.57	-0.52*	0.60	-0.35	0.70	-0.28	0.75
Indian/Asian	-0.53*	0.59	-0.71**	0.49	-0.72*	0.49	-0.67	0.51
White	-1.23***	0.29	-1.33***	0.26	-1.36***	0.26	-1.30***	0.27
Education (ref. primary/no schooling)								
Incomplete secondary	0.35	1.42	0.28	1.32	0.28	1.32	0.17	1.18
Matric	0.48*	1.62	0.31	1.36	0.29	1.34	0.14	1.15
Tertiary	1.32***	3.76	0.91**	2.49	0.83**	2.30	0.72*	2.05
Subjective poverty (ref. poor)								
Non-poor	0.33	1.38	0.16	1.17	0.24	1.27	0.27	1.31
Just getting by	0.16	1.18	0.08	1.09	0.05	1.05	0.05	1.05
Religiosity scale (ref. highly religious 8-10)								
Not very religious (0-4)	-0.34	0.71	-0.35	0.70	-0.24	0.79	-0.24	0.79
Moderately religious (5-7)	-0.19	0.83	-0.14	0.87	-0.20	0.82	-0.13	0.88
Geographic type (ref. trad. auth. area)								
Urban formal	0.02	1.02	-0.03	0.97	0.13*	1.14	0.08	1.08
Urban informal	0.67*	1.96	0.59*	1.81	0.84***	2.32	0.82*	2.26
Rural farms	0.70*	2.02	0.70*	2.02	1.03	2.79	0.99**	2.69
Subjective knowledge of biotechnology	…	…	0.53***	1.70	0.35***	1.42	0.32***	1.38
Index of perceived benefits of GM food	…	…	…		0.52***	1.68	0.50***	1.66
Factors influencing purchasing of GM food	…	…	…		0.23**	1.26	0.21**	1.24
Absence of ethical objections to GM food	…	…	…		0.20*	1.23	0.23*	1.26
Disagree that we over-rely on science	…	…	…		…	…	-0.11	0.90
Importance of science in daily life	…	…	…		…	…	-0.12*	0.89
Number of obs.	2847		2842		2798		2532	
Prob > chi^2	0.00		0.00		0.00		0.00	
Pseudo R^2	0.08		0.11		0.28		0.26	

Source: South African Social Attitudes Survey (SASAS) 2015

*Notes: 1. Data is weighted to be nationally representative of the adult South Africans. 2. A positive coefficient indicates a likelihood to hold the belief that GM food in South Africa is effectively regulated by the government. 3. The regression model controlled for an individual's province of residence. 4. Significance is reported as follows: * p<0.05; **p<0.01; ***p<0.001. 5. O.R. denotes 'Odds Ratio'.*

The addition of the three GM food attitudes variables in Model III does not appreciably alter the race and education effects. The salience of subjective knowledge as a predictor reduces slightly, though it remains a notable determinant of governance perceptions. Those recognising various benefits of GM food are more inclined to also view the governance of GM food positively. Similarly, those expressing a willingness to purchase to buy GM food if it provides specific benefits tend to provide favourable evaluations of governance. It can further be observed that an individual with no ethical or religious doubts about GM food is considerably more likely to believe that GM food is being regulated effectively. In Model IV, the addition of the two general attitudes towards science items does not change the associations with evaluations of biotechnology governance to any notable degree. The predictive power of the GM food attitudes measures therefore does not weaken substantially when we controlled for attitudes towards science. Disagreement with the statement that 'science is not important in daily life' is negatively correlated with the dependent variable, while there is not a significant association based on the over-reliance on science indicator.

Multivariate Key lessons: Perceived effectiveness of Government's regulation of GM food

Key trends and findings

- Subjective knowledge of biotechnology increases the odds of rating the governance of biotechnology favourably.
- Compared to black African adults, Coloured, Indian and especially white adults are less inclined to believe that GM foods are being regulated effectively.
- Those recognising various benefits of GM food are more inclined to also view the governance of GM food positively.
- An individual with no ethical or religious doubts about GM food is considerably more likely to believe that GM food is being regulated effectively.

Implications for public engagement with biotechnology

- The provision of information on biotechnology will indirectly serve to promote greater levels of confidence in the effectiveness of government's regulation of the GM food sector.
- It needs to be acknowledged that those harbouring ethical or religious concerns about GM food are likely to be circumspect about the governance of biotechnology, even after controlling for knowledge levels. Providing neutral and balanced information to the public may be the best way of responding such ethical concerns.

6.1.6 Knowledge of medical biotechnology

Having explored the determinants of both knowledge of and attitudes towards GM foods, attention will now be devoted to medical biotechnology. Specifically, the analysis looks at predictors of knowledge of medical biotechnology. The measure of knowledge that is used for this purpose, an index is constructed based on responses to level of familiarity with three particular medical applications of biotechnology: (i) genetic testing to detect inherited diseases; (ii) gene therapy to treat genetic conditions; and (iii) the production of medicines using GM organisms. The items employ the same coding scheme as the indicators that were used earlier on to construct the objective knowledge scale, namely 'have not heard of it', 'have heard of it, but know little or nothing about it' and 'know enough about it to explain it to a friend'. To create the knowledge of medical biotechnology index, these responses were assigned values of 0, 1 and 2 respectively, while 'do not know' responses were also assigned a value of zero together with those answering 'have not heard about it'. An additive scale was constructed based on the three items, ranging between a 0 (no knowledge) and 6 (maximum knowledge). The resulting index achieves good levels of reliability, with a Cronbach alpha coefficient of 0.8807, and no indicators identified for exclusion. The ordered nature of this dependent variable means that it is suited to the use of ordered logistic regression models. In Table 50, two models of knowledge of medical biotechnology are displayed, the first of which is the base model containing core socio-demographic variables. The second model supplements these personal attribute indicators with three knowledge variables, as well as the two general attitudes towards science items.

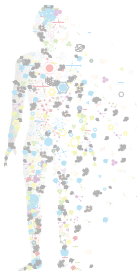


Table 50: Ordered logistic regression predicting knowledge of medical biotechnology

	Model I			Model II		
	Coeff.	Odds Ratio	Sig.	Coeff.	Odds Ratio	Sig.
Female (ref. male)	-0.03	0.9		0.10	1.1	
Age	-0.03	0.9		-0.02	0.9	
Age^2	0.00	1.0		0.00	1.0	
Population group (ref. black African)						
Coloured	0.18	1.2		0.45	1.5	*
Indian/Asian	0.13	1.1		-0.06	0.9	
White	0.58	1.7	*	0.68	1.9	*
Educational (ref. primary/no schooling)						
Incomplete secondary	0.46	1.6	**	0.39	1.4	
Matric	0.85	2.3	***	0.42	1.5	
Tertiary	1.61	5.0	***	0.87	2.4	**
Subjective Poverty (ref. poor)						
Non-poor	0.39	1.4	*	0.10	1.2	
Just getting by	-0.16s	0.8		-0.40	1.0	
Religiosity Scale (ref. highly religious 8-10)						
Not very religious (0-4)	0.17	1.1		0.19	1.2	
Moderately religious (5-7)	-0.09	0.9		0.00	1.0	
Geographic type (ref. trad. auth. area)						
Urban formal	0.62	1.8	***	0.55	1.7	**
Urban informal	0.25	1.2		0.03	1.0	
Rural farms	0.44	1.5		0.25	1.3	
Subjective knowledge of biotechnology	…	…		0.51	1.6	***
Knowledge of GM food	…	…		0.01	1.0	***
Knowledge of PUB programme	…	…		0.18	1.2	
Disagree that we over-rely on science	…	…		-0.10	0.9	
Importance of science in daily life	…	…		0.12	1.1	*
Number of obs.	285			247		
/cut1	0.79			2.68		
/cut2	1.26			3.23		
/cut3	1.83			3.88		
/cut4	3.14			5.33		
/cut5	3.68			5.90		
/cut6	4.28			6.54		
Prob > chi^2	0.0			0.0		
Pseudo R^2	0.0			0.1		

Source: South African Social Attitudes Survey (SASAS) 2015

*Notes: 1. Data is weighted to be nationally representative of the adult South Africans. 2. A positive coefficient indicates a likelihood to hold higher levels of knowledge of medical biotechnology. 3. The regression model controlled for an individual's province of residence. 4. Significance is reported as follows: * p<0.05; **p<0.01; ***p<0.001.*

From the results in Model I, educational attainment appears to exert the strongest positive association with knowledge of medical biotechnology. As level of education increases, the log odds of possessing greater knowledge rise considerably. All categories of education included in the model, from incomplete secondary schooling through to possession of a tertiary qualification, translate into a statistically higher level of knowledge of medical biotechnology than those with primary level or no formal schooling. Apart from this educational effect, weak positive associations are present in relation to race and economic status. More specifically, white adults were more inclined to be knowledgeable than black African adults, though there was not a significant association for coloured and Indian adults. In terms of subjective poverty status, those who classify themselves as non-poor demonstrate a significantly higher probability of possessing knowledge about medical biotechnology than those identifying themselves as poor. Those residing in formal urban areas also emerge as more likely to be knowledgeable about the medical applications of biotechnology than those living in rural traditional authority areas, though statistical significance is not achieved in the cases of informal urban settlements and rural farms. The model fails to yield significant sex, age or religiosity effects, which is a recurrent finding from the other regression analysis conducted.

The insertion of the knowledge and attitudinal items in Model II has a number of effects on the socio-demographic correlates of knowledge of medical biotechnology. The effect of education is moderated, to the extent that the difference in knowledge between those with a tertiary education and those with primary or no schooling is the association that retains statistical significance. In terms of race, the effect has been reinforcing rather than a weakening one. White adults continue to exhibit higher knowledge on average than black African adults, while coloured adults now also possess higher knowledge once all the other factors are controlled for. The change in the relationship between economic status and knowledge is more unanticipated, with the effect of being non-poor washing out. Instead, those who designate themselves as 'just getting by' are significantly less knowledgeable than those who are classified as poor. Such dynamics imply that different (self-rated) economic positions embody differential general and domain-specific levels of biotechnology knowledge and possibly varying perspectives on science in general. Once these knowledge and attitudinal differences are controlled for, the economic gradient alters substantially. Further testing of this assertion will be required in future. The strength of the association between residing in a formal urban area and knowledge of medical biotechnology also reduces between Models I and II, though to a lesser degree than for education. In fact, after tertiary education, it remains one of the strongest determinants of knowledge in the model. Two knowledge indicators were found to be significant predictors of knowledge of medical biotechnology, namely subjective knowledge in addition to knowledge of GM food. Knowledge of GM food tends to display a weaker association than the subjective knowledge indicator. Knowledge of the PUB programme has no significant effect on knowledge after controlling for the other factors included in the model. As for the relative influence of one's general predisposition towards science on knowledge of medical biotechnology, a higher importance attached to science in daily life corresponds with moderately higher knowledge, though views about the over-reliance on science over faith has no significant bearing.

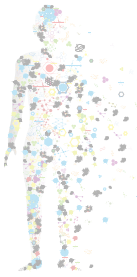
Multivariate key lessons: Knowledge of medical biotechnology

Key trends and findings

- Educational attainment appears to exert the strongest positive association with knowledge of medical biotechnology. As level of education increases, the log odds of possessing greater knowledge rise considerably.
- There are significant differences between economic groups on knowledge of medical biotechnology. These differences can be explained by differential general and domain-specific levels of biotechnology knowledge and possibly varying perspectives on science in general.

Implications for public engagement with biotechnology

- The provision of information on medical biotechnology should be packaged more effectively together with other education efforts, especially since around half the adult population is not aware of this type of application of biotechnology.



6.1.7 Overall evaluation of the benefits and risks of biotechnology

Two variables are included in the module that aim to capture the overall assessments of South Africans in relation to the benefits versus risks of biotechnology, one that is framed in terms of biotechnology as a whole and the other adopting a more narrow emphasis on GM food. Attention is first directed towards the cost-benefit analysis of biotechnology in general. The question is located at the end of the module and is phrased in the following manner: 'Taking into account all that you know about this topic and thinking about you and your family, do you see biotechnology more as a benefit or more as a risk?'. Three responses were provided for respondents to choose from, namely 'more as a benefit', 'more as a risk' and 'neither/indifferent'. This categorical variable does not lend itself neatly to ordinal regression analysis, and a sizeable share of adults (22%) answered 'don't know'. Taking this into account, it was decided to make use of a multinomial (polychotomous) regression, since this method best suits dependent variables with several categorical outcomes. The baseline outcome category has been specified as the 'risk' position, against which the predictors of the 'benefit', 'indifference' and 'don't know' categories will be compared. In Table 51, the results from the multinomial regression are presented. The modelling has been structured in two parts, firstly a base model containing socio-demographic attributes, and secondly a model that supplements these indicators with the standard knowledge, attitudinal, perceived governance and general attitudes towards science variables. The models in the table display both Relative Risk Ratios (RRRs) and the significance of relationships between the predictors and the dependent variable. The table therefore shows the ratio of the probability of choosing one outcome category over the probability of choosing the baseline category (i.e. risk).

In Model I, those with higher self-rated knowledge of biotechnology are significantly more inclined to perceive biotechnology more as a benefit than a risk. A one-unit increase in subjective knowledge would translate into a person being 1.25 times more likely to view biotechnology more as a benefit rather than a risk, holding the other variables in the model constant. As for economic status, for the non-poor relative to the poor, the chances of preferring the beneficial perspective over the risky viewpoint is expected to fall by half (0.50), holding other factors in the model constant. This suggests that the non-poor are more inclined to believe that biotechnology is a risk relative to the poor. No other variables achieve significance. Those favouring indifference over risk are significantly more likely to be black African than white adults and more likely to be moderately than highly religious. Lastly, compared to those viewing biotechnology more as a risk, those expressing uncertainty are likely to possess lower levels of subjective knowledge, have lower levels of religiosity, and have a greater chance of being poor than non-poor.

We now turn to the findings of Model II, which adds in biotechnology-related attitudinal measures. By so doing, there is no real change on economic status as a predictor. The non-poor are still less inclined than the poor to view biotechnology more as a benefit than a risk. The non-poor are also less likely than the poor to express indifference (relative to the risk position). The significant role that subjective knowledge played in informing the likelihood of opting for a beneficial rather than a risky perspective falls away. This further suggests that knowledge informs distinct attitudinal orientations, and as such controlling for attitudes to biotechnology erodes the salience of knowledge on overall evaluations. Black African adults continue to be more inclined than white adults to view biotechnology indifferently or with uncertainty rather than as a risk. Those who are moderately or not very religious demonstrate a greater propensity for an indifferent or uncertain perspective of biotechnology over one of risk compared to those who are highly religious. The introduction of the attitudinal indicator also means than those in formal urban areas are now less likely than those in former homeland areas to be uncertain about biotechnology. They are instead more inclined to opt for the risk perspective.

Those with a greater tendency to report perceived benefits of GM food are more likely to consider biotechnology as more beneficial than risky, and are less likely to be uncertain. In other words, seeing GM food as safe, a benefit to the economy and beneficial for farmers tend to increase support for biotechnology and reduce the chance of being uncertain about the benefits of biotechnology. A willingness to buy GM food if it was healthier, cheaper and less damaging to the environment was statistically associated with seeing biotechnology as a benefit (versus a risk), as well as being indifferent or uncertain about biotechnology. This simply suggests that a willingness to purchase GM food is associated with a greater tendency to see biotechnology as unthreatening (whether by viewing it as beneficial, by being indifferent, or by being unable to express a clear opinion).

