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2017
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THE ETHICS OF ANTIBIOTICS USE IN ANIMAL FARMING

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A Research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Masters of Science in Medicine Bioethics and Health Law.

Johannesburg, 2017

DECLARATION

I, Philisiwe Precious Ncayiyana declare that this Research Report titled **The Ethics of Antibiotics Use in Animal Farming** is my own, unaided work. It is being submitted for the Degree of Masters of Science in Medicine (Bioethics and Health Law) at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other university or institution for higher learning.



SIGNATURE

14th **DAY OF** JUNE **2017** **IN** JOHANNESBURG

DEDICATION

This report is dedicated to my parents: Christina Khonziwe Ncayiyana and Alpheus Mbuswa Ncayiyana

ABSTRACT

The unnecessary use of antimicrobials poses a global threat to human health by contributing to the Antimicrobial Resistance (AMR) development. This report evaluates the ethical and scientific implications of non-therapeutic use of antibiotics in animal farming. The report also critiques O'Neill's (2016) Final Report on AMR. The report provides a normative assessment and analysis of scientific evidence and ethical issues involved in farming with antibiotics making use of Mepham's Ethical Matrix. The report makes the case that non-therapeutic use of antibiotics in animal farming contributes to AMR development and that it is not ethically justifiable for farmers to carry on farming with antibiotics non-therapeutically. The study also argues that intensive factory farming poses the greatest risk in the preservation of all classes of antibiotics because it is customary to use antibiotics where a large number of animals are kept in close proximity for example, in poultry farming. An immediate ban of antibiotics deemed medically important for humans in animal farming is necessary in order to prevent the spread of antibiotic resistance. This however, must go hand in hand with preparation for abandonment of intensive farming systems in order for a ban to be successful. The study also recommends the adoption of O'Neill's (2016) recommendations on tackling AMR. In addition, a national public awareness campaign is justified by the threat posed by AMR. Governments and other relevant stakeholders involved should formulate policies or frameworks to deal with the problem with the urgency it requires.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to the following individuals:

1. My supervisors: Prof Ames Dhai and Dr Christopher Wareham, for their unwavering support and encouragement, throughout the duration of my research.
2. Prof Thaddeus Metz, for introducing me to the Steve Biko Centre for Bioethics and the contribution he has made towards the development of "An African Moral Theory" commonly known as Ubuntu, which has been a highlight of my journey in ethics.
3. Prof Trevor Carmichael, for being the best class mate and for allowing me to share in his wisdom.
4. SAfm AM Live team especially Jake Mokoma and Aubrey Setjie the producers of the show for hosting Prof Natalie Shellack and I on the 26th of May 2016 to discuss the current state of Antimicrobial Resistance and its implications for the general public.
5. Minister of Health, Dr Aaron Motsoaledi, for his support in raising awareness about the plight of Antimicrobial Resistance.
6. Lord, Jim O'Neill, for his contribution in the preservation of antibiotics globally and for inspiring this research report.

NOMENCLATURE

AIDS	Acquired Immune Deficiency Syndrome
AGP	Antibiotic Growth Promoter
AMR	Antimicrobial Resistance
AWA	Animal Welfare Approved
CDC	Centre for Disease Control
C.Diff	Clostridium Difficile
CIWF	Compassion in World Farming
DEFRA	United Kingdom's Department for Environment Food and Rural Affairs
E. coli	Escherichia coli
ESBLs	Extended Spectrum Beta-Lactamase
EU	European Union
FAO	Food and Agriculture Organisation of the United Nations
FDA	US Food and Drug Administration
GAO	US General Accounting Office
HIV	Human Immunodeficiency Virus
HREC	Human Research Ethics Committee
INTERPOL	International Criminal Police Organization
KFC	Kentucky Fried Chicken
LA-MRSA	Livestock Associated Methicillin-Resistant Staphylococcus Aureus
MRSA	Methicillin-Resistant Staphylococcus Aureus
NOAH	United Kingdom's National Office of Animal Health
OIE	World Organisation for Animal Health
RUMA	Responsible Use of Medicine in Agriculture
SA	South Africa
S. aureus	Staphylococcus aureus
SPCA	Society for the Prevention of Cruelty to Animals
TB	Tuberculosis
UK	United Kingdom
USA/US	United States of America
VCPr	Veterinarian Client Patient relationship
VRE	Vancomycin Resistant Enterococci
WHO	World Health Organisation

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CHAPTER 1: BACKGROUND INFORMATION AND INTRODUCTION

In this chapter, the background on non-therapeutic use of antibiotics in animal farming is discussed. The literature is divided into two parts. The first part looks at the scientific literature view (Empirical Literature). This section of the report provides scientific evidence that non-therapeutic use of antibiotics in animal farming is harmful to humans and directly contributes to the development of Antimicrobial Resistance (AMR). The second part reviews the ethics literature and examines how ethicists have responded to non-therapeutic use of antibiotics in animal farming in the past and what their challenges have been.

