From lab to fork? Press coverage and public (mis)perception of crop biotechnology in Uganda

by

Nathanael Ivan Lukanda

Dissertation presented for the degree of Doctor of Philosophy (Journalism), Faculty of Arts and Social Sciences, Stellenbosch University

Supervisor: Prof. George Claassen

2018

Declaration

This dissertation, *From lab to fork? Press coverage and public (mis)perception of crop biotechnology in Uganda*, was conducted at the Department of Journalism, Stellenbosch University (SU) from January 2016 to June 2018. It has never been submitted anywhere for any award. All assistance sought, and any work referred to in the arguments, are evidently acknowledged. Otherwise, all figures and tables used, except where acknowledged as sourced, are mine.

Date: December 2018

Abstract

This study explores the structure of the controversy surrounding genetically modified organisms (GMOs) in Uganda. It focuses on how two local newspapers, the *New Vision* and the *Daily Monitor*, cover the subject, and on the public perception regarding a contested science (biotechnology), promoted and de-campaigned in the same pages simultaneously. The aim was to establish the different ways in which media coverage of biotechnology influences public perception of its products, especially crop (food) GMOs, in Uganda. It draws on the science-in-society model, the public sphere and the media logic theoretical framework as a lens for understanding Uganda's case in this global debate. The study used content analysis, a face-to-face survey and in-depth interviews to obtain data and analyse Uganda's intricate situation in terms of having GMOs on the market in the absence of an enabling law to commercialise what is in the country's laboratories (labs).

The key findings indicate that the coverage and perception of GMOs are shaped by the contours of capitalism, mistrust in government institutions and outright misinformation, all tied to personal and societal beliefs. The controversy is laced with discrimination, noticeable in the sharp-tongued accusations and counter-accusations. The debate has been described as a "distortion", "deception", "complexity", "confrontation", "murky" and an "opportunistic interaction". In the two newspapers analysed for the purposes of this study, biotechnology was largely covered by freelancers, who were caught between evidence-based science reporting and providing a voice to all stakeholders on a subject newspaper editors consider peripheral in the light of audience and advertiser flight. Biotechnology is politicised to make it sellable. Legislation dominates the fault-finding elitist debate, driven mostly by events in other countries. Men are six times more likely to be used as sources in stories on biotechnology, but women's chances of being quoted more than triple when they are quoted in the same story with men. Experts have limited impact as both scientists, and non-(pseudo) scientists are major sources of information on biotechnology, a mark of weakened cultural authority of science in the post-expert age. Biotechnology is a controversial subject in the newsroom and in society. Newspapers are part of the chain link for creating awareness, educating, sustaining debate and generating an 'issues culture'. The scientist-journalists' relationship determines how biotechnology is covered. Ethics, health, patents, contamination, sustainability and bioterrorism are risk concerns. Biotechnology remains a fulcrum for scientific, cultural, political and economic arguments. The debate on GMOs is also a clash of traditions between conservationists and their pro-GMO opponents. The youth are more likely to oppose GMOs in a debate from which farmers are hardly represented. There is stigmatisation of information sources, and yet a change in source of information and increase in knowledge are more likely to have a negative impact on individuals' perceptions of the risks of GMOs. Public desire for face-to-face engagements with scientists is increasing, even though scientists' technical opinions seem to be an inconveniencing luxury in the polarised debate. This study births an economic-media bicycle-chain model to tentatively explain the key issues in the debate.

The study recommends the use of training in science communication to jump-start public engagement with biotechnology and other science subjects by inspiring academic involvement, increasing scientists' branding, promoting scientific culture and stimulating public participation. The use of edutainment images/visuals in science communication could enhance discussions and weave science into the fabric of citizens' day-to-day life as a form of accountability to the taxpayers who fund research. In addition, communicators should use traditional and digital media to harvest ideas to organise content, report about and engage with experts and their audience on new styles of storytelling that can be adopted to pave the way for dialogue on biotechnology and other science-related topics. Further, the study recommends the integration of a BrainLab in science institutions' curriculum to equip future researchers with the creative communication skills to engage the media, policymakers and the public, as researchers get credit for mentoring their students in such outreaches; researchers can also get input in such forums through crowdsourcing and feedback for feedforward in future research. Such an approach is expected to promote team science communication and prevent science from getting lost through translation.

Key words: activists, biotechnology, GMOs, journalists, policymakers, public engagement, science communication, scientists.

Opsomming

Hierdie studie dring deur die struktuur van die polemiek rondom geneties gemodifiseerde organismes (GMO's) in Uganda deur te fokus op hoe twee plaaslike koerante, die *New Vision* en die *Daily* Monitor, die onderwerp dek, asook op die openbare persepsies van 'n omstrede wetenskap (biotegnologie) wat terselfdertyd in dieselfde blaaie bevorder en teen gestry word. Die doel was om die verskillende maniere te bepaal waarop die mediadekking van biotegnologie in Uganda die openbare persepsie van die produkte daarvan beïnvloed, veral gewas (voedsel) GMO's. Dit gebruik die wetenskap-in-die-samelewing-model, die openbare sfeer en die media logika teoretiese raamwerk as 'n lens om die geval van Uganda in hierdie globale debat te verstaan. Die studie het gebruik gemaak van inhoudsanalise, 'n aangesig-tot-aangesig opname en diepte-onderhoude om Uganda se ingewikkelde situasie te analiseer in terme waarvan dit GMO's in die mark het in die afwesigheid van 'n magtigingswet vir die kommersialisering van wat in die land se laboratoriums gevind kan word.

Die vernaamste bevindings dui daarop dat die dekking en persepsie gevorm word deur die kontoere van kapitalisme, gebrek aan vertroue in regeringsinstansies en blatante valse berigte, wat almal gekoppel is aan persoonlike en samelewingsoortuigings. Die twispunt is deurtrek van diskriminasie, wat merkbaar is in die bitsige beskuldigings en teenbeskuldigings. In die twee koerante wat vir die doelwit van hierdie studie bestudeer is, is biotegnologie grootliks deur vryskutwerkers gedek, wat vasgevang is tussen bewyse-gebaseerde wetenskapsverslaggewing en die verskaffing van 'n stem vir alle belanghebbers oor 'n onderwerp wat koerantredakteurs beskou as op die rand in die lig van die vrees dat hulle lesers en adverteerders sal verloor. Biotegnologie word verpolitiseer om dit verkoopbaar te maak. Wetgewing domineer die foutvindende elitistiese debat, wat hoofsaaklik gedryf word deur gebeure in ander lande. Dit is ses keer meer waarskynlik dat mans as bronne gebruik word in stories oor biotegnologie, maar die kanse dat vrouens aangehaal word, verhoog drievoudig wanneer hulle in dieselfde storie as mans aangehaal word. Deskundiges het 'n beperkte impak, aangesien beide wetenskaplikes en nie(skyn)-wetenskaplikes vername bronne van inligting oor biotegnologie is, wat tekenend is van stukkende magstrukture in die ná-deskundige era. Biotegnologie is 'n omstrede onderwerp in die nuuskantoor en in die samelewing. Koerante vorm deel van 'n ketting vir die skep van bewussyn, onderrig, onderhoud van debatte en generering van 'n kultuur wat fokus op kwessies. Die verhouding tussen wetenskaplikes en joernaliste bepaal hoe biotegnologie gedek word. Etiek, gesondheid, patente, besmetting, volhoubaarheid en bio-terrorisme is risiko's waaroor kommer heers. Biotegnologie bly 'n

spilkop waarom wetenskaplike, kulturele, politiese en ekonomiese argumente draai. Die debat oor GMO’s behels ook ’n stryd tussen die tradisies van bewaringsgesindes en hulle pro-GMO opponente. Daar is ’n groter kans dat die jeug gekant sal wees teen GMO’s, maar boere is merkwaardig afwesig in die debat. Daar is stigmatisering van inligtingsbronne, en tog is daar ’n groter kans dat ’n verandering in die bron van inligting en ’n vermeerdering van kennis ’n negatiewe impak op individue se persepsies van die risiko’s van GMO’s sal hê. Die publiek se behoefte aan aangesig-tot-aangesig ontmoetings met wetenskaplikes is aan die toeneem, al behels die wetenskaplikes se tegniese opinies ’n luukse ongemak in die gepolariseerde debat. Hierdie studie lei tot die ontstaan van ’n ekonomie-media fietskettingmodel (*bicycle-chain model*) om sleutelkwessies in die debat voorlopig te verduidelik.

Die studie beveel dus die gebruik aan van opleiding in wetenskapskommunikasie om publieke betrokkenheid by biotegnologie en ander wetenskapsonderwerpe aan die gang te kry deur akademiese betrokkenheid te inspireer, die ‘handelsmerk’ van wetenskaplikes te verbeter, ’n wetenskaplike kultuur te bevorder en publieke deelname te stimuleer. Die gebruik van prente/beelde in wetenskapskommunikasie kan besprekings verbeter en wetenskap in die inrigting van burgers se daaglikse lewe verweef as ’n vorm van aanspreeklikheid aan die belastingbetalers wat die navorsing befonds. Daarbenewens moet kommunikeerders tradisionele en digitale media gebruik om idees te bekom om inhoud te organiseer, verslag te doen oor en betrokke te raak by kundiges en hulle gehore oor nuwe style van storievertelling wat aangepas kan word om die weg te baan vir dialoog oor biotegnologie en ander wetenskapsverwante onderwerpe. Verder beveel dit die integrasie van ’n BrainLab in die kurrikulum van wetenskapsinstellings om toekomstige navorsers toe te rus met die kreatiewe kommunikasievaardighede wat nodig is om met die media, beleidmakers en die publiek betrokke te raak, aangesien navorsers krediet kry as hulle hul studente in sulke uitreike mentor; navorsers kan ook insette in sulke forums kry deur *crowdsourcing* en vanuit terugvoer as vooruit voer vir toekomstige navorsing. Daar word verwag dat só ’n benadering sal keer dat die wetenskap verlore gaan deur vertaling.

Sleutelwoorde: aktiviste, beleidmakers, biotegnologie, GMO’s, joernaliste, openbare betrokkenheid, wetenskaplikes, wetenskapskommunikasie

Acknowledgement

This dissertation is an output of very many people who supported me in what could have been a lonely walk. I am grateful to my supervisor, Prof. George Claassen, for his patience, mentorship and dedication, and the invaluable comments in guiding me to improve my drafts. I am indebted to Prof. Lizette Rabe, the head of the Journalism Department at SU, for ushering me to the PhD table, where I shared ideas with and received ideas from supervisors and colleagues in the PhD programme. Mrs Elizabeth Newman ensured that my work environment was always perfect.

Special thanks to the Vice-Rector's office, for offering me a scholarship to do the PhD. Dr Cindy Lee Steenkamp, the Director of the Graduate School of Arts and Social Sciences, Mrs Yolanda Johnson, and Ms Tanja Malan, the coordinators at the Graduate School, in succession, ensured that I did not worry about my survival in Stellenbosch.

To members of my cohort: Amon Mwine, Peter Msaka, Nobert Basweti, Lunga Tshabalala, Miché Thompson, Jackline Ojiambo, Dominick Makanjila, Yakubu Ibrahim and Saibu Mutaru – you provided the necessary academic company. My officemates, Fred Ochoti, thank you for the company. Thank you Thulani Tshabangu and Bimbo Fafowora for the encouragement. Former Maties: Dr Levis Mugumya, Dr Medard Sentanda, Dr Edgar Nabutanyi, Dr James Ocita, Dr Sarah Nakijjaoba, Dr Eve Nabulya, Dr. Sibongile Mpofu and Dr. Mphathisi – thank you for the inspiration. To Moses Malinda, Keith Dinabantu, Lwando Nkhamisa, Jude Mugarula and Paul Wabiga, thank you for supporting me.

I am equally grateful to Ulli and Heide Lehmann, for organising the home fellowship that provided the much-needed fun every Thursday. I extend my gratitude to Maama Maggie Goosen of the International Fellowship, for assisting me in getting comfortable accommodation.

I appreciate my interviewees and survey respondents, for sparing time to participate in this study. I am grateful to my research assistants, Brian, Bonny and Deo, for strengthening my team. Xolela, your assistance during data analysis was invaluable. Sara Namusoga and Peter Msaka, thank you for helping me with the illustrations in Figure 4.1 and 8.1 respectively.

I thank Makerere University for granting me leave to embark on this study. I appreciate the inspiration of my colleagues at Makerere University: Prof. Goretti Nassanga, Dr Patricia Litho, Dr William Tayeebwa, Dr Aisha Nakiwala, Dr Fred Kakooza, Mr Wilson Kaija, Ms Marion

Alina, Mrs Harriet Sebaana and Mrs Robinah Kiiza. Ms Hellen Nabulya, your assistance is very much appreciated. I grateful to Mr. David Ouma Balikowa for the mentorship, and Rev. Grace Lubaale for the inspiration.

To my grandparents, parents and siblings, thank you for giving me the necessary support over the years that has enabled me to attain the PhD. My brothers, Isaac and Joseph, thank you for running my errands in Uganda while I was in South Africa.

To the Wankya, Kyalo, Dhamuzungu and Mubangizi families – you provided the necessary moral support to keep my family going. Mr David Luyiriika, Ms Agnes Natukunda, Rev. Ronald Kalende and the Shiloh family, your prayers increased my hope of a brighter future.

Of course, I am invaluably indebted to my wife, Anne, for taking care of our children, Elizabeth and Elisha, as I conducted this research. I know that my achievement does not make sense to you, Elizabeth and Elisha, because you are too young, but the thought of attending to you invigorated me to work harder and to complete in time.

Above all, thank You God, for the grace to start and complete this study (Philippians 1:6).

Dedication

To my wife, Anne, who supported me throughout this study.

Table of Contents

List of Tables

List of Figures

List of acronyms

CRISPR: Clustered Regulatory Interspaced Short Palindromic Repeats

DNA: Deoxyribonucleic acid

EPA: Environmental Protection Agency

EU: European Union

GDP: Gross domestic product

GE: Genetic engineering

GM: Genetic modification

GMOs: Genetically modified organisms

IARC: International Agency for Research on Cancer

ISAAA: International Service for Acquisition of Agri-biotech Applications

MAAIF: Ministry of Agriculture, Animal Industry and Fisheries

NAADS: National Agricultural Advisory Services

NaCRRI: National Crop Research Resources Centre

NARO: National Agricultural Research Organisation

NARL: National Agricultural Research Laboratories

NGOs: Non-governmental organisations

OWC: Operation Wealth Creation

UMWA: Uganda Media Women's Association

UNCST: Uganda National Council of Science and Technology

UPDF: Uganda People's Defence Forces

WHO: World Health Organisation

Organisation of the dissertation

This dissertation comprises eight chapters. Chapter 1 introduces the study by highlighting: i) the rationale, ii) background, iii) context, iv) objectives, v) research questions, vi) motivation, vii) significance, viii) problem statement, and ix) key results.

Chapter 2 is a literature review that identifies the knowledge gap and the position of the media in the debate. It consists of six parts: i) presentation of biotechnology; ii) news values; iii) role of the media in the biotechnology debate; iv) media coverage of controversies; v) knowledge gaps about biotechnology; and vi) relationship between scientists and journalists.

Chapter 3 describes the trifocal theoretical framework informing the study. It comprises: i) the science-in-society model; ii) science communication and the public sphere, and iii) the media logic theory. The chapter discusses the background to the theories and explains the reasons for using the theories to underpin the study.

Chapter 4 lays out the methodology. It discusses the research design, justifies the choice of the mixed-methods (triangulation) approach, and the methods, techniques and samples used. The chapter explains the reliability and validity of the results as well.

Chapter 5 outlines the results obtained from the content analysis and the in-depth interviews. It specifically answers questions 1 and 2. Chapter 6 outlines results from the face-to-face survey and in-depth interviews, and specifically answers questions 3 and 4. Both chapters use tables, figures and text to visualise the results according to the research questions.

Chapter 7 discusses the findings presented in Chapters 5 and 6. It draws on literature from different sources to provide a context for understanding the debate on genetically modified organisms (GMOs) in Uganda. This chapter also spells out the implications of the findings.

Chapter 8 provides the conclusion, along with the recommendations of the study. The conclusion is presented as a media-economics bicycle-chain model before its components are explained one-by-one. The conclusions precede the limitations of the study. Recommendations are then drawn from the conclusions. The recommendations are grouped into three: i) media; ii) science communication; and iii) further research.

Chapter 1
Introduction

The media operate at the interface between genetic researchers and the public, they are likely to play an important role in shaping public perceptions of genetics and its value and applications (Petersen, 2001:1256)

1.1 Rationale and preliminary study

This study sought to analyse the role of public debate and the media with regard to crop biotechnology (genetically modified organisms [GMOs]) in Uganda. It focuses on how media coverage, and specifically the coverage by two Ugandan daily newspapers, the *New Vision* and the *Daily Monitor*, can be integrated into public debate in disseminating scientific knowledge, igniting discussion and shaping debate on the controversy entangling biotechnology. The year 2012 marked a watershed period when Uganda started to legislate on overcoming the challenges of food quantity and quality using modern biotechnology to produce GMOs. In that year, Uganda drafted the Biotechnology and Biosafety Bill (2012), as stipulated by international law (Republic of Uganda, 2012). Internationally, the Cartegena Protocol on Biosafety Convention on Biological Diversity requires that the application of such technology must be preceded by a domestic law to protect human, animal and environmental health from the possible adverse effects of the products, including GMOs (Secretariat of the Convention on Biological Diversity, 2000).

Media coverage of the controversy related to what journalists have baptised the “GMO bill” has since showed that there is growing public interest in understanding how agricultural products, especially food, may be produced in the future. Such a move borders on embedding science in and making it indistinguishable from public daily lives. This study analyses how two leading Ugandan newspapers, the *New Vision* and *Daily Monitor*, covered the issue from 2012 to 2015. The study further assesses the newspaper content against public perceptions of GMOs.

The study assumes that media reportage on biotechnology is important in understanding the perceptions of the possibility of using GMOs to improve crop production in order to minimise the effects of hunger and malnutrition, while enhancing farmers’ income and the country’s gross domestic product (GDP). It is also vital to know the key issues that spur the debate to understand why Uganda’s GMOs have remained in science laboratories (labs), yet the yields of small-scale farmers continue to dwindle as crops succumb to pests, diseases, and drought amidst biting poverty in the country. The key stakeholders (actors) in the debate are biotechnologists, journalists, anti-GMO non-governmental organisations (NGOs) (also referred to as civil society or activists), government, other scientists, and farmers (at times referred to as the general public). These actors have been involved in an emotive debate on the domestication of GMOs. Their disagreements range from whether the Bill should ban or facilitate GMO development, to whether the government has the capacity to sustain an agricultural sector with GMOs in Uganda.

This chapter introduces the study by providing a background to the topic, the research problem, the motivation and rationale for the study, its objectives, and the research questions of the study. It also highlights the theoretical framework, methodology, and key findings of the study.

1.2 Background to the study

Biotechnology is the use of living materials or their products to generate or modify other products, and to enhance the quality of plants, animals and other organisms for specific purposes (Okafor & Okafor, 2017; Republic of Uganda, 2012). Biotechnology is also referred to as the "genetic manipulation", genetic modification (GM) or genetic engineering (GE) of living organisms to produce useful products for people (Rodriguez & Lee, 2016:102). Biotechnology has been exploited commercially, at times contentiously, in the medical and pharmaceutical fields to make products such as insulin and antibiotics; in industry to make bread, wine, beer, yogurt and juice and for the extraction of cobalt; in forensics to identify deoxyribonucleic acid (DNA) at crime scenes and determining parentage; and in agriculture to breed crops and animals (Giorno & Drioli, 2000).

The contention, however, is most pronounced in agriculture, where it can be used to produce GMOs, often simply referred to as GM food or GM crops (Hicks, 2017; Ventura, Frisio, Ferrazzi & Siletti, 2017). For the purposes of this study, the terms biotechnology and GM[Os] will be used interchangeably. The techniques in crop biotechnology involve the use of living organisms or components from such living things to make or improve a plant in ways that cannot be achieved or replicated through ordinary means, such as natural selection and grafting. Ordinary breeding takes a long time and may produce both the desirable and undesirable traits (Yıkmış, Gülüm, Aksu & Alpaslan, 2017). There are claims that these techniques can improve food production through genetic transfer to produce GMOs that are believed to be tolerant of drought, pests and diseases, produce higher yields, and have better tastes (International Service for Acquisition of Agri-biotech Applications [ISAAA], 2016). Yet the associated risks are debatable and form the hallmark of the heated emotive debates, largely mediated by journalists

(Bhatta & Misra, 2016; Priest, 2008). The actors or stakeholders in these debates are usually biotechnologists, scientists who are not biotechnologists, civil society, policymakers and the general public (ordinary people who do not belong to any of the groups specified herein).

The application of biotechnology in plant and crop breeding has been part of human civilisation for millennia, but it only became a distinct discipline a century ago (Pantchev, Rakleova, Pavlov & Atanassov, 2018). The science has been evolving over time to suit different interests. Nonetheless, public interest started emerging in the 1970s, with the development of recombinant DNA (Kurath & Gisler, 2009; Priest, 2008). The progress marked a paradigm shift from conventional biotechnology, such as grafting in plants and artificial insemination in animals, to modern (laboratory) biotechnology. Under modern biotechnology, scientists can manipulate specific genes in a plant to increase yields, modify the period of maturity, make the plant tolerant to specific pests and diseases, or any other possibility (Republic of Uganda, 2008b). For more than two decades, the public debate on biotechnology remained subtle, but it was triggered to a higher level by the importation of GM Monsanto Roundup Ready soya into Britain in 1996 (Bauer, 2002b). In 1997, public interest heightened when scientists in Scotland announced that they had cloned the first mammal – Dolly the sheep. Based on the Scottish cloning of Dolly, the debate burgeoned further in 1998, when American scientist Richard Seed threatened to make children for couples not capable of producing children naturally, in what Danish scholar, Maja Horst, described as a "cloning sensation" (Horst, 2005:185). In response, Horst (2005) notes that the Danish newspapers and technophobes called upon authorities to protect society against scientific controversy before an ethical disaster could happen. Yet biotechnology is rated one of the significant scientific "revolutions" in the world (Chen, Chu, Lin & Chiang, 2016:1).

Compared to other forms of science, such as physics, chemistry and astronomy, which have existed for centuries, biotechnology is a relatively nascent, but growing branch of modern agricultural technology around the world. Crop biotechnology was first commercialised in the United States of America (USA) in 1996. Since then, 26 countries around the world have adopted GMOs, and acreage has grown from 4.3 million to 5,312 million acres (ISAAA, 2016:7). The USA, Brazil, Argentina, Canada, India, Paraguay, Pakistan and China are the leading producers of GMOs. Spain, Portugal, Slovakia and the Czech Republic are the only European countries growing GMOs. Soybean, maize, cotton and canola were the most planted crops according to the 2016 ISAAA report. The report lists South Africa and Sudan as the only African countries growing GMOs. An earlier report included Burkina Faso for growing Bt.

Cotton (ISAAA, 2015:1). By 2017, 12 African countries were researching the possibilities of growing GMOs (Cerier, 2017).

ISAAA cites the unsuitable regulatory systems that foreground uncertainty as the major constraint to the adoption of GMOs. American companies Monsanto[1] and Dupont, and the Swiss multinational Syngenta, control 75% of the GM seed market, even though Switzerland itself has not commercialised GMOs (GMWatch, 2017). These GM seed companies are also chemical manufacturers, producing pesticides and herbicides sold in a cocktail. The newness of the technology, the backtracking of some countries, and the failure by countries hosting some of the GM companies to approve GMOs, seem to amplify the uncertainty surrounding biotechnology.

1.3 Uganda – the context of the study

The study was conducted in the Kampala and Wakiso districts in Uganda. Wakiso encircles Uganda's capital Kampala and is home to many city dwellers and farmers. As such, the district has the characteristics of both a rural and urban area. Specifically, the survey was conducted in Busukuma sub-county, which hosts the National Crops Resources Research Institute (NaCRRI) at Namulonge. The survey involved two sites neighbouring Namulonge, namely Kasambya (rural) and Kiwenda (urban). The sites were chosen because the two communities interact with the institute by way of providing accommodation and labour to some of its casual and technical staff. It was anticipated that such communities would have better knowledge about biotechnology and GMOs than any other geographical community in the country. By studying a rural and an urban area, the study obtained a wealth of information from the different settings with minimum resources. The study location is illustrated in Figure 1.1.

As illustrated in Figure 1.1 on the next page, Uganda is a landlocked country in East Africa. It gained its independence from Britain in 1962. Uganda has had nine presidents, without changing power peacefully. It covers an area of 236,040 km^2. Agriculture is a major economic activity, contributing 24% of the GDP (Uganda Bureau of Statistics [UBOS], 2016a).

The GDP, i.e. the total expenditure on all final goods and services produced within the country, is USD 26 billion (World Bank, 2017a). With a population of about 41 million people and a GDP per capita of USD 615.3, Uganda is described as a low-income country (World Bank, 2017a). The International Monetary Fund (IMF) ranks Uganda 25th on its list of the poorest

[1] Monsanto was bought by Bayer in June 2018.

countries (Gregson, 2017). About 60% of the country's working population is involved in the agricultural sector (World Bank, 2017a).

Figure 1.1: Map of Uganda, showing the area where the research was conducted (Credit: Google Images)

Despite the significant contribution to the GDP, the agricultural sector has not received the attention it requires, leaving many parts of the country occasionally in dire need of food. A

Food and Agricultural Organisation ([FAO], 2017) annual state of food insecurity report indicates that Uganda is at high risk of hunger and undernourishment. Several reports have highlighted the problem of hunger and its consequences of malnutrition, along with the inability to think and work, that have resulted in mortality over the decades (FAO, 2017; Magulu, 2009; Mugisha, 2000). The drive toward the adoption of biotechnology seems to be a response to such reports.

Through the National Agricultural Research Organisation (NARO), Uganda established national centres for agricultural research in biotechnology at the National Agricultural Research Laboratories (NARL) at Kawanda launched in 2003, and later the National Crops Resources Research Institute (NaCRRI) at Namulonge, and at other institutions in different parts of the country. With these facilities, Uganda has developed crop GMOs in bananas, cassava, maize and rice, among others (NaCRRI, 2015). Research in biotechnology has been guided by the National Biotechnology and Biosafety Policy 2008 (Republic of Uganda, 2008a). These GMOs, sometimes referred to as ‘innovations’, cannot be commercialised and therefore cannot be adopted. This is due to the lack of an enabling law that will allow farmers to grow them for the market (Watsemwa, 2015; Kawooya, 2016). It took Parliament five years to pass the Biotechnology and Biosafety Bill (Republic of Uganda, 2012), which was clouded in controversy. The controversy became even more glaring when the president refused to assent to the Bill being passed in October 2017 and returned it to Parliament in December the same year, citing the law’s inability to protect native species and to guard against contamination, especially regarding maize (Okuda, 2017b).

The controversies around biotechnology are many. They include health and environmental concerns; labelling of GMOs; intellectual property rights of the innovations; and the use of genetic information. Other controversies are the privatisation of research activities and the impact of biotechnology on biodiversity. However, Bauer and Gaskell (2002a) argue that the most fundamental issues for the public are the rights and wrongs of modern biotechnology. In the case of Uganda, the loss of control over seeds, the strength of the agricultural system to sustain GMOs, and the ability of institutions to regulate GMOs are research-worthy. The gist of this study was biotechnology as the science relates to crops, and how this scientific endeavour is perceived in Ugandan society through a process of science communication.

The controversies have been at the centre of the postponement of the Ugandan Parliament’s passing of the Uganda Biotechnology and Biosafety Bill since 2013 (Zawedde, Gumisiriza, Tibasaaga, Mugwanya, & Muhumuza, 2016; Emorut, 2017). The controversies are a sign that there is a divide between the proponents of biotechnology (the biotechnologists) and the opponents of biotechnology, who are mainly non-biotechnology scientists, policymakers, civil society and the general public.

It then is not surprising that the attention given to GMOs has increased worldwide and in Africa over the last two decades (Bauer & Gaskell, 2002a; Cerier, 2017; Lamphere & East, 2016). In the case of Uganda, reporting about the controversies related to GMOs started in this century, when the idea of enacting a law was mooted (Luganda & Tenywa, 2002; Tenywa & Price, 2003). Public debate started a decade later, however, when the Bill was drafted in 2012. The debate intensified in 2013, when the Bill was presented before Parliament for the first reading, and in 2015, when the National Resistance Movement (NRM), the ruling political party, 'whipped' its Members of Parliament (MPs) to support the Bill the next time it was presented (Wesonga, 2015). The NRM passed the Bill in October 2017, without noticeable resistance, since some opposition MPs had been suspended and others were boycotting the Speaker's action.

Against this backdrop, the present study sought to analyse the logic used by the two media houses to cover biotechnology and GMOs, and how their coverage reflects or could have influenced public perception in Uganda. More concretely, the study has investigated how the two Ugandan dailies, the *New Vision* and the *Daily Monitor*, cover biotechnology, especially GMOs, and compare the coverage with public perceptions of GMOs. It focuses on the period starting in 2012, when the Bill was enacted, until the year 2015, when the ruling party agreed to support it. No studies similar to the current one were found to cover that period.

1.4 Objectives of the study

The major objective of this study was to establish the different ways in which media coverage of biotechnology influences public perception of its products, especially GMOs, in Uganda. The specific objectives were to:

1. analyse how the *New Vision* and the *Daily Monitor* present news about crop biotechnology and the factors that influence the media logic;
2. establish the role of the press in the biotechnology debate;
3. establish the existing public perception about biotechnology-related products in Uganda; and

4. explore the knowledge gaps in the biotechnology debate in Ugandan society.

1.5 Central research question

To attain the above objectives, the study was guided by a key research question: In what ways does media coverage of biotechnology influence public perception about its products, especially GMOs, in Uganda?

1.6 Specific research questions

The specific research questions were:

1. How do the *New Vision* and the *Daily Monitor* present biotechnology? Focus:
    i. Prominence
    ii. Format
    iii. Size of articles
    iv. Basis of articles
    v. Gender of author
    vi. Origin of story
    vii. Stories by key words
    viii. Focus of articles
    ix. Tone of articles
    x. Controversy
    xi. Gender of sources quoted
    xii. Type of photographs used
2. What is the role of the *New Vision* and the *Daily Monitor* in the science communication process of informing the public and in shaping the debate about biotechnology? Focus:
    i. Awareness
    ii. Education
    iii. Sustaining debate
    iv. Issues culture
3. What is the public perception of biotechnology and GMOs in Uganda? Focus:
    i. Place
    ii. Gender
    iii. Education

iv. Age
v. Income status
vi. Occupation
vii. Risk association
viii. Sources of information
ix. Engaging scientists
x. Action on GMOs
xi. Willingness to grow GMOs

4. What are the knowledge gaps in the biotechnology debate in Uganda? Focus:
   i. Risks
   ii. Uncertainty
   iii. Indeterminacy
   iv. Ambiguity
   v. Ignorance

1.7 Motivation for this study

This study was inspired by the growing interest in the subject of GMOs, especially their expected benefits amidst global scientific, economic, political, legal and moral controversies (Bauer, 2002a; Bagley, 2007, Feindt & Kleinschmit, 2011; Gupta, 2017; Imperiale & Casadevall, 2015), yet the same issue is controversial in Uganda. A preliminary review of the literature showed that the Ugandan media have been covering GMOs since the beginning of the 21st century (Ariko, 2002; Luganda & Tenywa, 2002), but no studies were found on how the media, particularly the press, have been covering the debate. One study focused on consumers' willingness to buy GM bananas (Kikulwe, Wesseler & Falck-Zepeda, 2011). This study focused on aspects of attitudes and perception, but not on the media. Another study focused on how the media cover science and technology in Africa (UNESCO, 2011). UNESCO's study explored the probability of biotechnology being covered as science subject alongside other topics such as health, physics, astronomy and climate change in four African countries, namely Cameroon, Kenya, South Africa and Uganda. Both studies were conducted before Uganda started legislating about biotechnology. The present study delves into the specifics of one of the subjects highlighted by UNESCO's broad study. It also reconceptualises Kikulwe *et al.*'s study by introducing the media into the debate on public perception about GMOs.

Furthermore, the study is an attempt to localise a global controversy, pitting the claimed need for a higher quantity and better quality of food against perceptions of the processes through which food is produced (Bauer & Gaskell, 2002b; Hicks, 2017). Thus, the need to locate Uganda in the questioning of food production processes amidst challenges of food shortages provided a second motivation.

The third motivation is the idea that the media are essential in shaping perception by directing debate (Bhatta & Misra, 2016; Clancy & Clancy, 2016; Liu, 2017). To gain the broader context of public perceptions of biotechnology in Uganda, it was necessary to consider the factors that determine how the press cover the subject and also understand the knowledge of the general public about biotechnology. The Bill is discussed in this study, as it is a gateway to GMOs. The Bill is analysed in the context of the interests it may protect or endanger, and how such shielding or exposure may have an impact on perception.

1.8 Significance of the study

There is increasing interest in press coverage of controversial issues. These include topics such as climate change, tobacco, cancer, ufology, minorities and homosexuality (Fowler & Gollust, 2015; Pierro, Barrera, Blackstock, Harding, McCue & Metatawabib, 2013; Pigliucci, 2010). In the case of Uganda, the most recent controversial subjects have been climate change (Berglez, & Nassanga, 2015) and homosexuality (Namusoga, 2017). These studies have largely focused on newspaper coverage. Nonetheless, the findings from these studies have provided a basis for understanding the factors that determine the role of the media, especially the press, in shaping debate on issues with socio-economic and political implications.

By conducting this study, the researcher intended to understand the discussion of GMOs from both the media angle and the public perception viewpoint. Hence, the results of this project provide a basis for understanding the debate about GMOs in the Ugandan context for scientists, journalists, media scholars, consumers, policymakers and civil society on multiple fronts. It is anticipated that the recommendations of this research will help journalists improve the way they report about GMOs. Furthermore, it is hoped that the recommendations will guide scientists in communicating about GMOs and replicate the concepts to communicating with the public about other forms of science in better ways. It is also expected that the recommendations will guide policymakers in understanding the implications of legislation on the biotechnology debate in Uganda.

1.9 Problem statement and focus

While crop biotechnology has been hailed as an important contributor to food security, medicinal aspects and poverty alleviation (Rodriguez & Lee, 2016), negative public perceptions of the innovation limit its adoption (Gaskell, Bauer & Durant, 1998; Rzymski & Królczyk, 2016). The media have been blamed for influencing perception through biased reporting about biotechnology, and Ardèvol-Abreu and Gil de Zúñiga (2016), Caulfield (2005) and Karidi (2017) stress that there is limited coverage of the subject and, when covered, it is not analytical enough to inform decisions, but merely announces new innovations without emphasising the social complexities and controversies in achieving the right to food using modern science. Yet not much research has been done in the developing world to establish the factors that drive the way media report on biotechnology (Kamanga, Wambugu, Obukosia, Gidado & Suleiman, 2014; UNESCO, 2011). Kamanga *et al*. (2014) and UNESCO (2011) have looked at media coverage of science in Africa generally, without emphasising Uganda or audience perceptions of the uptake of biotechnology-related products in Uganda. Consequently, there is a research gap in understanding the link between press coverage and public (audience) (mis)conceptions about biotechnology, especially in Uganda. This study looks at biotechnology from both the production side (science laboratories and press) and the consumption side (general public) in Uganda. It uses the science-in-society model, the public sphere and media logic theories in a mixed-methods approach. The aim of the project was to: a) analyse how two Ugandan newspapers cover crop biotechnology; b) establish the role of the media in the controversy; c) examine the public perception of biotechnology; d) establish the knowledge in the debate and make recommendations for integrating press coverage into public debates on biotechnology products in Uganda.

1.10 Methodology

The study adopted a cross-sectional study design to analyse how the *New Vision* and the *Daily Monitor* newspapers covered biotechnology from 2012 to 2015. This design was the most relevant because the study sought to understand how the newspapers covered biotechnology over a specific period in Uganda (Creswell, 2015; Kumar, 2005). These two mainstream publications were selected because they are the oldest newspapers in Uganda, having been in operation for more than two decades. The newspapers also tend to set the agenda, since other media houses frequently review their content and policymakers often cite them in their presentations.

The study opted for a mixed-methods approach. This approach combines quantitative and qualitative methods of inquiry in triangulation (Flick, 2008; Onwuegbuzie & Frels, 2016). Triangulation allows the researcher to harness the strengths of both approaches while counteracting the weaknesses of each approach (Creswell, 2015; Flick, 2008). Related studies have used the mixed-methods approach to study debatable subjects where information choices are still limited, thus necessitating the need to compare content published with the views of the authors of articles analysed and the sources and targets of media content (Brüggemann & Engesser, 2017; Kimenju & De Groote, 2008).

For the quantitative approach, the study specifically employed content analysis and the face-to-face survey methods. On the one hand, content analysis is useful in communication studies because it helps to classify the characteristics of the articles published, describe themes and establish trends for the period covered (Kahlor, Dudo, Liang & AbiGhannam, 2015; Malyska, Bolla & Twardowski, 2016; Picardi & Masick, 2014). On the other hand, the face-to-face interview survey is useful in producing aspects of results that describe the current reality. As such, social scientists consider "surveys an invaluable source of data about attitudes, values, personal experiences and behaviour" (Simmons, 2008:183). This kind of survey was conducted with 42 members of the public, the majority of whom were farmers, to understand their knowledge and perceptions of GMOs. Such surveys have been used in studying attitudes in different parts of the world (Duffy, Smith, Terhanian & Bremer, 2005; Nandi & Platt, 2017). The results from the quantitative approach informed the qualitative interviews with experts.

The qualitative approach employed in-depth interviews. These included interviews with relevant scientists, journalists, a legislator, a clerk to a parliamentary committee and members of civil society because they are key actors in the uptake of biotechnology. In-depth interviews (semi-structured interviews) explore what people think, feel and experience (Bryman, 2015).

1.11 Key results

The highlights of the results from the triangulation indicate that:

- Biotechnology is considered a fringe subject by the newspaper editors. As such, the issue is side-lined in the editors' pecking order and mainly gets news coverage when it is politicised. The coverage is usually during events when a prominent person, such as the president, a minister or MP, mentions it in his or her address.

- The newspapers are inconsistent in their coverage of biotechnology. The spikes of coverage tend to coincide with national events, commemorations and workshops involving prominent people. But these spikes in news coverage tend to enlist multiple opinions from the readers.
- The content of the articles published during this period is dominated by the Bill. Different stakeholders expressed their bias, directly or indirectly, toward the Bill as they tried to lobby for a fair law that would protect their interests.
- Farmers are mostly absent from the reports, with the pro-GMO and anti-GMO activists all purporting to represent the farmers' views. The marginalisation of farmers, and by implication consumers, in the debate, coupled with the radical views carried by the different stakeholders, biases the debate on biotechnology.
- The newspapers articles demonstrate that the debate in Uganda has foreign influence. Indeed, this position is corroborated by interviewees, who kept referring to the debate on GMOs in Burkina Faso, the USA and Europe. The GMO movement in Uganda is influenced by debates in other countries.
- Biotechnology tends to be covered by freelancers. The subject requires dedicating a lot of time to field visits, workshops and conferences. Editors seem unwilling to assign their staff reporters to cover such a subject. The use of freelancers, who are not really facilitated by the media houses to cover such stories, makes them vulnerable to their pro- or anti-GMO sources, who may want to bias their reportage in the polarised debate.
- The relationship between scientists and journalists is improving reporting on biotechnology. However, this relationship is seen with suspicion by activists, who have also moved to draft journalists into their activities to ensure coverage. Such moves may further polarise the debate.
- Moreover, there is stigmatisation of those involved in the debate. There are accusations and counteraccusations against the pro- and anti-GMO promoters. These accusations extend to the newsrooms, where some reporters have been forced to withdraw from covering the subject to insulate themselves from any form of accusation.
- There are more men than women expressing their views about biotechnology. This study speculates that the scenario could be due to higher literacy rates among Ugandan men than women. Nevertheless, the study does not rule out the possibility of women desiring to read newspapers not focused on this topic or having other sources of information altogether.

- Women are more likely to associate GMOs with risks than men. These risks included allergies, environmental degradation, diseases and loss of indigenous seeds.
- The attempt to weigh the views of scientists against those of non-scientists escalates the controversies surrounding GMOs. Nonetheless, this false balance unearthed that non-scientists and pseudoscientists are also sources of science (mis)information and should be considered in science communication endeavours, as their work can (mis)direct the debate.
- The study finds a complex relationship between education and support for GMOs. Educated people are found to be argumentative and to have informed subjective views about GMOs. This is because they tend to resort to their established sources of information, whose authenticity is sometimes questionable.
- The public have multiple (mis)conceptions about GMOs. This could be a sign that elite opinions in the newspapers are percolating to ordinary people.
- Although media coverage tends to ignore the sociocultural factors, the survey reveals that the debate on GMOs is a clash of traditions between conservationists and their pro-GMO opponents. People who believe in the current food regime that considers the ecological system are afraid of the invading food production regime in the form of GMOs.
- The need to earn income is likely to override risks associated with GMOs. Farmers are willing to grow GMOs, if such seeds can guarantee them high yields for them to sell and earn money.
- The respondent's source of information has a major influence on his/her perception of GMOs. A change in source of information is likely to influence one's perception of GMOs negatively. This is because most of the available sources of information are either pro- or anti-GMOs. Considering that sources of information, especially websites and social media, sometimes carry fake news, this finding holds.
- Increase in knowledge does not guarantee improvement in public perceptions of GMOs
- There is overwhelming desire among the public to meet with scientists and discuss issues related to biotechnology directly. Workshops are preferred because they offer the public an opportunity to make personal contact with the scientists. Such avenues allow mutual learning between scientists and laypeople.

- The public doubt the capacity of science institutions to provide agricultural solutions. This mistrust is based on past failures of the government not only in agriculture, but also in other departments, including the judiciary and the police.

Therefore, the passing of the GMO bill will not end the debate. Rather, the debate is likely to morph as issues related to GMOs emerge locally and in the international community. The local debate is likely to continue being influenced by issues in other countries, as captured in the literature chapter that follows.

Chapter 2

Literature review

In addition to scientific literacy, it is important to consider where consumers receive their information when examining the extent to which citizen perceptions affect the use of GM food

(Ceccoli & Hixon, 2012:307)

2.1 Introduction

This chapter is an overview of the literature highlighting the role of the media in the biotechnology controversy and the factors that determine the way the media report the subject to society. It explains the logic of the media and other factors that influence the way biotechnology is presented to the public, and the way literature on the contentious issue of biotechnology in society reflects the debate. It analyses the perception of biotechnology among the public, but also underscores the relationship between scientists and journalists as a key element in negotiating the meaning, potential benefits and risks related to this relatively novel science. The chapter identifies the knowledge gap in the uptake of biotechnology and endeavours to determine the position of the media in this gap.

2.2 Presentation of biotechnology

The study took stock of the fact that scientific knowledge is useless if it is not "read, heard, and seen" (Habermas, 1989:164), or understood by the intended recipients. Consequently, the demand on scientists to disseminate their findings to the public has been gaining momentum for many years (Bauer, 2002a; Bhatta & Misra, 2016; Carver, 2014; European Academies Science Advisory Council, 2013). Although science information can be shared in personal conversations, workshops, seminars and journals, among other forums, the media are the most important avenue available to stakeholders – the public, scientists, policymakers, industrialists, farmers, businesspeople and consumers – to share their views (Claassen, 2011; Dunwoody, 2008a; Kahlor *et al*., 2015; Rodriguez & Lee, 2016). Such a privileged position is conferred upon the media in appreciation of their sustained "role in social representation, agenda setting, and reliance" on specific sources for information (Einsiedel & Thorne, 2008:52). The media have the ability to disseminate information to various audiences at the same time (in the case of broadcast and online media), can be kept as reference material for a long time (print, audio, video and online media), and can allow 'feedback' from the various stakeholders, a key feature of any democratic debate. For this reason, Dunwoody (2008b:61) concludes that the “mass media reign as our principal storyteller on the cusp of the 21st century”.

The media have undeniably told the story of science communication for centuries and of biotechnology for decades, as explained in later sections of this chapter. For instance, after the cloning of Dolly the sheep in 1996, biotechnology started seeing a shift away from progress reporting to concern reporting (Bauer & Gaskell, 2002b). Researchers contended that crop biotechnology was too important to be monopolised by the scientists. They argued that there was a need for ethical guidelines in scientific research, and that the public needed to participate as the targets of the products of biotechnology. In demonstration of the media’s role in sustaining debate and providing reference material, *The Washington Post* carried a story of Dolly’s clones 20 years later, on 26th July 2016 (Harvey, 2016), as it still had news value.

2.3 News values and the power of knowledge

Journalists derive their power from having more information about events and issues than the public, in line with English philosopher Francis Bacon’s famous proclamation of 1597, “knowledge is power” (Cortes-Ramírez, 2014:25-42). Bacon’s assumption infers that “knowledge is a commodity and access is the key” (Dziuban, Moskal & Hartman, 2005:1). Therefore, journalists have to choose a criterion (news values) and present information as news to their ‘customers’ (audience). The hypothetical criteria of “news values”, initially developed by Walter Lippmann in 1922 but popularised by Johan Galtung and Mari Ruge (1965:65-90) in their study on international news in Norway, explains how particular features of an event increase its probability of being selected as news by journalists. The selection involves pursuing, publishing and placement – where the audience will access the information when the news is presented. For more than half a century, Galtung and Ruge’s 12 news values have been applied by journalists and communicators in selecting what they would consider appealing to their audiences.

For its novelty, Galtung and Ruge’s structure was a lens that journalists would use to forecast the possible story angles about an event. However, after considering the “subjective” nature of journalism, the “dumbing down of news”, and the current “multimedia landscape” punctuated by social media, British scholars Tony Harcup and Deirdre O’Neill (2001:261-280) suggested 10 value criteria to address the flaws identified in Galtung and Ruge’s model. Harcup and O’Neill’s 10 points are: the elite influence, superstars, entertainment, surprise, evil, good news, scale of impact, proximity, follow-up, and newspaper agenda. Harcup and O'Neill's criteria also apply to science journalism.

Caple and Bednarek (2013:3) categorise news values into two aspects: "culture free (based on perception) and culture bound". The culture-free values are frequency, impact, relevance, expectedness, randomness and sequence. The culture-bound values include foreign influence, elite power, human interest and reference to negativity. One or a combination of these factors is at play every time news outlets are deciding what to publish and what to exclude. For instance, good pictures are often published even if they have less essential newsworthiness. Based on the media reports, including the distortions, society will eventually "construct [the] reality", in most cases, different from what happened (Brants & Van Praag, 2015:4; Galtung & Ruge, 1965:65). Therefore, a distortion at the point of collection or selection will be replicated in what will finally reach the reader or listener. From Galtung and Ruge, Harcup and O'Neil, and Caple and Bednarek's arguments, the choice of news values to apply at any given time depends on the editorial policy or the interests of media houses, as reflected in their framing of stories.

It then can be maintained that, although journalists often do not participate in the ensuing dialogue, they influence what the public finally perceive as the reality using news frames. News value also influences the news frames, as sensitive issues that generate contention tend to be selected as news over others. Frames are evident in words, phrases, images, sources of information and patterns, which may work in concert to construct perception (Entman, 1993). In tune with this, Dunwoody (2008b:69) contends that a journalist's supremacy rests in the "ability to select voices". In reporting on sensitive facts such as biotechnology, Bhatta and Misra (2016:577) hold that it is important that journalists are "careful in choosing their frames on the basis of accurate facts and current scientific understanding of the issues" to enable the public to comprehend the issues and engage in meaningful discussion. Besides, in reporting about science, passion, diligence and truth should be at the heart of good reporting, rather than "fairness and balance" (Pigliucci, 2010:91). For Pigliucci, fairness and balance are undermined in science reporting because facts sometimes do not have alternative views, apart from pseudoscience, especially when the science is new and controversial. In such unfamiliar situations, journalists are usually short of both the time and the expertise to assess the truthfulness of information they get from their sources.

In contrast, Dunwoody (2008b:71) asserts that, when in doubt, journalists "pull out of their toolboxes two strategies" – objectivity and balance. Under objectivity, they try to capture the information and attribute it to their sources for accuracy. In this case, accuracy is epitomised as a tenet of a journalistic story, but the validity of the information presented becomes secondary. Under balance, journalists provide multiple views, thereby transferring the burden of judging the truth to the audience. Thus, media logic theory, a broad framework used in explaining the role of technologies and corresponding formats in influencing social reality (Altheide & Snow, 1979; Meyen, Thieroff & Strenger, 2014), becomes important in understanding the science debates and their relationship to media coverage, perceptions and political decisions as scientists and journalists negotiate the construction of new science, such as biotechnology.

Whereas multiple voices are crucial in a controversy, a lack of consensus undermines scientific authority (Kunseler & Tuinstra, 2017; Pigliucci, 2010). Moreover, some scholars have asserted that the norm of "journalistic balance" in scientific issues can be a precursor to a "form of informational bias" (Boykoff & Boykoff, 2004:129). The ensuing debates make the general public doubt the credibility of science, which was believed to be rigorous in coming up with findings. Yet scientific authority tends to submit to the frames typology.

Nisbet and Lewenstein (2002) are credited with developing the frames typology as a lens for analysing science debates. This typology suggests that science should be looked at as a development that should emphasise not only the technological progress, but also the associated social, economic, and political impact. Science requires the consent of the citizens, public accountability, and professionalism, if it is to be meaningful to the country. As such, Bhatta and Misra (2016:576-577) argue that biotechnology necessitates taking precautions, as negligence may lead to "catastrophe" or "fatalism, where there is no way to avoid the consequences" of a "chosen path".

Therefore, the positions journalists take can have a major influence on the way the public understand biotechnology. The responsibility, then, falls on journalists to base their reports on well-established positions in science. Here, responsibility may call for quoting authoritative sources, and carefully observing the principles of objectivity, fairness and balance to avoid giving pseudoscientists a platform. Journalists need to publish new milestones in science, but also to highlight the shortcomings in the new discovery, noting that the development is tentative and highly contextual. Such a critique allows scientists to close the lacunae in their findings, since science streams are self-correcting disciplines.

When journalists play the role of middleman among the many players, they facilitate empowerment in society. The media allow the public to know what scientists are doing, but the scientists can also learn about public expectations of their laboratory work. Scientists become cognisant of indigenous knowledge in society and find ways of accommodating it in their science in the light of the science-in-society model (Bucchi & Trench, 2014) and public sphere theory elucidated on in Chapter 3. A lot of indigenous knowledge has been accumulated over the millennia of human existence, before laboratory science started providing solutions. Ignoring that knowledge, especially in agriculture, would be equivalent to disconnecting science from the context of the people. Science communication, therefore, integrates scientific culture into general societal culture and vice versa.

Moreover, journalists and science communicators should remember that scientific developments are a demonstration of power (Aronowitz, 1988; Horst, 2005). Science is demonstrated in a country's ability to produce war weapons, treat complicated illnesses, manufacture high-quality goods in large quantities, explore, and feed the population throughout the year. Countries that have managed nature in this way have also tended to dominate society. Countries such as Russia, the United States of America, the United Kingdom, Germany, Israel (in the Middle East) and South Africa (in Africa), which have succeeded in dominating nature, also have a lot of influence in international relations. In contrast, countries in Sub-Saharan Africa, such as Malawi, Uganda and Zambia, which still suffer the vagaries of nature to a critical degree, seem to have less influence in global politics.

The developments in science and technology have created complex societies within and amongst democracies. Such complexity has triggered excitement and fear among the people who stand to benefit, but who also feel vulnerable to the extent of being described as "risk" societies (Broom & Dozier, 1986:39; Liu, Wang, Shao & Zhou, 2016:587; Malyska *et al*., 2016:530). Vulnerability has also meant that modern societies have to rely on the media for information on how to adapt to everyday life. Increasingly, the information, education and entertainment roles of the media are coming to be appreciated. In terms of democracy, the media are the watchdogs of society, "signalling injustice or unwanted developments", with environmental, health and moral risks foregrounded (Gutteling *et al*., 2002:95).

As biotechnology becomes a reality in Uganda, the media will have to provide these services in the context of the innovations in the country, highlighting the novelty and benefits, but also the risks associated with new science. Gutteling and colleagues (2002:95) argue that "individual dependency on the media will be especially high in the case of modern biotechnology because it is virtually impossible to gather information on this subject through direct personal experiences". By implication, public perceptions of biotechnology will largely be constructed based on what individuals will have seen through the lenses of the media.

These images will, in turn, become the basis for conversations (interpersonal communication) or public discussions in bigger groups, media engagements and possible legislation. Thus, media coverage can form the basis, directly or indirectly, for public acceptance or rejection of biotechnology. The thinking that the media could have a possible influence on the public perception of biotechnology in Uganda partly formed the basis for choosing media logic theory, discussed in Chapter 3, to explain the identification of subjects to cover, the selection of news material, the production process, the framing of news on scientific subjects such as biotechnology, and how media coverage is negotiated in the public sphere.

Therefore, reporting the technical facts on biotechnology requires competent journalists who hold the principles of accuracy, fairness and balance dear. Although some scholars have reasoned that the media should reflect society (Claassen, 2011; Liu *et al*., 2016), others have argued that journalists construct meaning by presenting a mediated world rather than mirroring reality (objectivity) (Davies, 2009; Pigliucci, 2010; Stocking, 2008). Indeed, Vasterman (in Harcup & O'Neill 2001:265) asserts that:

> But news is not out there, journalists do not report news, they produce news. They construct it, they construct facts, they construct statements and they construct a context in which these facts make sense. They reconstruct 'a' reality.

Hence, what the public see as news is a product of selection processes from a series of several happenings and issues within their locus, as dictated by resources, and the technology available to a media house. The news value defines what is newsworthy for individual media houses, as stipulated in editorial guidelines or as dictated by individual editors. Moreover, journalists are influenced by their cultural and historical background, and the way they present news will always be coloured by those experiences and perceptions. For that matter, the identification of news is done by journalists who belong to, or sympathise with, social groups based on training, religion, tribe, race or political organisations, professional organisations and neighbourhoods, all of which influence the framing of news to fit in the available time, space and technology. Social and technical factors affect the way news is identified, collected, interpreted, contextualised, edited and disseminated to the public. So, the media logic theory suggests that information must be condensed or expanded into "journalistically manageable dimensions" (Gutteling *et al*., 2002:96), depending on the publication's editorial policy. The editorial policy determines the focus of the story, the news sources, the placement, the headline and other technical nitty-gritty. Media logic theory, deliberated upon in Chapter 3, contends that media policy is dynamic and may encourage a publication to concentrate on certain aspects of biotechnology, but may also ignore others altogether. A media house can choose to cover biotechnology as hope or doom for a country, or just present the controversy.

2.4 The role of the media in biotechnology

In addition to what has been discussed in the foregoing section, the mass media constitute major arenas through which people learn about new technologies – their application, benefits and risks. The media make judgements regarding the ease and/or complexities of using technologies. The information provided on media platforms creates perceptions, generates discussions and shapes debate as people form opinions about the technology. The opinions may involve taking precautions, accommodating the new science or considering it as conventional This scepticism is especially so for relatively new public issues such as nanotechnology and biotechnology, which few people have experienced directly (Bonfadelli, Dahinden & Leonarz, 2007). Whereas there is a general agreement that the media are influential, studies have not been able to produce consistent results to establish a consensus on the extent of influence. Mass media "frame public issues, serve the 'agenda-setting' role, and … pander to, and therefore, by way of appeal, express public opinion" (Bauer & Gaskell, 2002b:7). Based on this argument, it is apt to posit that the media explain and legitimise government policies to the ordinary people in the traditional linear communication model, but they are also the arena for the laypeople to raise their issues with policymakers in the bottom-up dialogue approach under the non-traditional interactive models. In brief, media coverage is directly linked to policy discourse, and consequently to public perception.

The mass media inform the public about biotechnology. Scholars observe, that in democratic societies, the information role of the media reduces the gap by building an informed society that can meaningfully debate issues related to controversial subjects such as biotechnology (Bonfadelli *et al*., 2007; Ceccoli & Hixon, 2012; Gastrow, 2010; Horst, 2005; Ji-kun & Bo-wen, 2015; Katz, 2001; Kurath & Gisler, 2009; Rodriguez & Lee, 2016). In developing countries like Uganda, sharing scientific knowledge on ways of improving the agricultural sector, which forms the backbone of the economy, is pertinent. Almost 82% of Uganda's population lives in rural areas (World Bank, 2013:8), and 72% of the 35 million people depend directly or indirectly on agriculture (UBOS, 2014:ix). To perform the information role effectively, it would be important to research the information needs of identified audiences, the channels they access, and how to package the messages appropriately – not only to inform them, but to also allow them to engage with all the stakeholders on the subject of biotechnology. Such engagement will allow feedforward in this science communication process.

Although media sociology looks at mass media as an outcome of a productive process in which public views are shaped into news, the media are not necessarily neutral mediators in constructing meaning about biotechnology (Dunwoody, 2008a, b; Einsiedel & Thorne, 2008; Horst, 2005). Journalists develop their stories around limited events and issues, willing and available sources, in a limited timeframe, and will interpret the information in line with the editorial policies of their respective media houses, putting into consideration the production technology of individual media organisations. It should also be stated that, in some cases, such as strikes and national celebrations, journalistic instinctiveness causes them to relay live events if they feel their audience does not require any mediation, but only unfiltered news.

Journalists contextualise information by making comparisons with the rest of the world. Usually, biotechnology coverage is in line with what is happening elsewhere in the world. Local media houses regularly domesticate the news by talking to local scientists about the possibility of a similar issue in their respective countries, and interpreting it in what is normally called giving "context" to the story (Aerni, 2002:1123; Basu & Leeuwis, 2012:34; Feindt & Kleinschmit, 2011:184–5; Imperiale & Casadevall, 2015:4; Lamphere & East, 2016:2; Lewenstein, 2003: 288). The media content provides a good basis for the moral, social, cultural, economic and political context for governing biotechnology as a science (Horst, 2005). Hence conflicts about biotechnology are reflections of disagreements about the way society should be governed. Disagreements are testimony to the fact that science has a role in determining the way society is governed. In February and August 2016, when the Democratic People's Republic of Korea (North Korea) launched a rocket, the United States of America (USA) accused the country of being under a rogue regime. The USA accusation was similar to what it had made about Iran's development of nuclear technology in recent years. In 2003, Sadam Hussein of Iraq was attacked for allegedly possessing what the USA and the United Kingdom (UK) called biological weapons and weapons of mass destruction (subsequently proven to be false), some of which were believed to be products of biotechnology.

It is therefore appropriate to deduce that the media can inspire and educate the public about biotechnology, raise awareness, reassure the public, and encourage learning about biotechnology. With their role of interpretation, news media should be seen as reflections of the laboratories. The determination, establishment and production of facts in laboratories are closely related to the production of content in newsrooms (Horst, 2005). To gain insight into how biotechnology is understood by the public also implies studying the news production process. It would be interesting to understand how the 5Ws and H[2] are applied by scientists and journalists in their respective fields with the general public in mind. From a sociological angle, the meaning attached to scientific results is "constructed" when playing the educational role (Hendriks, Kienhues & Bromme, 2016:6).

Moreover, the media produce 'issues cultures'. An issues culture refers to long-term perspectives by "which events are achieved in terms of interpretation, meaning, metaphors, catch phrases, images and other symbolic devices" (Maeseele & Schuurman, 2008:437). The issues culture tends to grow following the Altheide (2013) media logic – prominence of the actors, newsworthiness of the event, impact of the occurrence, currency of the event in relation to similar happenings, the context of the society in which the media operate, and the technology of the time. Maeseele and Schuurman (2008:435) identify two factors that influence media representation in science – "standing" and "framing". Standing refers to a situation in which organisations or individuals come to be treated as agents with voices and are therefore sought by the media to add context to the story. Framing is the shrewdness to influence the news angle by interpreting and packaging what is favourable to one's interests (Berglez, 2011; Dunwoody, 2008b; Entman, 1993). Frames usually follow "cultural resonance", are dictated by the "sponsor", but have to have news value for their views to be acceptable as media content (Maeseele & Schuurman, 2008:438). Maeseele and Schuurman (2008) further argue that both standing and framing are influenced by cultural, political and socio-economic power, and have a significant impact on media content as actors gain advantage over others in public

[2] Who is involved? What is at stake? Where is it happening? When is it happening? Why is it important? How is the public affected?

deliberations. Standing and framing combine to form the science-industrial complex, which influences governments to make policies in their favour.

> Politicians tend to emphasise the long term for opposite reasons: they can stress the uncertainties in detail, and talk about action without needing to take any. Yet these distant forecasts have also become the basis of how people assess and communicate the probable effects [of adopting biotechnology] (Watson, 2016:437).

A complexity of this nature tends to influence media coverage and, by implication, perception to a significant extent, as clarified in Chapters 5, 6 and 7. It is therefore worth giving attention to the contestations born out of this complexity.

Movements against the establishment, however, tend to become prominent and therefore attract media attention as the contesting voice(s). These movements tend to be linked to environmentalists, consumers, academics and religious leaders, demanding public accountability and ethics in scientific processes. Lamphere and East (2016:1) chronicle how Monsanto, a biotechnology seed giant, "concealed" the actors in the industry, and framed the discourse on sustainability to strengthen its global image and promote its products as the biotechnology industry continued to grow. Monsanto's approach echoes arguments that biotechnology is a political, economic and sociocultural issue that arouses emotive interest from both pro- and anti-biotechnology actors.

Whichever way one looks at biotechnology and the media, effective communication is likely to create new research opportunities as ordinary people share their ideas with scientists and policymakers on the subject. Such sharing provides a platform for scientists to know the challenges laypeople face and why they look up to scientists for solutions. A symbiotic relationship of this nature not only enables the public to know about and hopefully understand the application of science, but also allows scientists to know the context in which people use the knowledge generated in the laboratories. The media provide the best platforms through which conflicting sides in science are able to express their varying views. Dunwoody (2008b:70) concludes that "scientists [also] rely on media for information about science".

2.5 Media coverage of controversial issues

2.5.1 Introduction

The media are no strangers to controversy, more so in the coverage of science. The media report the discoveries, interpretations of results, caveats on the results, and the disagreements on how science should be conducted (Friedman, Dunwoody & Rogers, 2008:xii). As a scientific field, biotechnology evokes strong feelings that are manifested in absolute alarm and utter objection. As a matter of fact, most of the disagreements in society are reflected in the media as the platforms play their mirroring role (Claassen, 2011), but the media are also "a major source of misinformation and therefore confusion" (McHughen, 2007:1107).

Such controversy has been evident in the coverage of global warming, HIV, ufology, second-hand smoking, developments in evolution and the debate between evolutionary scientists on the one side and creationists and intelligent design activists on the other, the anti-vaccination campaign, biotechnology, and other subjects. When the media houses find themselves in unfamiliar territory, as is usually the case when covering highly divisive issues, individual media houses handle controversies differently on a case-by-case basis. But, generally, media houses tend to adopt a tone – positive, negative or neutral (Bauer & Gaskell, 2002; Maeseele & Schuurman, 2008; Stocking, 2008; Reul, Paulussen, Raeijmaekers, Van der Steen & Maeseele, 2016; UNESCO, 2011). The common denominator is that these issues tend to be "under-covered unless events fit certain news streams" and only appear in the news as "spikes" (Pierro *et al*., 2013:13) or "episodes" (Caple & Bednarek, 2013:27; Ceccoli & Hixon, 2012:3; Meyen, *et al*., 2014:277), but usually "peaks in media coverage tend to coincide with important events" (Geary, Camicioli & Bubela, 2016:740). Consequently, controversial issues rarely get consistent coverage or follow-up stories, as evidenced in the studies on minority groups, climate change, health, HIV/Aids, ufology and biotechnology. The subsequent sections explain the logic media houses use to frame issues, the factors that influence the logic, and how professional, economic, cultural and political forces determine what the public perceive as the reality.

2.5.2 Minority groups

In their study, Pierro *et al*. (2013) found that the Aborigines, who comprised about 2% of the population of Canada's Ontario province, got less than 0.5% of the online and print media coverage from 2010 to 2013, despite the marginalised group facing serious housing crises, famine, unfavourable laws, land conflicts, unemployment and limited access to quality education, among other injustices. The researchers discovered that some controversial issues were reflected in editorial and opinion pages, a manifestation that senior managers in newsrooms knew the issues but deliberately ignored them. The authors corroborate the idea that media-house coverage of controversies differs from country to country, but the bottom line is that it is “rooted in century-old stereotypes rather than reality” (Pierro *et al*., 2013:16). Hence, positive, negative or neutral coverage of issues perpetuates what the public know about an issue and can facilitate or act as an obstacle to change in society. Media prefer reporting what resonates with the society in which they operate. A 2014 Runnymede Trust survey in the UK, published in the *Independent* online, revealed that 78% of the respondents believed that media coverage (framing) of the minorities promotes racism (Burrell, 2014). Minorities also tend to be portrayed as criminals, terrorists, drug traffickers, and an inconvenience to the social setup of the host country/community at the expense of other social problems they face, such as language and racial attacks (Khan, 2016). Generally, the public respect the ability of science communicators to “correct the myths” and overstatements published by quackery-promoting publications (Su, Akin, Brossard, Scheufele & Xenos, 2015:601).

Pierro *et al*. (2013:18) conclude that the publication of inaccuracies or actual media blackout of an issue “skews public opinion and allows people to rely on hearsay to form judgments about an entire population”. The implication, Khan (2016:37) argue, is that “there is a consistent danger that covering social and political issues is uneven and one-sided, and that its reliance on open hobby can bring about an accentuation on embarrassment and sentimentality”. The spike in the media may be attributed to some events being occasional and the stakeholders choosing to load those occasions with events to attract media attention. For instance, an Aboriginal, Hindu or Karamojong minority protest coinciding with a human rights day will most likely attract media attention, much in the same way a science discovery would on a national science day.

Public relations professionals have mastered the news values, know what will attract journalists to their events and give them coverage, at least for that event. This may be a sign that controversial issues rarely have dedicated journalists to cover them as their beat to constitute themes, but once the event fits in multiple news values, especially conflict, it becomes irresistible for the media to cover it. It should, however, be remembered that the framing will differ from media house to media house, issue to issue or from country to country. This PhD study describes how news values apply to controversial issues, especially in the context of science as presented in the earlier sections of this chapter.

2.5.3 Climate change

Media tend to support the mainstream view. This can be attributed to the "enormous influence and amount of money injected in advertising and the fear of being isolated on the losing side of the debate" (Semujju, 2013:338). Although this approach of conforming to established news routines kowtows to the media logic theory discussed in the later chapters of this thesis, it does not show "how journalists grapple with news issues in their expanding and revolutionary development" (Berglez, 2011:450). Semujju (2013) cites cases where the Ugandan newspapers, *New Vision* and *Daily Monito*r, maintained the global position that industrial carbon dioxide is the major cause of global warming, instead of emphasising the dangers of methane gas resulting from the many animals in the country with few industries to emit the dangerous gases. Unfortunately, Semujju does not vouch for the same media houses to focus on the "militaristic" view (Brown, Hammill & McLeman, 2007). The militaristic view emphasises that global warming in under-industrialised Africa is caused by the movement of toxic gases from the industrialised countries in America and Europe, since the airspace is shared, and therefore constitutes an act of aggression. A key proponent of this idea is Uganda's president, Yoweri Museveni, who has mooted the idea of industrialised countries compensating Africa for the damage resulting from sharing space. Yet despite their president mooting the idea, fewer than 50% of Ugandans think climate change is a "serious threat" and that "environment news is less prioritised than crime, sports," entertainment and fashion (Berglez & Nassanga, 2015:38-39). Berglez and Nassanga (2015:39) note that media reportage of climate change in Uganda is on the rise, but "the quantity and quality of reporting do not match the scale of the problem".

From the preceding arguments, four issues emerge in relation to climate change, but which could apply to science reporting generally: 1) science stories are only covered if they fall under the category of breaking stories; 2) many journalists think science stories do not appeal to the public because they are difficult to understand unless they are tied to particular events or issues to make them sellable; 3) objectivity is largely lacking in the reports, with the media ignoring certain angles on biotechnology; and 4) there are also logistical problems, such as transport to sites where biotechnology laboratories are located, and airtime to make telephone calls to scientists can be a problem.

Considering the increasing monetisation of the media and “commodification of information, news must have a buyer” (UNESCO, 2011:6). At the same time, sources, especially scientists, could refuse to talk to journalists (in time for the scribes to beat their deadlines, or for other reasons). The failure to respond on the part of scientists occasionally leads to some stories being dropped, since there are not many scientists to talk to about biotechnology issues. In some cases, journalists resort to talking to any available scientist, who may have limited knowledge on the subject (Rehbock, 2009). Strikingly, journalists select those whose “voices are heard” as scientists try to explain new and controversial science (Dunwoody, 2008b:61). It is then necessary to understand the centrality of science issues in the public sphere and the several challenges encountered as institutional journalistic policies interact with events and issues in the process of news-making.

It is worth noting that what we eventually see as news stories are products of a production process, which involves time. The pressure on journalists to beat deadlines is sometimes reflected in the sources and errors manifested in the stories. This is not to justify the errors common in news stories, but to acknowledge that the production process is very complicated, and its products cannot be disassociated from the human, technological, political, economic, technical and ethical factors at play. As Reul *et al*. (2016:3) admit, the media logic theory discussed in Chapter 3 “dictates that news is produced using time- and cost-efficient methods, delivering appealing news stories (often interpreted as episodic, dramatic, unusual) to an interested target audience”. Consequently, the issues at the production stage filter into the final products that are consumed (news stories) to shape perception. It is prudent to compare the coverage of climate change to the reportage of health issues.

2.5.4 Media and health

The media tend to politicise health and scientific issues. For instance, Fowler and Gollust (2015) demonstrate how politics altered the issue of mammography screening guidelines released in November 2009 by the US Preventive Services Task Force, an independent panel on prevention and evidence-based medicine. The guidelines were against routine medical check-ups for breast cancer for women under 50 years. The standards came at a time when the healthcare reform debate was on the agenda of United States citizens. The release of the guidelines increased the number of politicised stories on the subject from two on the first day of coverage to twelve on the fourth day (Fowler & Gollust, 2015). The increase was a result of journalists doing follow-up stories in which they interviewed stakeholders, including politicians, for context. Fowler and Gollust conclude that the dramatisation takes place for three reasons:

- political sources are mentioned to emphasise a political conflict;
- stories highlight political contexts within which the public can interpret the issue; and
- the journalists tend to cover the issues as controversies in the political arena.

It is also possible that media houses inclined to reporting economics choose to focus on the costs implied in taking a certain action and how the taxpayer may be affected. It appears, therefore, that media houses play a crucial role in defining the final product, which the public may perceive as reality. The findings of Fowler and Gollust's study confirm earlier results that showed that politics influences what the public know about cancer (Mayer, 2003).

Similarly, when Thabo Mbeki replaced Nelson Mandela as president of South African in 1999, Mbeki disregarded scientific evidence from research by leading international virologists proving that Aids was caused by HIV. In fact, Mbeki's views were given a fatal blow when two French virologists, Luc Montagnier and Françoise Barré-Sinoussi, shared the Nobel Prize for Physiology or Medicine in 2008, "for their discovery of human immunodeficiency virus" (The Nobel Prize Assembly, 2008:n.p.). Throughout his term, Mbeki insisted that antiretroviral drugs (ARVs) were poisonous and therefore useless for people living with the virus (Rehbock, 2009). Apparently, Mbeki was citing an American/European study by Duesberg and Rasnick (1998), "The AIDS dilemma: drug diseases blamed on passenger virus", in which the scientists said that the HIV virus was not sexually transmitted; that the virus was common among drug-addicts and homosexuals; and that ARVs were toxic. Consequently, South Africa lagged behind in providing treatment for people who were HIV-positive. The country attracted condemnation from the international community for promoting herbal remedies for HIV patients.

There was passionate criticism of Mbeki's views by the SA media. Rehbock (2009) cites Media Monitoring Africa, an organisation whose research found that coverage was largely reactive, frequently ill-informed and often sensationalised to sell newspapers. Rehbock believes this on the evidence of Media Monitoring Africa, but its studies had serious flaws in it, as the Afrikaans media, in which most critical pieces were written, were not even included. This situation changed when Mbeki was replaced as president by Kgalema Motlanthe in 2009. The new government accepted the causal link between HIV and Aids. Motlanthe's approach removed the conflict factor from the news value, thereby allowing balanced coverage. Mbeki, however, rekindled the debate years later when he wrote in March 2016 that it is not possible for "a virus to cause a syndrome" and that HIV is a "minor contributory" factor to Aids (Mbeki, 2016:n.p.). Mbeki was found to be on the wrong side of science again. In an article two days later, a *News24* online columnist gave examples of syndromes that are caused by a virus. These include Ramsey Hunt Syndrome II, caused by the Varicella zoster virus; Fitz-Hugh–Curtis syndrome, caused by gonorrhoea or chlamydia; and Acquired Immune Deficiency Syndrome (AIDS), caused by HIV (Geffen, 2016).