Table 51: Multinomial (polytomous) logistic estimates predicting response to whether biotechnology is s risk

	Model I						Model II					
	Benefit vs. risk		Indifferent vs. risk		Uncertain vs. risk		Benefit vs. risk		Indifferent vs. risk		Uncertain vs. risk	
	RRR	Sig.	RRR	Sig.	RRR	Sig.	RRR	Sig.	RRR	Sig.	RRR	Sig.
Female (ref. male)	1.06		1.01		0.98		1.04		0.99		1.01	
Age	0.97		0.96		1.02		0.97		0.96		1.02	
Age^2	1.00		1.00		1.00		1.00		1.00		1.00	
Population group (ref. black African)												
Coloured	0.80		1.23		1.57		1.01		1.47		1.48	
Indian/Asian	0.65		0.79		0.76		0.64		0.82		0.52	
White	0.78		0.28	***	0.46		1.09		0.28	***	0.31	***
Educational (ref. primary/no schooling)												
Incomplete secondary	0.83		1.11		1.13		1.74	*	1.18		1.47	
Matric	0.62		1.10		1.08		1.91	*	1.25		1.45	
Tertiary	0.77		0.87		0.51		1.05		0.89		0.75	
Subjective poverty (ref. poor)												
Non-poor	0.50	**	0.72		0.33	***	0.50	*	0.76		0.37	***
Just getting by	0.69		0.92		0.67		0.64		0.94		0.77	
Religiosity scale (ref. highly religious 8-10)												
Not very religious (0-4)	0.81		1.67		1.73	*	0.94		1.76	**	1.47	
Moderately religious (5-7)	1.38		1.78	**	1.86	**	1.23		1.64	**	1.96	**
Geographic type (ref. trad. auth. area)												
Urban formal	0.75		0.95		0.67		0.84		0.97		0.64	*
Urban informal	0.89		1.02		0.60		0.97		1.31		0.77	
Rural farms	1.15		1.04		0.62		1.47		1.16		0.86	
Subjective knowledge of biotechnology	1.25	*	1.05		0.62	***	1.01		1.00		0.93	
Index of perceived benefits of GM food	…		…		…		1.46	***	1.04		0.67	***
Factors influencing purchasing of GM food	…		…		…		1.57	***	1.22	**	1.23	**
Absence of ethical objections to GM food	…		…		…		2.70	***	1.98	***	1.48	**
Absence of ethical objections to medical biotechnology	…		…		…		1.12		0.98		0.45	***
Perceived effectiveness of GM food governance	…		…		…		1.39	*	0.79		0.17	***

	Model I						Model II					
	Benefit vs. risk		Indifferent vs. risk		Uncertain vs. risk		Benefit vs. risk		Indifferent vs. risk		Uncertain vs. risk	
Disagree that we over-rely on science	…		…		…		1.14		0.93		1.44	***
Importance of science in daily life	…		…		…		1.03		0.95		0.92	
Constant	5.08	*	7.56	**	5.44	*	0.12	***	4.77	*	1.51	
Number of obs.	2839						2782					
Log likelihood	-3505.7						-2764.93					
Pseudo R^2	0.10						0.28					

Source: South African Social Attitudes Survey (SASAS) 2015

*Notes: 1. Data is weighted to be nationally representative of the adult South Africans. 2. The base outcome is "risk". 3. The regression model controlled for an individual's province of residence. 4. Significance is reported as follows: * p<0.05; **p<0.01; ***p<0.001. 5. RRR denotes Relative Risk Ratio.*

An individual with no ethical or religious objections to GM food is much more likely to believe that biotechnology is a benefit rather than a risk. They are similarly more likely to offer indifferent or uncertain views than declare biotechnology as risky. An individual with no moral or spiritual objections to medical uses of biotechnology is much less inclined to be undecided than view biotechnology as a risk, even after controlling for a range of objective and attitudinal variables. If an individual thinks that government effectively regulates GM food, then he or she will be less likely to view biotechnology with uncertainty, and more likely to rate it as a benefit than a risk. Finally, those disputing the fact that we over-rely on science are more likely to view biotechnology with uncertainty than as a risk. No statistical effect is found based on perceptions regarding the importance of science in one's daily life. Therefore, the general attitudes towards science indicators yield either counter-intuitive or no effects on overall assessments of biotechnology.

Multivariate key lessons: Overall evaluation of the benefits and risks of biotechnology

Key trends and findings

- Economic status appears to exert an effect on evaluations. The non-poor are more inclined to believe that biotechnology is a risk relative to the poor.
- Those with a greater tendency to report perceived benefits of GM food are more likely to consider biotechnology as more beneficial than risky, and are less likely to be uncertain. A willingness to purchase GM food is associated with a greater tendency to view biotechnology more favourably.
- An individual with no ethical or religious objections to GM food is much more likely to believe that biotechnology is a benefit rather than a risk.
- If an individual thinks that government effectively regulates GM food, then he or she will be less likely to view biotechnology with uncertainty, and more likely to rate it as a benefit than a risk.

Implications for public engagement with biotechnology

- The provision of information on biotechnology will *not* necessarily predispose people towards regarding biotechnology more as a benefit than a risk. Confidence in the benefits of biotechnology is better explained by other factors. From the regression results presented in Table 53, we find that the public is more likely to see GM food as a benefit (and indeed purchase it) if they perceive health, cost and environmental gains. Furthermore, South African adults are also more likely to view GM food positively if they are provided with convincing evidence that it is safe to eat, good for the economy, promotes food access, and benefits commercial and subsistence farmers. Such initiatives would obviously indirectly increase knowledge of biotechnology, but the model suggests that there is no direct association between knowledge and perceiving GM food as a benefit (controlling for other variables in the model).

6.1.8 Level of agreement with the view that GM foods provide more benefits than risk to society

The final models that we examine are conceptually similar to the overall assessment of the benefits versus risks of biotechnology measure analysed above. In this case, the indicator that is used as a dependent variable more specifically concerns final evaluations of GM foods. Respondents were asked to rate their level of agreement with the statement that 'overall, GM foods provide more benefits than risks for society'. Answers were captured using a four-point agreement scale, ranging from strong agreement to strong disagreement and excluding a neutral category. The share answering 'don't know' was again high (36%), and so a decision was made to collapse responses into three outcome categories, namely agreement (benefit), disagreement (risk) and 'don't know' (uncertain). A multinomial logistic regression was performed, with disagreement (risk) as the baseline outcome category that will be used as the comparator category. The modelling results are presented in Table 52, with the relative risk ratios and significance levels displayed. The first model contains basic socio-demographic variables, the second model adds in subjective knowledge, while the third model introduces attitudinal variables (i.e. attitudes towards GM food and its regulation, as well as general attitudes towards science).

In Model I, it is apparent that sex and age have no bearing on whether one views GM foods are more of a benefit than a risk to society. Coloured adults are less likely than black African adults to mention GM foods as beneficial rather than risky, while white adults are less inclined to be uncertain than black African adults about this form of biotechnology. Education has a strong, positive bearing on reporting of GM foods more as a benefit than a risk, though no educational effect is present in determining uncertainty about the benefits versus risks. With regard to economic status, the non-poor are less likely than the poor to report GM foods as a beneficial or to voice uncertainty. Those living on rural farms are less likely than those in former homeland areas to report GM foods as beneficial rather than a risk, while residents of informal urban settlements are less likely to provide 'don't know' responses than those in the former homeland areas after controlling for other factors. Religiosity makes no difference to assessments of benefit versus risk, but lower levels of religiosity are associated with higher uncertainty about such evaluations.

In Model II, the inclusion of subjective knowledge of biotechnology slightly alters these patterns. While the lack of effect of sex and age remains, the differences between coloured and black African adults fall away. White adults, however, continue to be less inclined to report uncertainty than risk compared to black African adults. While education remains a notable predictor, the effect of tertiary education relative those with primary or no schooling becomes statistically insignificant. The same patterning on the non-poor relative to the poor remains unchanged, with the coefficients virtually identical as Model I. Those who are not very religious continue to be more likely than the highly religious to state that they are uncertain about GM foods rather than declaring them as a risk. Those living on rural farms continue to be less likely than those in rural traditional authority areas to view GM foods as a benefit than a risk. The newly included subjective knowledge variable has no sway over whether respondents report GM foods more as a benefit or risk. However, those with more knowledge of biotechnology are more likely to report GM foods as a risk than being uncertain in their assessment.

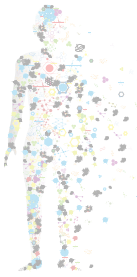


Table 52: Multinomial (polytomous) logistic estimates predicting level of agreement with the view GM foods provide more benefits than risk to society

	Model I				Model II				Model III			
	Benefit vs. risk		Uncertain vs. risk		Benefit vs. risk		Uncertain vs. risk		Benefit vs. risk		Uncertain vs. risk	
	RRR	Sig.	RRR	Sig.	RRR	Sig.	RRR	Sig.	RRR	Sig.	RRR	Sig.
Female (ref. male)	0.78		0.78		0.79		0.74		0.73		0.68	*
Age	0.99		1.00		0.99		1.00		0.99		0.98	
Age^2	1.00		1.00		1.00		1.00		1.00		1.00	
Population group (ref. black African)												
Coloured	0.58	*	0.95		0.60		0.91		0.88		0.75	
Indian/Asian	0.62		0.57		0.61		0.62		0.68		0.40	**
White	0.55		0.34	**	0.56		0.35	**	0.92		0.19	***
Educational (ref. primary/no schooling)												
Incomplete secondary	1.64	*	1.22		1.59	*	1.31		1.63	*	1.51	
Matric	2.21	**	1.12		2.13	**	1.35		2.31	**	1.74	
Tertiary	2.01	*	0.65		1.86		1.02		1.66		1.57	
Subjective poverty (ref. poor)												
Non-poor	0.59	*	0.30	***	0.58	*	0.36	***	0.65		0.34	***
Just getting by	0.86		0.78		0.85		0.85		0.79		0.95	
Religiosity scale (ref. highly religious 8-10)												
Not very religious (0-4)	0.89		1.96	*	0.89		2.05	*	0.84		1.88	
Moderately religious (5-7)	1.04		1.49	*	1.06		1.45		0.88		1.39	
Geographic type (ref. trad. auth. area)												
Urban formal	0.69		0.92		0.68		0.95		0.67		1.01	
Urban informal	0.64		0.45	*	0.63		0.52		0.43	*	0.44	*
Rural farms	0.35	**	0.59		0.35	**	0.61		0.27	**	0.90	
Subjective knowledge of biotechnology	…		…		1.09		0.57	***	0.95		0.77	*
Index of perceived benefits of GM food	…		…		…		…		1.58	***	0.59	***
Factors influencing purchasing of GM food	…		…		…		…		1.32	**	1.32	**
Absence of ethical objections to GM food	…		…		…		…		1.14		1.06	

Disagree that we over-rely on science	…		…		…		…		1.05		1.21	
Importance of science in daily life	…		…		…		…		1.07		1.35	**
Perceived effectiveness of GM food governance	…		…		…		…		1.32		0.37	***
Constant	5.95	**	3.14		5.24	*	6.88	**	0.40		1.88	
Number of obs.	2848				2843			2530				
Log likelihood	-2600				-2534			-1676				
Pseudo R^2	0.12				0.14			0.36				

Source: South African Social Attitudes Survey (SASAS) 2015

*Notes: 1. Data is weighted to be nationally representative of the adult South Africans. 2. The base outcome is "disagreement" with the statement. 3. The regression model controlled for an individual's province of residence. 4. Significance is reported as follows: * p<0.05; **p<0.01; ***p<0.001. 5. RRR denotes Relative Risk Ratio.*

From Model III, the addition of knowledge and attitudinal variables serves to remove the race and religiosity effects completely but retains the education effect on evaluations of GM foods as a benefit or risk to society. The non-poor are no longer significantly different from the poor in their views of GM foods as beneficial versus risky though the observed differences in uncertainty versus risk are still evident. Turning to the attitudinal indicators, those who perceive more benefits from GM food and express a willingness to purchase GM food lean more towards reporting GM food as a benefit than risk overall, while ethical views on GM food, general attitudes towards science and views on the governance of biotechnology do not inform views about whether GM foods are ultimately regarded as beneficial or risky for society. In terms of whether one views GM foods as risky or with uncertainty, a willingness to purchase GM foods increases the odds of being uncertain. By contrast, greater perceived benefits of GM foods sways individuals more towards a position of risk rather than uncertainty.

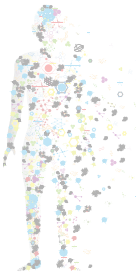
Multivariate Key lessons: GM foods provide more benefits than risk to society

Key trends and findings

- Education has a strong, positive bearing on reporting of GM foods more as a benefit than a risk, though no educational effect is present in determining uncertainty about the benefits versus risks.
- Religiosity makes no difference to assessments of benefit versus risk, but lower levels of religiosity are associated with higher uncertainty about such evaluations.
- Those who perceive more benefits from GM food and express a willingness to purchase GM food lean more towards reporting GM food as a benefit than risk overall.
- Ethical views on GM food, general attitudes towards science and views on the governance of biotechnology do not inform views about whether GM foods are ultimately regarded as beneficial or risky for society.

Implications for public engagement with biotechnology

- The provision of information on biotechnology, through the PUB programme, will help people make up their minds about the risks posed by biotechnology. However, greater knowledge of biotechnology will *not* increase people's confidence in the benefits of biotechnology.



6.1.9 Summary conclusions based on the multivariate analysis

The multivariate analysis presented in this section of the report has attempted to provide greater insight into the public understanding of biotechnology than has typically been undertaken in the country to date. By way of drawing together the findings from the different sets of modelling, it is instructive to compare the levels of significance for the different predictors across the different models. This is presented in Table 53 below, based on the final fully specified models.

Table 53: Summary of modelling

	1.	2.	3.	4.	5.	6.	7.	8.
	Subjective knowledge	Objective knowledge	Knowledge of GM food	Factors encouraging purchasing of GM food	Perceived effectiveness of GM food regulation	Knowledge of medical biotechnology	Overall evaluation of biotechnology (Benefit vs. risk category)	Agreement that GM foods provides more benefits than risks (benefit vs. risk category)
Female (ref. male)	n.s.	***	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Age	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Age^2	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Population group (ref. black African)								
Coloured	n.s.	***	n.s.	n.s.	n.s.	*	n.s.	n.s.
Indian/Asian	*	n.s.	n.s.	*	n.s.	n.s.	n.s.	n.s.
White	n.s.	n.s.	n.s.	**	***	*	n.s.	n.s.
Educational (ref. primary/no schooling)								
Incomplete secondary	*	**	n.s.	n.s.	n.s.	n.s.	*	*
Matric	**	***	n.s.	n.s.	n.s.	n.s.	*	**
Tertiary	***	***	*	n.s.	*	**	n.s.	n.s.
Subjective poverty (ref. poor)								
Non-poor	**	***	n.s.	n.s.	n.s.	n.s.	*	n.s.
Just getting by	n.s.	n.s.	n.s.	n.s.	n.s.	**	n.s.	n.s.
Religiosity scale (ref. highly religious 8-10)								
Not very religious (0-4)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Moderately religious (5-7)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Geographic type (ref. trad. auth. area)								
Urban formal	n.s.	n.s.	n.s.	n.s.	n.s.	**	n.s.	n.s.
Urban informal	n.s.	n.s.	n.s.	n.s.	*	n.s.	n.s.	*
Rural farms	n.s.	n.s.	n.s.	n.s.	**	n.s.	n.s.	**
Subjective knowledge of biotechnology	…	…	***	n.s.	***	***	n.s.	n.s.
Disagree that we over-rely on science	n.s.	n.s.	n.s.	*	n.s.	n.s.	n.s.	n.s.
Importance of science in daily life	n.s.	n.s.	n.s.	n.s.	*	*	n.s.	n.s.

Knowledge of GM food	***	***	…	…	…	n.s.	…	…
Knowledge of medical biotechnology	***	***	***	…	…	…	…	…
Knowledge of PUB programme	***	***	***	…	…	***	…	…
Index of perceived benefits of GM food	…	…	…	***	***	…	***	***
Factors influencing purchasing of GM food	…	…	…	…	**	…	***	**
Absence of ethical objections to GM food	…	…	…	***	*	…	***	n.s.
Effective regulation of GM food by government	…	…	…	**	…	…	*	n.s.
Absence of ethical objections to medical bio-technology	…	…	…	…	…	…	n.s.	n.s.
Planted seeds for crops	…	…	n.s.	…	…	…	…	…
Engaged in traditional farming practices	…	…	**	…	…	…	…	…
Identified change in maize	…	…	***	…	…	…	…	…

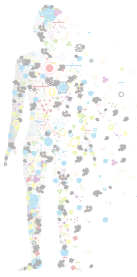
*Note: n.s. signifies not statistically significant at p<0.05; * = p<0.05; **=p<0.01; *=p<0.001; '…' indicates that the variable was not included in the model.*

In terms of the socio-demographic correlates of knowledge and attitudes towards biotechnology, it is clear that sex, age, religiosity and geographic location do not play a strong role. In virtually all the finally specified models, these variables mostly fail to achieve statistical significance. There are some race-based effects, though these are not consistent across the models. Controlling for other factors, white adults are less likely than black African adults to favour the purchasing of GM food in the presence of demonstrable benefits and they are also less sanguine in their evaluation of GM food regulation by government. Conversely, white adults tend to exhibit greater knowledge of the uses of medical biotechnology than black African adults. Coloured adults are also display more objective knowledge of biotechnology in general and knowledge of medical biotechnology more narrowly than black adults, other factors being held constant.

Educational attainment is one of the most notable predictors in the modelling that is presented. In particular, those with a tertiary education tend to report higher scores on most of the knowledge-based dependent variables compared to those with primary or no formal schooling. The tertiary educated are also more likely to positively evaluate the effectiveness of government's regulation of GM food. It is nonetheless interesting to observe that education has little bearing in the final determination as to whether biotechnology or GM food is ultimately seen as a benefit or risk, controlling for other factors. Another class-based variable included as a predictor in the models is subjective poverty status. Looking across the models, there is some sign that economic status has a bearing on biotechnology assessments. Most notably, the self-rated non-poor tend to demonstrate greater levels of subjective and objective knowledge than those classifying themselves as poor. Furthermore, the non-poor are less likely than the poor to declare biotechnology as a benefit than a risk.

A greater level of subjective knowledge of biotechnology is positively associated with more knowledge of GM food, as well as the perceived effectiveness of government's regulation of GM foods. In some of the models, subjective knowledge is not statistically significant in the fully specified models due to a washing out effect following the introduction of other knowledge and attitudinal variables. In some of the initial models conducted, where subjective knowledge is included in isolation alongside select socio-demographic indicators, it is a significant predictor, but the diminished strength of effect after adding in other variables suggests that knowledge may predispose individuals to hold specific attitudinal orientations towards different aspects of biotechnology. Apart from subjective knowledge, certain models also include other domain specific measures of knowledge, such as levels of awareness of GM food, the medical uses of biotechnology and of the PUB programme. Each of these forms of domain specific knowledge are positively related to overall subjective and objective knowledge.

With respect to the relative role of attitudes, those who are more inclined to report various benefits of GM food are predisposed towards buying GM food, viewing GM food governance favourably, and mentioning biotechnology and GM food more as a benefit than a risk. Similar patterns on governance and evaluations



of benefit versus risk are found among those stating that they would buy GM food if it presented certain personal and societal benefits. Not having any religious or moral objection to GM food improves the odds on individuals reporting that they would buy GM food if it were healthier, cheaper or produced environmental gains and also increases the probability of positive appraisals of GM food governance. The absence of ethical objections to medical biotechnology is, however, not a significant predictor in any of the models once controlling for views on the ethics of GM food. Finally, from a behavioural standpoint, having engaged in traditional farming practices is related to higher reported knowledge of GM food, though there is no additional independent effect of having previously planted seeds for crops.

These findings suggest a fairly nuanced perspective on the determinants of the public understanding of biotechnology, with patterns varying based on the specific dependent variable being modelled. A mix of knowledge, attitudes and personal traits all converge to shape general predispositions towards biotechnology. In certain instances, cancelling or washing-out effects are occurring between these different indicators. Nonetheless, in the final estimation, it is apparent that knowledge and education are key drivers, since these are likely to promote distinct attitudes and beliefs about biotechnology, which in turn have the potential to shape whether biotechnology is ultimately viewed as a benefit or risk in South Africa.

7. CONCLUSION

The biotechnology sector offers major economic and social benefits, but at the same time is esoteric and poorly understood by the public. Strategic and evidence-informed public engagement by biotechnology stakeholders is thus an important means of better positioning the sector in the public sphere. The DST, SAASTA, and PUB programme therefore commissioned this nationally representative survey of public perceptions of biotechnology. This concluding chapter outlines the main themes emerging from the research. It examines changes over time, primarily through a comparison with the results of the SASAS 2004 survey. It situates South Africa in the international context through a review of international comparative analyses. In the context of a highly stratified South African society, it summarises the perceptions of a range of demographic groups across the core set of thematic areas related to perceptions of biotechnology. Finally, it reflects on a possible framework for policy makers and other actors in the biotechnology sector who aim to engage the public in a more strategic and empirically informed manner.

Public awareness of biotechnology has escalated rapidly since the last nationally representative survey, conducted in 2004. Five dominant themes characterise the latest, 2015 data. Firstly, there is the unique and powerful role of age in determining perceptions of biotechnology. Responses by age were almost in all respects reported on a gradient, with successively younger cohorts being successively more connected to sources of information, successively more knowledgeable, and having generally more positive attitudes towards biotechnology. The second dominant theme was that of privilege: educational attainment and living standard were powerful predictors of perceptions of biotechnology. Those with lower levels of education and lower living standards are less connected and have lower levels of knowledge (although their attitudes display a degree of variance). Thirdly, there is the predominance of polarisation of viewpoints: most indicators of attitudes towards biotechnology reveal a public that is polarised, with substantial proportions being respectively in favour and against a particular issue. Only in the area of food labelling was there any meaningful consensus (a strong public opinion in favour of labelling). Lastly, the question of 'don't know' responses remains important: significant proportions of the public (generally between 10 and 30 percent) were not able to provide responses to survey questions. This indicates firstly that these sections of the public are disengaged from biotechnology as a topic, and also that the survey results need to be interpreted with this in consideration. This group also represents a strategic public for biotechnology stakeholders – a group where knowledge and attitudes are not yet fully formed, and where preconceptions or inherent biases are not yet present.

7.1 Changes over time

A review of changes in public perceptions of biotechnology between 2004 and 2015 shows, overall, a major increase in public awareness of biotechnology, and a major increase in attitudes that favour the purchasing of GM food (Table 54). Public familiarity with the term 'biotechnology' more than doubled during this period, from 21% of the population to 53%. Public awareness that GM foods form a part of their diet more than tripled, from 13% to 48%. Each of these changes signifies a major shift in public awareness. We can hypothesise that these changes are due to increased levels of education, increased access to information, and greater prominence of biotechnology in the public discourse during this period. It may be the case that the labelling of (some) GM foods has played a role. However, testing these hypotheses would require further research, including qualitative research.

Attitudes towards the purchasing of GM foods also changed significantly. The proportion of the public that would purchase GM foods on the basis of health considerations increased from 59% to 77%, on cost considerations increased from 51% to 73%, and on environmental considerations from 50% to 68%. Table 55 shows the Pearson Chi-Square statistic for selected measures, which provides evidence to support that the changes observed in Table 54 are statistically significant. Again, a rigorous understanding of the causes behind these changes would require further, qualitative research.

Other aspects have remained more stable. Perceptions of human evolution have not changed as much as other perceptions (see Table 15). Sources of information about biotechnology have, on the aggregate level, seen very little change (see Table 43).

Table 54: Summary of key changes, 2004-2015

	2004	2015	2004	2015	2004	2015
	Yes/agree		No/disagree		Don't know	
Are you familiar with the term 'biotechnology'?*	21	53	68	17	11	36
Have you ever eaten GM food?	13	48	25	17	62	36
I would buy GM maize if it were healthier	59	77	18	11	22	12
I would buy GM maize if it cost less than ordinary maize	51	73	26	15	23	12
I would buy GM maize if it were grown in a less damaging way to the environment	50	68	24	16	26	16

**phrasing modified to allow for in-table comparability*

Table 55: Summary of χ^2 results for 3 x 2 tables for five comparative measures in 2004 and 2015

	Pearson Chi-Square	df	P-value
Are you familiar with the term 'biotechnology'?*	280.32	2	p = 0.0000
Have you ever eaten GM food?	1278.12	2	p = 0.0000
I would buy GM maize if it were healthier	116.12	2	p = 0.0000
I would buy GM maize if it cost less than ordinary maize	337.77	2	p = 0.0000
I would buy GM maize if it were grown in a less damaging way to the environment	137.53	2	p = 0.0000

**phrasing modified to allow for in-table comparability*

7.2 International comparison

There are no nationally representative studies of public perceptions of biotechnology from developing countries – extant studies are all stakeholder studies with small samples. This means that international comparisons can only be made with developed country studies, in this case Europe, the US, and Australia. The results clearly show that the South African public can be broadly described as 'less informed, but more positive' about biotechnology, and specifically GM food (which forms the focus of most international studies).

Table 56 presents a summary of key points for international comparison, in this case comparing South African and European studies. South Africans are more than twice as likely as Europeans to believe that GM food is safe to eat, and are also significantly more likely to see GM foods as good for the economy (53% compared to 31%). South Africans are also less likely to see the environmental impact of GM food productions as being higher than conventional farming (42% compared to 52%). However, for each of these questions, South Africans were also more likely to reply with a 'don't know' response, indicating that these generally positive attitudes are formed in a social context that is generally less informed. This supports the thesis that being more informed about biotechnology does not necessarily lead to the formation of positive attitudes. Rather, increased informedness results in greater engagement with the topic and the formation of more clearly defined attitudes. In Europe, these attitudes have tended to be more critical.

Table 56: Summary international comparison: South African Social Attitudes Survey (SASAS) 2015 and Europe 2010 Eurobarometer 73.1

	SA	EU	SA	EU	SA	EU
	Agree		Disagree		Don't know	
'GM foods are safe to eat'	49	21	21	58	30	20
'GM foods are good for the economy'	53	31	16	50	31	19
'The environmental cost of farming GM crops is higher than that of traditional farming methods'	45	52	17	23	38	24

It thus appears that the level of knowledge required to meaningfully engage with questions of GM food safety, economic impact, and environmental impact, are lower in South Africa than in developed countries. However, South Africans do have some basic knowledge of GM foods that is at a level that is roughly comparable to a developed country. For example, roughly the same proportions of South Africans and Australians are aware of the country's primary GM crop. 41% of Australians were aware of the farming of GM canola, and 40% of South Africans were aware of the farming of GM maize (see Table 17). Public awareness of the country's secondary GM crop was also similar (9% in Australia, and 7% in South Africa). From these findings we can hypothesise that the South African public's basic knowledge about GM crops is similar to that of a developed country, even though the level of more advanced knowledge might be lower.

As is the case for understanding the causality behind observed changes in perceptions over time, understanding the causes of different perceptions in different countries would also require further research, including qualitative research.

7.3 South Africa and its publics: perceptions of biotechnology in a highly stratified society

South Africa is a highly stratified society, characterised by deep divisions along lines of economic inequality, educational inequality, ethnicity, race, and geographical location, amongst others. The intersections of these strata create distinct South African 'publics', each of which have different perceptions of biotechnology, and each of which may require distinct strategies for engagement. Table 57 presents a high-level overview of the main thematic areas of this study, distinguishing between the perceptions of the South African public as delineated by the key demographic indicators: age, education, LSM, race, and geographical location. Other demographic variables, such as gender and religion, did not play as important a role in determining perceptions of biotechnology. The findings of both the descriptive analysis and multivariate analysis are considered here.

Since this is a high-level summary, it excludes most of the detail, nuance, and occasional contradiction that characterises a more detailed assessment of public attitudes. Instead, this presents findings at the most generalised level, with the aim of providing a broad overview that may be of use for policy makers and others in the biotechnology sector that are involved in public engagement. Each of these key findings should, however, be considered in the context of the more detailed sections in the descriptive and multivariate analyses of this report.

Thus in summary, and as indicated in Table 57, we can highlight the key roles of:

- *Age*: younger generations are successively more connected, more knowledgeable, and more positive about biotechnology compared to older generations.
- *Education*: more educated groups are successively more connected, more knowledgeable, and more positive about biotechnology compared to less educated groups. However, those with a tertiary education are more likely than other groups to see biotechnology as risky rather than beneficial.
- *Living standard*: those with higher living standards are successively more connected, more knowledgeable, and more positive about biotechnology than lower living standard groups.
- *Race*: Indian and white groups are more knowledgeable than other groups, but attitudes towards various aspects of GM food are distinct for each group, with neither an overall positive or overall negative viewpoint for a particular race group. Each of the racial groups draws on a distinct set of sources of information.
- *Geographical location*: the different geographical locations have distinct profiles of attitudes towards biotechnology. Those in urban areas are more connected and more knowledgeable (in general), but those in rural areas have greater practical knowledge and familiarity with GM crops and IKS applications of biotechnology.

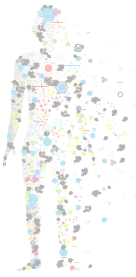


Table 57: Summary of public perceptions of biotechnology by thematic area and demographic grouping

	Age	Education	LSM	Race	Geographical location
Public understanding of science	Younger groups more likely to appreciate the benefits of science, but also more concerned about the balance between science and faith.	More educated groups are more likely to view science as making our lives 'healthier, easier, and more comfortable'. Less educated groups are more likely to believe that the benefits of science are greater for the rich than for the poor.	Higher income groups are more likely to view science as making our lives 'healthier, easier, and more comfortable'. Lower income groups are more likely to believe that the benefits of science are greater for the rich than for the poor.	Whites are less likely to believe that the benefits of science are greater for the rich than for the poor.	Those living in urban informal areas are less likely to view science as making our lives 'healthier, easier, and more comfortable'.
Self-rated knowledge of biotechnology	Younger groups report higher levels of self-rated knowledge.	More educated groups report higher levels of self-rated knowledge.	Higher income groups report higher levels of self-rated knowledge.	Indian and white groups report higher levels of self-rated knowledge compared to coloured and black African groups.	Rural areas reported lower levels of self-rated knowledge than urban areas.
Objective knowledge of biotechnology	Younger groups have more objective knowledge of biotechnology.	More educated groups have more objective knowledge of biotechnology	Higher income groups have more objective knowledge of biotechnology*.	Indians are more likely to report higher levels of self-rated knowledge than black Africans*.White, Indian, and coloured groups have greater objective knowledge than black Africans*.	Those in formal urban areas report have higher levels of objective biotechnology knowledge compared to other areas
GM food knowledge	Younger groups have successively more knowledge about the presence of GM crops in South Africa.	More educated groups have more knowledge about GM food*, and greater knowledge about the presence of GM crops in South Africa.	Higher income groups have more knowledge about GM food*. Low income groups have a higher levels of awareness of changes in maize characteristics.	Indians have higher levels of awareness of the presence of GM crops in their diet compared to other race groups. Coloureds have the lowest levels of awareness.	Those in traditional authority areas are more likely to be aware of GM food in their diet. Those living in rural areas are more likely to perceive changes in maize crops.

	Age	Education	LSM	Race	Geographical location
GM food attitudes	Younger generations are: more likely to have positive attitudes towards the economic benefits of GM food, more likely to see a benefit in terms of food security, and more likely to see GM foods as an overall benefit to society.	More educated groups are: more likely to see GM food as beneficial to society*, more positive in their assessment of the regulation of GM food*, more positive in their assessment of the morality of GM food production, and less likely to see benefits in terms of food security.	Higher income groups are: more likely to see GM foods as beneficial rather than risky*, and more likely to have a positive assessment of the morality of GM food production.	Black and coloured groups are more likely to see a benefit in terms of food security. White, Indian and coloured groups are less inclined than black African groups to believe that biotechnology is effectively regulated*. Black Africans are more positive than whites in their assessment of the regulation of GM food*. Black Africans are more likely than whites to favour purchasing GM food*. Black Africans are more likely than other groups to be in favour of purchasing GM foods on the basis of health, cost, and environmental characteristics*. Black Africans are more likely that coloureds to view GM foods as beneficial rather than risky*.	Those living in an urban context are more positive about the morality of G M food production. Those living in informal urban settlements and rural farms are more favourable in their views on the effectiveness of GM food regulation compared to those in traditional authority areas*. Those living in traditional authority areas are more likely than those on rural farms to see GM foods as beneficial rather than risky*.
GM medicine knowledge	Younger generations have greater knowledge about medical biotechnology.	More educated groups have greater knowledge about medical biotechnology*.	Higher income groups have greater knowledge about medical biotechnology*.	Whites have greater knowledge of GM medicine than black Africans*.	Those living on formal urban areas have greater knowledge than those living in traditional authority areas*
GM medicine attitudes	No substantial variance across age groups.	More educated groups were more positive about the ethical implications of GM medicine.	Higher income groups were more positive about the ethical implications of GM medicine.	White and coloured groups were slightly more positive about the ethical implications of GM medicine compared to black African and Indian groups.	No substantial variance by geographical location.

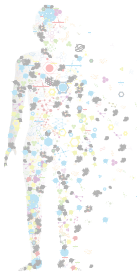
	Age	Education	LSM	Race	Geographical location
Indigenous knowledge systems	No substantial variance across age groups.	The use of IKS based biotechnology is higher among those with low levels of education.	The use of IKS based biotechnology is higher among those with low living standards.	The use of IKS based biotechnology is far higher among black Africans than other race groups	The use of IKS based biotechnology is higher in rural areas and informal urban areas
Sources of information	Younger groups are more connected across all the main media channels, with the exception of radio.	More educated groups are more likely to use the internet and print media, and less likely to use the radio.	Higher living standards are associated with greater use of print media and the internet. The group with medium living standards are most likely to use television, radio, public institutions, and other people as sources of information compared to both high and low income groups.	Each racial group exhibits a distinct pattern of media usage across the various sources of information. Black Africans are more likely to use television and radio, and Indians more likely to use the internet and print media. Whites are the least likely to use the television or radio, but more likely to use the internet than black African or coloured groups.	Those living on rural farms are less connected across all the sources of information. Those living in urban informal areas remain highly connected across all media channels.
Overall risk/benefit	Older generations are more likely to see biotechnology as a risk.	Increased educational attainment is associated with a more positive risk/benefit perception, except for those with a tertiary education, where this is strongly reversed*.	Higher living standard is associated with a greater likelihood of viewing biotechnology as a risk*.	Whites are more likely to see biotechnology as an overall risk compared to black Africans*. Indians are more negative in their assessment compared to other population groups.	Those living on rural farms and in urban informal areas are more positive than other areas in their risk/benefit assessment*.
Summary	Younger generations are successively more connected, more knowledgeable, and more positive about biotechnology compared to older generations.	More educated groups are successively more connected, more knowledgeable, and more positive about biotechnology compared to less educated groups. However, those with a tertiary education are more likely than other groups to see biotechnology as risky rather than beneficial.	Higher income groups are successively more connected, more knowledgeable, and more positive about biotechnology than lower income groups.	Indian and white groups are more knowledgeable than other groups, but attitudes towards various aspects of GM food are distinct for each group, with neither an overall positive or overall negative viewpoint for a particular race group. Each of the racial groups draws on a distinct set of sources of information.	The different geographical locations have distinct profiles of attitudes towards biotechnology. Those in urban areas are more connected and more knowledgeable (in general), but those in rural areas have greater practical knowledge and familiarity with GM crops and IKS applications of biotechnology.

** A statistically significant relationship identified through multivariate analysis*

7.4 A framework for policy implications

The evidence shows us that public engagement by the biotechnology sector takes place in the context of rapidly escalating public awareness of biotechnology. The South African public is also, in comparison to the EU, both more positive and less informed. These two factors pave the way for strategic interventions that will build up public knowledge, while at the same time cultivating constructive engagement between the public and the biotechnology sector.

Policy interventions should harness these opportunities by strategically directing accurate and constructive messages towards specific publics, on an empirically informed basis. Connectivity plays a key role. The suggested generic process is thus to firstly assess which 'publics' require engagement in terms of specific issues as identified in the key themes emerging from this report; for example, knowledge of or attitudes towards biotechnology in general, or of particular aspects of GM food, GM medicine, or IKS and biotechnology. The second stage would be to engage with these 'publics' using the sources of information they are most disposed to using for engaging with biotechnology. The third stage would be to conduct further research into qualitative and quantitative aspects of public perceptions of biotechnology in order to assess changes over time and the impact of engagement interventions.