A similar case of pseudo-science involved the discredited UK gastroenterologist (digestive system specialist), Dr Andrew Wakefield, which led to his expulsion from practising medicine and the subsequent withdrawal of his article from the prestigious medical journal, *The Lancet*, ten years later. Wakefield's grave mistake was publishing an article in 1998 whose sham results showed that the measles, mumps and rubella (MMR) vaccine caused autism among children (Bigliardi, 2017; Kloor, 2017). Wakefield's influence and that of anti-vaxxers such as Jenny McCarthy, Oprah Winfrey and other celebrities have led to major outbreaks of measles, mumps and other children's diseases because they believe, wrongly, that the MMR vaccine was linked to autism. Bigliardi (2017:159) asserts that such beliefs or conspiracies are "harmful" because they are an obstacle to science communication and politicise official sources of knowledge. The media's role in giving these celebrities publicity for their conspiracies should be questioned seriously.

Again, the mammography, HIV and vaccine cases in the USA, South Africa and the UK respectively are typical examples of how political leaders and celebrities can use or misuse resources at their disposal to influence their followers. The UK case demonstrates how acceptable science can be politicised and how conspiracists can spread pseudofacts that can be detrimental to entire countries. Health issues aside, the controversies in science sometimes absorb pseudoscientists, as described in the case of ufology.

2.5.5 The Washington Post coverage of ufology

This case was extracted from Massimo Pigliucci's (2010) book, *Nonsense on stilts*. He cites an article that appeared in *The Washington Post* on 19 June 1998 about ufology (Pigliucci, 2010:84-94). Ufology is "the study of unidentified flying objects as elements of an independent theoretical scheme" (Blake, 1979:315). The article, which was about

> the first independent scientific review of the controversial topic [ufology] in almost 30 years [found] cases that included intriguing and inexplicable details, such as burns to witnesses, radar detections of mysterious objects, strange lights appearing repeatedly in the skies over certain locales, aberrations in the workings of automobiles, and irradiations and other damage found in vegetation (*The Washington Post*, as cited in Pigliucci, 2010:89).

It later turned out that the assumed panel of scientists was a group of pseudoscientists sponsored by the Society for Exploration, a group sympathetic to ufology claims. The group had scientists who believed in drawing powers from empty space, a premise contrary to the rules of thermodynamics, and others who believed that alien abductions were real. The controversial report that was run by *The Washington Post* was based on a well-written press release, endorsed by some well-known scientists.

From the foregoing examples, one can deduce that it is possible for respected scientists and academics to hold strange views, including the denial of the existence of HIV/Aids, refuting the idea that oil is a fossil or that smoking is dangerous, and denying the reality of global warming. Evidently, this brings to the fore the journalistic argument that all stories must give 'the other side' for fairness and balance (Karidi, 2017; Oreskes & Conway, 2010; Vilella-Vila & Costa-Font, 2008). It appears that, in scientific arguments, not all sides are deserving of the same space or airtime, since some positions are more nuanced than others. While the idea of giving all possible sides an opportunity to voice their views works in politics, it "is a mistake" when covering controversies such as biotechnology, because one side has scientific evidence and the other is groundless (McHughen, 2007:1108), and constitutes "balance as bias" (Boykoff & Boykoff, 2004:125). Articles denying the link between HIV and Aids and supporting ufology would never have been published had the journalists investigated. Media houses need to take extra care in applying the principle to avoid giving equal space or airtime to hawkish opinions that have not been researched and can mislead the public. Media investigation enables the "public [to] filter the golden nuggets from the ocean of nonsense that will otherwise bury any intelligent social discourse" (Pigliucci, 2010:91). For avoidance of doubt, balanced coverage of science denotes "apportioning weight according to the balance of evidence" (Rensberger, 2010:21). It is not clear, however, whether the approaches suggested by the Boykoffs, Pigliucci and Rensberger should apply to the stream of biotechnology, where the science has not yet settled, as some scientists continue to lionise health and environmental risks as the public raise moral concerns.

2.5.6 Media coverage of biotechnology

Coverage of public interest usually follows the five steps that form the 'issue-attention cycle': "1) pre-problem stage, 2) alarmed discovery and enthusiasm stage, 3) realising the cost is significant stage, 4) gradual decline of intense public interest, and 5) post-problem stage" (Downs, 1972:39-40). At the pre-problem level, the problem is known to exist, but no one has raised a red flag. The issue may be brought under the spotlight by an investigative reporter, a demonstration by activists, the death of a person or in a presentation by an expert at a conference. At the alarm discovery and enthusiasm stage, many stakeholders come on board to voice their concerns. The issue may attract politicians, who may twist it to fit their interests, allowing the issue to become media fodder. At the third stage, different interested groups realise that the solution to the problem may threaten the status quo in their disfavour. In the case of biotechnology, the scientists begin to fear that funding for investigations in laboratories may stop and government may become afraid or the opposition may twist the issue in their favour. Ordinary people may feel threatened that the food they have been eating may be banned or may have unknown effects, and thus may choose to reserve their thoughts. The reservation may also be a result of waning public interest, so the issue only appears in the media when there is a new angle to it. At the post-problem stage, the issues may disappear from public discourse for a very long time because of audience fatigue.

The biotechnology debate followed the 'issue-attention cycle' between 1996 and 2002. Until 1996, the debates on GMOs were subtle. But when reporting started, public interest increased with the birth of Dolly the sheep in 1996. Thereafter, the public felt threatened and appealed to the respective governments to reign in the work of scientists, before catastrophe could befall Europe (Bauer, 2002b; Horst, 2005; Maeseele & Schuurman, 2008). The debate then waned, but it occasionally resurfaces when there is a new development, especially one with a political twist. In the case of Uganda, the debate peaks when there is a new development, such as the president or MPs talking about the Bill.

From the discourse above, it is clear that the poor coverage of controversial issues can be attributed to three reasons: 1) the limited knowledge about the issue on the part of journalists and editors; 2) the tendency to maintain traditions; and 3) the unavailability of information and the limited resources to look for information about controversial issues. The problem of limited resources is complicated by the fact that most newsrooms do not have desks dedicated to covering science, and many scientists are media averse (Claassen, 2011; UNESCO, 2011). For emphasis, the relationship between scientists and journalists will be stressed in a later section. Also, what is significant in the coverage of biotechnology and science generally is the notion that the profession of journalism is dominated by individuals with a humanities and social sciences background. Such a background requires enormous input, coupled with passion, for the journalist to learn the scientific terms used in this stream of science before reporting on it effectively. The education background scenario creates a vicious cycle, with newsrooms having limited resources to finance training, and the field requiring a lot of resources to invest in dedicated individuals to learn beyond what they studied at journalism or communication school to report or communicate on the subject efficiently.

Perhaps stories on biotechnology are avoided because many journalists fear of the subject and there are intricacies to learning the subject if one is not passionate about it. Nonetheless, there are journalists who have mastered reporting about the subject, and there are scientists who have mastered journalism and discuss the subject well. Dr Sanjay Gupta of CNN and Claudia Hammond on BBC are good examples of scientists doing journalism. American astronomer Carl Sagan (1934-1996) is recognised as one of the first science popularisers, through his television programme *Cosmos*. Others are Russian-American physicist George Gamow (1904-1968) and French mathematician Henry Poincaré (1854-1912). Ugandan pathologist Sylvester Onzivua, who often writes about medicine and the law in the *Saturday Monitor,* can be included in the category of science communicators.

In the case of Uganda, reporting is complicated by the controls instituted by political regimes. Moreover, most of the biotechnology laboratories are run by government. As noted in Chapter 1, science is a political weapon at the local, national and international level. As such, Ugandan scientists are bound by the Official Secrets Act (Government of Uganda, 1964), which requires government employees to be cleared by government before releasing any information. In a demonstration of the effectiveness of governments in controlling science, Iran executed Shahran Amiri, a nuclear scientist, in August 2016, describing him as "a spy who had given away state secrets" to the United States of America (Dehghan, 2016:n.p.). Sylvester Onzivua was arrested at Entebbe airport in December 2012 on his way to South Africa to conduct pathology tests on the body parts of a Ugandan MP, Cerina Nebandah, who was believed to have been poisoned by the state. Onzivua was allegedly travelling at the request of Parliament. Pigliucci (2010) notes that, when science threatens politics, the state will always prevail over science. Pigliucci's argument suggests that, in science, policy decisions go beyond the laboratory results. The supremacy of the state in science partly explains why some scientists prefer to keep quiet when contacted by the media. The silence may be a fear of reprisal from the state, whose locus of power extends to funding, patent control, and knowledge sharing.

Moreover, journalists who "uncover evidence of science distortion that upsets activists" on controversial subjects such as climate change, environment and biotechnology are often "attacked" (Kloor, 2017:60). Sensing danger in the midst of constant criticism, Kloor holds that such reporters often opt out of mainstream journalism and become online reporters or public relations officers as they search for softer grounds. Such moves on the part of reporters deplete the science communication practice of much-needed expertise.

Reporting on science is complicated further because many media houses do not know their publics (UNESCO, 2011). It is not clear whether stories on science are for the general public, farmers, policymakers, scientists or the industry. While science stories should be kept simple and clear, it is important to have an idea of the intended audience for the purpose of choosing the "spectacular angle" relevant to the intended segment(s) of the population, while paying attention to professionalism (Berglez & Nassanga, 2015:39), as targeting the general public is a monstrous challenge.

Journalists should make judgement calls based on the obtainable scientific evidence when reporting on biotechnology, and not lend their ears to activists, who sometimes are more inclined to use emotion rather than evidence to make their claims. Media houses should not get behind the public perception that GMOs are good or bad for human health and the environment without substantive evidence. Science is a self-correcting profession, based on the measurement, testing, observation and validation of processes through repeating processes based on evidence. To provide a solution, Reul *et al*. (2016:6) suggest that journalists can approach issues of biotechnology either from a constructionist point, where they seek as many voices as possible, or from a transparency point, by "revealing their subjective position to the readership".

Indeed, biologist and science philosopher Pigliucci (2010:303) affirms that science has "the fundamental aspects of being an investigation of nature, based on the construction of empirically verifiable theories and hypotheses". Therefore, the coverage of controversial issues, especially those involving science, is influenced by both the production and consumption of material. From Pigliucci's assertion, science should not be taken for granted, since many scientific findings are approximations and the results are based on how the scientists treat nature at the point of research. Considering that scientists are human beings influenced by emotions in solving everyday issues, journalists must triple-check for the validity of the information they get from scientists before publishing it to avoid misinforming the public. The scribes or communicators should report the story when it is breaking and developing to reflect the stage the science has reached.

2.6 Public perception about biotechnology

Scientific breakthrough is as important as the public attitudes that emerge after the scientific development. The media provide a key avenue in birthing, raising, nurturing and understanding public attitudes toward technology. Gaskell, Thompson and Allum (2002) argue that press coverage affects public perception on an issue. Positive, negative or neutral coverage has a corresponding effect. The views of Gaskell *et al*. (2002) augment Leahy and Mazur's (1980) idea that, in technological controversies, the quantity of coverage is directly proportional to the negative or positive perception of an issue in society. In the case of biotechnology, countries that emphasise progress and economic benefits are likely to have a more positive public perception than those that accentuate ethics. It would have been of interest to compare coverage of a technology and the resulting public attitudes toward it to the Ugandan context, but no local studies were found for reference.

As noted earlier in this chapter, the subject of biotechnology is always entangled in controversy. As a stream of science, biotechnology is trapped in economic, social, cultural and political challenges. In Chapter 1, the study highlighted that 26 countries had adopted and commercialised this emerging technology that was anticipated to have the potential to "revolutionise the way society organises its production and distribution of food, fibre and feeds" (Hossain, Onyango, Adelaja, Schilling & Hallman, 2002a:1). The subject of GM crops, however, has attracted mixed public perceptions about its benefits and risks. The perceptions are in many cases reflected in the regulatory frameworks of individual countries, as mentioned in Chapter 1; while the USA and South Africa accepted it, many countries in the European Union rejected it, and African countries such as Tanzania and Uganda are still struggling to enact laws to govern the application of biotechnology. Malyska *et al*. (2016:530) assert that most people learn about technologies through media platforms and therefore "media claims often trigger public risk perceptions of emerging technologies".

Wagner *et al*. (2002:268) categorise the general "semantics of biotechnology discourse" into two: "humankind's progress in overcoming natural obstacles" and "humans' unwarranted interference with nature". In terms of progress, biotechnology is seen as a tool in "fighting the enemies of mankind" (Wagner *et al*., 2002:268). It is a possible solution to hunger and malnutrition, which are reported on in local and international media almost every year, the prevention and cure of diseases such as cancer and Aids, and the promotion of health and general well-being (Nelson in Hossain, Onyango, Adeleja, Schilling & Hallman, 2002b). Victory over hunger and diseases can improve livelihood around the world. Wagner *et al*. (2002:268) also document biotechnology as "tailoring living nature (fake life)", implying that humans can imitate God by 'creating' what pleases them, in opposition to the laws of nature.

The study by Wagner and colleagues highlights that, from the producer's perspective, GM food is easier, more efficient, and more profitable to grow. GMOs are considered better, 'cheaper', 'bigger' and 'more beautiful', and have a longer shelf life (Wagner *et al*., 2002:265-270). GM farmers can predict, almost with precision, the quantities they will harvest from individual plants or gardens over a given period of time at lower costs. Biotechnology can then allow farmers to meet market quotas, since they have fair control over the quantity, quality (flavour, shape and colour) of the goods the markets may want. Consequently, consumers are assured of a constant supply, since the vagaries of nature are said to be reduced. Based on this advantage, Hossain *et al*. (2002b:1) state that consumers "supported" the use of biotechnology in growing food. As noted in Chapter 1, most countries do not have enabling laws for the commercialisation of biotechnology.

"Whereas the biotechnology industry assumed that regulatory processes were the sole hurdle prior to commercialisation, it is now apparent that a second hurdle, national and international public opinion, must be taken into account" (Bauer & Gaskell, 2002b:1). Bauer and Gaskell (2002b) maintain that the issue of public resistance to technology first came to light in 1993, during a Science Museum exhibition in London, at which tourists raised concern about GMOs. Scholars observe that public resistance to technology is a sign that the public are experiencing challenges applying the science (Bagley, 2007; Clancy & Clancy, 2016; Fowler & Gollust, 2015; Gauchat, 2012; Horst, 2005), but the resistance should act as a "catalyst for learning" (Dunwoody, 2008b:70). Therefore, the 1993 Science Museum in London acted as an arena for scientists and social scientists to share experiences about the public reception of biotechnology in Europe and North America. The following years provided an opportunity for the different actors to know what society thought about manipulating nature.

As if planned, the importation of GM soya to Europe in 1996, and the cloning of Dolly the sheep in the same year, cultivated both excitement and anxiety about the technological wit that "turned science from fiction into a reality" (Bauer & Gaskell, 2002b:3). The knowledge and attitudes that had been simmering since the 1970s coalesced into what Bauer and Gaskell (2002b:3) call the great "European biotechnology debate" that crowned the 20th century, after the media sensationalised the subject from 1997 on. The debate focused on the novel technology that could be used in pharmaceuticals, medicine, industries and agriculture for various purposes, as cited in Chapter 1. While the public had accepted biotechnology to some degree, in other industries there was vehement opposition to its use in agriculture, specifically for plant and animal breeding.

In Wagner and colleagues' (2002:269) study, the respondents described manipulating nature as "playing", "tampering", "messing", and "tinkering" with the natural social order and justice, expecting the repercussion of nature fighting back. "Some argue that since genes are naturally occurring entities that can be discovered (not invented), granting patent ownership to genetic findings and processes is morally and ethically untenable" (Hossain *et al*., 2002a:2). The issues raised by anti-biotechnology movements included health, environment, bio-diversity and labelling, among others.

Wagner *et al*. (2002:203-223) postulate that, to understand perceptions, researchers need to study with what people associate the phenomena. The researchers discovered that Europeans associated eating GM food with diseases, allergies and resistance to antibiotics; reducing the biological diversity of plants and animals; and inviting super weeds that may not be easy to control. For many people, the sweetness of a product did not matter; all they needed was labelling. In the Swedish media, the GMO situation was described as "'leaking uncontrollably over the borders', 'gene food sneaking into the shelves' or 'mixing modified and natural beans so that we will not know'" (Wagner *et al*., 2002:257). Wagner *et al*. (2002) further explain that Swedish respondents imagined that the fruit and vegetables from biotechnology were "'bigger', 'unnatural' and 'artificial'". The Germans, Britons and French described the products as:

> giant fruits, bigger potatoes, cattle with more meat, wheat yielding more flour, manipulated giant tomatoes, artificial colours (Germany); making tomatoes rounder, making apples larger and greener (United Kingdom); … tomatoes as big as pumpkins and melons, a tomato that is mixture of tomato and potato and

> that tastes like a banana, [and] square tomatoes (France) (Wagner *et al*., 2002:265-70).

Peculiar to Germany, biotechnology was compared to nuclear energy and radioactivity, and the respondents used the term "(ir)radiated food" to describe the products of biotechnology (Wagner *et al*., 2002:269). By this, they meant that biotechnology is dangerous, and its effects may spill over to the vegetables and fruit they eat much in the same way nuclear atoms can affect their environment. The clamour for labelling, mainly by organic farmers and environmentalists, forced the United States Congress to pass a bill in July 2016 that would "require food companies to disclose whether their products contain genetically modified ingredients, whether in the form of a label or a scannable QR [Quick Response] code on the packaging" (Harvey, 2016:n.d.). The labelling could also be in respect of the consumers' rights to know the full contents of the food they buy and/or eat.

The negative perceptions should be understood in the context of food being a key indicator of tribal, religious, community and even national identity. Atkins and Bowler (2016:vii) affirm that food "has a central role in sustenance, pleasure, and touches the deepest of nerves in our economy, politics and culture." One scholar contends that the GM controversy is not a disagreement of facts (science) versus emotions (public), but a "philosophical" disagreement over how countries should manage the "food regime" – socio-economic ways of managing food production (Hicks, 2017:68-69). Hicks admits that the foundation of the divide is in looking at "food as a commodity and food production as a business" (Hicks, 2017:68). On the one hand, the pro-biotechnology activists belong to the dominant paradigm, which looks at genetic engineering (GE) as a way of minimising the costs of food production while ensuring a profit in the world market. On the other hand, the anti-biotechnology activists reject the dominant food regime and propose one in which "food is valued primarily in cultural and ecological terms, not economic ones" (Hicks, 2017:69). Hicks's argument is supported by another recent study, which divides the conflicting camps into two: "conventionalists and non-conventionalists" (Martin & Enns, 2017:207). Conventionalists look at providing safe food in large quantities to feed the ever-growing world population, while non-conventionalists think that food production should take into consideration the ecosystem, including the environment, community and social justice.

Henceforward, any alterations in the production of food disrupts societal settings as food signifies culture and power (D'Sylva & Beagan, 2011). In ethnic societies such as Uganda, every tribe is associated with certain food, much in the same way some religions forbid the consumption of selected foods (Muggaga, Ongeng, Mugonola, Okello-Uma, Kaaya & Taylor, 2017). Thus, the meaning of food varies across the social strata and affects status of individuals, gender roles, associated taboos, myths and food-related rituals. By implication, the planting, pruning, harvesting and preservation of crops and the preparation of meals reflect the culture of the respective societies. GE may have effects on all of these, or at least one of them, and presents a challenge to which the public are responding through resistance to cultural alteration. In addition, biotechnology raises the question of what is natural and unnatural. For ordinary people, it remains unclear whether a plant with genes adopted from another plant remains natural or becomes artificial. As noted in previous paragraphs, the response has tended to be equal to the challenge. In situations where the challenge is not strong, the public responses have gone unnoticed, as noted when tracing the history of the biotechnology debate in Chapter 1. If the new development (technology) improves the status quo, it will receive support, but if it threatens the status quo, then it will be resisted.

In situations where the challenge was great, as in the case of introducing GM soya in Europe in 1996, public opposition attracted media attention to lubricate the debate. It follows then that, when biotechnology presents a challenge, the response draws many to the centre of the contest. Scientists do the laboratory work; the agricultural industry grows and markets the food; but the governors receive the taxes from the industry and the complaints from the consumers, who may appreciate or feel frightened by the new technology. Such a multifaceted debate usually splits society into pro- and anti-biotechnology proponents, and those with ambivalent voices are vexed out, as media spaces and airtime are contested by the different actors to influence policy. Scholars posit that decisions about biotechnology are not always based on "scientific rationale … if and when adopted regulations do not comply with the public's perception of risks, policy makers will find themselves under pressure to ban or restrict the use of the respective products" (Malyska *et al.*, 2016:530). When this situation arises, politicians might select only "information that appeals to their constituencies" and use it to rally them to the politicians' best interests (Priest, 2008:108).

Observers note that there are also moral controversies surrounding biotechnology inventions, stemming from several concerns, including those arising from the mixing of biological matter across species, the perceived denigration of human dignity, and the concept of ownership of the crops (Bagley, 2007; Gurău & Ranchhod, 2016; Hossain *et al.*, 2002a, 2002b; Johnson-Cartee, 2004). The debate also advances the issue of whether it is justifiable for scientists to produce everything they have knowledge about, and whether there is need to do so. Imperiale and Casadevall (2015:1) raise the "dual-use-of-research-concern", to denote beneficial life sciences research of which the results could be abused by 'anarchists' to cause harm, as in the case of bioweapons or bioterrorism. These issues tend to suppress attempts to improve institutional factors, such as national research capacity, food and environmental safety regulations, agricultural input markets, and intellectual property rights.

Biotechnology also gives rise to other moral and ethical arguments. It is referred to as messing with homes in food production, especially with the flavour, colour and size of products. Everything artificial means it is unhealthy for a natural body, these opponents argue. Wagner *et al*. (2002) observe that introducing something foreign is associated with "pollution", much in the same way as contaminating the environment. The need to remain 'pure' has been a source of resistance to the technology. Moreover, beliefs about biotechnology may not come from the media per se but are cumulative. There are usually "personal sources of information", such as family members, friends, teachers, and clergy (Priest, 2008:108), and the sources are defined by "individual values and moral traditions" in the community where one lives (Hielscher, Pies, Valentinov & Chatalova, 2016:2). The argument put forward by Priest and Hielscher and others is corroborated by Zehr (2008:17), who affirms that, when people get confused, they tend to replace the scientific uncertainty with "hybrid knowledge that combines scientific and lay knowledge". As a result, Dunwoody (2008b:61) asserts that content producers such as journalists and scientists should distinguish between "need to know" and "accepting my version of reality". Based on this complexity, public disapproval of GMOs is disconnected from scientific facts.

There is also the issue of terminator genes. Farmers are afraid that, with the introduction of biotechnology, they would have to buy fresh seeds for planting every year, since their harvested seeds cannot be saved for replanting the following season (Thomas & De Tavernier, 2017). Related to the terminator gene is the issue of such crops affecting crops in neighbouring gardens through pollination and the release of toxic nutrients into the soil. McHughen (2007:1107) states that contamination through pollination is unlikely, considering that GM crops are "sterile" and therefore unable to spread and "conquer" new environments. But contamination is common even under ordinary breeding. Mixed farmers in Uganda often harvest maize of multiple colours (white, yellow, green, blue) that result from pollination if 'red' maize seeds used in the production of popcorn are planted near 'white' maize used mainly in the production of maize flour. The change in colour of the harvest is a sign that even traditional breeding methods are not entirely clean; they can cause contamination, either through pollination or spraying.

Hossain *et al*. (2002b) found that knowledge of science, opinions (positive or negative) of the GM companies, and the trust they have in the government of the day are important factors that determine whether people adopt biotechnology or not. Hossain and colleagues raise issues such as the fact that developed countries are using biotechnology to produce what they initially imported from the developing world, hence disrupting the balance-of-trade figures against poor nations. Further, the scholars contend that biotechnology may lead to farmers eventually becoming "permanently dependent on multinational corporations for their means of production", with a likelihood of negative socioeconomic and political outcomes (Hossain *et al*, 2002a:2). Knowledge, as described in the subsequent section of their paper, can play a double-edged role in allowing people to explain why they should or should not adopt the technology. Regarding the corporations supplying GM seeds, it appears that citizens think the source is as good or suspect as the product. It is noteworthy that government often determines whether people should adopt the technology or not. High trust in government is a suggestion that consumers will adopt the technology, if government makes it a policy, and the lack of trust in the leadership will frustrate efforts to adopt a technology. However, the implication of legalising or accepting GMOs is that farmers who choose GMOs have to rely on corporations for seeds, which will result in added expenditure at the point of planting and cultivating through specialised spraying. Whether the GM seeds will lead to better yields remains a question in the case of Uganda, where the value of crop biotechnology is still being weighed up.

In their study, Gaskell *et al*. (2002) found that there was more support for GM crops in the USA than in Europe. About 30% of Americans were in support of GM foods, compared to 13% in Europe. The authors attribute the differences to individual cognition and perceptions, rather than to public debates, because GMOs had not penetrated Europe much by the time the data was collected in 1996. The authors ascribe the opposition to fear of the unknown risks, considering that the industry was hesitant to label GMOs but wanted to sell them like the organic foods. At the same time, scientists and the industry had emphasised the benefits of biotechnology to the producers, without doing the same for the consumers – the ones who would be affected if the food was found defective. Studies show that the "commercialisation of science" (Einsiedel & Thorne, 2008:54) has tended to "obscure the scientific uncertainties" and risks (Stocking, 2008:27), but lionised its benefits. In its issue of 21st July 2016, *The*

Washington Post quoted journalism scholar Dominique Brossard as explaining that "media coverage has focused a lot on that question of consensus and health risk," and "it will be interesting to see how this develops as the labelling issue develops and comes into play" (Harvey, 2016:n.p.). A recent study found no valid "evidence of a difference in risks to human health" from GMOs and conventionally bred crops (Committee on Genetically Engineered Crops, 2016:8). A related study shows that 78% of Americans did not know that scientists lack substantial evidence linking GM food to health conditions, such as cancer, kidney disease, obesity and autism (The Annenberg Public Policy Research Centre, 2016:n.p.). So, even in the light of such substantial evidence, resistance to GMOs can persist.

It appears, then, that the biotechnology industry will have to adopt a user-oriented design to address the demands, make concessions, break resistance to its original design and accommodate the various interests. The actors need regulators, media coverage and the public to engage in meaningful discussions that can shape informed opinions for or against GMOs. These changes are easier to achieve if they are packaged as the agenda of political parties in the form of conservatism, socialism or liberalism, as leaders construct the past of their respective countries, define the present, and postulate about the future (Bauer & Gaskell, 2002). The media and other public spheres with different scope will be central to the GMO debate as conveyors and moderators as the technology takes shape in Uganda.

Scholars claim that any stream of science that cannot be understood by the ordinary people who are supposed to benefit from it becomes useless to such a geographic community or community of interest. For biotechnology to be implemented, it must reach a level at which it is "acceptable, understandable and accessible" by society (Bhatta & Misra, 2016:573). Perceptions develop over time, take long to change, and require the involvement of the groups at risk before, during and after implementation. Communication has been key to revealing the reality of climate change, the effects of tobacco, and the existence of HIV in South Africa (Bhatta & Misra, 2016; Oreskes & Conway, 2010; Pigliucci, 2010). Nonetheless, communication has not completely stopped the denial narratives that continue to be peddled by anti-science activists.

Moreover, with the ascendance of Donald Trump to power in the USA, and his selection of climate change sceptics such as Rex Tillerson, Scott Pruitt and Rick Perry for influential positions in his initial cabinet, there likely will be reduced public funding for science research. In agreement with Trump, President Vladimir Putin of Russia told an Arctic forum sitting in the northern Russian city of Arkhangelsk that he doubts man-made global warming because the heating “had already started by the 1930s”, when emissions were not an issue (Agence France-Presse [AFP], 2017:n.p.). Trump’s government planned to fund a “red team” of scientists not only to investigate and “challenge” the view that human activity is causing global warming (Harvey, 2017:n.p.), but also “halt” his predecessor, Baraka Obama’s, pledges to limit greenhouse gas emission in terms of the Paris climate accord (Mufson & Mooney, 2017:n.p.). With such leaders, there is a great possibility of entrenching scepticism about science around the world and making science communication harder than it is.

Public awareness of climate change, tobacco and HIV issues enabled citizens to clamour for change in the policies of their respective governments, and later also of the international community. As this study notes in the contextual perspective under the science-in-society model in Chapter 3, behavioural change requires organised communication and putting the interests of the people first, preferably in a public sphere. Public communicators must be drawn to the fact that, with the emergence of new technologies, especially social media, the level of interaction within and between communities and across borders has increased. Interaction allows not only for the dissemination of facts, but also of falsehoods or misinformation. It is then apparent that there should be official channels of information to refer to in cases of doubt. The United Kingdom took stock of this need at the start of the 21st century when the British Parliament select committee on science and technology guaranteed the importance of engagement in the public understanding of science. The committee recommended that “direct dialogue with the public should move from being an optional add-on to science-based policy-making and to the activities of research organisations and learned institutions, and should become a normal and integral part of the process” (House of Lords, 2000:n.p.). Other countries, including Uganda, may need to adopt this approach to make science a public good, as this study will show later. Indeed, Priest (2008:94) observes that controversies tend to reduce if the citizenry is “informed rather than when it is ignorant or propagandized”.

Midden, Boy, Einsieldel, Faestad, Liakopoulos, Ohman and Wagner (2002:203) affirm that the opinions people have about a certain phenomenon or technology constitute a “social fact”. Their study revealed mixed reactions from the European audience, with some citizens expecting positive consequences and others negative consequences of biotechnology. The consequences are illustrated in Table 2.1. below.

Table 2.1: Mixed reactions about GMOs in Europe

	Possible consequence	**Likely**	**Unlikely**
1.	Substantially reduce environmental pollution	47	46
2.	Reduce world hunger	36	56
3.	Better utilisation of natural resources in the developing countries	54	32
4.	Likely to replace most existing food varieties products with new varieties	45	43
5.	Likely to reduce the range of fruits and vegetables available	28	60

Source: Table drawn from results presented by Midden *et al*. (2002)

The study concluded that respondents employ four criteria in judging biotechnology – use, risk, moral acceptability and encouragement. However, the study also found that the components of these criteria are not connected. For instance, the public do not rate risk to the environment and health as a crucial consideration in adopting biotechnology, contrary to what scientists and other technocrats think. The scholars also aver that the "debate on these complex and contested issues requires specialised knowledge beyond the experience of majority of people" (Midden *et al*., 2002:211). But the fact that the environment is part of the judgement is a clear indication that some members of the public think about it, although they do not accord it the same weight as the scientists.

The structural model of antecedent factors presented by Midden and others reveals that the core attitudes to the adoption of biotechnology in society are three-pronged:

- the level of expectation (positive and negative) (possibility of benefits or risks);
- the optimism or pessimism about the technology in general (brightness of the future of the technology); and
- the level of 'informedness' (knowledge).

Informedness can serve a positive and a negative role. High levels of knowledge and comprehension bolster technological optimism, a direct effect on the attitude that biotechnology is after all not that risky. On the other hand, informedness has a negative effect; informed people tend to be more sceptical about the technology than those who are less informed. Informedness tends to increase with level of education. People with high knowledge levels tend to have refined, extreme opinions about the technology. More extreme attitudes tend to be informed by high knowledge levels. Attitudes based on reasoning are very hard to change, as knowledge is an indicator of the quality of attitudes (Eagly & Chaiken, 1993; Midden *et al*., 2002). Midden *et al*.'s (2002) survey showed that a quarter of Europeans were optimistic about biotechnology as a solution to economic and health problems, but were also cognisant of the social and moral threats caused by the technology. Congruently, Midden and colleagues noted that individuals' attitudes usually crystallise after a major event. In the case of Europe, it was after the importation of GM soya in 1996 and the birth of Dolly the sheep in 1997 – akin to the attention cycle (Downs, 1972). Notwithstanding the foregoing, debates on biotechnology take place largely among the elite and appear heavily contested. Yet Midden and co-researchers emphasise that such scenarios should not lead us to conclude that the public is heavily involved in the debate. Rather, we should define and look out for the actual voices of the common people.

Be that as it may, Midden *et al*. (2002) found no relationship between religion, political and environmental consciousness in determining views on biotechnology. However, their study confirmed that the manipulation of plants is associated with food. Further, the biological application is associated with moral risks, and entwines with environmental responsibility and protecting the tourist potential. To others it means pesticide-free agriculture, vegetables, food and textiles, growing tomatoes, and growing food in space.

Other studies indicate that there is a relationship between gender, age and public perception of biotechnology. Men are more willing to accept GM food than women (Gurău & Ranchhod, 2016; Mucci, Hough & Ziliani, 2004). Individuals below 35 years are more willing to experiment by eating GM food than their older counterparts, and individuals are more willing to eat GM food if they "found that nutritional modifications were perceived as beneficial and necessary" (Mucci *et al*., 2004:365). The study by Mucci and colleagues (2004:365) also demonstrates that "consumers who were younger, female, or had higher education tended to be more reluctant to accept GM foods, while older, male and less-educated consumers were less suspicious of this new technology and its outcomes". Although their study did not elaborate on the reasons for their options, the results indicate that any attempt to change public perceptions should integrate gender and age issues into the scientific, economic, political and cultural issues that relate to the biotechnology debate. Nonetheless, social acceptance of biotechnology products will rest on individuals, who may need technology to enable them to establish whether the food they will be buying is organic or inorganic (contains GMOs). The demand to know may be obstructed by the fact that the definition of GMOs has kept changing with the introduction of gene editing and other mechanisms of improving plants without leaving a trail.

Considering the caveats scientists create when interpreting results, the public have a genuine stake in determining public policy to govern science, but this role is best played by an educated and informed, rather than an ignorant, public (Malyska *et al*., 2016; Midden *et al*., 2002; Priest, 2008). However, in the case of Uganda, the domination of an educated-informed audience will negate the reality that the agricultural sector employs over 72% of the population (UBOS, 2014:ix), the majority of whom are either illiterate or semi-illiterate and live in rural areas. The role of radio, which is accessed by more than 83% of Uganda's population, will be crucial in sharing information with rural dwellers (Uganda Communications Commission, 2015:10), who stand to gain or lose with the introduction of biotechnology. Journalists can be at the centre of moderating the engagement between the scientist and the public to create an informed community.

Whereas society trusts scientific rigour more than it approves of journalism, science organisations compromise journalistic reporting by manipulating "story choices" (Dunwoody, 2008b:62) or "source use" (Einsiedel & Thorne, 2008:53) through press releases, video news releases, press conferences, tip sheets, and personal contacts with media houses or individual journalists. It is common knowledge that relying on limited sources "provides the audience with a partial picture of an issue" (Einsiedel & Thorne, 2008:53). Journalists' choice of sources is usually determined by their level of experience, which is usually synonymous with their source base. In the case of biotechnology, where emotions tend to reign over science in the interpretation of results, journalists can predict with certainty the views of individual sources and contact them to confirm for the record. In some cases, individual scientists are interested in giving their stories to a particular journalist because they trust the journalist's ability to present their views the way scientists want them, although this can be interpreted as being partisan. Indeed, individual public relations officers have created respective armies of journalists to cover issues of biotechnology every time their organisations need visibility, especially when launching a new product, as a way of "self-promotion, image building and image maintenance and self-marketing" (Carver, 2014:2). Consequently, science can only be meaningful to the public if media houses stop looking at scientists as 'sources' of information, but rather as 'partners' in communicating science (Ardèvol-Abreu & Gil de Zúñiga, 2016;

Maille, Saint-Charles & Lucotte, 2010; Rodriguez & Lee, 2016). Such a partnership presupposes that the journalists have public interests at heart and are unlikely to sell their conscience to the corporate science institutions.

It is thus possible to deduce that the public "recognise the benefits that come with GM food" (Simelane, Masuku, Rugambisa & Earnshaw, 2016:27), but the risks of GMOs, such as that half of children will have autism by 2025 (Alliance for Natural Health, 2014), are "perceived as substantial and irreversible" (Hielscher *et al*., 2016:2). Moreover, Hicks (2017:69) concludes that responding to socio-political issues regarding food systems and societal values supersedes the science versus the anti-science stigma and requires "political deliberation at many levels of government and civil society". From the discussion above, it is evident that most of the objections are tied in with personal and societal myths. The presence of these myths suggests the existence of a knowledge gap, which scientists, journalists, politicians and civil society can close by engaging with the different publics using the available communication channels.

2.7 Knowledge gaps about biotechnology

Many scientific innovations never leave the laboratories where they are made. This sometimes happens because the invention is inferior to existing products; the risks outweigh or are assumed to outweigh the benefits; the public reject the technology; or if there is no existing law to enable the introduction of the resultant products to the public to address the application, transfer and related ethical challenges (Gurău & Ranchhod, 2016). Every time an innovation is delayed in the laboratory, taxpayers lose, because most scientific experiments are driven by public resources. In democratic societies, the application of science is highly political. Therefore, public awareness campaigns to influence images, opinions and attitudes are important before the introduction of new technologies to avoid unintended reverse effects. As Bauer and Bonfadelli (2002) contend, individuals already have mental pictures of biotechnology; the knowledge exists in informal conversations at places of work, in restaurants where people discuss it over coffee, lunch, dinner or alcohol; in metros, buses, taxis and private cars as people travel; at funerals and weddings; in religious congregations; and as media content. What is not clear is how the informal and formal platforms interact with one another to create salience that can influence future developments in biotechnology, with due consideration of the knowledge gap.

Proposed in 1970 as a postmodernist perspective for studying traditional mass media effects, knowledge gap theory posits that, when there is an increase in information supply in society, the elite tend to accumulate more information than those in the lower ranks, leading to an information divide between the two groups, rather than closing this divide (Tichenor, Donohue & Olien, 1970). This theory is still relevant half a century later, where the "convergence" of two-way social media or multimedia (Jeffres, Atkin & Fu, 2011:30) with one-way traditional media to share news and entertainment has left knowledge "unevenly distributed" across the social strata (Tran, 2013:831). Scholars hypothesise that the elite are usually more educated than others, have better communication and information gathering skills, are more aware as a result of stored information from school, textbooks and discussions, and have the relevant social contacts to share with them information about public issues. They also enjoy selective exposure resulting from optimum use of media, and are usually the prime target of media organisations.

As a middle-range theory, the knowledge gap hypothesis measures the level of "intensity of representation of non-local issues by examining the relations among the intensity of media coverage, the level of controversy and level of pluralism characterising a particular public sphere" (Bauer & Bonfadelli, 2002:149). The argument is that, before media can influence people, topics first have to be generated on the basis of individual experiences, informal conversations, formal media or any other information they have accumulated over time. In the case of subjects such as climate change and biotechnology, which are complex and controversial (Bhatta & Misra, 2016; Gaskell *et al*., 1998; Priest, 2008; Townson, Brewer & Ley, 2016), abstract and beyond the understanding of an ordinary person in societies like Uganda, public views will largely be shaped by the way media represent the subject. Based on this, it is apt to argue that it is easier to target the educated people or the elite than the less educated using media platforms, since the gap tends to narrow in fairly homogenous communities, or when the topic involves controversy, forcing the public to yearn for information. The knowledge gap can thus be influenced by the knowledge topic (whether it is practical or abstract), the type of knowledge (agenda, factual or abstract), the media channels (newspapers versus television versus social media), the length of time and the intensity of exposure.

Topics involving science, such as biotechnology, trigger debate at home, in workplaces, bars and places of worship, among others, thereby generating more material for media focus

(McHughen, 2007; Tran, 2013). Such engagements are usually a demonstration of democracy, where people participate in consensus building. Studies of the media's role in science and technology have sounded the need for scientists to be accountable to the broader community in order to enable individuals and groups to make informed choices on adopting or rejecting the application of new knowledge (Bhatta & Misra, 2016; Friedman *et al.*, 2008).

The use of biotechnology seems to have been stifled by the lack of public support to establish the necessary governance frameworks in many parts of Africa. Further, the slow penetration could be due to limited knowledge, on the part of the scientists, about the importance of a planned science communication strategy in getting governments, decision makers and the media to buy into this scientific research. Garrett and Bird (2000) aver that biotechnologists are highly trained in a body of knowledge and often use coded language to communicate their findings "as an index of their expertise" (Fiske, 2010:72), and just a few people can understand the meaning of their jargon. Thus, a knowledge gap is created when the would-be users, especially the farmers and consumers, are left ignorant or insufficiently informed about the scientific benefits published.

In spite of their enabling and constraining roles, the media have hardly been integrated into disseminating crop-innovation systems in developing countries due to limited research (Feindt & Kleinschmit, 2011). For this reason, whether biotechnology can be translated into responsible and socially integrated innovations in agricultural systems that benefit the poorest in developing countries and, if possible, how it can be integrated, has been a long-standing and challenging issue for research and society. Consequently, a well-planned science communication process is vital to getting governments, decision makers and the media to accept, reject or share knowledge and shape debate in this field of scientific research.

This research project seeks to make conceptual, empirical and practical contributions to the understanding of the social conditions for disseminating knowledge about crop biotechnology in developing countries. By critically assessing the frequency of and the knowledge gaps in covering biotechnology, the research aims to generate better understanding of the actors who influence the news frames, including how the science is presented and perceived by the public in Uganda. It is also anticipated that this research will enhance public discussions about biotechnology legislation by critically reflecting on its media/public images and the role of such images in the uptake of this scientific research and its products – as shaped by the interaction between scientist and journalists.

2.8 Relationship between scientists and journalists

2.8.1 History

Although studies about the development of science communication are rare, scholars observe that there were traces of science communication in the 19th century through magazines and newspapers (Dunwoody, 2008b; Govoni, 2010). The content of the publications was commonly composed of lecture notes and opinions on natural occurrences such as earthquakes and meteorites. The scholars explain that scientists, then, supposed that they had a moral duty to inform and educate the public about their discoveries using the communication platforms of the time as part of garnering societal support and approval. Economic and social progress have been intimately associated with developments in science and technology. The Royal Society of England was central to improving the relations between experts and non-scientists through engagement, especially on issues of medicine, evolution and exploration, among others, by rewarding excellence in science. Thus, popularisation reached a peak during the Victorian age, a period marked by industrial revolution, colonial expansion, and the creation of modern states, as scientists intensified their "dialogue" in different languages with politicians, industrialists, the middle class, workers, artisans, women and the youth as their audience (Govoni, 2010:24). It was through such engagements that "Newtonian physics" and "chemistry" became popular in England, much the same way the French were enamoured by "Pasteurisation" (Govoni, 2010:23).

Dunwoody (2008a) notes that scientists' public participation started declining in the United States in the first decades of the 20th century when they started specialising. At the same time, scientists started professionalising, developing, coining exclusive terms, and preferring to share information with fellow scientists through journals and conferences, rather than with the general public. The systems of professional development encompassed stringent rules that barred scientists from popularising their discoveries and denied them affiliation if they defied the establishment (Bucchi & Trench, 2014 Davies & Horst, 2016). By the 1980s, scientists, afraid of ruining their careers, abandoned public engagements and some journalists have since filled the gap. The practice, however, has been riddled with a serious shortage of specialist reporters, often requiring editors to interchange/alternate the "generalists" (reporters who are not science journalists) – not only to ensure that the beat is covered, but also "to prevent the pitfalls of reporter-source intimacy" (Dunwoody, 2008a:16), which sometimes limits investigative reporting (Dunwoody, 2008a; Einsiedel & Thorne, 2008). Although there are currently many science journalists belonging to various national and international associations, observers admit that science remains under-reported because many media houses lack specialists. Indeed, even in the digital age, science communication has largely remained a "goodwill exercise" (Bucchi, 2016:905). This communication is voluntary activity for researchers, because institutions regard it secondary to research and teaching. As such, it is the photogenic scientists who usually become TV commentators, and others can make careers as radio, newspaper and online contributors.

In Italy, science was used as a political tool to demonstrate support for or against Catholicism through "*indoctrination*" [researcher's emphasis] of the public as science became a cultural force (Govoni, 2010:25). This approach allowed Catholic fundamentalists to attack scientists who professed support for the Darwinian theory of evolution. A notable victim of Italian scientific propaganda was astronomer Galileo Galilei, who maintained that the earth rotated around the sun, contrary to Catholic teachings that the earth was at the centre of the solar system. In 1616, Galileo was consequently banned from popularising his thinking, as it contradicted the 'interpretation' of the Bible. "So the sun stood still, and the moon stopped ..." (*The Bible*, Joshua 10:31). Galileo was later tried and in 1633 sentenced to home imprisonment for eight years for heresy. Only in 1992 did Pope John Paul II apologise for the church's mistake.

Bucchi and Trench (2014) chronicle the story of science communication from 1800 to 2014 under six research eras and themes: 1800 to 1900s (deficit model paid attention to increasing public knowledge on ready-made science); 1930s to 1940s (selling science as redemption of societal problems); 1960s (science journalism begins to question science); 1980s (public relations in science is born); late 1900s (dialogue gives rise to the science-in-society model, pushing the House of Lords in the UK to document the need for sharing information with citizens at all levels in 2000); and 2006 to date (crisis of traditional mediators [media] of science communication as social media entrenches itself). Science communication has been globalised, raising the issue of the democratisation of expertise.

Based on the above history, the relationship between scientists and journalists is of fundamental interest to this study, for three major reasons – 1) attracting and justifying funding; 2) legitimising one's work before fellow scientists and the public; and 3) building partnerships between scientists and commercial enterprises, beyond advertising (Claassen, 2011; Malyska *et al*., 2016). The scientists have the information, but for the visibility of their work they need journalists to share this information in a language understandable by the ordinary people. The public's understanding of science, and more so, social debates on subjects such as biotechnology, usually happen through the lenses of the media, which transmit and popularise the knowledge, on the basis of which they form opinions (Bauer & Gaskell, 2002a,b; Maille *et al*., 2010; Malyska *et al*., 2016; Peters, 2013). The relationship is based on the premise that scientific findings can only be beneficial to society if they are accessible to the public. The widest dissemination is best achieved through the media (Bucchi, 2016; Claassen, 2011; Miller, 2010; Tran, 2013). Even then, this symbiosis has sometimes been antagonised by the suspicion that has plagued science communication for decades.

Peters (2013:14102) uses six different metaphors – "distance, gap, barriers, fence, oil and water, and creative tension" – to describe the rift between internal scientific communication and public communication. The use of different metaphors is an indicator that scientists and journalists probably have different agendas. Peters (2013:14103) believes that scientists and journalists are like "strangers, not able to understand each other's language", and notes how the professions vary in principle and practice. The antagonism seems to be rooted in the struggle between the scientists and journalists for influence to communicate to the public and perhaps become celebrities. On the one hand, the scientists generate the information, but on the other hand journalists have the contact with the public to fill the "structural hole" (Maille *et al*., 2010:76).

Maille *et al*. (2010:71) explain that journalists blame scientists for confining themselves to the "ivory towers" and lacking the expertise to explain the results of their routine work to ordinary people. Journalists criticise scientists for wanting to check the stories in which they have appeared as sources for the purposes of checking accuracy before they are published, a point the journalists object to as unnecessary (Claassen, 2011; Maille *et al*., 2010). Stocking (2008) lists seven concerns of the scientists: 1) journalists often omit caveats on scientific claims; 2) journalists often use a single source for their stories, thereby locking out other scientists from interpreting the results; 3) journalists' lack of context (many stories do not connect to the past, ongoing work or the future) in terms of related studies; 4) focus on product triumph over process (stories often omit the method used in the study). thereby "solidify[ing] or mystify[ing]" scientific claims or "obscuring scientific uncertainties"; 5) journalists sometimes make science appear uncertain, yet knowledge will have settled on some issues, such as the causes of HIV/Aids and global warming; 6) unexpected and unexplained contradictions in linking a new story to the initial story with similar results; and 7) giving equal weight to minority and fringe scientists (sometimes journalists allocate the same space and airtime to scientists who have published widely and those working for think tanks to create doubt in mainstream science, or giving equal weight to victims who are non-scientists and the scientists who cannot find a link between the effect and the available scientific evidence) (cf. Davies, 2009; Oreskes & Conway, 2010; Pigliucci, 2010).

Thus, many scientists have a generally negative perception of the way the media cover science, especially controversial subjects such as biotechnology. Scientists have argued that they resent the media because journalists misrepresent science, leading to misinformation among the public. As such, scientists feel that, in many cases, scientific data are deliberately ignored when science is reported (Bhatta & Misra, 2016; Caple & Bednarek, 2013; Carver, 2014; O'Brien & Pizmony-Levy, 2015).

On the other hand, resulting from differences in training, there is also a lack of understanding on the of part of the two actors on what makes news (Basu & Leeuwis, 2012; Berglez, 2011; Brants & Van Praag, 2015; Dziuban *et al*., 2005; Rodriguez & Lee, 2016). It seems, then, that to the scientists, their findings are news enough, but to the journalists the results become news only after adding the social, political, economic and environmental context and recontextualisation, often with some sensation and hence distortion. The distortion sometimes emanates from the differences in training, which breed terminologies hard to understand by journalists. Maille *et al*. (2010) maintain that journalists think that scientists are not mindful of the time element in responding to their questions. Often journalists want scientists to give them timely comments for the next deadline, yet the scientists want to first read, understand and contextualise before commenting. To beat deadlines, journalists omit the methods used in conducting the research, to the chagrin of scientists, who think methodology is important in contextualising the results. To the scientists, the method is as good as the results. Maille and co-researchers further reason that science communication is complicated by the fact that some scientists think that, because of the complex methods they use, the results they generate are secondary to public interests.

Some scientists suggest that the general public should be left out of the science production and validation process altogether, but that the scientists can share their already published research in the public arena according to the "Ingelfinger rule" (Toy, Vandenbroucke, Journal, Holden & Franz, 2002:195). The rule is a general principle developed by Franz Ingelfinger of *The New*

England Journal of Medicine in the 1970s. The principle is used by editors of scientific journals to reject any article whose results have already appeared in the journalistic media for purposes of exclusivity. In Peters' (2013) study, scientists revealed that it is realistic to talk to journalists about results that have already been approved by their peers. According to Peters (2013), 60% of scientists believe that science should be treated as "specialist" knowledge and that the general public should be treated as an external "audience". In this case, the public are not the primary target of the research, but the findings can be used to educate them about issues such as biotechnology, as suggested by the deficit model or scientific literacy model (Lewenstein, 2003; Secko, Amend, & Friday, 2013; Trench, 2008). The literacy model approach is a significant departure from the humanities and social sciences, where research results tend to focus on the ordinary people as an "active" primary audience (Fairclough, 2008:182).

Social scientists are inclined to have more interaction with the media than researchers from the natural sciences, law, archaeology and philosophy. For the scientists, it becomes hard to communicate results to the unintended audience, unlike for the social scientists, who produce knowledge with the vision that the general public have to validate the results. On this issue, Peters (2013:14103) concludes that "the gap may be a steep canyon in the sciences but a smooth valley in the humanities and social sciences".

So, as democracy deepens, the considered boundaries between science and society should become permeable by way of embracing public participation. The right to know should extend to what scientists do, since, as already discussed, most of the scientific work is maintained by public funds to find solutions to problems faced by citizens. Countries, then, need to craft ways of adopting "democracy for science" as a knowledge area, which has been dictated "by individual curiosity" for millennia, to bring it to conformity with democracy, which survives principally on the consent of the governed (Priest, 2008:98). The operation of democracy is certainly contrary to science, which is largely driven by systematic measurement, peer review, caution, reason, evaluation and replication (Davies, 2009; Pigliucci, 2010; Priest, 2008). But public accountability is necessary if leaders are to answer a vital question: how can the world feed the current population and ensure sustainable biodiversity for the future generations?

In terms of the frequency of contacts between scientists and journalists, Peters (2013) explains that the difference in coverage sometimes is a result of the individual interest of journalists and their audiences in some topics, but not others. Hence, the interests of researchers in some fields and the contacts such scientists build with journalists play a critical role in making journalists and the public interested in following their fields of research. Public information activities, such as annual events, exhibitions and fairs, draw scientists and journalists close (Broom & Dozier, 1986; Gunter, Kinderlerer & Beyleveld, 1999; Lewenstein, 2003). The other reason is the scientific journals in which the research appears. Publishing in journals such as *Nature*, *Science* or *The Lancet* is likely to draw media attention to scientists' research (Bhatta & Misra, 2016; Ji-kun & Bo-wen, 2015; Vilella-Vila & Costa-Font, 2008). The last reason is the willingness of the researcher to talk to the media, which will either draw journalists close or keep them away. This point also explains why there is "heavy reliance" on some individuals or organisations as sources of quotes on similar stories (Reul *et al*., 2016:6), providing a possibility for "neglect of [the] sociological, cultural, ethical, historical and educational contexts" bolstering science, specifically in relation to subjects such as biotechnology (Petersen, 2001:1258).

The popularity of the organisation and rate at which it publishes are normally associated with the frequency of media coverage. The relationship becomes even clearer if such organisations have strong public relations personnel who take the opportunity to publish as "advertising", or have "principal investigators" associated with them (Peters, 2013:14105). Such organisations tend to drive coverage (Dunwoody, 2008a, 2008b). Nonetheless, journalists must use caution when using press releases to write stories, because some organisations package pseudoscience and want to use the media as conduits to the public (Davies, 2009; Pigliucci, 2010).

Also, critical for understanding the frequency of coverage is the ratio of journalists to scientists; the number of local publications vis-à-vis international publications; and the routines of journalists (news releases, scientific publications, or interviews with scientists). Generally, there are few science journalists compared to the number of science streams to be covered, hence the under-reporting of science. Journalists tend to report streams of science such as medicine, which is more popular for ordinary people than astronomy, which the audience hardly encounters in everyday life (Dunwoody, 2008a). However, the interests of the public vary from society to society. Island countries like Japan may be interested in understanding biotechnology and marine science, but desert countries like Sudan would be better off concentrating on understanding biotechnology and desert life. In the same way, tropical countries like Uganda should prioritise understanding biotechnology in the context of tropical agriculture.

Reporters who depend on news releases are more likely to cover science only when the research organisation is ready to release the information, in contrast to enterprising journalists, who may take the initiative to investigate and report using angles the organisations may not have anticipated. Noteworthy is that disciplines like medicine and the environment, in which contact with scientists is a routine activity, tend to get more coverage than others. Sometimes, journalists use public relations events to give their decaying information a "timely edge" (Dunwoody, 2008b:66). Relatedly, scientists occupying high office stand higher chances of interacting with the media than others, because their prominence drives journalists to seek their opinions (Peters, 2013), especially after an event or when there are social issues the media want to report on.

Scientists are able to directly and indirectly dictate the agenda and story angles through news releases, press conferences, video releases, flyers, posters, and choosing the journalists to whom they give the information. They also choose or recommend the journals to which the media can have access. In terms of Altheide and Snow's (1979) media logic and Entman's (1993) principle of framing, discussed in Chapter 3, journalists can only be creative when using accessible material. Considering that most journalistic stories are reactive, scientists are more powerful in the relationship. Journalists frame the stories following the media logic, but scientists are asked to interpret the stories, often creating uncertainty for the audience in the process. The ensuing debate culminates in a controversy.

The uncertainties involved in science could be another possible reason for avoidance by journalists. Moreover, training journalists and doing investigative stories on science is very expensive. This scenario can be attributed to the astronomical costs incurred by the media organisation and the journalist. For that reason, investigative stories are "scarce indeed" (Dunwoody, 2008b:65), but this situation is worse in science reporting, and possibly worst in relation to biotechnology. Yet, when journalists investigate science, "they don't check the past papers of the scientists for mistakes, check raw data, or ask for source of funding" (Dunwoody, 2008b:65). Often, journalists select stories "which are quick to cover and safe to publish" (Davies, 2009:114). Therefore, it is important to stress that what the general public reads as news is largely what was convenient for the journalists and their respective organisations to publish.

In closing this section, it is imperative to assert that the "diffusion of scientific culture" requires the public to use their "knowledge and skills" to face their lived challenges, beyond knowledge acquired through the school curriculum, to achieve an attitude of "participation and scepticism" (Govoni, 2010:28). Such a combination can be a product of collaboration among science communicators, journalists, scientists and politicians through the education system, or through orientation outside the academic curricula.

2.8.2 Differences in orientation

The collaboration between scientists and the media is largely grounded in orientation – benefits, costs, moral obligation. The interaction is usually linked to the leadership role of contemporary scientists, rather than psychological factors such as the scientists' perceptions of moral obligation, assumed media impact, negative perceptions of the media, and financial motivation (Peters, 2013). When scientists take up leadership positions in an organisation, it becomes expected of them to face the media and explain key issues, no matter their character as individuals. In other words, psychological factors are secondary to the orientation of a scientist. Indeed, engagement is nowadays encouraged by many scientific journals, which include the contact details of the principal investigators for follow-up stories. Such stories, especially in the media, increase the visibility of the scientist, the organisation he/she works for, and the journal in which the findings were published. Many scientists have taken this as a moral duty. Yet the gender, race and age of a scientist are also key factors in determining their willingness to engage with the public (Joubert, 2017). Joubert's (2017) study reveals that white, male, senior researchers older than 50 years are more likely to engage in public discussions than others. But Davies and Horst (2016) argue that beyond the structure of the population, the institutional culture strongly influences a researcher's willingness to engage the public to demonstrate the organisation's competitiveness among its peers.

For Rödder (2012), scientists who choose to interact with the media must be competent in the subject matter; be confident in their presentation; ensure that scientific communication is a priority; and speak only to reputable news organisations. In the case of biotechnology, it is important that scientists know the 'bias', if any, of the respective journalists and the media houses they work for before addressing them. Such knowledge is important on the part of the scientists for the purposes of anticipating the likelihood of being misquoted while 'facing' the media, as journalists' understanding of science is crucial to the social contexts in which science applies and is debated.

More recently, public relations officers of organisations facilitate the interaction between scientists and journalists for the purposes of increasing visibility, securing public support and legitimacy, attracting the attention of sponsors, and increasing competitiveness for contracts (Bucchi, 2016; Peters, 2013). Hence public relations tools such as press releases, blogs, newsletters and wikis have been adopted in the management of organisations doing scientific research, in order to contribute to the enjoyment, visibility, attracting opinion, and understanding of science (Carver, 2014; Jarreau, 2016). Such publicity is linked to the growing commercialisation of science as the field expands to compete, maintain and expand opportunities for government and international funding (Jasinsk, 2010; Mackenzie *et al*., 2003; Mtui, 2011; Townson *et al*., 2016). For that reason, in many cases the mediatisation of scientific research requires clearance from the organisation or senior colleagues when the individual disseminating is not the principal investigator.

Further, Peters (2013:14106) notes that many scientists have come to embrace publishing their research in the media, although significant percentages have remained “ambivalent” about popularising science. Peters intimates that institutions are using subtle means to encourage their scientists to face the media by offering them rewards, crafting press releases for researchers, and training them in dealing with the media in the long run. Often, the role of clearance is to ensure that the interaction with the media is anchored within the organisation’s strategic plan.

On the part of journalists, the way they cover science is sometimes skewed towards edging out their “competitors” (Stocking, 2008:67). Stories have to sell, hence the spicing with political and socio-economic angles for occasional sensationalism, even when the scientific facts may not be interesting (Berglez & Nassanga, 2015; Maeseele & Schuurman, 2008; Takens, Van Atteveldt, Van Hoof & Kleinnijenhuis, 2013). In fact, editors always admit that “what customers want drives the editorial judgement” (Davies, 2009:135). This strategy is aimed at increasing revenue for the media houses. In contrast, the focus on revenue makes media outlets ignore stories for which they would have to invest much and opt for sports and entertainment, where the content is almost readily available, and the audience is interested, rather than biotechnology, which may require training journalists in science communication and being patient with scientists to compose their responses to make quotes for stories. So, profits are central to the political economy of media houses (Rodriguez & Lee, 2016; Susen, 2011; UNESCO, 2011), including those in Uganda.

For journalists, including many voices is important for balancing the story. Balancing is important in journalistic pieces because "sometimes scientific claims turn out to be faulty and they are retracted" (Dunwoody, 2008b:66), as demonstrated in the case of Mbeki's basis for rejecting ARVs (antiretrovirals) for South African HIV patients in the first section of this chapter. Journalists hide under the cover of balance for safety, especially where they are not sure of the facts. Covering a story from different angles presupposes neutrality and allows media houses to avoid apologising to aggrieved parties. Nevertheless, Davies (2009:131) asserts that, by the same rule, "journalists are encouraged to abandon their primary purpose – truth telling". It is under the balancing principle that, in the 1980s and 1990s, when scientists warned that tobacco is linked to lung cancer, journalists kept seeking voices from tobacco companies, which generously responded with counterclaims that raised doubts. Journalists have always given an audience to oil companies to punch holes in scientific evidence on global warming. Other ways in which journalists do their work include selecting only safe facts; steering clear of individuals with power to influence the news or cause their sacking from the job; selecting safe ideas; giving the public what they believe in; and playing to the moral panic of society (Davies, 2009). Such journalism practices of gauging scientists against pseudoscientists, however, complicate the public's ability to understand biotechnology.

Stocking (2008:23-24) divides Davies' production rules into four parts – 1) individual factors; 2) media routines; 3) organisational demands; and 4) ownership patterns. Individual factors such as education and experience are important in covering science with accuracy and completeness when reporting on subjects. Besides, experience in number of years has been proven to improve the ability to report science. At the same time, individual journalists' consideration for scientists' values and journalistic ethics tend to put a burden of responsibility on the journalists to report well. Further, journalistic desire for significance entices them to ignore the caveats made by the scientists. These factors combine with organisational demands, especially audience interests, pressure from advertisers, professional norms, level of competition, the ownership patterns and editorial policy, to determine what is published, and who and how sources should be quoted (Caple, 2013; Reul *et al.*; Sarrimo, 2016). In their article, 'The case of the media against the media. By the media', *The New York Times* (2016:n.p.) investigation concluded that social media have exposed traditional media as "partisan, mendacious, lazy, sloppy, and shrill", different from the 'angels' the media purport to imitate. Yet Bucchi (2004:108-109) identifies this attitude or position (on the part of scientists) as the "diffusionist" conception:

> indubitably simplistic and idealized, which holds that scientific facts need only be transported from a specialist context to a popular one ... On the one hand, it legitimates the social and professional role of the 'mediators' – popularizers, and scientific journalists in particular – who undoubtedly comprise the most visible and the most closely studied component of the mediation. On the other hand, it authorizes scientists to proclaim themselves extraneous to the process of public communication so that they may be free to criticize errors and excesses – especially in terms of distortion and sensationalism. There has thus arisen a view of the media as a 'dirty mirror' held up to science, an opaque lens unable adequately to reflect and filter scientific facts.

It is apt to conclude that scientists and journalists see reality using different lenses, hence aggravating the controversies in science, and more so in relation to biotechnology. It also becomes important to explain the challenges in the scientist-journalist's relationships.

2.8.3 Challenges

Some scientists consider their knowledge special and not for everyone. They consider engagements with the media as arenas that lead to the oversimplification of their findings. They also think that any strategy to reach the ordinary people through the media "erodes" the facts (Dunwoody, 2008b:60), especially if it involves "fostering excitement" (Besley, Dudo, Yuan & AbiGhannam, 2016:370).

Indeed, the need for increased public engagement between scientists and journalists faces the challenge of the push by some scholars that scientists should also face the public directly, in addition to the occasional media appearance (Howard, 2012; Miller & Fahy, 2010; O'Brien & Pizmony-Levy, 2015; Von Roten, 2011). This certainly will most likely be time-consuming, since scientists would have to meet small groups of people, but it may be more efficient. For the engagement to be efficient, it will require scientists to be re-oriented from their structural exclusivity during training to embracing approaches that consider the dissemination of information to ordinary people from project design to implementation. Importantly, this may have the effect of reducing the time available to be busy in laboratories, but will provide the opportunity to get more ideas from many people. Ideas may also be received through internet-powered platforms.

The reduced cost of uploading and maintaining a website, however, has meant that many science organisations have put a lot of their content online. Cheap online technology enables institutions to open websites, and run blogs, wikis, Twitter handles and Facebook accounts. Peters (2013) considers this as direct competition with the media in an age where sales of print media are dwindling. The use of social media to publish scientific information seems to be slowly, but steadily, limiting face-to-face contact between journalists and scientists on the one hand, but accelerating the flow of information on the other (Bell, 2016). Moreover, *The New York Times* online (2016:n.p.) affirms that social media are “bringing new voices to the fore and connecting established ones to new audiences”. The connections are becoming easier with the development of non-commercial investigative technology such as The Intercept and ProPublica.

While the above phenomenon may be a threat to the authenticity of facts, it should also be seen as an opportunity for journalists to get information readily from the websites, rather than looking for scientists to interview when they need comments about a story. Additionally, it should also be another opportunity for sustained discussions from multiple social angles on topics and engagements on the same topics on Facebook, Twitter and possibly WhatsApp, among other social media platforms. In other words, the new media platforms are balancing the flow of information to the citizens, thereby reducing the journalists’ privilege to exclusive information born out of their contacts with principal investigators. Scientists can now discuss new innovations, implications for funding, legal, moral and ethical implications directly with the public. Bidirectional or multidimensional approaches beyond the media are indeed agitated for by scholars, who think that the right to information encompasses “non-journalistic” media (Dudo, Brossard, Shanahan, Scheufele, Morgan & Signorielli, 2011:756), and intrapersonal, interpersonal and public discussions for a healthy debate (Besley *et al.*, 2016). The sustainability of this approach to science communication has to subjected to further research.

It now appears that science communicators want to minimise mediated communication with the public. Lessening mediation should allow scientists to address issues such as “misinformation” (Besley *et al*., 2016:370), which they have complained about for many years. Such interaction will not only democratise science, but it will also increase public “support” for potential funding for specific streams of science (Ceccoli & Hixon, 2012:301; Fowler & Gollust, 2015:162; Geary *et al.*, 2016:740). An interactive approach can strengthen the biotechnology movement, as discussed in Chapter 3. Moreover, some scientists have already chosen platforms (e.g. radio, television, newspapers, community outreach, science fairs and exhibitions) on which they are "engaging" with the ordinary people (Besley *et al*., 2016:368; Von Roten, 2011). Still, it remains unclear how other scientists, those who belong to the old school that argues that science is beyond the understanding of the ordinary people, will adapt to this wave. Besides, scientists with paternalistic views doubt ordinary people's competence to understand scientific findings and use the results to engage in meaningful discussions about scientific topics, even on social media (Besley *et al*., 2016; Dunwoody, 2008a).

It should be noted that the technological developments are not a panacea to the structural challenges of the media. Journalists seem to corroborate this structural problem when they allude to:

> … deals with anonymous sources, the pressure for speed and easy hits that squeezes the nuance out of the complicated stories, editors who knowingly simplified stories past the point of accuracy and publishers who spent resources on subjects they believed were trivial rather than those they felt were important (*The New York Times*, 2016:n.p.).

While it is hard to predict the future of science communication, it is clear that social media present new platforms for sharing scientific findings (Bucchi, 2016; Bucher & Helmond, 2017; Smailhodzic, Boonstra & Langley, 2016; Van Rooyen, 2016). However, the issue of the authenticity of what is published on social media is likely to keep the audience with the mainstream media as a more trusted source than the former, as elaborated on in Chapter 3. But it is a worthwhile consideration that the new media, such as blogs and social networks, expand opportunities for science communication. These opportunities are expected to narrow the gap between scientists and the public as the online platforms enable faster sharing of information and wider reach, if used appropriately. Goujard (2016:n.p.), a journalist, proposes five ways reporters can engage with scientists and their audiences in meaningful storytelling: 1) engage the scientist and audience before publishing by opening up the newsroom to allow them to contribute ideas for the newsrooms to follow up; 2) create a direct relationship with the public by contacting them directly on phone or e-mail to verify the content they share with the journalists; 3) reward the scientists and the members of the general public who contribute by quoting them in the stories; 4) adapt newsrooms to the scientific community and the audience by analysing whether their contributors want to remain anonymous or to feature; and 5) show the methods used to developing the story to enable them appreciate the cost of news production and the price the audience pays for the news. Further research in this area will be crucial.

2.9 Chapter conclusion

There is a paradox in the relationship between scientists and journalists. On the one hand, scientists claim journalists are inaccurate in their reports, but agree that they are partners in ensuring that scientific knowledge reaches the ordinary people, who are both the potential beneficiaries and the at-risk communities of the scientific knowledge. On the other hand, journalists think that scientists are loners and consequently poor communicators who take pride in confining themselves in their laboratories at research centres.

Journalists argue that scientists are not sensitive to the time element at the core of media operations, yet scientists think that methodology is key when sharing scientific findings with the public in order to allow ordinary people to understand the context of the study. As long as journalists look at scientists as sources, but not as partners in disseminating scientific information, the antagonistic relationship will continue. It appears that the proliferation of social media platforms that minimise face-to-face contact between scientists and the media will smoothen the relationship, although with reservations regarding accuracy. Thus, there is a need for change in the way scientists and journalists interact to achieve an improvement in the public understanding of science. Journalists will need constant training to discern what constitutes science, the validity of the results and how to present them in meaningful ways without distorting facts. Similarly, scientists will need training in preparing popular versions for ordinary people to understand, on top of their technical reports for their peers.

Considering that media houses have different editorial policies, it is hard to cover the interests of all stakeholders in a single story, hence the need for multiple platforms, beyond the mainstream media. A striking concern for the media is how to remain the most credible sources of information for reference at a point when technological developments are allowing everyone to disseminate text, photographs, audio and video without being experts on the topics they talk or write about, as the boundaries between journalism and communication are blurred by technological advancements. The technological advancements are also providing platforms for pseudofacts to be disseminated, thereby complicating the public understanding of science, particularly in relation to biotechnology. The literature was analysed in the light of this study, which concentrated on how two Ugandan newspapers cover biotechnology vis-à-vis other global challenges highlighted in Chapter 1 – the audience perceptions of biotechnology, the knowledge gap in the light of the science-in-society model, the public sphere theory, and the media logic theory discussed in Chapter 3.

Chapter 3

Theoretical framework

Oversaturation of the information environment has created specialized knowledge groups and increased the level of overall ignorance about scientific issues

(Takahashi & Tandoc, 2016:675)

3.1 Introduction

This research adopted a threefold theoretical framework. It employed the science-in-society model, the public sphere theory of Habermas (Habermas, 1989, 1991), and the media logic theory to analyse media coverage, the knowledge gap, and perceptions about biotechnology in Uganda. The science-in-society model explains how scientists share information with the public (Davies & Horst, 2016; Jarreau & Porter, 2017; Scheufele, 2013); media logic theory explains what media houses consider before publishing information (Altheide & Snow, 1979; Enli & Simonsen, 2017), and public sphere theory explains how the public share information (Habermas, 1989). The science-in-society model is harmonised with the media logic theory and public sphere theory using communication in tailoring a context for the public understanding of biotechnology in Uganda, as demonstrated in the Figure 3.1 below.

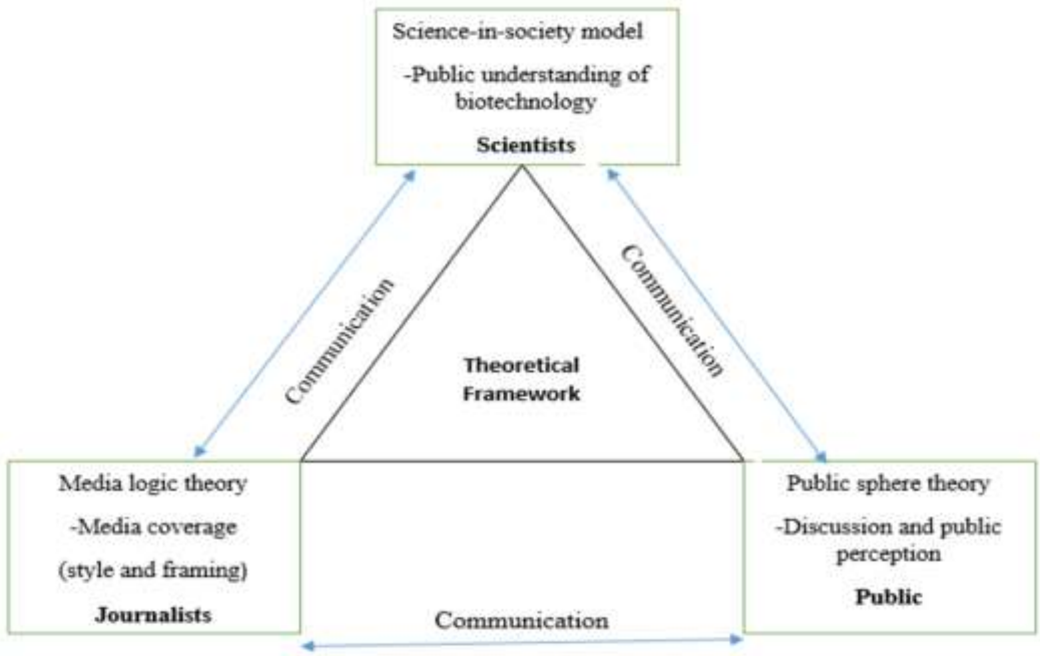

Figure 3.1: A graphic illustration of the theoretical framework showing the key stakeholders in communicating biotechnology

3.2 Science-in-society model

The science-in-society model aims to bridge the gap between professionals and laypeople who do not have formal education in science, in this case in biotechnology. The assumption is that informedness can promote interest in the subject of biotechnology. It is believed that informedness can trigger dialogue on science policy research, stimulate civil society involvement, and promote shared values as a way of increasing opportunities for scientists, policymakers and citizens to discuss scientific issues, such as the subject of this dissertation. For this model to work, there must be communication processes to link the three most important parties in the science communication process – "scientists, the media and the general public" (Friedman *et al.*, 2008:xii). Thus, communication is seen as a mechanism for energising democratic discourse, a process punctuated by the negotiation of meaning.

Communication can be defined from a "technical" and "meaning-centred" level (Steinberg, 2007:39). On a technical level, communication is concerned with the precision and efficiency with which a message can be "transferred" from one person to another using the available channel (Bhatta & Misra, 2016; Malyska *et al.*, 2016; Simons, Tiffen, Hendrie, Carson, Muller, McNair & Sullivan, 2017; Tagliabue, 2017). On a meaning-centred level, communication focuses on the "production, exchange" (Fiske, 2010:2) and "interpretation of meaning" (Steinberg, 2007:39). Adopting Fiske's and Steinberg's views is akin to concurring with Jones Jr. (2016:3), who looks at communication "as the process of generating meaning by sending and receiving verbal and nonverbal symbols and signs that are influenced by multiple contexts". As a social process, the exchange of messages takes place between (among) people and places, but the bottom line is that "all communication involves the creation of meaning" (Dimbley & Burton, 1992:xiv).

This study looks at science communication from a journalistic angle because the media are the most important avenue through which people learn about science, as stated in Chapters 1 and 2 (Claassen, 2011; Rodriguez & Lee, 2016). It is thus important to define journalism as it applies to this study. The study adopts Rudin and Ibbotson's (2002:5) definition, which refers to journalism as an activity that that involves gathering, "selecting", assessing truth and contextualising events, "comments" and issues.

From the above definition, it is apparent that the editorial policy and application of news values by a media house alter the order of facts in the production process to suit the perceived audience and media house interests. But the definition puts truthfulness towards the end to conform to Davies' (2009:131) assertion that, in the production process, "journalists are encouraged to abandon their primary purpose − truth telling".

The technology used in the practice of journalism constitutes the media as we understand the communication outlets in the daily use of the word. The communication technology can include newspapers (print), radio and television (broadcasting/electronic) and online platforms (multimedia) (Fourie, 2007, 2017). The above definition, however, does not comprehensively cover citizen or participatory journalism, which are key features of modern society and therefore of journalism. Using mobile phones, cameras, other gadgets and the internet, individuals, groups and organisations can share photographs, videos, news and other information via social media platforms such as Facebook, WhatsApp, Twitter, MySpace, blogs and YouTube (Dewing, 2012; Fourie, 2017). These platforms have become "alternative sources of news" (Barnes, 2012:26). The key attributes of social media include collaboration, discussion, searchability, replication and access (Dewing, 2012; Jarreau, 2016), and the possibility for modification of content at any time, especially with the availability of the internet.

The proliferation of social media has been aided by the expansion of broadband, the invention of compliant computers and mobile devices, advancements in software, economic affordability of gadgets, growing interest in computers and mobile devices, and the increasing commercial viability of social media (Murugesan, 2007). However, social media have also presented new challenges related to appropriateness, context, comprehensiveness of information and identity, as well as the motive of the source (reporter) (Dewing, 2012). Thus, social media provide tools that widen freedom of expression, including discussing scientific issues such as biotechnology, in a democracy. Nevertheless, questions regarding trust of the content shared on social media keep emerging and persisting.

Bell (2016:2) writes about the changing ecosystem of news:

> [Traditional] news publishers have lost control over distribution of news… Now the news is filtered through algorithms and platforms which are opaque and unpredictable. [The] inevitable outcome of this is the increase in power of social media companies. The largest of the platform and social media companies, Google, Apple, Facebook, Amazon, and even second order companies such as Twitter, Snapchat and emerging messaging app

> companies, have become extremely powerful in terms of controlling who publishes what to whom, and how that publication is monetized.
>
> [Furthermore], [o]ur news ecosystem has changed more dramatically in the past five years than perhaps at any time in the past five hundred... Social media hasn't just swallowed journalism, it has swallowed everything. It has swallowed political campaigns, banking systems, personal histories, the leisure industry, retail, even government and security. The phone in our pocket is our portal to the world. I think in many ways this heralds enormously exciting opportunities for education, information, and connection, but it brings with it a host of contingent existential risks. Journalism is a small subsidiary activity of the main business of social platforms, but one of central interest to citizens.

Although the public have lost power to a small group of unelected and unaccountable technology controllers, who determine the publishers, receivers of information and how such information is shared, some scholars have made a case for the co-existence of traditional and social media platforms. For instance, Dooly (2008:83) posits that "traditional media is the outside looking in. Citizen journalism [social media] is the inside looking out. In order to get a complete story, it is necessary to get both points of view". Media houses have realised the inevitability of social media and adopted it. Many of them, including the BBC, CNN, the *New Vision* and the *Daily Monitor*, now encourage their respective audiences to share their views, photographs and videos with the media houses for publication, depending on the media house, in electronic and print form. Some journalists add social media accounts to their by-lines to allow discussions with the audience beyond the newsroom. Sharing allows them to get a wide range of independent views about an issue or occurrence. Many media houses have developed apps for the purpose of knowing the users and using that information to target the audience with advertisements that increase the company's revenue. For the purposes of this study, it is necessary to add that some biotechnology research institutes have also opened websites for the purposes of sharing information with the public. For instance, Malaysia, Kenya and Uganda have opened biotechnology information centres, where information about biotechnology in their respective countries is occasionally posited as a way of trying to demystify it. Perhaps they will consider using apps and other forms of social media as the media ecosystem evolves.

From the above definition of communication and that of journalism, it is apparent that a comprehensive study of science communication should look at the subject from both the production and consumption sides of information. The foregoing paragraphs have demonstrated that, to do this, it is important to go beyond traditional journalism, to look at other forms of communication, which are being integrated into the practice of journalism, as they directly influence the public sphere in which science is discussed. This study adopts the science-in-society model, which looks at a number of communication models and harmonises them with media logic theory in crafting a context for understanding biotechnology in Uganda.

3.2.1 Explaining the model

A model is a simplified graphic representation of reality that depicts the main elements of a structure or process (McQuail & Windahl, 1993:2). McQuail and Windahl (1993) assert that models have three major functions in communication research: organisation, explanation, and prediction. Models serve the organising function by ordering and relating different circumstances that influence an issue or occurrence. By providing information in a simplified way, models have explanatory power of what would otherwise have been abstract issues. Models help researchers predict the possible outcome(s) of a process. Equally, models have three broad weaknesses: they restrict researchers to "certain circumstances; repeating similar mistakes; and are usually either incomplete, oversimplified or involve many concealed assumptions" (McQuail &Windahl, 1993:3), which may make the communication process more complicated.

In explaining the communication process, McQuail and Windahl (1993:5) observe that the process involves "a sender, a channel, a message, a relationship between the sender and a receiver, an effect, a context within which communication takes place, the intension to send or to receive the message". The process can be an action on, an interaction with, or a reaction to others. The process sometimes involves encoding (translating the message to be sent) and decoding (interpretation of the message by the receiver). Some models provide for feedback, largely for purposes of sustaining the conversation and seeking clarity. Other models provide for the reality of interference in the communication process as a pointer to the complexity of the process.

McQuail and Windahl (2015) categorise communication models into eight broad categories: 1) basic models, which are largely linear or circular; 2) personal influence; 3) effects of mass communication; 4) audience-centred; 5) organisational; 6) planned communication; 7) new media and information society; and 8) international communication models. However, they leave room for students to create their own models to address the issues of the time (McQuail & Windahl, 2015). Hence, this study is based on the science-in-society model, weaved from the different categories to address the controversial issue of how biotechnology is reflected in the media and perceived by the public in Uganda.

Models are important in communicating complicated science subjects that draw emotions and involve many stakeholders (Bauer, Allum & Miller, 2007; Cortes-Ramírez, 2014; Malyska *et al*., 2016; Priest, 2008; Reul *et al*., 2016). Trench (2008) argues that, until the 1990s, science was communicated using the deficit model, has dominated institutional policies, academic research, debates in scientific communities, and science-society relations. By referring to deficit, Trench (2008) means that science was transmitted by experts to audiences perceived to be deficient in awareness and understanding. Unlike in a dialogue, where participants are on an equal level, in science communication the scientists are superior to their audiences, thereby relegating ordinary people to passive listeners. The superiority of the scientists is largely attributed to the "absolute epistemic privilege" of scientific knowledge (Suldovsky, 2016:415). Because of this judgement, participation by the different stakeholders is not always realised in deliberation on biotechnology in many countries (Midden *et al*., 2002).

The science-in-society model can be subdivided into three, four or five models, depending on the corporate organisation or scholar. The Wellcome Trust divides this approach into three models: the deficit model, the consultation model and the engagement model (Research International, 2000). Lewenstein (2003) divides it into four: the deficit model, the contextual model, the lay expertise model and the public participation model. Other scholars divide the approach into five models: deficit model, dissemination model, duty model, dialogue model, and deference models (Trench & Junker, 2001).

The differences in the number of models can be attributed to the disagreements in demarcating where indigenous knowledge ends and where science begins; and to the ethical and political issues communicators contend with when dealing with controversial subjects. The Wellcome Trust, Lewenstein, as well as Trench and Junker's demarcations explain the same approach using a different number of models. For this study, the researcher adopted Secko *et al*.'s (2013) four models of science communication, which demarcate the boundaries fairly well using journalistic thinking, while capturing all the elements highlighted in the previous paragraph.

Although the Secko *et al*. (2013) and Lewenstein (2003) models are similar in substance, Secko and others go a step further to categorise the models into two fields – traditional and non-traditional – and suggest contexts for the application of each. On the one hand, the traditional category is comprised of the science literacy model and the contextual model (Secko *et al*., 2013), as illustrated in Figure 3.2 below.

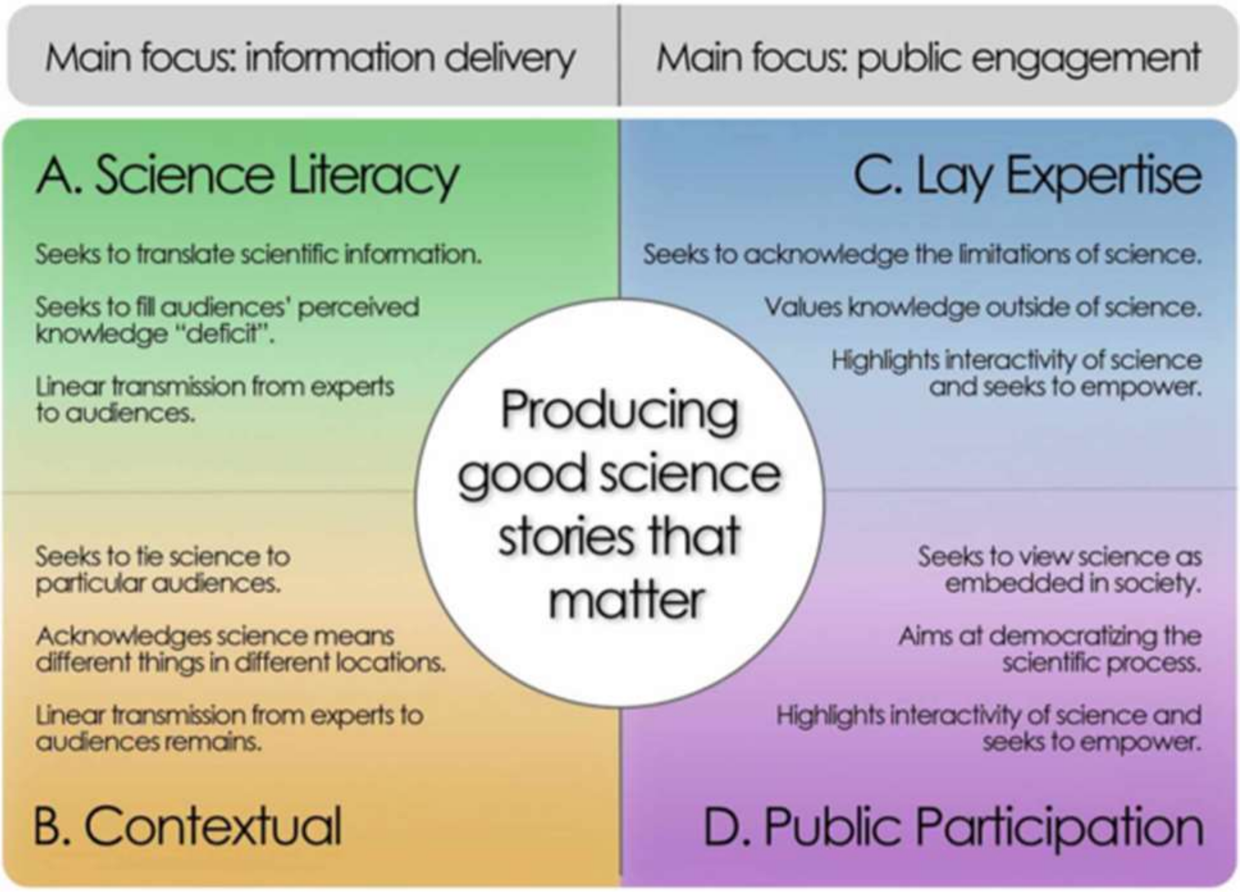

Figure 3.2: Secko *et al*.'s four models of science journalism (from Brossard and Lewenstein, 2010)

Figure 3.2 above shows that the science literacy model assumes that there is an information gap and seeks to fill the gap by transferring information from the experts to ordinary people to create "science literacy" (Logan, 2001:135), and "public understanding of science" with a view to improve attitudes towards science (Bauer *et al*., 2007:79). The model has a transformative pedagogical orientation and emphasises the relevance of the method in getting the superior knowledge – science (Secko *et al*., 2013). In this model there is an imbalance of power, as scientists perceive the citizens to be a hostile, ignorant lot to their knowledge, but one that can be persuaded (Trench, 2008). The assumption is that critical knowledge of scientific "ideas and concepts is required for people" to be cognisant of science in various "cultural contexts", since scientific knowledge is considered "fixed and certain" (Einsiedel & Thorne, 2008:49). In an earlier study, Bauer (1992) makes a distinction between textbook science and frontier science. Textbook science is the settled scientific knowledge in the natural sciences on which one can build – for example, the theory of relativity or gravitational forces in physics. In contrast, frontier science is still being conducted. Its results are new and tentative, as in biotechnology and nanotechnology. Stories written about this frontier science following the science literacy format should have crop biotechnologists as the primary sources – sharing knowledge with a passive public, which is supposed to utilise that information to improve their living standards. The model is particular about the journalistic principle of objectivity in translating scientific facts to ordinary people in story formats.

The contextual model ties science to particular audiences by emphasising that the way science is understood differs from society to society. Cultural, socio-economic and political factors influence the way people understand science. Secko *et al*. (2013:72) explain that individuals and communities understand science in the context of how it "relates" to their daily lives and the communities in which they live. Therefore, in terms of reporting, stories about biotechnology should follow the conservative format of what the scientists are saying and how that relates to what they grow in their gardens, buy in the market, and eat for survival and enjoyment. Hence, Secko *et al*. (2013) recommend that scientists should be the primary sources, and non-scientists should be secondary or tertiary sources if the story demands multiple sourcing.

However, the traditional models discussed in the previous paragraphs have been criticised for presenting science as the legitimate (Priest, 2008; Secko *et al*., 2013) and "definitive" form of knowledge (Friedman *et al*., 2008:8), and being linear, hence perpetuating the up-down approach, with only scientists sending information to non-scientists. The model has been castigated for focusing on knowledge and facts while ignoring the process (methods including measurement and observation), which leaves room for peer-reviewing, controversies, uncertainty, and replication of experiments to get confirmatory results and forgetting that knowledge alone does not translate into love for something (Secko *et al*., 2013). This 'knowledge equals love' issue was previously explained in detail in Chapter 2 when dealing with perceptions. Indeed, Dunwoody (2008b:61) emphasises that content producers should know what the "audience need to know is usually on their convenience".

Einsiedel and Thorne (2008) first criticise the traditional models, but also point out their ramifications. These scholars make four critical points against the model:

1) operational definitions differ from field to field and, in some cases, there is no consensus;
2) the demand for an audience to be literate is not clear on what they should be literate about;
3) the model assumes that the audience is homogeneous, yet in any given society there are sociocultural, political, economic, age, educational and other differences; and
4) science is not static; it changes from time to time and from society to society, let alone in terms of subjects.

The ramification of this, according to Einsiedel and Thorne, is that sometimes there are glaring knowledge gaps and a top-down approach is unavoidable, on topics such as HIV/Aids or the Zika virus. It becomes important that experts introduce an issue to the community, especially if it is foreign to that group of people.

On the other hand, the non-traditional category is comprised of the lay expert model and the public participation model (Secko *et al*., 2013). The lay expert model values knowledge outside science; it empowers ordinary people to adopt new knowledge to improve on their indigenous knowledge while considering the limitations of science. The model is cognisant of the existence of other forms of knowledge that individuals and communities gather over time as a result of interacting with other people and the environment they live in. In other words, it looks at science as "part of social and institutional connections" (Einsiedel & Thorne, 2008:50). In some cases, scientific knowledge and public knowledge interact because science has not settled. This would be a recommended approach to topics such as the treatment of the Zika virus or Down's syndrome. On such topics, people's ability to acquire knowledge is determined by their level of "motivation [and] social networks" (Einsiedel & Thorne, 2008:51). In applying this model, the scholars contend that journalists should adopt a style that mirrors significant "engagement" of laypeople with the scientific community by soliciting their voices as primary sources about a phenomenon and using scientists as secondary sources (O'Brien & Pizmony-Levy, 2015; Pierro *et al*., 2013). For instance, stories about traditional crop-breeding methods should have laypeople, who have been growing the crops for decades, as primary sources and scientists as secondary or tertiary sources to fill the gaps. In this case, the scientists are only explaining existing situations.

The public participation model seeks to democratise science by looking at the subject as knowledge generated from within society (Secko *et al*., 2013). The model looks at science from cultural and political angles using the Baconian analogy that ‘knowledge is power’ and everybody in society is entitled to it. Indeed, Bauer *et al*. (2007:80) allude to culture and politics when they assert that “scientific education ties with the quest for basic literacy in reading, writing and numeracy”, and that in every democracy people can only make the right decisions if they “command knowledge of the political process and its institutions”. The model looks at knowledge as an ingredient of democracy and the inadequacy of knowledge as a “cognitive deficit” (Einsiedel & Thorne, 2008:50). Such arguments suggest that journalists covering subjects such as biotechnology should go beyond scientists, policymakers and ordinary people to include the voices of activists for or against the subject, environmentalists, farmers, medical doctors, exporters of agricultural products and lawyers to capture the issues from a wide spectrum.

From the foregoing two paragraphs, it is evident that the non-traditional models advance interaction and empowerment as key issues in science communication, more so on controversial subjects such as biotechnology. The study links both categories of models as designed by Secko and others to media logic theory to explain the way biotechnology is reflected and perceived in Uganda. The models recognise that non-scientists are knowledgeable on many aspects of society that affect their occupations and their personal, community and other interests. With or without modern science, some communities have accumulated knowledge and mastered the art of managing uncertainties over generations. Before the advent of modern biotechnology, individual farmers survived on the natural selection of seeds, which they kept in family or community seed banks and replanted to ensure a steady food supply over the decades. Such wisdom was extended to animals, where lineages of high-quality breeds (for example bulls in cattle farming) were preferred for reproduction, hence maintaining a steady production of milk and meat in farming communities. The study does not conclude that the survival of indigenous knowledge over the decades implies that such knowledge is superior to modern biotechnology. Nevertheless, traditional knowledge should not be discarded, but improved upon to suit modern times.

It is also evident that both the traditional and non-traditional models aim at “producing good science stories that matter” (Secko *et al*., 2013:67). Scholars emphasise that the public deficit model (traditional), in terms of which knowledge is supposed to flow from scientists to non-scientists, is still valid, although it requires reframing to expand it beyond surveys. Bauer *et al*. (2007) and Trench (2008) argue that the model can be improved by integrating survey results with qualitative perspectives to capture explanations for causation, context, and the sociocultural, political and economic influences on the analysis of figures and trends.

For Bauer *et al*. (2007) and Gastrow (2010), the science-in-society model considers the relationship between science and the public as a construction of social processes. Bauer (2002) considers biotechnology as a ‘social movement’ with the following five attributes:

1) Biotechnology projects need to mobilise from firms, governments, academics or the goodwill of the public;
2) envisioned future developments and scientific arguments usually influence this support in society;
3) the actors in the movement may have conflicting goals
4) the actors operate in a public arena influenced by the public perceptions of the technology (everyday conversations, media coverage and regulatory processes); and
5) it is an amalgamation of competing actors united by a common objective in the public interest.

As a social movement, biotechnology has defenders and opponents (Thomas & De Tavernier, 2017). A key strategy of the anti-GMO movement is to domesticate global issues by discussing them as community- and country-specific challenges to appeal to natives. In “fusing” the GMO debate, defenders and opponents attempt to situate the struggle by framing the issue in a way that makes it most attractive to the political class (Clancy & Clancy, 2016:2). The movements have different visions. Generally, they tend to advocate the development of domestic solutions through citizen participation, trade restrictions, favourable regulation, and protection of the ecosystem (Aerni, 2002).

Despite their differences, social movements tend to gel their diverse interests to harness new political opportunities. The movements tend to evolve by creating coalitions that allow them to dissolve their individual values, interests and beliefs by framing them as one objective in a strategic plan (Braimah, Atuoye, Vercillo, Warring & Luginaah, 2017; Gupta, 2017). Such alliances allow the new movement to focus on the common goal and ideology by conducting joint activities. The move allows established civil societies an opportunity to give identified causes mileage through “scale shifting” (Tarrow, 2005:32). This scaling usually banks on the internet, especially websites and social media, to boost or restrategise their programmes (Braimah *et al*., 2017; Clancy & Clancy, 2016).

In other words, the way biotechnology is presented by the media and perceived by the public is not uniform across information platforms and societies and reflects the interests of actors. The understanding of biotechnology is multi-directional, from scientists to the media and to the public, and from the public to the media and to the scientists. This information flow is kaleidoscopic and changes from society to society and from time to time. Analysing scientific controversy in the media is of great interest, as it raises the socio-economic and political stakes (Gastrow, 2010). Based on this understanding, this study surmises that the public perceptions of biotechnology are mainly based on the cultural and socio-political environment in Uganda.

Reul *et al*. (2016) contend that media attention to an issue may help social movements disseminate their message to wider audiences. In their case of 'The Big Potato Swap', the protest attracted scientists, environmentalists, civilians and agriculturalists, and sympathy from others who had read or heard about the issue through the media, raising the issue of freedom of scientific research versus freedom of expression. They argue that any such protest against the existing status quo tends to attract negative coverage as a "violent", "disruptive", "irrational", "disorganised", "undemocratic", "unreasonable" and "criminal" act (Reul *et al*., 2016:3), or is "destructive" and "rejectionists" in its "civil disobedience" (Osgood, 2001:93).

In the current study, the science-in-society model is analysed, evaluated and applied in the light of Secko *et al*.'s (2013) four models of science journalism. Gastrow (2010) posits that the science-in-society model focuses on the public as stakeholders who desire to get scientific knowledge, rather than considering them as an ignorant part of society when it comes to science. The model emphasises closing the knowledge gap through mediation. Mediation can be through involving the public in formulating policies about controversial subjects such as biotechnology, and looks at public officers, communication officers, civil society groups and the media as individuals and platforms for dissemination and engagement. Thus, the science-in-society model seeks to move away from the public understanding of biotechnology to public engagement on the subject, but Logan (2001:135) warns that the "traditional" and "interactive" models are interdependent and should not be analysed in isolation. Moreover, the engagement has to consider the language used in packaging information for clearly identified publics on the different platforms to produce content that matters to them – the ultimate goal of science communication – in Habermas' public sphere discussed in the subsequent section.

3.3 Science communication and the public sphere theory

To understand the science-society-model, it is important to connect Secko and other researchers' models to the concept of the public sphere to appreciate how the public make sense of biotechnology. German Frankfurt scholar, Jürgen Habermas, theorised the concept "public sphere" to describe the deliberative space between private individuals and the state (Habermas, 1989:1ff). Habermas (1991:27) observes that "the bourgeois public sphere may be conceived above all as the sphere of private people come together as a public". The public sphere emerged in the 17th century, when publications targeting educated people emerged. The publications carried general information and critiques of what had already been published. In the 18th century, academic and scientific arguments came to public attention thanks to the journalists of the time. Later, academics of different disciplines started submitting articles to editors of various newspapers in turn, commenting about contemporary issues and how they related to their respective disciplines.

Although there are contentions over what constitutes a public sphere, Habermas (1991:30) asserts that the public sphere "[was] the coffee houses, the salons and the table societies". In these places, laypeople raised private matters affecting them as individuals and their families in the public domain. For instance, issues such as diet, diseases and poverty affecting one family could be discussed in the context of the community. Key in these discussions was the idea of dialogue; that space where the discussions took place was negotiated between the state (police, army, executive) and civil society (individuals). Therefore, while it is not accurate to state that the participants in the discussions were at the same level, it appears that discussion happened in a fairly unregulated environment to allow individuals to deliberate on issues without fear of coercion.

Considering that they were also paying taxes, citizens became interested in the actions of their leaders. For instance, travel and parties organised by the monarchs became issues of public interest because they involved the expenditure of public money. When issues accumulated, the print media became very important in reporting about "imperial diets, wars, harvests, taxes, transport of precious metals, and, of course, reports on foreign trade" (Habermas, 1991:19). Rutherford (2000:18-19) observes that the success of a public sphere relies on the "degree of access (universality), degree of autonomy (no coercion), rejection of hierarchy (level-headedness), [and] rule of law (quality of participation)".

Based on Habermas's explanation, what may appear to be individual issues sometimes transcend boundaries to emerge as public issues. Therefore, individuals and society have a symbiotic dependency and are mutually inclusive. In other words, the thoughts, perceptions and arguments of individuals are influenced by their cultures, traditions, environment and experience, among other social issues. Susen (2011:43) best summarises this when he argues that "individuals are autonomous not in isolation from but in relation to one another … in relation to a public of autonomous beings".

Susen's sociological perspective suggests that there are many actors in the public sphere, and science can only be understood if the knowledge is analysed in the context of the dominant sociocultural beliefs of the society. The actors are highlighted in Chapters 1 and 2. Due to the involvement of political, economic and sociocultural interests in the production and dissemination of scientific knowledge, Gauchat (2012:168) concludes that "science has always been politicized". However, the impact of political orientation in shaping public trust in science, and how science is organised remain unclear. Chapter 7 partly discusses how politics influences the GMO debate in Uganda.

Considering that, in Secko and other researchers' traditional models (science literacy and contextual models) above, the legitimacy of science is tied to its objectivity and rationality, the "politicisation of science … poses larger questions about the unevenness of the cultural authority of science and the potential for deep sociocultural divisions in the public sphere" (Gauchat, 2012:168). This politics extends to GMOs (Varzakas, Arvanitoyannis & Baltas, 2007). The divide usually depends on the level of controversy linked to the issue. Controversial issues such as biotechnology are more likely to divide the public sphere than those less debated, such as astronomy. Using the Habermasian perspective, the interaction of scientific knowledge and indigenous knowledge is encased in the cultural values of modernity in understanding the role of scientific progress in society. This may lead to a scientific "cultural ascendency", where an increase in knowledge and innovations can lead to a steady increase in public trust for a period, but may be retarded by similar distrust in the government of the time, leading to "public alienation" (Gauchat, 2012:169). The ascendency may result from improved agricultural yields, cheap food resulting from improved means of production, and better tests of food. The alienation may be a product of a general feeling among the public that the scientific claims about a particular technology are false, or when they start suspecting that they are suffering the effects of scientific developments. These effects can be pollution resulting from industrialisation or the use of fertilisers in agriculture, or becoming disappointed with the poor yields and testing of food after genetic modification.

The cultural ascendency or public alienation of a geographical community or community of interest can result from its distinctiveness based on the level of education, race, religion, political affiliation, social capital or income level, among others, of its members. Religious groups usually have different views from scientists regarding the ethics, epistemology and ontology of Darwinism, climate change, abortion, HIV/Aids, and biotechnology (Al-Attar, 2017; Gauchat, 2012; Kahan, 2015; Nisbet, 2009; Rodriguez & Lee, 2016; Rzymski & Królczyk, 2016). Scepticism is sometimes promoted by some think tanks, media houses, internet sites, publishing houses, parastatals, NGOs and civil societies (Oreskes & Conway, 2010; Pigliucci, 2010). NGOs and civil society use different tactics of "approaching policymakers, lobbying entrepreneurs, or attracting and educating mass audiences" to influence them on several environmental issues (Dai, Zeng & Wang, 2017:1). All these affect the public sphere and consequently how scientific issues such as biotechnology are understood and adopted by society.

The discussion on the science-in-society model has consistently singled out the media as the playground where the contestation among the different actors takes place. Thus, it is only proper that a theory analysing the workings of the media as a public sphere is combined with the science-in-society model, hence the addition of media logic theory.

3.4 Media logic theory

Media logic theory, coined by David Altheide and Robert Snow in 1979, is used in analysing the role of media technologies and corresponding formats in shaping communication and social reality. In their more advanced work, Altheide and Snow (1991:ix) explain that "the media logic consists of the form of communication, the process through which media present and transmit information [format, organisation, style of presentation, focus, grammar and other rationality]", and how this process turns issues and events into reality that permeates society. In modern society, the media tend to affect people's daily lives by presenting and interpreting events and issues (Altheide & Snow, 1979:11; Ardèvol-Abreu & De Zúñiga, 2016; Raupp, 2017). Media logic can also be expressed as "the news values and the storytelling techniques the media make use of to take advantage of their own medium and its format, and to be competitive in the ongoing struggle to capture people's attention" (Strömbäck, 2008:233).

Media logic extends to simplification, polarisation, intensification, personalisation, visualisation, stereotypisation, and framing (Strömbäck, 2008), focus on stars, scandals, and listening to the common man (Meyen *et al*., 2014). Other scholars see media logic as the way in which "media content is editorially shaped and structured" (Cushion, Thomas, Kilby, Morani & Sambrook 2016:473).

Altheide and Snow (1979) observe that, through the diffusion of innovation (Rogers, 2010), the power of the media was generally believed to be natural and therefore neutral in social institutions. It is this power that the media harnessed for most of the 20th century to set the agenda and guide the public sphere. Altheide and Snow's initial analysis demonstrates that the media's claim to neutrality was partly a result of their ability to stream content "to saturate coverage of events over a short period, slack off, and eventually turn to something else" (Altheide & Snow, 1979:238). The streaming is done using styles and frames that are meant to keep the public attracted to their content. Style is a technique that media houses use to capture public attention, and it can involve publishing stories "with spectacular, negative, predictable, or unique elements" (Berglez, 2011:451), often engrained in the journalism principles of fairness, balance and objectivity. Framing is linked to selecting, defining and narrowing the focus of a story to highlight the publisher's preferred interpretation by marginalising alternative narratives in shaping the thoughts of the audience (Andrews, Clawson, Graming & Raymond, 2017; Berglez, 2011; Entman, 1993).

Media logic, thus, involves the analysis of a complex structure of interaction consisting of technological, socio-economic and political factors that determine the representation of reality. Mazzoleni (2008) admits that media logic mirrors how well the editorial traditions of individual media organisations knit their content in the interests of the specific audiences with due regard to the formal or informal technological, technical, cultural and economic factors that determine content production and distribution. Such an argument suggests that media content should not be detached from the process of categorising, selecting and presenting the content through which it is produced (Altheide & Snow, 1991; Cacciatore, Scheufele. & Iyengar, 2016; Enli & Simonsen, 2017). In other words, the quality of the news is wholly influenced by the processes through which it is generated.

Media logic is alive to the idea that public life subscribes to journalistic criteria, and that some groups in society, such as politicians, have mastered those criteria and apply them even better than the scribes, not only to work crowds, but also to attract and retain media attention.

Politicians try to plan their activities with media routines in mind and "anticipate" that the journalists will "pick" their views, publish them as part of the news, and hence serve as a "public relations tool for politicians" by providing an alternative way of reaching their constituents (Van Gorp & Sinardet, 2017:244). Politicians who master media logic usually apply aspects of the news value definitions by Galtung and Ruge (1965) and Harcup and O'Neill (2001) to influence coverage. For instance, they can use statistics to emphasise magnitude, craft messages around prominent people at the expense of public policies, or present allegations as concrete 'new' facts. More recently, Brüggemann and Engesser (2017:59) confirmed that editors factor in the "the most powerful" news values, such as proximity, conflict, relevance, prominence and novelty of a happening or an actor in the production of news. So, how do the *New Vision* and the *Daily Monitor* present biotechnology?

Moreover, the journalistic "norm of balance" in an attempt to achieve fairness (Boykoff & Boykoff, 2007) also influences the framing of a subject when the press presents contending opinions on a scientific issue as if they carry equal weight, whereas not. But reporting science differs from reporting other fields in terms of balancing coverage. When evidence is absent, it cannot be replaced with belief. Balanced coverage of science means "apportioning weight according to the balance of evidence", but not giving equal weight to different sides of an argument (Claassen, 2016:8-9). Yet Brüggemann and Engesser (2017) confirm that the "rise of interpretative journalism" is increasing bias as journalists try to fit any available information to the news value at individual, national and news organisational levels.

The borrowing of journalistic criteria by politicians proves that reality is "socially constructed" through interaction between the press, issues and events, and the public (Brants & Van Praag, 2015:2; Lamphere & East, 2016:2; Wenzelburger, 2017:1). This assertion suggests that it is hard to unravel contemporary issues in society such as biotechnology without putting into context the impact of the media in tangling social phenomena.

The media, then, are only extensions of human communication through which individuals, groups or organisations share their opinions (Meyen *et al*., 2014; Splendore, 2016), with a view to amplifying their voices in many outlets. This amplification was first pointed out by the Canadian communication scientist, Marshall McLuhan, in 1957. He emphasised that the media are an extension of our senses (McLuhan, 1964). Thus, cultures have to evolve to accommodate the ever-changing tools of communication to make human existence more meaningful through participation (Bucher & Helmond, 2017; Hielscher *et al*., 2016; Mellado & Van Dalen, 2016;

Shao & Wang, 2016). Media logic then appears to be a key component of social change. For instance, many political parties, businesses, religious organisations and schools in Uganda use social media to reach out to their various publics. However, some scholars illustrate that the use of social media can potentially reduce the time spent on outdoor activities, especially sports and recreation, thereby raising health challenges (Vilhelmson, Thulin & Elldér, 2017).

As a result of media power, Meyen *et al*. (2014:272) postulate that "mediatisation, medialisation, or mediation" have become popular themes in communication research to signal that "all forms of communication are modifications of face-to-face dialogs [sic]". Based on Lazarsfeld's map of media effects, Katz (2001:278) categorises mediatisation into five facets: 1) the nature of effect: change or reinforcement; 2) the object of effect: opinion, social structure; 3) the unit affected: individual, group, nation, etc.; 4) the time-frame of response: short or long run; and 5) the active ingredient, or attribute of the medium: content, technology, ownership, situation of contact.

Media logic is also linked to the routines, demands and challenges of ownership, advertising and ethics, and the limitations of time, space and journalistic skills in selecting, presenting and interpreting news (Berglez, 2011). Splendore (2016) identifies four types of media logic: commercial logic (selling), industrial logic (professionalism), cultural logic (audience), and technological logic (production, constructing, presentation, circulation, and interpretation). Hence, in covering scientific subjects such as biotechnology, the media are torn between following the professional journalism values of accuracy, balance and fairness on the one hand, and the sensationalising of facts on the other, so as to increase sales in the case of newspapers as in this study, and listenership for radio and viewership for television, or likes in the case of social media (Facebook and Twitter). The commercial logic has become so fundamental to media logic that "news content characteristics such as conflict, personalization, negativity or scandal reporting … are assumed to be increasingly deployed by journalists to gain public attention" in the unstable news market (Karidi, 2017:1). For instance, considering the way they are reported about, GMOs are "most frequently seen as dubious, or even harmful" ways of producing food, often attracting social scientists and activists not only to question the process used in genetic engineering, but also call for tougher regulations on such science (Tagliabue, 2017:1). In an environment in which media houses are looking for possible ways of attracting and retaining the widest audience at the least cost, media houses that simply gather, analyse and provide information to fulfil a democratic function are likely to decline in the wake of social media (Karidi, 2017; Simons *et al*., 2017).

At the same time, research has shown that, with regard to certain countries, the mainstream media have become so commercialised that the elite are locking out the common as corporate profits replace high-quality journalism. Increasingly, journalists solicit bribes and media houses charge news sources to present their sponsored material to the gullible audience in what scholars refer to as turning information into a commodity for sale to the audience (Oberiri, 2016; Sarrimo, 2016; Sulehria, 2017). By implication, both the pro- and anti-GMO activists can use their (financial) muscle to have their views reflected in the media if the journalists accept to sell their conscience. Such a situation would mean that the public cannot easily get accurate and balanced information on GMOs through the media.

In the case of biotechnology, media logic will differ in the different media platforms, depending on type of ownership, the politics of the day and the corresponding commercial logic and controversies. While this study focused on two newspapers published in the same city, their reporting of biotechnology was expected to differ to reflect the ownership and the different values they stand for as they target the same audience in the selection of ideas, "events and angles" (Berglez, 2011:52). The level of experience of the reporters may also determine the media logic. Experienced reporters tend to identify story angles faster than their less-experienced colleagues (Sachsman & Simon, 2006). For example, climate change might be reported differently in a mainstream newspaper and in an ecology magazine, perhaps due to differences in the target audience. The selection criteria for events, angles, and sources, may differ sharply, and this might be noticed in the use of scientific language. The newspaper may opt for popular-scientific language, while the magazine may opt for more expert-oriented narratives.

Splendore (2016) observes that mediatisation has four major effects: determining the agenda for public engagement; contexualising science communication; fragmenting science communication to allow individuals and groups to discuss what concerns them; and the winnowing effect (sifting ideas). To be applicable to the subject of biotechnology, the effects above should be analysed in the light of how, why, when and where actors in the biotechnology industry adapt to media logic and the indicators for measuring such adaptation in the public sphere. In the case of Uganda, it is important to look at the Parliament, academic forums, science forums, workshops, interpersonal communication, and how the views from these forums combine with media coverage to shape perception. So, what is the public perception of biotechnology and GMOs in Uganda?

The ever-changing media landscape, as driven by changes in technology, stretched budgets and the fluid demands of audiences, necessitates media managers and communication strategists to keep abreast of advancements in the media. Constant audience research allows media houses to frame content using styles that conform to audience interests, as explained by Galtung and Ruge's (1965) news values and in Davies's (2009:109) "rules of production". Style, here, refers to "the form, structure, and rules of journalistic writing" or communication (Johnson-Cartee, 2005:122). On this point, Berglez (2011) notes that media houses tend to tailor content to suit individuals, geographical areas and cultural contexts in covering controversies between and among actors. This idea needs to be considered when dealing with subjects, such as biotechnology, with regard to which the knowledge gaps are wide in many societies. News principles such as accuracy, balance and objectivity are some of the key challenges newsrooms grapple with in achieving the commercial, cultural and industrial logic of a media platform. Style thus is the lifeblood of framing. Entman (2004:5) defines framing as the act of "selecting and highlighting some facets of events or issues and making connections among them so as to promote a particular interpretation, evaluation, and/or solution". So, what are the knowledge gaps in the biotechnology debate in Uganda?

As mentioned in the discussion of the science-in-society model earlier, the coverage of biotechnology should be looked at in the light of Bauer's (2002) social movement as well. In covering such social movements, Reul *et al*. (2016:3) outline three 'mechanisms' that influence the coverage: 1) marginalising story framing, where media houses can depict protests as unrealistic; 2) reliance on official sources, resulting in dominance of the official position of the government; and 3) invoking public support (Reul *et al*., 2016:3). For that reason, "social movements are cognizant of the impact their tactical choices have on both potential government action and public opinion" (Huff & Kruszewska, 2016:2). The views reflected in the media tend to be seen as those held by the public (Sarrimo, 2016). In other words, the media tend to legitimise the views and phrases of the dominant individuals and groups in society by selecting events and issues to cover on the basis of the business or political mind of the owners. Readers' interests, in the case of this study, require taking note that the government of Uganda owns a 51% capital share in *New Vison* and the Nation Media Group owns the *Daily Monitor*. Generally, the *New Vision* is associated with stories that support the government line, while the

Daily Monitor is viewed as representing the alternative voice. Media houses tend to publish what the readers "want to believe in" because "the readers are never wrong" (Davies, 2009:141) in what Einsiedel and Thorne (2008:53) call "market-driven journalism".

But Mazzoleni (2008:50) interjects that "underdog leaders … [can] exploit media proclivity by resorting to strategies" such as strikes, inviting celebrities to grace their occasions and phrasing their messages around key political issues to ensure coverage. Such strategies strengthen the forces of demand and supply of newsworthy information, with the possible effect of popularising originally insignificant biotechnology movements. Thus, activists can use the jargon of the scientists "to compel scientists [and the government] to consider their arguments" (Einsiedel & Thorne, 2008:47). This action gives the media the option of serving as a powerful tool for mobilisation.

Altheide and Snow's theory, however, has been criticised for being fixed by emphasising static components of the media and ignoring the dynamism involved in media logic (Meyen *et al*., 2014). Their theory assumes that media houses and technology are uniform and constant across societies over time. The theory does not take into consideration the niche of the various media. For example, some media houses focus on geographical locations, some are issue oriented, while others are class oriented or politically or economically focused. As such, the "construction of reality should change depending on the channel" and the "news traditions as defined by editors" (Meyen *et al*., 2014:277). Therefore, the rise of cable television in the 1980s and distinct audiences unlike the mass publics almost dwarfed the theory (Van Dijk & Poell, 2013). Such developments manifested simultaneously with the commercialisation of culture and information, which has implied that news and advertisements, facts and opinions, public service and commerce are increasingly mixed (Cottle, 2006; Van Dijk & Poell, 2013). Increasingly, media organisations are partnering with corporate firms and political entities to provide favourable coverage in exchange for advertisements. Through public relations offices, science organisations are able to influence story choices as well (Dunwoody, 2008a, 2008b; Friedman *et al*., 2008; Priest, 2008; Stocking, 2008). In other words, many media houses are also conduits of public relations messages and provide political mileage when necessary. These sponsorships or advertorials have acquired the designation "native advertising", especially when digital companies connive with the public relations and marketing arms of organisations to syndicate content to their audience (Bell, 2016:5). The researcher observed that this has been extended to social media in the form of endorsements (support) for certain products, ideas, individuals and organisations in Uganda. Usually, influential journalists or digital companies are hired to tweet on events. In some cases, government ministries and NGOs buy airtime to have live coverage of their events. While these collaborations appear healthy for the economic functioning of the media, such operations annihilate the editorial independence of media houses.

Moreover, with the proliferation of social media, scholars have also coined the term "social media logic" to refer to the "intricate dynamics between social media, mass media, users and social institutions" that allow them to create and share information, ideas, pictures and videos, thereby creating networks, at times known as virtual communities (Van Dijk & Poell, 2013:2). Social media are "a group of Internet-based applications that build on the ideological and technological foundations of web 2.0 and allow the creation and exchange of user-generated content" (Kaplan & Haenlein, 2011:255). Social media became a global reality at the start of the 21st century with the invention of social networking platforms, such as Facebook, Twitter, LinkedIn, MySpace and Friendster, and user-generated content sites including Wikipedia, Flickr, YouTube, Inbound.org and Reddit.

The nature of social media thus allows them to permeate their logic beyond the boundaries of the platforms that support them, but retain the peculiar technological, deliberative, organisational and business schemes that allow them to seem neutral (Howard, 2012; Laroche, Habibi & Richard, 2013). Consequently, they conform to the idea that communities, communication and commerce are not mutually exclusive. Their ability to facilitate consuming as well as creating, and talking as well as listening, has allowed social media to transform print and broadcast from being mainly monologues (apart from letters to the editors) to social dialogues. Social media logic is then a contemporary version of media logic, and consequently intertwined with Altheide and Snow's (1979) media logic. Van Dijk and Poell (2013:5) identify four key elements that distinguish social media logic from media logic and thus make social media logic an important aspect of this study: "programmability", "popularity", "connectivity", and "datafication". As stated earlier in this chapter, social media, by largely determining who publishes, who receives content, and what, when and how the audience receives it, have basically gulped down everything for their commercial benefit (Townson *et al*., 2016).

Social media have replaced mass media 'programming', which meant content scheduling in broadcasting, but could be interchanged with the term 'section' in print, as an editorial plan to interest the audience in listening (in the case of broadcast) or reading (in the case of print) their varied content with Twitter handles and other forms of sharing information with the public. Van Dijk and Poell (2013) contend that the meaning of the term 'programming' has evolved to include computer codes and users. Organisations responsible for programming can determine whom to engage by the use of codes, data, protocols, interfaces and algorithms (coded instructions). Social media use terms such as "liking", "favouriting", "recommending" (Facebook) and "people you may know" (LinkedIn). Through "retweeting" (Twitter) and "liking" (Facebook), social media are able to categorise topics as trending if the number of people reading or viewing them is high. Basing on numbers, YouTube can categorise a video or a piece of information as going 'viral' if tens of thousands of people are paying attention to it. Such secretly kept protocols work like automated editorials. These platforms allow users to not only contribute content, but also channel traffic to the site they prefer, in some cases with the option of anonymity.

The social media logic then combines the crowdsourcing option of social media with the editorial values of mainstream media. The element of programmability has been utilised and at times abused by advertisers, public relations professionals, social movements and politicians to reach the intended audiences. Science communicators can jump onto the bandwagon and utilise these platforms more efficiently to share information with the general public, thereby stimulating debate based on established facts. The problem with these platforms is that they allow individuals to post their views and opinions on issues they may not have any expertise in. By identifying and interpreting facts and falsehoods, social media constitute provocative was of sharing scientific knowledge (Bik & Golding, 2013; Jarreau, 2016; Novak, 2015). Usually, more likings or retweets give individuals without expertise the ability to post more unauthentic information to exacerbate misinformation about controversial subjects.

The mass media's ability to sieve influential voices in shaping opinions is being reinforced as social media continue to mature. The platforms have the ability to measure popularity using scores such as "Likes" for Facebook, "Trending topics" for Twitter, "Google Analytics" for the Google search engine, and "most viewed video" for YouTube. Hence such ability offers the platforms an opportunity to tap into their viability to deliver legitimate clients and ideas to interested individuals and organisations. Indeed, Van Dijk and Poell, (2013:7) argue that "each platform is in the business of developing its own thermometer for measuring aggregated popularity or influence". Therefore, the ability to simultaneously measure popularity while influencing it at the same time differentiates mass media logic from social media logic.

Social media allow purposeful participation – connectivity. Van Dijk and Poell (2013) explain that connectivity is the ability of individuals to use networked platforms to link content to the activities of users and advertisers. Connectivity, accordingly, suggests that the networks have the communication potential, but also predispose users to being customers for advertising firms. Unlike the mass media, which are heterogenous, the networks have options for hiding personal information, thereby allowing individuals to choose whom to connect with and whom to avoid. Some scholars have argued that the ability of social media to filter users allows protests to morph from "collective to connective" (Van Dijk & Poell, 2013:8). In terms of science communication, social media can allow the actors involved to create a genuine or pseudo-platform for the public, and the pro- or the anti-biotechnology activists to share their "opinions" (Dunwoody, 2008b:70). However, the most important thing is that they can promote debate on a wide range of platforms.

Therefore, the combination of mass media and social media logic is important in analysing how the modern media houses use the available technology to define their styles and frames in creating and disseminating information to the public. Because traditional print media and traditional broadcasting have evolved to co-opt internet and web 2.0-based technologies, it is no longer possible to distinctively differentiate print from broadcasting and social media in the age of "convergence" (Mishra, 2016). For instance, the *New Vision* and the *Daily Monitor* newspapers link their websites to their broadcasting outlets, but also run Facebook pages, Twitter accounts, and sometimes send and/or pick content from YouTube, among other platforms. Consequently, this has allowed their audiences to use the social media technology to give feedback to the newspapers, but also create content when necessary. In vouching for the role of a journalist in the age of social media, Sacco (2016:363) summarises the roles of scribes as "moderators of news diffusion within those platforms … producers, mediators and curators of social media content". So, what is the role of the *New Vision* and the *Daily Monitor* in the science communication process of informing the public and in shaping the debate about biotechnology?

3.5 Chapter conclusion

This chapter has identified the possible models that could have been applied in the current study, but settles for Secko *et al*.'s (2013) four models of science journalism because they look at the coverage of science in different contexts. Public sphere theory was adopted as a mechanism for analysing how people debate society in fairly unregulated settings. Media logic theory was adopted to analyse how the production of science content is dependent on the available technology and the ability of staff to technically adopt and adapt styles and frames. These styles and frames enable media professionals to deliver content that is professionally acceptable, but also appealing to audiences, thus allowing media houses to break even commercially. This study could also have adopted a single theory such as framing, but such an approach would have limited it to analysing the production of content. The aims of this study included how biotechnology is perceived, hence the threefold theoretical framework.

The trifocal theoretical framework allowed the researcher to look at biotechnology from both the media production and citizen consumption ends. This approach allowed the option of analysing the challenges involved in simplifying scientific content into stories understandable by ordinary people, and how the audience (consumers) engage with the content in what Dunwoody (2008b:59) calls “a complicated dance”. The theoretical framework also enabled the researcher to analyse how the media, the key element at the epicentre of the biotechnology debate, reflect on their interaction with other actors – scientists, activists, lawmakers and consumers – in negotiating meaning on biotechnology.

The theories informed the methods that were used in this study – content analysis (science-in-society model and media logic theory), interviews (content analysis) and face-to-face surveys (public sphere). Hence the theory and the methodology supported one another in achieving the aim of the study – to find out how the Ugandan media cover biotechnology, and the public perceptions that emerge from that coverage.

Chapter 4
Research methodology

Quantitative research is hard and reliable … qualitative research is deep and rich (Bryman, 1996:94)

4.1 Introduction

Based on the theoretical framework in the previous chapter, the suitable methodology for this study was chosen. In this chapter, the research design is described, and the methods used, the reasons for triangulating a content analysis of two newspapers, the face-to-face survey with farmers, and in-depth interviews with key stakeholders are elucidated. Firstly, the researcher used content analysis to establish the frequency, trend, actors and issues covered by the newspapers. Secondly, the researcher conducted a face-to-face (interview) survey to establish the varying (mis)perceptions of farmers (consumers). Finally, the researcher conducted in-depth interviews with scientists, journalists, a Members of Parliament, a clerk to a parliamentary committee, civil society and academia to explain the coverage and (mis)perceptions about biotechnology and GMOs in Uganda. In some cases, diagrams are utilised to elaborate on the methodology.

4.2 Research design

This study employed a cross-sectional design to answer the research question set in Chapter 1 concerning the ways in which media coverage of biotechnology may influence public perception of its products, especially GMOs, in Uganda. This concern is also reflected in the title of the current dissertation. A content analysis was conducted of how biotechnology is presented in the two leading newspapers in Uganda – the *New Vision* and the *Daily Monitor* – from 1st January 2012 to 31st December 2015. The goal was to establish the role of the newspapers in creating (mis-)perceptions among different actors and identifying the knowledge gap based on what was published during that period.

A cross-sectional study enables researchers to analyse the views of different population groups about an issue at a specific point in time in order to establish patterns without manipulating the environment (Babbie, 2010; Graziano & Raulin, 2010; Greener, 2012). Kumar (2005:93) states that this design, sometimes referred to as the “one-shot or status” study design, is “best suited to studies aimed at finding out the prevalence of a phenomenon, situation, problem, attitude or issue, by taking a cross section of the population" to provide a general understanding of the phenomenon at the time of study. Kumar (2005:94) distinguishes the cross-sectional design from the before-and-after design, longitudinal study design and experimental design. Kumar argues that the before-and-after study design (pre-test/post-test design) is used to measure the change in variables affecting a phenomenon between two points in time. He contends that the longitudinal study design measures the pattern of change, while the experimental design measures the process of intervention from beginning to end. The current study opted for the cross-sectional design because it intended to measure coverage by two newspapers over a four-year period.

In this study, the *New Vision* and the *Daily Monitor* were selected from more than 10 newspapers published in Uganda to find out how the two newspapers cover biotechnology, and how the press coverage influences the perceptions of legislators, civil society, farmers and the general public. The reasons for their selection are explained in this chapter under content analysis.

It was necessary to look at the subject from multiple angles sequentially – beginning with coverage to identify patterns, issues and stakeholders, conducting a survey with the largest number of stakeholders (farmers), and interviewing the scientists, journalists, legislators and civil society about media coverage and the issues surrounding biotechnology in the case of Uganda. Although the methods used in this study could each stand on their own, biotechnology, especially as it applies to GMOs, is a fairly new subject in Uganda, and public understanding of the science surrounding it is still scanty, as not many studies about its coverage or public perception were found on Uganda or its surrounding countries. At the point of integrating the data, the study adopted the explanatory sequential design. In this design, one method snowballs (identifies) the issues and actors in the phenomenon, especially if the subject is "understudied", as was the case in this study (Creswell, 2015:6). In this case, content analysis revealed some of the actors involved in sustaining the debate in what is sometimes known as the "biotechnology movement" (Bauer, 2002a), whose composition varies from country to country.

Content analysis provided the ideas for developing the questionnaire for the farmers and the interview guides for the key informants. The intention was to conform to Kumar's (2011) three considerations for using mixed methods: whether the methods are used sequentially or almost simultaneously; whether one method is a building block of others; and whether the methods are considered of equal weight and can each stand on their own. These considerations are confirmed by other scholars (Alexander, Thomas, Cronin, Fielding & Moran-Ellis, 2008; Creswell, 2015). In this study, content analysis provided the foundation, face-to-face survey built the walls, and the in-depth interviews offered the roof.

4.3 Research approach

The study adopted a mixed-methods approach. While the definition of the approach is disputable, Alexander *et al*. (2011:125) explain that a debate has been ensuing among sociologists about the actual definition of a mixed-methods approach. Although the use of the mixed-methods approach can be traced to the 1950s, when William F. Whyte's (1955) ethnographic study used observation and personal notes to study gangsters in the Eastern United States of America, the debate started in the 1980s, when paradigm wars (positivism [objectivity] versus constructivist [subjectivity]) broke out (Hanson, 2015). Objectivity was associated with value-free studies aimed at generating universal laws, and subjectivity was associated with generating knowledge that was context bound in meaning and application (Allan, 2003). These differences could be a sign that the two approaches have different histories.

Alexander *et al*. (2008) argue that the mixed methods approach could be any two methods, irrespective of whether they are qualitative or quantitative. Some scholars, however, aver that it should be the combining of any quantitative and qualitative methods (Bryman, 2011:87-100; Daniel, 2012:6; Flick, 2012:188). This study adopted a definition identical to the latter. Thus, the mixed-methods approach refers to the combination of two or more methods (Alexander *et al*., 2008; Flick, 2008; Onwuegbuzie & Frels, 2016), with one "qualitative and [at least one] quantitative" element in the same research project (Bergh, Corley & Ketchen, 2017:180; Bergman, 2011:1). But, if the approach involves the application of many qualitative or many quantitative methods, it becomes a "multimethod" study (Creswell, 2015:3; Flick, 2017:50) or a "multi-strategy" approach (Brannen, 2011:53). Fetters and Molina-Azorin, (2017:5), however, clarify that mixed methods is "one category of multimethod or multiple methods". Further, Fetters and Molina-Azorin argue that the clarification separates mixed-methods studies from those studies using methods from one family, i.e. qualitative or quantitative (multimethod), and lays bare the peculiar philosophical and theoretical challenges of mixing qualitative and quantitative methods.

Other debates border on whether analysing the same data strand using different methods should constitute mixed methods; and whether quantification of qualitative data at the analysis stage, especially using content analysis, should follow suit (Alexander *et al*., 2008; Bryman, 2011). This study adopted the mixed-methods approach because it involved the use of content analysis and face-to-face survey research as quantitative methods and in-depth interviews as a qualitative method.

DeCuir-Gunby (2011:129) asserts that the mixed-methods approach is accompanied by "intramethod and intermethod mixing". She defines intramethod mixing as a situation in which a researcher uses a method that has both qualitative and quantitative approaches, e.g. content analysis or a questionnaire that has both closed-ended and open-ended questions. DeCuir-Gunby then explains intermethod mixing as a situation where a study employs different methods. For instance, a study can involve in-depth interviews and a survey. This study, therefore, involved both intramethod and intermethod mixing.

The mixed-methods approach sometimes goes by several typologies from which researchers can select to suit the purpose of their respective projects. These typologies embrace: "complementarity, development, initiation, expansion, and triangulation" to describe the application of both quantitative and qualitative research methods in a project (Alexander *et al*., 2008:128). For this study, the "triangulation" typology was adopted because it is contemporary and has been used in numerous recent studies (Bergh *et al*., 2017; Flick, 2017; Fetters & Molina-Azorin, 2017; Gastrow, 2015; Tourangeau, 2017). Moreover, the application of triangulation seems synonymous with the growth of a mixed-methods approach.

Triangulation involves using different types of data and employing different investigators or theory to concentrate on different aspects of the study at the same time, or at different points in time (Brannen, 2011; Flick, 2017; Fetters & Molina-Azorin, 2017). For instance, a content analysis can be followed by a survey and interviews to answer a range of questions (Bain, Selfa, Dandachi & Velardi, 2017). The current study starts with the quantitative approach (content analysis and face-to-face surveys) and ends with the qualitative approach (in-depth interviews). Theoretical triangulation in this study involved using the science-in-society model, public sphere, and the media logic theory, as discussed in Chapter 3.

The roots of triangulation in social research can be traced to the mid-20th century, when Campbell and Fiske (1959) published their work on convergent and validation of measurements in research and Webb, Campbell, Schwartz and Sechrest (1966) published *Unobtrusive measures: Nonreactive methods in the social sciences*. However, the method was popularised by sociologist Norman Denzin (1978, 1989), in his work *The research act*. Generally, triangulation is used for checking validity, getting complementary information, and gathering information using methods that have different foundations to improve validity and reliability. Alternatively, triangulation can be achieved by simply comparing different accounts, such as evaluating interview results from eye witnesses of an event or assessing observational data of the phenomenon being studied from different angles "to reduce the chances of reaching false conclusions" (Hammersley, 2008:23). Bergman (2011:4) summarises the development of the mixed-methods approach as a new paradigm to end mono research, using quantitative and qualitative methods by bridging "epistemological, ontological, and axiological differences between" the two approaches as illustrated in Figure 4.1 below.

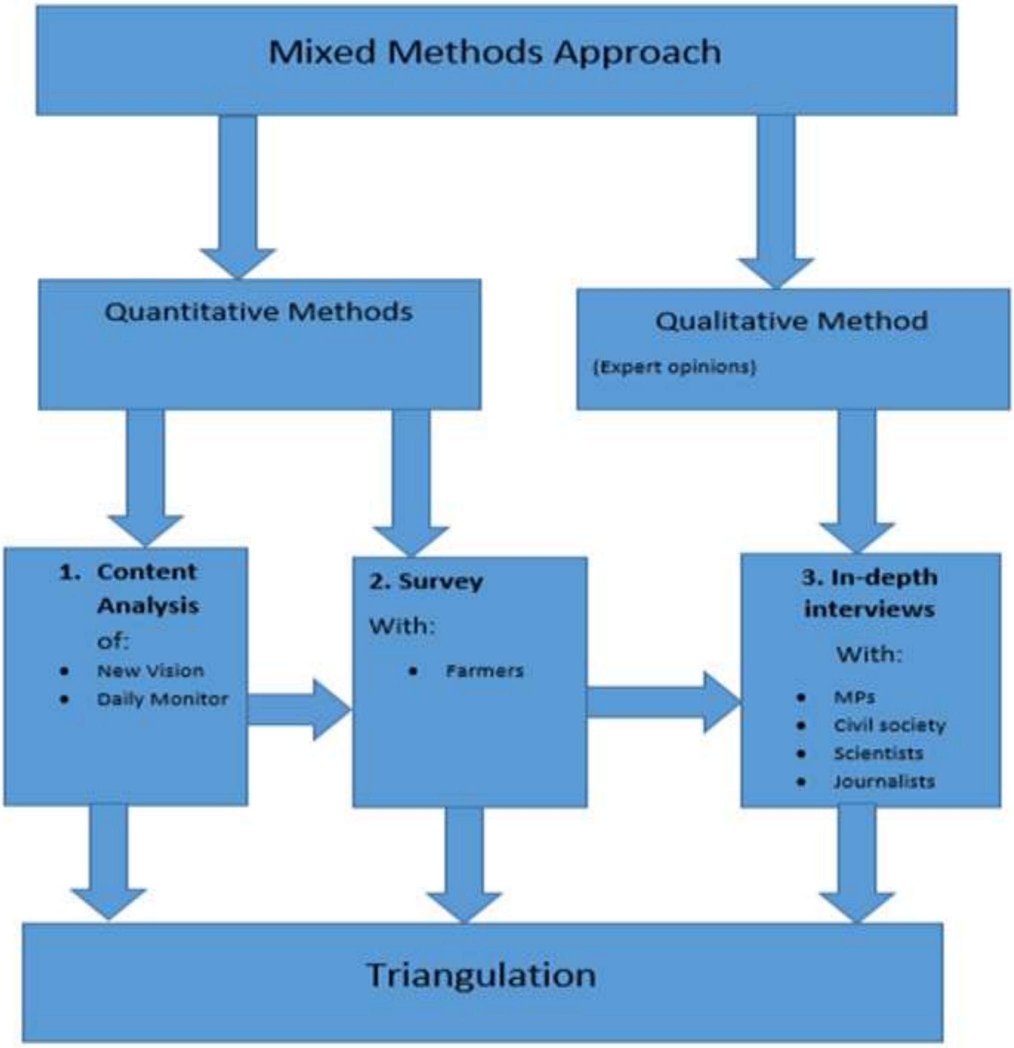

Figure 4.1: A flow chart of the methodology used in the study

Indeed, a number of recent studies have employed the mixed-methods and triangulation approach (Massarani & Peters, 2016; Petersen, Anderson, Allan & Wilkinson, 2009; Ross, 2017). Although the current study is not the first to use all three methods in one project, it could be the first on controversial science, since no such study was found with a main focus on Eastern and Central Africa. The number of participants involved is presented in Table 4.1.

Table 4.1: Distribution of participants by method

Nature of participant	**Site for research**	**Number of participants**	**Type of information**	**Method/tool**
Farmers	Community meeting	**42**	Quantitative	Face-to-face interview survey (questionnaire) See Appendix 2
Biotechnologists (Pro-GMO scientists)	Research stations	3	Qualitative	In-depth interviews (interview guide) See: Appendix 3 Appendix 4 Appendix 5
Newspaper journalists	Newsroom	6		
Newspaper editors	Newsroom	2		
Radio journalist	Newsroom	1		
Online journalist	Newsroom	1		
Ant-GMO activists	Offices	3		
Science academic	University	1		
Member of Parliament	Parliament	1		
Clerk to parliamentary committee	Parliament	1		
Sub-total	**19**			
Total	**61**			

4.4 Quantitative research

Quantitative research is assumed to be solid and reliable, as it generates statistics through the application of methods such as surveys and structured interviews (Bryman, 1996; Dawson, 2013). The advantages of quantitative research are drawn from the general assumptions that the approach allows researchers to involve large numbers of people and draw conclusions. This form of research can analyse data efficiently using packages such as the Statistical Package for Social Scientists (SPSS) to study "relations" in order to establish causes and effects while minimising “bias” and appealing to people’s preference for figures (Creswell, 2015:5; Davies, 2008:82). Pierce (2008:42) emphasises that quantitative research is generally believed to be “rational, logical, planned and systematic” – concepts he associates with objectivity and trustworthiness.

The limitations of quantitative research include the fact that it does not record the explanations of participants to provide a good understanding of the context of the respondents, and that it is largely researcher-agenda driven (Creswell, 2015; Davies, 2008). Relatedly, Pierce (2008:44) identifies five weaknesses of quantitative research: Firstly, its claim to positivism is contestable in social science research. Secondly, it is too “detached, remote and clinical” to be applied in studying the complexity of social phenomena. Thirdly, “it is bad science” because it does not meet the rigour of the natural sciences, which include testing and replication of studies. Fourthly, some concepts, such as behavioural change and attitudes, are hard to measure. Fifthly, the dependence on techniques such as observation limits its application to only that which can be seen and measured. For these weaknesses, quantitative research in the social sciences may require support from qualitative research if it is to benefit from the latter’s explanatory and contextual power. This study involved 42 participants and used a semi-structured questionnaire.

However, Pierce (2008) also posits that the new statistical packages such as SPSS can be used to generate results with acceptable confidence levels. Pierce explains that many concepts. such as power, behaviour and perceptions, can be observed using measurable indicators designed by qualified researchers to incorporate science into human behaviour and to adopt terms such as social science, political science or communication science to describe the body of knowledge. To effectively study the components of media coverage and public perception, the study adopted qualitative research to benefit from its explanatory strengths.

4.5 Qualitative research

The qualitative approach involves respondents sharing their “feelings, thoughts or experiences in some depth” (Davies, 2008:139). Its strength lies largely in its ability “to understand the underlying values of individuals and groups” (Pierce, 2008:45). It captures the analysis of “interaction and communication” and “documents [such] as texts, images, film or music” for the purposes of understanding, describing and explaining social phenomena (Flick, 2008:xi). Qualitative studies are generally associated with small samples, face-to-face encounters, the minimum use of statistics, and fewer questions than those common in survey questionnaires. Therefore, they are more engaging and require lengthy discussions between the researcher and the respondent. Because qualitative studies happen in "natural settings" (Marshall & Rossman, 2016:2), the methods are considered "more human" than methods such as surveys, which often require respondents to tick boxes to answer closed-ended questions (Davies, 2008:140). As a result, qualitative methods capture the respondents' experiences in context. They are based on the "voices" of the participants other than the researcher, thus allowing appealing stories to trickle into the research findings (Creswell, 2015:5). Qualitative research methods enable us to "understand how meanings are negotiated between members … the group dynamics involved" and are therefore useful in developing theories through "induction" (Pierce, 2008:45). Thus, qualitative research is essentially interpretative and usually presents society as a holistic and complex place to live in.

However, because it is interpretative, qualitative research is accused of having limited generalisability as a result of "go[ing] native" (over-identifying with the subjects) or suffering from "observer drift" (where the researcher ignores views considered to be negative) (Pierce, 2011:47). The approach does not provide statistics to back arguments and it is highly subjective, since interpretation varies from individual to individual. Moreover, the approach allows the involvement of only a "few participants" or subjects, whose expertise the researcher largely relies on to analyse and draw conclusions (Creswell, 2015:5). Qualitative research then requires a lot of experience on the part of researcher to draw meaningful conclusions.

Apologists of qualitative research concede the challenge of researcher effect in the findings but take precautions to minimise the bias. They aver that close supervision should be emphasised and researchers are required to make available recordings, photographs, full transcripts and any other records to demonstrate that interviews, focus group discussions or an ethnographic study was conducted (Davies, 2008; Pierce, 2008). Figure 4.2 captures the researcher interacting with some of the respondents.

Figure 4.2: The researcher addressing the public before starting the face-to-face survey in Kasambya-Wakiso district (Photo: Brian Semujju)

The photograph in Figure 4.2 above was taken while the researcher was creating rapport with respondents before gathering information using the face-to-face survey questionnaire. The tool used is attached as Appendix 2. The in-depth interviews enabled this researcher to get a deeper understanding of the results from the content analysis and the face-to-face surveys to augment the justification for a mixed-methods approach.

4.6 Rationale for a mixed-methods approach

Considering that both qualitative and quantitative methods have limitations, a mixed-methods approach offers the best of both worlds (Pierce, 2008). Based on the discussion in the above section, it is necessary to point out the rationale for the mixed-method approach. This study benefited from Creswell's (2015) five strands in the mixed-methods approach:

1) It enabled this researcher to obtain different perspectives, partly drawn from the content analysis and closed-ended questions asked in the face-to-face survey questionnaire, and partly drawn from the open-ended questions put to the key informants.
2) It allowed the researcher to gather more nuanced views and more data about biotechnology than either approach (quantitative and qualitative) could provide.
3) The researcher was able to correlate biographical (personal) data (quantitative) about the age, gender, place and level of education to opinions held by the respondents.

4) The use of qualitative methods allowed the researcher to know and to meet key informants (qualitative) to ensure that the tools (quantitative) fitted the participants and sites being studied.
5) Qualitative data enabled the researcher to appropriately identify key informants for the study, and to assess the personal experiences of scientists, journalists, legislators and civil society as they explained the phenomenon of biotechnology in detail.

4.7 Methods

The study employed three methods: content analysis, face-to-face surveys, and in-depth interviews. The methods are explained in subsequent sections of this chapter.

4.7.1 Content analysis

Content analysis, sometimes referred to as "textual analysis" or "text mining" (Pierce, 2008:263), is the "study of recorded human communications" (Babbie, 2010:333). Berelson (1952:18) describes content analysis as a research technique for "the objective, systematic and quantitative description of the manifest content of communication". It is used as a technique for making inferences by systematically/mathematically identifying specific characteristics of content and using a structured coding mechanism to ensure accuracy in capturing and interpreting media content.

In content analysis, researchers create categories and tally the number of instances each category occurs, thereby allowing different "researchers to arrive at the same results when the same material" is studied (Silverman, 2010:20). Hence, content analysis requires "enumeration and understanding" (Hyvärinen, 2011:481), "analyz[ing] and then creat[ing]" (Neuman, 2011:49) or "examin[ing] content" (Picardi & Masick, 2013:140), and using a structured method for recording specific words, terms, themes or concepts used within a text. The content analysed can be words, speeches, ideas, themes, photographs, movies, songs, books, clothing, graffiti or organisational records (Picardi & Masick, 2013; Silverman, 2010). Contemporary content analysis involves using computerised techniques to classify variables for the analysis of content from "credible data sources" (Picardi & Masick, 2013:140). It is then possible to deduce that content analysis is applied in identifying, categorising, describing and quantifying short-term and long-term trends by reducing the material to specific themes representative of the phenomenon to establish the meaning embodied in the text. To make sense of what the text embodied, this researcher analysed stories about biotechnology published in two Ugandan newspapers from 2012 to 2015 using the coding sheet in Appendix 1 as a tool.

4.7.1.1 Strengths and weaknesses of content analysis

Unlike interviewing and doing surveys, content analysis is a "nonreactive method" because the originator of the information is unaware that their product will be analysed at any given time (Neuman, 2011:49). In other words, text is treated to "have an independence from its sender or intended receiver", even when analysing media content (Pierce, 2008:263). Because of this nature, content analysis allows researchers to document certain characteristics of large documents that may not be perceived. For instance, using content analysis, Reul *et al*. (2016:15) conclude that "individual journalistic choices, organisational and ideological leverage, and extra-medial determinants" have the potential to shape media content and consequently drive debate in partisan directions on controversial science.

Using content analysis, therefore, brings about the required rigour and authority in scientific inquiry. In addition, the text to be studied is abundantly available in electronic and hard copies, thereby making it cheap (Pierce, 2008). Pierce (2008) emphasises that, because content analysis allows quantifying findings, ensuring distance from the subject, the method is assumed to be the object. Further, the method can also be used in comparison of media content (McQuail, 2005:551). Thus, content analysis is a useful method in studying huge amounts of data, such as media coverage of the phenomenon of biotechnology in Uganda.

However, like any other method, the use of content analysis is associated with certain weaknesses and limitations. In the case of studying media content, McQuail (2005) points out that in media research the meaning exposed by content analysis is only a cumulative version of the consequence of many discrete decisions, rather than the actual position of individual journalists or editors. McQuail (2005:364) contends that:

> The usual practice of constructing a category system before applying it involves the risk of an investigator imposing a meaning system rather than discovering it in the content… The outcome of content analysis is itself a new text, the meaning of which may, or even must, diverge from the original source material.