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Appendix A: 2015 South African Social Attitudes Survey module: Public Understanding of Biotechnology

APPENDIX

Appendix A: 2015 South African Social Attitudes Survey module: Public Understanding of Biotechnology

2015 SASAS MODULE ON
Public Understanding of Biotechnology

Final Version

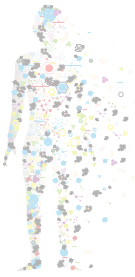
MODULE AUTHORS
Michael Gastrow
Jennifer Thomson
Vijay Reddy
Ben Roberts
Jarè Struwig
Shameelah Ismail

(62 module items)

plus

standard background variables
(personal and household characteristics)

8 October 2015



PUBLIC UNDERSTANDING OF BIOTECHNOLOGY

I am now going to ask you some questions about science and technology.

To what extent do you agree or disagree with the following statements? [Showcard 1]

		Strongly agree	Agree	Neither agree nor disagree	Dis-agree	Strongly disagree	(Do not know)
86	Science and Technology are making our lives healthier, easier, and more comfortable	1	2	3	4	5	8
87	We depend too much on science and not enough on faith	1	2	3	4	5	8
88	It is not important for me to know about science in my daily life	1	2	3	4	5	8
89	Human beings have evolved from other animals	1	2	3	4	5	8
90	Scientific advances tend to benefit the rich more than they benefit the poor	1	2	3	4	5	8

91 Overall, would you say you are very knowledgeable, somewhat knowledgeable, not very knowledgeable or not at all knowledgeable about biotechnology?

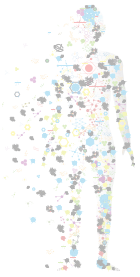
Very knowledgeable	1
Somewhat knowledgeable	2
Not very knowledgeable	3
Not at all knowledgeable	4
(Do not know)	8

92 To what extent do you agree or disagree that biotechnology is too specialized for me to understand? [Showcard 1]

Strongly agree	1
Agree	2
Neither agree nor disagree	3
Disagree	4
Strongly disagree	5
(Do not know)	8

How familiar are you with the following terms? [Showcard 6]

		Have not heard of it	Have heard of it, but know very little or nothing about it	Know enough about it to explain it to a friend	(Do not know)
93	DNA	1	2	3	8
94	Genes	1	2	3	8
95	Biotechnology	1	2	3	8
96	Genetic modification	1	2	3	8
97	Genetically modified food or GM food	1	2	3	8



Interviewer: PLEASE READ OUT the FOLLOWING DEFINITIONS OF GENES, GENETIC MODIFICATION and Biotechnology to <u>all</u> respondents.

I am now going to read out descriptions of these terms.

Biotechnology is the use of biological science to change living things and create new products. It has been used in agriculture to make crops resistant to disease. It has also been used in medicine and industry.

Genes are inside all living things. They carry information that makes living things look the way they do, such as their colour, shape and size. These characteristics are passed from one generation to the next by genes.

Genetic Modification (or GM) is used by scientists to change or remove a gene inside a living thing. This is done to change the characteristics of plants and other living things.

If you wanted to learn more about biotechnology, how likely would you be to get your information from the following sources? [Showcard 7]

		Very likely	Somewhat likely	Not very likely	Not likely at all	(Do not know)
98	TV	1	2	3	4	8
99	Radio	1	2	3	4	8
100	Print media (books, newspapers, and magazines)	1	2	3	4	8
101	Internet	1	2	3	4	8
102	School or college	1	2	3	4	8
103	Science centre	1	2	3	4	8
104	Friends or family	1	2	3	4	8

105 How much have you heard about the Public Understanding of Biotechnology programme of South Africa's Department of Science and Technology?

Nothing at all	1
A little	2
Quite a bit	3
A lot	4
(Don't know)	8

I would now like to get your views on genetically modified food. Using modern biotechnology, it is possible to make farming more productive. Genetically Modified (GM) food is derived from crops that have been genetically modified in this manner.

106 As far as you know, are genetically modified crops allowed to be grown in South Africa?

Yes	1
No	2
(Don't know)	8

107. Can you name any genetically modified crops currently grown in South Africa?

INTERVIEWER: DO NOT READ OUT OPTIONS. MULTIPLE RESPONSES ALLOWED. CIRCLE ALL THAT APPLY.

a.	Apples	01
b.	Canola	02
c.	Cotton	03
d.	Maize	04
e.	Potatoes	05
f.	Sorghum	06
g.	Soya	07
h.	Tomatoes	08
i.	Wheat	09
j.	Other crop (SPECIFY)	10
k.	None of the above	11
l.	(Do not know)	88
m.	(Never heard of genetically modified crops)	99

108 Have you ever planted seeds to grow crops?

Yes	1	→ Ask Q.109
No	2	Go to Q.110
(Don't know)	8	

109. How were the seeds obtained: -

INTERVIEWER: MULTIPLE RESPONSES ALLOWED. CIRCLE ALL THAT APPLY.

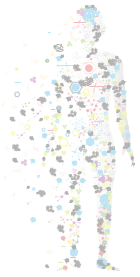
a.	Saving seeds from previous crops	1
b.	Exchanging seeds with other farmers	2
c.	Buying GM seeds	3
d.	Buying non-GM seeds	4
e.	Buying seeds (but unsure if they are GM or non-GM)	5
f.	(Don't know)	8

110. Have you ever eaten GM food?

Yes	1
No	2
(Don't know)	8

111. If you compare the maize you eat today with the maize eaten twenty years ago, would you say it…:

…is the same	1
…has a different appearance	2
…grows differently	3
…has both a different appearance and grows differently	4
(Don't know)	8



To what extent do you agree or disagree with the following statements about genetically modified food or GM food and everyday life? [Showcard 17]

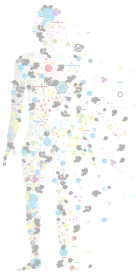
		Strongly agree	Agree	Disagree	Strongly disagree	(Do not know)
112.	I would buy GM maize if it were healthier	1	2	3	4	8
113.	I would buy GM maize if it cost less than ordinary maize	1	2	3	4	8
114.	I would buy GM maize if it were grown in a less damaging way to the environment compared to non-GM maize	1	2	3	4	8

Please assess the following statements, indicating whether you agree strongly, agree, disagree, or disagree strongly. [Showcard 17]

		Strongly agree	Agree	Disagree	Strongly disagree	(Do not know)
115.	The genetic modification of food is interfering in God's plan	1	2	3	4	8
116.	The genetic modification of food is wrong	1	2	3	4	8
117.	The international corporations that make GM foods act in an ethical manner	1	2	3	4	8

And now please to what extent you agree or disagree with the following statements. [Showcard 17]

		Strongly agree	Agree	Disagree	Strongly disagree	(Do not know)
118.	GM foods are safe to eat	1	2	3	4	8
119.	The long term health effects of eating GM food are unknown	1	2	3	4	8
120.	Products containing GM foods should be labelled	1	2	3	4	8
121.	GM foods are good for the economy	1	2	3	4	8
122.	GM foods benefit large-scale commercial farmers	1	2	3	4	8
123.	GM foods benefit small-scale subsistence farmers	1	2	3	4	8
124.	GM foods provide more secure access to food for my family	1	2	3	4	8
125.	The environmental cost of farming GM crops is higher than that of traditional farming methods	1	2	3	4	8
126.	Overall, GM foods provide more benefits than risks for society	1	2	3	4	8



Biotechnology is also used in medicine. How familiar are you with the following medical uses of biotechnology? [Showcard 6]

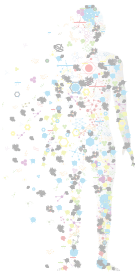
		Have not heard of it	Have heard of it, but know very little or nothing about it	Know enough about it to explain it to a friend	(Do not know)
127.	Genetic testing to detect inherited diseases	1	2	3	8
128.	Gene therapy to treat genetic conditions	1	2	3	8
129.	Production of medicines using GM organisms	1	2	3	8

Please assess the following statements, indicating whether you agree strongly, agree, disagree, or disagree strongly. [Showcard 17]

		Strongly agree	Agree	Disagree	Strongly disagree	(Do not know)
130.	Using GM organisms in the production of medicine is intervening in God's work	1	2	3	4	8
131.	Using GM organisms in the production of medicine is wrong.	1	2	3	4	8
132.	The international corporations that use biotechnology to make new medicines act in an ethical manner	1	2	3	4	8

How often have you engaged in the following traditional practices? [Showcard 8]

		Often	Sometimes	A few times	Rarely	Never	(Do not know)
133.	Using traditional medicines (such as wild herbs)	1	2	3	4	5	8
134.	Making food that uses biological processes (such as brewing traditional beer or processing sour milk)	1	2	3	4	5	8
135	Traditional farming practices (such as growing crops using the traditional knowledge of your community)	1	2	3	4	5	8



The development and use of biotechnology is governed by various laws and policies. I am going to list a number of groups in society. How much influence to you think they should have in making these laws and policies? [Showcard 9]

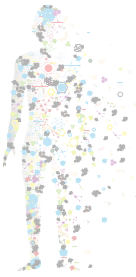
		A great deal of influence	A fair amount	A little influence	None at all	(Don't know)
136.	Environmental groups/NGOs	1	2	3	4	8
137.	International corporations	1	2	3	4	8
138.	South African businesses	1	2	3	4	8
139.	Commercial farmers	1	2	3	4	8
140.	Small scale/subsistence farmers	1	2	3	4	8
141.	Media	1	2	3	4	8
142.	Religious organisations	1	2	3	4	8
143.	South African government	1	2	3	4	8
144.	University scientists	1	2	3	4	8
145.	The general public	1	2	3	4	8

146. Do you think that GM foods are effectively regulated by the government in South Africa?

Yes	1
No	2
(Don't know)	8

147. Taking into account all that you know about this topic and thinking about you and your family, do you see biotechnology more as a benefit or more as a risk?

More as a benefit	1
More as a risk	2
Neither / indifferent	3
(Do not know)	8

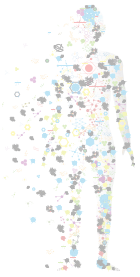


BACKGROUND VARIABLES
VOTING

I am now going to ask to a few questions about voting and elections.

220. For which party did you vote in the last national election, which was held in 2014?

INTERVIEWER: DO NOT READ OUT OPTIONS. PLEASE CIRCLE ONE OPTION ONLY	
African Christian Democratic Party (ACDP)	01
African National Congress (ANC)	02
Agang South Africa	03
Azanian People's Organisation (AZAPO)	04
Congress of the People (COPE)	05
Democratic Party / Alliance (DA)	06
Economic Freedom Fighters (EFF)	07
Freedom Front Plus / Vryheidsfront Plus (FF+/VF+)	08
Inkatha Freedom Party (IFP)	09
Minority Front (MF)	10
New Freedom Party (NFP)	11
Pan-Africanist Congress (PAC)	12
United Christian Democratic Party (UCDP)	13
United Democratic Movement (UDM)	14
Other (specify)	15
Did not vote	16
Uncertain	17
(Refuse to answer)	97
(Do not know)	98



221. If there were a national election tomorrow, for which party would you vote?

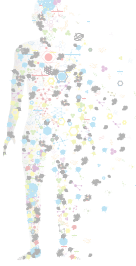
INTERVIEWER: DO NOT READ OUT OPTIONS. PLEASE CIRCLE ONE OPTION ONLY.

African Christian Democratic Party (ACDP)	01	Skip to Q.223
African National Congress (ANC)	02	
Agang South Africa	03	
Azanian People's Organisation (AZAPO)	04	
Congress of the People (COPE)	05	
Democratic Party / Alliance (DA)	06	
Economic Freedom Fighters (EFF)	07	
Freedom Front Plus / Vryheidsfront Plus (FF+/VF+)	08	
Inkatha Freedom Party (IFP)	09	
Minority Front (MF)	10	
New Freedom Party (NFP)	11	
Pan-Africanist Congress (PAC)	12	
United Christian Democratic Party (UCDP)	13	
United Democratic Movement (UDM)	14	
Other (specify)	15	
Will not vote	16	→ Ask Q.222
Uncertain	17	Skip to Q.223
(Refuse to answer)	97	
(Do not know)	98	

222. If answered 16 in Q. 221: What is your main reason for thinking that you would not vote if a national election were held tomorrow?

INTERVIEWER: DO NOT READ OUT OPTIONS. PLEASE CIRCLE ONE OPTION ONLY

Too young	01
Not interested	02
Not registered	03
Disillusioned with politics	04
Too much effort required	05
Polling station too far away	06
Fear of intimidation or violence	07
Only one party could win	08
Health reasons/sick	09
Do not have an ID book	10
Other (specify)	11



223 To which party do you feel most close?

INTERVIEWER: DO NOT READ OUT OPTIONS. PLEASE CIRCLE ONE OPTION ONLY

African Christian Democratic Party (ACDP)	01	Ask Q.224
African National Congress (ANC)	02	
Agang South Africa	03	
Azanian People's Organisation (AZAPO)	04	
Congress of the People (COPE)	05	
Democratic Party / Alliance (DA)	06	
Economic Freedom Fighters (EFF)	07	
Freedom Front Plus / Vryheidsfront Plus (FF+/VF+)	08	
Inkatha Freedom Party (IFP)	09	
Minority Front (MF)	10	
New Freedom Party (NFP)	11	
Pan-Africanist Congress (PAC)	12	
South African Communist Party (SACP)	13	
United Christian Democratic Party (UCDP)	14	
United Democratic Movement (UDM)	15	
Other (specify)	16	
No party	17	Skip to Q.225
(Refuse to answer)	97	
(Do not know)	98	

224. How close do you feel to this party?

Very close	1
Quite close	2
Not close	3
Not at all close	4
(Do not know)	8

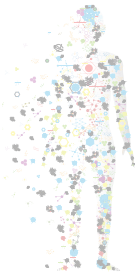
RESPONDENT CHARACTERISTICS

225. ex of respondent [copy from contact sheet]

Male	1
Female	2

226. Race of respondent [copy from contact sheet]

Black African	1
Coloured	2
Indian/Asian	3
White	4
Other	5



227. Age of respondent in completed years [copy from contact sheet]

			Years

(Don't know) = 998

228. Do you have a spouse/partner and if yes, do you share the same household?

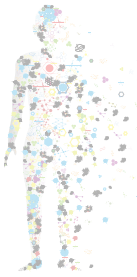
Yes, I have a spouse/partner and we live in the same household	1
Yes, I have a spouse/partner but we don't live in the same household	2
No spouse/partner	3
(Refused)	9

229. What is your current marital status?

Married	1
Civil partnership	2
Separated from spouse/civil partner	3
Divorced from spouse/ legally separated from my civil partner	4
Widowed/civil partner died	5
Never married/never in civil partnership	6
(Refused to answer)	7
(Don't know)	8

230. What is the highest level of education that you have ever completed?

No schooling	00
Grade R/ Grade 0	01
Grade 1/ Sub A/Class 1	02
Grade 2 / Sub B/Class 2	03
Grade 3/Standard 1/ ABET 1 (Kha Ri Gude, Sanli)	04
Grade 4/ Standard 2	05
Grade 5/ Standard 3/ ABET 2	06
Grade 6/Standard 4	07
Grade 7/Standard 5/ ABET 3	08
Grade 8/Standard 6/Form 1	09
Grade 9/Standard 7/Form 2/ ABET 4	10
Grade 10/ Standard 8/ Form 3	11
Grade 11/ Standard 9/ Form 4	12
Grade 12/Standard 10/Form 5/Matric	13
NTC 1/ N1/NC (V) Level 2	14
NTC 2/ N2/ NC (V) Level 3	15
NTC 3/ N3/NC (V) Level 4	16
N4/NTC 4	17
N5/NTC 5	18



N6/NTC 6	19
Diploma	20
Advanced diploma (AD)	21
Bachelor degree	22
Post graduate diploma (PGD)	23
Bachelor degree	24
Honours degree	25
Master degree	26
Doctorate degree, Laureatus in Technology	27
Other (specify)	28
(Do not know)	88

231. How many years of full time education have you completed?

INTERVIEWER: INCLUDE ALL PRIMARY AND SECONDARY SCHOOLING, UNIVERSITY AND OTHER POST-SECONDARY EDUCATION, AND FULL-TIME VOCATIONAL TRAINING, BUT DO NOT INCLUDE REPEATED YEARS. IF RESPONDENT IS CURRENTLY IN EDUCATION, COUNT THE NUMBER OF YEARS COMPLETED SO FAR.