Furthermore, Pierce (2011:264) asserts that content analysis leaves room for researcher bias in selecting material for analysis through choosing a representative sample, defining boundaries, and exaggerating the benefits of the methods, thereby rendering the application of "Boolean and other mathematical software bad science".

However, Coleman and Thumim (2016:1357) perceive content analysis as a "limiting technique" for allowing a researcher to focus on what they can manage at a time. In other words, the reliability and validity of the results are largely dependent on the workmanship of the researcher and his or her assistants in conducting the exercise. Errors in coding the results may occur if the coding book is not clear, is misinterpreted by the coders, or the categories are mixed up. In this study, the principle investigator trained the co-coder well, allowing him to internalise and practise data capture using the coding sheet and the coding book. They independently used the tool to capture data for stories published in two different months, each capturing data for a different month. They interchanged the months and double checked every entry to minimise mistakes. They then exchanged the 'codings'. On the first checking, the level of agreement was 72%. They checked the stories again, one by one. The level of agreement reached 86%. They checked the third time and the level of agreement was 98%. All the calculations are agreeable, considering that some studies have an inter-coder agreement of 68% to 77% (Siegrist, 2001), 56% to 94% (Carver, Rodland & Breivik, 2012), and 73% to 88% (Mellado & Van Dalen, 2016).

A further limitation is that the method is weak at establishing causal relationships between variables, analysing the general society from which the material studied was generated, or localising the content in terms of where the audience that consumes such text lives (Wigston, 2010). This contradicts Pierce's (2008) general argument in support of quantitative research providing the best route of identifying and comparing phenomena. As such, other methods such as surveys should be employed if causal-effect relationships must be studied.

With these weaknesses and limitations in mind, Pierce (2008) concludes that content analysis should not be used in isolation, but as a supplementary instrument of analysis. Hence, this study applied a face-to-face survey and in-depth interviews to corroborate the results from the content analysis.

4.7.1.2 Application of content analysis

The study involved a content analysis of biotechnology coverage in two leading Ugandan newspapers, the *New Vision* and the *Daily Monitor*. The *New Vision* (established in 1986 as a government newspaper) and the *Daily Monitor* (established in 1993 as a privately-owned newspaper) are the oldest newspapers in circulation in the country today. The survival of the two newspapers in a country with a high newspaper mortality is not only a testimony to their resilience, but could also be an indicator of public trust in the publications' content. As a matter of fact, most radio and television stations and social media use the publications as news sources, including their press review programmes. While radio is the most dominant source of information in Uganda, with the country hosting 292 radio stations (Uganda Communications Commission (UCC), 2015:29), the industry faces challenges of recordkeeping. This challenge makes conducting content analysis of radio very difficult and justifies the use of print news as proxy for understanding media coverage in Uganda. Besides the two newspapers seem to 'set the agenda' for other media on several national issues in Uganda, and considering them as case studies could be reflective of other media's practices (Oberiri, 2016; Raupp, 2017; Thaker, Zhao & Leiserowitz, 2017; Townson *et al*., 2016). The two newspapers have a combined daily circulation of about 50, 000 copies (Audit Bureau of Circulation, 2016), and includes legislators, regulators, scientists, NGOs and some consumers in their elite readership as they are published in English – a language only understood by the 'well-educated' in Uganda. Analysing these newspapers increased the chances of finding different opinions in the two papers. Moreover, elite newspapers usually avoid sensational reporting on "contentious" issues in the "public sphere" (Beyeler & Kriesi, 2005:100). Therefore, studying the two newspapers provides a balanced view of the understanding of biotechnology in Uganda, a country where the GMO debate is largely elitist.

Using content analysis, the study considered the period from 1st January 2012 to 31st December 2015, with 2012 being the year the Biosafety Bill, which spells out how modification and adoption of living organisms should be undertaken, came into place, while 2015 marks the year when the NRM, the ruling party in Uganda, agreed to support the Bill if it was presented for debate in Parliament again. The Bill was passed in 2017, when ruling party MPs were 'whipped' to pass it in a sitting that was not attended by opposition MPs, who were serving a suspension for rowdily opposing the "age limit bill" that would allow the sitting president to contest for office beyond the constitutional age of 75 (Emorut, 2017). The president, however, returned the Bill to Parliament, citing ecological challenges. The content analysis involved coding of key words such as biotechnology, GMO, genetic engineering and GM food. Furthermore, the information was categorised into various themes relating to the field of biotechnology and the message about it in the media.

Content analysis on similar subjects has been taken from an 'average' week (Chow-White, Struve, Lusoli, Lesage & Oldring, 2017), for three months (Reul *et al*., 2016), 10 years (Navarro, Panopio, Malayang & Amano, 2011), up to 26 years (Bauer & Gaskell, 2002b). A key characteristic of all these studies is that they involved more than one investigator. Therefore, a period of four years for a student project is within acceptable range.

The media analysis combined quantitative and qualitative content analysis (integrated data analysis strategy; this included length [space], position [prominence], accompanying illustration [photographs and other graphic representations], controversy [bias], persistence [trend], and sources of articles – units of analysis – as proxy for prominence and impact); actors and their gender; and issue frames as implied in earlier works (Entman, 1993; Feindt & Kleinschmit, 2011). Such analysis helped to establish the relationship between the media and other actors, and the trends and dominant issues in the biotechnology debate.

Content analysis can be conducted both manually and electronically. While Picardi and Masick (2013:140-141) acknowledge that conducting the exercise manually is laborious, they recommend manual coding because it allows the researcher to understand the "context in which the data was presented". This advantage is sometimes lost if the data is captured and translated using computer software. PDFs were used when found, and the researchers resorted to hard copies where PDFs were not available. This researcher manually categorised the data to determine the categories and sub-categories that emerged and those that were absent. The categories were simple and easy to understand by both the researcher and the research assistant. This quickened the process of fitting issues into the "predetermined measures categories" and improved both the validity and reliability of the data (Coleman & Thumim, 2016:1357). For this to happen, all categories and themes were clearly defined to establish boundaries; coding schemes were exhaustive; the categories were mutually exclusive; and the sample reflected the research problem.

The content analysis frame considered the section in which the article appeared for categorisation; the size of the article as an indicator of news importance; the format of the article to establish the level of organisation; and whether the article appeared to be controversial to establish the level of knowledge on the subject. The content analysis frames provided a grid for comparison in terms of framing, thematic structure and evaluation of biotechnology.

The news event or issue was characterised by authorship, the actors identified with biotechnology, the themes, their specialisation, attributed consequences in terms of benefits and risk, and the implied evaluation of biotechnology as suggested by Bauer and Gaskell (2002b). Quality assurance included careful negotiation of the sampling and coding procedures; acquaintance with the procedure in the Ugandan context; revision of the content frame to take account of pilot work; and deliberate reliability checks for consistency. Piloting of the coding used 15% of the total sample to provide an adequate amount of data for the coders to practise and agree.

Two different months, with an interval of one month, were piloted in each of the years under study, as indicated in Figure 4.3 below.

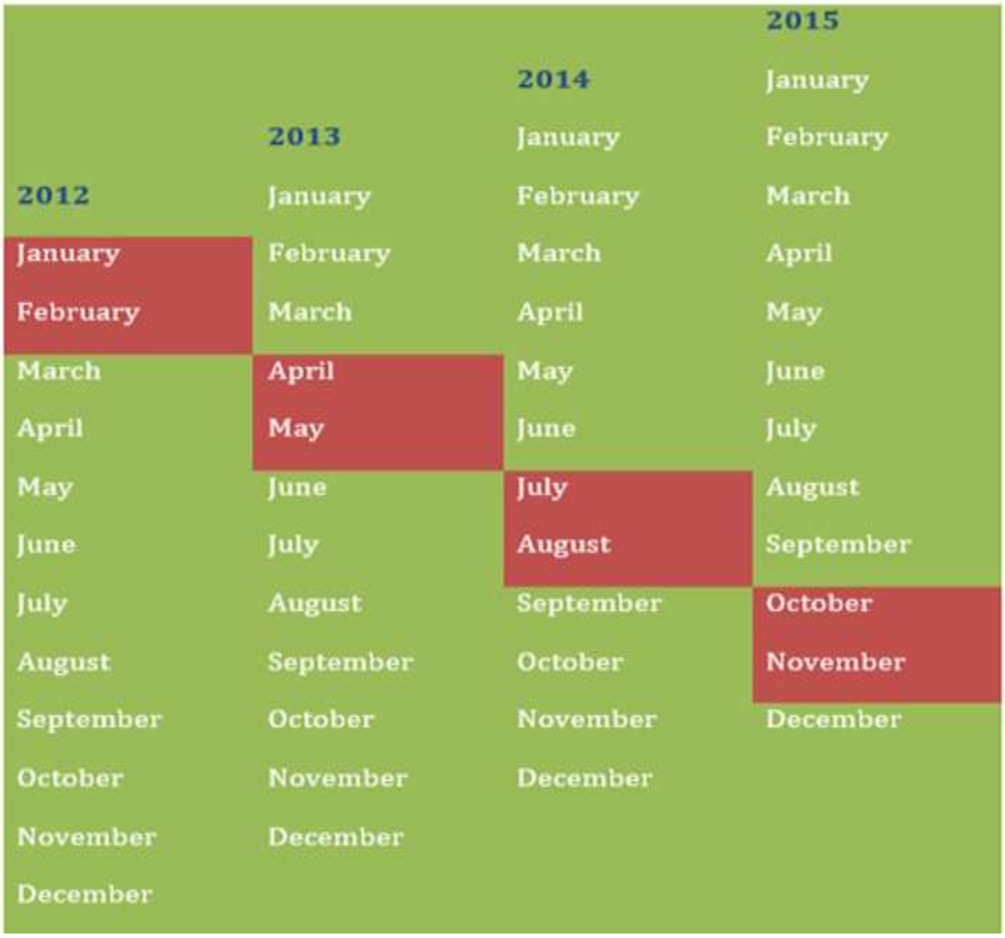

Figure 4.3*: The months piloted (Source: Author)*

4.7.1.3 Coding system

The researcher developed a coding system, which consisted of two to 10 categories. Indeed, this number was considered "parsimonious" because the categories were neither too many nor too few when compared to studies that had only three variables (Picardi & Masick, 2013:141). In some cases, variables have yielded six categories (Maeseele & Schuurman, 2008), and in one extreme case 48 categories (Feindt & Kleinschmit, 2011). From these studies, it appears that there is no standard number of categories, but every research project should be evaluated in its own right. In this study, the variables were well described to avoid confusion in the process of coding. Both the researcher and research assistant had codebooks, from which the data was later extracted for entry into SPSS for analysis.

4.7.1.4 Selection of articles

The articles selected were those published from 2012 to 2015. Carver *et al*. (2012: 457) argue that selecting a recent period gives the researcher an opportunity to "capture the current context" in both hard copy and online, since the websites of the two newspapers under study are less than two decades old. Selecting recent articles was particularly important, because this study considered all articles published on crop biotechnology in both the hard-copy and online versions of the *New Vision* and the *Daily Monitor*. The selection was limited to articles that contained the word(s) gene, DNA, GMO, crop biotechnology and genetic engineering in relation to crops. Articles that contained these words used in relation to animals or humans were omitted, as this study focuses on crops. Leaving out animals and humans was a limiting technique to avoid digressing into cloning, forensics, and other forms of biotechnology.

4.7.1.5 Coding frame

Words, phrases, images and sources of information were used collectively to describe a coding frame in frames analysis (Entman, 1993). Deductive frames analysis applies an existing coding scheme to discover the presence of certain patterns in the material. In contrast, inductive framing is the act of describing new frames by determining and classifying new devices (Carver *et al*., 2012). Both deductive (existing characteristics) and inductive (explaining the emerging issues) frames were used in this study.

A coding book was developed by this researcher, upon which he recruited and conducted training sessions with one research assistant. The training also ensured that inter-coder reliability was achieved because the coders had a similar understanding of the issues related to biotechnology. They looked for the media logic in framing and the variables at play in the article. The results were allotted in periods – 2012, 2013, 2014 and 2015. These time periods were used to study the range of issues covered, the trends in and frequency of coverage. The articles were coded for their manifest characteristics in terms of the risk-benefit analysis and regulation. The study adopted five coding considerations (Gutteling *et al*., 2002). Information was categorised according to: 1) newspaper – the *New Vision* or the *Daily Monitor;* 2) themes – agriculture, regulation and policy, ethics, identification, safety and risks, and others; 3) actors – scientists, journalists, NGOs, politicians, legislators, industry, international community, and others; 4) promise – benefit/solution or risk/doom/fear; and 5) coder's overall impression of the article – positive or negative, balanced or neutral, using definitions provided. Stories were also coded to establish whether they were controversial or noncontroversial. The coders looked out for the nature and gender of the source quoted, the country mentioned and the type of photograph accompanying the story, if any.

The coders also identified the dominant and secondary logics. The dominant logic is usually expressed in the headline and the introduction (Kitzinger, 2007), and the secondary and tertiary frames are buried in the body (Petersen, 2001). The coders looked out for both the dominant and secondary logic.

4.7.1.6 Additional coding

The study adopted the three-categories model of Carver *et al*. (2012) – author, type of article, and other. Articles therefore were coded for type of author: 1) general journalist, 2) science journalist, 3) expert, 4) columnist, and 5) other. Type of article: 1) feature, 2) news including briefs, 3) commentary, 4) interview, 5) other. Type of topic: innovation, regulation, benefit, and risk.

In this study, the unit of analysis was an article on biotechnology in either the *New Vision* or the *Daily Monitor*. The article had to contain references to biotechnology identified by terms such as GMO, GM food, biotech, genetic engineering, living modified organisms, research, novel food, ethics of modern biotechnology, and campaigns supporting or opposing GMOs. All articles in the newspapers published from 1st January 2012 to 31st December 2015 were considered, no matter the section, and were coded. Gutteling *et al*. (2002) argue that this is important for two reasons – to ensure thorough coverage of what the newspapers covered, and for analysis of perceptions and policy processes on biotechnology in Uganda. This two-pronged approach ensured that the various approaches used in crop biotechnology were captured.

By analysing two newspapers, the researcher was able to realistically capture an accurate impression of the social dynamics of information processing related to science, especially biotechnology. Although these opinions can also be found by analysing electronic platforms (radio, television and online media), print material is usually systematically preserved. Besides, the Uganda Communication Commission Act (2013) requires that broadcast media keep their content for only a mandatory three months. This makes it almost impossible to find all electronic content for a four-year study in a country where record keeping is still a problem. The study considered the fact that biotechnology is not a very popular topic in Ugandan newspapers, so the search included both the hard copies of the newspapers and their online version to obtain a fair number of stories for analysis. A total of 317 stories related to biotechnology were analysed, as indicated in Table 4.2 below.

Table 4.2: The distribution of the stories analysed by publication

New Vision	74
Daily Monitor	243
Total	**317**

Source: Primary data

4.7.1.7 Validation of the coding frame

Each article was recorded for up to four frames. This included all possible options on the code sheet. Outliers were coded under the option “other”.

4.7.2 Face-to-face interview survey (in-person survey/structured interviews)

Surveys are any measurement procedures that involve systematically asking the same questions to a large number of participants and recording their responses, not only to establish the current status of population characteristics, but also to discover relationships between or among variables (De Vaus, 2011; Neuman, 2011; Silverman, 2011). Surveys produce results that “describe and interpret aspects of current psychosocial reality” (Davies, 2007:51). As such, social scientists consider “surveys an invaluable source of data about attitudes, values, personal experiences and behaviour” (Simmons, 2008:183). Simmons categorises surveys into four types or formats: 1) face-to-face; 2) telephone interviews; 3) postal (mail or self-administered) questionnaires; and 4) online surveys (Simmons, 2008:182-205). But Graziano and Raulin (2000) and Plowright (2012) add group-administered questionnaires, in reference to a study that may involve getting responses from a big group such as a class or a club to get a response in unison. Other scholars add computer-assisted interviewing (Bryman & Bell, 2014).

The study adopted the face-to-face (interview) survey format. The face-to-face interview survey, also known as an in-person interview, is a type of structured or standardised interview in which the researcher asks the same "predetermined", identical questions, following the same phrasing and order of questions as stated in the interview schedule (Kumar, 2011:145; Simmons, 2011:186). An interview schedule is an outline of questions the researcher prepares to ask the respondents. It is different from the flexible interview guide, which was used in the in-depth interviews in the next section. In other words, an interview schedule is used in quantitative research and an interview guide is used in qualitative research (Bryman & Bell, 2014; Simmons, 2011). Another difference between an interview schedule and a questionnaire is that, in the former, the researcher asks the questions and records the responses on an interview schedule, and in a questionnaire the responses are written down by the respondents themselves (Kumar, 2005:126). Kumar (2011:145) argues that an interview schedule can have "open-ended or closed" questions, but Bryman and Bell (2014:203) emphasise that this tool is usually "closed-ended, pre-coded, or fixed choice". Kumar (2005:135) vouches for closed-ended questions because they are a sure way of guaranteeing that the necessary information is "obtained" in a study. Closed-ended questions are important, considering that the aim of the face-to-face interview survey is to ensure that respondents are asked the same questions in the same way and are expected to respond in a similar way to "minimise the differences between interviews in the same project" (Bryman & Bell, 2014:201). Such a provision of uniform information enables "comparability of data" (Kumar, 2011:145). In this study, it was necessary to compare how a government newspaper and a privately-owned newspaper cover controversial science.

A set of questions with fixed responses was developed, but was followed with an open-ended question, "why?", to get the farmers' reasons for choosing the pre-coded answer in the previous question, as this researcher benefited from Dawson's (2013:31) provision for a "combination of both" closed-ended and open-ended questions by using both types of questions.

Justification for mixing closed-ended questions with open-ended questions is based on the argument that "… dependence on purely quantitative methods may neglect the social and cultural construction of variables which quantitative research seeks to correlate" (Silverman, 2011:40). Silverman suggests that it is wrong to study attitudes using quantitative questions, since human behaviour is too dynamic to be understood based on statistics alone. In other words, not every aspect of society can be quantified.

The questions were asked by a well-trained research assistant and the researcher himself. Farmers who had participated in a study conducted on GMOs by agricultural students were invited by the sub-county agricultural officer to two common meeting places in their neighbourhood, where they met the researcher and his assistant. The latter introduced themselves as a way of creating rapport with their respondents before requesting them to participate in the study. It was explained to the participants that the results were purely for academic purposes and that there were no monetary rewards. Respondents were also requested to sign a consent form before participation. With only two researchers interviewing the gathered farmers it drastically reduced the cost of "paying interviewers and their travel costs", which is common in such studies (Kumar, 2011:187).

In each group, the farmers sat and naturally continued discussing their private matters as the agricultural officer called them for the interview one by one. Each researcher was given two plastic chairs, one for himself and one for the respondent. The farmers were seated approximately 20 meters away from each of the researchers in what appeared like a triangle, as demonstrated in the figure below. Each farmer was interviewed in privacy and left immediately after the interview, to avoid the "intrusion" that may influence others during the interview (Bryman & Bell, 2014:206).

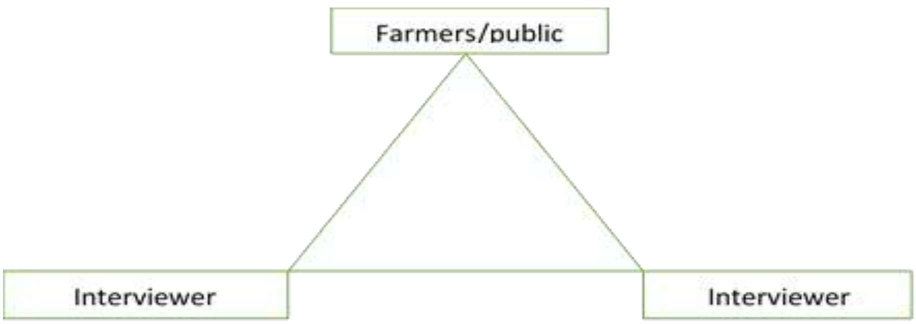

Figure 4.4: The setup of the face-to-face survey site

The questions were read out to the individual respondents exactly and in the same order the questions appeared in the schedule to achieve "'true' or 'real' variations not induced by "interview context"' (Bryman & Bell, 2014:202). The farmers' responses were recorded by ticking the available alternatives and writing down their reasons for choosing the fixed choices. The farmers' undetermined responses were later codified and entered into SPSS for analysis as the reasons for their choices. Bryman and Bell (2014:204) note that this approach increases "accuracy and ease of data processing".

Furthermore, Liu (2017:12) asserts that, because interviewers administer the face-to-face survey, "they control the flow and speed of the survey". Each interview took between 11 and 17 minutes. Figure 4.5 below shows the researcher conducting one of the interviews.

Figure 4.5: The researcher listening to and filling in the questionnaire for one of the participants from Kasambya (Photo: Brian Semujju)

An interview schedule is common in research involving lots of people (Dal Grande, Chittleborough, Campostrini & Taylor, 2016; Duffy *et al.*, 2005). Popek and Halagarda's (2017) study on consumer awareness of GMOs involved 976 people from the UK and Poland. The current study involved 42 respondents, who were mainly farmers and potential consumers of GMOs. This number is smaller compared to the number used in neighbouring Kenya, which involved 97 maize farmers, but the study involved neither content analysis nor in-depth interviews (Auma, Wangia, Magomere, Ligare & K'obill, 2017). However, the sample size is higher when compared to similar studies (Ross, 2017; Simonetti, 2016). This study is not far from the statistical recommendations by scholars who propose even "fewer than 30 cases" (Bailey, 1982:100) or "perhaps 60" respondents (Davies, 2008:51).

Kumar (2005:127; 2011:148) explains that, for a researcher to choose structured interviews over questionnaires, three conditions must exist. The first relates to the nature of the investigation: If the study is too sensitive, it is better to use a questionnaire for anonymity. However, if a study is sensitive but better information can only be got by interviewing respondents, researchers should opt for the structured questionnaire. Secondly, if the population is scattered over a wide geographical area, a questionnaire would be preferred because interviewing such a population would be extremely expensive. Thirdly, if the study population includes minors (children), the handicapped, the elderly and illiterates, the best alternative would be interviewing them.

In this study, the issue of biotechnology is sensitive, but required explanation for the respondents before they could answer the questions, because the science is fairly new to the general population. Therefore, the structured interview was preferred. The study also took place in areas that are densely populated, hence the interview was efficient. The population interviewed consisted of only adults (above 18 years by Ugandan law), but there were also illiterates or semi-literates, hence the preference for structured interviews over questionnaires.

4.7.2.1 Advantages of the face-to-face survey

Structured interviews can be more flexible. A skilled interviewer can gather more information from it than from a postal questionnaire, which is left to the respondent to interpret the questions in any way (Simmons, 2008). At the same time, interviewer variability is reduced because the questions and the answers are pre-coded (Bryman & Bell, 2014:204). Further, Bryman and Bell argue that such a process also makes it easy to process data, unlike in qualitative interviews, where whole sentences have to be written down by the interviewer.

Unlike the postal survey, which is limited to the literate, and the telephone survey, which is limited to those who can afford mobile phones (and keep them active by way of charging and buying airtime), the face-to-face interview allows a range of people to participate, since it is administered by an interviewer who can rephrase some questions to a certain degree to make them clearer for the respondent (Kumar, 2005; Simmons, 2008). The researcher took stock of the fact that some farmers were uneducated and would not be able to complete the questionnaires, or were not reachable by telephone as a result of a poor network or their phones blacking out due to limited access to power.

Unlike the telephone interview, in which interviewers have to listen to signals to indicate a lack of understanding, in face-to-face surveys, the interviewer can observe the respondent's body language, gauge that the question is not clear and rephrase it accordingly (Simmons, 2008).

Indeed, some respondents asked the researchers to rephrase the questions for them, a request they never objected to.

4.7.2.2 Disadvantages of a face-to-face survey

Unlike the telephone survey, which makes it cheaper to reach many respondents, face-to-face interviews are expensive because they involve paying many interviewers for their time and travel costs to accomplish the work in time (Simmons, 2008). In this study, the number was limited to 42 to minimise costs.

In addition, some potential respondents may shun the interview, although they might have been willing to be involved if it were a postal survey or a questionnaire (Simmons, 2008). This could be the reason why none of the meetings attracted more than 30 people, although the survey targeted a total of 70 participants. But the few who turned up accepted to participate because they had the confidence of the sub-county agriculture officer, whom they had met several times in sensitisation meetings.

To minimise the effect of fixed choices, the questionnaire often included the option “other” for those who could not choose from the pre-coded options (Simmons, 2008:192). The addition of this option enabled the researcher to capture responses not thought of previously.

In face-to-face surveys, the physical presence of the interviewer may influence interviewee response, as respondents try to give responses that may please the respondent (Nandi & Platt, 2017). Rapport was created with the respondents and this allowed them to express themselves freely.

Bryman and Bell (2014) raise the issue of systematic bias in response sets. A study on possible bias in the interview process reveals that nationals with mobile phones only were less likely to be included in the survey done in an area dominated by landlines (Dal Grande *et al.*, 2016). The farmers surveyed in our research study in Uganda were mainly those who had attended earlier engagements on GMOs and therefore had an interest in learning about them. However, other farmers, who had missed the meeting on GMOs but turned up were also interviewed, after the general briefing. Such sampling minimised systematic bias.

4.7.2.3 Administering the face-to-face survey

The researcher developed a set of questions on the public perception of biotechnology in Uganda. The questions were edited and pre-tested for clarity and meaning. The interview schedule included both closed-ended and open-ended questions as indicated in Appendix 2.

4.7.2.4 Sampling

A sample must be representative if the results have to be generalised (Graziano & Raulin, 2000). For the purposes of ensuring confidence in the data, a probability sample, in which each person stood a known chance or had a specified probability of being selected, was opted for (Graziano & Raulin, 2000). This is called a simple random sample. The sampling frame included farmers from Wakiso district who were living near the National Crop Resources Research Institute (NaCCRI) in Namulonge. This institute is about 25 km north of Kampala, the capital city. Choosing farmers from areas around this institute was necessary because biotechnology is a relatively new subject in Uganda. The areas surrounding the institute were selected for mainly two reasons: firstly, the application of crop biotechnology would most probably be better known to farmers living near this research institute than those living hundreds of kilometres away; secondly, the comparison of an urban and a rural population sample may enhance the conclusions of this study by providing a greater degree of data analysis and understanding, and therefore enriching the value of this study for academics and policymakers; and thirdly, the areas are home to some of the institute's researchers and casual labourers. A village (Kasambya) and an urban area (Kiwenda trading centre) were selected to get views from both a rural and an urban population. A study by Gurău and Ranchhod (2016) considered two neighbouring countries (France and the UK) with different food traditions for purposes of comparison. A similar comparison was followed in this study.

4.7.2.5 Sample size

The size of the sample required to represent a population depends on the degree of homogeneity in the population. But generally, the larger the sample, the more representative of the general population it is likely to be (Bailey, 1982; Graziano & Raulin, 2000). A large sample is also likely to improve the confidence interval – the level of confidence in the results. Nonetheless, scholars caution that the size of the sample should also factor in the cost of administering the questionnaire and the time available to the researcher (Creswell, 2015; Graziano & Raulin, 2000; Kumar, 2005). At the same time, researchers must be guided by sampling theory, which emphasises: 1) the avoidance of bias in selection; and 2) the attainment of maximum precision for a given outlay of resources (Kumar, 2005:23). This student project had no specific funding for fieldwork, yet it had to be completed within three years. Moreover, the survey was supplemented by other methods, such as content analysis and in-depth interviews. Hence, a precise sample of areas surrounding NaCCRI was necessary.

A study by Gurău and Ranchhod (2016:7) eliminated the very young (below 18 years), because they were not expected to have enough knowledge about GMOs, and the very old (75 and above), because they were expected to be less interested in the future of food production. This study deliberately excluded those below 18 years because they are below the majority age of 18 in terms of the laws of Uganda, and by coincidence none of the respondents were older than 70.

In terms of time used per interview, this study is comparable to that of Gurău and Ranchhod (2016). The interviews conducted by them took between 10 and 15 minutes. The Ugandan interviews took between 11 and 17 minutes, which is within acceptable limits.

4.7.2.6 Ensuring high response rate

The researcher opted for an event at which farmers were gathered and administered the questionnaire after the meeting. This saved time and money. Therefore, the combination of farmers in a rural area and farmers in an urban area should capture a representative picture of public perceptions of biotechnology in Uganda.

4.7.3 In-depth interviews

In-depth interviewing is a key method in interpretative (qualitative) research. Although any conversation between two people can pass for an interview, in-depth interviewing is defined as "repeated face-to-face encounters between the researcher and informants directed towards understanding informant's perspectives on lives, experiences, or situations as experienced in their worlds" (Taylor & Bogdan, 1998 in Kumar, 2005:124). Therefore, key to in-depth interviewing is that the engagement involves the physical presence of both the interviewee and the interviewer, and it must be seeking to understand the interviewee's perspective. Because it tends to be lengthy, the assumption is that a rapport is created and enhanced, and that the relationship should lead to accurate information. The success or failure of in-depth interviews is heavily reliant on the individual “performance of an interviewer” and “their skills as an analytical interpreter of the evidence” they gather (Davies, 2007:155).

For this reason, the interview guides were pre-tested to ensure that the questions were clear enough to draw relevant feedback on the subject. Questions that were not clear were rephrased. Questions were also re-ordered to ensure consistency in the flow of information. Some of the material received from piloting the tools was used in the main report, since there is “no strict boundary between exploration, piloting and data collection in small sample interviewing” (Davies, 2007:55). To maximise this stage, the researcher planned for a piloting phase of two weeks to ensure that the tools were compliant with the sample population. The pre-testing was done with a radio editor and an online journalist known to report about biotechnology. To ensure that all issues are covered in the conversations, the interview guides for journalists (Appendix 3) and scientists (Appendix 4) included a checklist, which the interviewer kept ticking, as the issues to be covered were many. The interview guide for activists (Appendix 5), is slightly different and shorter.

Mainly open-ended questions were asked to gather the thoughts and experiences of the participants. The respondents had to sign a consent form before the interview could begin. They were also informed that the interview would be recorded before the process began. The interviews were recorded, but notes were also taken as a backup measure in case the recorder failed. In two cases, the recorder switched off in the middle of the interview, but the interview was saved by a mobile phone recorder, which was always switched on as another back-up measure. The interviews were recorded with the permission of the respondents, transcribed verbatim, and coded using Atlas.ti in terms of how informants explained their understanding of issues related to biotechnology.

The scientists, journalists, activists and MP interviewed are those who had appeared in the media, but who also allowed “access” (Silverman, 2010:139) or were “available” (Creswell, 2015:76). In total, 19 interviews were conducted, and the process was stopped after reaching a “saturation point” – a stage in qualitative research when the chances of getting any new information is negligible (Creswell, 2015:77; Kumar, 2006:165).

By comparison, one study on biotechnology in Kenya involved 17 semi-structured interviews with farmers (Bandewar, Wambugu, Richardson & Lavery, 2017). In another study, the researcher conducted six in-depth interviews (Ross, 2017). Therefore, 19 in-depth interviews for a single student project should suffice. Interviewees were at liberty to make corrections, and if they thought they needed to clarify the views they had shared with the researcher they had his contact details (telephone number and e-mail address), which were given to all interviewees. Semi-structured questions allowed the interviewer to rephrase questions for the comprehension of the respondents, depending on the context. The study involved in-depth interviews with three scientists, eight science journalists, including two news editors (four journalists from each newspaper), three NGOs focusing on food, two policymakers (a legislator and a clerk) from the parliamentary science and technology committee, and one academic. In-depth interviews (semi-structured interviews) explore what people think, feel and experience (Bryman & Bell, 2014; Harding, 2013). The interview guide was flexible enough to allow adjusting the interview schedule to accommodate and explore any new issues that the researcher had not encountered during the content analysis.

The analysis of the interview data involved thematic coding (interactive combination of inductive and deductive coding) with Atlas.ti. The findings were aligned to qualitative and quantitative data from the content analysis. The interviews were conducted after ethical clearance was separately granted by the Stellenbosch University Research and Ethics Committee and the Uganda National Council of Science and Technology as indicated in Appendix 6.

In terms of length of time spent doing the interviews, time spent on this study's interviews were comparable with that in other studies. Gastrow's (2015:58) interviews lasted one to two hours. Martin and Enns's (2017) in-depth interviews took less than one hour. Berglez's (2011) in-depth interviews took between 33 and 80 minutes. The shortest interview in this study took 26 minutes and the longest 78 minutes. Again, the time spent on each interview was within acceptable limits.

4.8 Data analysis

Data from the content analysis and the face-to-face survey was entered into SPSS to generate trends in the coverage of issues in the two papers. Using Atlas.ti, themes, families and quotes were generated from transcripts of the in-depth interviews to explain the coverage of biotechnology and the public perceptions about this new and controversial science. The study adopted the two-cycle thematic coding method (Saldaña, 2013). In the first cycle of coding, the researcher opted for the initial in vivo emotion versus simultaneous structural coding to capture the conflict within and between respondents. This technique was necessary because the interviews focused on media attention given to GMOs, but also the public perception in light of the pending legislation.

In the second cycle, the researcher opted for axial coding to create categories and sub-categories, while highlighting the relationship within and between them since the data was collected using different interview guides for the various key informants.

4.9 Reliability and validity through triangulation

To achieve validity, this study adopted the triangulation approach. Triangulation data analysis is useful in that data collected from various methods enrich each other for a fuller and a more complete understanding of the phenomenon by cross-checking the accuracy of explanation done by the researcher (Creswell, 2016; Flick, 2017; Silverman, 2010). Triangulation allowed the researcher to "counteract the weaknesses in both quantitative (content analysis and face-to-face survey) and qualitative (in-depth interviews) methods" (Dawson, 2013:20) by harnessing "the strengths that this combination brings to the study" (Creswell, 2015:2). Flick (2008:41) asserts that the methods and/or datasets must be "linked … treated and applied on an equal footing and in an equally consequent way". Therefore, triangulation allows a researcher to gather knowledge at different levels, thereby significantly improving the quality of data. It can further be argued that the strategy minimises the personalistic biases that may stem from using one method, a single set of data or a single investigator.

In addition, Flick (2008) contends that triangulation is aimed at knowledge validation and not necessarily at creating a mutual relationship between or among methods or facilitating the other method(s); the 'mixture' should therefore be seen as a complementary combination. By building on facilitation and complementarity, Bryman and Bell (2014) contend that triangulation allows researchers to use qualitative methods to check the quantitative results and vice versa; provide a more generalisable picture of the phenomenon; and interpret the relationships established by one method for clarity of the phenomenon. Through triangulation, mixed methods allow a researcher to navigate between qualitative and quantitative families through the radical middle (Onwuegbuzie, 2012), with the intention of ending the "paradigm wars" (Flick, 2008:93).

Reliability is the measure of the consistency of research results (Bryman & Bell, 2014; Patten, 2009). Scholars emphasise that reliability implies that study results can remain stable over time if measured using the same indicators, even if the measurement is done by different observers. Validity is defined as the ability of an indicator "devised to gauge a concept really measures that concept" (Bryman & Bell, 2014:159). Thus, validity can only be achieved if the results are reliable. Indeed, Patten (2009:73) asserts that "validity is more important than reliability". Therefore, reliability is only a signpost to validity.

The study used the results from the content analysis to develop questions for qualitative, in-depth interviews to obtain explanations to interpret the statistics with the aim of capturing a more holistic view of the phenomenon based on the understanding of the key informants in the biotechnology web in Uganda. The content analysis was followed by a face-to-face survey to get the views of ordinary people. The face-to-face survey was aimed at establishing whether the views published in the newspapers were in tandem with the views of the audience (public). The details of the sample selection criteria were discussed under individual methods in earlier sections of this chapter.

The challenge with a triangulation approach is that it is rigorous, since the combination of quantitative and qualitative methods increases the scope of each approach. Consequently, different sets of data were collected and used in the analysis. At the same time, the mixed-methods approach "undermines many taken-for-granted assumptions" across quantitative and qualitative research (Bergman, 2011:3). The undermining blurs the differences between quantitative and qualitative research, approaches which have a long epistemology and ontology in application, with the potential of causing confusion. Hammersley (2008) attributes this to the belief that mixed methods are neither uniform, consistent nor realistic if stretched beyond their elasticity. Further, the approach makes the study complex and can give the impression of producing ground-breaking results, which the study may not (Fielding, 2011). Yet Bryman (2011) asserts that there is a danger of the merged method failing to address the questions in the unique design. Considering that the quantitative and qualitative methods have different epistemological and ontological points of departure, it is difficult to establish criteria for assessing the quality of rigour (Tashakkori & Teddlie, 2011). Other scholars think that mixing data from different sources may leave some results unexplained (De Leeuw & Hox, 2011).

To minimise the potential flaws of triangulation, scholars make some very useful suggestions. In the triangulation approach, data can be collected "simultaneously or sequentially" (DeCuir-Gunby, 2011:129). DeCuire-Gunby further explains that simultaneous data collection is when all the methods used are of equal status and can be used at the same time in what is sometimes known as “concurrent mixed methods” (Creswell, 2011:14). Scholars argue that sequential data collection is when data from one method is used to develop questions for the other. For instance, face-to-face survey (quantitative) data can be used to develop an interview guide for in-depth interviews (qualitative). Creswell (2011, 2015) and Creswell and Clark (2011) maintain that the sequential use of methods, where one method provides a lead for another method, helps in reducing the possible contradictions in the use of the mixed-methods approach

Therefore, it cannot be denied that mixed methods is an approach that offers researchers opportunities to be creative in the craft of research. Consistent with the scholarly arguments above, this study opted for the sequential approach, where content analysis provided the issues for designing the survey, and the issues from both content analysis and the survey provided the basis for the in-depth interviews with the different stakeholders in the biotechnology web while answering the key question of this study: In what ways does media coverage of information about biotechnology influence public perception of biotechnology in Uganda?

The sequential approach ensured the reliability and validity of the study. Conceptually, the project analysed how media coverage can be integrated into public discourses on biotechnology innovation systems beyond journals, workshops, academic forums, science laboratories, and one-on-one conversations. Empirically, the research systematically assessed the range of thinking, research, presentation, trends and patterns of biotechnology reporting in Uganda. Practically, the study proposes policy recommendations for communicating biotechnology to the public in Uganda, with lessons to be learned for other African countries in subsequent chapters.

Chapter 5
Findings of the study I

The major source of information about GMOs is rumours (Activist C, 2017)

5.1 Introduction

In this chapter, research questions 1 and 2 are answered in meeting the objectives set in Chapter 1, and alluded to in other chapters. Tables, figures, statistics and text are used to explain the findings from the content analysis and in-depth interviews carried out in this study. The figures from the content analysis are explained using quotations from the in-depth interviews with scientists, journalists, activists, and government officials.

Scientists A and B are breeders, who had been quoted in newspapers commenting about GMOs. Scientist C is a biosafety specialist and runs the national biosafety information centre. Scientist D is an academic opposed to GMOs. Journalist C is an editor at the independent *Daily Monitor* and covered Parliament for a decade. Journalist D is a senior reporter at the *Daily Monitor* and often covers Parliament. Journalist E runs an online science publication. Journalist F is an editor of the government-owned *New Vision*. Journalist H is an editor but reported on biotechnology as a freelance reporter. Journalist G is a senior science reporter at the *New Vision*. Journalists B and K are freelance reporters at the *New Vision*. Journalist I is a freelance reporter the at *Daily Monitor*. Journalist A is a senior editor at the national broadcaster, but also a stringer for a publication in the United States of America. Activists A, B and C have appeared in the media opposing GMOs. The clerk of the committee has worked in Parliament for more than 10 years, and on the science and technology committee for more than half of that time. The MP was serving his second term and was the chairperson of the science and technology committee. The central research question for this study was: In what ways does media coverage of biotechnology influence public perception about its products, especially GMOs, in Uganda? The chapter is divided into four parts according to the first questions of the study. The questions are further subdivided into subthemes for easy reading.

5.2 Question 1: How do the *New Vision* and the *Daily Monitor* present biotechnology?

This question corresponds with Objective 1 and embodies the findings from the content analysis and information obtained using in-depth interviews. Under this question, the findings were organised according to prominence in terms of placement, size, author, origin, key words, tone of articles, controversy and sources quoted.

The four-year content analysis revealed 317 articles, of which 76.7% (n=243) were from the *Daily Monitor* and 23.3% (n=74) were from the *New Vision*. The articles were segmented into six category formats as presented in Table 5.1.

Table 5.1: Frequency of coverage by the *New Vision* and the *Daily Monitor* by category format

	Format						Total
Publication	**Editorials**	**Features**	**Letters**	**News**	**Opinions**	**Pull-out**	
Daily Monitor	3	11	27	44	54	104	243
New Vision	3	4	11	10	45	1	74
Total	**6**	**15**	**38**	**54**	**99**	**105**	**317**

5.2.1 Articles by prominence (placement)

Typical Ugandan newspapers are usually divided into four segments – the first few front or back pages are for news – largely politics and sports respectively; the next few pages are for editorial/opinions/letters; the inner pages are devoted to topics such as health, business and agriculture (features); and occasionally a pull-out section for articles that are good for the public, but do not 'sell' the newspaper. This practice largely guided the subdivision by prominence in Table 5.1 and Table 5.2.

Table 5.2: Format by year of publication

Format of the articles	**Years**				**Total**
	2012	2013	2014	2015	
Editorials	0	4	1	1	**6**
Features	1	6	4	4	**15**
Letters	1	12	13	12	**38**
News	7	21	14	12	**54**
Opinions	11	38	28	22	**98**
Pull-out	6	24	31	44	**105**

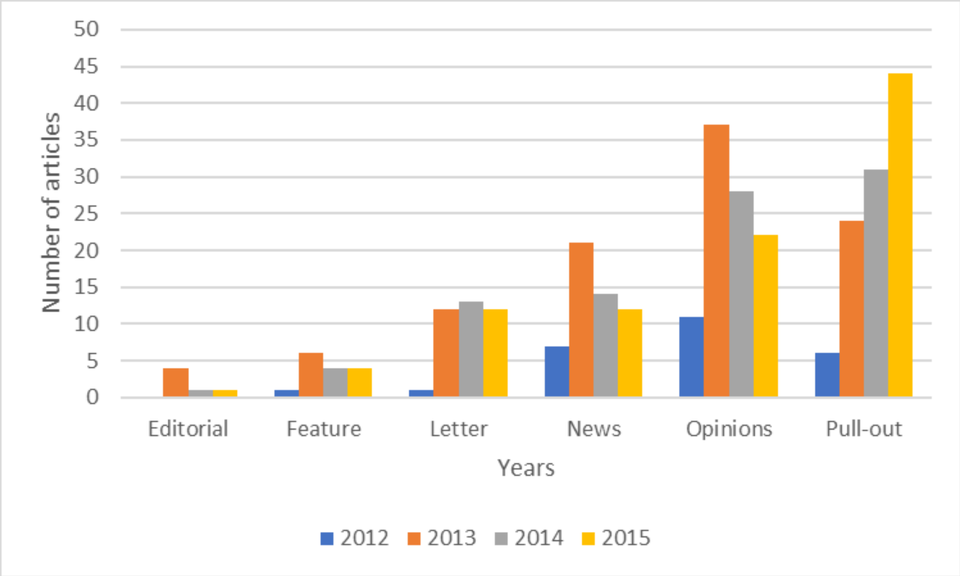

Figure 5.1: Trend of media coverage of biotechnology by format

The bar graph in Figure 5.1 above shows that all category formats peaked in 2013, when the Bill was first presented in Parliament. The opinion category recorded the highest number of articles, although it was later overtaken by the pull-out, which maintained a gradual increase in number of articles from 2012 to 2015. In the beginning, the gradient of the opinion bars is identical to that of the editorial, news, feature and letters, but the opinion bars later maintain a steady rise as other bars fall. The statistics and the bars illustrate that the public tended to respond to a spike of news with multiple opinions to the editors.

In the press, the editorial is one of the most-read sections and tends to draw the attention of policymakers. For this reason, issues evaluated as "editorially important are likely to be given greater prominence" by running them on the front page (or back page for sports), making them page or section leads and in some cases accompanying them with a photograph (McDaniel, Lown & Malone, 2017:3. The fact that biotechnology was given only six editorials in four years suggests that the issue is side-lined in the pecking order. Further, the study breaks down the distribution of the news articles across the four years in Table 5.3.

Table 5.3: Six-month distribution of news articles across period of study

	Publication	**January-June 2012**	**July-December 2012**	**January-June 2013**	**July-December 2013**	**January-June 2014**	**July-December 2014**	**January-June 2015**	**July-December 2015**
News	***Daily Monitor***	4	0	6	12	6	6	5	0
	New Vision	0	3	1	1	1	1	5	2

From Table 5.3, the news trend seems to suggest that the *Daily Monitor* is more inclined toward covering biotechnology than the *New Vision*. The *Daily Monitor*'s news coverage seems to provide a consistent trend of rise, peak and stability before dropping to infinity. At a point when the *Daily Monitor*'s stories were increasing, the *New Vision* consistently posted fewer stories. Strikingly, the two publications covered biotechnology equally from January to June 2015, but thereafter the *Daily Monitor* spent a whole six months without a news story on biotechnology. Hence, the two publications are inconsistent in their news coverage of biotechnology, as demonstrated in the bar graph in Figure 5.2 below. Although most of the letters were against GMOs, the *Daily Monitor* continued its coverage, a sign that it is more aware of scientific developments, but also more liberal than the *New Vision.*

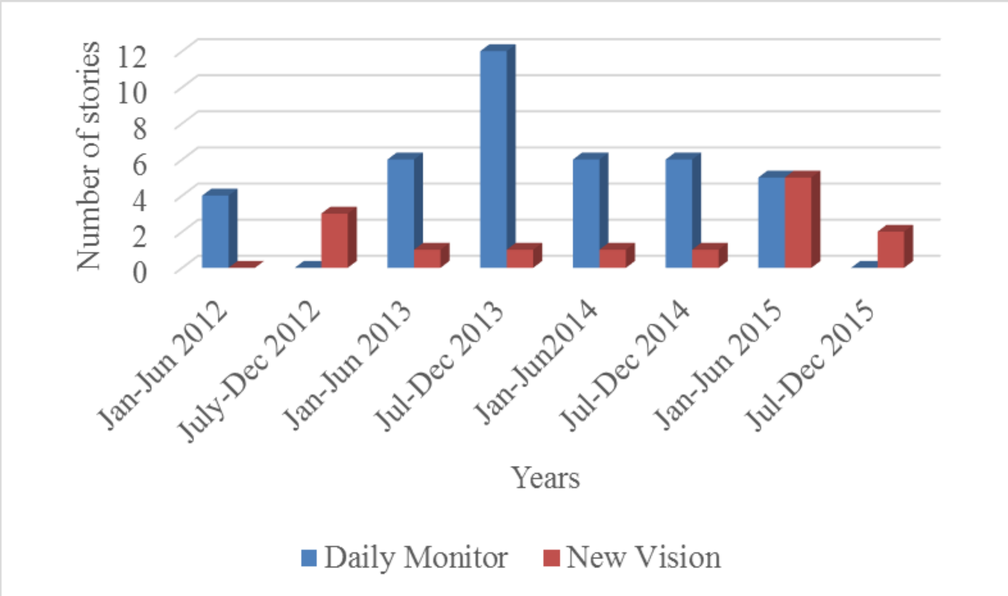

Figure 5.2: The distribution of news stories across the years

From the content analysis and in-depth interviews, it was clear that 2013 had a lot of activity in line with the Bill. In that year, the Bill was presented to Parliament for the first time. In the same year, MPs visited the Monsanto headquarters in St. Louis, Missouri to orientate themselves with the technology they wanted to legislate on. Activist B (2017), who claimed to have been following discussions on GMOs for close to two decades, confirmed that, "from 2013 there has been consistent debate on the Bill", hence the many opinions in Figure 5.2.

Table 5.4: Publication, size of article and format over study period

Format	Size								
	Brief	Ear-piece	Full-page	Half-page	One-third	Quarter	Spread	Three-quarter	Total
Editorial: *Daily Monitor*	1				0	2			3
New Vision	0				1	2			3
Total	**1**				**1**	**4**			**6**
Feature: *Daily Monitor*			5	3		1	1	1	11
New Vision			2	0		2	0	0	4
Total			**7**	**3**		**3**	**1**	**1**	**15**
Letter: *Daily Monitor*	11			0		16			27
New Vision	4			1		6			11
Total	**15**			**1**		**22**			**38**
News: *Daily Monitor*	17			8	1	18		0	44
New Vision	0			0	1	7		2	10
Total	**17**			**8**	**2**	**25**		**2**	**54**
Opinions: *Daily Monitor*	8		2	26	0	16	1	1	54
New Vision	2		2	17	2	16	0	6	45
Total	**10**		**4**	**43**	**2**	**32**	**1**	**7**	**99**
Pull-out: *Daily Monitor*	6	2	17	28		37	2	12	104
New Vision	0	0	0	0		1	0	0	1
Total	**6**	**2**	**17**	**28**		**38**	**2**	**12**	**105**
Total: *Daily Monitor*	43	2	24	65	1	90	4	14	243
New Vision	6	0	4	18	4	34	0	8	74
Total	**49**	**2**	**28**	**83**	**5**	**124**	**4**	**22**	**317**

5.2.2 Publication, size of article and format

From Table 5.4, it can be seen that about 40% (n=124) of the stories were quarter-pagers; 26% (n=82) were half-pagers; and 9% (n=8) were full-pagers. About 16% (n=49) were briefs, although there was a notable 1% centre spread, published by the *Daily Monitor*. In all cases, the *Daily Monitor* published more stories because of its pull-out, *Seeds of Gold*, which dedicated many pages to biotechnology. For instance, of 22 three-quarter stories, the *Daily Monitor* published 64% (n=14). In *Seeds of Gold*, the *Daily Monitor* dedicated a lot of space to biotechnology and agriculture, hence differing from the *New Vision*, which hardly ran any articles on biotechnology in its agricultural pull-out, *Harvest Money*.

In the in-depth interviews, Journalist C explained that biotechnology and other science stories must make economic sense for the newspapers to cover them.

> It tells you that as media we still think that that kind of news is at the periphery … The public itself is not prepared for a science story. Such content does not sell (Journalist C, 2017).

Journalist A (2016) stated that "sometimes the money bit outweighs the information bit". Journalist E (2017) echoed this when he argued that a "media house is based more on business than science".

Further, the Clerk to the Parliamentary Committee on Science and Technology (Clerk, 2017) contended that:

> … in Parliament, we don't request journalists to come and cover committee meetings, however journalists follow what sells to them and this biotechnology subject is little known in our country… it's not an exciting topic, you journalists are found of making, following up on who has stolen what and yet those are also still allegations until proved in courts of law.

The tendency among journalists to find information that will interest their readers or audience on multiple platforms seemed to be a key driver in the biotechnology debate. Scientist D (2017) seemed to refer to this opportunism:

> When the topic now is GMO he [journalist] will run to you as much as possible, but now that it is off topic and you have an issue, stories [opinions/letters] never come out.

5.2.3 Nature and basis of coverage

As many as 63% (n=199) of the articles were issue-based and 37% (n=118) were event-based. A disclaimer in these statistics is that 75% (n=149) of the issue-based articles were opinions. Of the 54 news articles, only 17% (9) were issue-based. Other news articles were event-based, with opportunities for writing presented by press conferences, press releases, meetings, scientific studies, announcements and commemorations in the form of thematic days. Based on the content analysis and in-depth interviews, most of the events were (activities) organised as meetings by NARO, the Uganda National Council of Science and Technology (UNCST), Parliament and anti-GMO activists. Other activities included sponsored training programmes and local and international trips for journalists. The journalists were simply invited to the training programmes, but their stories invigorated readers to write opinions in the newspapers. It was common to find opinions alluding to published stories. In the in-depth interviews, the journalists acknowledged that their organisations neither had specific policies on covering science nor desks dedicated to that purpose. Additionally, the media houses hardly provided any facilitation to covering this beat. Such a scenario left the journalists vulnerable to their sources, which exploited the lacunae by organising events during which they 'facilitated' the reporters. A comparison of the nature of coverage is presented in Table 5.5.

Table 5.5: A comparison of the nature and the basis of the articles for the *Daily Monitor* and the *New Vision*

Basis		**Newspaper**	**Nature**		**Total**
			Event-based	**Issue-based**	
Investigation		*Daily Monitor*	18	21	39
		New Vision	2	1	3
	Total		20	22	42
Press conference		*Daily Monitor*	6		6
	Total		6		6
Press release		*Daily Monitor*		1	1
	Total			1	1
Meeting		*Daily Monitor*	39	9	48
		New Vision	4	1	5
	Total		43	10	53
Scientific study		*Daily Monitor*	3	3	6
		New Vision	1	0	1
	Total		4	3	7
Interview		*Daily Monitor*	2	3	5
		New Vision	3	0	3
	Total		5	3	8
Announcement		*Daily Monitor*	4	2	6
	Total		4	2	6
Opinion		*Daily Monitor*	8	95	103
		New Vision	8	53	61
	Total		16	148	164
Commemoration		*Daily Monitor*	14	4	18
		New Vision	1	0	1
	Total		15	4	19
Other		*Daily Monitor*	2	2	4
	Total		2	2	4
Meeting & opinion		*Daily Monitor*	1		1
	Total		1		1
Scientific study & opinion		*Daily Monitor*		2	2
	Total			2	2
Investigation & interview		*Daily Monitor*	1	2	3
	Total		1	2	3
Meeting & commemoration		*Daily Monitor*	1		1
	Total		1		1
Grand total		*Daily Monitor*	99	144	243
		New Vision	19	55	74
	Total		118	199	317

On facilitating the reporters, one respondent noted:

> But the local media are doing badly, such that if I want to woo them I call them for a meeting, and I facilitate them and give them whatever information … and you know sometimes you don't bite the hand that feeds you (Activist A, 2017).

The activists contended that the pro-GMO organisations, including the UNCST, NARO and multinational seed company Monsanto, took advantage of their big funding to bribe journalists, both directly and indirectly, to give them positive coverage. Moreover, it is these very organisations that had the financial muscle to organise training sessions for science journalists.

> Most times when you engage certain media, they give a very small quote about the potential problem of GMOs. But they will write a full page about the benefits, because every time they write an article there is something they get... those corporations brainwash our media (Activist C, 2017).

The journalists rose to the challenge:

> The anti-GM groups have had their voices and what they say is reflected in the media; it's been given space. But when you interact with them, they think the media shouldn't have said anything about what the scientists who do genetic engineering are doing (Journalist E, 2017).

Table 5.6: Comparison of coverage by prominence between the two newspapers

	Prominence by position						
Publication	**Edition lead**	**Editorial**	**Lead opinion**	**Letter of the day**	**Page lead**	**Others**	**Total**
Daily Monitor	2	12	10	44	76	99	243
New Vision	2	3	11	10	25	23	74
Total	**4**	**15**	**21**	**54**	**101**	**122**	**317**

Table 5.5 reveals that, in 62% of the cases, biotechnology was given emphasis by placing it as an edition lead (n=4), editorial including the pull-out (n=15), lead opinion (n=21), letter of the day (n=54) or page lead (n=101). It is only in 38% (n=122) of the cases that biotechnology was

hidden under others, a category used in this section to identify letters other than letter of the day and lead article in the different sections of the newspapers. Chiefly, the letters to the editor and opinion pages provided the general public an avenue to vent their opinions in favour of or against GMOs. The articles were essentially emotive. Articles in favour tended to describe GMOs as a solution to challenges of food. Terms such as "renegade scientists", and "cancerous," "strange," "demonic" and "problematic" products were often used in opinion pages to describe the biotechnologists and their products respectively, by those opposed to the science. Other writers associated GMOs with anaemia, obesity, miscarriages, and damage to the liver, kidney, spleen, and eyes.

All the journalists interviewed for this project highlighted this difference in coverage. When asked to explain, an editor at the *Daily Monitor* argued that content on biotechnology was not a priority for the newspaper.

The reasons for the *New Vision's* low coverage ranged from economic sense on the part of the media house, to emotions in the newsroom and the attitudes of individual editors.

> … five six years ago [2012] when I started, … I found it very hard … mere talking about biotechnology … ha ha … those people would want to kill us, even in newsrooms … so that partly explains why (Journalist F, 2017).

Journalist J (2017) narrated how one journalist at the *New Vision* was forced into self-censorship on the beat because of being mocked in the newsroom.

> … but the editor kept on teasing him. Monsanto bought you and what and what, and he lost interest so [Which editor?] Oh I don't want [to tell you]. I kept on. My understanding was it was like a joke, but [name withheld] took it seriously.

The experience of Journalist A, also a broadcast editor and stringer for a foreign publication, could apply to the two newspapers in the age of multimedia journalism. She explained how stories on topics such as biotechnology are left out:

> … a science story that will be taken in is if there's a disease outbreak. That is breaking news. Disease outbreak has killed so many ... but if it's a research story, someone [editor] will say, agriculture will come in towards the end [if there is time/space] (Journalist A, 2016).

Condensing these anecdotes suggests that the media are monetised to such an extent that science stories have to compete for space like any others in a capitalistic economy. Without a sanctioned science desks in the newsrooms, stories on subjects like biotechnology are seen as trivial, only to command space and voice when they are sensationalised to fit the political economy of the media.

Table 5.7: Gender of the author

Gender		**Author of the article**					**Total**
			Generalist	**General public**	**Specialised journalist**	**Specialist**	
Both female and male		*Daily Monitor*	1	3	0	1	5
	Total		1	3	0	1	5
Cannot tell		*Daily Monitor*	1	4	0	0	5
	Total		1	4	0	0	5
Female		*Daily Monitor*	11	4	42	6	63
		New Vision	2	5	1	3	11
	Total		13	9	43	9	74
Male		*Daily Monitor*	54	36	58	14	162
		New Vision	7	33	7	13	60
	Total		61	69	65	27	222
Undisclosed		*Daily Monitor*	0	8	0	0	8
		New Vision	0	3	0	0	3
	Total		0	11	0	0	11
Total		*Daily Monitor*	67	55	100	21	243
		New Vision	9	41	8	16	74
	Total		76	96	108	37	317

From Table 5.7 above it can be seen that, overall, 70% (n=222) of the articles were written by men only, whilst 24% (n=74) were written by women only. Shared by-lines constituted about 2% (n = 5), but in about 3% (n=8) of the articles the gender of the authors was unidentifiable, either because the articles did not have by-lines or the coders could not categorise the gender of the author based on the name alone.

In terms of specialisation, 34% (n=108) of the articles were written by specialised journalists and 23% (n=76) by generalists. Articles written by specialists in different fields of science, including communication officers, amounted to 12% (n=37), a sign that science institutions are beginning to participate in the debate on biotechnology. A significant 31% (n=96) of the articles came from the public, an indicator of public interest in biotechnology.

Of interest is that 98% (n=42) of the articles written by specialised female journalists were published in the *Daily Monitor*. Only 11% (n=7) of the articles reported by specialised male journalists were published in the *New Vision*. Again, 85% (n=11) of the articles written by female generalists were from the *Daily Monitor* compared to only 12% (n=7) of the articles by *New Vision* male generalists. The difference in the general public's contribution to articles appears marginal, with 56% (n=5) of the *New Vision*'s articles coming from female readers and 48% (n=33) of the *Daily Monitor*'s articles coming from male readers.

Table 5.8: Origin of the story

Publication		Origin				Total
		Foreign	**Local**	**Local and foreign**	**Undisclosed**	
	Daily Monitor	7	232	3	1	243
	New Vision	8	59	7	0	74
Total		**15**	**291**	**10**	**1**	**317**

From Table 5.8 above, it is clear that the *New Vision* published 53% (n=8) of the foreign articles, while the *Daily Monitor* published 80% (n=232) of the local articles. Again, the *New Vision* published 70% (n=7) of articles with local and foreign writers. Also, worth noting is that one article could neither be described as local nor foreign, since the actors and the author were anonymous. Although most articles did not indicate a foreign source, in-depth interviews revealed that the debate in the newspapers had external influence. Indeed, all the sources interviewed indicated that they had had international experience in the form of trips to other countries. The interviewees tended to site Burkina Faso for both good and bad experiences with GMOs. Other countries often mentioned included South Africa, the USA, Brazil, Canada, the United Kingdom; Ghana, Kenya and Tanzania. Interviewees also made reference to the Cartagena Protocol, health issues around the world, and Monsanto. Journalists in particular mentioned attending training workshops and fellowships in other countries.

All the journalists interviewed had either attended a training session on biotechnology abroad, or had attended a training programme organised locally but facilitated by at least a foreign expert. Six journalists mentioned using online resources, especially the "Google" search engine, to access materials from both pro- and anti-GMO activists. Two journalists mentioned receiving e-mails containing science reports. At the same time, the respondents mentioned reading articles written in Ugandan newspapers by Dr Opio Oloya, a Ugandan based in Canada, and Prof. Calestous Juma, an American professor of agricultural innovation. Some journalists mentioned reading international journals to get information. This may be a reason why activists are wary that the proposed Bill is alien to Uganda. Activist A (2017) argued that their problem is that the Bill is not pro-poor, but "instead [it is] coming to promote the interest of the multinationals". Issues such as labelling, patents and contamination, which have driven the debate in developed countries, tend to drive the debate in Uganda too, an indicator that the debate risks degenerating into a raucous fight, thereby obscuring national interests. The amorphousness of the debate is echoed in the terms used in the debate as presented Table 5.9.

Table 5.9: Articles by key words

S/N	**Key words in articles**	**Publication**	
		Daily Monitor	***New Vision***
1	Biotechnology	121	6
2	GMOS	39	12
3	Genes	1	0
4	Other	2	0
5	Biotechnology and GMOs	64	43
6	Biotechnology and genetic engineering	1	0
7	Biotechnology and other	2	0
8	GMOs, bioethics, super weeds and contamination	1	0
9	Biotechnology, GMOs and contamination	1	0
10	GMOs and other	3	1
11	GMOs and contamination	1	2
12	Biotechnology, GMOs and genes	1	2
13	Biotechnology, GMOs, genes and genetic engineering	1	0
14	Labelling and contamination	1	0
15	Biotechnology, labelling and contamination	1	0
16	Biotechnology, GMOs and DNA	1	0
17	Biotechnology, GMOs, genetic engineering and DNA	1	0
18	Biotechnology, GMOs and genetic engineering	1	0
19	GMOs, super weeds and contamination	0	1
20	Biotechnology, GMOs, genes, and contamination	0	1
21	GMOs, labelling and contamination	0	1
22	Biotechnology, GMOs and other	0	1
23	GMOs and genes	0	1
24	Biotechnology, GMOs, genetic engineering, contamination and other	0	1
25	GMOs, labelling and super weeds	0	1
	Total	**243**	**74**

From Table 5.9, it can be seen that, overall, at 62% (n=195), the *Daily Monitor* was about four times more likely to use the term "biotechnology" in its articles than the *New Vision* (17%, n=53). Both publications used the acronym GMOs alone in 16% of their stories. At 58% (n = 43), the *New Vision* was more likely to mention both the process and the products (biotechnology and GMOs), more than twice the number of times the *Daily Monitor* mentioned the two terms. Therefore, the inclusion of biotechnology and GMOs as key words in the search for articles was apt.

No stories solely had genes, genetic engineering, DNA or bioethics as the theme. Activist B (2017) argued that the Bill talks about a "broader subject under a narrow context". The Clerk (2017) confirmed that:

> The law that is before Parliament is related to agricultural biotechnology, although it is called the National Biotechnology and Biosafety Bill. It is aiming at ensuring safety of agricultural biotechnology development. The talk now is GMOs. There are so many sciences [related to biotechnology] they have told us, all those have to be regulated. So, we have to leave room for provision for such new developments.

It appears then that the media are picking the nomenclature of the stakeholders. The influence of the actors could explain why many writers used biotechnology and GMOs in the same story.

5.2.4 Articles by focus

At least 75% (n=182) of the *Daily Monitor*'s stories focused on agricultural production and regulation. More than 47% (n=35) of the articles published by *New Vision* had a similar focus. Taken together, 12% (n=37) of the stories mentioned health as an issue. The effects on the environment received the same score, a sign that newspaper coverage largely gives human health and environmental protection equal weight. Generally, 37.2% (n=118) of the stories mentioned regulation as an issue, with a significant 57% (n=67) of all stories in this category focusing on only the law. At least 5% (n=15) of the total number of stories focused on labelling. Again, 4% (n=14) of the stories focused on other issues, such as the moral worth of biotechnology. Worth noting is that it was common to find four issues in an article, as illustrated in Table 5.9.

In terms of context, 27% (n=85) stories focused on legislation, and 25% (n=77) looked at biotechnology as an innovation. Therefore, overall legislation on biotechnology as an innovation to produce GMOs accounted for more than half of the stories published by the two papers, but 86% (n=73) of the stories were published in the *Daily Monitor*.

Both publications covered the 2008 policy in less than 2% of all their stories. Dissemination, application of biotechnology, ethics, politics, nutrition, religion and culture individually scored less than 5% of the overall coverage.

From the submissions of the interviewees, the reasons for mixing issues appear to emerge from the packaging of the Bill under discussion. From its title, the Biotechnology and Biosafety Bill 2012 promises more than it delivers. More specifically, the Bill is about GMOs. However, because of its title, the general public, which rarely reads such bills in their entirety, has found it easy to write and talk about any issue related to this subject, even if such an issue is remote in the proposed law. Although all interviewees agreed that the media are the main source of information, Activist C (2017) faulted media practices as avenues for the distortion of issues related to GMOs.

> The main source of information is rumours they hear on radio, …people who are not informed, confusing hybrids with GMOs, confusing improved [seeds] with GMO… the media would play a key role, only if they were impartial and unfortunately most of our media is already misinformed, is ignorant or is just surviving, if they can be given anything, then they will write what you want (Activist C, 2017).

Some media practitioners held similar views to this activist. They argued that:

> … some of them [journalists], not that they lack the knowledge; they are not willing to read about biotechnology (Journalist A, 2016).

> we lack reporters who really understand the subject. Journalists need training to know what to look out for (Journalist C, 2017).

5.2.5 Articles by tone

The tone used in the articles was largely positive, as illustrated in Table 5.10 below.

Table 5.10: Articles by tone

Publication		**Tone**				**Total**
		Balanced	**Negative**	**Neutral**	**Positive**	
	Daily Monitor	24	59	40	120	243
	New Vision	8	32	13	21	74
Total		**32**	**91**	**53**	**141**	**317**

From Table 5.10 above it is clear that 43% (n=32) of the content of *New Vision*'s was negative compared to that of the *Daily Monitor* (25%, n=59). On the one hand, almost half (n=120) of all the content published in the *Daily Monitor* was positive, but only 10% (n=24) was balanced and 16% (n=40) could be regarded as neutral. On the other hand, 28% (n=21) of the *New Vision*'s content was positive and about 11% (n=8) could be described as balanced, with about 18% (n=13) of the content found to be neutral. Nearly 75% (n=79) of the content published in the *Daily Monitor's* pull-out was positive and less than 4% (n=4) was negative. The other stories were either balanced or neutral. A total of 68% (n=59) of the negative stories were published by the *Daily Monitor*. Considering that only 27% (n=32+53) of the content was either neutral or balanced, at least 83% (n=91+141) of the content had an element of bias.

These findings confirm an earlier study, which posited that "the rise in reaction against a scientific technology appears to coincide with a rise in quantity of media coverage, suggesting that media coverage tends to elicit a conservative public bias" (Mazur, 1981:109). This analysis is emphasised Chapter 6, where change in a source of information is linked to developing a negative rather than a positive perception of GMOs.

Journalist I argued that science should be reported as development rather than as political journalism, which tends to be sensational. The *Daily Monitor*'s *Seeds of Gold* takes a development journalism approach to stories. The journalist stated:

> In fact, where I see people talking their controversy, I withdraw. Because I have been trained in reporting scientific issues, so I know what I am looking for [ok] I wouldn't even go to someone who is imposing this technology without backing it. I will go to the laboratory and see how this scientist is doing this thing. If you start looking at balancing you will never write any science piece. I report the facts the way they are because they are facts that have been qualified by an organisation like FAO, the World Health Organisation, the American Academy of Science. If really all these people say that these crops have been tested and they don't see a problem with them, I don't see a need to go to Action Aid to interview somebody who is from the humanities, a lawyer who is opposing the science without understanding it (Journalist I, 2017).

Journalist H (2017), also an editor, argued that sometimes they ask people with opposing views on biotechnology to write opinions and the publications run them either on the same page, in the same publication or in response to a given opinion.

Other journalists submitted that:

> You give the side of the story of those people who are pushing for the policy, for the technology and then you get reactions from Parliament and then you're able to get what we call a balanced story (Journalist G, 2017).

> When the biotechnology bill came up, as *Monitor* we covered it from Parliament and we even continued to cover the sensitisation meetings with MPs. Even MPs did not understand what this biotechnology bill sought to achieve because it was a private member's bill. It wasn't a government sponsored bill. So, it faced a lot of challenges. We thought that was a national matter, so we covered it. But somehow as *Monitor*, we were covering two sides. There were others who were opposed to it, others were in favour of that bill. So, as *Monitor* we took a decision. I must admit that the same matter came in one of the editorial meetings that how can *Monitor* cover such the bill? They were divided. Others were saying this is the way to go, other were saying no this genetically modified food will destroy our farming. So, it was a disputed bill, even at *Monitor* level. The editors did not agree on how to cover, but somehow for us who were on the front line we kept publishing stories (Journalist C, 2017).

However, scientist B (2017) criticised the tendency of some journalists to weigh their well-researched ideas against other arguments rather than peer reviews.

> We keep asking them, what balance do you want from a fact? But they indeed, still go out there to look for someone who is saying otherwise.

5.2.6 Articles by controversy

Articles were also analysed to establish the level of controversy in reporting about GMOs. Again, the emphasis was on editorial, feature, letters, news, opinions and the pull-out. The results are illustrated in Table 5.11.

Table 5.11: Articles by controversy

Format		**Publication**	**Controversy**		**Total**
			Controversial	Non-controversial	
Editorial		*Daily Monitor*	1	2	3
		New Vision	1	2	3
	Total		**2**	**4**	**6**
Feature		*Daily Monitor*	2	9	11
		New Vision	0	4	4
	Total		**2**	**13**	**15**
Letter		*Daily Monitor*	16	11	27
		New Vision	1	10	11
	Total		**17**	**21**	**38**
News		*Daily Monitor*	21	23	44
		New Vision	4	6	10
	Total		**25**	**29**	**54**
Opinions		*Daily Monitor*	16	38	54
		New Vision	2	43	45
	Total		**18**	**81**	**99**
Pull-out		*Daily Monitor*	16	88	104
		New Vision	0	1	1
	Total		**16**	**89**	**105**
Total		*Daily Monitor*	72	171	243
		New Vision	8	66	74
	Total		**80**	**237**	**317**

According to Table 5.11 above, at least 25% (n=80) of all the articles published were found to be controversial. More than 46% (n=25) of news (almost one in every two news stories) published was controversial. This means that more than half of the stories tended to take/have a clear position – negative or positive, and mentioned positives and risks. Another key finding is that one in two editorials was controversial. Over 90% (n=10) of the letters in the *New Vision* were non-controversial. Overall, 45% (n=17) of the letters were controversial and more than half of them were in the *Daily Monitor*.

From the in-depth interviews, it was evident that the subject of GMOs is controversial at several levels of society, including newsrooms. In an attempt to provide balance, the editors decided to give their readers an opportunity to express themselves on the opinion and letter pages. On the one hand, the *Daily Monitor* continued running the controversial stories in addition to opinions from the readers, even with a divided newsroom. On the other hand, the *New Vision* reduced its coverage, as some reporters were intimidated out amidst accusations of bias from some editors, as stated earlier.

5.2.7 Articles by sources quoted

Regarding news sources, in at least 39% (n=124) of the articles the source of information was missing. The articles were based on the writer's knowledge of the subject, including heresy or beliefs in conflict with science. Only 27% (n=86) of articles quoted a biotechnologist as a source of information. When aggregated, 44% (n=24) of the articles that quoted biotechnologists were news stories. The biotechnologists were usually identified as crop breeders or as scientists or experts from the known research institutes. Only 11% (n=35) of the articles quoted other scientists, such as entomologists, pathologists, soil scientists and agricultural economists, on issues of biotechnology. At least 24% (n=13) of the news articles were published with non-biotechnologists as sources. All included, only 9% (n=29) had government officials as news sources. These were usually ministers or directors in charge of science and technology. Government officials were usually quoted when the event required opening and closing or during commemorations. Approximately 8% (n=25) of the sources were from civil society. An equal percentage (8%) of the voices of activists often appeared in opinion pages, consultation meetings and event-based stories, where they were proposing alternatives to GMOs. A low 7% (n=22) of voices came from the general public, whose voices usually appeared in the letters and letter of the day. A deeper analysis showed that most of the articles were source-generated, or the actors, individually or through their organisations' public relations and outreach departments, influenced the coverage by staging the events, choosing the speakers and therefore the angle. The percentages are graphically illustrated in a funnel chart in Figure 5.3.

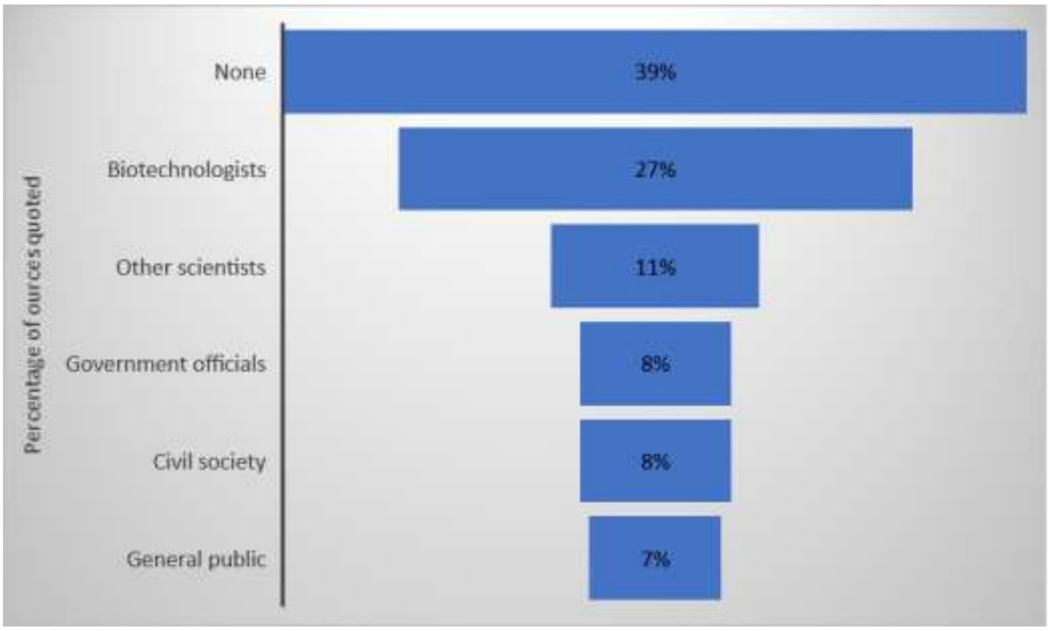

Figure 5.3: A funnel chart showing the progressively decreasing frequency of sources quoted

As illustrated by the funnel, biotechnologists were the priority sources of information when a writer wanted to quote someone in an article. However, their chances were only slightly double those of other scientists who were not experts in biotechnology. Articles without any source were 1% (n=3) more likely to appear in the press than those citing both biotechnologists and other scientists combined. Of the five possible sources of news stories focused on in this study, the general public stood the least chance of being quoted. It, therefore, is not surprising that activist B (2017) argued that the major source of information for the public is “rumours”. Thus, these findings confirm that most sources of information quoted in the pro-and anti-biotechnology contest are “usually partisan” (Mazur, 1981:109). Moreover, peripheral views “may be lent credibility in mass media”, even though the sources may not be trustworthy (Dearing, 2016:341). Media access, therefore, is a recipe for further controversy, since both scientific and maverick ideas flow through the same channels.

5.2.8 Articles by gender of sources quoted

The study took stock of the gender representation of the sources. Generally, nearly half (n=149) of the articles were based on reports and, therefore, the category gender description was not applicable. Approximately one third (n=92) of the articles had male sources. Only 5% (n=16) of the stories had females only as sources. At least 16% (n=51) of the articles had both male and female sources in the same article. In some cases, however, it was not possible to identify the gender of the sources based on names only. This was most especially so where the first name and the surname of the sources could be shared by both gender as a common combination. The findings are elaborated on in Figure 5.4.

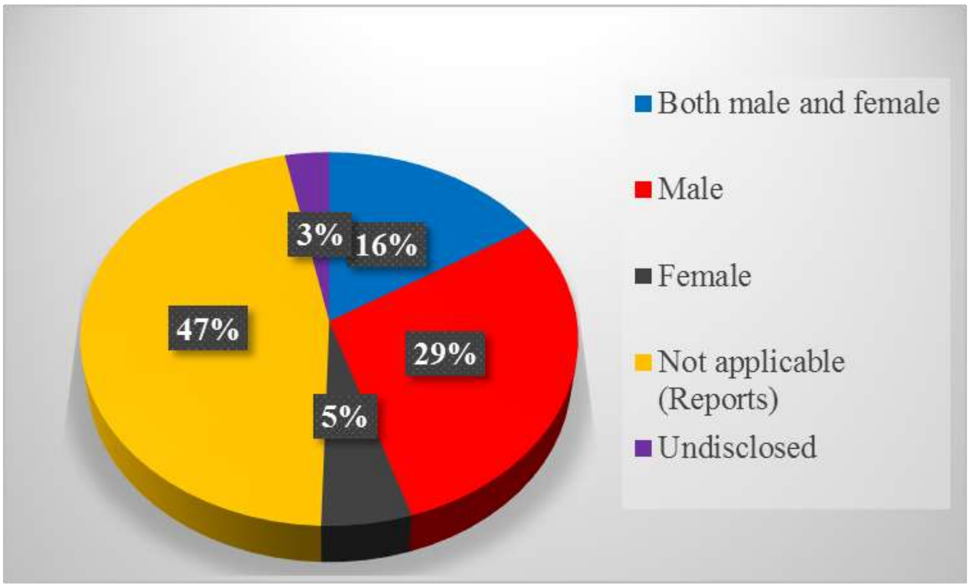

Figure 5.4: Gender and sources quoted

From the chart in Figure 5.4, men alone (29%, n=92) were almost six times more likely to be quoted in articles on biotechnology than women alone (5%, n=17). But women's chances of being quoted in articles more than tripled if they were to be cited in the same story with men (16%, n=51). Yet the chances of a biotechnology story substituting a human face with a report were almost half. Thus, many articles were based on reports alone (47%, n=147).

In the in-depth interviews, the editors argued that the issue was so sensitive that it was better left to their audience to express themselves. Indeed, some scientists and activists interviewed for this project reported having contributed articles to the newspapers. Journalists B, G, I, and J averred that sources are chosen based on their relevance and not necessarily on their gender. Although many female biotechnologists were found in the laboratories, the most senior positions in this line of science were occupied by men. Considering that prominence is a key news value, as discussed in Chapter 2, journalists found it easy to quote the male scientists.

5.2.9 The use of pictures

There was noticeable use of pictures to accompany biotechnology stories. The pictures were categorised as establishment photos, mugshots and standalones.

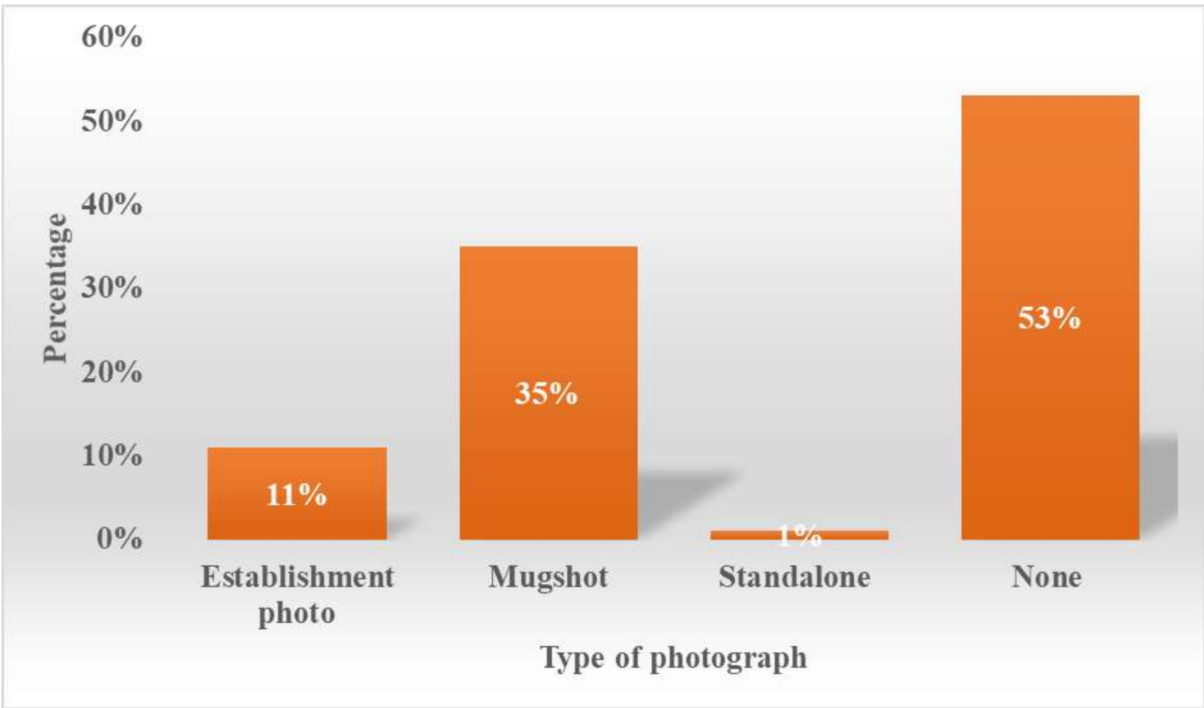

Figure 5.5: The types of photographs used to accompany biotechnology stories

From Figure 5.5 above, it is clear that articles on biotechnology stood a 53% (n=168) chance of running without a photograph. Generally, articles with photographs were few and far between. The newspapers tended to use establishment photographs (long shots) of scientists or farmers in gardens or crops under confined field trials. Mugshots (close-ups) of individuals quoted were rare, but an iconic photo of a tomato being injected with a needle was common. The picture could easily create a negative perception of biotechnology, since pictures can tell stories alone, or draw attention to stories by directing readers when used in combination with text, especially in a tabloidising news industry like that of Uganda.

Figure 5.6: An iconic photo of a tomato newspapers used to depict how GMOs are made (Credit: Google Images)

The editors explained that the tomato in Figure 5.6 was only used in the absence of other accompanying pictures, especially for readers' letters to the editor. Readers are not required to submit photos when they are expressing themselves on an issue. The previous sections of this chapter have demonstrated that the media has a role in the biotechnology debate. This role is explained in the subsequent section.

5.3 Question 2: What is the role of the press in the biotechnology debate?

The study identified four roles of the media. These are: awareness, education, sustaining debate and an issues culture. Although these roles are related, it was necessary to make a distinction between them for emphasis.

5.3.1 Awareness

From the content analysis, it became clear that the role of newspapers is to create awareness by providing the relevant information to all stakeholders. The *New Vision* and the *Daily Monitor* combined published 317 biotechnology-related articles over a period of four years. Stories were mainly based on press conferences, meetings, scientific studies, investigations and announcements as ways of sensitising the public about biotechnology and GMOs. The Secretariat of the Convention on Biological Diversity (2000) Cartagena Protocol requires countries to sensitise their public as much as possible before GMOs are commercialised. Indeed, some activists, journalists and scientists alluded to this international mandate (see anecdotes below).

> I am happy the security guys are also saying wait a minute, we also need to be part of this debate; the economists are coming to debate; the farmers are coming to debate; the consumers are coming to the debate. The curve of awareness is growing (Activist B, 2017).
>
> They can put up a budget in their research proposals to include media awareness, may be trips for journalists. UBIC [Uganda Biosafety Information Centre] has helped. They want their law to pass in Parliament, they are focusing on Parliament and journalists (Journalist F, 2017).
>
> They want to control the market by creating awareness so that we can change our laws to facilitate the commercialisation of their trade. To that effect, it becomes a bit tricky

> to people who are trying to protect public interests, but at the same time highlighting the goodness of biotechnology (Journalist G, 2017).
>
> This new Ministry [Science and Technology] once it starts to create the awareness, and the need for our science community to protect what they discover. I think it will have done us very good, because that is how almost all the other countries have managed to develop through their innovations, to protect them and then earn maximally from them for some time (Scientist B, 2017).

Studies indicate that the media play the role of framing policy issues and highlighting the magnitude to which ethical issues are perceived as important. The media serve as channels for introducing ethical issues to the public, hence “raising public (and policy maker) concerns that may not have existed prior to the media exposure” (Caulfield, 2005:223). Moreover, awareness is central to uniting the stakeholders to debate the shared challenge of biotechnology (Mnaranara, Zhang & Wang, 2017; Nisbet, 2009). Therefore, media presentation of a technology can shape how the public view the technology and frame the corresponding debate.

5.3.2 Education

In a way, many of the articles published were educating the public about biotechnology and GMOs to reduce the misperceptions about GMOs. Other articles were simply biased. Interviewees agreed that the principles of biotechnology can apply to medicines (especially immunisation), cosmetics, detergents, soaps, industrial sciences and food (GMOs), among other purposes.

> The umbrella body for science and technology in Uganda [should] educate the public about biotechnology. So many people do not know about biotechnology, when you talk of biotechnology, people run straight to GMO, and yet GMO is just a small component of biotechnology (Clerk, 2017).
>
> Our job is to always keep sensitising, educating the public [about biotechnology] through the media. (Scientist A, 2017).
>
> Agricultural institutions have tried to educate journalists and editors, so during those discussions they also highlight the importance of biotechnology, the fears around it, so by going down there [grassroots] we are able to cover this subject well (Journalist G, 2017).

> If you're not an educated person, then someone will say … ehh which means we can now produce babies on a maize cob? I think we have educated the public, they are getting to know what this science is all about (Journalist I, 2017).

> There are some organisations that try to educate farmers, but you know they have selfish interests, so whichever organisation, will try to drive farmers to their direction (Member of Parliament, 2017:1:4).

Sometimes, education came in the form of statements issued by UBIC and fact sheets about biotechnology issued by the Uganda National Council of Science and Technology. At other times, education was packaged as opinions or letters to the editor. Education is "cardinal" in enabling the public to appreciate and gauge innovations before making informed decisions (Braimah *et al*., 2017:15). However, as stated in Chapter 3 and as will be discussed in Chapter 6, the public prefer a dialogue, where they have a say, to being educated (monologue) through the media. Therefore, level of education needs to be complemented with individuals' motivations to acquire information and express themselves, and press gatekeepers hence the need to find a balance between facts and appeal in the debate.

5.3.3 Sustaining debate (fostering multiple-way communication)

Although talk by policymakers about regulating GMOs started at the beginning of the 21st century (Luganda & Tenywa, 2002; Tenywa & Price, 2003), Activist B argues that the consistent debate started in 2013, after the first presentation of the Bill. The content analysis revealed 317 articles as testimony of deliberations in a debate that has enlisted scientists, legislators, ministers, social scientists, economists, human rights activists, lawyers, security personnel, farmers, consumers, and ecologists, with journalists mediating. At the beginning of the actual debate, "the scientists would give an impression that GMOs [are] a silver bullet, [but] they have slowly started tilting their submissions (Activist B, 2017).

The activists claim that the proponents of GMOs have not defined the challenge of food production in depth. Further, the activists argue that their 'nemesis' hold them at ransom by reasoning that Uganda has a problem of hunger and food insecurity, the cause of which the proponents never discuss to the comprehension of the activists. Activist B (2017) called this a "stampede" in the debate.

> So, I have told you it is politics. When you discuss with our colleagues, they say oh no this is scientific brah brah brah. No, it should be debated by scientists. Listen to the

> scientists please! My dear, your science is on the floor of Parliament, the heaven of politics.

A key aspect is that biotechnology and GMOs are debated interchangeably. This seems to emanate from the nomenclature of the Bill, yet the legal instrument is largely about GMOs. It is clear from the content analysis and in-depth interviews that many MPs and scientists do not understand GMOs. Such a scenario makes consultation with the public very difficult. Another key aspect is that biotechnology is regulated under the UNCST, which hosts the Ministry of Science and Technology (MST). However, the MST operates under the Ministry of Finance. In a way, this misplaces the Bill on agricultural biotechnology, which would best be understood by the Ministry of Agriculture, as it employs the majority of the agricultural scientists under NARO. No wonder then that, when this Bill was first presented in Parliament as a private member's Bill in 2013, it lacked enough support. Journalists who covered Parliament at the time noted:

> We have a divided country, as far as GMO is concerned because government has kept a low profile. Government has not come out to prove that they are interested; it's as if they are not interested in what is happening, or they are interested but they don't want to come out. So, they have also confused the public. What we see is a confused debate (Journalist C, 2017).

> Many people will make the most noise about GMOs, but they don't even know one percent about GMOs. Unfortunately, they are the decision makers and they are the guys who are shouting (Journalist G, 2017).

Accusations and counter-accusations punctuate the opinion pages. In one opinion, a scientist accused civil society for being "ignorant" and misleading the public about GMOs. In a response, an activist used the term "renegade scientists" to refer to crop biotechnologists. The term "renegade" is mainly used in Uganda to refer to soldiers who breach the military codes of conduct. Such soldiers often face court martial, with the options of dismissal or facing the firing squad. In some cases, scientists replied to what they called "false" accusations against them by readers. These accusations ranged from GMOs killing indigenous seeds, causing super weeds and being of poor quality, to destroying their organic agriculture. Other expressions were also used by activists in the interviews. For instance, they argued that GMOs were "frightening", and "not nutritious", "not safe" and put their lives on "tenterhooks", images that did not seem innocent:

> It tells you that people wanted to use the media to bias debate. So, many people would push in their opinion in order to bias Parliament because they knew that Parliament was handling the matter, either they wanted to bias Parliament or they wanted to inform Parliament that hey guys… look, you are against this Bill, but it is important (Journalist C, 2017).

In the in-depth interviews, activists accused journalists of supporting scientists on GMOs.

> They are looking for money. The companies promoting GMO and biotechnology, have a lot of money, and the countries that are there to benefit from the technology. That is the political side of it. Have all the money, to get the media on their side. So, many of the media houses and persons I have talked to have confessed that: You know, we have been told not to run anything that is against GMOs. So, they are under the armpits of corporations. So, media is under siege, and that limits information flow (Activist C, 2017).

Indeed, 60% (n=6) of the journalists conceded to being on the side of the scientists all the time. Their argument is that a science story is never complete without a scientist or a scientific report as a source. This is glaring evidence that scientists and journalists have a working relationship.

> As a journalist who has trained in biotechnology, I believe we somehow have related agendas. We are there to inform the public so that they make informed decisions (Journalist B, 2017).

> We are all working in the end for the same farmers. We have the technology, or the technologies, and they want to relay on the media for mobilisation, but also passing on the information (Scientist A, 2017).

Moreover, a previous study has demonstrated that scribes tend to contact scientists they have confidence in either "personally, or by reputation, or by the stature and proximity of the source's" organisation (Mazur, 1981:109). This closeness tends to be at the core of science reporting, where a few articulate scientists usually dominate the media as the journalists obediently record their arguments for fear of losing important sources of information.

Even then, other reporters seem to claim the principle of balance in sourcing:

> We bring in the civil society that we feel understands the GMO debate better than us. Sometimes we have those that are against GMOs and those that are for the GMOs. So, ours is to throw it to the public for them to weigh from that debate (Journalist A, 2016).

Others cast the net of the controversy beyond the newsroom:

> I don't think the journalists have any agenda, but the people who have other agendas, could be the politicians, civil society people and the scientist. Those are the people who have failed to agree… maybe the scientists need to explain more for people to appreciate what this GMO bill is about (Journalist C, 2017).

> So, it's a basis of equal space to contrasting views (Journalist H, 2017).

Journalist H's argument does not match the statistics from the content analysis, which shows that the majority of the stories were negative, as depicted in Table 5:10. However, on closer inspection, there are instances where the newspapers, especially the *Daily Monitor*, put positive and negative opinions on the same page to ensure that as many sides as possible in the debate were reflected. As observed later in Chapter 2 and the subsequent chapters, such an approach gives rise to the knowledge gap and controversy.

Journalists accused activists of wanting to use them by presenting their unresearched views as scientific evidence against GMOs. They averred that if activists want their ideas to be weighed against those of scientists, they should always present scientific evidence.

Different terms were used to describe the debate on GMOs. These included "distortion" (Activist A:2017); "deception" (Activist B, 2017); "complexity" (Activist C, 2017; Scientist B, 2017; Scientist C, 2017); "opportunistic interaction" (Scientist D, 2017); "complication" (Journalist I, 2017); "fight" (Activist B:2017; Scientist D, 2017), "limited" (Journalist F, 2017), and "tough task" (Scientist D, 2017). These descriptions reflect the sentiments of the actors involved in the debate.

Journalists characterised their relationship with scientists in two parts – before and after familiarisation. They described biotechnologists as an arrogant, mean and secretive group of experts, who think journalists are ignorant, inaccurate and misreport everything they tell them. Thus, the relationship was labelled as that of "traditional enemies" (Journalist G, 2017), "hide and seek, and blame game" (Journalist B, 2017), "confrontational" (Journalist I, 2017), "mistrust" (Journalist H, 2017), "murky, tricky" (Journalist G, 2017), and "hate and love" (Journalist C, 2017). The initial interface between the scientists and journalists was tense, strange and strained by a "fault line" between the laboratory and the newsroom (Franklin, 2010:145). Such a clouded relationship is fragile and makes reporting difficult for fear of annoying the few available sources. A delicate relationship of this kind could explain why the activists are infuriated by the rapport between biotechnologists and some science journalists.

However, after familiarisation with each other, the science journalists, on one hand, describe the relationship as "cordial" (Journalist H, 2017), "collaborative" (Journalist I, 2017), "partners" (Journalist B, 2017) and "good" (Journalist J, 2017). On the other hand, the biotechnologists described the journalists as their "allies" (Scientist A, 2017), "friends" (Scientist B, 2017), and "cooperative" (Scientist C, 2017). Nonetheless, Scientist D (2017) asserted that the science journalists were "unquestioning" and were bound to regurgitate the views from biotechnologists.

This relationship and the resulting coverage suggests that the media platforms are playing both the "watchdog role", of allowing critical issues to trickle to the public, and the "development role", of supporting scientists to enhance their knowledge (De Beer, Malila, Beckett & Wasserman, 2016). While this dual role is healthy in politics, it has the effect of permeating controversy in science by slanting the debate through cherry-picking the issues on which to focus. Nevertheless, the awareness created through the press greases and sustains the debate on the issue of GMOs.

5.3.4 Issues culture

The interpretation of issues tended to coincide with media logic theory, discussed in Chapter 3. Every time a newspaper reported a story on biotechnology or GMOs, the number of responses from readers tended to increase, as indicated in Figure 5.1. Generally, the issues inclined toward regulation of biotechnology, especially GMOs. In the content analysis, the study identified nine key areas, which dominate the debate in Uganda.

a) Regulation
b) Benefits of GMOs
c) Economics of GMOs
d) Knowledge about GMOs
e) External influence
f) Media coverage
g) Risks related to GMOs
h) Politics of GMOs
i) Perception about GMOs

Media coverage tended to concentrate on legislation (regulation), with pro- and anti-GMO MPs as the sources in parliamentary events. However, general public events tended to have biotechnologists and activists as the sources. The biotechnologists were mostly inclined to the use of biotechnology as an alternative to improving agricultural production in the wake of increasing drought and reducing crop yields as hallmarks of climate change. The activists usually emphasised the risks involved in adopting biotechnology as an alternative in farming. Activists accused biotechnologists and the MPs of supporting the Bill for selfish reasons. In the opinion pages, the protagonists were neck and neck, with the pro- and anti-GMO groups alleging that their challengers had external funders. Activists compared biotechnologists pushing the GMO agenda to "crooks", "renegades", "terrorists" and "fundamentalists" who manipulated MPs and journalists without expertise in such science by taking them on trips to GMO-growing countries such as South Africa, Brazil and the USA. The activists attacked the political establishment for deliberately weakening the agricultural sector; failing to respond adequately to climate change warnings by reviving and establishing irrigation schemes; deceiving Ugandans about there being a farming crisis; and pushing for GMOs that cannot thrive without an organised farming/social system. The scientists accused the activists of avoiding the reality, alluding to the fact that Ugandans were already eating GMOs imported in the form of food and medicine, and that the country risked losing out on the benefits of GMOs and importing them without knowing if Uganda did not dvance its capacity to develop and detect GMOs.

In an in-depth interview, an activist elaborated on the mistrust of civil society in the political leaders and technocrats who make public (mis)perceptions about GMOs emotional.

> In the context that our capacity as a developing country is extremely weak. I can say there are many things that are happening. People are mixing ARVs (HIV drugs) in feeds for poultry. I have seen it on farms. And Ugandans are eating that. There is nobody to regulate on that. Now you're going beyond that and you want to go and modify a seed. A seed is the foundation of life, and the moment you modify it and you release it in the environment you might not have control. I am speaking about a county, where we know cassava mites for example was because of the careless actions by our researchers, and cassava mite is in the gardens of farmers in Ugandans, and nobody was held responsible. Our media is not doing us service, to give an impartial debate. This is a geopolitical debate involving multinationals. BSc scientists cannot understand that. The institution responsible for science and the one that is championing GMO discussion, the UNCST, is not worthy leading that debate anymore (Activist C, 2017).

Other concerns were linked to the organisation of government. For instance, while the Ministry of Agriculture is concerned with overseeing improvements in farming in the country, the Ministry of Water and Environment is supposed to develop irrigation schemes. Without sectoral planning and collaborative policy implementation, improvement in agriculture is hard to achieve. The two ministries should be aligned in implementing irrigation systems.

Moreover, there is external influence in the debate. The biotechnologists and political leaders tended to quote the World Health Organisation, the Food and Agriculture Organisation and the European Food and Safety Association as some of the organisations that have approved GMOs. The activists and some MPs opposed to the Bill usually argued that "artificialising our food will put us in danger", "enslave Ugandans to multinationals", e.g. Monsanto and Du Ponte, and may "lead to more cases of cancer and autism". They also argued that multinationals want to kill "our tastiest and heathiest crops", and multinationals want to "kill our organic agriculture". They often quoted the 2009 report of the American Academy of Environmental Medicine, whose link (http://www.aaemonline.org/gmopost.html) was not active at the time this research was conducted. Activists also quoted Greenpeace, an international environmental protection group, which is eternally opposed to GMOs. Furthermore, activists cited cases of farmers committing suicide in India after crop failure, Bt cotton failing in Burkina Faso, and Zambia's refusal of GM maize as a donation at the peak of the famine in 2002. The scientists countered these comments as being unfounded, emphasising that the cases from those countries resulted from other factors, including farmers not reading the release notes of the respective varieties before planting the seeds. These arguments are reflected in the public perceptions of biotechnology. The newspaper editors ran articles, hence also determined the issues to which they gave prominence. Moreover, media coverage of an issue tends to be driven by the interest of the gatekeepers, which may include conflict among actors. The coverage may be a response to release of a research report, speculation (analysis), and newsroom enterprise or response to a news story they ran recently (Brüggemann & Engesser, 2017).

It appears that there is a knowledge gap between the stakeholders involved in the biotechnology debate that is breeding mistrust among the actors. This study endeavoured to establish the public (mis)perceptions and the knowledge gap in this dispute.

Chapter 6

Findings of the study II

The issue of GMOs is very sensitive because it is liked by very many and hated by very many … others sit on the fence without taking a position (Scientist A, 2017)

6.1 Introduction

This chapter answers Question 3 of the study using the results from the survey and in-depth interviews with the stakeholders explained in Chapters 4 and 5. The survey was conducted in Kasambya village and Kiwenda Township in Busukuma sub-county, Wakiso district in central Uganda. This sub-county hosts the National Crops Resources Research Centre at Namulonge, in whose neighbourhood the two study areas are located. The survey assessed individuals' perceptions of biotechnology and GMOs based on their location, gender, age, education level, income level and knowledge, with the aim of comparing their views to what appears in the national newspapers. The study involved 42 people, mostly small-scale farmers, as indicated in Table 6.1 below. The response rate was 60% (n=70) of the expected participants.

6.2 Question 3: What is the public perception of biotechnology and GMOs in Uganda?

It can be seen in Table 6.1 below that urban women were 23% (n=12 vs n=10) more informed than rural women, as identified by the "Yes" response. However, rural men were 19% (n=7 vs n=1) more informed than urban men. Generally, the urban respondents were 4% (74% vs 70%) more informed than their rural counterparts. Overall, 73% (n=22) of those who said they had knowledge about GMOs were women.

Table 6.1: Place, gender, and knowledge of GMOs

	Female		**Male**		**Total**
	No	Yes	No	Yes	
Kasambya	5	12	3	7	27
	19%	44%	11%	26%	100%
Kiwenda	4	10	0	1	15
	27%	67%	0%	7%	100%

The response rate here suggests that more women are interested in information on GMOs and could be involved in agriculture than men. The result could also suggest that rural males are more likely to be involved in agriculture than urban males. Further, the study analysed the link between and among place, age, knowledge and biotechnology.

Table 6.2: Place, age, and knowledge

	Age												Total
	18-25		26-33		34-41		42-49		50-57		58-65		
Knowledge	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	
Kasambya	3	3	2	6	1	4	1	1	0	1	1	4	**27**
	11%	11%	7%	22%	4%	15%	4%	4%	0%	4%	4%	15%	**100%**
Kiwenda	2	1	0	0	1	3	0	2	1	3	0	2	**15**
	13%	7%	0%	0%	7%	20%	0%	13%	7%	20%	0%	13%	**100%**

Table 6.2 above shows that knowledge was highest in the age group 26 to 33 in the rural area (Kasambya), with 22% (n=6), and in the age groups 34 to 41 and 50 to 57 in the urban area (Kiwenda), with 20% (n=4). The least knowledge was recorded in the 26 to 33 (n=0) age group in the urban area, with 0%. It appears that, regarding GMOs, age may not be a factor determining the knowledge level in that area, but interest in GMOs could be.

Table 6.3: Place, education and knowledge

	No formal schooling		**Primary**		**Primary school completed**		**Some secondary school**		**Post-secondary qualification**		**Some university**		
Knowledge	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	
Kasambya	0	0	3	7	2	1	2	8	0	3	1	0	27
	0%	0%	11%	26%	7%	4%	7%	30%	0%	11%	4%	0%	
Kiwenda	0	1	1	1	0	2	3	7	0	0	0	0	15
	0%	7%	7%	7%	0%	13%	20%	47%	0%	0%	0%	0%	

Reading from Table 6.3, respondents with some secondary education reported the highest level of knowledge, at 30% (n=30) in the rural area and 47% (n=7) in the urban area. Strikingly, there were categories without contributors. Of the categories with participants, those with some primary school education reported the lowest level of knowledge, at 11% (n=3) and 7% (n=1) for the rural and urban areas respectively. Surprisingly, those with university education also reported unawareness of biotechnology and GMOs, at 4% (n=1), a sign that education level may not be a factor in determining level of knowledge on biotechnology and genetically modified food. The details are presented in a bar graph in Figure 6.1 below.

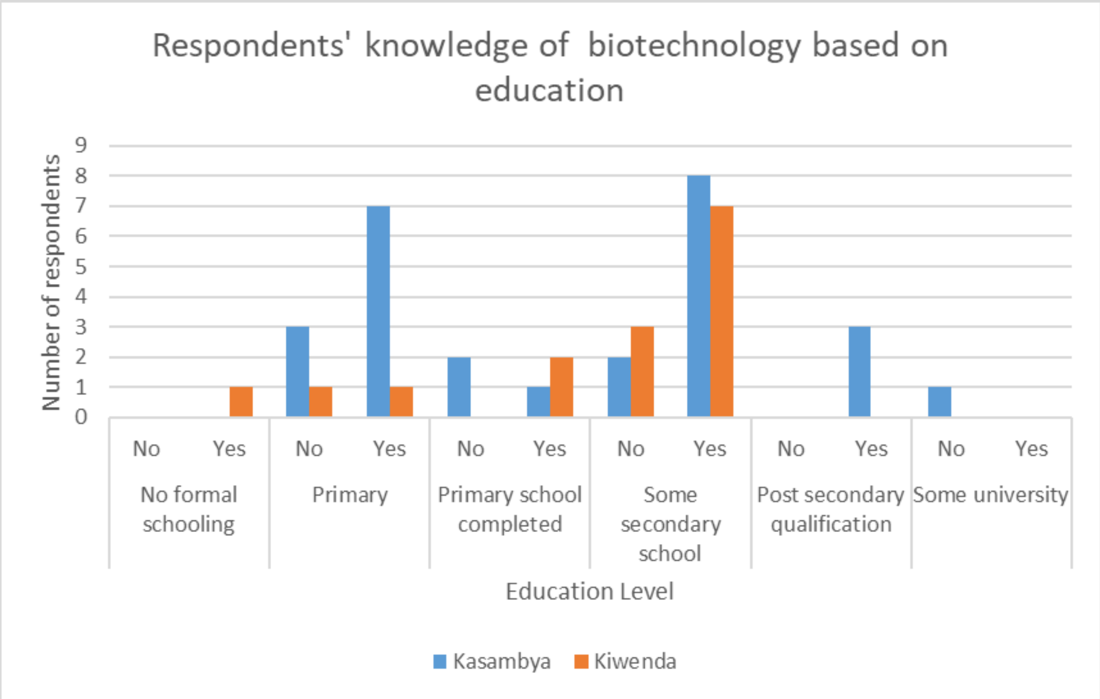

Figure 6.1: Respondents' knowledge of biotechnology based on education

6.2.1 Place, occupation and knowledge of respondents

The study also investigated whether there was a correlation between place, occupation and knowledge. The respondents revealed involvement in other activities apart from agriculture. Fortunately, the pilot study had pointed to this fact and a question was included to capture the other activities that respondents could be practicing to improve their livelihoods. Some farmers were also tailors, businesspeople, graphic designers, pastors, health workers and casual labours. Knowledge was uppermost among those specialising in farming, at 41% (n=11) in the rural area and 67% (n=10) in the urban area. This statistic may be misleading, but on close examination the numbers are based on the number of participants in the respective areas. Such a finding could suggest that participating in agriculture increases one's chances of knowing about biotechnology and GMOs.

In the rural area, all those doing farming alongside another job reported having knowledge of biotechnology (n=6). Again, the number of individuals in the rural area not specialising in farming who knew about biotechnology was equal to that of specialised farmers who did not know about it at all (n=6). The result could indicate that some farmers are making an effort to learn about GMOs, but, as the elite noted in newspaper opinions, sensitisation on GMOs should be imminent, whether biotechnology and GMOs are to be adopted nor not. The details are presented in Table 6.4 and the clustered bar chart in Figure 6.2 below.

Table 6.4: Knowledge of public based on occupation

	Farmer and another job(s)		Farmer		Other jobs		Total
	No	Yes	No	Yes	No	Yes	
Kasambya	0	6	6	11	2	2	27
	0%	22%	22%	41%	7%	7%	
Kiwenda	1	1	2	10	1	0	15
Total	7%	7%	13%	67%	7%	0%	100%

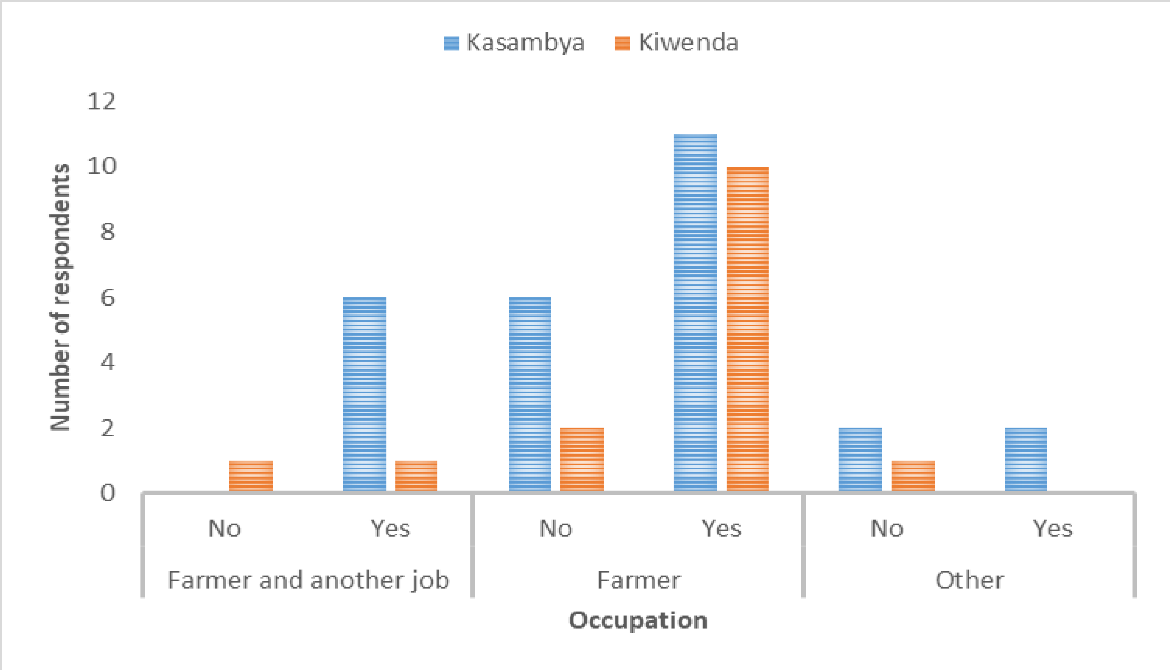

Figure 6.2: Respondents' knowledge of biotechnology based on education

6.2.2 Gender and benefits of GMOs

The results in Figure 6.3 reveal that 29% (n=12) of the total number of respondents had no knowledge of biotechnology, while 71% (n=30) expressed knowledge of the subject.

Biotechnology is also associated with some benefits. Generally, 45% (n=19) thought GMOs can lead to better yields per acre, and 29% (n=13) thought GMOs can alleviate hunger as well. A noticeable 15% (n=6) associated biotechnology with lowering of prices. Other arguments included producing food with better flavour and nutritional value, and growing food with longer shelf life.

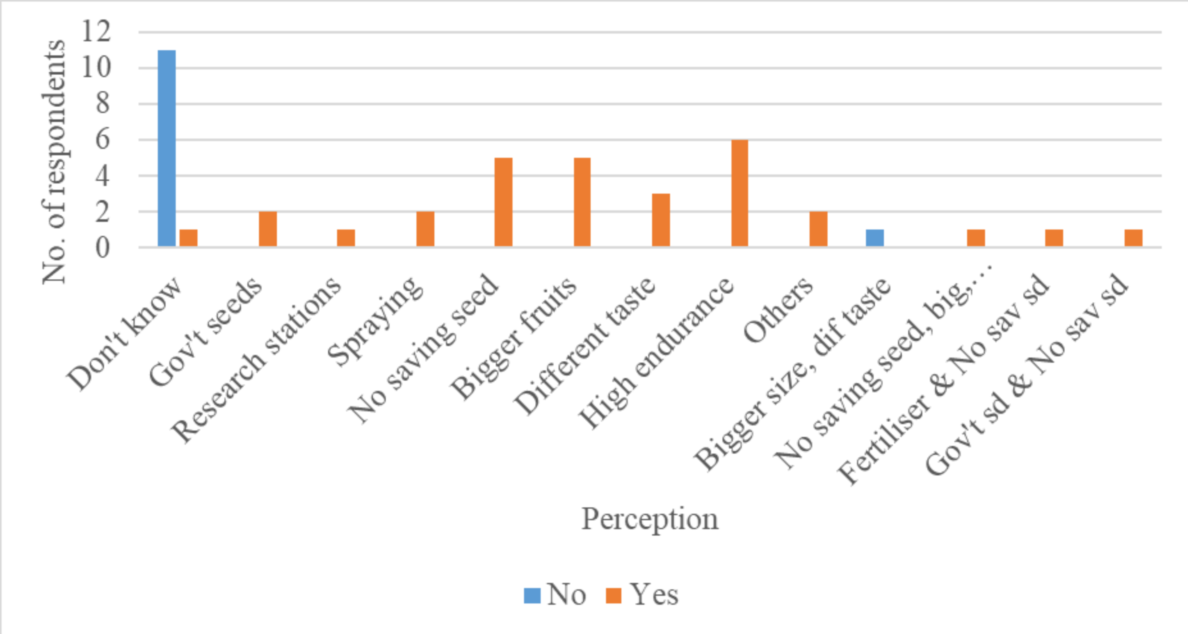

Figure 6.3: Knowledge of and attitudes toward biotechnology

In terms of gender and perception, 75% (n=9) of those who could not associate biotechnology with any advantages were women, and 56% (n=5) of them were from the urban area. In total, six respondents associated biotechnology with bigger fruit and 67% (n=4) of them were women from the rural area. Of the aggregated 14% (n=6) who said GMOs could have high endurance compared to seeds bred by other means, 33% (n=2) were men from the rural area. Of the overall 15% (n=6) who associated biotechnology with no saving seed, 33% (n=2) were male. The others, who formed less than 5% (n=2) of the overall number of respondents, reported that GMOs could be an "organisation on its own because the people who talk about them usually come in groups" and all respondents were from the rural area. Some respondents had multiple understandings of biotechnology and their views are captured in Table 6.5..

Table 6.5 Issues associated by the respondents with GMOs

Place	Gender	Do not know	Gov't seeds	Research stations	Spraying	No saving seed	Bigger fruit	Different taste	High endurance	Others	Bigger size & different taste	No saving seed, bigger fruit & high endurance	Fertiliser & No saving seed	Gov't seed & No saving seed	Total
Kasambya	Female	4	1	1	0	0	3	3	2	1	1	0	0	1	17
		24%	6%	6%	0%	0%	18%	18%	12%	6%	6%	0%	0%	6%	100%
	Male	3	1	0	1	1	1	0	2	1	0	0	0	0	10
		30%	10%	0%	10%	10%	10%	0%	20%	10%	0%	0%	0%	0%	100%
Kiwenda	Female	5	0	0	1	3	1	0	2	0	0	1	1	0	14
		36%	0%	0%	7%	21%	7%	0%	14%	0%	0%	7%	7%	0%	100%
	Male	0	0	0	0	1	0	0	0	0	0	0	0	0	1
		0%	0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	100%

In an in-depth interview, the MP described the benefits of GMOs as “enormous”. In other in-depth interviews, Scientists A (2017), B (2017) and C (2017) argued that GMO science was aimed at breeding “drought-tolerant varieties” with the ability to “resist pests and diseases”. The journalists, except Journalists C and F, who were editors, agreed with most of the scientists interviewed for this project. It seems that the scientists were responding to the farmers’ key need – getting “high yields per acre”. However, the Clerk (2017) cautioned that biotechnology is not a “guarantee” to increased agricultural production. Indeed, Scientist D (2017) asserted that GMOs should not even be an “option” for Uganda, since the developed countries that have GMOs mainly use them in the form of “bio-fuels” for cars and “cotton seedcake for animals”.

Although the activists agreed that GMOs could have the potential to improve certain properties of plants, as argued by the majority of the scientists, Activist B (2017) was quick to add that such a process could make a plant lose “natural balance by weakening other properties” and aggravate the problems in food production. Further, Activist B claimed that introducing GMOs was a pretext by government to run away from its obligation to feed the people after “killing the agricultural sector when it replaced extension workers with NAADS [National Agricultural Advisory Services] in 1999”.

To increase yields, Scientist D and the activists said that government should construct and desilt more dams to improve irrigation, support farmers to get fertilisers and manure, and improve extension services to allow farmers to get the right information on agriculture, including technologies, in time.

The study also took stock of the risks the respondents associated with biotechnology and GMOs. The results are presented in Table 6.6.

Table 6.6: Gender of respondents and risks associated with biotechnology

Place		Do not know	Allergies	Diseases	Harm environment	Do not increase yields & Unsustainable	Kill indigenous seeds	Others	Harm environment and others	Diseases & Kill indigenous seeds	Allergies, diseases, harm environment & unsustainable	Unsustainable and Kill indigenous seed	Diseases & Superweeds	Diseases & Harm environment
Kasambya	Female	8	1	0	1	0	4	0	1	2	0	0	0	0
		47%	6%	0%	6%	0%	24%	0%	6%	12%	0%	0%	0%	0%
	Male	4		0	0	1	1	1	1	1	0	0	0	1
		40%	0%	0%	0%	10%	10%	10%	10%	10%	0%	0%	0%	10%
Kiwenda	Female	9	0	1	0	1	0	0	0	0	1	1	1	0
		64%	0%	7%	0%	7%	0%	0%	0%	0%	7%	7%	7%	0%
	Male	0	0	0	1	0	0	0	0	0	0	0	0	0
		0%	0%	0%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Regarding risks, women reported having lower knowledge levels than men. The urban female respondents reported the lowest level of knowledge, at 64% (n=9), while 47% of the rural women reported ignorance (n=8). Women were more concerned about allergies, the environment and diseases that may result from GMOs separately, at a marginal 7% (n=1). Women were more concerned about the loss (killing) of indigenous seeds, at 24% (n=4), than men, at 10% (n=1). There appears to be a link between gender and the risks associated with GMOs, although the link is weak.

However, in in-depth interviews, Journalist B (2017) revealed that "as a mother, I am really concerned about what my children are eating, and what they will eat in future". Activists B (2017) and C (2017) also used the phrase "my mother" in making a case for their opposition to GMOs. Activist B (2017) argued that her mother was always concerned about the "taste" of the food she eats when she goes for fieldwork. Activist C (2017) used his mother as an example of the passion individuals have against GMOs in the expression, "… my mother whom I know over her dead body [swear], she will never plant GMO".

Activist A (2017), Journalists B (2017), C (2017) and J (2017), and Scientist B (2017) all said stories on biotechnology should be simple enough to be understood by "my grandmother". This could be a sign that these respondents have shared a source of information, perhaps attended a workshop together, read common material, or listened to or watched the same expert. Their submissions could reflect societal concerns for women. Relatedly, the Clerk used her father as an example of someone who does not understand biotechnology. The appeal to lineage could be a sign that social-cultural factors are significant in the uptake of biotechnology, specifically GMOs, although this argument is overlooked in media reports and indicates the importance individuals attach to their parents.

Table 6.7: Age and attitude

Age	Do not know	Gov't seeds	Research stations	Spraying	No saving seed	Bigger fruits	Different taste	High endurance	Others	Bigger size, different taste	No saving seed, big, endurance	Fertiliser & No saving seed	Gov't seed & No saving	Total
18-25	5	0	0	0	0	0	1	1	1	1	0	0	0	9
	56%	0%	0%	0%	0%	0%	11%	11%	11%	11%	0%	0%	0%	100%
26-33	2	2	0	0	1	1	0	1	0	0	0	0	1	8
	25%	25%	0%	0%	13%	13%	0%	13%	0%	0%	0%	0%	13%	100%
34-41	2	0	1	0	2	2	1	0	0	0	0	1	0	9
	22%	0%	11%	0%	22%	22%	11%	0%	0%	0%	0%	11%	0%	100%
42-49	1	0	0	0	0	0	0	2	1	0	0	0	0	4
	25%	0%	0%	0%	0%	0%	0%	50%	25%	0%	0%	0%	0%	100%
50-57	1	0	0	0	2	0	0	1	0	0	1	0	0	5
	20%	0%	0%	0%	40%	0%	0%	20%	0%	0%	20%	0%	0%	100%
58-65	1	0	0	2	0	2	1	1	0	0	0	0	0	7
	14%	0%	0%	29%	0%	29%	14%	14%	0%	0%	0%	0%	0%	100%

In terms of age, it is clear from Table 6.7 above that 56% (n=5) of those between the ages of 18 to 25 could not express any attitude towards biotechnology. However, 25% (n=2) of those in the age range of 26 to 33 associated biotechnology with seeds provided by the government. Approximately 11% (n=1) of those in the age range 34 to 41 associated GMO seeds with research stations. Although almost all the age ranges, except those in the range 34 to 41, associated biotechnology with high endurance, the highest score of 50% (n=2) was in the age range 42 to 49. Moreover, 29% (n = 2) of those in the age range 58 to 65 associated the seeds with spraying and bigger fruit. At the same time, 40% (n = 2) of those aged 50 to 57 associated biotechnology with not having any seed to save, hence buying seeds every season. The highest score for differences in taste was among those aged 58 to 65, although those in the 18 to 25, at 14% (n=1) and 42 to 49 age groups, at 11% (n=1), gave it the same score. For mixed opinions, about 10% (n=4) of the total number of respondents associated GMO seeds with government, bigger size, endurance and fertilisers, but also no saving seed.

These results are consistent with the results from in-depth interviews with the scientists, activists, journalists and government officials, which revealed that the general public does not understand biotechnology and GMOs. The results could also explain why MPs have been postponing consultation meetings with their constituents since 2013. Importantly, no particular group can claim a monopoly of knowledge on GMOs, "even the ones you would expect [scientists] don't understand it" (Scientist B, 2017).

Table 6.8: Age and benefits of biotechnology

Age	Do not know	High yields	Protects environment	Reduces pesticides	Affordable food	Alleviates hunger	High yields/ Reduces pesticides/ Alleviates hunger	High yields/ alleviates hunger	High yields/ Affordable food/ Alleviates hunger/ Better flavour/ Longer shelf life	High yields/protects environment/ Reduces pesticides/ Affordable food/Alleviates hunger	High yields/ Reduces pesticides	High yields/ Reduces pesticides/ Affordable food/ Alleviates hunger/Better flavour	High yields/ Longer shelf life	Total
18-25	5	1	0	0	0	0	1	2	0	0	0	0	0	9
	56%	11%	0%	0%	0%	0%	11%	22%	0%	0%	0%	0%	0%	100%
26-33	2	2	0	1	1	0	0	1	0	0	0	1	0	8
	25%	25%	0%	13%	13%	0%	0%	13%	0%	0%	0%	13%	0%	100%
34-41	3	2	1	0	0	0	0	1	1	1	0	0	0	9
	33%	22%	11%	0%	0%	0%	0%	11%	11%	11%	0%	0%	0%	100%
42-49	2	1	0	0	0	0	0	0	0	0	0	0	1	4
	50%	25%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	25%	100%
50-57	2	3	0	0	0	0	0	0	0	0	0	0	0	5
	40%	60%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	100%
58-65	5	0	0	0	0	1	0	0	0	0	1	0	0	7
	71%	0%	0%	0%	0%	14%	0%	0%	0%	0%	14%	0%	0%	100%

The lowest level of knowledge was recorded among the 58 to 65 age group, at 71% (n=5). The 50 to 57 age group reported the highest optimism for GMOs increasing yields, at 60% (n=3). The 26 to 33 age group reported the highest level of optimism in GMOs reducing the use of pesticides and making food affordable, at 13% (n=1). The 34 to 41 age group was the only one to contend that GMOs can help in protecting the environment, although the overall score was only 11% (n=1). Only the 58 to 65 age group argued that GMOs can alleviate hunger. No respondent believed solely that GMOs provide better flavour and longer shelf life, although the two issues were raised in combination with others.

The experts made no reference to age in making a case for biotechnology. Age and perception could be good areas for further research if GMOs are legalised in Uganda.

Table 6.9: Age and risks associated with biotechnology

Age	Do not know	Allergies	Diseases	Harm Environment	Don't increase yields & Unsustainable	Kill indigenous seeds	Others	Harm environment & others	Diseases & Kill indigenous seeds	Allergies, diseases, harm environment & unsustainable	Unsustainable and kill indigenous seed	Diseases and Super weeds	Diseases & harm environment	Total
18-25	5	0	0	0	0	2	0	2	0	0	0	0	0	9
	56%	0%	0%	0%	0%	22%	0%	22%	0%	0%	0%	0%	0%	100%
26-33	5	0	0	1	0	1	1	0	0	0	0	0	0	8
	63%	0%	0%	13%	0%	13%	13%	0%	0%	0%	0%	0%	0%	100%
34-41	5	1	0	0	2	0	0	0	0	1	0	0	0	9
	56%	11%	0%	0%	22%	0%	0%	0%	0%	11%	0%	0%	0%	100%
42-49	2	0	0	0	0	0	0	0	0	0	0	1	1	4
	50%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	25%	25%	100%
50-57	2	0	0	1	0	1	0	0	0	0	1	0	0	5
	40%	0%	0%	20%	0%	20%	0%	0%	0%	0%	20%	0%	0%	100%
58-65	2	0	1	0	0	1	0	0	3	0	0	0	0	7
	29%	0%	14%	0%	0%	14%	0%	0%	43%	0%	0%	0%	0%	100%

Referring to Table 6.9, it is clear that the highest level of ignorance of risks was 63% (n=5), recorded in the age group 26 to 33, and the lowest was in the age group 58 to 65, at 29% (n=2). Other issues associated with biotechnology included causing allergies and sicknesses such as cancer. A combination of allergies, diseases, harm to the environment, and GMOs being unsustainable was reported at 43% (n=3) among those in the age group 58 to 65. All the other risks were below 30% (with usually one respondent). Among those aged 58 to 65, GMOs killing indigenous seeds and being harmful to the environment were scored separately at 20% (n=1) each. The 34 to 41 age group singularly reported allergies at 11% (n=1), although the same group was concerned about GMOs not being a sure way to increase yields, as they are unsustainable.

Participants attributed their preferences for biotechnology and GMOs to the fact that, because GMOs have specifically bred characteristics, such seeds could require "less investment" in the form of irrigation, "seeds grow faster", "have inbuilt resistance to drought, pests and diseases", "the fruits are bigger than indigenous", and the seeds were "not connected to Kawanda", a research station whose name tends to be associated (on behalf of all other agricultural research stations), rather negatively, with high-yielding fruit with a bad taste. The survey revealed that farmers think that such attributes can "get yields", "enough to eat and sell", hence "quick money, less expenses". Such assertions seem to suggest that farmers prioritise an increase in their income and downgrade any scientific arguments against GMOs.

Despite the optimism, the respondents also dreaded the risk associated with GMOs. For instance, phrases such as "the yields may not have market", GMOs "may cause cancer and ulcers", and "GMOs cannot be replanted, we have to keep buying seeds every season", were used to demonstrate their worries. A notable anecdote was that a "gene of a pig can be transferred into a banana to make it big". Such an action would be haram in the Islamic tradition and would also be abhorred by Seventh Day Adventists, who do not eat pork. To express uncertainty, one farmer asked: "Shall we replant our original seeds if GMOs fail?" Some farmers recalled losing their traditional potato varieties when research stations gave them hybrid potato leaves to plant. Others gave the example of *Mpologoma,* a banana variety hyped for its resistance to drought, which turned out to be failure.

In the in-depth interviews, the concerns of the public were stressed by the activists, who raised issues related to intellectual property, government inefficiencies, inadequate capital of farmers, and limited knowledge on the part of farmers to apply this new, but complex, science. Activist B (2017) called GMOs a "sugar coating" and a "deception" to the food security of Uganda, as farmers would be hit hard by multinational patents under the Plant Varieties Protection Act 2014, a law passed on the same day as the Anti-Homosexuality Act, to protect the interests (knowledge) of breeders, funders and their institutions. Scientist D (2017) said multinationals stood to benefit from patenting "pesticides, fertilisers, and irrigation technology", since every GMO variety tends to be grown following specific release notes, which may specify the type, quantity and quality of chemical, fertiliser and irrigation technology to be used. Although Scientist B earlier contended that Uganda would benefit from patenting its innovations, Scientist C (2017) did not think the public needed to know about patents, since ordinary people "never really get to know the owner of the drugs they take". The biotechnologists' arguments seem to ignore the politics and economics of food production, and they may find themselves following the dictates of their funders if the Bill is passed into law, which will mean that sponsors will have controlling power over inventions.

The activists were concerned that Uganda may never benefit from these patents, since biotechnology research is fully funded by multinationals such as Monsanto and the Bill and Melinda Gates Foundation. Scientists D was concerned that these organisations are donating the genes to be used, and in some cases staff to help in research. Activist C (2017) was worried that "if they are funding research, they will decide which direction it takes". Furthermore, Journalist G (2017) emphasised that "these people are not our brothers or our cousins; they will want to recoup their money somehow". However, the Member of Parliament (2017) argued that government needs the law on biosafety to allow the Ministry of Science, Technology and Innovation to "recruit experts" and "fund research". Without a clear law, even scientists risk being sucked into the economic black hole of the multinationals. In fear of this, the Clerk (2017) noted that "we are looking at this law in different angles, we are going to produce the best law".

While acknowledging the farmers' worries about losing indigenous seed, Scientist A (2017) admitted that "recycling seed is not always good", as improved varieties are better. The MP (2017) argued that government would have gene banks. To that end, he noted that, in case something went wrong with a variety, "we resort to our indigenous seeds". Commenting on enslaving farmers to buying seeds every season, Journalist J (2017) said that some farmers have already made the choice:

> There is not a government policy that every Ugandan must plant hybrid; it was individual initiative. These people saw the advantages of buying improved seed went into it and they are not complaining. Every season they go to Container Village [a place in downtown Kampala where seeds, pesticides and herbicides are sold] and buy seed, so I think it will remain like that.

The activists and Journalist G predicted that such a scenario may enslave small-holder and medium-sized farmers who are used to sharing seed and may lead to a dependency of some form. But Scientist B (2017) explained that:

> We look for genetic elements, processes, and protocols that are not protected. There might still be a few, that are protected, but then we tend to prefer those who will allow us to use them for development process, development purpose in none seeded species like bananas for substance growers. Then for us who have been running around that principle for many of the patented process that we are working with so that once the product is developed we don't have to pay royalties to whoever owns a piece of them. Whoever owns a piece of what we have used, because we have explained to them that we are developing this matooke [East African plantain], once we give farmers two suckers they will never comeback to pay your royalties. So, this is in a way a technology you have donated. Because the farmers will go; matooke doesn't have seed. They will multiply as much as they want.

On the inferiority of newer varieties, Scientist B argued that the failure of some varieties to yield better than the indigenous varieties largely resulted from "expansion into areas where the mother variety was not suitable". In other words, new varieties, including GMOs, are highly specific and should be treated on a case-by-case basis.

Journalist H and Activist B were also anxious that the mixing of genes from different plants could cause allergies. Activist B (2017), who said she did not drink soda because she is allergic to such soft drinks, was "very scared because increasingly we are getting food allergies … we do not have a functioning health care system [to deal with the effects of] food manipulation". However, in response, the MP (2017) noted that the law would address issues of "allergenicity" and "toxicity" and other associated risks, as presented in Figure 6.4 below.

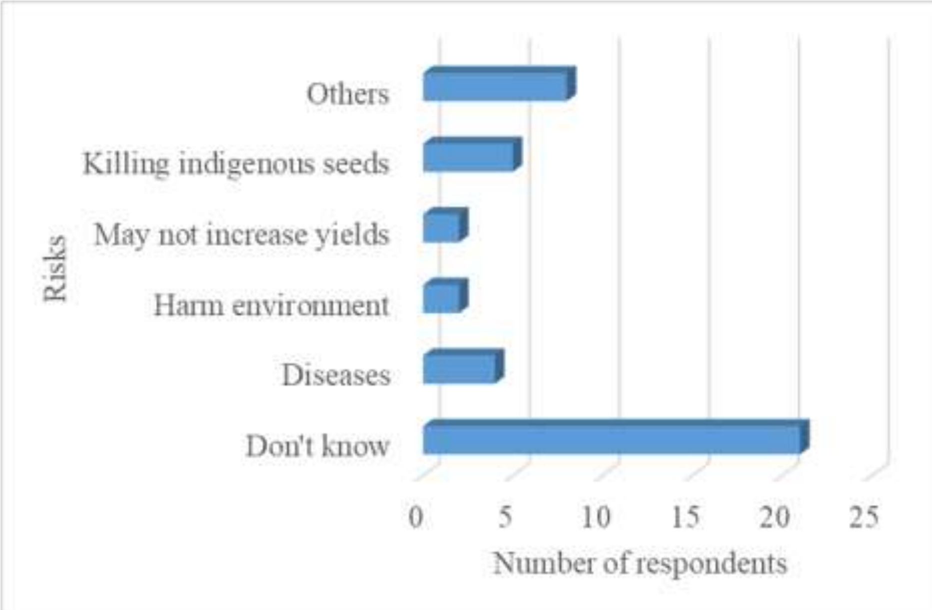

Figure 6.4: Risks associated with biotechnology

According to Figure 6.4 above, half (n=21) of the respondents could not associate GMOs with any risks. Nearly 12% (n=5) associated GMOs with killing indigenous seeds; fewer than 5% (n=2) believed GMOs may harm the environment; and a similar percentage feared the possibility of them not increasing yields as promised. About 10% (n=4) associated GMOs with diseases, especially cancer and ulcers. Other risks mentioned included GMOs lacking a market, no saving seed and seeds being expensive in the long run, all summing to 19% (n=8). The weighty 57% (n=24) of the respondents who highlighted risks had a secondary education.

Of interest in Figure 6.5 below is that the no schooling, post-secondary and university categories got the same score, of 5% (n=2). Those who had attended primary school (47%, n=20) and those who had a secondary education (38%, n=16) expressed the highest level of ignorance of any risks that could be associated with biotechnology. No strong relationship was found between education and attention to risks.

The biotechnologists said the idea that GMOs would cause illnesses such as cancer was unfounded. Journalists F and I echoed the scientists' views. Journalist F compared the "allegations" of cancer to the effects that mobile phones were speculated to have on fertility. He argued: "People used to say it's going to make men impotent, but up to now [some] people hold two mobile phones [or more] and are producing twins" (Journalist F, 2017). An attempt to correlate education with risks revealed a complex situation, as in Figure 6.5 below.

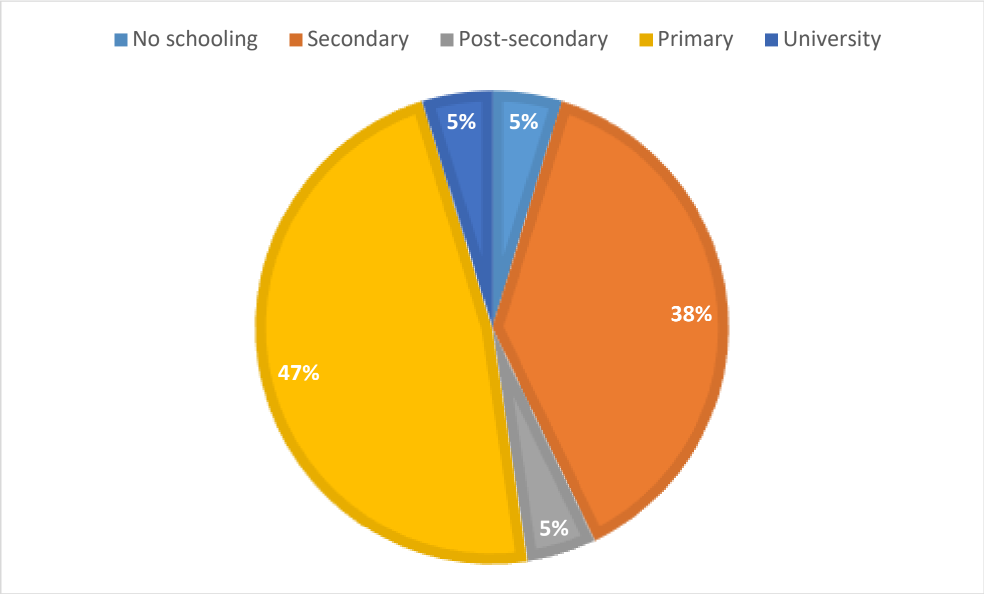

Figure 6.5: Distribution of education levels of those who do not associate biotechnology with any risks

In contrast, Journalist G (2017) contended that it is possible to get cancer by consuming GMOs, since the plant mutates through the transfer of genes:

> Traditionally we have gene transfer from animal to animal or from plant to plant, but now you can even transfer DNA from bacteria and put it in a human being, and people say it is going to lead to so many mutations. In human beings, mutations can lead to cancer; can lead to a child being born without an eye or a leg and things like those. And some research is being done, but it will take a lot to prove.

Activist C augmented this position when he said that the lack of scientific evidence does not eliminate the evident risk. If it was later proven that GMOs indeed have effects on human health, scientists would stand to take the blame. If GMOs are to be consumed in Uganda, activists want a strong law with punitive and restoration clauses for such scenarios. Moreover, the Clerk (2017) was concerned that GMOs posed a security threat to Uganda in the form of "bioterrorism". This could be the reason security personnel picked interest in the subject. To limit this risk, the activists wanted a law that would demand that the top scientists in any organisation doing research on GMOs should be Ugandans. The assumption was that citizens would jealously protect national interests. This is important for a militaristic country like Uganda, which has been conducting foreign missions for almost half a century. It would be suicidal to have its army fed by foreigners on food whose ingredients could be negatively manipulated, they argue. It hence became necessary to study the information sources of the respondents.

6.2.3 Information sources

Many respondents indicated that they were accessing information from various channels, especially radio, television, relatives and friends, and occasionally workshops. Largely, the sources of information varied across education levels.

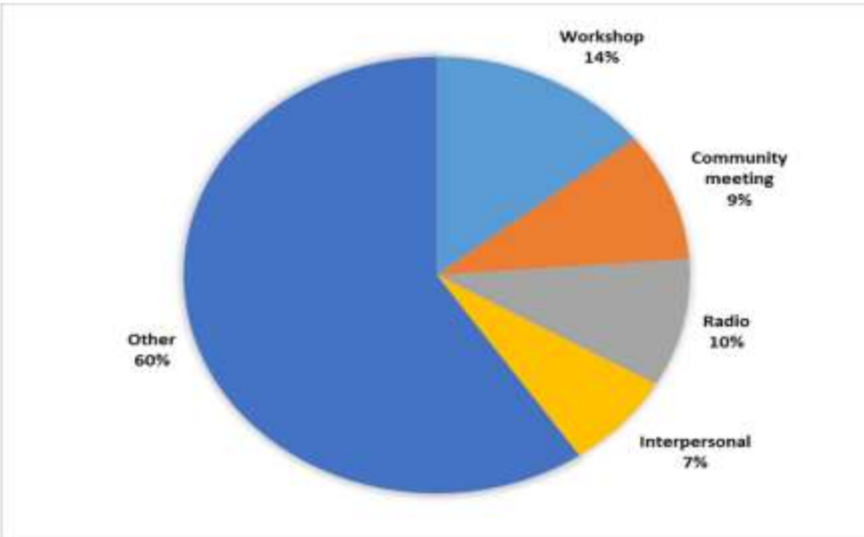

Figure 6.6: Current sources of information

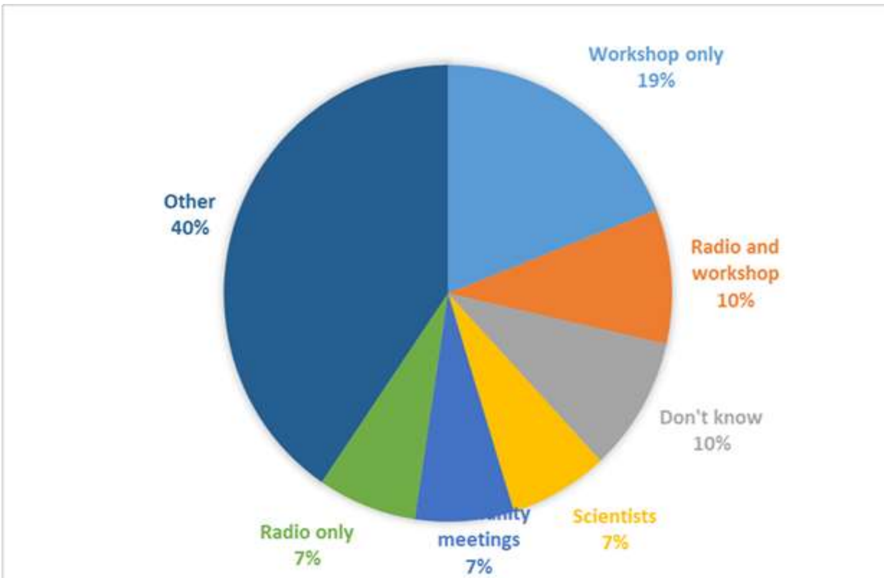

Figure 6.7: Preferred sources of information

Figures 6.6 presents a surprise in that 60% (n=17) of respondents reported receiving information from “other” sources, such as agricultural extension workers, seed dealers, and NARO staff, and from their indigenous/native knowledge. Although radio is the most prominent source of information in Uganda, with the country hosting 292 radio stations (Uganda Communications Commission (UCC), 2015:29), 14% (n=6) of the respondents reported receiving information on agriculture and GMOs from workshops they have attended. Radio came a distant third, with 10% (n=4). Community meetings and interpersonal messages from relatives and friends were notably important, although their popularity was slightly below radio.

In terms of preference, Figure 6.7 above demonstrates that radio only, community meetings and interpersonal communication each scored 7% (n=3), the same score for those who did not know. Interestingly, workshops were preferred nearly three times (19%, n=8) more than radio, the largest source of information in Uganda. Indeed, half of those who preferred workshops had at least secondary education. Noteworthy in this study is that individuals preferred mixed-methods approaches, coded here as others, with radio and workshops being the most preferred combination. The university graduates preferred television and community meetings, while those who had not received formal education did not indicate any preferences.

The respondents who preferred radio intimated that, at that time od conducting this research, some radio stations had “good programmes” on agriculture through which they could also get information about biotechnology. Their problem was that they sometimes "[lacked] the airtime to call in and contribute to the discussion" and at times the "lines [were] so busy", making it hard to get through. Those who preferred mobile phones held that, on such a platform, a "message can be read anytime", unlike radio and television stations, which are "many and cannot be tuned in [to] simultaneously". However, those who preferred workshops contended that such forums allow "interaction through question-answer sessions", "personal contacts for follow-up", and might be less expensive if organised at the grassroots level. The personal contacts allowed interpersonal discussions between experts and farmers and farmer-to-farmer exchange of knowledge.

Unfortunately, the science institutes were only organising workshops for MPs, civil society and journalists in hotels and at confined trial sites, as discovered in the content analysis. From the feedback above it was clear that farmers are largely passive receivers of information from the various media platforms. Both the activists and journalists interviewed vouched for workshops. The activists wanted to be facilitated to organise sensitisation workshops. But the MP argued that activists only "bias" citizens against GMOs. Engagement is almost impossible because of financial difficulties, the fragmented nature of the media and literacy rates that are too low to read newspapers, among other impediments, yet farmers' work is practical. Hence, there is a need for the physical presence of an expert to explain and respond to their questions, preferably in a workshop or on a farm. Indeed, the MP pointed at sensitisation meetings at sub-county level, but none had been organised by the Parliamentary Science and Technology Committee. The MP also proposed social media as another avenue for sensitising farmers and the general public.

Although a series of consultation meetings were advertised at the district level, only one meeting took place at the national level – at the beginning of February 2017. In fact, this researcher went to Kayunga district headquarters where a similar meeting was scheduled to take place on 10 February 2017, according to the advert, but the leadership in Kayunga was ignorant about such a meeting in their district on the scheduled date. When he contacted the vice-chairperson of the Parliamentary Committee on Science and Technology, he too expressed ignorance. This proves that engagement with farmers at grassroots regarding GMOs had not yet happened by the time this research was done.

In the in-depth interviews, journalists expressed their role as that of mediating the debate on controversial issues like biotechnology and GMOs. Journalist C (2017) argued that they publish stories about biotechnology, whether the stories are for or against the technology. Journalist A (2016) asserted that their role was to "throw it to the public for them to weigh [in on] that debate". Unfortunately, a debate on a divisive issue such as GMOs usually leaves the public very confused, as explained later in the discussion on the knowledge gap in this chapter.

6.2.4 Engaging scientists

The survey also revealed that the public were interested in meeting the scientists, especially those involved in generating knowledge that concerns them directly. Interviewees were asked for their preferred channels for engaging with the scientists and their responses are captured in Figure 6.8.