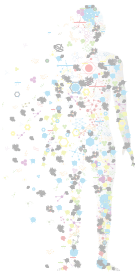
years

(No formal schooling) = 00

(Don't know) = 98

232. What language do you speak mostly at home?

Sesotho	01
Setswana	02
Sepedi	03
Siswati	04
IsiNdebele	05
IsiXhosa	06
IsiZulu	07
Xitsonga	08
Tshivenda/Lemba	09
Afrikaans	10
English	11
Other African language	12
European language	13
Indian language	14
Other (specify)	15



233. Are you currently working for pay, did you work for pay in the past, or have you never been in paid work?

I am currently in paid work	01	→ Ask Q.234
I am currently not in paid work but I had paid work in the past	02	→ Skip to Q.235
I never had paid work	03	→ Skip to Q.244
No answer	08	

234. How many hours, on average, do you usually work for pay in a normal week, including overtime?

☐☐☐ Hours

96 hours or more	96
(Do not know)	98

235. Are/were you an employee, self-employed or working for your own family's business? (Refer to your main job)

An employee	1	→ Skip to Q.237
Self-employed without employees	2	→ Skip to Q.239
Self-employed with employees	3	→ Ask Q.236
Working for your own family's business	4	→ Ask Q.236
(No answer)	9	
NAP (Never had work)	0	

236. How many employees do/did you have, not including yourself?

☐☐☐ employees

9995 employees or more	9995
(No answer)	9999
(Not applicable)	0000

237. Do/did you supervise other employees?

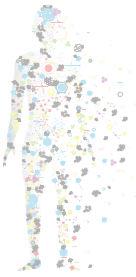
INTERVIEWER: IF NOT CURRENTLY EMPLOYED, ASK FOR MOST RECENT JOB

Yes	1	
No	2	→ Skip to Q.239
(Don't know)	8	
(No answer)	9	
(Not applicable - never had a job)	0	

238. How many other employees do/did you supervise?

☐☐☐ employees

9995 employees or more	9995
(No answer)	9999
(Not applicable)	0000



239. Do/did you work for a for profit organisation or for a non-profit organisation?

INTERVIEWER: CIRCLE ONE RESPONSE. IF NOT CURRENTLY EMPLOYED, ASK FOR MOST RECENT JOB

For-profit organisation	1
Non-profit organisation	2
(Don't know)	8
(No answer)	9
(Not applicable – never had a job)	0

240. Do/did you work for a public or private employer?

INTERVIEWER: CIRCLE ONE RESPONSE. IF NOT CURRENTLY EMPLOYED, ASK FOR MOST RECENT JOB

Public employer	1
Private employer	2
(Don't know)	8
(No answer)	9
(Not applicable – never had a job)	0

241. What is your current occupation (the name or title of your main job)?

INTERVIEWER: WRITE DOWN RESPONSE IF NOT CURRENTLY EMPLOYED, ASK FOR MOST RECENT JOB

(Refused to answer)		97
(Don't know, inadequately described)		98
(Not applicable – never had a job)		99

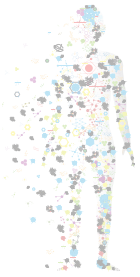
242. What kind of activities do you do most of the time (In your main job)?

INTERVIEWER: WRITE DOWN RESPONSE IF NOT CURRENTLY EMPLOYED, ASK FOR MOST RECENT JOB

(Refused to answer)		97
(Don't know, inadequately described)		98
(Not applicable – never had a job)		99

243. What does the firm/organisation you work for mainly make or do – what kind of production/function is performed at your workplace?

INTERVIEWER: IF RESPONDENT WORKED FOR MORE THAN ONE EMPLOYER, OR IF HE/SHE IS BOTH EMPLOYED AND SELF-EMPLOYED, PLEASE REFER TO THE MAIN JOB. IF HE/SHE IS RETIRED OR NOT CURRENTLY EMPLOYED, ASK FOR MOST RECENT JOB



(Refused to answer)	97
(Don't know, inadequately described)	98
(Not applicable – never had a job)	99

244. What is your current employment status? (Which of the following best describes your present work situation?)

Employed full time	01
Employed part time	02
Employed less than part time (casual work/piecework)	03
Temporarily sick	04
Unemployed, not looking for work	05
Unemployed, looking for work	06
Pensioner (aged/retired)	07
Permanently sick or disabled	08
Housewife, not working at all, not looking for work	09
Housewife, looking for work	10
Student/learner	11
Other (specify) ……	12

245. If you are married or have a partner, is he or she currently working for pay, did he/she work for pay in the past, or has he/she never been in paid work?

Currently in paid work	1	→ Ask Q.246
Currently not in paid work, paid work in the past	2	→ Skip to Q.247
Never had paid work	3	→ Skip to Q. 252
Not applicable (No partner)	0	→ Skip to Q.253

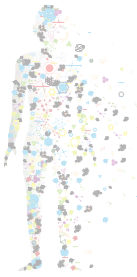
246. How many hours, on average, does your spouse /partner usually work for pay in a normal week, including overtime?

Hours

96 hours or more	96
(Do not know)	98
(No answer)	99
(Not applicable - not currently working)	00

247. Is/was your spouse/partner an employee, self-employed, or working for his/her own family's business?

An employee	1
Self-employed without employees	2
Self-employed with employees	3
Working for your own family's business	4
(No answer)	9
(Not applicable - Never had a job)	0



248. Does/did your spouse/partner supervise other employees?

INTERVIEWER: IF NOT CURRENTLY EMPLOYED, ASK FOR MOST RECENT JOB

Yes	1
No	2
(Don't know)	8
(No answer)	9
(Not applicable - never had a job)	0

249. What is /was your spouse's/partner's occupation (the name or title of your main job)?

INTERVIEWER: WRITE DOWN RESPONSE IF NOT CURRENTLY EMPLOYED, ASK FOR MOST RECENT JOB

(Refused to answer)		97
(Don't know, inadequately described)		98
(Not applicable – never had a job)		99

250. In his/her main job, what kind of activities does/did he/she do most of the time (in the main job)?

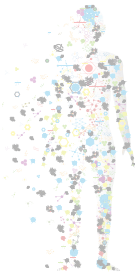
INTERVIEWER: WRITE DOWN RESPONSE IF NOT CURRENTLY EMPLOYED, ASK FOR MOST RECENT JOB

(Refused to answer)		97
(Don't know, inadequately described)		98
(Not applicable – never had a job)		99

251. What does/did the firm/organisation he/she work/worked for mainly make or do – what kind of production/function is /was performed at his/her workplace?

INTERVIEWER: IF SPOUSE/PARTNER WORKED FOR MORE THAN ONE EMPLOYER, OR IF HE/SHE IS BOTH EMPLOYED AND SELF-EMPLOYED, PLEASE REFER TO THE MAIN JOB. IF HE/SHE IS RETIRED OR NOT CURRENTLY EMPLOYED, ASK FOR MOST RECENT MAIN JOB

(Refused to answer)		97
(Don't know, inadequately described)		98
(Not applicable – never had a job)		99



252. Which of the following best describes your spouse's / partner's current situation?

In paid employment	1
Unemployed and looking for a job	2
In education (student / learner)	3
Apprentice or trainee	4
Permanently sick or disabled	5
Pensioner / retired	6
Looking after the household	7
In community service	8
Other (specify)	9

253. Are you or have you ever been a paid-up member of a Trade Union?

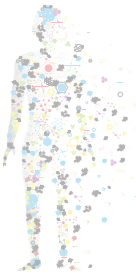
Yes, I am currently a member	1
Yes, previously but not currently	2
No, never a member	3
(Refused)	7

254. Do you consider yourself as belonging to any religion?

Yes	1	
No	2	→ Skip to Q.0

255. If answer is yes, which one? Please specify denomination

Christian (without specification)	01
African Evangelical Church	02
Anglican	03
Assemblies of God	04
Apostle Twelve	05
Baptist	06
Dutch Reformed	07
Full Gospel Church of God	08
Faith Mission	09
Church of God and Saints of Christ	10
Jehovah's Witness	11
Lutheran	12
Methodist	13
Pentecostal Holiness Church	14
Roman Catholic	15
Salvation Army	16
Seventh Day Adventist	17
St John's Apostolic	18



United Congregation Church	19
Universal Church of God	20
Nazareth	21
Zionist Christian Church	22
Other Christian	23
Islam / Muslim	24
Judaism /Jewish	25
Hinduism / Hindu	26
Buddhism / Buddhist	27
Other (specify)	28
(Refused)	97
(Do not know)	98
(Not answered)	99

256. Apart from special occasions such as weddings, funerals and baptisms, how often do you attend religious services or meetings?

Several times a week or more often	01
Once a week	02
2 or 3 times a month	03
Once a month	04
Several times a year	05
Once a year	06
Less frequently than once a year	07
Never	08
(Refused)	97
(Do not know)	98
(No answer)	99

256b. Regardless of whether you belong to a particular religion, how religious would you say you are? [Showcard 16]

Not at all religious										Very religious	(Do not know)
00	01	02	03	04	05	06	07	08	09	10	88

257. Do you or anyone in this household receive any of the following Welfare grants?

INTERVIEWER: MULTIPLE RESPONSES ALLOWED. CIRCLE ALL THAT APPLY.

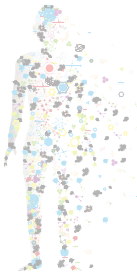
a.	Old Age Grant	01
b.	Child Support Grant	02
c.	Disability Grant	03
d.	Care dependency grant	04
e.	Foster care grant	05
f.	Grant in aid	06
g.	UIF (Blue Card) or workman's compensation	07
h.	Social Relief of Distress (emergency food parcels, food vouchers or temporary cash transfer)	08
i.	(No-one in household receiving any benefits)	09
j.	(Refused to answer)	97
k.	(Do not know)	98

258. Would you say that you and your family are…

Wealthy	1
Very comfortable	2
Reasonably comfortable	3
Just getting along	4
Poor	5
Very poor	6

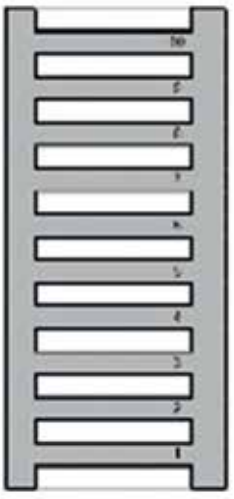
259. People sometimes describe themselves as belonging to the working class, the middle class, or the upper or lower class. Would you describe yourself as belonging to the…?

Lower class	1
Working class	2
Middle class	3
Upper middle class	4
Upper class	5
(Don't know)	8



260. In our society, there are groups which tend to be towards the top and groups which tend to be towards the bottom. Below is a scale that runs from the top to the bottom. Where would you put yourself on this scale?

TOP ….	10
	9
	8
	7
	6
	5
	4
	3
	2
BOTTOM ….	1



261. Taking all things together in your life, how would you say things are these days? Would you say you are very happy, fairly happy, fairly unhappy or very unhappy?'

Very happy	1
Fairly happy	2
Neither happy nor unhappy	3
Fairly unhappy	4
Very unhappy	5
(Don't know)	8

HOUSEHOLD CHARACTERISTICS

262. Indicate the type of main dwelling that the household occupies?

Dwelling/House or brick structure on a separate stand or yard or on farm	01
Traditional dwelling/ Hut/ Structure made of traditional materials	02
Flat or apartment in a block of flats	03
Town/cluster/semi-detached house (simplex, duplex or triplex)	04
Unit in retirement village	05
Dwelling/House/Flat/room in backyard	06
Informal dwelling/Shack in backyard	07
Informal dwelling/Shack not in backyard, e.g. in an informal/squatter settlement or on farm	08
Room/Flatlet	09
Caravan/Tent	10
Other, specify	11

263. What is the most often used source of drinking water by this household?

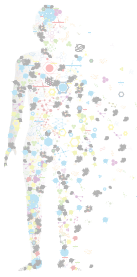
INTERVIEWER: PLEASE CIRCLE ONE NUMBER ONLY	
Piped tap water in dwelling-metered	01
Piped tap water in dwelling-pre-paid meter	02
Piped tap water on site/yard-meter	03
Piped tap water on site/yard-pre-paid meter	04
Piped tap water on site/yard-no meter	05
Public/communal tap – Free	06
Public/communal tap – Paid	07
Neighbour – Free	08
Neighbour – Paid for	09
Water carrier/tanker	10
Water carrier/tanker on site / communal	11
Borehole on site	12
Borehole off site/communal	13
Rainwater tank on site	14
Flowing river/stream	15
Dam/pool	16
Stagnant pond	17
Well	18
Spring	19
Other, specify	20

264. What type of toilet facility is available for this household?

INTERVIEWER: PLEASE CIRCLE ONE NUMBER ONLY		
Flush toilet connected to a municipal sewage system	01	
Flush toilet connected to a septic tank	02	
Chemical toilet	03	
Pit latrine with ventilation pipe (long drop)	04	
Pit latrine without ventilation pipe (long drop)	05	
Bucket toilet	06	
Other, specify ……	07	
None.	08	→ Skip to Q.266
(Do not know)	98	

265. Where is this toilet facility located?

In dwelling	1
On site (In yard)	2
Off site (outside yard)	3

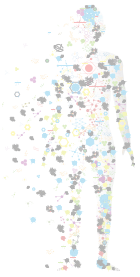


266. Do you have access to electricity in your household?

In-house meter	1
In-house pre-paid meter	2
Connected to other source which I pay for (e.g. connected to neighbour's line and paying neighbour)	3
Connected to other source which I do not pay for (e.g. connected to neighbour's line and not paying)	4
Illegal connection (e.g. connected to Eskom line)	5
Generator/battery	6
Other (specify)	7
No access to electricity	8
(Uncertain/Don't know)	9

267. Please tell me which of the following, if any, are presently in your household (in working order). Does your household have…?

		Yes	No
267.	Hot running water from a geyser	1	2
268.	Fridge/freezer combination	1	2
269.	Microwave oven (in working order)	1	2
270.	Domestic worker (live-in / part-time)	1	2
271.	Vacuum cleaner/floor polisher	1	2
272.	A washing machine	1	2
273.	A computer (desktop or laptop) at home	1	2
274.	DVD player / Blu Ray player	1	2
275.	An electric stove	1	2
276.	A TV set	1	2
277.	A tumble dryer	1	2
278.	A home telephone (excluding cellphone)	1	2
279.	No or only one radio	1	2
280.	Built in kitchen sink	1	2
281.	Home security service	1	2
282.	A deep freezer (in working order)	1	2
283.	M-Net, DStv, TopTV or other pay TV subscription	1	2
284.	A dishwashing machine	1	2
285.	There is a motor vehicle in our household	1	2
286.	Home theatre system	1	2
287.	Swimming pool	1	2
288.	Air conditioner (excluding fans)	1	2



289. How many cellphones are there presently in your household in working order? Does your household have…?

None	1
Only one cellphone in household	2
2 cellphones in household	3
3 or more cellphones in household	4

290. Do you have access to the Internet?

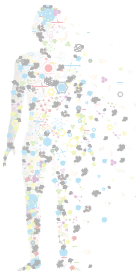
INTERVIEWER: MULTIPLE RESPONSES ALLOWED. CIRCLE ALL THAT APPLY.

a. Yes, at home	1
b. Yes, at work	2
c. Yes, at an educational institution	3
d. Yes, at an internet cafe	4
e. Yes, at a community centre	5
f. Yes, at a post office	6
g. Yes, through a cellphone	7
h. Yes, other (please specify)	8
i. None	9

PERSONAL AND HOUSEHOLD INCOME

291. Please consider the income of all household members and any income which may be received by the household as a whole. What is the main source of income in your household?

Salaries and/or wages	1
Remittances	2
Pensions and/or grants	3
Sale of farm products and services	4
Other non-farm income	5
No income	6
(Refused to answer)	7
(Don't know)	8



SHOWCARD G2

292. Please give me the letter that best describes the TOTAL MONTHLY HOUSEHOLD INCOME of all the people in your household before tax and other deductions. Please include all sources of income i.e. salaries, pensions, income from investment, etc.

293. Please give me the letter that best describes your PERSONAL TOTAL MONTHLY INCOME before tax and other deductions. Please include all sources of income i.e. salaries, pensions, income from investment, etc.

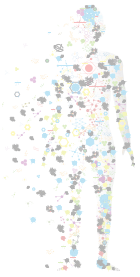
		292. Household	293. Personal
	No income	01	01
K	R1 – R500	02	02
L	R501 –R750	03	03
M	R751 – R1 000	04	04
N	R1 001-R1 500	05	05
O	R1 501 – R2 000	06	06
P	R2 001 – R3 000	07	07
Q	R3 001 – R5 000	08	08
R	R5 001 – R7 500	09	09
S	R7 501 – R10 000	10	10
T	R10 001 – R15 000	11	11
U	R15 001 – R20 000	12	12
V	R20 001 – R30 000	13	13
W	R30 001 – R50 000	14	14
X	R 50 001 +	15	15
	(Refuse to answer)	97	97
	(Uncertain/Don't know)	98	98

294. What monthly income level do you consider to be minimal for your household, i.e. your household could not make ends meet with less?