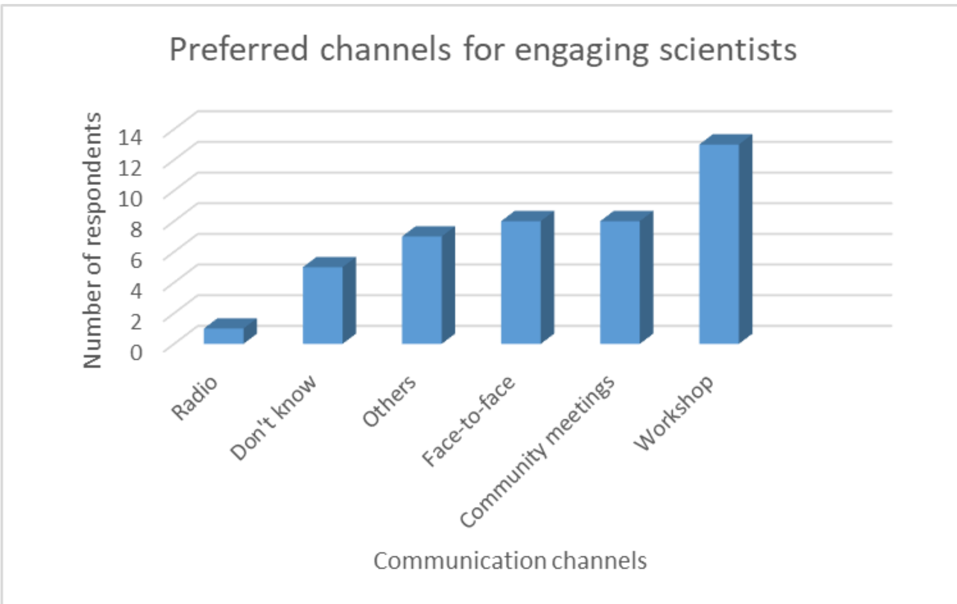

Figure 6.8: Preferred channels for engaging with scientists

From Figure 6.8 above it can be seen that there is interest among the general public to meet scientists in person. Again, workshops stood out as the preferred channel for engaging with scientists, at 31%. Community meetings and face-to-face meetings would also be important to the public, some of whom were quoted as saying, "scientists only talk to us when they are desperate for information". Public arguments for meeting scientists included "wanting to get first-hand detailed explanations about what they do", "ordinary people voicing their views to scientists as a community", and "to publicly disagree with them about some of the solutions they provide that do not work". Further, they wanted to get personal contacts of the scientists in case the public needed assistance. Some preferred meeting them in workshops because they believed scientists are "very busy people" who cannot meet individuals.

Almost 50% (n=15) of those who wanted to meet scientists face to face and in community meetings (n=27) had secondary education. At the same time, 77% (n=10) of those who wanted to meet scientists in workshops had secondary education. However, 80% (n=4) of those who did not express an interest in meeting scientists had not gone beyond primary school. Only university graduates expressed interest in meeting scientists on social media. Considering that face-to-face workshops and community meetings would all involve the physical presence of scientists, then 69% (n=29) of the respondents desired to meet scientists and discuss issues related to biotechnology with them.

All respondents in the in-depth interviews revealed a need for scientists to engage more with the public beyond the media, especially through community meetings and farm visits as outreach activities to explain to the average people (farmers) the meaning of biotechnology and GMOs in the simpler language. As Journalist G (2017) put it, it is important for scientists to "pull off their laboratory coats" to engage with the public on their perceptions as influenced by community culture. But Scientist A (2017) contended that, as biotechnologists, "we have spent quite a lot of effort and resources trying to up our communication on biotech through the media". Moreover, Activist C said that "few scientists are engaged in biotechnology", making community outreach hard.

6.2.5 Action on GMOs

The respondents were asked to suggest what government, the regulator of GMOs, should do about biotechnology, and their responses are captured in the sunburst chart in Figure 5.9. The views on what action government could take on biotechnology and GMOs varied across education levels, with a notable 15% (n=6) preferring not to make any suggestions. Ten percent (n=4) wanted all activities related to biotechnology and GMOs banned in Uganda, with 36% (n=15) showing an interest in planting GMOs and a majority of 39% (n=16) wanting sensitisation before deciding whether to support or reject GMOs. Those who supported the idea of planting GMOs asserted that "traditional seeds were not producing enough yield any longer, hence a need for seeds that have been proven to yield under different environmental challenges".

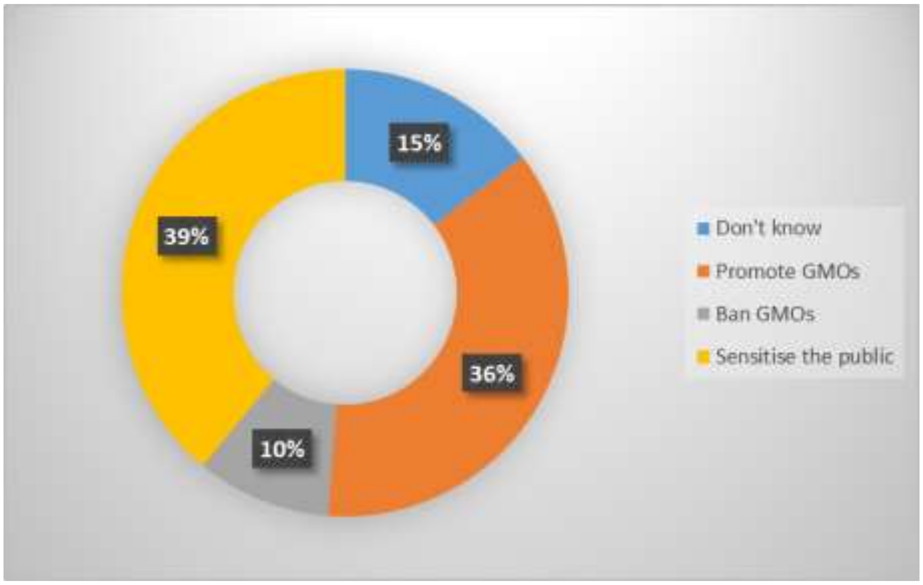

Figure 6.9: Proposed actions on GMOs

Proponents also see GMOs as "relief" from the drought they had suffered in recent years. On the other hand, those who wanted the seeds banned asserted that "government was already investing a lot of money in treating cancer and it would be unwise for the same government to promote seeds that could cause cancer". In addition, the opponents stated that "government should first find [a] market for GMOs before promoting them". Moreover, the opponents added that GMOs could lead to the "dying of organic farming", as seed "companies rip off farmers through selling to them seeds every season". Those who argued for further sensitisation were concerned that there was "contradicting information" in circulation, for and against GMOs, hence a need for government to make its position on GMOs clear. From these statistics, public support for or against GMOs may swing either to the side of the biotechnology industry or the conservationists, or cause a deadlock, in which case labelling would be the compromising position.

The public suggestions on biotechnology were further categorised by place and gender and plotted on a bar-line graph in Figure 6.10.

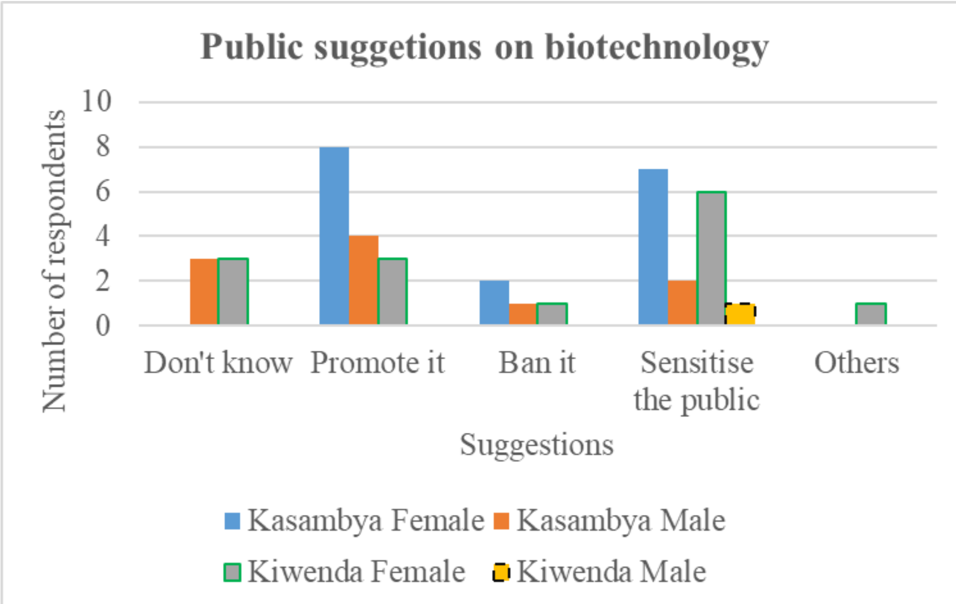

Figure 6.10: Public suggestions on GMOs

6.2.6 Farmers' willingness to grow GMOs

Farmers' views on whether or not to grow GMOs varied by location, knowledge, education and income boundaries. Overall, more than 80% (n=36) were willing to grow GMOs despite the risks highlighted earlier, as plotted in the pie chart in Figure 6.11. This section of respondents also seemed to be early adopters and were eager to "grow GMOs to confirm whether they are high yielding or not". Their views are plotted in the pie chart in Figure 6.11.

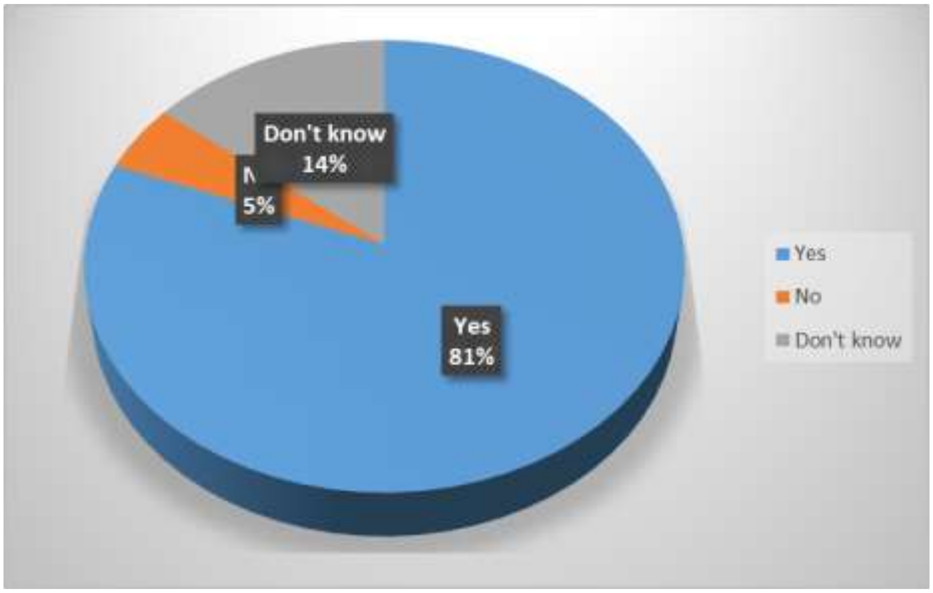

Figure 6.11: Farmers' willingness to grow GMOs

However, it was observed that 50% (n=3) of those who have not decided had some primary school education, and those opposed to growing GMOs have secondary and post-secondary education.

All respondents agreed that sensitisation was important before biotechnology can be commercialised. This view from the in-depth interviews corresponds with the views from the survey, as indicated in the line-bar graph in Figure 6.10 and the pie chart in Figure 6.11.

6.2.7 Income and information sources

Income was found not to be a major factor in determining the individuals' information sources. However, it was found to be a major factor in determining participation. Overall, only 12% (n=5) of the respondents earned at least 800, 000 Uganda shillings, or about 222 US dollars a month. More than 85% (n=36) reported being low-income earners and sometimes indicated that what they were reporting is what they had sold in their most recent harvest. Some refused to reveal their earnings, arguing that that they had not sold any produce and any money they earned was from either their spouses, relatives or friends. Acreage was not an obstacle to determining whether they would grow GMOs or not. The respondents who were willing to grow GMOs owned land of different sizes.

The study also took stock of individuals' willingness to grow GMOs based on their knowledge, and the details are plotted on the bar graph in Figure 6.12 below.

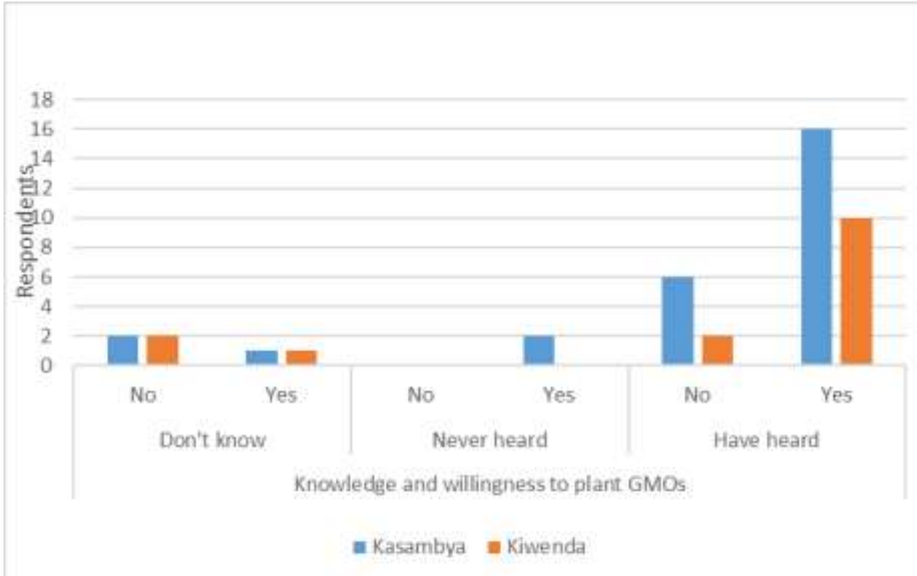

Figure 6.12: Knowledge and willingness to plant GMOs

Worth noting is that 8% (n=2) of the total number of respondents who answered the question were willing to grow GMOs, even if they had never heard about GMOs previously, possibly indicating that farmers have an insatiable desire to try something new. In the rural area (Kasambya), 25% (n=6) of those who had heard about GMOs were not willing to grow them. In comparison, 17% (n=2) of those who had heard about GMOs in Kiwenda were not willing to grow them. Thus, the need for high yields, which farmers can sell to earn more income, is more likely to override factors such as the concern for environment and health risks if the public are willing to buy GMO food.

6.2.8 Regression of perceptions of GMOs

The researcher also conducted a regression of nine variables to find those that may affect perceptions of GMOs and presents the results in tabular form. A disclaimer in the regression is that the study was conducted at the peak of a drought, with media reports at the time indicating that several people had died due to starvation in many parts of the country. The drought forced the Government of Uganda to postpone local council elections and reallocate money to buying food for Isingiro, Teso and Karamoja, which were affected the most (Nakato, 2017). The regression considered nine variables, as indicated in Table 6.10 below.

Table 6.10: Ordinary least squares (OLS) regression of nine variables likely to influence perception

Variables	**Coefficients**	**P > (t)**
Willingness to plant GMOs	-0.92315	0.201
	(0.70757)	
Information sources	-0.12006*	0.085
	(0.06759)	
Risks	0.22829**	0.044
	(0.10902)	
Gender	1.56945	0.155
	(1.07643)	
Age	0.06066	0.839
	(0.29567)	
Occupation	-0.49228	0.490
	(0.70492)	
Education	-0.27668	0.529
	(0.43432)	
Knowledge	-3.76710***	0.006
	(1.29277)	
Benefits	0.11684	0.322
	(0.11625)	
Constant	**9.16561****	**0.018**
	(3.67625)	
Observations	***42***	
R-squared	***0.57358***	
Probability > F	***0.0004***	
Adjusted R^2	***0.4536***	
NB: Standard errors in parentheses		

*** p < 0.01 (99% probability), ** p < 0.05 (95% probability), * p < 0.1 (90% probability)

Closer inspection of Table 6.10 above shows that three of the nine hypothesised variables were found to significantly (p>0.1 or 90%) affect the perception the respondents had of biotechnology and GMOs. Taken together (indicated by the adjusted R^2), these three independent variables explain about 45% of the total variation in attitude towards biotechnology and GMOs. In addition, the f-test (probability F=0.0004) puts forward that these significant independent variables are jointly significant at the 0.01 level (99%). However, it is important to highlight that these estimated coefficients may be biased because of lower sample size (n=42) and the resulting degrees of freedom of choice. Even though the coefficients might be biased due to the preceding factors, important information may still be inferred regarding the direction and level of influence of the variables that significantly affect the respondents' perceptions. The respondents' type of information source was found to have a significant ($p<0.1$) negative influence on their perceptions. Hence, a change in the type of information source would most likely result in a negative change in perception of the respondent toward GMOs. A "spot" of media exposure is more dangerous than a blackout because it encourages the public to talk about science out of context (Arata, 2007:178).

Strikingly significant at the 99% (p=0.006) level, knowledge was found to have a negative influence (coefficient=3.76710) on individuals' perceptions of biotechnology; as individuals gain more knowledge about biotechnology, their perceptions about GMOs are more likely to curve toward rejecting the products. Hence, the more knowledge circulates, the more resistance the proponents of GMOs are likely to receive from anti-GMO crusaders. As noted in Chapter 2, knowledge is an indicator of the quality of attitudes (Eagly & Chaiken, 1993; Midden *et al*., 2002). Although the regression shows that education accounts for about 53% (p=0.529), it is possible to infer that educated individuals tend to gather more information than their less-educated colleagues and use the knowledge to express their opinions for or against GMOs.

Prominent at a level of 95.6% (p=0.044) in Table 6.10 above is that the respondents' association of GMOs with risks was a potential factor influencing their perceptions and attitudes negatively. The risks most probably result from change in information source, thereby triggering knowledge accumulation to pay attention to potential risks, even if the risks are not estimated scientifically. Studies suggest that individuals who associate GMOs with high risks are also likely to link them to lower benefits (Ventura *et al*., 2016).

Moreover, the in-depth interviews revealed that sensitisation was necessary through different media platforms. The fact that the MP and journalists were afraid that the interaction between anti-

GMO activists and the general public may "bias" citizens against GMOs confirms the hypothesis above: A change in the source of information would most likely increase knowledge and result in a negative change in perception of the respondents toward GMOs**.** The results in Chapter 5 and the first sections of Chapter 6 show that there are knowledge gaps worthy exploring.

6.3 Question 4: What are the knowledge gaps in the biotechnology debate in Uganda?

Regarding this objective, the researcher analysed the knowledge gaps identified using the various methods applied in the study. Answering this question was also a way of bridging the gap between the findings and the discussion in Chapter 7. From the content analysis, the face-to-face survey and the in-depth interviews it is clear that there is a knowledge gap driving the GMO debate in Uganda. The study adopted the GenØk (Norwegian Centre for Biosafety) five-point measure for assessing a knowledge gap when applying novel science in multifaceted systems (Nordgård, Bøhn, Gillund, Idun, Grønsberg, Iversen, Myhr, Okeke, Okoli, Venter & Wikmark., 2015). These are risks, uncertainty, indeterminacy, ambiguity and ignorance.

6.3.1 Risks

By adopting biotechnology, Uganda risked losing its indigenous seeds, enslaving its farmers to multinationals, killing indigenous seeds, losing its market for organic products, and risking its nationals to suffering from new and unknown illnesses, among other risks revealed in the content analysis, survey and interviews. It is not clear whether biotechnology could be hazardous in any of these and related ways, and how uncertainties can be managed using conventional risk evaluation procedures. No studies have been conducted to quantify the likelihood of any of these risks occurring if GMOs are adopted in Uganda. The statement, "[a]doption should be on a case-by-case basis" (Scientists A, B, & C, 2017), suggests there could be intervening variables that cannot be exposed by current science. Under such circumstances, it becomes hard to convince either side of actors in the debate because of the glaring uncertainty.

6.3.2 Uncertainty

As in the case of risks, there is insufficient knowledge to compute the probability that the risks will occur. Moreover, no research has been conducted to establish the range of possible hazards and whether the country would be able to manage the risks through conventional approaches.

> I have heard people who wake up on the operating table and tell the surgeon that can I come back tomorrow. We don't wish to get to that, because the opportunity to retract may not be as open (Activist B, 2017).

The assertion made by Activist B above was reflected in the opinions to editors in the newspapers and in the survey results. Biotechnology seems to be a fulcrum for scientific, cultural, political and economic arguments.

6.3.3 Indeterminacy

Biotechnology is a typical example of a phenomenon that is complex, with its tentacles around natural and social systems. As in any study, studies about biotechnology indicate the factors considered and the caveats, as an index that the results generated are inherently tentative, thereby exposing scientific findings to dynamic realities. Scientist A, a breeder interviewed for this study, encouraged users of new knowledge to "always read the release notes". In other words, the seeds or plantlets developed by scientists are supposed to thrive under predetermined conditions that are specified in the release notes. Scientist D, an anti-GMO crusader, noted that GMO seeds are "synonymous with Roundup", meaning that "food that comes from Roundup-ready crops are pesticides". Such arguments support the idea that scientific studies are always reductionist in nature. Moreover, organisations such as the World Health Organization and the Food and Agriculture Organisation support the use of GMOs, while others like Greenpeace and the American Academy of Environmental Medicine disapprove of the technology. In a free marketplace of ideas, the public is likely to take those ideas that resonate with their beliefs, hence a series of (mis)conceptions.

6.3.4 Ambiguity

The content analysis revealed that information about GMOs is interpreted in different ways by biotechnologists, anti-GMO scientists, activists and policymakers in the public sphere. While biotechnologists and some government executives see biotechnology as an alternative to the challenges facing agriculture, anti-GM scientists, activists and some legislators see the technology as a form of neo-colonialism, which is not sustainable and could have far-reaching effects on the health of Ugandans, the environment and the economy. Journalist G (2017) asserted that "Africa is caught up in the middle of this debate".

At the time of doing this research, these plural framings all seemed plausible. While the biotechnologists presented the scientific facts, the social structure did not seem to favour the introduction of the technology. From the survey, it is clear that the public had doubts about scientific breeding, considering that some of the hybrids had not yielded to their expectations. This lack of trust was extended to the government. The activists did not believe that a government that had failed to support viable irrigation projects and postharvest handling, meaningful value-addition schemes for the available agricultural produce, and linking farmers to markets, had the capacity to regulate the use of sensitive technology. Yet the views of the activists could hardly fit into scientific frames. The activists thought that introducing GMOs was a plan by leaders to hoodwink the public as they ran away from their "responsibility of feeding the citizens". Such mistrust worked to inhibit the passing of the Biotechnology and Biosafety Bill, 2012, a key ingredient for commercialising GMOs in Uganda. Additionally, actors accused one another of having been bribed by their respective funders. Besides, all shades of opinion, except farmers, were given a fair chance to express themselves in the media, as indicated in the content analysis. These and other issues, as discussed in Chapter 6, shaped the debate in the complex science-socio-political arena to create a controversy. One journalist summarised the ambiguity of the debate in the following anecdote:

> So, the government must come out and state its position and give guidance to the country through its scientists, through ministry of agriculture. That will help to shape debate and also sensitise the public. We must focus the debate, go back to the drawing board, and even send MPs to the public, to help them [public] understand and the government must always use the media to explain the government position and the scientists should have a working relationship with the media (Journalist C, 2017).

6.3.5 Ignorance

While the survey indicated there was high optimism about the benefits of GMOs, it also flagged that there was great inability to conceptualise and state the possible risks related to using GMOs. This embodied the failure of the general public to ask questions rather than displaying their aptitude to offer the correct response. The sensitisation has been at a high level, with MPs, activists and journalists, thereby relegating the gatekeepers of the agricultural industry – the farmers – to passive participants. The multiple voices and plural framing only exacerbated the knowledge gap so that MPs keep asking for more time to study the issue, a mark that the legislators also do not understand it.

A recent study revealed that the public concerns about the harmful effects of biotechnology and GMOs are largely "mythical fears" (Mbugua-Gitonga, Mwaura & Thenya, 2016:11), attributed to "public ignorance, bad schooling, poor understanding of probability, and widespread and undifferentiated risk-aversion, all stirred up by irresponsible journalists" (Gregory, Agar, Lock & Harris, 2010:207). Moreover, little research has been done on these effects in Uganda, with most of the information cited drawn from North America and Europe. Yet the media can determine the range of issues, depth of knowledge and values emphasised through the media logic by framing, priming and setting the agenda. The media can best play this role with an army of journalists who understand biotechnology and are able to accurately report on the subject in the simplest language. Although a symbiotic dependence between scientists and journalists is necessary to clarify the science behind biotechnology, such moves have been opposed by GMO sceptics (including some scientists) to demonstrate, for the first time, that there is no scientific community in Uganda.

6.4 Summary of findings

The biotechnology debate involves different actors and interests. Publications are torn between the professional obligation of balance, market share and evidence-based science when reporting about GMOs. The subject is treated as peripheral, and is reported haphazardly by freelancers, who are hardly facilitated in the absence of science desks, thereby exposing the journalists to bribery from interested parties. The debate is punctuated by counteraccusations by the actors and stigmatisation of the parties holding contrasting views in what appears to be an attempt to force opponents into a silence. The coverage is dominated by legislation and influenced by issues in other countries. Generally, there is growing public interest, as the subject of crop biotechnology has attracted scientists with varying expertise, politicians, NGOs, and ordinary people to express their views through the newspaper pages. Overall, more men have tended to express their opinions on the subject in form of articles. Journalists are more inclined to use male sources than female sources in their stories. A majority of the articles were biased, as they were source-generated by the individuals and organisations known to directly support or oppose GMOs.

This study finds that knowledge about GMOs is still low, as evidenced by the complex diversity of perceptions about them. Middle-aged people (26 to 41 years) were more likely to accept GMOs than their younger and older counterparts. Moreover, there is public mistrust of government institutions. Gender, occupation and level of education were found to affect perception in various ways, particularly of the expected advantages and risks associated with GMOs and the questions regarding the ethics of such science. The study reveals that a change in the source of information has a negative impact on individuals' perceptions of GMOs. Therefore, the more knowledge that circulates from different sources, the more resistance proponents of biotechnology are likely to receive from the anti-GMO crusaders. Support for GMOs in Uganda is therefore still open to a public contest, with the journalist and money factors influencing the debate, visualised as the media-economics bicycle-chain model in Chapter 7.

Chapter 7
Discussion

Which particular institution here in Uganda are you confident about? Is there a particular legislation where we have scored highly on enforcement? (Activist B, 2017)

7.1 Introduction

This chapter comprises a discussion of the study results. The findings in Chapters 5 and 6 are examined in the light of the literature review in Chapter 2 and the theoretical framework in Chapter 3 to submit the implications of the study. The discussion was guided by a general question regarding the ways in which media coverage of information about biotechnology influences the public perception about its products, especially GMOs, in Uganda. Conclusions are drawn from the discussion of the results in comparison to global studies to form Chapter 8.

7.2 Discussion and implications of findings

The content analysis has illustrated that the public tended to respond to a spike in news with multiple opinions to the editors. Their thoughts were published on the opinion and letters-to-the-editor pages, where readers submit views on previously published stories, and selected letters are published as articles. Responses from readers are a sign that the audience is interested in an issue (Duffy *et al*., 2005; Gurău & Ranchhod, 2016). The letters do not only demonstrate the readers' level of curiosity, but are also aimed at garnering support for the writer's point of view. The rising curve of opinions and letters to the editors in Figure 5.1, thus, demonstrates the growing interest in the GMO debate, especially with regard to what should be regulated vis-à-vis the perceived benefits and possible effects. Secko *et al.'s* (2013) science-in-society models discussed in Chapter 3 become crucial in choosing stakeholders to involve in the debate and deciding how they should participate. For journalists, such challenges are reflected in the choice of sources quoted in their stories, as they try to fit their facts in Galtung and Ruge's (1965) news values.

Biotech a fringe subject: The fact that biotechnology was given only six editorials in four years, however, suggests that the issue is side-lined in the editors' view of newsworthiness. A similar study found that science as a broad subject was given less than 2% of all editorial space in selected South African media (Van Rooyen in Claassen, 2011:351). Yet Eveland and Cooper (2013:14089) report that only "0.5% of science journal articles get media coverage", and most of the coverage is commanded by health and medicine. The choice bias was confirmed by the editors interviewed for this study, who posited that biotechnology is seen as a fringe subject that is not likely to vie for the attention of their readers, in the same way that political scandals, corruption, kidnapping, accidents, murder, sports and nocturnal activities of celebrities would. In the editors' opinions, no one buys a newspaper to read about biotechnology. Considering that editors are the gatekeepers who choose, shape and direct the flow of content in their publications according to Altheide and Snow's (1979) media logic, by producing, reproducing and transforming information, then the editorial and actual coverage is likely to echo their positions, thereby biasing debate (Czerniewicz, Goodier & Morrell, 2017; Kurath & Gisler, 2009; Ross, 2017). It is possible that if more editorials had been dedicated to biotechnology, the opinion bars in Figure 5.1 would have been higher. Nevertheless, bias and perception are too dynamic to be understood through content analysis alone. Galata (2017) used cultivation analysis to understand the coverage of GMOs, but she also recommends the Orientation-Stimulus-Orientation-Response (O-S-O-R) model, through which participants are exposed to a message before they are surveyed. This study combines content analysis with a face-to-face survey and in-depth interviews to get a fairer picture of the mediated public sphere in the context of biotechnology in Uganda.

Coverage dominated by Bill: Legislation on biotechnology as an innovation to produce GMOs accounts for more than half of the articles published by both Ugandan publications targeted in this study. Yet dissemination, application of biotechnology, ethics, politics, nutrition, religion and culture individually scored less than 5% of the overall coverage. Such a finding points to the centrality of legislation in adopting GMOs. It also emphasises that Uganda is sitting on the fence. On the one hand, the country has a policy under which scientists have been doing research since 2003 (Republic of Uganda, 2008), using taxpayers' money. On the other hand, there is no law to allow the products to leave the laboratories for farmers to grow them. While some products are reportedly ready for release, the Cartagena Protocol only allows the release of such seeds/seedlings/plantlets from laboratories and confined fields after domestic legislation (Secretariat of the Convention on Biological Diversity, 2000).

As such, the controversy regarding legislation of biotechnology dominates coverage. An earlier study suggested that adding opinion, letter pages and the editorial to analysis, as was done in this study, increases the chances of getting a fuller overview of pertinent news content (Reul *et al*., 2016). This is premised on the fact that what eventually appears as content in the newspapers is a sum of the interests of editors balancing personal views, media-house policy, national laws and sociocultural considerations and professional practices vis-à-vis current scientific evidence regarding GMOs. Harmonising these interests suggests that biotechnology is likely to be covered from a wider perspective as the editorial tries to absorb pressure from multiple angles that converge in the newsroom in deciding the news values. To cope with such pressure, every newsroom adapts to "internal constructions, [and] disciplinary practices that produce patterned communicative geography of the public sphere" (Boykoff & Boykoff, 2007:1202). This adaption cartography negated the scientific issues and limited the parameters for debate to mainly legislation on GMOs in the public sphere as the issue made little sense in the media logic of the two newspapers. In the case of the *New Vision* and the *Daily Monitor*, it limited contact with the subject as a means to play it safe, although the few editorials and articles published were controversial and reflected the pressures stated earlier in this sub-section.

Inconsistencies in news coverage: The content analysis reveals that the *Daily Monitor* and the *New Vision* are inconsistent in their news coverage of biotechnology. The spikes tend to happen when the Bill is mentioned at policy level, as was the case in 2013, regarding consultation workshops on the Bill, the mention of GMOs by a minister or the president at political gatherings where they talked about poverty and hunger, field tours organised by biotechnology organisations, or press conferences organised by anti-GMO activists. Journalists' reports from such events enlisted audience responses in the form of opinions and letters to the editor in the newspapers. This finding confirms earlier assertions that GMOs, as other controversial topics, tend to be "under-covered unless events fit certain narrative streams" (Pierro *et al*., 2013:13), and only appear in the news as "episodes" (Caple & Bednarek, 2013:27; Ceccoli & Hixon, 2012:3; Meyen *et al*., 2014:277). Other scholars affirm that "peaks in media coverage tend to coincide with important events" (Geary *et al*., 2016:740). For instance, stories of climate change tend to peak during extreme weather conditions involving drought and water shortages or hurricanes and floods, or during international conferences (Berglez & Nassanga, 2015; Cramer, 2008; Olsson & Eriksson, 2016; Thaker *et al*., 2017). This analysis is consistent with the media logic theory discussed in Chapter 3. The implication is newspapers may continue tying biotechnology to politics as a way of selling it to their readers.

Biotechnology as news business: Biotechnology and other science stories have to make economic sense for the newspapers to cover them, since media houses are money-generating entities that need to sell content/information. Several studies attest to the assertion that media are in the news businesses (Karidi, 2017; Ross, 2017; Sandman, 1994; Sarrimo, 2016; Su *et al*., 2015). As commercial entities, they must have business models that are profit-oriented.

Hence, the news peg (what makes the story newsworthy) must consider the news values discussed in Chapter 2 to keep the business even from the economic bottom line (Galtung & Ruge, 1965; Harcup & O'Neill, 2001; Karidi, 2017). Often, editors use "literary tricks" to appeal to a sense of humour and to refine events and issues as a way of making them newsworthy through "glib and slick" (Radford, 2010:95), depending on the "scientific and risk management controversies" (Navarro *et al.*, 2011:1). Frequently, this results in exaggeration and consequently the distortion of facts, especially if the story is placed outside the science section to lure readers' attention. For Palmerini (2010:114), the "cover is a very risky place for a science story to be". The literature here explains, on the one hand, why the news stories in both the *Daily Monitor* and the *New Vision* are controversial, citing science facts, fiction from the activists, and politicians for the stories that were in the news sections of the publications. On the other hand, the developmental stories in the *Daily Monitor*'s pull-out are less sensationalised and tend to present a positive picture of biotechnology. Possibly, the commercial imperative to sell the newspapers drives biotechnology stories from the front pages of both publications to inside pages. Moreover, the finding confirms that the politicisation of an issue draws more attention to it, thereby making it sellable in line with the media logic theory and the science-in-society model discussed in Chapter 3 (Altheide and Snow, 1979; Gauchat, 2012; Mazzoleni, 2008; Secko *et al.*, 2013).

The implication of the finding above is that different stakeholders are likely to court different politicians to support their pro- or anti-GMO agendas to drum up support for their interests. This may require lobbying to harmonise the interests of politicians, who can increase the visibility of biotechnology issues, and scientists or anti-GMO activists. Kings, religious leaders, musicians and comedians may be drafted into the debate to give opposing sides mileage, as it happens – although inappropriately – during political campaigns. The use of opinions leaders to support public causes has been witnessed when mobilising communities to support for public issues, such as health drives such as mass immunisation, cancer and fistula campaigns. Music, dance, drama and comedy (theatrics) have also been used in HIV/Aids awareness campaigns in Uganda. Edutainment may be co-opted into communicating GMOs.

No science desks: The two publications neither have policies on covering science nor dedicated desks to aid that cause. As observed in Chapter 5, general reporters contribute significantly to covering science, as most specialised reporters are freelancers who cover biotechnology because of passion for the subject. Several studies have recommended the establishment of science desks in newsrooms to improve reporting on subjects such as health, climate change and biotechnology (Bucchi, 2016; Claassen, 2011; Rensberger, 2010). Such a move would guide reporters in getting it right and 'balancing' the arguments on a subject where the science is overwhelmingly one-sided, but not enough to garner the critical public support to drive public perception in its favour. The move could also possibly end the limited coverage of this subject, seen as crucial because it concerns food. Thus, the scientific issue must make economic sense if it has to be published in the mediated public sphere.

Freelancers: In addition to a lack of dedicated science desks in the newsrooms, the limited coverage could be explained by the fact that most of the journalists covering biotechnology (specialists) are freelancers. Covering biotechnology sometimes requires journalists to be away from the work station for long hours, or even to spend days in the field or in workshops. Full-time journalists would find it hard to beat their targets of reportedly 30 stories a month if they are to spend long hours or days 'chasing' a single story. For example, scientists sometimes need time to read a study before making comments to journalists pressured by daily deadlines. Yet writing a good science story requires a lot of time, which staff writers may not have (Maille *et al*., 2010; Massarani & Peters, 2016; Ross, 2017). Other studies have documented the dismantling of science desks and the disappearance of trained science, technology and environment staff reporters as the journalism industry tries to conform to the commercial media logic (Scheufele, 2013, 2014). Indeed, good science stories often challenge the value of immediacy in news reporting. Perhaps the freelancers have the patience to wait for the scientists to analyse studies and make comments; to attend workshops and conferences and tour experimental fields; and to translate the facts about biotechnology into palatable stories for the public sphere. Two aspects of this finding are critical. Firstly, some stories on biotechnology were written accidentally, since the writers had written only one story in the four years studied. Some stories were also published because of the prominence of the individual involved, not because biotechnology was the focus. Secondly, it is hard for management to mentor many science journalists in the absence of a science desk where guiding and mutual learning can take place. The implication is that improving the quality and quantity of biotechnology stories covered will remain at the periphery of the newsrooms in the absence of science desks, whose establishment is considered costly in the capitalistic media market.

Unfacilitated journalists and anonymous sources: Because they are freelancers, journalists covering biotechnology activities are rarely or not at all facilitated, thereby exposing them to possible bribery by their pro- or anti-GMO sources. Göpfert (2010) argues that the corporate industry offer money to freelancers, who spend long hours writing articles for which they do not get proportionate pay. In other words, it is the money from the partisan sources, allowances for travel/brown envelopes, that is sustaining biotechnology reporting in Uganda, suggesting that journalists sort of are 'investors' for the reputable, but cash-strapped, newspapers that cannot effectively support news gathering. To a certain extent, this influences media houses to run public relations messages in a form that is disguised as pseudo-journalism (Davies, 2009). These sponsorships could explain the 39% of articles analysed in this study that had anonymous sources of information. Besides, Göpfert (2010) argues that the symbiotic dependence between journalism and public relations by way of sharing information should recognise the importance of the two industries sticking to their respective roles. Public relations should allow journalists to discover the weaknesses in the arguments by the actors in the biotechnology debate that are worth criticising to enable the media retain its saltiness. The biotechnology industry will not benefit from being covered by newspapers that have lost their integrity. In the current setting, it is hard for the media to play watchdog in relation to the biotechnology industry. The reporting is driven by Secko and co-researchers' science literacy and contextual models, which are largely linear in nature. By implication, the limited facilitation to journalists suggests that reporting biotechnology will mostly be driven by the top-down (deficits) approach, where information is mostly one-way – from experts to ordinary people.

Emotions: The articles published in the newspapers embody the emotions arising from the accusations and counteraccusations of the parties involved. For instance, the opponents separately accuse journalists of taking bribes from their challenger to promote opposing views. The journalists deny all the accusations, pointing to the polarisation in the debate, which is marked by ignorance on how the opponents in the biotechnology industry work – secrecy and antagonism (Lamphere & East, 2016). Thus, the differences in opinion on biotechnology are inherent and provoke the emotions, that are noticeable in the public sphere (entire debate). Indeed, "hearing scientists, policy-makers, industrialists and others disregard or dismiss their [opponents] concerns only broadens the gulf and intensifies the anger and mistrust" (Osgood, 2001:90). Although the debate is necessary, it may not be adequate to stop the "conspiracy theories" among the general public, who perceive scientists and government as being allies of multinational corporations that are "ostensibly preoccupied with making profit" (Kangmennaang, Osei, Armah & Luginaah, 2016:37). The debate seems to mask the development of GMOs as a 'money-eating' scheme for the stakeholders. It is likely that this emotional debate will cause a chain reaction, as the anti-GMO movement imprints its impact on the mediated public sphere. If the debate is left to continue without considering scientific findings and evidence-based recommendations, the controversy and accompanying hyperboles will bring emotions to a boiling point, with the possibility of violence against scientists and their research.

Stigmatisation: The parties and organisations involved in the GMO debate are stigmatised for taking or not taking the position of their opponents. In various articles and interviews, terms such as “renegade”, “crooks”, “terrorists” and “traitors” were used to refer to biotechnologists, and the terms “fundamentalists,” “erroneous” and “ignorant” or “scare mongers peddling falsehoods” were used to refer to the anti-GMO campaigners. Yet it is public knowledge that scientists can create dangerous products, such as toxins, (bio)weapons and diseases, if precautions are not taken. Sometimes scientists participate in illegal activities such as organ trafficking, soliciting money from dubious sources, and forging of results to support a partisan position. They are also corruptible. Scientists, in short, can also waste taxpayers’ money on unfeasible projects. A study affirms that as various scientists struggle to be on the right side of the facts, “dissident scientists are stigmatised by mainstream scientists” (Fjæstad, 2010:127). Earlier studies have hinted at the potential for results from surveys on genetic engineering to be used to discriminate against those with opposing views, or to shield those with whom they share an opinion climate from seclusion (Aerni, 2002; Bauer *et al*., 2007; Caulfield, 2005). The stigmatisation creates a cartel of knowledge experts that coerces minorities into a spiral of silence (Noelle-Neumann, 1974). The minorities’ hesitance to express themselves allows the majority views to morph into the predominant assessment and for the media to capture them as such. Often, this dominance of the public sphere driven by the media logic leads to the denial of funding to those with minority views.

This study reveals that even journalists reporting the beat of biotechnology are mocked in the newsrooms by colleagues, who claim they are “bought”, thereby forcing some reporters into self-censorship and reinforcing the spiral of silence. The discrimination is worsened by the fact that there seems to be a science-social stigma among the public, since they favour stories on politics, entertainment and sports, as stated by the editors. The implication is that information meant to be for public consumption is hoarded, as key stakeholders go incommunicado to insulate themselves against public judgement.

Biotechnology and corporate communication: The debate has attracted specialists in different fields of science – medicine, soil science, communication officers, politicians, and the general public – a pointer to the public attention being paid to this new science. Such participation is encouraged in Secko and co-researchers' (2013) lay expert and public participation models discussed in Chapter 3. This participation is proof that biotechnology, like many fields of science, has become corporate. Dialogue has become a "valued tool for guiding public sector planning and services", especially in science/environment-based businesses that require lobbying (Gregory *et al.*, 2010:206). The new trend encourages 'public engagement' as science becomes engrained in democracy – a perceived symbol of the civilisation of our technoscientific societies (Bhatta & Misra, 2016; Hicks, 2017; Nisbet, 2009; Outram, 2010). Such engagement is noted by Secko *et al.'s* (2013) in their model, which not only acknowledges the limitations of science, but also encourages public participation as a way of democratising science in society. To emphasise the importance of engagement, one scholar contends that, while it is "critical" to conduct science activities, to "defend [science] is kernel of the political realm" (sic) (Franklin, 2010:156). While the scientists develop the scientific knowledge and products, the politicians take the credit or the blame if the science works or does not work for the public respectively. Besides, the politicians possess the power to allocate the resources, including funding, land and equipment, to do science. In the case of Uganda, the majority of the research centres making GMOs are owned by government, hence the interest of people from diverse backgrounds to write about biotechnology and GMOs. The implication is that political interests will override any other issues related to biotechnology, and this may extend to the public sphere.

Gender and biotechnology: The study reveals that men are more active by way of writing articles, either as journalists or members of the general public. This finding contradicts a recent study that showed that women "express greater concern about GM organisms and are less likely to approve GMOs for consumption than men" (Sarathchandra & McCright, 2017:3). The difference could probably be attributed to their lower levels of literacy in Uganda, at 68% compared to that of men at 77.4% (UBOS, 2016b:29). Even then, the ratios of literacy do not match the low number of stories and opinions posited. Perhaps women prefer other sources of information, such as television, radio and social media, or they may be reading other newspapers that were not considered for this study.

Although not many studies were found on the status of women journalists in Ugandan newsrooms (Nassanga, 1997; Semujju, 2015), a recent study has demonstrated that the clear difference in the treatment of male and female journalists continues, as women are still marginalised in decision-making positions. The study posits that an innate gender bias and feminisation prevent women from covering hard news. Whereas the number of female journalists covering hard news stories such as politics, business and crime is recognisable, most “female reporters remain pigeon-holed in those traditionally female story areas” of health, entertainment, and education (North, 2016:356).

However, North’s results, which imply that a surge in the number of women in the newsrooms leads to the femininisation of news, may not apply to Uganda, where the editorial section of the biggest multimedia newsroom, Vision Group, was headed by a woman at the time of doing this research. Further, Nation Media Group’s television station, NTV Uganda, had a woman as its managing director from 2013 to 2017. At the same time, Uganda has for close to two decades been home to Africa’s first women’s radio, *Mama FM*, started by the Uganda Media Women’s Association (UMWA). Yet marginalisation in the media industry and the public sphere cannot be dismissed based only on these facts. The explanation for fewer stories about biotechnology being posited by female reporters may then lie outside the newsroom and may be a subject for further research.

Furthermore, men were six times more likely to be used as sources in stories on biotechnology, but women’s chances of being quoted more than tripled when they were quoted in the same story as men. These findings are consistent with results from related studies. Women are at best underrepresented as sources of information for news and, at worst, voiced as victims, or as associates of men in the news, or used as decoration, especially in photographs accompanying science stories (González, Mateu & Pons, 2017; Ross, 2011; Zoch & Turk, 1998). A recent international study on membership of national science academies reveals that women comprise on average 12% of members, that the average standing is 10% in Africa, with South Africa leading the continent at 24%, followed by Uganda at 13% (Ngila, Boshoff, Henry, Diab, Malcolm & Thompson, 2017:3-4). Another study illustrates that women science graduates are less likely than men to work as professionals in their fields due to sexual harassment in the work environments. As a result, less than 14% of patents are filed by women (Organisation for Economic Co-operation and Development [OECD], 2017:np). This outcome suggests that, as in politics, women scientists struggle to break the structural institutional, professional and economic stereotypical challenges facilitated by the macho culture of mainstream media that posits them as a powerless group, thereby perpetrating gender-based hostility. Structural factors freeze women out of the clusters of prominent people likely to be sought by journalists as news sources. The implication is that, without deliberate efforts to seek the voices of female scientists, women’s expert voices will continue to be underrepresented in biotechnology stories. As it appears, even with Secko *et al.’s* (2013) lay expert and public participation models discussed in Chapter 3, the deficit model seems to persist, as the media logic alienates women out of the news and the public sphere.

Foreign influence: Although most articles do not indicate a foreign source, reference to other countries in in-depth interviews testifies that the debate in the Ugandan newspapers has external influence. There is a correlation within and between examples given by the respondents. Interviewees tended to cite the same countries, especially Brazil, the USA, South Africa and Burkina Faso, and quoted similar sources of information, especially websites and journals. Moreover, most interviewees had attended workshops abroad or meetings organised in Uganda that were facilitated by a foreign expert. This is not surprising, however. Top secrecy is a strategy used by seed and chemical companies to sustain their businesses through legitimisation. Since the mid-1990s, when GMOs were commercialised, "Monsanto consistently employed discursive resources that concealed details about actors and action, reflected trends among experts in global sustainability discourse, and reshaped narratives to promote itself, products, and biotechnology in general" (Lamphere & East, 2016:1). These subtle external voices collectively influence the national debate when stakeholders selectively apply knowledge from other countries to locate their country on the global stage. When "externalities are in place", countries are "prone to consider options more attractive if they are consistent with what others have chosen" (Pakseresht & McFadden, 2017:4).

Moreover, external factors determine the internal tactics adopted by activist movements to influence decision making on the adoption of technologies, with due consideration to international trade, social and cultural factors (Bett, Ouma & De Groote, 2010; Huff & Kruszewska, 2016). Wenzelburger (2017:19), however, reminds us that, while external influence is real, governments avoid being seen as caving in to adopt or reject GMOs as a "reaction to external pressure", since the liberalisation of GMOs can have direct consequences in terms of the support for the government in power. The various external and internal interests as presented in the media contribute to the complexity of legislation in Uganda. Government's inability to base on media reports to predict the consequences the adoption may have on its public support could explain its reluctance to support the commercialisation or outright rejection of GMOs in a relatively unstable political environment, that has to contend with differences in position.

Indeed, government passed the Biotechnology and Biosafety Bill on a day when there was no opposition legislator in Parliament. The opposition Members of Parliament (MPs) skipped

Parliament to show solidarity with their 24 colleagues who had been suspended for defying the Speaker's ruling to allow a motion that would pave the way for the removal of the age limit on the position of presidential candidates. The motion would imply allowing President Yoweri Museveni, who had ruled the underdeveloped East African nation for over 30 years, to contest after reaching the age of 75, in a country where majority of the MPs belong to the ruling party.

While Europe views GMOs as the future of food production, Russia and Italy are increasing organic food production and stamping out GMOs (*Russia Today*, 2017). Besides, the United States ambassador to Uganda noted at the workshop of the United States Agency for International Development (USAID) on 'Feed the Future Uganda Agricultural' in Kampala that Uganda's fertile soils (without GMOs) have the capacity to feed 200 million people, beyond its current population of 41 million (Senyonga, 2017). The push by scientists and government to adopt GMOs is then dwarfed by campaigns by some developed countries to move away from the same technology. Such confusing signals in media reports, influenced by the commercial logic, only add to the controversy and leave the public wondering whether they should eat (grow) GMOs or leave them in the laboratories. The international and local media logic splits the public sphere, where GMOs are discussed.

Uganda's struggle to pass the law is reminiscent of other African countries facing similar scenarios since the turn of the 21st century. Suspicion about passing such laws heightened when the USA demanded that African countries receive its food aid unreservedly, with the intention of promoting its foreign policy and boosting its multinational firms. In the face of hunger, Zambia rejected such bullying when it rejected consignments of US food in 2002, sparking a debate on GMOs on the continent (Zerbe, 2004). Cameroon, Ethiopia, Ghana, Kenya, Malawi, Mozambique, Nigeria, Zambia and Zimbabwe are also struggling with legislation (Cerier, 2017). With the help of NGOs and donors, African elites have used their affiliations to Europe to influence the enacting of "stringent" policies, regulations and legislation similar to that of their European counterparts (Bett *et al*., 2010:332), where individual member states of the European Union have to decide whether or not to cultivate GMOs and label them before distribution (Rzymski & Królczyk, 2016). From the content analysis, face-to-face survey and in-depth interviews, there is no doubt that Uganda needs a law to regulate biotechnology, but the dispute is about the strength of the law.

The scientists want the US approach, where GMOs have been allowed to accommodate companies like Monsanto and DuPont, therefore a law that will allow them to patent their products and commercialise the respective crops under research. However, the NGOs want a rigorous law that will not burden Ugandans with patents, while holding government, scientists, biotechnology institutions and their funders accountable in the case of liabilities arising from scientific activities. In addition, the Bill should cover other forms of biotechnology, such as medical and industrial products that may emanate from the agricultural products. Although the Parliament of Uganda 'passed' the Bill, the necessary level of public engagement seems to have been skipped. However, the president refused to sign the Bill into law (Okuda, 2017b). The government is torn between shielding the public against harmful new products and ensuring that potential new products are accessed by the public to avoid situations where products initially considered harmful are approved to be of substantial benefit or vice versa (Ceccoli & Hixon, 2012). With or without a law, the debate is likely to be fuelled in relation to the impact of labelling on trade and whether the public will perceive GMOs to be as safe as crops bred through conventional means. The implication is that future debates may focus on whether legislation should pay attention to the process or the products of biotechnology and the media logic is likely to drive the direction of the debate.

Use of the terms biotechnology and GMOs: The terms biotechnology and GMOs were used interchangeably, a sign that the debate is following the phrasing in the Bill. Scholars argue that the "choice of terms influences how audiences respond to biotech stories" (Navarro *et al.*, 2011:8). In terms of media logic theory, the newspapers were accurate in capturing the audience and determining the flow of scientific information in the public sphere. Journalists are writing for the "imaginary reader", in reaction to the "needs of the audience" (Mellado & Van Dalen, 2016:3). However, discussing biotechnology broadly, from the narrow perspective of the law meant to promote GMOs, only deepens the controversy. The debate would have been more focused if the Bill had a clearer name.

Tone of articles: Generally, the articles are biased either in favour or against biotechnology. In his view, Petersen's (2001:1257) asserts that articles on genetics tend to "reflect social biases and assumptions". In the case of the *Daily Monitor* and the *New Vision*, a lot of the biased opinions come from the research institutions and their researchers promoting GMOs, and NGOs opposing GMOs. Such articles exaggerate the perceived benefits and risks associated with GMOs. These articles are enhanced by press releases and media invitations to public relations events. The publication of the biased opinions of representatives of organisations, who also often serve as the faces of institutions, suggests that "mainstream news media are elite-biased" (Raupp, 2017:4). While journalists do not always rely on information from press releases or the opinions of institutions, source-generated information influences the stories reported or the opinion articles accepted for publication by the editors as a way of cultivating effects and polarising an issue (Caulfield, 2005; Dai *et al*., 2017; Galata, 2017; Göpfert, 2010; Maeseele & Schuurman, 2008).

The biases are often linked to the professional difference between scientific research and mass mediatisation cultures, as the two institutions have different histories (Massarani & Peters, 2016; Peters, 2013; Petersen *et al*., 2009). However, the two-culture argument has largely been debunked (Bucchi, 2016; Maille *et al*., 2010), as journalists have "become crucial partners in the construction of science meaning whose role is sanctioned by all concerned" (Dunwoody, 2008b:69). Through in-depth interviews, the study revealed that biotechnologists had co-opted journalists into the biotechnology industry, although such arrangements were criticised by the anti-GMO activists, who argued that the marriage was not blessed by 'national interests'. Nonetheless, the integration of reporters marks the end of an era of inadvertently downgrading the media, the chain-link in sharing scientific information with the public. By the media logic theory, such integration indirectly subsidises the cost of news gathering. Thus, using news values and framing, the media logic has and will continue having influence on the GMO debate in Uganda.

Controversy of editorials: One in two editorials was controversial. Since the editorial represents the position of a newspaper (Kangmennaang *et al*., 2016; McDaniel *et al*., 2017), biotechnology is a divisive issue at several levels when considering the working conditions of the journalists, their individual beliefs and professional practices, and the economic, political and sociocultural factors in a society. The lack of consensus is undeniably epitomised by the disagreements among scientists, politicians and (potential) consumers. These differences in perception were also glaring in the newsroom and media content, and were demonstrated in the in-depth interviews and content analysis. Although the multiple voices are important to demonstrate the uncertainty of biotechnology, they are not useful, since the science is still novel and non-biotechnologists do not have substantial alternative views to offer (Dunwoody, 2008b). Besides, journalists do not want to concretise biotechnology as a fitting science for Uganda, for fear of the scientific mechanisms that may query such knowledge in other studies. Later research may leave media houses red-faced as a result of publishing falsehoods. Considering that conflict is a news value in itself that "creates a peak in media coverage" (Navarro *et al*., 2011:1), and "journalists' ability lies in the power to select voices" (Dunwoody, 2008b:69), the newspapers choose to retain their credibility by presenting as many competing voices as possible. This media logic allows the actors in the biotechnology debate not only to inform the public of their positions, but to also give the different factions an opportunity to know the opposing views. So, even scientists (non-biotechnologists) are relying on the media to know about biotechnology and use the same channels to respond. Such an approach allows the audience to decide based on weight of evidence (Claassen, 2016; Dunwoody & Kohl, 2017; Rensberger, 2010). Even so, the tendency by journalists to ‘throw’ information at the public to weigh up for themselves leaves the citizens more confused than before they received the information. Hence the debate is likely to get fiercer and leave ordinary people on the fence between indigenous practices and GMOs.

Source-generated articles: Most of the articles were source-generated, or the actors, individually or through their organisations’ public relations and outreach departments, influenced the coverage by staging events, preparing tip sheets, choosing the speakers and reporters and therefore the angle. Scientists and their organisations also choose the journals that journalists can access. At least half of the science stories are source-generated, “so scientists are able to strategically package news items for journalists” (Petersen *et al*., 2009:515). Studies show that journalists select and frame from the available information (Göpfert, 2010; Navarro *et al*., 2011; Maeseele & Schuurman, 2008). The organisations involved have thus been able to drive the agenda by benefiting from the media logic and the science literacy and contextual models, with science journalists as passengers playing a development journalism role. But the situation changes when biotechnology is presented in political forums, especially Parliament, where generalists cover the events. The generalists tended to present the competing issues, including raising issues of public interest, in what appears to be an illustration of the watchdog role of the media. Unfortunately, the watchdog role is not extended to investigating biotechnology, although the stories deal with controversies in Uganda. Such investigations could have unearthed the sources of funding, checked raw data and past scientific papers for mistakes. The blame cannot solely be put on newspapers for not sanctioning investigations, but investigative reporting generally is still not well-established in Uganda, and is usually limited to covering politics and crime. Science is a neglected beat. The implication is that science organisations, and especially departments with information on biotechnology, need to sponsor reporters to cover their events, if science is to benefit more from the media logic. Although this is not a desirable phenomenon, there are no immediate alternatives for increasing coverage of biotechnology.

People versus reports as sources of information: The shortage of local sources leaves journalists with limited options – dependence on reports and scientific journals if they are granted access. The chances of a biotechnology story substituting a human face with a report were almost half of all the articles analysed for this study. Indeed, many articles were based on reports alone. This could be explained by the availability of only a few scientists interested in speaking about the subject, as the journalists noted in the in-depth interviews. The implication is that, as long as scientists shy away from commenting, the debate on biotechnology will continue featuring a limited range of views as journalists struggle to gain and maintain sources, a situation best explained by *Secko et al.'s* science literacy and contextual linear models and the commercial media logic. Stigmatisation of the parties involved may exacerbate the limited range of opinions.

Photographs: Most articles were published without original photographs. Pictures are a vital part of storytelling, as establishments, closeups, standalones, or as illustrations in the form of drawings, maps, plans and infographics, satellite photographs, tables or combinations of these to visualise information. The use of photographs or visuals in science communication, and particularly in communicating biotechnology, serves as "irrefutable evidence, lending credibility to a particular definition of genetics" (Petersen, 2001:1259). Photographs provide greater comprehension to articles. However, the use of an internet open-access picture of a tomato being injected with chemicals purporting to show how GMOs are made, seems to scare rather than demonstrate the actual laboratory work (see Figure 5.6). Moreover, this particular picture was published several times, a sign of laziness on the part of journalists, thereby denying the audience diverse angles to the issue. Scholars say that international information sharing through the internet encourages "laziness" by making journalists reluctant to seek local sources to answer newsworthy questions (Massarani, Buys, Amorim & Veneu, 2010:77). Journalists and editors hinted at the same during the in-depth interviews. On the part of the newspapers, the reluctance to use original photographs, but just occasionally picking pictures from the internet, suggests an obstacle in information flow. Such pictures have more potential to scare, rather than invite the audience to accept GMOs. The pictures also suggest that the gatekeepers (editors) have a negative perception, represented by the syringe/needle, chemicals and tomato. Thus, the news framers' views influence the media logic. The implication is that the newspapers are likely to continue churning out negative articles, since the gatekeepers are largely biased against GMOs.

Awareness, educating, and sustaining debate: The newspapers served the role of creating awareness, educating the public, sustaining debate and generating an issues culture, as discussed in Chapters 2 and 5. For an issue to stay in the media for the four years of study, and beyond, public interest has to be maintained. The increase in the number of letters and opinions on the debate is evidence of Downs's (1972) attention cycle, also discussed in Chapter 2. The cycle explains the variations in media coverage of biotechnology, marked by spikes of journalistic coverage and floods of opinions from the audience. It is possible that increased coverage will attract even more opinions in the newspapers, and the debate may spill over to radio, television and social media, before trickling into daily 'machineless' conversations, if the subject becomes popular and the editors find it worthwhile in their media logic.

Education and perception: Although the face-to-face survey did not find education to be a direct factor in determining knowledge about GMOs, the fact that newspapers are a medium for a literate population creates the link. Studies differ in their analysis of education and attitude. At least two studies highlight that educated people are more likely to perceive GM crops as being beneficial (Oguz, 2009; Sarathchandra & McCright, 2017). However, other scholars have argued that educated people tend to be more sceptical about the safety of GMOs (Braimah *et al*., 2017; Huang & Peng, 2015; Midden *et al*, 2002). The current study reveals a more complex relationship – a radical middle of individual expected benefits. The study finds that educated people are argumentative about food-related issues, but do not support either of the above scholarly positions. The fact that 50% of those opposed to growing GMOs had some secondary and post-secondary education suggests that support depends on the benefits an educated person stands to enjoy by supporting either side.

A more plausible explanation is provided by Maes, Bourgonjon, Gheysen and Valcke (2018:16), namely "GM acceptance correlated more strongly with subjective knowledge [what they think they know] than with objective knowledge [what they know in reality]". Educated people tend to read newspapers, write opinions in the same media, and access several sources of information online, in books and other forums, which often carry a lot of misinformation about GMOs. The difference in access to information expands the knowledge gap in the public sphere. Therefore, as more negative information about GMOs circulates, Uganda's elite are likely to resist the technology even more, as evident in the opinion pages of the *New Vision* and the *Daily Monitor*. However, propositions by other members of the elite are also likely to increase, as protagonists turn to online sources that tend to organise information and syndicate it, based on preferences and using algorithms, for audiences other than the mainstream media.

Farmers more informed than the rest of the public: Farmers were more likely to be informed about GMOs than other people in the same community. Their knowledge level stood at 67%, compared to 7% for those who were not involved in farming. By comparison, the surveys conducted in Tanzania put farmers' knowledge at 24% (Mnaranara *et al*., 2017:593). In both cases, the farmers constituted the highest number of respondents. In Tanzania, the low level of awareness was attributed to a combination of a low level of education and limited access to relevant information. In the case of Uganda, the high level of awareness can be attributed to the choice of study areas near the National Crop Resources Research Centre (NaCRRI), coupled with the fact that some members of the population chosen had participated in another survey that asked questions about GMOs, conducted by students studying agriculture a year earlier.

The general level of awareness of GMOs in the current survey was recorded at 71%. This is relatively high compared to similar surveys in Tanzania (The Government of Tanzania, 2012:16), Ghana (Zakaria, Adam & Abujaja, 2014) and Kenya (Bett *et al*., 2010), which found that general awareness was 49.1%, 64.1% and 82% respectively. The disparities can be explained in terms of the sample used for the different studies. In Tanzania, the survey included regulatory authorities, academics and farmers, some of whom were not in direct contact with GMOs. In Ghana, the sample comprised members of farmer-based organisations, which usually seek information about new technologies. In the case of Kenya, the study involved gatekeepers, namely respondents from supermarkets and milling companies, who were better positioned to know about GMOs. In the present study, the sample was chosen from people in the neighbourhood of a government research station, where interaction with workers from the institute is likely to allow knowledge to trickle into the public sphere. The knowledge about biotechnology and GMOs might have been significantly lower if the current survey was conducted further from a research station or involved a national sample. The finding suggests that journalists should appropriately apply the science-in-society model to involve the experts and non-experts as the issue of GMOs is multifaceted. The implication is that the public's reaction to GMOs may surprise policy-makers if the law accepting GMOs is passed without much consultation with the public.

Multiple conception: Respondents had multiple (mis)conceptions of biotechnology, with some associating it with enormous advantages and others rejecting it as absolutely risky science. This could be a sign that scepticism is increasing as people share their ideas about GMOs. However, this finding also corresponds with the picture painted by the newspapers, where the elite share their opinions about biotechnology and GMOs. It appears that the elite's controversy is percolating to the grassroots. This trend may bolster the two opposing groups, the one for and the other against GMOs, to spur the debate in the public sphere.

Women's concerns about risks: Women were more likely to associate biotechnology with risks. Their scepticism emanates from the fact that "women assess most risks larger, scarier and more severe, and worry about them more than men" (Leikas, Lindeman, Roininen & Lähteenmäki, 2007:234). These results confirm what other studies have showed, which is that women tend to be more concerned about and less receptive of biotechnology (Maes *et al*., 2018; Mucci *et al*., 2004). However, the current results contradict those of another recent study that shows that women are "more enthusiastic" about GM food purchases than men, who often suppress their opinions (Popek & Halagarda, 2017:10). The difference in opinions could be a combination of indignation, task-related stereotypes, differences in income and level of informedness to make decisions, and "gender oppression" in "foodwork" (D'Sylva & Beagan, 2011). Indeed, in Uganda, it is common for more women than men to engage in agriculture for their livelihood. In addition, women do most of the domestic work, including cooking. Therefore, there is a need for more research on the implications of the gender-risk assessment of GMOs, and how this issue is covered in the context of Uganda's media.

Clash of traditions: Social-cultural factors influence the biotechnology debate, although media tend to overlook them in their articles. But the purposes of biotechnology must match the "lives, livelihood and culture of the people" by considering the conventional ways of food production, which prioritise the ecosystem, rather than the non-conventional ways (Bhatta & Misra, 2016:577), that look at food as a business commodity only (Atkins & Bowler, 2016; Hicks, 2017; Martin & Enns, 2017). Hence, hunger in this context goes beyond filling the stomach; it means eating outside one's culture, or eating an 'inferior' food variety in one's pecking order. In other words, food has an intrinsic value. Practices such as sharing seed and preparing food in specified, 'pleasurable' ways are cherished. Agriculture/food therefore is an interactive, integrative and collaborative social activity in many communities. Certain foods are eaten on special occasions; and songs and dances, rituals and initiation ceremonies are associated with foods and agricultural seasons (Muggaga *et al*., 2017).

Such symbolism is a sign that food production is engrained in the culture and traditions of people. Uganda is still quite a conservative society that would want to maintain its environment, which has sustained the population for food and medicine despite the harsh conditions. It is for this reason that there is a need for the participatory science-in-society model rather than the deficit models discussed in Chapter 3. There are tribal societies that would want to hold on to their traditional crops to preserve their agelong lifestyles. There are also individuals who consider GMOs unhealthy/contaminated. The cultivation of GMOs is sacrilegious in some religions (*haram*) (Al-Attar, 2017). Thus, a change in production may suggest a change in preparation and consequently a difference in the taste/meaning of food. Accordingly, the debate marks a clash of traditions. Traditions must be considered in the debate (Hicks, 2017), even in the face of an increasing population and the demand for larger quantities of food. Biotechnology therefore must present resilient options for it to be accepted. How Uganda can have a food chain whose supply threatens the values and health of some people, while others go hungry, remains a question. The implication is that the failure to match the biotechnology with the sociocultural interests of the public will embolden society to resist the new science, and this is likely to be reflected in the media, as the editors seem to share many societal concerns.

Age and perception: The age group 26 to 41 years reported the highest level of optimism that GMOs would reduce the use of pesticides, make food affordable and protect the environment. They also recorded the lowest level of risk associated with GMOs. A recent study found that respondents aged 41 to 55 were more likely to buy GM foods than any other age group, while those aged 26 to 40 were the most reluctant to buy such products (Popek & Halagarda, 2017). Another study found that respondents between 18 and 24 years were less likely to buy GMOs than their counterparts above 25 (Tsiboe, Nalley, Dixon & Danforth, 2017). Studies illustrate that support for GMOs "decreases with age" (Sarathchandra & McCright, 2017:4), but such neophobia (fear to try food produced through other means) can stabilise in adulthood (Maes *et al*., 2017). Although the results seem to be contradictory, a common ground is that middle-aged people are more likely to accept GMOs than their very old and very young counterparts. This finding spells doom for Uganda, with 70% of its population below the age of 24 (UBOS, 2016:14-15). The statistics suggest that GMOs will present an Achilles heel for a country with a fast-growing population, which is likely to reject the alternative food production regime. Future studies may focus on the evolution of neophobia in Uganda's public sphere.

Income and GMOs: While the survey does not provide a direct link between income level and perception of GMOs, an inference can be made about what the public associate GMOs with. A majority were willing to grow GMOs to earn high yields, as presented in Table 6.9 in the previous chapter. This finding challenges a Turkish study that revealed that "income level …

[does] not have an impact on consumers' attitudes about GM foods" (Oguz, 2009:160). The result, however, is consistent with studies that show that off-farm income acts as an incentive for farmers to adopt new technology (Obayelu, Ajayi, Oluwalana & Ogunmola, 2017). T appears that support for GM crops tends to "increase with income" (Sarathchandra & McCright, 2017:4).[3] It appears that farmers prioritise an increase in their income and ignore any scientific arguments against GMOs. In developing countries where credit markets for farmers are either missing or dysfunctional, farmers use such income as liquid capital to hire labourers, buy inputs such as seeds, fertilisers and pesticides, and use any excess money for school fees and paying hospital bills (Obayelu *et al.*, 2017). The implication is that farmers will use the public sphere to advocate and try any possible means to increase yields, while reducing costs at the same time. Hence, once GMO seeds become available in Uganda, it is likely that farmers who think GMOs can increase production will plant them and subject the products to the forces of demand and supply.

If the public are willing to grow GMOs, the need for high yields that farmers can sell to earn more money, is more likely to override other factors, such as concern for the environment and health risks. In biotechnology, scientists seem to be responding to the farmer's key need – getting high yields, and the farmers seem contented with this approach. In addition, the curiosity to know whether GMOs are high yielding or not is a stirring force that is likely to drive farmers to adopt GMOs, no matter the possible side effects. A study has demonstrated that the promise of the capacity of a GMO variety to enhance yields and profitability, by reducing the cost of herbicides and pesticides, increases interest in and support for the legitimisation of such technology in the public sphere (Basu & Leeuwis, 2012). The media houses are likely to portray these varying interests in their publications.

Sources of information: Workshops as a source of information are preferred three times more than radio, as indicated in Figure 5.12. The public prefer face-to-face exchanges of information on the issue of GMOs. The mass media, including radio and newspapers, become good channels for mobilising citizens for such engagement, but not for the actual discussion. Personal contact allows interpersonal discussions between experts and laypeople and a laypeople-to-laypeople exchange of information. Hence, multiple channels of information are necessary in this debate, although they may not guarantee a change in attitude. Experts interviewed for this study vouched for workshops. A survey in neighbouring Tanzania revealed

[3] Ugandan farmers tend to eat part of their food crop produce and sell the excess.

that workshops were the favoured form of sharing information about GMOs (The Government of Tanzania, 2012). Workshops allow participants to get first-hand information about biotechnology by encouraging interaction, thereby bolstering public awareness of the safe usage of GMOs (Bandewar *et al*., 2017; Kunseler & Tuinstra, 2017; Okafor & Okafor, 2017). Such an approach operationalises Secko *et al*.'s (2013) models of science communication in the public sphere, discussed in Chapter 3. However, under conditions where mistrust and conflict of interest rule the debate on biotechnology, the question that arises and seems to persist is who will independently organise and facilitate the workshops as public spheres.

The respondents' type of information source was found to have a significant ($p<0.1$, or more than 90% accurate) negative influence on the perceptions that the respondents have of biotechnology. This implies that a change in the type of information source would most likely result in a negative change in perception of the respondent toward GMOs. The possibility is even more pronounced in the age of multiple forms of information, with both legacy media (newspapers, television and radio) and online sources becoming central in producing science communication. The finding is premised on the practice of individuals who choose to pay attention to outlets that meet their particular need in "accordance with their particular worldview and believed to be detached from immediate political and economic interests" as most people cannot rely on their lived experiences to make decision on biotechnology (Aerni, 2002:1126).

From the above quotation, it is worthwhile noting that the choice of media evolves over time. Studies show that the popularity of print media has been declining as electronic platforms gain an audience, and trends are favouring online dissemination. A mediated reality is likely to have more impact in the political arena than an objective reality to increase or decrease trust in science (Scheufele, 2014). Thus, people's tendency to choose to refer to the same sources of information is likely to augment their attitudes toward biotechnology. Additionally, as noted earlier in this section, individuals tend to express their subjective views rather than their actual knowledge about GMOs. Furthermore, the use of algorithms to locate members of the audience and target them not only exposes individuals to multiple-related sources of information, but may also challenge their knowledge and sentiments in the face of fake news. It appears that radical media outlets benefit as mainstream (neutral) platforms lose their audience, and therefore their source of capital. Biased news platforms therefore have the potential to polarise the biotechnology debate on both sides by targeting partisan audiences.

Association with risks: The respondents' association of GMOs with risks is a potential factor influencing their perceptions and attitudes negatively. The use of the "fear appeal" by conservationists and "exaggerated claims" by the pro-GMO proponents are common techniques in the biotechnology industry (Navarro *et al*., 2011:9). If the technology was to follow the lifecycle of a human being, the existence of GMOs in field trials suggests that the technology is in its adolescent stage, being exhibited as a promising option, but seen as a threat at the same time. Biotechnology is still going through the processes scientific innovations go through – excitement at the promise of the economic potential of GMOs, concerns about risks and uncertainties, and social and political controversies (Scheufele, 2014). This binary nature of promise and risk seems to be contributing to the sentiments in the articles published by the newspapers under and consequently the public sphere under scrutiny in this study. With a polarised debate, GMOs may stay longer in the adolescence stage, or may even die at that stage, but be reported about when the media logic allows so.

Scientists' engagement with the public: This research finds that there is a 69% desire among the public in Uganda to meet scientists personally and to discuss issues related to biotechnology with them, beyond what they read in the media. This need suggests that the time when scientists were seen as uncaring, cold and solitary people confined to laboratories in ivory towers is long gone. Modern research involves institutional and international collaborations. Science involves public resources, and the competition for funding is getting stiffer. Therefore, science is becoming part of the modern democracy, where accountability is not only a tenet, but an integral component in decision making. Scientists need to meet and know the public they serve and who contribute to the scientists' welfare through paying taxes. Deliberate science-society interactions in the early stages of technology development or implementation permit the involvement and mutual learning of all parties involved. This will then lower the chances of resistance to new knowledge (Kurath & Gisler, 2009). Public engagement also enhances feedforward processes, and increases the credibility of scientific processes and knowledge, and of the socio-economic impacts. Further, in the public sphere, scientific claims are evaluated in such consultations for policy learning and to guide action (Gregory *et al*., 2010; Kunseler & Tuinstra, 2017; O'Brien & Pizmony-Levy, 2015).