R _____
(Don't know = 98)

295. Is the total monthly income of your household higher, lower or more or less the same as this figure?

Much higher	1
Higher	2
More or less the same	3
Lower	4
Much lower	5
(Don't know)	8



APPENDIX B: SASAS 2004 PUBLIC UNDERSTANDING OF BIOTECHNOLOGY MODULE

PUBLIC UNDERSTANDING OF BIOTECHNOLOGY

115. Apart from the brand name, how often do you read the information on food labels?

Never	Seldom	Sometimes	Often	Always
1	2	3	4	5

116. What information would you like to see on food labels
[Fieldworker: Do NOT read list - multiple response]

a.	Contains pesticides	1
b.	Contains GMOs	1
c.	Fat content	1
d.	Health benefits	1
e.	Grown locally	1
f.	Country of origin	1
g.	Certified organic	1
h.	Irradiation	1
i.	More info on ingredients	1
j.	Other _____	1
k.	Don't know	1

117. What do you think of when you hear the word Biotechnology:

_____

_____

118. Is this thought about biotechnology negative or positive?

Very negative	Negative	Neither/nor	Positive	Very positive	Don't know
1	2	3	4	5	6

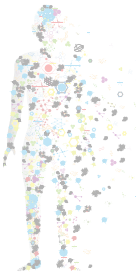
119. What do you think of when you hear the word *genetic engineering*:

_____

_____

120. Is this thought of genetic engineering negative or positive?

Very negative	Negative	Neither/nor	Positive	Very positive	Don't know
1	2	3	4	5	6



121. What do you think of when you hear the word genetic modification:

_____

_____

122. Is this thought of genetic modification negative or positive?

Very negative	Negative	Neither/nor	Positive	Very positive	Don't know
1	2	3	4	5	6

123. What do you think of when you hear the word cloning?

_____

_____

124. Is this thought of cloning negative or positive?

Very negative	Negative	Neither/nor	Positive	Very positive	Don't know
1	2	3	4	5	6

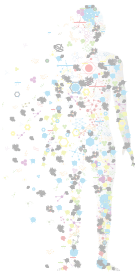
Of the following list of new technologies that are currently developing, please say whether you think they will improve, worsen or have no effect on our way of life in the next 20 years?

[FIELDWORKER: Read out options]

		Improve	No Effect	Worse	Don't know
125.	Solar energy	1	2	3	4
126.	Computers & information technology	1	2	3	4
127.	Biotechnology /Genetic engineering	1	2	3	4
128.	Nanotechnology	1	2	3	4
129.	Space exploration	1	2	3	4
130.	Nuclear energy	1	2	3	4
131.	Mobile phones / cell phones	1	2	3	4

132. As far as you know, have you ever eaten any food containing GM (Genetically Modified) ingredients?

Yes	1
No	2
Do not know	3



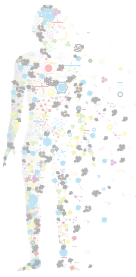
133. Can you name any foods containing GM ingredients on sale in shops or supermarkets in South Africa? If yes, please specify which foods.
[Fieldworker: Do not read list]

a.	Apples	1
b.	Canola	1
c.	Carrots	1
d.	Cereals/grains	1
e.	Cooking oils	1
f.	Maize	1
g.	Fruits – general	1
h.	Lettuce	1
i.	Meats/poultry – general	1
j.	Milk/dairy/cheese/yoghurt/eggs	1
k.	Potatoes	1
l.	Processed foods (cookies, breads, prepared foods etc)	1
m.	Soy bean products	1
n.	Tomatoes	1
o.	Vegetables – general	1
p.	Rice	1
q.	Taco shells	1
r.	Other foods (Specify)	1
s.	Everything	1
t.	Not asked question	1
u.	Don't know or no answer	1

FACTUAL KNOWLEDGE

[FIELDWORKER: Read out and randomise questions asked]

		True	False	Don't know
134.	Ordinary tomatoes as well as genetically modified tomatoes contain genes	1	2	3
135.	By eating genetically modified fruit your genes could also become modified	1	2	3
136.	Yeast brewed for beer is made of living things	1	2	3
137.	It is possible to find out in the first few months of pregnancy whether a child will have Down's Syndrome	1	2	3
138.	Genetically modified animals are always larger than ordinary animals	1	2	3
139.	It is possible to put animal genes into plants	1	2	3



ATTITUDES AND JUDGMENTS

Biotechnology is the use of living things to create products and services to meet our needs and desires.

140. Have you heard of this before?

Yes	1
No	2
Do not know	3

141. To what extent do you agree that "BIOTECHNOLOGY" is a risk for society?

Strongly agree	Agree	Neither/nor	Disagree	Strongly disagree	Don't know
1	2	3	4	5	6

142. To what extent do you agree that biotechnology is morally acceptable?

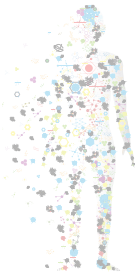
Strongly agree	Agree	Neither/nor	Disagree	Strongly disagree	Don't know
1	2	3	4	5	6

143. If you have negative feelings about biotechnology, genetic engineering, genetic modification or cloning, what is the single most important reason for these negative feelings?
[Fieldworker: Don't read list]

Violates religious/ethical principles	1
Is unhealthy for humans	2
Is unhealthy for animals	3
Is unhealthy for environment	4
Changes the taste or nutritional value of the food	5
Is just wrong	6
Other (specify)	7
Don't know	8

The following practices use biotechnology. Do you think they should be stopped or continued?

		Stopped	Continued	Don't know
144.	Making foods such as bread and cheese	1	2	3
145.	Moving genes from plants to make crops resistant to insect pests	1	2	3
146.	Using living things to make medicines	1	2	3
147.	Making biodegradable plastics (plastics that are not harmful to the environment)	1	2	3



TRUST

148. Which ONE of the following organisations do you trust MOST to tell you the truth about biotechnology?
[FIELDWORKER: Read out and only one option]

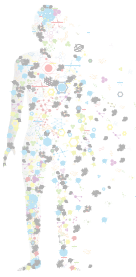
Universities	1
Consumer organisations	2
Environmental groups	3
SA Government	4
Religious organisations	5
Media	6
Industry (Private sector)	7
Don't know	8
None	9

Please say whether you agree or disagree with each of the following statements:
[FIELDWORKER: Read out options]

		Agree	Disagree	Don't know
149.	I would buy genetically modified maize if were healthier	1	2	3
150.	I would buy genetically modified maize if it cost less than ordinary maize	1	2	3
151.	I would buy genetically modified maize if it were grown in a less damaging way to the environment	1	2	3
152.	I would buy genetically modified maize if it tasted better	1	2	3
153.	I would support the police having access to everybody's genetic information to help solve crimes	1	2	3
154.	I would be willing to eat the eggs of chickens fed on genetically modified maize	1	2	3
155.	Where would you MOST like to get information about biotechnology?			

[FIELDWORKER: Read out – only one response]

Television	1
Radio	2
Newspapers	3
Magazines	4
Internet	5
All of the above	6
Other (specify)	7
Not interested	8



156. Which ONE of the following uses of biotechnology would you like to know more about?
[FIELDWORKER: Read out – only one response]

Health/medical	1
Cloning	2
GM foods/agriculture	3
Industrial	4
Environmental	5
Other (Please specify)	6
Do not know	7

Appendix C: Analysis of Variance and descriptive statistics for selected items and indices

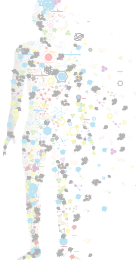
Table 58: Belief in human evolution: analysis of variance and descriptive statistics

	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	45.3	32.2		
Age group of respondent				
16-24	47.9	33.3	n.s.	
25-34	45.8	30.6	[F(4, 2466)=2.22, p=0.0647]	
35-49	44.6	32.4		
50-64	42.3	32.6		
65+	43.0	31.8		
Sex of respondent				
Male	45.1	33.3	n.s.	
Female	45.4	31.1	[F(1, 2469)=0.05, p=0.8230]	
Population group of respondent				
Black African	46.9	32.3	***	Black African > Coloured, Indian
Coloured	37.4	30.5	[F(3, 2467)=9.50, p<0.001]	White > Indian
Indian/Asian	34.1	26.7		
White	43.3	32.7		
Educational attainment				
Primary or lower	46.6	31.0	*	No subgroup differences significant
Incomplete secondary	47.2	32.4	[F(3, 2434)=3.51, p=0.0146]	
Matric or equivalent	43.2	31.9		
Tertiary or equivalent	42.1	32.9		

Living standard level				
Low living standard	43.3	31.0	*	medium > high
Medium living standard	47.0	31.6	[F(2, 2253)=4.59 p=0.0103]	
High living standard	42.8	33.2		
Geographic location				
Urban formal	43.4	32.4	***	rural trad. auth. areas > formal urban areas
Urban informal	47.3	32.8	[F(3, 2467)=7.48, p<0.001]	
Rural trad. auth. areas	50.8	30.4		
Rural farms	42.8	33.8		

Table 59: Subjective knowledge: analysis of variance and descriptive statistics

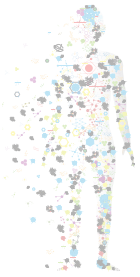
	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	26.3	31.1		
Age group of respondent				
16-24	31.6	33.3	***	16-24 > 35-49, 50-64, 65+
25-34	28.6	30.1	[F(4,2919)=20.09, p<0.001]	25-34 > 50-64, 65+
35-49	25.6	30.9		35-49, 50-64 > 65+
50-64	22.4	30.1		
65+	12.9	23.5		
Sex of respondent				
Male	28.8	31.7	***	Male > Female
Female	24.0	30.2	[F(1,2922)=17.51, p<0.001]	
Population group of respondent				
Black African	24.8	30.7	***	Indian, White > Coloured, Black African
Coloured	21.3	28.9	[F(3,2920)=27.77, p<0.001]	
Indian/Asian	42.5	33.6		
White	38.7	30.7		
Educational attainment				
Primary or lower	9.7	21.1	***	All differences statistically significant
Incomplete secondary	21.3	28.9	[F(3,2887)=133.13, p<0.001]	Tertiary > matric > incomplete secondary > primary or no schooling
Matric or equivalent	32.1	31.6		
Tertiary or equivalent	48.4	31.4		



Living standard level				
Low living standard	17.2	28.1	***	high living standard > low, medium
Medium living standard	21.8	29.5	[F(2, 2666)=54.26, p<0.001]	
High living standard	33.8	32.2		
Geographic location				
Urban formal	28.6	32.0	***	Urban formal, urban informal > rural trad. auth. areas
Urban informal	29.2	30.9	[F(3, 2920)=17.56, p<0.001]	
Rural trad. auth. areas	18.7	26.9		
Rural farms	22.9	29.4		

Table 60: Self-rated accessibility of biotechnology knowledge: analysis of variance and descriptive statistics

	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	37.1	27.7		
Age group of respondent				
16-24	39.4	27.1	***	16-24, 25-34, 35-49 > 65+
25-34	38.1	27.5	[F(4, 2412)=4.96, p<0.001]	
35-49	37.2	28.2		
50-64	35.0	27.3		
65+	29.7	28.9		
Sex of respondent				
Male	36.8	27.2	n.s.	
Female	37.4	28.2	[F(1, 2415)=0.21, p=0.6458]	
Population group of respondent				
Black African	37.8	28.2	***	All > Coloured
Coloured	28.3	25.1	[F(3, 2413)=9.46, p<0.001]	
Indian/Asian	36.8	25.3		
White	40.2	25.9		
Educational attainment				
Primary or lower	32.3	29.9	***	All differences statistically significant
Incomplete secondary	33.4	26.7	[F(3, 2383)=25.59, p<0.001]	Tertiary > matric > incomplete secondary, primary or no schooling
Matric or equivalent	39.4	26.8		
Tertiary or equivalent	47.6	28.3		



Living standard level				
Low living standard	36.7	29.0	***	high > medium
Medium living standard	34.8	27.9	[F(2, 2204)=10.10 p<0.001]	
High living standard	40.2	27.6		
Geographic location				
Urban formal	38.0	28.0	n.s.	Urban formal > urban informal, rural trad. auth. areas
Urban informal	36.3	22.7	[F(3, 2412)=2.19, p=0.0868]	
Rural trad. auth. areas	34.8	28.4		
Rural farms	33.6	28.6		

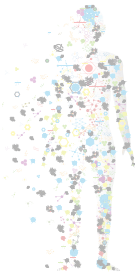
Table 61: Knowledge of core biotechnology concepts: analysis of variance and descriptive statistics

	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	37.3	29.4		
Age group of respondent				
16-24	42.3	29.7	***	16-24, 25-34 > 35-49, 50-64, 65+
25-34	39.8	28.2	[F(4, 2905)=14.85, p<0.001]	35-49, 50-64 > 65+
35-49	34.5	26.5		
50-64	34.8	32.6		
65+	28.5	30.8		
Sex of respondent				
Male	42.0	31.2	***	Male > Female
Female	33.0	27.0	[F(1, 2908)=69.26, p<0.001]	
Population group of respondent				
Black African	33.2	27.9	***	All differences statistically significant
Coloured	43.4	25.4	[F(3, 2906)=26.78, p<0.001]	White > Indian > Coloured > Black African
Indian/Asian	53.2	33.2		
White	60.1	31.1		
Educational attainment				
Primary or lower	17.0	19.8	***	All differences statistically significant
Incomplete secondary	31.4	25.9	[F(3, 2872)=242.69, p<0.001]	Tertiary > matric > incomplete secondary > primary or no schooling
Matric or equivalent	43.6	27.6		
Tertiary or equivalent	64.7	29.4		
Living standard level				
Low living standard	22.8	21.3	***	All differences statistically significant
Medium living standard	29.0	25.5	[F(2, 2651)=234.75, p<0.001]	high > medium > low
High living standard	51.7	30.2		

Geographic location				
Urban formal	42.1	30.2	***	Urban formal > all other categories
Urban informal	27.9	23.6	[F(3, 2906)=54.46, p<0.001]	
Rural trad. auth. areas	27.1	25.2		
Rural farms	31.9	29.1		

Table 62: Sources of information – TV: analysis of variance and descriptive statistics

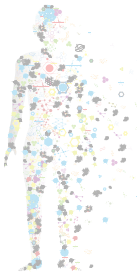
	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	71.8	35.6		
Age group of respondent				
16-24	78.8	31.8	*** F(4,2744)=25.34, p<0.001	All > 65+
25-34	72.4:	34.7		16-24 > 50-64
35-49	72.8	35.4		
50-64	67.3	37.1		
65+	52.7	39.6		
Sex of respondent				
Male	72.2	35.5	n.s. F(1,2747)=0.35, p = 0.5523	
Female	71.4	35.6		
Population group of respondent				
Black African	75.8	33.9	*** F(3, 2745)=44.79, p<0.001	Black African > rest
Coloured	58.4	37.1		
Indian/Asian	61.5	35.2		
White	55.3	38.8		
Educational attainment				
Primary or no schooling	62.9	38.9	*** F(3, 2715)=13.07, p<0.001	matric > primary, tertiary
Incomplete secondary	72.8	35.4		incomplete secondary > primary
Matric or equivalent	75.7	33.7		
Tertiary or equivalent	68.2	35.7		
Living standard level				
Low living standard	50.2	41.1	*** F(2, 2507)=33.23, p<0.001	High > medium > low
Medium living standard	75.1	34.2		
High living standard	68.5	35.8		



Geographic location				
Urban formal	72.1	34.8	*** F(3, 2745)=14.56, p<0.001	All > rural farms
Urban informal	78.0	31.8		
Rural traditional authority areas	71.9	37.3		
Rural farms	49.1	40.1		

Table 63: Sources of information – Rad: analysis of variance and descriptive statistics

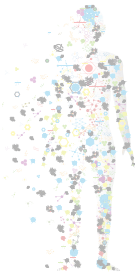
	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	60.0	37.6		
Age group of respondent				
16-24	60.9	37.8	*** F(4,2737)=6.93, p<0.001	All > 65+
25-34	61.1	35.1		
35-49	62.0	37.7		
50-64	59.7	39.2		
65+	47.3	38.9		
Sex of respondent				
Male	61.1	37.6	n.s. F(1,2740)=2.35, p = 0.1257	
Female	58.9	37.6		
Population group of respondent				
Black African	65.9	35.5	*** F(3, 2738)=96.80, p<0.001	Black African > rest
Coloured	41.8	38.1		Coloured, Indian > White
Indian/Asian	42.9	36.5		
White	32.8	35.4		
Educational attainment				
Primary or no schooling	59.1	39.0	* F(3, 2709)=3.52, p=0.0145	incomplete secondary > tertiary
Incomplete secondary	62.1	37.4		
Matric or equivalent	60.1	37.3		
Tertiary or equivalent	54.4	37.5		
Living standard level				
Low living standard	51.5	40.9	*** F(2, 2502)=61.06, p<0.001	medium > rest
Medium living standard	67.1	36.0		
High living standard	50.6	37.3		



Geographic location				
Urban formal	57.2	37.6	*** F(3, 2738)=18.44, p<0.001	urban informal, rural trad. auth. areas > urban formal, rural famers
Urban informal	74.0	30.4		
Rural traditional authority areas	64.7	37.8		
Rural farms	51.5	40.4		

Table 64: Sources of information - Print media: analysis of variance and descriptive statistics

	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	55.1	36.7		
Age group of respondent				
16-24	62.6	34.0	*** F(4,2725)=32.85, p<0.001	All > 65+
25-34	59.0	35.1		16-24 > all except 25-34
35-49	55.8	35.9		25-34, 34-49 > 50-64
50-64	44.5	39.4		
65+	37.0	36.5		
Sex of respondent				
Male	57.1	36.5	** F(1,2728)=7.16, p = 0.0075	Male >Female
Female	53.3	36.8		
Population group of respondent				
Black African	56.6	36.8	*** F(3, 2726)=11.67, p<0.001	Indian > rest
Coloured	50.9	34.4		Black African > Coloured, White
Indian/Asian	64.5	33.0		
White	44.4	37.0		
Educational attainment				
Primary or no schooling	33.8	37.6	* F(3, 2697)=73.99, p<0.001	tertiary > matric > inc sec > primary/ no schooling
Incomplete secondary	53.2	36.6		
Matric or equivalent	61.3	33.2		
Tertiary or equivalent	69.8	34.4		
Living standard level				
Low living standard	34.4	39.0	*** F(2, 2495)=36.97, p<0.001	high > medium > low
Medium living standard	52.6	37.1		
High living standard	60.9	34.7		