However, there are arguments that this stepping from the scientific "priesthood … without priestly duties" can work to the peril of science (Franklin, 2010:155), since social behaviour is difficult to anticipate (Blancke, Grunewald and De Jaeger, 2017). As explained later in this chapter, the public do not have much trust in science institutions to provide solutions to agricultural challenges. As such, when scientists remove their laboratory coats to participate in the public sphere, the participants sometimes disrupt the conversation by asking questions spontaneously and making defamatory claims against such experts to depict a science-society conflict. Sometimes, scientists become the targets of radical green organisations. This often reduces scientists' willingness to be part of such debates in the future. Some scientists, for example, may wish to argue that they do not have the time to spend in debates with ordinary people. Even then, given the pressing need to debate biotechnology, scientists need to learn the art of sharing information with laypeople, and to create time for such events, if they are to neutralise the space. Such an approach is likely to increase trust in their work in the public sphere.

Public mistrust of government science institutions: Farmers do not necessarily trust scientific knowledge from research stations or government institutions to provide agricultural solutions. This is because of their prior experience with hybrid bananas, coffee and sweet potatoes that did not work for many members of the public. Farmers rather trust knowledge they get from fellow farmers. A similar study to this one established that the general public feel that GMOs are an avenue for promoting Western capitalistic and globalisation agendas (Osgood, 2001). Several studies show that there is mistrust in the ability of government, its science institutions and official representatives to guarantee the public interest. Mistrust in government regulatory agencies is an issue that amplifies risk perception and consequently GMO phobia (Kangmennaang *et al*., 2016; Kurath & Gisler, 2009; Vilella-Vila & Costa-Font, 2008). In the case of Uganda, the mistrust is apparent between government and its science research institutions on the one hand, and civil society on the other. Civil society accuses government and biotechnologists of a conflict of interest by bending to the interests of international seed companies such as Monsanto, DuPont, Bayer and Syngenta through supporting a Bill that allows such companies to patent seeds to the disadvantage of citizens. Farmers would have to buy seeds from companies almost every season, since GMO plants do not produce seeds that can be replanted. They accuse UNCST for wanting to be a promoter and a regulator of GMOs at the same time. Government agencies and biotechnologists accuse the civil society organisations of getting sponsorships from La Via Campesina (the peasants' way), Moms Across Africa, the Consumer Union, Greenpeace and European countries that want to import Uganda's organic agricultural products. Arguments from pro- or anti-GMO online sources that trickle through the newspapers, and the hesitation of government officials to discuss the issue, have fuelled confusion. At the same time, these extremist websites make the debate murky. Extremism in the debate may push the political leaders into making wrong decisions, based on the interest group that screams loudest in the mediated public sphere.

The Ugandan public has doubts about scientific breeding, considering that some of the hybrids have not yielded what was expected of them, as explained earlier in this section. Moreover, researchers have pointed to past successes or failures as points of reference in determining the application of scientific knowledge in the future, in both developed and developing societies (Thomas & De Tavernier, 2017; Wynne, 2017). Individuals who consider GMOs as risks to human and environmental health also tend to find them to be socio-economic hazards, but believe the effects can be managed through government controls (Oguz, 2009). In the case of Uganda, the mistrust extends to the government's performance in service delivery, as presented in media reports of scandals. The activists do not believe that a government that failed to support viable irrigation projects, operate functional extension services and establish post-harvest handling mechanisms had the capacity to regulate the use of sensitive biotechnology. Underlying the mistrust is the impunity with which government replaces experts with political cadres. For instance, in 2014, the government replaced NAADS technocrats with Uganda People's Defence Forces (UPDF) officers, who were clueless about agriculture (Musisi, 2014). Observers joked in 2017 that the deployment of soldiers was the cause of the devastating army worm that ravaged the country, leading to poor yields, hunger and related deaths.

Furthermore, the Ministry of Agriculture, Animal Industry and Fisheries (MAAIF) itself is riddled with scandals. The government newspaper, the *New Vision*, reported that MAAIF had spent five billion shillings (about $1,388,888) on buying eight bulls from South Africa (Editorial Team, 2017). The government has also failed in running its own ranches, inherited from past regimes (Okuda, 2017a). With its research institutions not declaring substantial non-taxable revenue (NTR) as profits from their harvest and because of their efficient management, public mistrust seems unavoidable. Scandals are not peculiar to MAAIF. The judiciary has many 'cadre judges', whose rulings usually favour the ruling party, so much so that, at one point, the Speaker of Parliament referred to its rulings as stupid orders (Arinaitwe, 2017). Parliament itself has been bribed in the past to pass laws to enable the president to stay in power (Lumu, 2012). MPs claimed they were bribed to pass the Biotechnology and Biosafety Bill (Kaaya, 2017). Besides, the health sector is falling short, with many health facilities lacking basic equipment and drugs (Lanyero, 2013). In 2017, two ministers of health, Dr Ruth Achieng and Dr Joyce Moriku Kaducu, had to seek treatment abroad at the same time, despite it being their mandate to improve healthcare in the country. In a country where the police Directorate of Criminal Investigations (CID) rarely obtain substantial evidence to convict offenders (Tumwine & Bagala, 2017), mistrust in science, industry, policymakers and government regulatory authorities is unavoidable. Media depiction of the increasing pessimism about government institutions is likely to derail the debate on GMOs. It appears that any attempt by the government to introduce GMOs is also seen as a sinister plan to corrupt the food production regime. When the media logic delivers such scandals, scepticism in the public sphere is bound to happen.

Additionally, the Government of Uganda has not been responding appropriately to international warnings about projected food shortages, thereby allowing East Africa's food basket to run empty annually (Editorial, 2007; Food and Agriculture Organisation [FAO], 2015, 2017; Magulu, 2009). Failure to respond to such warnings seems to raise disbelief in the public sphere by making the public think that leaders are faking Uganda's vulnerability to food insecurity by presenting GMOs as an alternative to mask their failures to develop the agricultural sector.

At the same time, Uganda does not have enough capacity to protect its borders against GMOs. Despite a security presence, the country's borders are porous. Citizens have accused the Uganda National Bureau of Standards (UNBS) of failure to detect counterfeit products on the market, some of which have resulted in the loss of lives through road accidents and house/industrial fires (Karugaba, 2017; Kato, 2016). Without the capacity to detect transgenes and gene editing done to agricultural products, policing GMOs will be an impossible task for the authorities. While it seems that the solution is in developing capacity to make and detect GMOs, it appears that Ugandans do not believe that they can rely on science and thus have to trust their experts in government departments. For example, in the health sector, many Ugandans seem to be shunning government hospitals by resorting to herbal medicine and prayers, if the advertisements in the different media platforms are a good basis for analysis. Indeed, top government officials, middle managers and their relatives rarely seek medical attention from government hospitals (Lanyero, 2013; Wesonga, 2017). This could be the reason why many respondents are stressing the preservation of their 'indigenous' seeds, and others emphasise reliance on their largely undocumented indigenous knowledge, rather than delving into unchartered areas of science. Implicit in this is that public perception of biotechnology may improve with an enhancement of service delivery in other government departments, as may be reported in the media.

Upstream sensitisation: The sensitisation has been at a high level, with MPs, activists and journalists, thereby alienating the gatekeepers in the agricultural industry – the farmers, as the required participation in the science-in-society model is ignored. Ideally, sensitisation should have started with the communities surrounding the research centre. Instead, the sensitisation is upstream, with policymakers and journalists. The implication is that GMOs may be sanctioned upstream and reported in the media as revolutionary scince, but be rejected downstream, where the farmers, to a large extent, determine what enters the market.

Disagreements among scientists: The opposition to GMOs by some scientists demonstrates that there is lack of cohesion among scientists themselves, a mark that there is no scientific community driving the GMO debate in Uganda. Biotechnologists are facing hostility from some soil scientists, conventional breeders, and medical doctors, who insist GMOs could be dangerous to the environment and human health. When scientists point bayonets at one another in the public sphere, nonexperts are left confused about the truth, especially in this information age, in which they are faced with a sea of 'questionable facts'. Underlying the division is the surge in postmodernism that is threatening to undermine scientific authority, built on principles of studying natural phenomena using shared standards. Postmodernists argue that scientific truth and independent ideology should be treated as "equal", since all knowledge is socially "constructed" and deconstructed in the public sphere (Kuntz, 2012:885). This post-World War II paradigm often falsely equates scientific assessments with political claims. Indeed, scientists who object to alternative knowledge strands are accused of "scientism", a belief that only knowledge gathered through scientific methods is relevant (Kuntz, 2012:886). The anti-science crusade is usually supported by pseudoscientists, who often erroneously cite studies from other countries, and their actions sometimes lead to violence against research and researchers (Reul *et al.*, 2016; Thomas & De Tavernier, 2017). Since some politicians support activists in the name of democracy and pluralism (Kuntz, 2012), the postmodernist approach can delay or prevent research by debasing its role in decision making. Postmodernism seems synonymous with the spread of pessimism about scientific knowledge and techniques. Therefore, while the participation of stakeholders in the GMO debate should not be allowed to interfere with scientific questions, such legitimate deliberations can guide policy. By implication, the debate on GMOs needs to be regulated by a competent modulator to prevent emotions from meddling with scientific facts in the public sphere.

Chapter 8

Conclusions, limitations and recommendations

Metaphors should be carefully chosen and evaluated alongside empirical evidence, because they shape data interpretation and how science influences society (Kueffer & Larson, 2014:719)

8.1 Introduction

From the discussion of the findings in Chapter 7, it is evident that the debate on biotechnology and GMOs embodies several interests that may facilitate, derail or cause the complete rejection of biotechnology in Uganda. It is clear from the results that the debate reflects nine key areas that form the core of the conclusion. The issues are: economics of GMOs, benefits of GMOs, regulation, scientific knowledge about GMOs, external influence, related risks, politics, public perception, and media coverage of GMOs. The issues were coded using Atlas.ti, and the conclusion is illustrated in Figure 8.1 below. The components in Figure 8.1 can overlap and the components can change formation depending on the circumstances.

8.2 Conclusion

8.2.1 Economics (capitalism) of GMOs

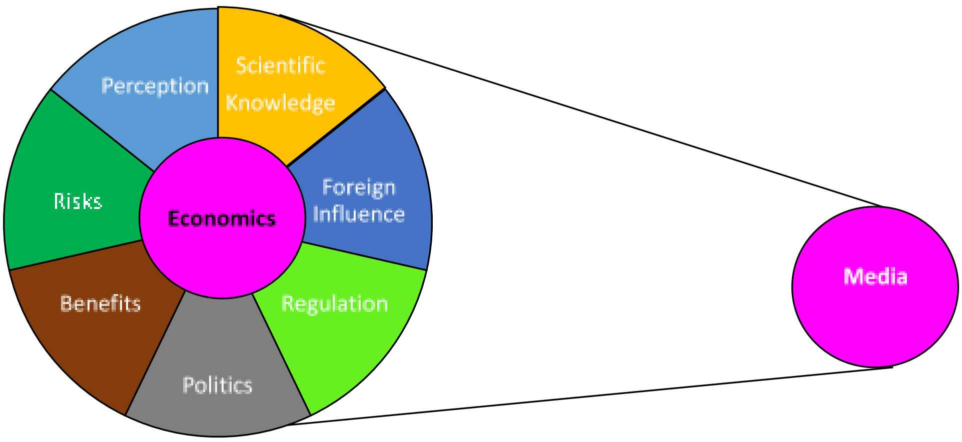

Figure 8.1 Media-economic bicycle-chain model (Source: Author)

Figure 8.1 shows that the debate about GMOs revolves around the economic gains/losses (crank) from such science, as propelled by the chain through the cogset (media). Money is at the centre of the debate. The GMO debate portrays a neo-liberal attempt to control other countries through monopolising the seed supply. The seed producers are all from developed countries, especially the United States, which polices the world – introducing GMOs, which can contaminate naturally selected seeds, points at an attempt to cripple indigenous seed regimes to make place for the modified crops. With high levels of land fragmentation, an inability to implement existing land laws, unfenced/ unprotected gardens hardly a metre apart, and unreliable data on the number of farmers and the crops they grow, Uganda seems ill prepared for GMOs, at least from the content analysis and interviews conducted. Without the ability to start local firms to compete with the likes of Monsanto (Bayer) or Syngenta, Uganda is likely to slave away in service of foreign countries, which control seeds and the corresponding pesticides and herbicides. The question that arises is whether Ugandan research organisations are able to compete in the international arena so as to benefit from intellectual property rights. Research in Uganda is poorly funded, and most of the money comes from donors. For instance, in 2015, Uganda spent only 2.23% of its USD 26 billion GDP on research and development (World Bank, 2017b). Therefore, media-economic bicycle-chain model surmises that the adoption of GMOs disenfranchises the country, since Uganda has to cede power over its agricultural sector to foreigners. Ghana has already raised fears of the dependency syndrome of developing countries, which stand to lose their comparative advantage in agriculture (Zakaria *et al*., 2014). Local organisations and individuals can only benefit as surrogates for the multinationals. The perceptions of scientific knowledge held by individuals regarding the benefits, risks assessment and the politics involved, especially in regulation, are largely about how individuals stand to gain or lose if foreign companies control the biotechnology industry in Uganda. The media logic seems to be driven by the country's capacity to benefit from such science and portray GMOs as unsuitable, although the issue of the correctness of GMOs for Uganda is beyond the scope of the current study. The public sphere where the interviewees participated portrayed biotechnology as a science trapped in capitalistic interests linked by the media.

8.2.2 Benefits of GMOs

Different stakeholders are strategising to benefit from GMOs through direct and indirect means. Profit seems to be the direct motive. Seed companies expect to make a lot of money from their investment in terms of time, equipment and skills as capital. The companies expect to get this money through economic goods, especially patents. Scientists expect to get a lot of funding from both credible and dubious sources to do research. Journalist expect to benefit directly by mirroring the debate and indirectly through trips and bribes from the parties involved. Farmers expect to earn the highest profit. Anti-GMO companies will want to justify the funding they get from international environmental protection funders. Individuals in government departments may benefit through taking bribes from seed companies that want to operate in the country. The desire of individuals and groups to gain compounds the debate, as it gives rise to a sum total of counter-accusations that are likely to intensify over time and leave the public helpless. The multiple interests make it hard for journalists to use the media logic to fairly portray the public issues in the public sphere by choosing who should participate in line with the science-in-society model discussed in Chapter 3. However, the media and its logic is key in driving the interests of the actors as its coverage can help researchers understand the interests at stake.

8.2.3 Regulation

The Bill remains a contest between the pro- and anti-GMO crusaders. According to the Cartagena Protocol, the law is supposed to ensure that approved GMOs are as safe as their traditional counterparts. GMOs are supposed to be tested for safety, including nutritional value, toxins, potential to cause allergies, and ecological suitability.

Disagreements on the law notwithstanding, Uganda needs a law on biotechnology and biosafety, whether the country will commercialise GMOs or not. Such a law should allow testing of the GMOs developed within its borders, and to detect imported GMOs or products with GMO components in the country. With the production of GMOs, now including precise technologies such as gene editing that uses clustered regulatory interspaced short palindromic repeats (CRISPR and CRISPR Cas9), the disagreements on the strictness of the law to be enacted are likely to become fiercer. Under such circumstances, politicians, rather than technocrats, are likely to influence the outcome and any amendments to the law. Without a clear law on GMOs, Uganda will be sucked into the black hole of multinationals and international trade as these relate to science. In the midst of this dilemma, government has to take a gamble by putting a law on biotechnology in place, even with the differences among stakeholders vis-à-vis limited information. The theatre of legislation and the need to amend the law to capture emerging interests will allow biotechnology to enjoy spikes of coverage, which should be good enough to ensure that the debate continues. The implication of not passing a law when the products are ready for release is that scientists may smuggle GMOs to farmers. Without clear laws on how to prosecute errant scientists, the culprits may go free, and the country may grapple with the unknown effects of the technology. Using the media logic makes it possible to understand the range of public understanding of science. Such information should guide in actors in coming up with the appropriate legislation for the country.

8.2.4 Scientific knowledge about GMOs

There is little knowledge on the perceived benefits and risks, the withdrawal position in case GMOs fail, the context for adopting GMOs, and the differences between GMOs and conventionally bred crops. The knowledge gap results from the fact that biotechnology is a new science in Uganda, and the different channels of information send out mixed messages. Without a functioning structure of extension workers to help in the diffusion of information, GMOs will be the reserve of elite farmers who can read and understand the release notes that contain the instructions for growing them. Controversy is likely to continue, since a low level of knowledge forms the basis of the debate.

Many people are not willing to accept scientific facts. They are interested in applying knowledge from relatives, friends and the community, knowledge they can recall when they need to decide on adopting a new technology. This researcher did not find any studies on the willingness of Ugandans to accept scientific knowledge. Of particular concern is the lack of scientific literacy among the public to process new scientific information on which urgent decisions have to be made, even when facts and values are in dispute. This world of "postnormal science" is trapped in the maze of fake news, where individuals and organisations deliberately publish lies as facts under the guise freedom of expression (Scheufele, 2013:14041). Moreover, Uganda repealed the law on false news in 2002. Therefore, the high stakes involved and the interdisciplinary nature of GMOs complicate issues for the nonexpert audiences, especially when experts from different streams of science do not agree on the safety of GMOs. The commercial logic which influences media houses decisions a lot of the time may drive media houses to overstate the positions of the respective actors, thereby misrepresenting (overrating or underrating) biotechnology to the public.

8.2.5 External influence

The contentious nature of the debate on biotechnology is largely in synch with the disagreements surrounding GMOs in the countries that first experienced the new science. Several lawsuits have been filed against companies making GMOs. At the heart of the lawsuits has been the global seed company Monsanto and its flagship products, Roundup and Dicamba. In 2015, the WHO International Agency for Research on Cancer (IARC) associated glyphosate-based Roundup with increased cancer in humans. The IARC argued that glyphosate is carcinogenic, a label Monsanto is fighting in courts of law by quoting (anonymous) studies indirectly sponsored by the chemical company. Consequently, the European Union started considering banning Roundup from its market (MintPress News, 2017). After the $63 billion acquisition of Monsanto by German chemical giant Bayer in June 2018, beekeepers from northern France immediately filed a legal challenge against the company over glyphosate in honey (Chow, 2018). Monsanto (now Bayer) has also been to court over its new weed killer, Dicamba. With an instruction manual of over 4, 000 words, Dicamba is said to affect plants adjacent to its target if spread at temperatures above 91°F, when wind is stronger than 15 metres per hour, or when it is spread more than 24 inches above the crops (Polansek & Plume, 2017). Moreover, many US weed scientists declined to attend a summit that would legitimise Dicamba as a safe herbicide (Polansek, 2017). Despite this, Dicamba was approved by the United States Environmental Protection Agency (EPA).

At the same time, a European Union court approved the growing of GMO maize, after the Italian government banned the cultivation of the same maize following recommendations from Italian scientists, who questioned the safety of the crop (Cusack, 2017). Italy is not alone in rejecting GMOs. In the past, protestors have vandalised government field trial sites across Europe (Kuntz, 2012). In 2015, 17 European countries, including Austria, Denmark, France, Germany, Greece, Hungary, Italy, the Netherlands and Poland, declared a ban on GMOs (Lynas, 2017). Thus, the North, with better capacity to test GMOs, is still contesting their adoption. For Uganda, which exports agricultural products to the European Union, the adoption of GMOs would mean losing a substantial percentage of its market through restrictions. Hence, Uganda has a better comparative advantage from organic agriculture than from GMOs. By implication, Ugandan exporters will relentlessly fight the move toward GMOs, and will try to push their agenda to fit into the editors media logic.

Uganda's situation is even more precarious considering that neighbouring Kenya is also on the brink of releasing GMOs (Bor, 2017). Besides, South African multinational businesses, Game and Shoprite, are already selling unlabelled agricultural products through their Ugandan outlets. There is no guarantee that such agricultural products do not contain GMOs.

It seems that the cloud enveloping GMOs keeps darkening as knowledge exchange across the borders becomes easier with the help of the internet and social media. With the North still in doubt of GMOs, and Uganda inadvertently importing GMOs, it is apt to conclude that the debate is about a typical foreign technology whose outcomes and implications are uncertain in African societies.

The rise of scientists, politicians, court rulings against science, and civil societies encouraging the shutting out of GMOs, science in the developed North is already having a ripple effect on the developing South, where biotechnology is a science at the crossroads. Politicians and civil society may influence the debate through discrimination and/or denial the of funding to those with contrasting views. When issues regarding GMOs are reported in foreign publications, local newspapers pick up those and try to contextualise them for Uganda. Thus, the availability of the internet and corresponding algorithms allows media, and individuals interested GMO issues, to access such information and try to locate Uganda in the global debate. Such information flow allows editors to use the media logic to domesticate global issues, sell them to the public, thereby allowing such ideas to trickle into the public sphere.

8.2.6 Risks related to GMOs

There are risks associated with biotechnology in agricultural production, although many of them have not been studied in the Ugandan context. There is no guarantee that GM crops will yield more so as to lower prices in the market. In 2018, without GMOs, the market was flooded with maize grain and farmers were forced to sell their produce at Uganda Shillings 200 (about $0.05) (Editorial, 2018). Further, GMOs may also lack market, since countries can have anti-GMO policies or public perceptions may not be in favour of such products. The appeal to fear and, to a lesser extent, the moral significance of biotechnology, are reflected in media reportage and public perception. Such emotions have mirrored biotechnology to be more of a social issue than a scientific one. By the media logic theory, the risks are sensationalised in an attempt to sell media content. Yet, such exaggeration often polarises the debate as the science comes to seen as both a panacea and a danger in the same public sphere.

8.2.7 Politics of GMOs

The science of GMOs is synonymous with politics. It will take a long time for biotechnology to resolve the ethical, moral, social and political stigma associated with it as reflected in the newspapers. Politicians could lose their integrity by supporting ‘unwanted/demonic’ science or opposing a viable technology, depending on whether one is pro-or anti-GMOs.

By implication, biotechnology is a political issue, since access to food can be used as a tool to control people or to influence international relations. As much as the technocrats and activists are driving the debate, the decision to adopt biotechnology and GMOs is in the power of politicians, who must balance personal, technical and public interests. Therefore, the science of GMOs is likely to be aligned with the dominant political interests at the time of passing the law. Media logic's exaltation of the prominent, especially the politicians, allows those in power to make unscientific statements which their constituents want to hear. Such statements are often captured by the journalists and reported in the media as facts whereas not. Politicisation may have the effect of overshadowing the science of biotechnology and push the policymakers to take decisions based on political interests rather than scientific ones, basing on the dominant voices in the public sphere.

8.2.8 Perceptions of GMOs (sociocultural factors)

While science has started delivering the laboratory products, a multifaceted drawback is emerging – to get the population to accept GMOs on their forks. Public perception can determine how science is regulated, funded and applied. Ugandans seem scared about the possible change in the food production chain that could tamper with the planting, pruning, harvesting, refining, preserving of food and fruit. There is fear of the unknown, and the anxiety is increasing with the fact that there is no reliable structure to detect GMOs, or to assess their safety, even if the producers or importers choose to label them. Considering the inefficiencies in other government departments, Ugandans are guarded about ushering in a technology whose sustainability is doubtful in the countries where it originated.

Whatever the case, the passing of the Bill into law will not end the debate. The media logic will continue influencing the public, determining how biotechnology is discussed verbally, in text, audio and video, and influences public perception. The battle over the food regime appears to be a referendum on the performance of the government in all its sectors, including agriculture. It is clear that the agricultural sector has glaring structural problems resulting from its leadership, which may pose a hurdle to accepting GMOs, as much as there are scientific concerns. Hence, funding for the development of biotechnology should involve public engagements as a way of preparing the market for the products, as scares and actual crises can dent public confidence in the food production chain to deliver safe food. Thus, biotechnology can sometimes be very much like a soap opera, whose end is not yet defined. Consequently, public support for/or against GMOs is open to contestation between the biotechnology industry and the ecologists, driven by the media.

8.2.9 Media coverage

The above issues surrounding GMOs are 'rolled' by the media in the media-economic bicycle chain model presented as Figure 8.1. The media are caught in a conflict of interest between balancing representation based on weight of evidence, and providing a voice to the various stakeholders as they emerge. Every stakeholder is obsessed with courting the media or forming a network of journalists to reflect their agenda and, by implication, protect their economic interests. Shrinking newspaper readership and consequently revenue suggest that reporting on biotechnology may remain dependent on individuals who have a passion for the subject (enterprise journalism) and are subsidised by the industry. Subsidies are important because management is not willing to invest in training and hiring science journalists or establishing science desks. Poor remuneration, coupled with laziness on the part of many journalists covering science, suggests that more biased and partisan stories about biotechnology are likely to keep running as journalists manoeuvre around the structural challenges. This media logic is synonymous with the ever "shrinking news hole" (space or airtime obtainable for content in a media outlet) (Scheufele, 2014:13588).

Although the media occupy a prime position in the biotechnology industry, they are also contributing to the controversy on biotechnology and GMOs. Biotechnology is a binary news item, with varying degrees of controversy. It tends to attract less controversy when it is presented as a development issue in pull-outs or in the science pages, than when newspapers try to play the watchdog role by presenting it as a political issue. While some reporters demonstrated maturity in science reporting by quoting institutional sources, others demonstrated naivety by quoting political sources and activists, without providing scientific evidence. This can be attributed to the immaturity of the biotechnology industry itself, and the brief relationship between biotechnologists and journalists. The differences confirm a cultural cognition or "belief gap hypothesis" (Eveland & Cooper, 2013:14090). The belief gap (an offshoot of the knowledge gap hypothesis) contends that, as a scientific topic becomes politicised, more media attention to that issue will contribute to progressively varied beliefs about it in a way consistent with an individual's political views.

The inclusion of civil society as an alternative source of science communication only compounded the confusion in the haze of opinions, since Ugandans have not consciously experienced biotechnology or GMOs. Nonetheless, the scenario points to the importance of considering civil society in implementing science projects, as ignoring them may deflect the debate on GMOs.

8.3 Limitations of the study

The results of this study may not be generalised, since its validity and reliability were bound in relation to time and finances. The scholarship required the student to complete the PhD within three years. For this reason, the content analysis covers a period of only four years (2012 to 2015). It does not cover the period preceding the drafting of the Bill and the two years leading to the ‘passing’ of the GMO Bill in 2017. The study concentrates on two daily newspapers, as they were found to be most suited for this student project, which was resource constrained. A face-to-face survey was conducted to capture perspectives that could have been missing from the newspapers. Even then, the survey involved only 42 respondents. The survey was furthermore conducted near the national crop research station to ensure that it captured some respondents with knowledge about biotechnology and GMOs. In-depth interviews were conducted with a range of experts to bridge the gaps resulting from the small samples used in the content analysis and survey.

In addition, the survey and the in-depth interviews were conducted at the peak of a severe drought (December 2016 to March 2017). This could have exaggerated the emotions of the respondents. Nevertheless, the possible circumstantial effects were neutralised by the content analysis of articles published almost a year before the food shortage. Indeed, some of the findings are consistent with studies conducted in other countries.

Only a limited number of studies could be found about Uganda and the region to refer to on issues related to science communication. In a way, this study is preliminary.

Despite the limitations, the findings from this study have provided a starting point for studying biotechnology and GMOs in media coverage and public perception in the context of Uganda. The results depict an emotional debate, but experimental evidence is required. For starters, the researcher makes some critical recommendations to the media, science communicators and for further inquiry.

8.4 Recommendations for integrating media coverage with biotechnology

This section presents the recommendations of the study. First, the study makes recommendations for improved media coverage. Second, it makes proposals to other science communicators for improved discussion of the subject. Third, it identifies areas for further research. The recommendations take into account the fact that this study had limitations, as identified at the end of the previous section.

8.4.1 Media

To avoid being accused of having been "bought", journalists should always state their sources of information, such as interviews, surveys of identified organisations, press releases, conferences, and journal articles. Identifying sources enables interested readers or members of the audience with vested interests to look up the sources for confirmation or to get details.

Reporters should also specify the sample size and nature of the study. The journalists should mention the subjects involved (scientists who conducted the study and crops used), the lengths of the study, tests conducted, and what was observed. The stories should include the potential limitations. Including such details will provide the necessary transparency and scrutiny of the new results.

The stories should highlight the evidence connecting the variables involved. The linkage will minimise doubt or may trigger future research for others.

Pairing journalists with scientists will allow mutual learning. The pairing will help the scientists understand how journalists work and journalists will understand how scientists work to strengthen their relationship. This may work to improve science reporting, but may not take away the controversies that are heightened when a biotechnology story is moved from the science section to the front page or national or international news pages. This arrangement, however, may require funding to keep the partnership running.

Moreover, reporters need to negotiate with editors for space and to ensure that stories on biotechnology are not sensationalised. The headlines should not mislead, and quotes should not be used to mask overstatements by scientists and their public relations officials.

Journalists should be wary of scientists and institutional press statements that overemphasise study findings for or against biotechnology. To minimise such overemphasis, reporters should quote the biotechnologists involved and external sources with suitable expertise. Such a move will enable reporters to analyse the results independent of the public relations arms of (anti)science.

There is a need for science journalism clubs or organisations to establish databases of biotechnologists and other scientists, which reporters can refer to when sourcing stories. This will enable journalists to balance science stories based on appropriate expertise in providing context for a research report.

Newspapers need to establish science desks, where reporters, including freelancers, are nurtured. On these desks, senior scribes can mentor junior reporters to write competitive science stories that can be carried on the cover page of newspapers, where they can have a greater impact.

Further, there is need for an endowment to facilitate science journalists to independently investigate stories on biotechnology. This will allow newspapers to question the stakeholders in the biotechnology debate and enable the public to understand issues better.

The coverage and discussion should emphasise the fact that the possible health, environmental and socioeconomic risks occur on a case-by-case basis. They are specific for crop varieties and are climate sensitive. Understanding the methods raises unnecessary anxiety, since the product may not be as good or as bad as the process through which it was produced.

It is hoped that such an approach would allow the science communicator and the general public to discuss issues on a common ground. The discussion should include issues of public interest; be conducted in a place or on a platform that people can access; and in a form/language the public can comprehend. It is also hoped that this approach would allow the general public to understand that the strengths and criticisms levelled against the breeding mechanism are not integral to biotechnology, but to specific crops.

Journalists should use social media to harvest ideas to report about and to engage experts and their audience on new styles of storytelling that can be adopted in their framing and voicing of biotechnology and other science-related topics. They should, however, avoid breaking science stories using social media accounts, unless it is absolutely necessary, since this may compromise the popularity of the printed story or the one posted on their digital platform.

Furthermore, they should refrain from joining partisan groups, making comments or editorialising on partisan topics, as their views may be considered endorsements by the media house, since is hard to distinguish the views of journalists from those of media houses.

Reporters should be considerate when responding to criticism on social media to avoid ruining the reputation of the media house. But they can use their influential voices on Twitter, Facebook, Instagram and other social media to update stories and reach new readers of science stories. In other words, journalists must follow editorial policy when using social media to give the organisation mileage, rather than denting its public standing.

8.4.2 Science communicators

The complexity of biotechnology requires an extensive learning curve that bars all but the most qualified from participating (Blancke *et al*., 2017). Yet, communicating biotechnology will require the warmth and competence of the conveyor for the message to be credible. The scientists may be met with people espousing religious values, political differences, questions about the trustworthiness of science and other prejudices that may confront the debate. The intricacies may be a disincentive to involvement. However, the increasing role of science and technology in society, particularly in agriculture for a farm-dependent country like Uganda, makes scientists' contribution to public understanding of science a matter of urgency to prevent science from getting lost through translation.

Based on media logic theory, which incorporates agenda setting and agenda building through priming and framing, scientists have no option but to subject their laboratory knowledge to public debates if they want to remain on the public agenda. Engagement, as an element of democracy, requires scientists to speak the layman's language and use illustrations to explain how biotechnology works. Frequent engagements are necessary, because the public rely on their memories to make judgements and take decisions. The use of illustration and frequent meetings with non-scientists will increase the chances of remembering. Scientists should avoid a situation where they will be forced into a spiral of silence that will allow misconceptions to flourish (Noelle-Neumann, 1974). Science institutions need to develop progressive communication strategies that reflect consensus in public discourse. This is in line with Scheufele's (2014) view that exposure to alternative viewpoints may motivate those in favour of or against, and can serve a corrective function to save one's self-esteem and public image.

Biotechnologists need to interact more with social scientists to understand the underlying factors that inform individual, group and societal choices regarding GMOs. They will also need to interact with specialists in the humanities to learn how to craft messages using narratives that suit specific audiences. Narratives increase "comprehension, interest and engagement" with a non-scientific audience (Dahlstrom, 2014:13614). Such interaction will also allow scientists to understand the impact of communication among stakeholders. Training scientists in science communication is important in order to bridge the skills gap in the reward system scientists are groomed in. Biotechnology has gone past the point of excitement and promise to attracting controversies in the socio-political arena, and the science needs to be defended.

The debate should take place on multiple platforms. Information from the media should be augmented with workshops and interpersonal communication. Such an approach will increase the likelihood of storage and retrieval for sound debates on biotechnology to be achieved. The multiple platforms will allow the percolation of information to several people to ensure an informed debate. The assumption is that the debate will be based on accurate information. If an institution chooses to address the concerns of the public, that organisation should also choose the platform on which to do so. An institution should not choose more than two platforms for daily engagement with the public. If it is social media, the institutions can choose to open a Twitter handle or Facebook account for purposes of efficiency. Making the response platforms elastic by adding Instagram, WhatsApp, MySpace and others may overwhelm the available staff and cause inefficiency in the feedback and feedforwarding processes. The platforms chosen should resonate with their target audience for feedforward to take place.

Scientists could use their influence on social media to engage with journalists and the public. They can also test new ways of storytelling. However, care must be taken when presenting partisan views, as the public rarely make a distinction between scientists' personal views and those of the organisations they work with, for good or ill. Scientists therefore should observe ethics when communicating biotechnology. Observing ethics is the price scientists pay for accepting to work with the respective organisations, since their views will be associated with those groups, and must be acceptable in society.

Bench scientists should seek out audiences outside their disciplines to inform public debates about GMOs. These could include communication experts, social scientists, students, MPs, lawyers and farmers to engage in debates about biotechnology and GMOs, since this fairly novel science has wider societal implications beyond the laboratory and garden. Groups seeking to organise such engagements may need to find independent sources of funding to support such meetings.

Possibly, the debate on GMOs could start in schools to improve the familiarity of the public with biotechnology and increase their knowledge about it. Such debates would also give young people the opportunity to critique the technology without necessarily being directly influenced to support or oppose it.

Religious institutions should be involved in sensitisation about GMOs. Religious institutions are particularly important, because the faithful gather voluntarily on a weekly basis. Utilising such gatherings would minimise the resources required in national sensitisation. However, caution should be taken to avoid a situation where the views of the clergy dwarf the opposing views of the faithful. Furthermore, the lack of scientific knowledge among the clergy may be a hindrance to getting the right information across to the people.

Although effective communication cannot guarantee that the audience reaches a consensus about what the informed decision should be, as individuals apply knowledge differently (Fischhoff & Scheufele, 2013), biotechnology should be framed in a way that allows the opposing sides to listen to one another. Science communication cannot be a panacea for disagreement, but rather minimises the disagreements to allow people to focus on the values and socio-political issues as they relate to a technology. Without any point of agreement, the audience can attack the message if they feel that their action will compel the leaders to listen to their non-scientific concerns before introducing a technology.

GMOs should not be presented as a topic. Rather. the discussion should focus on a breed/variety of crop, since the strengths and weaknesses of biotechnology are context-specific. The discussion should not be general, and the modulation should put this into context. Focusing on a particular breed enables the communicator to keep the discussion within manageable limits and prevent rambling.

Biotechnology should be presented simply as one of the possible ways of breeding. It should not be presented as superior to other ways of breeding. Like natural selection or organic farming, it has its pros and cons. The communicator should note that genetic engineering is only one of the solutions to agroecological, industrial or organic agriculture. Presenting GMOs this way will allow for a levelled engagement. Since evidence is supreme in science, the communicator should emphasise that GMOs are evidence-based science and uptake must be based on evidence.

The science communicator needs to allow the audience to raise its concerns about the technology. The communicator should not be arrogant, but acknowledge that the public concerns are genuine. The general public can then be 'advised' that their concerns do not apply to all forms of that technology. They can be advised on how to minimise the effects, preferably by working with an agricultural extension officer if there is one in their locality. The communicator should respond to specific questions, since although this is more laborious, it is more effective than replying to general questions. For instance, questions about herbicides should be responded to by pinpointing the effects of a particular herbicide.

Issues regarding patents should be responded to by including reference to patents for other innovations outside of agriculture. The general public should understand the meaning of patents and why they are necessary in innovation and for the country. They should be made aware that patents exist even in conventional breeding. Different countries have similar laws.

Scientists/communicators should stay abreast of the social, political and economic issues linked to science and democracy. They should also know the position of agriculture in society, farmers' concerns, and the influence of industry or commercial imperatives that drive science in the international public sphere.

Without necessarily laying blame on other sectors or government departments, the communicator should identify the role of scientists in agriculture as a way of acknowledging that, if there is any mistrust regarding genetic modification, it should not necessarily be levelled at the inefficiency of agricultural scientists. The communicator can point out the link between and among sectors of the economy, for instance, the need for extension officers to help farmers implement technologies and the need for more funding to enable scientists to regularly discuss issues with the public. Other issues that require fixing include: the need for the electricity grid to reach production areas to ignite processing; good networks to transport agricultural produce from areas of abundance to places of scarcity; dams/irrigation systems to utilise the abundant water in the country; facilities to minimise postharvest losses; and a modern meteorological department to forecast weather more accurately.

The use of fiction, cartoons, music and comedy may reduce counterarguments to the different campaigns, as the audience will engage with the narrative more easily than through news and community discussions. If these are combined with visual illustrations, the collective impact may be superior to the sum of the influence of its autonomous platforms, as entertainment is already a popular way of mobilising and disseminating information on HIV and politics. In addition, science communicators can produce videos about biotechnology and share the content with individuals as WhatsApp messages, and with groups using projectors.

Communicators should develop computer applications (apps) that can allow knowledge seekers to easily access scientific information. These apps can also allow the audience to share their views with both the journalists and the scientists. Crowdsourcing can also be used, by which the brainpower of the citizens can be harnessed through science web portals, mobile phones and apps to provide ideas to researchers for feedforward. Computer games for young people can awaken their interest to participate in science and related debates in which their views can be captured. This approach requires a thorough consideration of access to devices, the affordability of data, the possession of skill to operate devices and fluency in the chosen language of engagement.

Science institutions should adopt the “BrainLab” approach (Devonshire & Hathway, 2014:12-15). This approach should integrate community outreach in the curriculum or projects of science institutions to allow scientists train their students through engaging with communities to identify citizens’ problems, and to collect data in the process, for which the researchers will get credit. By providing a forum for scientists, the media, policymakers and laypeople, both online and offline, the BrainLab enables direct and efficient exchange of information on biotechnology for feedback and feedforward purposes. The BrainLab would inspire academic involvement and stimulate audience participation in science projects, since scientific knowledge from the laboratories has to be shared with the citizens as a form of accountability to the taxpayers who fund research. The BrainLab will not only magnify scientists’ visibility and earn them personal and professional rewards, but will also link with the operation of the general media and the dynamics of public discourse, which in turn will benefit science immensely through the crowdsourcing of ideas. Such a laboratory will enhance capacity development for engagement with the media, the general public and other stakeholders. The BrainLab will contribute to establishing a scientifically and technologically literate community as citizens obtain knowledge, students gain the necessary skills, and senior researchers get credit for the time spent with laypeople. Such an approach is expected to promote team science communication and prevent science from getting lost through translation.

In summary, biotechnology is an interdisciplinary subject that requires multiple expertise, strategic marketing, and collaboration in decision making. Messages must be compelling, relevant, clear, concise, and informative to the audience. Effective communication must include voices that resonate with the audience. In addition, the messenger must be agreeable to the audience; the messenger should not be controversial. In engaging the audience, GMO issues should be depoliticised as a way of respecting the public. Face-to-face interactions are important in developing relationships and influencing the learning outcomes. The communicator should acknowledge their own bias and be transparent in their communication. Thus, scientists must involve other members of society to generate socially acceptable.

8.4.3 Further research

Regarding further research, one consideration is to study the effects of social networks on the biotechnology debate in the context of Uganda. It appears that social media constitute provocative ways of sharing scientific information by identifying and interpreting facts and hoaxes. It would, then, be interesting to understand how emotions about this contestable science flare in the fairly unregulated environment of social media.

The codebook, questionnaire and interview guide can be starting points to study how tabloids, radio, and biweekly, triweekly, local and online newspapers and magazines cover GMOs. Particularly, it is vital to research the possible impact of Bukedde Television's popular *Agatalkio Nfuufu* (dustless news), a news bulletin that 'reverses news values' in covering biotechnology.

A national survey on people's perceptions about GMOs, and a content analysis involving print, electronic and online platforms, may provide a broader context for understanding the subject. A study of how radio, the dominant source of information for Ugandans, covers biotechnology is particularly important.

Considering that Uganda is home to several tribes speaking different tribes, it would be imperative to study the role of language in researchers' ability to communicate science. Such study would perhaps highlight the commonest languages used in sharing science, and why some scientists remain silent.

To determine the immediate effects of the media on public perception, a control study is also recommended. This should involve a group of people, preferably students, reading a story and expressing their views in a survey.

Research should be conducted to establish the gender gaps in associating risks with GMOs. Further research could be done to establish the reasons for fewer stories about biotechnology written by female reporters. It would also be interesting to do research to establish the relationship between age and perception of GMOs.

Finally, it is important to research the influence of indigenous knowledge in shaping perceptions about GMOs. Such a study will support the context for science communication on GMOs.

Bibliography

Activist A. 2017. In-depth interview. 15 January, Kampala.

Activist B. 2017. In-depth interview. 17 January, Kampala.

Activist C. 2017. In-depth interview. 17 February, Kampala.

Aerni, P. 2002. Stakeholder attitudes toward the risks and benefits of agricultural biotechnology in developing countries: A comparison between Mexico and the Philippines. *Risk Analysis*, 22(6):1123-1137.

Agence France-Presse. 2017. Like Trump, Vladimir Putin says climate change not man-made and warming began in the 1930s [Online]. Available: http://www.scmp.com/news/world/russia-central-asia/article/2083650/trump-vladimir-putin-says-climate-change-not-man-made [2017, October 6].

Al-Attar, M. 2017. Food ethics: A critique of some Islamic perspectives on genetically modified food. *Zygon*, 52(1):53-75.

Alexander, V.D., Thomas, H., Cronin, A., Fielding, J. & Moran-Ellis, J. 2011. Mixed methods, in N. Gilbert (ed.). *Researching social life*. 3rd edition. London: Sage. 125-144.

Allan, G. 2003. A critique of using grounded theory as a research method. *Electronic Journal of Business Research Methods*, 2(1):1-10.

Alliance for Natural Health. 2014. MIT researcher: Glyphosate herbicide will cause half of all children to have autism by 2025. *Health Impact News* [Online]. Available: https://healthimpactnews.com/2014/mit-researcher-glyphosate-herbicide-will-cause-half-of-all-children-to-have-autism-by-2025/ [2018, March 9].

Altheide, D.L. & Snow, R.P. 1991. *Media worlds in the photojournalism era*. New York: Walter de Gruyter.

Altheide, D.L. & Snow, R.P. 1979. *Media logic*. Bevedy Hills, CA: Sage.

Altheide, D.L. 2013. Media logic, social control, and fear. *Communication Theory*, 23(3):223-238.

Andrews, A.C., Clawson, R.A., Graming, B.M. & Raymond, L. 2017. Finding the right value: Framing effects on domain experts. *Political Psychology*, 38(2):261-278.

Arata, M. 2007. PR for the physics of matter: Tops … and flops, in M.W. Bauer & M. Bucchi (eds.). *Journalism, science and society*. New York: Routledge. 173-182.

Ardèvol-Abreu, A. & Gil de Zúñiga, H. 2016. Effects of editorial media bias perception and media trust on the use of traditional, citizen, and social media news. *Journalism and Mass Communication Quarterly*, 94(3):703-724.

Ariko, C. 2002. Govt cautious on GMOs. *New Vision*, 1 October [Online]. Available: https://www.newvision.co.ug/new_vision/news/1047995/govt-cautious-gmos [2017, July 8].

Arinaitwe, S. 2017. Speaker Kadaga throws out Justice Kavuma's "stupid" order. *Daily Monitor*, 11 January [Online]. Available: http://www.monitor.co.ug/News/National/Speaker-Kadaga--Justice-Kavuma-order-Parliament/688334-3513024-79a0iq/index.html [2017, May 5].

Ariong, S. 2016. Hunger kills 11 in Kaabong. *Daily Monitor*, 23 February [Online]. Available: http://www.monitor.co.ug/News/National/Hunger-kills-11-in-Kaabong/-/688334/3088240/-/dye0o1z/-/index.html [2017, January 8].

Aronowitz, S. 1988. *Science as power: Discourse and ideology in modern society*: University of Minnesota Press.

Atkins, P. & Bowler, I. 2016. *Food in society: Economy, culture, geography*. New York: Routledge.

Audit Bureau of Circulation. 2016. *Third quarter (November)*. Johannesburg, South Africa: ABC.

Auma, P., Wangia, S.M., Magomere, T., Ligare, E.C. & K'obill, J. 2017. Effectiveness of community radio in disseminating market information among smallholder maize farmers: Experience from Suba Sub-county – Kenya. *International Journal of Innovative Research and Development*. 6(3):54–63.

Babbie, E. 2010. *The practice of social research*. 12th edition. Boston: Wadsworth.

Bagley, M.A. 2007. A global controversy: The role of morality in biotechnology patent law. Public Law and Legal Theory Working Paper Series, Working Paper No. 57. Charlottesville, VA: University of Virginia Law School.

Bailey, K.D. 1982. *Methods of social research*. 2nd edition. New York: Free Press.

Bain, C., Selfa, T., Dandachi, T. & Velardi, S. 2017. "Superweeds" or "survivors"? Framing the problem of glyphosate resistant weeds and genetically engineered crops. *Journal of Rural Studies*, 51:211-221.

Bandewar, S.V.S., Wambugu, F., Richardson, E. & Lavery, J.V. 2017. The role of community engagement in the adoption of new agricultural biotechnologies by farmers: The case of the Africa harvest tissue-culture banana in Kenya. *BMC Biotechnology*, 17(1):1-11.

Barnes, C. 2012. Citizen journalism vs. traditional journalism: A case for collaboration. *Caribbean Quarterly*, 58(2-3):16-27.

Basu, S. & Leeuwis, C. 2012. Understanding the rapid spread of System of Rice Intensification (SRI) in Andhra Pradesh: Exploring the building of support networks and media representation. *Agricultural Systems*, 111:34-44.

Bauer, H.H. 1992. *Scientific literacy and the myth of the scientific method*. Chicago: University of Illinois Press.

Bauer, M.W. 2002a. Arenas, platforms, and the biotechnology movement. *Science Communication*, 24(2):144-161.

Bauer, M.W. 2002b. Controversial medical and agri-food biotechnology: A cultivation analysis. *Public Understanding of Science*, 11:93-111.

Bauer, M. & Bonfadelli, H. 2002. Controversy, media coverage and public knowledge, in M.W. Bauer & G. Gaskell (eds.). *Biotechnology: The making of a global controversy*. Cambridge, UK: Cambridge University Press. 149-178.

Bauer, M.W. & Gaskell, G. 2002a. *Biotechnology: The making of a global controversy*. M.W. Bauer & G. Gaskell, Eds. Cambridge, UK: Cambridge University Press.

Bauer, M.W. & Gaskell, G. 2002b. Researching the public sphere of biotechnology, in M.W. Bauer & G. Gaskell (eds.). *Biotechnology: The making of a global controversy*. London: Cambridge University Press. 1-17.

Bauer, M.W., Allum, N. & Miller, S. 2007. What can we learn from 25 years of PUS survey research? Liberating and expanding the agenda. *Public Understanding of Science*, 16(1):79-95.

Brannen, J. 2011. The practice of a mixed methods research strategy: Personal, professional and project considerations. In Advances in mixed methods research. M.M. Bergman, Ed. Los Angeles: Sage.

Cusack, L. 2017. EU rules Italian ban on GMO crop unlawful. *Reuters* (London). 13 September. [Online], Available: https://www.reuters.com/article/us-gmo-eu-court/eu-rules-italian-ban-on-gmo-crop-unlawful-idUSKCN1BO1QN.

D'Sylva, A. & Beagan, B.L. 2011. "Food is culture, but it's also power": The role of food in ethnic and gender identity construction among Goan Canadian women. *Journal of Gender Studies.* 20(3):279–289.

Davies, M.B. 2008. *Doing successful research projects*. New York: Palgrave Macmillan.

Dawson, C. 2013. *Introduction to research methods: A practical guide for anyone undertaking a research project*. 4th ed. Glasgow: Bell & Bain.

DeCuir-Gunby, J.T. 2011. Mixed methods research in social sciences. In *Best practices in quantitative methods.* J.W. Osborne, Ed. London: SAGE Publications. 125–136.

Editorial. 2007. Uganda to face severe food shortage - FAO. *Uganda Radio Network* (Kampala, Uganda, Uganda). 11 April. [Online], Available: https://ugandaradionetwork.com/story/uganda-to-face-severe-food-shortage-fao.
Food and Agriculture Organisation. 2015. *The state of food insecurity in the world*. Rome: FAO.

Food and Agriculture Organisation. 2017. *Millions of people face food shortages in the Horn of Africa*. Addis Ababa: FAO

Bell, E. 2016. Facebook is eating the world. *Columbia Journalism Review*, 1-7.

Berelson, B. 1952. *Content analysis in communication research*. Glencoe, Illinois: Free Press.

Bergh, D.D., Corley, K.G. & Ketchen, D.J. 2017. Mixed methods in the organisational sciences: Taking stock and moving forward. *Organisational Research Methods*, 20(2):179-192.

Berglez, P. 2011. Inside, outside, and beyond media logic: Journalistic creativity in climate reporting. *Media, Culture & Society*, 33(3):449-465.

Berglez, P. & Nassanga, G.L. 2015. What is the difference between cross-national comparisons and semi-comparative work? Example of Swedish-Ugandan climate change communication Research. *Journal of Development and Communication Studies*, 4(1):33-48.

Bergman, M.M. 2011. Introduction: Wither mixed methods? in M.M. Bergman (ed.). *Advances in mixed research methods*. London: Sage. 1-7.

Besley, J.C., Dudo, A.D., Yuan, S. & AbiGhannam, N. 2016. Qualitative interviews with science communication trainers about communication objectives and goals. *Science Communication*, 38(3):356-381.

Bett, C., Ouma, J.O. & De Groote, H. 2010. Perspectives of gatekeepers in the Kenyan food industry towards genetically modified food. *Food Policy*, 35(4):332-340.

Beyeler, M., & Kriesi, H. 2005. Transnational protest and the public sphere. *Mobilization: An International Quarterly*, 10(1):95-109.

Bhatta, A., & Misra, K.D. 2016. Biotechnology communication needs a rethink. *Current Science*, 110(4):573-578.

Bigliardi, S. 2017. Science, pseudo-science, and fiction. *Zygon*, 52(1):146-171.

Bik, H.M. & Goldstein, M.C. 2013. An introduction to social media for scientists. *PLOS Biology*, 11(4) [Online]. Available: http://journals.plos.org/plosbiology/article?id=10.1371/journal.pbio.1001535 [2017, April 2].

Blake, J.A. 1979. Ufology: The intellectual development and social context of the study of unidentified flying objects. *The Sociological Review*, 27(1):315 – 337.

Blancke, S., Grunewald, W. & De Jaeger, G. 2017. De-problematizing “GMOs”: Suggestions for communicating about genetic engineering. *Trends in Biotechnology*, 35(3):185-186.

Bonfadelli, H., Dahinden, U. & Leonarz, M. 2007. Mass media and public perception of red and green biotechnology: A case study from Switzerland, in D. Brossard, J. Shanahan & C.T. Nesbitt (eds.). *The media, the public, and agricultural biotechnology*. Wallingford, UK/Cambridge: CABI. 97-125.

Bor, G. 2017. In GMO, hope is beckoning for farmers. *Daily Nation*, 21 August [Online]. Available: http://www.nation.co.ke/oped/opinion/In-GMO--hope-is-beckoning-for-farmers-

/440808-4064660-tpius0/index.html [2017, August 22].

Boykoff, M.T. & Boykoff, J.M. 2004. Balance as bias: Global warming and the US prestige press. *Global Environmental Change*, 14:125-136.

Boykoff, V.M. & Boykoff, V. 2007. Climate change and journalistic norms: A case-study of US mass-media coverage. *Geoforum*, 38:1190-1204.

Braimah, J.A., Atuoye, K.N., Vercillo, S., Warring, C. & Luginaah, I. 2017. Debated agronomy: Public discourse and the future of biotechnology policy in Ghana. *Global Bioethics*, 28(1):3-18.

Brannen, J. 2011. The practice of a mixed methods research strategy: Personal, professional and project considerations, in M.M. Bergman (ed.). *Advances in mixed methods research*. Los Angeles: Sage. 53-65.

Brants, K. & Van Praag, P. 2015. Beyond media logic. *Journalism Studies*, 18(4):395-408.

Broom, G.M. & Dozier, D.M. 1986. Advancement for public relations role models. *Public Relations Review*, 12(1):37-56.

Brossard, D. & Lewenstein, B. 2010. A critical appraisal of models of public understanding of science: Using practice to inform theory, in L.A. Kaholr & P.A. Stout (eds.). *Communicating science: New agendas in communication*. New York: Routledge. 11-39.

Brown, O., Hammill, A. and McLeman, R. (2007) Climate change as the 'new' security threat: Implications for Africa. *International Affairs*, 83(6):1141-1154.

Brüggemann, M. & Engesser, S. 2017. Beyond false balance: How interpretive journalism shapes media coverage of climate change. *Global Environmental Change*, 42:58-67.

Bryman, A. 1996. *Quantity and quality in social research*. London: Routledge.

Bryman, A. 2011. Why do researchers integrate/combine/mesh/blend/mix/merge/fuse quantitative and qualitative research? in M.M. Bergman (ed.). *Advances in mixed methods research*. Los Angeles: Sage. 87-100.

Bryman, A. 2015. *Social research methods*. Oxford: Oxford University Press.

Bryman, A. & Bell, E. 2014. *Business research methods*. 3rd edition. Oxford: Oxford University Press.

Bucchi, M. 2004. *Science in society: An introduction to social studies of science*. 5th edition. London: Routledge.

Bucchi, M. 2016. Science communication and science in society: A conceptual review in ten keywords. *Italian Journal of Science & Technology Studies*, 7(2):151-168.

Bucchi, M. & Trench, B. (eds.). 2014. *Routledge handbook of public communication of science and technology*. 2nd edition. London: Routledge.

Bucher, T. & Helmond, A. 2017. The affordances of social media platforms, in J. Burgess, T. Poell, & A. Marwick (eds.). *The Sage handbook of social media*. London. Sage. 1-41.

Burrell, I. 2014. Media coverage of ethnic minority Britons "promotes racism". *Independent*, 19 January [Online]. Available: http://www.independent.co.uk/news/media/tv-radio/media-coverage-of-ethnic-minority-britons-promotes-racism-9049849.html [2016, August 5].

Cacciatore, M.A., Scheufele, D.A. & Iyengar, S. 2016. The end of framing as we know it … and the future of media effects. *Mass Communication and Society*. 19(1):7–23.

Campbell, D. & Fiske, D. 1959. Convergent and discriminant validation by the multitrait-multimethod-matrix. *Psychological Bulletin*, 56:81-105.

Caple, H. & Bednarek, M. 2013. *Delving into the discourse: Approaches to news values in journalism studies and beyond*. Oxford: The Reuters Institute for the Study of Journalism.

Carver, R.B. 2014. Public communication from research institutes: Is it science communication or public relations? *Journal of Science Communication*, 13(3):1-4.

Carver, R.B., Rodland, E.A. & Breivik, J. 2012. Quantitative frame analysis of how the gene concept is presented in tabloid and elite newspapers. *Science Communication*, 35(4):449-475.

Caulfield, T. 2005. Popular media, biotechnology, and the "cycle of hype". *Houston Journal of Health Law & Policy*, 5(2):213-233.

Ceccoli, S. & Hixon, W. 2012. Explaining attitudes toward genetically modified foods in the European Union. *International Political Science Review*, 33(3):301-319.

Cerier, S. 2017. *Led by Nigeria, Africa opening door to genetically modified crop cultivation*. Genetic Literacy Project [Online]. Available: https://geneticliteracyproject.org/2017/03/06/led-nigeria-africa-gradually-opening-door-genetically-modified-crop-cultivation/ [2018, March 3].

Chen, S.Y., Chu, Y.R., Lin, C.Y. & Chiang, T.Y. 2016. Students' knowledge of, and attitudes towards biotechnology revisited, 1995-2014: Changes in agriculture biotechnology but not in medical biotechnology. *Biochemistry and Molecular Biology Education*, 44(5):475-491.

Chow, L. 2018. Beekeepers file legal complaint against Bayer over glyphosate in honey. *EcoWatch*, 12 June [Online]. Available: https://www.ecowatch.com/glyphosate-honey-bayer-monsanto-2577435405.html [2018, June 15].

Chow-White, P., Struve, S., Lusoli, A., Lesage, F., & Oldring, A. 2017. "Warren Buffet is my cousin": Shaping public understanding of big data biotechnology, direct-to-consumer genomics, and 23andMe on Twitter. *Information, Communication & Society*, 4462(March):1-17.

Claassen, G. 2011. Science and the media in South Africa: Reflecting a "dirty mirror". *Communicatio*, 37(3):351-366.

Claassen, G.N. 2016. *Platforms and role players in public science engagement: Science and the media*. Online short course in science communication @ Stellenbosch University. Closed online source.

Clancy, K.A. & Clancy, B. 2016. Growing monstrous organisms: The construction of anti-GMO visual rhetoric through digital media. *Critical Studies in Media Communication*, 33(3):279-292.

Clerk to Parliamentary Committee on Science and Technology. 2017. In-depth interview. 7 March, Kampala.

Coleman, S. & Thumim, N. 2016. Researching local news in a big city: A multimethod approach. *International Journal of Communication*, 10:1351-1365.

Committee on Genetically Engineered Crops. 2016. *Genetically engineered crops: Past experiences and future prospects*. Washington DC: The National Academies Press.

Cortes-Ramírez, E.E. 2014. Knowledge is power. Francis Bacon's theory of ideology and culture. *Via Panorâmica: Revista Electrónica de Estudos Anglo-Americanos/An Anglo-American Studies Journal*, 3(Número Especial):25-42.

Cottle, S. 2006. *Mediatised conflicts*. Maidenhead, UK: Open University Press.

Cramer, C.M. 2008. The framing of climate change in three daily newspapers in the Western Cape province of South Africa. Unpublished Master's thesis. Stellenbosch: Stellenbosch University.

Creswell, J.W. 2011. *Research design: Qualitative, quantitative and mixed methods approaches*. 3rd edition. Los Angeles: Sage.

Creswell, J.W. 2015. *A concise introduction to mixed methods research*. Los Angeles: Sage.

Creswell, J.W. 2016. *30 essential skills for the qualitative researcher*. Los Angeles: Sage.

Creswell, J.W. & Clark, V.L.P. 2011. *Designing and conducting mixed methods research*. 2nd edition. Thousand Oaks, CA: Sage Publications.

Cusack, L. 2017. EU rules Italian ban on GMO crop unlawful. *Reuters*, 13 September [Online]. Available: https://www.reuters.com/article/us-gmo-eu-court/eu-rules-italian-ban-on-gmo-crop-unlawful-idUSKCN1BO1QN. [2017, September 17].

Cushion, S., Thomas, R., Kilby, A., Morani, M. & Sambrook, R. 2016. Interpreting the media logic behind editorial decisions: Television news coverage of the 2015 UK general election campaign. *The International Journal of Press/Politics*, 21(4):472-489.

Czerniewicz, L., Goodier, S. & Morrell, R. 2017. Southern knowledge online? Climate change research discoverability and communication practices. *Information Communication and Society*, 20(3):386-405.

Dearing, W. 2016. Newspaper coverage of maverick science: creating controversy through balancing. *Public Understanding of Science*. 4(4):341–361.

Dahlstrom, M.F. 2014. Using narratives and storytelling to communicate science with nonexpert audiences. *Proceedings of the National Academy of Sciences*, 111(Suppl. 4):13614-13620.

Dai, J., Zeng, F. & Wang, Y. 2017. Publicity strategies and media logic: Communication campaigns of environmental NGOs in China. *Chinese Journal of Communication*, 4750 (March):1-16.

Dal Grande, E., Chittleborough, C.R., Campostrini, S. & Taylor, A.W. 2016. Bias of health estimates obtained from chronic disease and risk factor surveillance systems using telephone population surveys in Australia: Results from a representative face-to-face survey in Australia from 2010 to 2013. *BMC Medical Research Methodology*, 16(1):1-13.

Daniel, J. 2012. *Sampling essentials: Practical guidelines for making sampling choices*. London: Sage.

Davies, M.B. 2008. *Doing successful research projects*. New York: Palgrave Macmillan.

Davies, N. 2009. *Flat earth news*. London: Vintage.

Davies, S.R. & Horst, M. 2016. *Science communication: Culture, identity and citizenship*. London: Palgrave Macmillan.

Dawson, C. 2013. *Introduction to research methods: A practical guide for anyone undertaking a research project*. 4th edition. Glasgow: Bell & Bain.

De Beer, A.S., Malila, V., Beckett, S. & Wasserman, H. 2016. Binary opposites – Can South African journalists be both watchdogs and developmental journalists? *Journal of African Media Studies*, 8(1):35-53.

D'Sylva, A. & Beagan, B.L. 2011. "Food is culture, but it's also power": The role of food in ethnic and gender identity construction among Goan Canadian women. *Journal of Gender Studies*. 20(3):279–289.

DeCuir-Gunby, J.T. 2011. Mixed methods research in social sciences, in J.W. Osborne (ed.). *Best practices in quantitative methods*. London: Sage. 125-136.

Dehghan, S.K. 2016. Iran executes nuclear scientist who returned to country from US. *The Guardian UK*, 8 August [Online]. Available: https://www.theguardian.com/world/2016/aug/07/iran-executes-nuclear-scientist-shahram-amiri-returned-country-from-us [2016, August 8].

De Leeuw, E. & Hox, J. 2011. Mixing data collection methods: Lessons from social survey research, in M.M. Bergman (ed.). *Advances in mixed methods research*. Los Angeles: Sage. 138-149.

Denzin, N.K. 1978. *The research act*. Chicago, IL: Aldine.

Denzin, N.K. 1989. *The research act*. 3rd edition. Englewood Cliffs, NJ: Prentice Hall.

De Vaus, D. 2011. Comparative and cross-national designs, in P. Alasuutari, L. Bickman & J. Brannen (eds). *A handbook of social research methods.* Los Angeles: Sage. 249-264.

Devonshire, I.M. & Hathway, G.J. 2014. Overcoming the barriers to greater public engagement. *PLoS Biology*, 12(1):12-15.

Dimbley, R. & Burton, G. 1998. *More than words: An introduction to communication*. 3rd edition. New York: Routledge.

Dewing, M. 2012. *Social media: An introduction*. Ottawa: Parliamentary Information and Research Service.

Dooly, P. 2008. *The technology of journalism: Cultural agents, cultural icons*. Evanston, IL: North Western University Press.

Downs, A. 1972. Up and down with ecology – the "issue-attention" cycle. *The Public Interest*, 28:38-50.

Dudo, A., Brossard, D., Shanahan, J., Scheufele, D.A., Morgan, M. & Signorielli, N. 2011. Science on television in the 21st century. *Communication Research*, 38(6):754-777.

Duesberg, P. & Rasnick, D. 1998. The AIDS dilemma: Drug diseases blamed on a passenger virus. *Genetica*, 104(2):85-132.

Duffy, B., Smith, K., Terhanian, G. & Bremer, J. 2005. Comparing data from online and face-to-face surveys. *International Journal of Market Research*, 47(6):615-639.

Dunwoody, S. 2008a. Science journalism, in M. Bucchi & B. Trench (eds.). *Handbook of public communication of science and technology*. London: Routledge. 15-26.

Dunwoody, S. 2008b. Scientists, journalists and the meaning of uncertainty, in S. Friedman, S. Dunwoody & C. Rogers (eds.). *Communicating uncertainty: Media coverage of new and controversial science*. London: Lawrence Erlbaum Associates, Publishers. 59-80.

Dunwoody, S. & Kohl, P.A. 2017. Using weight-of-experts messaging to communicate accurately about contested science. *Science Communication*, 39(3):1-20.

Dziuban, C., Moskal, P. & Hartman, J. 2005. Higher education, blended learning and the generations: Knowledge is power - no more. *Elements of quality online education: Engaging communities*. 85–100.

Eagly, A.H. & Chaiken, S. 1993. *Psychology of attitudes*. Orlando, Fl: Harcourt Brace Jovanovich College Publishers.

Editorial. 2007. Uganda to face severe food shortage – FAO. *Uganda Radio Network*, 11 April [Online]. Available: https://ugandaradionetwork.com/story/uganda-to-face-severe-food-shortage-fao [2018, February 4].

Editorial Team. 2017. Government spends Shs5B on eight bulls. *New Vision*, 11 September:29.

Editorial. 2018. Produce prices: Govt must stop firefighting. *Daily Monitor* (Kampala). 16 August. [Online], Available: http://www.monitor.co.ug/OpEd/Editorial/Produce-prices--Govt--must-stop-fire-fighting/689360-4714526-txqmwp/index.html [Accessed: 2018, August 17].

Einsiedel, E. & Thorne, B. 2008. Public responses to uncertainty, in S. Friedman, S. Dunwoody & C. Rogers (eds.). *Communicating uncertainty: Media coverage of new and controversial science*. London: Lawrence Erlbaum Associates, Publishers. 43-58.

Emorut, F. 2017. Uganda allows GMOs use. *New Vision*, 6 October [Online]. Available: https://www.newvision.co.ug/new_vision/news/1463108/parliament-finally-passes-gmo [2018, February 4].

Enli, G. & Simonsen, C.A. 2017. “Social media logic” meets professional norms: Twitter hashtags usage by journalists and politicians. *Information, Communication & Society*, 4462(March):1-16.

Entman, R. 1993. Framing: Toward clarification of a fractured paradigm. *Journal of Communication*, 43(4):51-58.

Entman, R. 2004. *Projections of power: Framing news, public opinion, and U.S. foreign policy*. Chicago: The University of Chicago Press.

European Academies Science Advisory Council. 2013. *Planting the future: Opportunities and challenges for using crop genetic improvement technologies for sustainable agriculture*. Cardiff: European Academies Science Advisory Council.

Eveland, W.P. & Cooper, K.E. 2013. An integrated model of communication influence on beliefs. *Proceedings of the National Academy of Sciences*, 110(Suppl. 3):14088-14095.

Fairclough, N. 2008. The language of critical discourse analysis: Reply to Michael Billig. *Discourse & Society*, 6(2):185-206.

Feindt, P.H. & Kleinschmit, D. 2011. The BSE crisis in German newspapers: Reframing responsibility. *Science as Culture*, 20(2):183-208.

Fetters, M.D. & Molina-Azorin, J.F. 2017. The *Journal of Mixed Methods Research* starts a new decade: Principles for bringing in the new and divesting of the old language of the field. *Journal of Mixed Methods Research*, vii (1):3-10.

Fielding, N. 2011. Analytic density, postmodernism, and applied multiple method research, in M.M. Bergman (ed.). *Advances in mixed methods research*. Los Angeles: Sage. 37-52.

Fischhoff, B. & Scheufele, D.A. 2013. The sciences of science communication. *Proceedings of the National Academy of Sciences*, 110 (Suppl. 3):14033-14039.

Fiske, J. 2010. *Introduction to communication studies*. London: Routledge.

Fjæstad, B. 2010. Why journalists report science as they do, in M.W. Bauer & M. Bucchi (eds.). *Journalism, Science and Society*. New York: Routledge. 123-131.

Flick, U. 2008. *Managing quality in qualitative research*, Los Angeles: Sage.

Flick, U. 2012. *Introducing research methodology: A beginner's guide to doing a research project*. Los Angeles: Sage.

Flick, U. 2017. Mantras and myths: The disenchantment of mixed methods research and revisiting triangulation as a perspective. *Qualitative Inquiry*, 23(1):46-57.

Food and Agriculture Organisation. 2015. *The state of food insecurity in the world*. Rome: FAO

Food and Agriculture Organisation. 2017. *Millions of people face food shortages in the Horn of Africa.* Addis Ababa: FAO

Fourie, P.J. 2017. Social media and mediated communication in postmodern society, in P.J. Fourie, (ed.). *Media studies: Volume 4. Social (new) media and mediated communication today*. Cape Town: Juta. 1-37

Fourie, P.J. (ed.). 2007. *Media studies volume 1: Media history, media and society*. 2nd edition. Cape Town: Juta

Fowler, E.F. & Gollust, S.E. 2015. The content and effect of politicised health controversies. *The ANNALS of the American Academy of Political and Social Science*, 658(1):155-171.

Franklin, J. 2010. The end of science journalism, in M.W. Bauer & M. Bucchi (eds.). *Journalism, science and society*. New York: Routledge. 143-156.

Friedman, S., Dunwoody, S. & Rogers, C. (eds.). 2008. *Communicating uncertainty: Media coverage of new and controversial science*. London: Lawrence Erlbaum Associates, Publishers.

Galata, E.A. 2017. The cultivation of opinions. How did the press cover the last 16 years of experience with GMOs in Canada? *Cogent Business & Management*, 4(1):1-11.

Galtung, J. & Ruge, M.H. 1965. The structure of foreign news: The presentation of the Congo, Cuba and Cyprus crises in four Norwegian newspapers. *Journal of Peace Research*, 2(1):64-90.

Garrett, J.M. & Bird, S.J. 2000. Ethical issues in communicating science. *Science and Engineering Ethics*, 6(4):435-442.

Gaskell, G., Bauer, M. & Durant, J. 1998. The representation of biotechnology: Policy, media and public perception, in J. Durant, M. Bauer & G. Gaskell (eds.). *Biotechnology in the public sphere. A European Sourcebook.* London: Science Museum. 3-14.

Gaskell, G., Thompson, P. & Allum, N. 2002. Worlds apart? Public opinion in Europe and the

USA, in M.W. Bauer & G. Gaskell (eds.). *Biotechnology: The making of a global controversy*. Cambridge, UK: Cambridge University Press. 351-378.

Gastrow, M. 2010. *The public understanding of biotechnology in the media: A report for the National Advisory Council on Innovation and the National Advisory Committee*. Pretoria: Human Sciences Research Council.

Gastrow, M. 2015. *The stars in our eyes: Representations of the Square Kilometre Array telescope in the South African media*. Unpublished PhD dissertation. Stellenbosch: Stellenbosch University.

Gauchat, G. 2012. Politicisation of science in the public sphere: A study of public trust in the United States, 1974 to 2010. *American Sociological Review*, 77(2):167-187.

Geary, J., Camicioli, E. & Bubela, T. 2016. DNA barcoding in the media: does coverage of cool science reflect its social context? *Genome*, 59(9):738-750.

Geffen, N. 2016. Clearing up two of Mbeki's misconceptions. *News24*, 10 March [Online]. Available: http://www.news24.com/Columnists/GuestColumn/clearing-up-two-mbeki-misconceptions-20160310 [2016, March 11].

Giorno, L. & Drioli, E. 2000. Biocatalytic membrane reactors: Applications and perspectives. *Trends in Biotechnology*, 18(8):339-349.

GMWatch. 2017. The world's top 10 seed companies: Who owns nature? *GMWatch* [Online]. Available: http://www.gmwatch.org/en/gm-firms/10558-the-worlds-top-ten-seed-companies-who-owns-nature [2018, March 5].

González, D., Mateu, A., Pons, E. & Domínguez, M. 2017. Women scientists as decor: The image of scientists in Spanish press pictures. *Science Communication*, 39(4):535-547.

Göpfert, W. 2010. The strength of PR and the weakness of science journalism, in M.W. Bauer & M. Bucchi (eds.). *Journalism, science and society*. New York: Routledge. 215-226.

Goujard, C. 2016. Five ways journalists can engage their audiences in storytelling. *International Journalists' Network* [Online]. Available: https://ijnet.org/en/blog/five-ways-journalists-can-engage-their-audiences-storytelling [2016, July 1].

Government of Uganda. 1964. *Official Secrets Act*. Kampala: Government Printer.

Govoni, P. 2010. The rise and fall of science communication in late nineteenth century Italy, in M.W. Bauer & M. Bucchi (eds.). *Journalism, science and society*. New York: Routledge. 21-29.