Geographic location				
Urban formal	55.6	35.4	*** F(3, 2726)=17.51, p<0.001	urban informal > urban formal > rural trad. auth. areas > rural farms
Urban informal	67.7	33.4		
Rural traditional authority areas	51.2	39.3		
Rural farms	38.6	42.8		

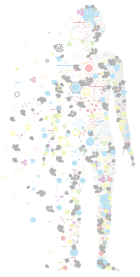
Table 65: Sources of information – Internet: analysis of variance and descriptive statistics

	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	53.7	41.7		
Age group of respondent				
16-24	73.1	35.0	*** F(4,2713)=39301, p<0.001	16-24 > rest
25-34	58.2	40.6		25-34 > all except 16-24
35-49	47.7	41.3		35-49 > 50-64, 65+
50-64	36.1	39.5		
65+	28.9	39.5		
Sex of respondent				
Male	56.5	40.5	** F(1,2716)=10.96, p <0.001	Male > Female
Female	51.2	42.6		
Population group of respondent				
Black African	52.4	41.8	*** F(3, 2714)=5.97, p<0.001	Indian > rest
Coloured	54.0	39.3		
Indian/Asian	69.3	37.5		
White	59.4	42.9		
Educational attainment				
Primary or no schooling	22.2	34.7	* F(3, 2685)=134.15, p<0.001	tertiary, matric > inc sec > primary/no schooling
Incomplete secondary	49.3	41.6		
Matric or equivalent	65.1	38.4		
Tertiary or equivalent	71.7	35.9		
Living standard level				
Low living standard	22.4	33.5	*** F(2, 2479)=82.09, p<0.001	high > medium > low
Medium living standard	47.9	41.3		
High living standard	63.7	40.0		

Geographic location				
Urban formal	55.9	41.3	*** F(3, 2714)=9.30, p<0.001	urban formal > rural trad., rural farms
Urban informal	57.0	39.9		urban informal > rural farms
Rural traditional authority areas	47.6	42.8		
Rural farms	40.8	41.0		

Table 66: Sources of information - School or college: analysis of variance and descriptive statistics

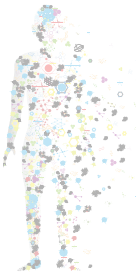
	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	46.8	40.9		
Age group of respondent				
16-24	68.9	36.7	*** F(4,2705)=108.65, p<0.001	16-24 > 25-34 > 35-49 > 50-64, 65+
25-34	48.4	39.2		
35-49	40.3	40.5		
50-64	29.7	36.4		
65+	22.7	33.4		
Sex of respondent				
Male	48.3	41.0	n.s. F(1,2708)=3.40, p=0.0652	
Female	45.4	40.8		
Population group of respondent				
Black African	49.3	41.4	*** F(3, 2706)=13.54, p<0.001	Black African > White, Coloured
Coloured	38.5	37.3		
Indian/Asian	43.1	37.5		
White	35.2	38.0		
Educational attainment				
Primary or no schooling	25.9	36.6	* F(3, 2678)=40.43, p<0.001	All > primary/no schooling
Incomplete secondary	49.6	41.4		
Matric or equivalent	51.0	40.4		
Tertiary or equivalent	50.2	39.0		
Living standard level				
Low living standard	37.6	41.6	** F(2, 2476)=4.98, p=0.0070	medium > low
Medium living standard	48.1	41.1		
High living standard	44.6	40.3		



Geographic location				
Urban formal	44.3	40.2	*** F(3, 2706)=9.08, p<0.001	Rural trad. > urban formal, rural farms
Urban informal	52.0	42.0		
Rural traditional authority areas	53.3	41.6		
Rural farms	40.9	43.2		

Table 67: Sources of information - Science Centre: analysis of variance and descriptive statistics

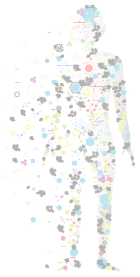
	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	46.6	42.1		
Age group of respondent				
16-24	61.7	40.9	*** F(4,2708)=47.58, p<0.001	16-24 > 25-34 > rest
25-34	49.5	42.2		35-49 > 65+
35-49	40.4	41.4		
50-64	35.8	38.5		
65+	28.1	38.1		
Sex of respondent				
Male	49.3	42.6	** F(1,2711)=10.11, p=0.0015	Male > Female
Female	44.1	41.5		
Population group of respondent				
Black African	48.4	42.2	*** F(3, 2709)=6.83, p=0.0001	Black African > White, Coloured
Coloured	41.4	39.2		
Indian/Asian	45.8	41.3		
White	37.4	43.0		
Educational attainment				
Primary or no schooling	29.6	39.6	*** F(3, 2680)=25.98, p<0.001	All > primary/no schooling
Incomplete secondary	49.2	42.0		
Matric or equivalent	47.6	41.7		
Tertiary or equivalent	53.6	41.9		
Living standard level				
Low living standard	31.4	41.3	*** F(2, 2478)=8.10, p=0.0003	high, medium > low
Medium living standard	46.6	41.8		
High living standard	47.0	42.4		



Geographic location				
Urban formal	44.7	41.6	*** F(3, 2709)=7.92, p<0.001	Rural trad. > urban formal, rural farms
Urban informal	53.4	41.8		urban informal > rural farms
Rural traditional authority areas	51.6	43.2		
Rural farms	35.9	42.9		

Table 68: Sources of information - Friends or family: analysis of variance and descriptive statistics

	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	46.8	38.8		
Age group of respondent				
16-24	52.8	39.8	*** F(4,2725)=10.25, p<0.001	16-24 > 35-49, 50-64, 65+
25-34	48.1	37.7		All > 65+
35-49	44.6	38.4		
50-64	43.7	38.3		
65+	35.5	38.0		
Sex of respondent				
Male	46.7	38.0	n.s. F(1,2728)=0.00, p=0.9789	
Female	46.8	39.5		
Population group of respondent				
Black African	50.1	39.0	*** F(3, 2726)=30.87, p<0.001	Black African, Indian > Coloured, White
Coloured	31.2	35.9		
Indian/Asian	49.8	30.7		
White	33.0	35.3		
Educational attainment				
Primary or no schooling	41.7	40.3	** F(3, 2697)=4.47, p=0.0039	incomplete secondary > primary/ no schooling
Incomplete secondary	49.3	39.9		
Matric or equivalent	47.3	38.3		
Tertiary or equivalent	43.6	34.0		
Living standard level				
Low living standard	45.7	40.4	*** F(2, 2496)=12.88, p<0.001	medium > high
Medium living standard	49.4	39.3		
High living standard	41.3	37.3		



Geographic location				
Urban formal	44.8	38.2	*** F(3, 2726)=12.38, p<0.001	Rural trad., urban informal > urban formal, rural farms
Urban informal	55.2	38.2		urban formal > rural farms
Rural traditional authority areas	51.8	39.4		
Rural farms	33.1	40.5		

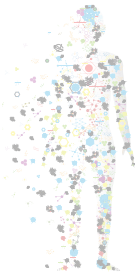
Table 69: Awareness of the PUB programme: analysis of variance and descriptive statistics

	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	17.2	25.9		
Age group of respondent				
16-24	21.0	28.6	***	16-24, 24-34, 35-39 > 50-54, 65+
25-34	18.6	25.1	[F(4, 2905)=12.45, p<0.001]	
35-49	17.2	26.1		
50-64	12.7	22.8		
65+	10.4	22.4		
Sex of respondent				
Male	20.0	28.0	***	Male > Female
Female	14.6	23.6	[F(1, 2908)=32.13, p<0.001]	
Population group of respondent				
Black African	17.2	25.6	***	White, Indian > Black African > Coloured
Coloured	8.7	19.4	[F(3, 2906)=17.61, p<0.001]	
Indian/Asian	22.9	29.0		
White	23.9	29.9		
Educational attainment				
Primary or lower	8.1	19.1	***	All differences statistically signif-icant
Incomplete secondary	13.9	23.8	[F(3, 2873)=54.20, p<0.001]	Tertiary > matric > incomplete secondary > primary or no schooling
Matric or equivalent	21.2	27.7		
Tertiary or equivalent	28.3	29.7		
Living standard level				
Low living standard	14.4	25.1	***	high > rest
Medium living standard	15.3	24.2	[F(2, 2652)=13.68 p<0.001]	
High living standard	20.6	28.5		

Geographic location				
Urban formal	17.8	26.4	***	Urban informal, urban formal > rural trad. auth. areas
Urban informal	23.1	28.0	[F(3, 2906)=10.04, p<0.001]	
Rural trad. auth. areas	13.0	22.2		
Rural farms	18.1	28.7		

Table 70: Growing GM crops in South Africa: analysis of variance and descriptive statistics

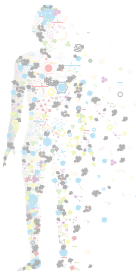
	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	0.54	0.50		
Age group of respondent				
16-24	0.59	0.49	***	16-24 > 50-54, 65+
25-34	0.56	0.50	[F(4, 2878)=5.85, p<0.001]	25-34 > 65+
35-49	0.51	0.50		
50-64	0.49	0.50		
65+	0.45	0.50		
Sex of respondent				
Male	0.58	0.49	***	Male > Female
Female	0.49	0.50	[F(1, 2881)=23.09, p<0.001]	
Population group of respondent				
Black African	0.53	0.50	**	all > Coloured
Coloured	0.46	0.50	[F(3, 2879)=5.29, p=0.0012]	
Indian/Asian	0.61	0.49		
White	0.62	0.49		
Educational attainment				
Primary or lower	0.40	0.49	***	All differences statistically signif-icant
Incomplete secondary	0.49	0.50	[F(3, 2851)=36.62, p<0.001]	Tertiary > matric > incomplete secondary > primary or no schooling
Matric or equivalent	0.58	0.49		
Tertiary or equivalent	0.75	0.44		
Living standard level				
Low living standard	0.55	0.50	*	high > medium
Medium living standard	0.51	0.50	[F(2, 2630)=4.31 p<0.0136]	
High living standard	0.57	0.49		



Geographic location				
Urban formal	0.52	0.50	n.s.	
Urban informal	0.60	0.49	[F(3, 2879)=2.07, p=0.1015]	
Rural trad. auth. areas	0.54	0.50		
Rural farms	0.60	0.49		

Table 71: Eating GM food: demographics: analysis of variance and descriptive statistics

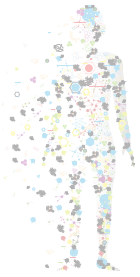
	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	0.48	0.50		
Age group of respondent				
16-24	0.50	0.50	***	all > 65+
25-34	0.51	0.50	[F(4, 2848)=6.10, p<0.001]	
35-49	0.49	0.50		
50-64	0.44	0.50		
65+	0.34	0.48		
Sex of respondent				
Male	0.50	0.50	*	Male > Female
Female	0.46	0.50	[F(1, 2851)=23.09, p=0.0257]	
Population group of respondent				
Black African	0.49	0.50	***	all > Coloured
Coloured	0.32	0.47	[F(3, 2849)=10.01, p<0.001]	
Indian/Asian	0.55	0.50		
White	0.48	0.50		
Educational attainment				
Primary or lower	0.38	0.49	***	tertiary > matric > incomplete secondary, primary or no schooling
Incomplete secondary	0.43	0.50	[F(3, 2819)=25.80, p<0.001]	
Matric or equivalent	0.51	0.50		
Tertiary or equivalent	0.67	0.47		
Living standard level				
Low living standard	0.52	0.50	n.s.	
Medium living standard	0.47	0.50	[F(2, 2602)=0.91 p=0.4041]	
High living standard	0.49	0.50		



Geographic location				
Urban formal	0.45	0.50	***	rural trad. auth. areas > urban formal
Urban informal	0.45	0.50	[F(3, 2849)=8.16, p<0.001]	
Rural trad. auth. areas	0.57	0.50		
Rural farms	0.44	0.50		

Table 72: Planted seeds to grow crops: analysis of variance and descriptive statistics

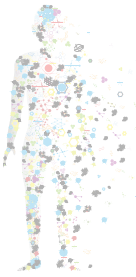
	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	0.38	0.48		
Age group of respondent				
16-24	0.34	0.47	***	50-64, 65+ > 16-24, 25-34, 35-49
25-34	0.34	0.47	[F(4, 2876)=15.85, p<0.001]	
35-49	0.33	0.47		
50-64	0.50	0.50		
65+	0.51	0.50		
Sex of respondent				
Male	0.41	0.49	**	Male > Female
Female	0.35	0.48	[F(1, 2879)=10.60, p=0.0011]	
Population group of respondent				
Black African	0.40	0.49	***	all > Coloured
Coloured	0.22	0.41	[F(3, 2877)=12.90, p<0.001]	
Indian/Asian	0.41	0.49		
White	0.33	0.47		
Educational attainment				
Primary or lower	0.54	0.50	***	primary or no schooling > rest
Incomplete secondary	0.38	0.49	[F(3, 2848)=25.85, p<0.001]	incomplete secondary > matric
Matric or equivalent	0.30	0.46		
Tertiary or equivalent	0.32	0.47		
Living standard level				
Low living standard	0.64	0.48	***	All differences statistically signif-icant
Medium living standard	0.41	0.49	[F(2, 2628)=47.00 p<0.001]	low > medium > high
High living standard	0.28	0.45		



Geographic location				
Urban formal	0.32	0.47	***	rural trad. auth. areas, rural farms > urban formal, urban informal
Urban informal	0.21	0.41	[F(3, 2877)=64.05, p<0.001]	
Rural trad. auth. areas	0.58	0.49		
Rural farms	0.54	0.50		

Table 73: Comparing maize eaten: analysis of variance and descriptive statistics

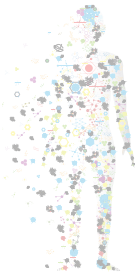
	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	0.85	0.76		
Age group of respondent				
16-24	0.79	0.78	n.s.	
25-34	0.89	0.74	[F(4, 2888)=2.09, p=0.0792	
35-49	0.86	0.76		
50-64	0.89	0.76		
65+	0.88	0.82		
Sex of respondent				
Male	0.84	0.76	n.s.	
Female	0.87	0.77	[F(1, 2891)=1.15, p=0.2829]	
Population group of respondent				
Black African	0.92	0.75	***	Black African, Indian > Coloured, White
Coloured	0.49	0.73	[F(3, 2889)=36.63, p<0.001]	
Indian/Asian	0.95	0.81		
White	0.63	0.79		
Educational attainment				
Primary or lower	0.98	0.79	***	primary or no schooling > incomplete secondary, tertiary
Incomplete secondary	0.80	0.73	[F(3, 2859)=6.46, p<0.001]	
Matric or equivalent	0.87	0.78		
Tertiary or equivalent	0.80	0.76		
Living standard level				
Low living standard	0.94	0.77	n.s.	
Medium living standard	0.91	0.75	[F(2, 2638)=16.30 p<0.001]	
High living standard	0.74	0.78		



Geographic location				
Urban formal	0.79	0.77	***	rural farms, rural trad. auth. areas > urban formal
Urban informal	0.93	0.71	[F(3, 2889)=14.52, p<0.001]	
Rural trad. auth. areas	1.00	0.75		
Rural farms	1.02	0.81		

Table 74: Attitude towards buying GM: analysis of variance and descriptive statistics

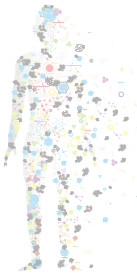
	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	68.2	22.1		
Age group of respondent				
16-24	70.5	19.6	***	16-24 > 50-64, 65+
25-34	68.6	21.5	[F(4, 2351)=6.39, p<0.001]	25-34, 35-49 > 65+
35-49	68.7	23.0		
50-64	65.4	23.0		
65+	62.6	26.0		
Sex of respondent				
Male	68.5	21.8	n.s.	
Female	67.9	22.3	[F(1, 2354)=0.53, p=0.4647]	
Population group of respondent				
Black African	70.5	19.8	***	Black African > rest
Coloured	66.1	19.8	[F(3, 2352)=49.11, p<0.001]	Coloured, Indian > White
Indian/Asian	62.2	20.5		
White	53.3	32.3		
Educational attainment				
Primary or lower	67.4	19.8	***	incomplete secondary > tertiary
Incomplete secondary	70.1	20.8	[F(3, 2328)=6.11, p<0.001]	
Matric or equivalent	67.9	22.9		
Tertiary or equivalent	63.9	25.8		
Living standard level				
Low living standard	69.1	16.4	***	medium > high
Medium living standard	69.7	20.6	[F(2, 2156)=9.85 p<0.001]	
High living standard	65.3	25.0		



Geographic location				
Urban formal	67.7	22.8	n.s.	
Urban informal	72.2	19.8	[F(3, 2352)=2.41, p=0.0648]	
Rural trad. auth. areas	68.4	21.2		
Rural farms	67.3	19.5		

Table 75: GM food morality: analysis of variance and descriptive statistics

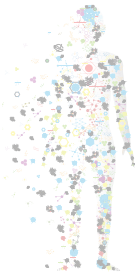
	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	49.1	25.7		
Age group of respondent				
16-24	51.0	25.5	n.s.	
25-34	47.1	26.9	[F(4, 2096)=2.26, p=0.0603]	
35-49	50.2	24.6		
50-64	48.7	25.4		
65+	46.7	26.0		
Sex of respondent				
Male	48.1	26.8	n.s.	
Female	50.0	24.6	[F(1, 2099)=2.85, p=0.0918]	
Population group of respondent				
Black African	49.1	24.9	n.s.	
Coloured	51.5	24.9	[F(3, 2097)=1.10, p=0.3465]	
Indian/Asian	46.6	25.3		
White	47.5	30.6		
Educational attainment				
Primary or lower	46.6	25.1	*	tertiary > primary or no schooling
Incomplete secondary	49.2	25.2	[F(3, 2079)=3.11, p=0.0256]	
Matric or equivalent	49.2	26.0		
Tertiary or equivalent	53.1	25.2		
Living standard level				
Low living standard	44.4	26.1	***	high > med, low
Medium living standard	47.4	25.0	[F(2, 1927)=10.38 p<0.001]	
High living standard	52.5	26.7		



Geographic location				
Urban formal	49.7	26.3	*	no subgroup differences significant
Urban informal	53.0	21.1	[F(3, 2097)=3.49, p<0.0152]	
Rural trad. auth. areas	46.2	24.7		
Rural farms	48.1	28.9		

Table 76: Knowledge of medical biotechnology: analysis of variance and descriptive statistics

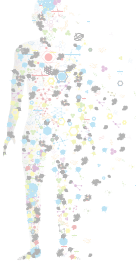
	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	19.5	27.3		
Age group of respondent				
16-24	22.4	28.1	***	16-24 > 35-49, 50-64, 65+
25-34	21.8	27.3	[F(4, 2908)=6.73, p<0.001]	25-34 > 50-64, 65+
35-49	17.5	27.0		
50-64	16.4	25.6		
65+	16.4	27.5		
Sex of respondent				
Male	21.2	28.3	**	Male > Female
Female	18.0	26.3	[F(1, 2911)=9.83, p=0.0017]	
Population group of respondent				
Black African	17.0	25.3	***	White > Indian, Coloured > Black African
Coloured	21.7	26.7	[F(3, 2909)=46.69, p<0.001]	
Indian/Asian	27.0	29.6		
White	36.1	35.1		
Educational attainment				
Primary or lower	8.9	19.7	***	All differences statistically significant
Incomplete secondary	15.9	24.2	[F(3, 2885)=72.39, p<0.001]	tertiary > matric > incomplete secondary > primary or no schooling
Matric or equivalent	22.8	27.9		
Tertiary or equivalent	34.5	32.5		
Living standard level				
Low living standard	9.4	19.0	***	All differences statistically significant
Medium living standard	15.4	24.0	[F(2, 2664)=68.36 p<0.001]	high > med > low
High living standard	27.1	31.2		



Geographic location				
Urban formal	22.4	28.6	***	urban formal > urban informal, rural trad. auth. areas
Urban informal	14.3	21.9	[F(3, 2909)=22.71, p<0.001]	
Rural trad. auth. areas	13.0	23.6		
Rural farms	17.8	24.3		

Table 77: Attitudes towards medical biotechnology: analysis of variance and descriptive statistics

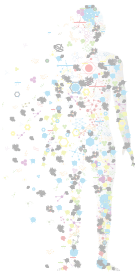
	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	50.9	24.6		
Age group of respondent				
16-24	51.1	23.8	n.s.	
25-34	51.3	26.6	[F(4, 1962)=1.10, p=0.3546]	
35-49	50.6	21.9		
50-64	48.9	25.3		
65+	53.8	26.5		
Sex of respondent				
Male	50.3	24.6	n.s.	
Female	51.4	24.6	[F(1, 1965)=1.07, p=0.3022]	
Population group of respondent				
Black African	49.5	24.8	***	White, Coloured > Indian, Black African
Coloured	57.1	21.3	[F(3, 1963)=9.03, p<0.001]	
Indian/Asian	48.1	21.7		
White	56.2	25.2		
Educational attainment				
Primary or lower	47.2	25.6	*	tertiary > rest
Incomplete secondary	51.9	24.3	[F(3, 1948)=12.89, p<0.001]	incomplete secondary > primary or no schooling
Matric or equivalent	48.3	24.6		
Tertiary or equivalent	58.2	23.5		
Living standard level				
Low living standard	42.8	25.0	***	high > med, low
Medium living standard	48.0	24.4	[F(2, 1807)=27.14 p<0.001]	
High living standard	56.0	24.3		



Geographic location				
Urban formal	52.3	24.4	***	urban formal > rural trad. auth. areas
Urban informal	53.4	23.5	[F(3, 1963)=7.65, p<0.001]	
Rural trad. auth. areas	46.3	24.7		
Rural farms	47.7	26.8		

Table 78: Biotechnology and Indigenous Knowledge Systems: analysis of variance and descriptive statistics

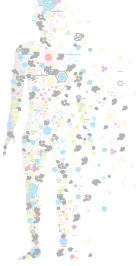
	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	37.0	32.5		
Age group of respondent				
16-24	36.3	32.3	n.s.	
25-34	38.3	33.0	[F(4, 2667)=2.22, p=0.0649]	
35-49	35.5	31.9		
50-64	39.9	32.6		
65+	33.5	33.3		
Sex of respondent				
Male	37.3	33.0	n.s.	
Female	36.7	32.1	[F(1, 2670)=0.18, p=0.6678]	
Population group of respondent				
Black African	43.3	32.1	***	Black African > rest
Coloured	15.3	23.9	[F(3, 2668)=138.05, p<0.001]	
Indian/Asian	16.6	26.4		
White	13.0	19.5		
Educational attainment				
Primary or lower	49.9	31.9	***	primary or no schooling > rest
Incomplete secondary	38.0	33.0	[F(3, 2648)=36.08, p<0.001]	incomplete secondary, matric > tertiary
Matric or equivalent	34.6	31.9		
Tertiary or equivalent	25.8	27.7		
Living standard level				
Low living standard	57.9	32.6	***	All differences statistically significant
Medium living standard	44.9	32.1	[F(2, 2443)=186.95 p<0.001]	low > med > high
High living standard	22.4	27.8		



Geographic location				
Urban formal	32.4	31.2	***	all < urban formal
Urban informal	43.0	30.2	[F(3, 2668)=37.34, p<0.001]	
Rural trad. auth. areas	47.2	33.9		
Rural farms	44.9	35.6		

Table 79: Perceived effectiveness of government regulation: analysis of variance and descriptive statistics

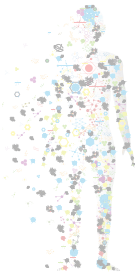
	Mean	Std. Dev.	ANOVA	Post hoc Scheffe
South Africa	0.43	0.49		
Age group of respondent				
16-24	0.48	0.50	***	16-24, 25-34 > 50-64, 65+
25-34	0.48	0.50	[F(4, 2904)=12.31, p<0.001]	35-49 > 65+
35-49	0.42	0.49		
50-64	0.36	0.48		
65+	0.27	0.44		
Sex of respondent				
Male	0.44	0.49	n.s.	
Female	0.42	0.49	[F(1, 2907)=1.78, p=0.1824]	
Population group of respondent				
Black African	0.47	0.50	***	Black African > Coloured, White
Coloured	0.32	0.46	[F(3, 2905)=25.14, p<0.001]	Indian > White
Indian/Asian	0.40	0.49		
White	0.23	0.42		
Educational attainment				
Primary or lower	0.33	0.47	***	tertiary > matric, inc sec > primary or no schooling
Incomplete secondary	0.43	0.49	[F(3, 2882)=14.75, p<0.001]	incomplete secondary > primary or no schooling
Matric or equivalent	0.44	0.49		
Tertiary or equivalent	0.57	0.49		
Living standard level				
Low living standard	0.44	0.49	*	med > high
Medium living standard	0.45	0.49	[F(2, 2661)=3.60 p=0.0276]	
High living standard	0.40	0.49		



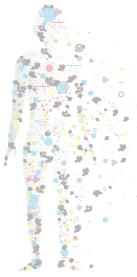
Geographic location				
Urban formal	0.40	0.49	***	all > urban formal
Urban informal	0.56	0.49	[F(3, 2905)=12.94, p<0.001]	
Rural trad. auth. areas	0.47	0.50		
Rural farms	0.57	0.49		

Appendix D: Indicators used for multivariate modelling

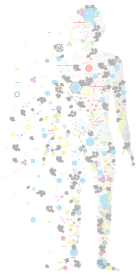
	Scale	Mean (95% CI)
Dependent variables		
Self-rated knowledge of biotechnology Overall, would you say you are very knowledgeable, somewhat knowledgeable, not very knowledgeable or not at all knowledgeable about biotechnology?	1 - 4	1.79 (1.72-1.85)
Objective knowledge Index constructed based on 5 questions concerning level of familiarity with the following terms: DNA, genes, biotechnology, genetic modification and GM food. Three precoded responses were provided to respondents, namely 'have not heard of it', 'have heard of it, but know little or nothing about it' and 'know enough about it to explain it to a friend', which were assigned values of 0, 1 and 2 respectively; 'do not know' responses were also assigned a value of zero. An additive scale was constructed based on the five items, ranging between a 0 (no knowledge) and 10 (maximum knowledge).	0 - 10	3.73 (3.51-3.96)
Knowledge of GM food The measure derives from three variables in the module. The first is a dummy variable based on whether respondents believe that 'genetically modified crops are allowed to be grown in South Africa'. The second variable is an index of how many of the three crops that contain GM genes that are legally allowed to in South Africa (White and yellow maize, soya and cotton) respondents are able to correctly identify. As such is scaled from 0 to 3, with zero indicating that none of the crops were identified and three denoting that all were mentioned by the respondent. The third indicator is another dichotomous variable focusing on whether the respondent reports ever having eaten GM food. In constructing the final knowledge of GM food measure, the three items were transformed into 0-100 scores and then averaged together.	0 – 100	39.6 (37.3-41.9)
Factors encouraging the purchasing of GM food An index was produced by combining responses to the following three statements: (i) 'I would buy GM maize if it were healthier'; (ii) 'I would buy GM maize if it cost less than ordinary maize'; and (iii) 'I would buy GM maize if it were grown in a less damaging way to the environment compared to non-GM maize'. Three dichotomous variables were constructed, based on whether or not survey participants voiced agreement with the statements or not. A value of 1 was assigned to those answering 'strongly agree' or 'agree', while a value of 0 was given to 'disagree', 'strongly disagree' and 'don't know' responses. A simple 0-3 index was derived through an additive process, with higher scores representing a greater tendency towards expressing a willingness to purchase GM food if it offers clear benefits.	0 – 3	2.18 (2.10-2.36)
Perceived effectiveness of government's regulation of GM foods This is a dichotomous variable based on responses to the question 'Do you think that GM foods are effectively regulated by the government in South Africa?'. Negative and 'don't know' responses were coded as 0 and positive responses coded as 1.	0 - 1	0.44 (0.40-0.47)

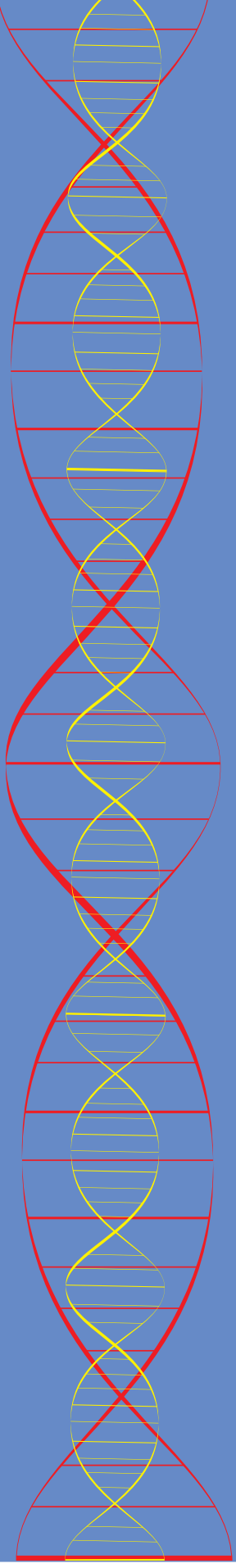


Knowledge of medical biotechnology Index constructed based on 3 questions concerning level of familiarity with the following medical uses of biotechnology: (i) genetic testing to detect inherited diseases; (ii) gene therapy to treat genetic conditions; and (iii) the production of medicines using GM organisms. Three precoded responses were provided to respondents, namely 'have not heard of it', 'have heard of it, but know little or nothing about it' and 'know enough about it to explain it to a friend', which were assigned values of 0, 1 and 2 respectively; 'do not know' responses were also assigned a value of zero. An additive scale was constructed based on the 3 items, ranging between a 0 (no knowledge) and 6 (maximum knowledge).	0 – 6	1.17 (1.05-1.29)
Overall evaluation of risks versus benefits of biotechnology This is based on the categorical outcome responses to the following questions: 'Taking into account all that you know about this topic and thinking about you and your family, do you see biotechnology more as a benefit or more as a risk?'. Three responses were provided for respondents to choose from, namely 'more as a benefit', 'more as a risk' and 'neither/indifferent'. This categorical variable does not lend itself neatly to ordinal regression analysis and a sizeable share of adults (22%) answered 'don't know'. Use is made of a multinomial (polychotomous) regression, since this method best suits dependent variables with several categorical outcomes.	1 – 3	Benefit category (1): 30.3 (27.3-33.5) Risk category (2): 23.0 (20.3-25.8) Indifferent category (3): 25.0 (22.3-27.9) Don't know: 21.7 (19.1-24.5)
Overall level of agreement with the view GM foods provide more benefits than risk to society The indicator used derives from a question that asks respondents to rate their level of agreement with the statement that 'overall, GM foods provide more benefits than risks for society'. Answers were captured using a four point agreement scale, ranging from strong agreement to strong disagreement and excluding a neutral category. The share answering 'don't know' was again high (36%), and so a decision was made to collapse responses into three outcome categories, namely agreement (benefit), disagreement (risk) and 'don't know' (uncertain). Multinomial logistic regressions were performed, with disagreement (risk) as the baseline outcome category.	1 – 3	Benefit category (1): 46.0 (42.5-49.4) Risk category (2): 18.5 (16.3-21.0) Don't know: 35.5 (31.8-39.4)
Independent variables		
Female	0 - 1	0.52 (0.49-0.55)
Age	16 - 95	38.1 (37.1-39.0)
Age squared	256 – 9025	1711.3 (1631.6-1790.8)
Population group (ref. Black African)		
Coloured	0 - 1	0.09 (0.07-0.11)
Indian / Asian	0 - 1	0.03 (0.02-0.04)
White	0 - 1	0.10 (0.07-0.13)
Education (ref. primary/no schooling)		
Incomplete secondary	0 - 1	0.40 (0.37-0.43)
Matric	0 - 1	0.33 (0.31-0.37)
Tertiary	0 - 1	0.11 (0.09-0.13)
Subjective Poverty (ref. Poor)		
Non-poor	0 - 1	0.31 (0.28-0.35)
Just getting by	0 - 1	0.43 (0.40-0.46)
Religiosity Scale (Ref. Highly religious 8-10)		
Not very religious (0-4)	0 - 1	0.16 (0.14-0.19)
Moderately religious (5-7)	0 - 1	0.37 (0.34-0.40)
Population group (ref. Black African)		



Urban formal	0 - 1	0.67 (0.61-0.73)
Urban informal	0 - 1	0.08 (0.03-0.13)
Rural farms	0 - 1	0.03 (0.01-0.05)
Disagree that we over-rely on science	1 – 5	2.23 (2.17-2.29)
Importance of science in daily life	1 – 5	2.91 (2.84-2.99)
Knowledge of GM food	0 – 100	39.6 (37.3-41.9)
Knowledge of medical biotechnology	0 – 100	19.5 (17.6-21.5)
Knowledge of PUB programme	0 – 100	17.2 (15.4-18.9)
Index of perceived benefits of GM food	0 – 5	2.48 (2.33-2.62)
Absence of ethical objections to GM food	0 – 2	0.80 (0.75-0.85)
Perceived effectiveness of GM food governance	0 – 1	0.44 (0.40-0.47)
Absence of ethical objections to medical biotechnology	0 – 2	0.71 (0.67-0.76)
Factors influencing the purchasing of GM food	0 – 100	68.2 (66.5-69.9)
Planted seeds for crops	0 – 1	0.38 (0.34-0.41)
Engaged in traditional farming practices	1 – 5	2.27 (2.15-2.38)
Identified changes in appearance and growth of maize	0 – 2	0.85 (0.80-0.90)





Biotechnology offers great opportunities for sustainable human development and economic growth. However, biotechnology faces several challenges in the public sphere. The public have mixed perceptions of what biotechnology is, how it is governed, how knowledge is produced, and how the benefits are distributed and accrued. In order to inform policy in the sector, the Public Understanding of Biotechnology programme of the South African Agency for Science and Technology Advancement commissioned a national survey of the South African public's perceptions of biotechnology. This included perceptions of agricultural biotechnology, medical biotechnology, and indigenous biotechnology knowledge. The results of this study provide indications of what the public know about biotechnology, how the public feel about a range of biotechnology-related issues, how the public access information about biotechnology, and the manner in which the public perceive biotechnology-related products. This publication offers new insights into the position of biotechnology in the public imagination, and how the institutions of science and the public sector may better engage with the public in a constructive manner.

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