Graziano, A.M. & Raulin, M.L. 2000. Field research: Naturalistic observation, case-study research, and observation, in A.M. Graziano & M.L. Raulin (eds). *Research methods: A process of inquiry*. 4th edition. Boston: Allyn and Bacon. 120-147.

Graziano, A.M. & Raulin, M.L. 2010. *Research methods: A process of inquiry*. 7th edition. New York: Allyn and Bacon.

Greener, I. 2011. *Designing research: A guide for the bewildered*. Los Angeles: Sage.

Gregory, J., Agar, J., Lock, S. & Harris, S. 2010. Public engagement of science in the private sector, in M.W. Bauer & M. Bucchi (eds.). *Journalism, Science and Society*. New York: Routledge. 203-213.

Gregson, J. 2017. The poorest countries in the world. *Global Finance*, February [Online]. Available: https://www.gfmag.com/global-data/economic-data/the-poorest-countries-in-the-world?page=12 [2018, March 6].

Gunter, B., Kinderlerer, J. & Beyleveld, D. 1999. The media and public understanding of biotechnology: A survey of scientists and journalists. *Science Communication*, 20(4):373-394.

Gupta, C. 2017. Contested fields: An analysis of anti-GMO politics on Hawai'i Island. *Agriculture and Human Values*, 35(1):181-192.

Gurău, C. & Ranchhod, A. 2016. The futures of genetically-modified foods: Global threat or panacea? *Futures*, 83:24-36.

Gutteling, J., Olofsson, A., Fjaestad, B., Kohring, M., Goerke, A., Bauer, M., Rasanen, T., Allansdottir, A., Berthomier, A., De Cheveigne, S., Frederiksen, H., Gaskell, G., Leonarz, M., Liakopoulos, M., Mortensen, A.T., Przestaslski, A., Ruhrmann, G., Rusanen, M., Schanne, M., Seifert, F., Stathopoulou, A. & Wagner, W. 2002. Media coverage 1973−1996: Trends and dynamics, in M.W. Bauer & G. Gaskell (eds.). *Biotechnology: The making of a global controversy*. Cambridge, UK: Cambridge University Press. 95-128.

Habermas, J. 1989. *The structural transformation of the public sphere*. Cambridge, UK: Policy Press (English translation. Original work published 1962).

Habermas, J. 1991. *The structural transformation of the public sphere: An inquiry into a category of Bourgeois society*. Cambridge: The MIT Press.

Hammersley, M. 2008. Troubles with triangulation, in M.M. Bergman (ed.). *Advances in mixed research methods*. Los Angeles: Sage. 22-36.

Hanson, B. 2015. Objectivities: Constructivist roots of positivism. *Quality & Quantity*, 49(2):857-865.

Harcup, T. & O'Neill, D. 2001. What is news? Galtung and Ruge revisited. *Journalism Studies*, 2(2):261-280.

Harding J. 2013. *Qualitative data analysis from start to finish*. London: Sage.

Harvey, C. 2016. People want GMO food labeled – which is pretty much all they know about GMOs. *The Washington Post*, 21 July [Online]. Available: https://www.washingtonpost.com/news/energy-environment/wp/2016/07/21/people-want-gmo-food-labeled-which-is-pretty-much-all-they-know-aboutgmos/?utm_term=.24876e0fabbe&wpic=nl_green&wpmm=1 [2016, July 25].

Harvey, C. 2017. These scientists want to create “red teams” to challenge climate research. Congress is listening. *The Washington Post*, 29 March [Online]. Available: https://www.washingtonpost.com/news/energy-environment/wp/2017/03/29/these-climate-doubters-want-to-create-a-red-team-to-challenge-climate-science/?utm_term=.adc76e18c1c5 [2017, March 31].

Hendriks, F., Kienhues, D. & Bromme, R. 2016. Evoking vigilance: Would you (dis)trust a scientist who discusses ethical implications of research in a science blog? *Public Understanding of Science*, 25(8):1-17.

Hicks, D.J. 2017. Scientific controversies as proxy politics. *Issues in Science and Technology*, 33(2):67-73.

Hielscher, S., Pies, I., Valentinov, V. & Chatalova, L. 2016. Rationalising the GMO debate: The ordonomic approach to addressing agricultural myths. *International Journal of Environmental Research and Public Health*, 13(5):476-486.

Horst, M. 2005. Cloning sensations: Mass mediated articulation of social responses to controversial biotechnology. *Public Understanding of Science*, 14:185-200.

Hossain, F., Onyango, B., Adelaja, A., Schilling, B. & Hallman, W. 2002a. Public perceptions of biotechnology and acceptance of genetically modified foods. *Journal of Food Distribution Research*, 34(3):36-50.

Hossain, F., Onyango, B., Adelaja, A, Schilling, B. & Hallman, W. 2002b. Uncovering factors influencing public perceptions of food biotechnology. Food Policy Institute Working Paper 18178. Rutgers University: Food Policy Institute.

House of Lords. 2000. *Select committee on science and technology third report* [Online]. Available: http://www.publications.parliament.uk/pa/ld199900/ldselect/ldsctech/38/3802.htm [2016, March 25].

Howard, A. 2012. *Connecting with communities: How local government is using social media to engage with citizens*. Canberra: ANZSOG Institute for Governance at the University of Canberra and Australian Centre of Excellence for Local Government [Online]. Available: https://opus.lib.uts.edu.au/bitstream/10453/42107/3/Connecting-With-Communities-Social-Media.pdf [2016, June 4].

Huang, J. & Peng, B. 2015. Consumers’ perceptions on GM food safety in urban China. *Journal of Integrative Agriculture*, 14(11):2391-2400.

Huff, C. & Kruszewska, D. 2016. Banners, barricades, and bombs: The tactical choices of social movements and public opinion. *Comparative Political Studies*. 1-35.

Hyvärinen, M. 2011. Analysing narratives and story-telling, in P. Alasuutari, L. Bickerman & J. Brannen (eds.). *The Sage handbook for social research methods*. Paperback edition. London: Sage. 447-492.

Imperiale, M.J. & Casadevall, A. 2015. A new synthesis for dual use research of concern. *PLOS Medicine*, 12(4):1-6.

International Service for Acquisition of Agri-biotech Applications (ISAAA). 2015. Brief 49: *Global status of commercialised biotech/GM crops*. Ithaca, NY: ISAAA.

International Service for Acquisition of Agri-biotech Applications (ISAAA). 2016. *Biotech crop highlights in 2016*. Metro Manila, Philippines: ISAAA.

Jarreau, P.B. 2016. Using Twitter to interact, but science communication to preach. *SciLogs* [Online]. Available: http://www.scilogs.com/from_the_lab_bench/using-twitter-to-interact-but-science-communication-to-preach/ [2017, February 27].

Jarreau, P.B. & Porter, L. 2017. Science in the social media age. *Journalism & Mass Communication Quarterly*, 1-27.

Jasinsk, A.H. 2010. Public relations as a tool of science communication with society. *Revista CENIC. Ciencias Biológica*, 41:1-10.

Jeffres, L.W., Atkin, D. & Fu, H. 2011. Knowledge and the knowledge gap: Time to reconceptualise the "content". *The Open Communication Journal*, 5:30-37.

Ji-kun, H. & Bo-wen, P. 2015. Consumers' perceptions on GM food safety in urban China. *Journal of Integrative Agriculture*, 14(11):2391-2400.

Johnson-Cartee, K.S., 2004. News narratives and news framing: Constructing political reality. Rowman & Littlefield Publishers.

Jones, R. 2016. Communication in the real world: An introduction to communication [Online]. Available: http://catalog.flatworldknowledge.com/bookhub/reader/14959?e=jones_1.0-ch01 [2016, April 21].

Joubert, M. 2017. In the footsteps of Einstein, Sagan and Barnard: Identifying South Africa's most visible scientists. *South African Journal of Science*, 113(11):1-9.

Journalist A. 2016. Personal pilot interview. 15 November, Kampala.

Journalist B. 2017. Personal interview. 13 February, Kampala.

Journalist C. 2017. In-depth interview. 3 February, Kampala.

Journalist D. 2017. In-depth interview. 3 February, Kampala.

Journalist E. 2017. In-depth interview. 8 February, Kampala.

Journalist F. 2017. In-depth interview. 10 February, Kampala.

Journalist G. 2017. In-depth interview. 10 February, Kampala

Journalist H. 2017. In-depth interview. 11 January, Kampala.

Journalist I. 2017. In-depth interview. 11 January, Kampala.

Journalist J. 2017. In-depth interview. 12 February, Kampala.

Kaaya, S.K. 2017. MPs claim they were bribed over GMO bill. *The Observer*, 5 July [Online]. Available: http://observer.ug/news/headlines/53693-mps-claim-they-were-bribed-over-gmo-bill.html [2017, July 8].

Kahan, D.M. 2015. Climate-science communication and the measurement problem. *Political Psychology*, 36(S1):1-43.

Kahlor, L.A., Dudo, A., Liang, M.C. & AbiGhannam, N. 2015. What are you saying? Challenges and opportunities for increasing visibility and understanding of indoor microbiological research. *Indoor and Built Environment*, 24(5):682-688.

Kamanga, G.D., Wambugu, F.M., Obukosia, S., Gidado, R., & Suleiman, I. 2014. Why communication and issues of management must occupy a central role in GM projects: Case study of Africa biofortified sorghum (ABS Project). In: *Biotechnology in Africa science policy reports*. *Springer* 7: 225-241.

Kangmennaang, J., Osei, L., Armah, F.A. & Luginaah, I. 2016. Genetically modified organisms and the age of (Un)reason? A critical examination of the rhetoric in the GMO public policy debates in Ghana. *Futures*, 83:37-49.

Kaplan, A.M. & Haenlein, M. 2011. Two hearts in three-quarter time: How to waltz the social media/viral marketing dance. *Business Horizons*, 54(3):253-263.

Karidi, M. 2017. News media logic on the move? In search of commercial media logic in German news. *Journalism Studies*, 19(9):1–20.

Karugaba, M. 2017. UNBS officials grilled over counterfeit goods. *New Vision*, 16 April [Online]. Available: https://www.newvision.co.ug/new_vision/news/1451183/unbs-officials-grilled-counterfeit [2017, November 12].

Kato, J. 2016. Fake car parts seized in Kiseka market. *Daily Monitor*, 20 November [Online]. Available: http://www.monitor.co.ug/News/National/Fake-car-parts-seized-in-Kiseka-market/688334-3457772-8j231f/index.html [2017, November 14].

Katz, E. 2001. Lazarsfeld map of media effects. *International Journal of Public Opinion Research*, 13:270-279.

Kawooya, F. 2016. Parliament should not force 'GMO noose' on Ugandans. *The Observer*. 21 March. [Online]. Available: http://observer.ug/viewpoint/letters/43184-your-mail-parliament-should-not-force-gmo-noose-on-ugandans. [2017, April 3].

Khan, Z.A. 2016. Media coverage provided to religious minorities. *International Journal of Applied Sciences*, 1(1):30-44.

Kikulwe, E.M., Wesseler, J. & Falck-Zepeda, J. 2011. Attitudes, perceptions, and trust. Insights from a consumer survey regarding genetically modified banana in Uganda. *Appetite*, 57(2):401-413.

Kimenju, S.C. & De Groote, H. 2008. Consumer willingness to pay for genetically modified food in Kenya. *Agricultural Economics*, 38(1):35-46.

Kitzinger, J. 2007. Framing and frame analysis, in E. Devereux (ed.). *Media studies: Key issues and debates*. London: Sage. 134-161.

Kloor, K. 2017. Journalism under Attack. Issues Sci. Technol. 33(2):60.

Kueffer, C. & Larson, B.M.H. 2014. Responsible use of language in scientific writing and science communication. *BioScience*, 64(8):719-724.

Kumar, R. 2005. *Research methodology: A step-by-step guide for beginners*. 2nd edition. London: Sage.

Kumar, R. 2011. *Research methods*. 3rd edition. London: Sage Publications.

Kunseler, E. & Tuinstra, W. 2017. Navigating the authority paradox: Practising objectivity in environmental expertise. *Environmental Science and Policy*, 67:1-7.

Kuntz, M. 2012. The postmodern assault on science. *EMBO Reports*, 13(10):885-889.

Kurath, M. & Gisler, P. 2009. Informing, involving or engaging? Science communication, in the ages of atom-, bio- and nanotechnology. *Public Understanding of Science*, 18(5):559-573.

Lamphere, J.A. & East, E.A. 2016. Monsanto's biotechnology politics: Discourses of legitimation. *Environmental Communication*, 11(1):75-89.

Lanyero, F. 2013. Hospitals are death traps, report says. *Daily Monitor*, 7 February [Online]. Available: http://www.monitor.co.ug/News/National/Hospitals-are-death-traps--report-says/688334-1687010-1hfgcyz/index.html [2017, November 18].

Laroche, M., Habibi, M.R. & Richard, M. 2013. To be or not to be in social media: How brand loyalty is affected by social media? *International Journal of Information Management*, 33(1):76-82.

Leahy, P.J. & Mazur, A. 1980. The rise and fall of public opposition in specific social movements. *Social Studies of Science*, 10(3):259-284.

Leikas, S., Lindeman, M., Roininen, K. & Lähteenmäki, L. 2007. Food risk perceptions, gender, and individual differences in avoidance and approach motivation, intuitive and analytic thinking styles, and anxiety. *Appetite*, 48(2):232-240.

Lewenstein, B.V. 2003. Models of public communication of science and technology. *Public Understanding of Science*, 96(3):288-293.

Liu, J.-H., Wang, J., Shao, J. & Zhou, T. 2016. Online social activity reflects economic status. *Physica A: Statistical Mechanics and its Applications*, 457:581-589.

Liu, M. 2017. Data collection mode differences between national face-to-face and web surveys on gender inequality and discrimination questions. *Women's Studies International Forum*, 60:11-16.

Logan, R.A. 2001. Science mass communication: Its conceptual history. *Science Communication*, 23(2):135-163.

Luganda, P. & Tenywa, G. 2002. Bio-safety law to be tabled soon. *New Vision*, 20 September [Online]. Available: https://www.newvision.co.ug/new_vision/news/1048907/bio-safety-law-tabled-soon [2017, August 7].

Lumu, D.T. 2012. How term limits were kicked out in 2005. *The Observer*, 13 May [Online]. Available: http://observer.ug/component/content/article?id=18710:how-term-limits-were-kicked-out-in-2005 [2017, August 10].

Lynas, M. 2017. With G.M.O. policies, Europe turns against science. *The New York Times*, 24 October [Online]. Available: https://www.nytimes.com/2015/10/25/opinion/sunday/with-gmo-policies-europe-turns-against-science.html [2017, October 25].

Mackenzie, R., Burhenne-Guilmin, F., La Viña, A.G.M., Werksman, J.D., Kinderlerer, J., Kummer, K. & Tapper, R. 2003. An explanatory guide to the Cartagena Protocol on Biosafety. *Environment Business*, 46:1-13.

Maes, J., Bourgonjon, J., Gheysen, G. & Valcke, M. 2018. Variables affecting secondary school students' willingness to eat genetically modified food crops. *Research in Science Education*, 48(3): 597–618.

Maeseele, P.A. & Schuurman, D. 2008. Biotechnology and the popular press in Northern Belgium: A case study of hegemonic media discourses and the interpretive struggle. *Science Communication*, 29(4):435-471.

Magulu, M. 2009. Uganda faces food crisis, warns FAO. *The Observer* (Kampala, Uganda), 28 September [Online]. Available: http://observer.ug/news-headlines/5242-uganda-faces-food-crisis-warns-fao [2017, August 10].

Maille, M.E., Saint-Charles, J. & Lucotte, M. 2010. The gap between scientists and journalists: The case of mercury science in Quebec's press. *Public Understanding of Science*, 19(1):70-79.

Malyska, A., Bolla, R. & Twardowski, T. 2016. The role of public opinion in shaping trajectories of agricultural biotechnology. *Trends in Biotechnology*, 34(7):530-534.

Marshall, C. & Rossman, G.B. 2016. *Designing qualitative research*. 6th edition. Los Angeles: Sage.

Martin, M.J. & Enns, K.J. 2017. The conflicts of agriculture: Exploring the agricultural ideologies of university agricultural education students. *Journal of Agricultural Education*, 58(1):207-222.

Massarani, L. & Peters, H.P. 2016. Scientists in the public sphere: Interactions of scientists and journalists in Brazil. *Annals of the Brazilian Academy of Sciences*, 88(2):1165-1175.

Massarani, L., Buys, B., Amorim, L.H. & Veneu, F. 2010. Growing, but foreign source dependent science coverage in Latin America, in M.W. Bauer & M. Bucchi (eds.). *Journalism, science and society*. New York: Routledge. 71-79.

Mayer, J.D. 2003. Book reviews. *Planning Theory & Practice*, 4(4):487-495.

Mazur, A. 1981. Media coverage and public opinion on scientific controversies. *Journal of Communication*. 31(2):106–115.

Mazzoleni, G., 2008. Populism and the Media, in D. Albertazzi & D.
McDonnell (Eds.). Twenty-first century populism. London: Palgrave Macmillan. 49-64.

Mbeki, T. 2016. Mbeki addresses 'Aids denialism' criticism. *Mail & Guardian*, 7 March [Online]. Available: https://mg.co.za/article/2016-03-07-a-brief-commentary-on-the-question-of-hiv-and-aids [2016, March 9].

Mbugua-Gitonga, A., Mwaura, F. & Thenya, T. 2016. Biotechnology and food security in Kenya: An assessment of public concerns on biosafety, public health and religious ethics. *Journalrepository.Org*. 9(3):1–13.

McDaniel, P.A., Lown, E.A. & Malone, R.E. 2017. US media coverage of tobacco industry corporate social responsibility initiatives. *Journal of Community Health*, 43(1):117-127.

McHughen, A. 2007. Public perceptions of biotechnology. *Biotechnology Journal*, 2(9):1105-1111.

McLuhan, M. 1964. *Understanding media: The extensions of man*. London and New York: No publisher. Did you get it here?: http://robynbacken.com/text/nw_research.pdf If so, present as online reference.

McQuail, D. 2005. *McQuail's mass communication theory*. 5th edition. London: Sage.

McQuail, D. & Windahl, S. 1993. *Mass communication models*. New York: Longman.

McQuail, D. & Windahl, S. 2015. *Communication models for the study of mass communications*. 2nd edition. London: Routledge.

Mellado, C. & Van Dalen, A. 2017. Challenging the citizen–consumer journalistic dichotomy. *Journalism & Mass Communication Quarterly*, 94(1):213-237.

Meyen, M., Thieroff, M. & Strenger, S. 2014. Mass media logic and the mediatisation of politics: A theoretical framework. *Journalism Studies*, 15(3):271-288.

Midden, C., Boy, D., Einsieldel, E., Faestad, B., Liakopoulos, M., Ohman, S. & Wagner, W. 2002. The structure of public perception, in M. Bauer & G. Gaskell (eds.). *Biotechnology: The making of a global controversy*. Cambridge, UK: Cambridge University Press. 203-223.

Miller, J.D. 2010. Civic scientific literacy: The role of the media in the electronic era, in D.

Kennedy & G. Overholser (eds.). *Science and the Media*. Cambridge, MA: American Academy of Arts and Sciences [Online]. Available: https://www.amacad.org/content/publications/pubContent.aspx?d=1093 [2016, April 29].

Miller, S. & Fahy, D. 2010. Can science communication workshops train scientists for reflexive public engagement? *Science Communication*, 31(1):116-126.

MintPress News. 2017. Monsanto calls for investigation into WHO agency for ignoring Monsanto-funded studies. *EcoWatch*, 28 August [Online]. Available: https://www.ecowatch.com/monsanto-investigation-who-2477067618.html [2017, August 29].

Member of Parliament (Science and Technology Committee). 2017. Personal interview. 4 January, Kampala.

Mnaranara, T.E., Zhang, J. & Wang, G. 2017. Public perception of genetically modified food in Tanzania. *Journal of Animal and Plant Science*, 27(2):589-602.

Mtui, G.Y.S. 2011. Status of biotechnology in Eastern and Central Africa. *Biotechnology and Molecular Biology Reviews*, 6(9):183-198.

Mucci, A., Hough, G. & Ziliani, C. 2004. Factors that influence purchase intent and perceptions of genetically modified foods among Argentine consumers. *Food Quality and Preference*, 15(6):559-567.

Mufson, S. & Mooney, C. 2017. As Trump reverses Obama's climate plans, China's leadership moment arrives. *The Washington Post*, 29 March [Online]. Available: https://www.washingtonpost.com/news/energy-environment/wp/2017/03/29/as-trump-reverses-obamas-climate-plans-chinas-leadership-moment-arrives/?utm_term=.9684158c659f &wpisrc =nlgreen&wpmm=1 [2017, March 31].

Muggaga, C., Ongeng, D., Mugonola, B., Okello-Uma, I., Kaaya, N.A. & Taylor, D. 2017. Influence of Sociocultural Practices on Food and Nutrition Security in Karamoja Subregion of Uganda. *Ecology of Food and Nutrition*. 56(5):424–447.

Mugisha, M. 2000. 115 Die of hunger in Karamoja as drought hits. *New Vision*. 25 July. Available: https://reliefweb.int/report/uganda/115-people-die-hunger-uganda [2016, July 22].

Murugesan, S. 2007. Understanding Web 2.0. *IT Professional*, 9(4):34-41.

Musisi, F. 2014. Museveni: Why I entrusted Naads programme with army. *Daily Monitor*, 16 June [Online]. Available: http://www.monitor.co.ug/News/National/Museveni--Why-I-entrusted--Naads-programme-with-army/688334-2349720-1guvia/index.html [2016, April 9].

Nakato, J. 2017. LC polls money was used to combat drought – Rugunda. *New Vision*, 24 March [Online]. Available: https://www.newvision.co.ug/new_vision/news/1449417/lc-polls-money-combat-drought-rugunda [2018, January 4].

Namusoga, S. 2017. The framing of homosexuality by two Ugandan newspapers: An analysis of *New Vision* and *Daily Monitor*. Unpublished PhD dissertation. Durban: University of KwaZulu-Natal.

Nandi, A. & Platt, L. 2017. Are there differences in responses to social identity questions in face-to-face versus telephone interviews? Results of an experiment on a longitudinal survey. *International Journal of Social Research Methodology*, 20(2):151-166.

Nassanga, G.L. 1997. Women, development, and the media: The case of Uganda. *Media, Culture & Society*, 19(3):471-476.

Navarro, M.J., Panopio, J.A., Malayang, D.B. & Amano Jr, N. 2011. Print media reportage of agricultural biotechnology in the Philippines: A decade's (2000-2009) analysis of news coverage and framing. *Journal of Science Communication*, 10(September):1-12.

Neuman, W.L. 2011. What are the major types of social research?, in W.L Neuman (ed). *Social research methods: Qualitative and quantitative approaches*. 7th edition. Boston: Allyn and Bacon. 25-53.

Ngila, D., Boshoff, N., Henry, F., Diab, R., Malcom, S. & Thomson, J. 2017. Women's representation in national science academies: An unsettling narrative. *South African Journal of Science*, 113(7-8):1-7.

Nisbet, M. 2009. Communicating climate change: Why frames matter for public engagement. *Environment: Science and Policy for Sustainable Development*, 51(2):12-24.

Nisbet, M.C. & Lewenstein, B.V. 2002 Biotechnology and the American media: The policy process and the elite press, 1970 to 1999. *Science Communication*, 23(4):359-391.

Noelle-Neumann, E. 1974. The spiral of silence: A theory of public opinion. *Journal of Communication*, 24(2):43-51.

Nordgård, L., Bøhn, T., Gillund, f., Grønsberg, I.M., Iversen, M., Myhr, I., Okeke, M.I., Okoli, A.S., Venter, H., & Wikmark., O.G. 2015. *Uncertainty and Knowledge Gaps related to Environmental Risk Assessment of GMOs*. Tromsø, Norway: GenØk – Centre for Biosafety.

North, L. 2016. The gender of "soft" and "hard" news: Female journalists' views on gendered story allocations. *Journalism Studies*, 17(3):356-373.

Novak, R. 2015. *Communicating #science on Twitter works*. Colorado State University [Online]. http://source.colostate.edu/communicating-science-on-twitter-works/ [2017, February 5].

Obayelu, A.E., Ajayi, O.D., Oluwalana, E.O.A. & Ogunmola, O.O. 2017. What does literature say about the determinants of adoption of agricultural technologies by smallholder farmers? *Agricultural Research & Technology Open Access Journal*, 6(1):1-5.

Oberiri, A.D. 2016. Journalists' perception of news commercialisation and its implication on media credibility in Nigeria. *World Scientific News*, 55:63-76.

O'Brien, T.L. & Pizmony-Levy, O. 2015. Going public, gaining credibility: Student perceptions of publicly engaged scholars. *Sociological Perspectives*, 59(2):246-269.

Oguz, O. 2009. Attitudes of consumers toward the effects of genetically modified organisms (GMOs): The example of Turkey. *Journal of Food, Agriculture and Environment*, 7(3-4):159-165.

Okafor, O.E. & Okafor P.I. 2017. Membership of cooperative society and adoption of agricultural technology in Awka North LGA of Anambra State, Nigeria. *Journal of Agriculture and Biodiversity Research*, 6:1-11.

Okuda, I. 2017a. Govt to give away Aswa, Nshaara ranches to NRM party, farmers. *Daily Monitor*, 11 April [Online]. Available: http://www.monitor.co.ug/News/National/Govt-to-give-away-Aswa--Nshaara-ranches-to-NRM-party--farmers/688334-3885386-mgsl56/index.html [2017, September 9].

Okuda, I. 2017b. Museveni declines to sign GMO bill into law. *Daily Monitor* (Kampala, Uganda), 28 December [Online]. Available: http://www.monitor.co.ug/News/National/Museveni-declines-to-sign-GMO-bill-into-law/688334-4243964-wfyluesnm9z/index.html [2018, January 1].

Olsson, E. & Eriksson, M. 2016. The logic of public organisations' social media use: Toward a theory of "social mediatization". *Public Relations Inquiry*, 5(2):187-204.

Onwuegbuzie, A.J. 2012. Putting the mixed back into quantitative and qualitative research in educational research and beyond: Moving towards the 'radical middle'. *International Journal of Multiple Research Approaches*, 6:192-219.

Onwuengbuzie, A.J. & Frels, R. 2016. *Seven steps to a comprehensive literature review: A multimodal and cultural approach*. Los Angeles: Sage.

Oreskes, N. & Conway, E.M. 2010. *Merchants of doubt: How a handful of scientists obscured the truth on issues from tobacco smoke to global warming*. London: Bloomsbury.

Organisation for Economic Co-operation and Development (OECD). 2017. *Report on the implementation of the OECD gender recommendations – Some progress on gender equality but much left to do*. Paris: OECD.

Organisation for Economic Co-operation and Development (OECD). 2017. Gender equality: Where are tomorrow's female scientists? Available: http://www.oecd.org/gender/data/wherearetomorrowsfemalescientists.htm. [2018, March 5]

Osgood, D. 2001. Dig it up: Global civil society's responses to plant biotechnology, in H.K. Anheier, M. Glasius & M. Kaldor (eds.). *Global civil society*. Oxford: Oxford University Press. 79-107. Available: http://www.gcsknowledgebase.org/wp-content/uploads/2001chapter41.pdf [2017 July 26].

Outram, S.M. 2010. Sub-Saharan Africa: The case of GMOs. *Journal of International Development*, 351(22):341-351.

Pakseresht, A. & McFadden, B.R. 2017. Consumer acceptance of food biotechnology based on policy context and upstream acceptance: Evidence from an artefactual field experiment. *European Review of Agricultural Economics*, 44(5):757-780

Palmerini, C. 2010. Science reporting as negotiation, in M.W. Bauer & M. Bucchi (eds.). *Journalism, science and society*. New York: Routledge. 113-122.

Pantchev, I., Rakleova, G., Pavlov, A. & Atanassov, A. 2018. History of plant biotechnology development, in A. Pavlov & T. Bley (eds). *Bioprocessing of plant in vitro systems*. Cham: Springer. 1-35.

Patten, M.L. 2009. *Understanding research methods: An overview of essentials*. Glendale, CA: Pyrczak Publishing.

Peters, H.P. 2013. Gap between science and media revisited: Scientists as public communicators. *Proceedings of the National Academy of Sciences of the United States of America*, 110(Suppl. 3):14102-14109.

Petersen, A. 2001. Biofantasies: Genetics and medicine in the print news media. *Social Science and Medicine*, 52(8):1255-1268.

Petersen, A., Anderson, A., Allan, S. & Wilkinson, C. 2009. Opening the black box: Scientists' views on the role of the news media in the nanotechnology debate. *Public Understanding of Science*, 18(5):512-530.

Picardi, C.A. & Masick, K.D. 2013. *Research methods: Designing and conducting research.* Los Angeles: Sage.

Pierce, R. 2008. *Research methods in politics*. London: Sage.

Pierro, R., Barrera, J., Blackstock, C., Harding, R., McCue, D. & Metatawabib, M. 2013. *Buried voices: Media coverage of Aboriginal issues in Ontario*. Ontario: Journalists for Human Rights.

Pigliucci, M. 2010. *Nonsense on stilts: How to tell science from bunk*. Chicago: University of Chicago Press.

Plowright, D. 2012. *Using mixed methods: Frameworks for an integrated methodology*. Los Angeles: Sage.

Polansek, T. 2017. U.S. scientists to skip Monsanto summit on controversial weed killer. *Reuters*, 26 September [Online]. Available: https://www.reuters.com/article/us-usa-pesticides-monsanto/u-s-scientists-to-skip-monsanto-summit-on-controversial-weed-killer-idUSKCN1C13CK [2017, September 27].

Polansek, T. & Plume, K. 2017. U.S. farmers confused by Monsanto weed killer's complex instructions. *Reuters*, 21 August [Online]. Available: https://www.reuters.com/article/us-usa-pesticides-labels/u-s-farmers-confused-by-monsanto-weed-killers-complex-instructions-idUSKCN1B110K [2017, August 23].

Popek, S. & Halagarda, M. 2017. Genetically modified foods – consumer awareness, opinions and attitudes in selected EU countries. *International Journal of Consumer Studies*, 1-21.

Priest, S.H. 2008. Popular beliefs, media, and biotechnology, in S. Friedman, S. Dunwoody & C. Rogers (eds). *Communicating uncertainty: Media coverage of new and controversial science*. London: Lawrence Erlbaum Associates. 95-112.

Radford, T. 2010. Scheherazade: Telling stories, not educating people, in M.W. Bauer & M. Bucchi (eds.). *Journalism, science and society*. New York: Routledge. 95-99.

Raupp, J. 2017. Public relations: Media effects, in P. Rössler, C.A. Hoffner & L.V. Zoonen. *The International Encyclopedia of Media Effects*. Berlin: John Wiley & Son. 1-9.

Rehbock, N. 2009. Better coverage for HIV in South Africa. Media Club South Africa [Online]. Available: http://www.mediaclubsouthafrica.com/themedia/1418-better-hiv-reporting-in-sa-media [2016, March 30].

Rensberger, B. 2010. *Desk guide for covering science*. Wellington, New Zealand: Science Media Centre.

Republic of Uganda. 2008a. *Biotechnology and biosafety law process in Uganda*. Kampala: Uganda Biotechnology and Biosafety Consortium, Uganda National Council of Science and Technology.

Republic of Uganda. 2008b. *Uganda Biotechnology and Biosafety Consortium*. Kampala: Uganda National Council of Science and Technology.

Republic of Uganda. 2012. *The National Biotechnology and Biosafety Bill*. Kampala: Parliament of Uganda.

Research International. 2000. *Science and the public: Mapping science communication activities.* London: Research International.

Reul, R., Paulussen, S., Raeijmaekers, D., Van der Steen, L. & Maeseele, P. 2016. Professional journalistic routines and the protest paradigm: The Big Potato Swap in traditional and alternative media. *Journalism*, 1-18.

Rödder, S. 2012. The ambivalence of visible scientists, in S. Rödder, M. Franzen & P. Weingart (eds.). *The sciences' media connection – Public communication and its repercussions*. Dordrecht, The Netherlands: Springer Science and Busniess Media. 155-177.

Rodriguez, L. & Lee, S. 2016. What can be gleaned from news coverage to improve science reporting and enhance public literacy about agricultural biotechnology in Ghana? *Journal of Agricultural and Food Information*, 17(2–3):91-109.

Rogers, E.M. 2010. *Diffusion of innovation*. 4th edition. New York: Simon and Schuster.

Ross, A.A. 2017. "If nobody gives a shit, is it really news?" Changing standards of news production in a learning newsroom. *Digital Journalism*, 811(March):81-99.

Russia Today. 2017. Russia looks to become leading organic food exporter as Europe sees future in GMO. *Russia Today,* 20 September [Online]. Available: https://www.rt.com/business/403932-russia-organic-food-export-gmo/ [2017, September 23].

Rudin, R. & Ibbotson, T. 2002. *An introduction to journalism: essential techniques and background knowledge*. Illustrate edition. London: Taylor & Francis.

Rutherford, P. 2000. *Endless propaganda: The advertising of public goods*. Toronto: University of Toronto Press.

Rzymski, P. & Królczyk, A. 2016. Attitudes toward genetically modified organisms in Poland: To GMO or not to GMO? *Food Security*, 8(3):689-697.

Sacco, V. 2016. How does social media shape media convergence? The case of journalists covering war and conflict. In *Media convergence handbook, Vol. 1*. Berlin & Heidelberg: Springer. 363-386.

Sachsman, D.B. & Simon, J. 2006. Regional issues, national norms. *Science Communication*, 28(1):93-121.

Saldaña, J. 2013. *The coding manual for qualitative researchers*. 2nd edition. London: Sage.

Sandman, P.M. 1994. Mass media and environmental risk: Seven principles. *Risk: Health, Safety & Environment*, 5(3):251-260.

Sarathchandra, D. & McCright, A.M. 2017. The effects of media coverage of scientific retractions on risk perceptions. *SAGE Open*, 7(2):1-11.

Sarrimo, C. 2016. The press crisis and its impact on Swedish arts journalism: Autonomy loss, a shifting paradigm and a ‘journalistification’ of the profession. *Journalism*, 1-16.

Scheufele, D.A. 2013. Communicating science in social settings. *Proceedings of the National Academy of Sciences*, 110(Suppl. 3):14040-14047.

Scheufele, D.A. 2014. Science communication as political communication. *Proceedings of the National Academy of Sciences*, 111(Suppl. 4):13585-13592.

Scientist A. 2017. In-depth interview. 20 February, Wakiso

Scientist B. 2017. In-depth interview. 20 February, Wakiso.

Scientist C. 2017. In-depth interview. 28 February, Kampala.

Scientist D. 2017. In-depth interview. 17 February, Kampala.

Secko, D.M., Amend, E. & Friday, T. 2013. Four models of science journalism. *Journalism Practice*, 7(1):62-80.

Secretariat of the Convention on Biological Diversity. 2000. *Cartagena Protocol on Biosafety to the Convention on Biological Diversity*. Montreal: Convention on Biological Diversity.

Semujju, B. 2013. Climate change in Ugandan media: A "global warming" of journalism ethics. *Journal of African Media Studies*, 5(3):337-352.

Semujju, B. 2015. Frontline farmers, backline sources: Women as a tertiary voice in climate change coverage. *Feminist Media Studies*, 15(4):658-674.

Senyonga, A. 2017. Uganda has potential to feed 200 million people – US envoy. *New Vision*, 20 September [Online]. Available: https://www.newvision.co.ug/new_vision/news/1461998/uganda-potential-feed-200-million-people-us-envoy [2017, September 20].

Shao, P. & Wang, Y. 2016. How does social media change Chinese political culture? The formation of fragmentized public sphere. *Telematics and Informatics*, 1-11.

Siegrist, M. 2001. Poorer European countries are less concerned about biotechnology than richer countries. *Risk: Health, Safety and Environment*, 12(1):27-40.

Silverman, D. 2010. *Doing qualitative research*. 3rd edition. London: Sage.

Silverman, D. 2011. *Interpreting qualitative data*. *A guide to principles of qualitative research*. 4th edition. Los Angeles: Sage.

Simelane, M.M., Masuku, M.B., Rugambisa, J.I. & Earnshaw, D.M. 2016. Analysis of consumer willingness to pay for genetically modified maize food in Swaziland. *International Journal of Sustainable Agricultural Research*, 3(1):19-28.

Simmons, R. 2008. Questionnaires, in N. Gilbert (ed.). *Researching social life*. 3rd edition. London: Sage. 182-205.

Simonetti, M. 2016. Knowledge of the West of Paraná farmers related to agricultural contracts. *Acta Iguazu*, 55:92–99.

Simons, M., Tiffen, R., Hendrie, D., Carson, A., Muller, D., McNair, B. & Sullivan, H. 2017. Understanding the civic impact of journalism. A realistic evaluation perspective. *Journalism Studies*, 18(11):1400-1414.

Smailhodzic, E., Boonstra, A. & Langley, D. 2016. Towards new social media logic in healthcare and its interplay with clinical logic. Paper presented at the Twenty-Fourth European Conference on Information Systems (ECIS). Date, Istanbul, Turkey.

Splendore, S. 2016. *Media logic* [Online]. Available: https://prezi.com/rjcgfc_fleox/media-logic/ [2016, May 2].

Steinberg, S. 2007. *An introduction to communication studies*. Cape Town: Juta and Company Ltd.

Stocking, S.H. 2008. How journalists deal with scientific uncertainty, in S. Friedman, S. Dunwoody & C. Rogers (eds.). In *Communicating uncertainty: Media coverage of new and controversial science*. London: Lawrence Erlbaum Associates, Publishers. 23-42.

Strömbäck, J. 2008. Four phases of mediatization: An analysis of the mediatization of politics. *The International Journal of Press/Politics*, 13(3):228-246.

Su, L.Y., Akin, H., Brossard, D., Scheufele, D.A. & Xenos, M.A. 2015. Science news consumption patterns and their implications for public understanding of science. *Journalism & Mass Communication Quarterly*, 92(3):597-616.

Suldovsky, B. 2016. In science communication, why does the idea of the public deficit always return? Exploring key influences. *Public Understanding of Science*. 25(4):415–426.

Sulehria, F. 2017. DD and PTV as victims of media globalisation. *Asian Journal of Communication*, 2986(March):96-112.

Susen, B.S. 2011. Critical notes on Habermas's theory of the public sphere. *Sociological Analysis*, 5(1):37-62.

Tagliabue, G. 2017. Product, not process! Explaining a basic concept in agricultural biotechnologies and food safety. *Life Sciences, Society and Policy*, 13(1):1-9.

Takahashi, B. & Tandoc, E.C. 2016. Media sources, credibility, and perceptions of science: Learning about how people learn about science. *Public Understanding of Science*, 25(6):674-690.

Takens, J., Van Atteveldt, W., Van Hoof, A. & Kleinnijenhuis, J. 2013. Media logic in election campaign coverage. *European Journal of Communication*, 28:277-293.

Tarrow, S. 2005. *The new transnational activism*. New York: Cambridge University Press.

Tashakkori, A. & Teddlie, C. 2011. Quality of inferences in mixed methods research: Calling for an integrative framework, in M.M. Bergman (ed.). *Advances in mixed methods research*. Los Angeles: Sage. 101-119.

Tenywa, G. & Price, S. 2003. Don't impose GMOs, researchers advise. *New Vision* (Kampala, Uganda). 31 July. [Online], Available: https://www.newvision.co.ug/new_vision/news/1263239/don-eur-impose-gmos-researchers-advise. [2017, January 4].

Thaker, J., Zhao, X., & Leiserowitz, A. 2017. Media use and public perceptions of global warming in India. *Environmental Communication*, 4032(January):1-17.

The Annenberg Public Policy Research Center. 2016. *Americans support GMO food labels but don't know much about safety of GM foods* [Online]. Available: http://www.annenbergpublicpolicycenter.org/americans-support-gmo-food-labels-but-dont-know-much-about-safety-of-genetically-modified-foods/ [2016, July 29].

The Bible, New King James Version. 1985. Joshua 10:31. Nashville, TN: The Gideons International.

The Government of Tanzania. 2012. *Survey of public awareness about biosafety issues in*

Tanzania. Dodoma: Government of Tanzania.

The New York Times. 2016. The case of the media against the media. By the media. *The New York Times*, 25 July [Online]. Available: http://nymag.com/daily/intelligencer/2016/07/case-against-media.html [2016, July 28].

The Nobel Prize Assembly. 2008. *The Nobel Prize in physiology or medicine for 2008*. Stockholm: Karolinska Institute.

Thomas, G. & De Tavernier, J. 2017. Farmer-suicide in India: Debating the role of biotechnology. *Life Sciences, Society and Policy*, 13(1):1-21.

Tichenor, P.J., Donohue, G.A. & Olien, C.N. 1970. Mass media flow and differential growth in knowledge. *Public Opinion Quarterly*, 34:159-170.

Tourangeau, W. 2017. *Unearthing the power in GMO discourse: An analysis of Canadian agriculture and agrifood debates*. Unpublished PhD dissertation. Ontario: University of Waterloo.

Townson, C., Brewer, P.R. & Ley, B.L. 2016. Public responses to forensic DNA testing backlogs: Media use and understandings of science. *Bulletin of Science, Technology & Society*, 35(5-6):1-8.

Toy, J., Vandenbroucke, J.P., Journal, E., Holden, E. & Franz, J. 2002. The Ingelfinger Rule: Franz Ingelfinger at *The New England Journal of Medicine* 1967−77. *Science*, 25(6):195-198.

Tran, H. 2013. Does exposure to online media matter? The knowledge gap and the mediating role of news use. *International Journal of Communication*, 7:831-852.

Trench, B. 2008. Towards an analytical framework of science communication models, in D. Cheng, M. Claessens, N.R.J. Gascoigne, J. Metcalfe, B. Schiele & S. Shi (eds.). *Communicating science in social contexts: New models, new practices*. No city: Springer Netherlands. 119-135.

Trench, B. & Junker, K. 2001. How scientists view their public communication. In *Sixth International Conference on Public Communication of Science and Technology*. Geneva [Online]. Available: http://visits.web.cern.ch/visits/pcst2001/proc/Trench-Junker.doc [2016, June 4].

Tsiboe, F., Nalley, L.L., Dixon, B.L. & Danforth, D. 2017. Ghanaian consumers' attitudes toward cisgenic rice: Are all genetically modified rice the same? *Ghana Journal of Development Studies*, 14(1):1–18.

Tumwine, A. & Bagala, A. 2017. Police infiltrated by criminals – Museveni. *Daily Monitor*, 20 March [Online]. Available: http://www.monitor.co.ug/News/National/Police-criminals-Museveni-Kayihura/688334-3856478-99rk64/index.html [2017, March 20].

Uganda Bureau of Statistics (UBOS). 2014. *National population and housing census*. Kampala, Uganda: UBOS.

Uganda Bureau of Statistics (UBOS). 2016a. *Statistical Abstract*. Kampala, Uganda.

Uganda Bureau of Statistics (UBOS). 2016b. *The National Population and Housing Census 2014 – Main Report*. Kampala, Uganda: Uganda Bureau of Statistics [Online]. Available: www.ubos.org [2017, October 5].

Uganda Communications Commission. 2015. *Access and usage of communication services across Uganda*. Kampala, Uganda [Online]. Available: http://www.ucc.co.ug/files/downloads/20150130-UCC-access-usage-dissemination.pdf [2016, August 16].

UNESCO. 2011. *Media coverage of science and technology*. Kampala, Uganda: Makerere University.

Van Dijk, J. & Poell, T. 2013. Understanding social media logic. *Media and Communication*, 1(1):2-14.

Van Gorp, B. & Sinardet, D. 2017. The role of news media in the policy process in Belgium, in M. Brans & D. Aubin (eds). *Policy analysis in Belgium*. 235-248. Bristol: Policy Press.

Van Rooyen, R.S. 2016. Science communication and the nature of the social media audience: Breaking and spreading of science news on Twitter in the South African context. Unpublished Master's thesis. Stellenbosch: Stellenbosch University.

Varzakas, T.H., Arvanitoyannis, I.S. & Baltas, H. 2007. The politics and science behind GMO acceptance. *Critical Reviews in Food Science and Nutrition*, 47(4):335-361.

Ventura, V., Frisio, D.G., Ferrazzi, G. & Siletti, E. 2017. How scary! An analysis of visual communication concerning genetically modified organisms in Italy. *Public Understanding of Science*, 26(5):547-563.

Vilella-Vila, M. & Costa-Font, J. 2008. Press media reporting effects on risk perceptions and attitudes towards genetically modified (GM) food. *Journal of Socio-Economics*, 37(5):2095-2106.

Vilhelmson, B., Thulin, E. & Elldér, E. 2017. Where does time spent on the Internet come from? Tracing the influence of information and communications technology use on daily activities. *Information, Communication & Society*, 4462(March):249-262.

Von Roten, F.C. 2011. Gender differences in scientists' public outreach and engagement activities. *Science Communication*, 33(1):52-75.

Wagner, W., Kronberger, N., Allum, N., De Cheveigne, S., Diego, C., Gaskell, G.M.H., Midden, C., Odegaard, M., Ohman, S., Rizzo, B., Rusanen, T. & Stathopoulou, A. 2002. Pandora's genes – Images of genes and nature, in M.W Bauer & G. Gaskell (eds.). *Biotechnology: The making of a global controversy*. Cambridge, UK: Cambridge University Press. 244-278.

Watsemwa, E. 2015. Uganda does not need GMOs – Lukyamuzi. *Daily Monitor*. May 5 [Online]. Available: http://www.monitor.co.ug/News/National/Uganda-does-not-need-

GMOs--Lukyamuzi/688334-2706342-5llh19z/index.html. [2017, April 3].

Watson, J. 2016. Bring climate change back from the future. *Nature*, 534(7608):437.

Webb, E., Campbell, D., Schwartz, R. & Sechrest, L. 1993. *Unobtrusive measures: Nonreactive research in the social sciences*. Chicago: Rand McNally and Co.

Wenzelburger, G. 2017. Different by design? Analyzing how governments justify GMO liberalization through the lens of strategic communication. *Policy Review Research*, 1-26.

Wesonga, N. 2015. NRM caucus backs GMOs. *Daily Monitor*, 6 May [Online]. Available: http://www.monitor.co.ug/News/National/NRM-caucus-backs-GMOs/688334-2707408-l45its/index.html [2017, September 4].

Wesonga, N. 2017. Ease travel for treatment abroad, Kadaga tells government. *Daily Monitor*, 3 July [Online]. Available: http://www.monitor.co.ug/News/National/Ease-travel-for-treatment-abroad---Kadaga-tells-government/688334-3998264-24aqtc/index.html [2017, September 4].

Whyte, W.F. 1955. *Street corner society*. Enlarged edition. Chicago, IL: The University of Chicago Press.

Wigston, D. 2010. Quantitative content analysis, in P.J. Fourie (ed.), *Media studies: Media content and media audiences*, vol. 3. 2nd edition. Cape Town: Juta and Company Ltd. 3-37.

World Bank. 2013. *Uganda: Second economic update*. Washington DC: World Bank.

World Bank. 2017a. *GDP per capita (current US$)*. Washington, DC: World Bank [Online]. Available: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD [2017, November 12].

World Bank. 2017b. *Research and development expenditure (% of GDP)*. Washington, DC: World Bank [Online]. Available: https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS [2017, November 12].

Wynne, B. 2017. Creating public alienation: Expert cultures of risk and ethics on GMOs. *Science as Culture*, 5431(April):445-481.

Yıkmış, S., Gülüm, L., Aksu, H. & Alpaslan, M. 2017. Determination of opinions and level of knowledge of culinary program students about genetically modified organisms (GMO's). *Istanbul International Journal of Agricultural and Life Sciences*, 3(1):136-146.

Zakaria, H., Adam, H. & Abujaja, A. 2014. Knowledge and perception of farmers towards genetically modified crops: The perspective of farmer-based organisations in northern region of Ghana. *American International Journal of Contemporary Scientific Research*, 1(2):149-161.

Zehr, S.C. 2008. Scientists' representation of uncertainty, in S.M. Friedman, S. Dunwoody & C.L. Rogers (eds.). *Communicating uncertainty: Media coverage of new and controversial science*. London: Lawrence Erlbaum Associates, Publishers. 3-22.

Zawedde, M.B., Gumisiriza, G., Tibasaaga, A., Mugwanya, N., Muhumuza, J. 2016. Uganda to ten facts about biotech and biosafety by 2015. Kampala. Uganda: Uganda Biosciences Information Centre.

Zerbe, N. 2004. Feeding the famine? American food aid and the GMO debate in Southern Africa. *Food Policy*, (29):593-608.

Zoch, B.L.M. & Turk, J.V. 2015. Women making news: Gender as a variable in source selection and use. *Journalism and Mass Communication Quarterly*, 75(4):762-775.

Appendices

Appendix 1: Coding sheet
Identification No. [insert here]

PROCEDURE: Please check the hard copies of *New Vision* and *Daily Monitor* (you can also visit their respective websites) and look for articles published from January 1, 2012 to December 31, 2015 with biotechnology or GMOs as the focus or subject. The headline should be your guide for selection. The article should fall in the category of either news, features, opinions, letters to the editor, photograph or cartoon. You have been provided with explanatory notes at the bottom of the form that you should refer to for guidance. Enter the relevant information by either writing in hand directly into the cell or by ticking/ highlighting in colour the appropriate choice from the alternatives given. Complete one form PER ARTICLE (not per newspaper). REMEMBER to number each form at the top.

1	Name of newspaper	New Vision Daily Monitor
2	Date of publication (Dd/mm/yy)	____/____/____
3	Headline[1]	
	Online story link (URL) if the article is from the website[2]	
4	Size of the article (number of words)	
5	Format of the article	News 6. Editorial Feature 7. Photo/photo story Opinions 8. Pull out Cartoon Letter
6	Nature of article	Event Issue based
7	Basis of the article	Original report/Investigation Press conference Press release A meeting

		Scientific study An interview An announcement Opinion Commemoration (national/international event thematic event) Other ……………………………
8	Article prominence	Edition lead Page lead Editorial Lead opinion Letter of the day Others ………………….
9	Author of the article	Specialised journalist Generalist Specialist Others
10	Gender of the author	Male Female Cannot tell Undisclosed Not applicable
11	Origin of the article	Local Foreign Local and foreign Undisclosed
12	Themes of the article[3]	Biotechnology 6. Bio-ethics GMO 7. Labelling Genes 8. Weeds/super weed Genetic engineering 9. Contamination DNA 10. Other………………..

13	Focus of the article	Agricultural production Effects on the environment Health risks Regulation Labeling Other issues ………………………….. Undisclosed/not clear
14	Context of the article[4]	Policy 7. Politics Innovation 8. Legislation Business 9. Culture/Religion Ethics/morality 10. Nutrition Dissemination of findings 11. Other Application of biotechnology
15	Tone of the article[5]	Negative Positive Balanced Neutral
16	Controversy[7]	Controversial Non-controversial
17	Nature of the story[8]	Event Issue
18	Source quoted (s)[9]	Biotechnologists 5. Civil society Other scientists 6. General public Government official 7. Other Member(s) of Parliament 8. None
19	Gender of the source(s)	Male only Female only Both male and female Undisclosed Not applicable
20	Photograph	Standalone photo Establishment shot

		Mugshot/ close up None

Explanatory Notes:

[1] This is the main title of the article.

[2] Type the headline or copy and paste the article's specific online link (web address) into the cell under the headline.

[3] The list is a guide but not exhaustive: **Biotechnology** (The use of biological processes or organisms for the production of materials and services of benefit to humankind or The scientific manipulation of living organisms, especially at the molecular genetic level, to produce new products, such as hormones, vaccines or monoclonal antibodies, **Biotech** (short form of biotechnology), **GM food** (Food that comprises, in whole or in part, material that has been modified by the application of recombinant DNA technology, **GMO** (Genetically Modified Food), a) **Genes** (the unit of heredity transmitted from generation to generation during sexual or asexual reproduction), **Genetic engineering** (Changes in the genetic constitution of cells (apart from selective breeding) resulting from the introduction or elimination of specific genes through modern molecular biology techniques), **DNA** (The long chain of molecules in most cells that carries the genetic message and controls all cellular functions in most forms of life), a) **Bio-ethics** (The branch of ethics that deals with the life sciences and their potential impact on society (attention on problems that need to be confronted in biotechnology), **Labelling** (The process of replacing a stable atom in a compound with a radioactive isotope of the same element to enable it to be detected by autoradiography or other techniques), **Weeds** (super weed) (a plant which has good colonising capability in a disturbed environment, and can usually compete with a cultivated species therein).

[4] A general descriptor of what the article is about e.g. policy; discovery or invention; innovation; business or economics; ethics or morality; finance; research findings or project; application of biotechnology; politics; legislation; culture; religion; etc.

[5] The tone is "negative" when the article in general is critical of or questions a particular development or issue. The tone is "positive" when the article in general expresses promise about or celebrates a particular development or issue. The tone is "balanced" when the article

has more or else equal measures of negative and positive tones. The tone is “neutral” when the article is neither negative nor positive.

[6] Determine whether the article emphasises the benefits or risks of a biotechnology development or activity.

[7] The article is considered "controversial" if it is apparent from the report that the subject is contentious whereby scientists, various authorities, and ordinary people are disputing the issue and taking opposing sides.

[8] If the article is about a specific occurrence e.g. breaking news, signing of an agreement, passing of a law, announcement of a discovery, etc. it is an “event”. If it is an analysis, exposition, or report about an activity, development or issue that has or has not been in the news, then it is classified as a “issue”.

[9] These are the individuals or groups to whom any information and views in the article are directly or indirectly attributed. It includes personalities or organisations or companies that speak or perform actions important to the story or are the subject of a significant amount of the reporting. It excludes anonymous sources.

Appendix 2- Face-to-face survey questionnaire
Questionnaire No: ___ ____

Date of interview: ……………………………………………….

Starting time: .... Finishing time: ………………………

District: ………………………………… Community: …………………………

From Lab to Fork? "Press Coverage and Audience Perception of Crop Biotechnology Systems in Uganda"

Face-to-face survey questionnaire for the general public (farmers and consumers)

Introduction

My name is Ivan Nathanael Lukanda. I am a PhD student at Stellenbosch University in South Africa. I am researching on how print media cover biotechnology and genetically modified food, and how such coverage influences public perceptions about crop systems in Uganda. The self-sponsored research will take five months.

I am requesting to interview you for 15-20 minutes for this study. Your participation will contribute to better public understanding of crop biotechnology in Uganda. Your privacy and confidentiality in this study is guaranteed. Please terminate this interview at any point you begin feeling uncomfortable. Further, your right to withdraw your comments after the interview will be respected. The results from the study will be shared in a research validation workshop, to which you may be invited.

Any information you provide will be used for only academic purposes and your participation is voluntary; there are no monetary benefits. Please let me know if you prefer attribution or anonymity for your views about this subject. Kindly ask for further explanation if any issue or question is not clear to you.

Thank you for accepting to participate in my research.

1. Biographical details

a) Gender

Male	1
Female	2

b) Age

18-25	1
26-33	2
34-41	3
42-49	4
50-57	5
58-65	6
Refused to answer	555
Don't know	556

c) Highest level of education

No formal schooling	1
Informal schooling only (including religious schooling)	2
Some primary schooling	3
Primary school completed	4
Some secondary school / high school	5
Post-secondary qualifications, other than university e.g. a diploma or degree from a technical or college	6
Some university	7
University completed	8
Post-graduate	9
Refused to answer	555
Don't know	556

d) Occupation

Farmer	1
Others	2

e) Income Level

Below 200,000	1
200,001-400,000	2
400,001-600,000	3
600,001-800,000	4
800,001 and above	5
Refused to answer	555
Don't know	556

f) Acreage

Less than 1 acre	**1**
1 acre	**2**
2 acres	**3**
3 acres	**4**
4 acres	**5**
5 acres and above	**6**
Don't know	**556**

Knowledge Indicator

2. Have you heard about biotechnology (Genetically modified food)?

Yes	1
No	2

If **NO**, continue to question 5?

3. Attitudes

a) What do you associate biotechnology with?

Seeds/seedlings given by government	1
Seeds from research stations e.g. Kawanda, Namulonge etc.	2
Crops grown with fertilizers	3
Spraying	4

Seeds which do not germinate after first planting	5
Fruits bigger than usual size	6
Slight difference in taste	7

b) Why? ………………………………………………………………………………

4. Perception

a) What advantages do you associate with biotechnology?

Can lead to better yields per acre	1
Protects the environment	2
Biotech reduces the use of pesticides (spraying)	3
It can lead to lowering the price of food (making food more affordable)	4
Alleviating hunger	5
Producing food with better flavour and nutritional value	6
Producing food with longer shelf life	7
Others	8
Don't know	556

b) Why? ………………………………………………………………………………

c) What risks do you associate with biotechnology?

May cause allergies	1
May cause diseases	2
May cause resistance to drugs such antibiotics	3
May increase use of herbicides	4
May cause super weeds	5
GMOs harm the environment (birds, amphibians, marine ecosystems, soil organisms, water bodies etc.)	6
They don't increase yields and are unsustainable	7
They are killing the indigenous seeds	8
Others (mention) ……………………………………………………..	9

Don't know	556

d) Why?..

5. Channels of Information

a) Where do you get information about agriculture?

Newspapers	1
Radio	2
Television	3
Interpersonal communication	4
Workshop	5
Websites	6
Mobile phone	7
Social media	8
Community meetings	9
Other	10

b) Through which channels do you want to learn agriculture?

Newspapers	**1**
Radio	**2**
Television	**3**
Interpersonal communication	**4**
Workshop	**5**
Websites	**6**
Mobile phone	**7**
Social media	**8**
Community meetings	**9**
Engaging with scientists	**11**
Others (mention)	**12**
Don't know	**556**

d) Why? ....

6. a) How do you want to engage (share information with) the scientists?

Writing to them letters in newspapers	**1**
A talk show on radio	**2**
Television discussion	**3**
Face-to-face discussion	**4**
In a workshop	**5**
On their websites	**6**
On social media	**7**
In community meetings	**8**
Others	**9**
Don't know	556

b) Why? ....

7. a) What should the government do about crop biotechnology?

Promote it	1
Ban them	2
Sensitize the public about it	3
Others	4
Don't know	556

b) Why? ....

8. a) Would you grow GMOs?

Yes	1
No	2
Don't know	556

b) Why? ....

Appendix 3: Interview guide for journalists

***1.* Respondent's biographical details**

a. Name (full name – underline the surname/last name):

b. Scientific field of specialisation, if any (exactly as stated by the interviewee):

c. Highest academic qualification:

d. Media organisation (specify the primary media platform i.e. newspaper, magazine, radio, TV, online)

e. Position:

f. Years of experience in journalism:

g. Date of interview:

Interview questions

2. Does your media organisation have an explicit policy for or a special interest in covering science? Be keen on
   i) ☐ Yes
   ii) ☐ No
   iii) ☐ Uncertain
- If YES…What is the policy and what is the basis of that special interest?
3. How do you cover controversial issues in biotechnology?
- Give us one example of a scientific controversy that you reported or which your media organisation covered? How did you ensure that your reporting or coverage was fair, balanced and informative?
4. What are your regular sources of stories about biotechnology?
- Which sources do you value most and why?
5. Some critics say that journalists who report on biotechnology are likely to be co-opted by their sources or to serve the interests of their sources?
- If you have observed any instances of this tendency, would you tell me about it?
6. Do you think that biotechnologists are generally reluctant to engage with the media by providing news, information, and opinions about their work or that of other scientists? Be keen on
   i) ☐ Yes
   ii) ☐ No
   iii) ☐ Uncertain

- Please explain your reasons for this reluctance.

7. Do you think that biotechnologists and journalists have different agendas and are motivated by different goals?

- If YES…How, in your view, do the interests and motivations of biotechnologists differ from those of journalists?
- If NO…Why do you think biotechnologists and journalists have similar interests and motivations, and what are they?

8. Are biotechnologists justified to condemn the media for inaccurate and sensational reporting of biotechnology?

- If YES…What instances of inaccuracy and sensationalism have you encountered in media coverage of biotechnology?
- If NO…Why do you think such condemnation is unjustified?

9. Do you agree with critics who complain that "biotechnology news is too superficial, that it lacks context, understanding, and effective interpretation"? Be keen on

   i) ☐ Yes
   ii) ☐ No
   iii) ☐ Uncertain

- If YES…Can you tell us a story on biotechnology you are familiar with that fell short of your expectations in the way these critics describe?

10. Do you agree with critics who complain that "science news is too complex, aimed only at a small, elite audience"? Be keen on

   i) ☐ Yes
   ii) ☐ No
   iii) ☐ Uncertain

- If YES…Can you tell us about a science story you are familiar with that fell short of your expectations in the way these critics describe?

11. Do you consider some issues of biotechnology of more value to the public than are others?

- If YES…Which issues do you wish to see covered more, in order of importance, and why?
- If NO…What should determine what gets covered?

12. Have you ever been voluntarily approached by scientist or a biotechnology research organisation to give information or views about a biotechnology-related issue?

- If YES…Were you satisfied with the outcome, and why?

13. There are claims that journalists lack the knowledge to give biotechnology issues meaningful coverage. Be keen on

   i) ☐ Agree
   ii) ☐ Disagree
   iii) ☐ Not sure

- If AGREE…Have you come across any media reports or had encounters with journalists that would support this claim?

14. Do you consider biotechnology issues too complex for journalists? **Be keen on**

   i) ☐ Yes
   ii) ☐ No
   iii) ☐ Uncertain

- If YES…Why is this so and what should scientists do to help?
- If NO…What is your contrary view, and why?

15. Do you consider biotechnology issues too complex for the public?

- If YES…Why is this so and what should scientists do to help?
- If NO…What is your contrary view, and why?

16. Describe the lowest common characteristics of the kind of audience member (newspaper/magazine reader) that you think science journalists should appeal to in their stories about biotechnology.

   i) ☐ Layperson
   ii) ☐ Any literate person
   iii) ☐ High school graduate
   iv) ☐ Average university graduate
   v) ☐ Civil society activist
   vi) ☐ Science professional
   vii) ☐ Policymaker (MPs, Ministers, Permanent Secretaries etc.)

17. How would you describe the relationship between scientists and science journalists as stakeholders in biotechnology? Be keen on

   i) ☐ Symbiotic (cooperative)
   ii) ☐ Neutral (No complaints about either group)

iii) ☐ Adversarial (Blame game)

iv) ☐ Unquestioning (Journalists agree to whatever scientists tell them)

v) ☐ Critical (judgmental, analytical)

- Could you explain your observation?

18. A common complaint is that biotechnologists are "so intellectual and immersed in their own jargon that they can't communicate with journalists or with the public".

- Is this a fair assessment? Be keen on

i) ☐ Yes ii) ☐ No iii) ☐ Uncertain

- Could you explain your observation?

19. What, in your view, would make the ideal biotechnology news story or article in the media?

20. How is reporting biotechnology (science) different from reporting other sectors, e.g. politics, sports, business?

21. What do you think is the possible impact of reporting on biotechnology on Ugandan society (culture), politics, and the economy?

22. Has your organisation invested any resources in building the capacity of journalists to cover biotechnology and other science-related issues? Be keen on

i) ☐ Yes ii) ☐ No iii) ☐ Uncertain

- Please explain the nature of this investment.

Appendix 4: Interview Guide for biotechnologists and other scientists

Scientist's biographical details

a. Name (full name – underline the surname/last name)

b. Highest academic qualification Be keen on

i) ☐ Diploma

ii) ☐ Bachelors degree

iii) ☐ Masters degree

iv) ☐ PhD

c. What field? ……………………

d. Institution of affiliation:

e. Position in the organisation or institution:

f. Years of experience in the field of specialization:

g. Date of interview:

Interview questions

1. Do you think biotechnology scientists engage enough with the media by providing news, information, and opinions about their work in biotechnology or that of other scientists?

- Please explain

2. Do you think that biotechnology scientists and journalists have different agendas and are motivated by different goals?

- If YES…How, in your view, do the interests and motivations of scientists differ from those of journalists?
- If NO…Why do you think scientists and journalists have similar interests and motivations, and what are they?

3. Are scientists justified to condemn the media for inaccurate and sensational reporting of biotechnology?

- If YES…What instances of inaccuracy and sensationalism have you encountered in media coverage of biotechnology?
- If NO…Why do you think such condemnation is unjustified?

4. Do you agree with critics who complain that "biotechnology news is too superficial, that it lacks context, understanding, and effective interpretation"?

- If YES…Can you tell us about a story on biotechnology you are familiar with that fell short of your expectations in the way these critics describe?

5. Do you agree with critics who complain that "science news (news about biotechnology) is too complex, aimed only at a small, elite audience"?

- If YES…Can you tell us about a science story you are familiar with that fell short of your expectations in the way these critics describe?

6. Are you confident in the ability of the media to report constructively and informatively about biotechnology?

- If YES…What gives you such confidence?
- If NO…What should journalists do to earn your confidence?

7. Do you consider some issues of biotechnology of more value to the public than are others?

- If YES…Which issues do you wish to see covered more, in order of importance, and why?
- If NO…What should determine what gets covered?

8. Have you ever been approached by a journalist to give information or your views about a biotechnology issue(s)?

- If YES…Were you satisfied with the outcome (story), and why?

9. Have you ever volunteered information or your views to the media about a biotechnology issue?

- If YES…What prompted you? Were you satisfied with the outcome, and why?

10. There are claims that journalists lack the knowledge to give biotechnology issues meaningful and serious coverage.

- Have you come across any media reports or had encounters with journalists that would support this claim?

11. Do you consider scientific issues on biotechnology too complex for journalists?

- If YES…Why is this so and what should scientists do to help?
- If NO…What is your contrary view, and why?

12. Do you consider scientific issues too complex for the public?

- If YES…Why is this so and what should biotechnologists do to help?
- If NO…What is your contrary view, and why?

13. Describe the lowest common characteristics of the kind of audience member

(newspaper/magazine) that you think science journalists should appeal to in their stories. Tick more than one choice, if necessary.

14. How would you describe the relationship between scientists and science journalists?

- Is it, for example, cooperative, neutral, adversarial, unquestioning, or critical?
- Could you explain your observation?

15. What, in your view, would make the ideal science news story or article in the media?

Appendix 5: Interview guide for legislators and food rights-based NGOs

1. Biographical details of interviewees

a. Name (full name – underline the surname/last name)

b. Institution of affiliation

c. Position in the organisation or institution

d. Years of experience in the field of specialisation

e. Date of interview

2. Why do you think it is necessary to regulate the biotechnology industry in Uganda?

3. Do you think ordinary people understand biotechnology?

- If yes, what do they think?
- If no, why?

4. Does biotechnology have any benefits to Uganda? If yes, mention the benefits.
5. Do you think, biotechnology could have any risks for Uganda? If yes, mention some possible risks.
6. In your opinion, what is the main source of information about biotechnology for Ugandans?
7. In your opinion, how should Ugandans learn about biotechnology?
8. What should Ugandans know about biotechnology? Probe for Human health, environment, right to know, and ethics.
9. In your opinion, how should government manage biotechnology in Uganda?

Appendix 6: Ethical clearance

UNIVERSITEIT·STELLENBOSCH·UNIVERSITY
jou kennisvennoot • your knowledge partner

Approval Notice

Stipulated documents/requirements

12-May-2017 Lukanda, Nathanael NI

Ethics Reference #: SU-HSD-003167

Title: From Lab to Fork? Press Coverage and Audience Perception of Crop Biotechnology Systems in Uganda

Dear Dr. Nathanael Lukanda,

Your Stipulated documents/requirements received on 14-Mar-2017, was reviewed and **accepted.**

Please note the following information about your approved research proposal: **Proposal**

Approval Period: 27-Oct-2016 - 26-Oct-2017

Please take note of the general Investigator Responsibilities attached to this letter.

If the research deviates significantly from the undertaking that was made in the original application for research ethics clearance to the REC and/or alters the risk/benefit profile of the study, the researcher must undertake to notify the REC of these changes.

Please remember to use your **proposal number** (**SU-HSD-003167**) on any documents or correspondence with the REC concerning your research proposal.

Please note that the REC has the prerogative and authority to ask further questions, seek additional information, require further modifications, or monitor the conduct of your research and the consent process.

We wish you the best as you conduct your research.

If you have any questions or need further help, please contact the REC office at 218089183.

Sincerely,

Clarissa Graham
REC Coordinator
Research Ethics Committee: Human Research (Humanities)

National Health Research Ethics Committee (NHREC) registration number: REC-050411-032.

The Research Ethics Committee: Humanities complies with the SA National Health Act No.61 2003 as it pertains to health research. In addition, this committee abides by the ethical norms and principles for research established by the Declaration of Helsinki (2013) and the Department of Health Guidelines for Ethical Research: Principles Structures and Processes (2nd Ed.) 2015. Annually a number of projects may be selected randomly for an external audit.

Investigator Responsibilities

Protec on of Human Research Participants

Some of the general responsibilities investigators have when conducting research involving human participants are listed below:

1.Conducting the Research. You are responsible for making sure that the research is conducted according to the REC approved research protocol. You are also responsible for the actions of all your co-investigators and research staff involved with this research. You must also ensure that the research is conducted within the standards of your field of research.

2.Participant Enrolment. You may not recruit or enroll participants prior to the REC approval date or after the expiration date of REC approval. All recruitment materials for any form of media must be approved by the REC prior to their use.

3.Informed Consent. You are responsible for obtaining and documenting effective informed consent using **only** the REC-approved consent documents/process, and for ensuring that no human participants are involved in research prior to obtaining their informed consent. Please give all participants copies of the signed informed consent documents. Keep the originals in your secured research files for at least five (5) years.

4.Continuing Review. The REC must review and approve all REC-approved research proposals at intervals appropriate to the degree of risk but not less than once per year. There is **no grace period**. Prior to the date on which the REC approval of the research expires, **it is your responsibility to submit the progress report in a timely fashion to ensure a lapse in REC approval does not occur**. If REC approval of your research lapses, you must stop new participant enrolment, and contact the REC office immediately.

5.Amendments and Changes. If you wish to amend or change any aspect of your research (such as research design, interventions or procedures, participant population, informed consent document, instruments, surveys or recruiting material), you must submit the amendment to the REC for review using the current Amendment Form. You **may not initiate** any amendments or changes to your research without first obtaining written REC review and approval. The **only exception** is when it is necessary to eliminate apparent immediate hazards to participants and the REC should be immediately informed of this necessity.

6.Adverse or Unanticipated Events. Any serious adverse events, participant complaints, and all unanticipated problems that involve risks to participants or others, as well as any research related injuries, occurring at this institution or at other performance sites must be reported to Malene Fouche within **five (5) days** of discovery of the incident. You must also report any instances of serious or continuing problems, or non-compliance with the RECs requirements for protecting human research participants. The only exception to this policy is that the death of a research participant must be reported in accordance with the Stellenbosch University Research Ethics Committee Standard Operating Procedures. All reportable events should be submitted to the REC using the Serious Adverse Event Report Form.

7.Research Record Keeping. You must keep the following research related records, at a minimum, in a secure location for a minimum of five years: the REC approved research proposal and all amendments; all informed consent documents; recruiting materials; continuing review reports; adverse or unanticipated events; and all correspondence from the REC.

8.Provision of Counselling or emergency support. When a dedicated counsellor or psychologist provides support to a participant without prior REC review and approval, to the extent permitted by law, such activities will not be recognised as research nor the data used in support of research. Such cases should be indicated in the progress report or final report.

9.Final reports. When you have completed (no further participant enrolment, interactions or interventions) or stopped work on your research, you must submit a Final Report to the REC.

10.On-Site Evaluations, Inspections, or Audits. If you are notified that your research will be reviewed or audited by the sponsor or any other external agency or any internal group, you must inform the REC immediately of the impending audit/evaluation.

THE REPUBLIC OF UGANDA

OFFICE OF THE PRESIDENT

PARLIAMENT BUILDING P.O. BOX 7168 KAMPALA, TELEPHONES: 254881/6, / 343934, 343926, 343943, 233717, 344026, 230048, FAX: 235459/ 256143
Email: secretary@op.go.ug, Website: www.officeofthepresident.go.ug

ADM 194/212/01

November 28, 2016

The Resident District Commissioner, Kampala District
The Resident District Commissioner, Wakiso District

RESEARCH CLEARANCE

This is to introduce to you **Ivan Lukanda** a Researcher who will be carrying out a research entitled **"FROM LAB TO FORK? PRESS COVERAGE AND AUDIENCE PERCEPTIONS OF CROP BIOTECHNOLOGY SYSTEMS IN UGANDA"** for a period of **6 months** in your district.

He has undergone the necessary clearance to carry out the said project.

Please render her the necessary assistance.

By copy of this letter **Ivan Lukanda** is requested to report to the Resident District Commissioners of the above districts before proceeding with the Research.

Masagazi Deogratius
FOR: SECRETARY, OFFICE OF THE PRESIDENT

Copy: Ivan Lukanda