1.1 Introduction

Scientific evidence suggests that non-therapeutic use of antibiotics in animal farming is one of the main contributors to Antimicrobial Resistance in human beings (Aarestrup 2015). By non-therapeutic, it is meant that antibiotics are routinely added to animal feed or drinking water to help animals gain weight faster and protect them from infectious diseases (US Food and Drug Administration [FDA], 2013). This method of farming has been seen for many years as a safe way of limiting transmission of infections from animals to humans via the food chain. It is also a way of producing food very cheaply because farmers could use antibiotics and other means to promote growth and control infections within confined spaces for penned animals. The problem with non-therapeutic use of antibiotics is that whenever antibiotics are used at sub-therapeutic levels, the chances of AMR development increase. Antimicrobial Resistance is "now recognised as one of the most serious global threats to human health in the 21st century" (Liu et al. 2016: 161).

The FDA in the past has approved the withdrawal of antibiotics known to cause resistant infections in human beings, for example, the withdrawal of Enrofloxacin for poultry in 2005. The FDA cited that it "caused the development of fluoroquinolone-resistant Campylobacter species in poultry" (FDA, 2005) and in human beings.

It is stated that AMR problem is also exacerbated by the lack of investment into the development of new classes of antibiotics by pharmaceutical companies because investing in antibiotics is not seen as profitable since there are tighter restrictions on the use of antibiotics in humans (Power 2006). However, farmers are allowed to buy large quantities of antibiotics without a veterinarian prescription if the antibiotics are to be added to feeds and not for treating animals (Anomaly 2009). Therefore, the reduced demand for antibiotics could also erode the pharmaceutical industry's profits, which could further limit the amount spent in developing new classes of antibiotics.

This research report seeks to critically examine the ethics of antibiotics use in animal farming. The question being addressed is: ***Is non-therapeutic Use of Antibiotics in Animal Farming Morally Justifiable?*** It is argued in this report that it is always morally unjustifiable to use antibiotics for any reason other than in the treatment and care of sick animals. The research supports the vaccination of animals as a preventative measure as opposed to routinely adding antibiotics to animal feed to prevent infections. The report also justifies a ban on using antibiotics deemed medically important for human beings in animals. Lastly, O'Neill's review titled "Tackling Drug-Resistant Infections Globally: Final Report and Recommendations"(O'Neill 2016) is critiqued.

1.1.1 Background Literature on Antimicrobial Resistance

The literature review is divided into two parts (the scientific and ethics literature). The main objective for the two parts is as follows: the scientific literature provides evidence that indeed non-therapeutic use of antibiotics in animal farming is harmful and can lead to fatal infections in humans. The ethics literature examines how ethicists have responded to the subject in the past and what their challenges have been.

Scientific Backdrop

Many researchers like Phillips et al. 2003; Bok et al. 2015; O'Neill 2016; von Salviati et al. 2015, et al, have provided sufficient scientific evidence to support the claim that non-therapeutic use of antibiotics in animal farming is one of the main contributors to antimicrobial resistance in human beings. Antimicrobial Resistance now rates amongst the most serious global threats to humankind (Liu et al. 2016). In addition, the FDA also pointed out that it is common knowledge that routine use of non-therapeutic antibiotics in animal feeds contributes to antimicrobial resistance (Kennedy 2012). AMR is consequent to a long history of poor antimicrobial stewardship in both animal and human medicine globally which has left the world with a serious problem of resistant infections caused by superbugs (Mendelson 2012). The overuse of antibiotics in animal farming is putting human lives at risk and driving up medical costs. For example, in the United States of America the cost of treating antibiotic resistance infection exceeds $20bn annually to hospitals alone (O'Neill 2015).

There is overwhelming evidence of the emergence of superbugs that have caused deaths in human beings and these can be directly linked to animal origins. The antibiotics of last resort like *Colistin* are no longer effective against many bacterial infections for example, the Extended Spectrum Beta-Lactamase (ESBLs), Escherichia coli (E. coli), Methicillin-Resistant

Staphylococcus Aureus (MRSA), because of the resistant gene called mcr-1 that was first reported in China (Liu et al. 2016).

In 2012, the World Health Organisation (WHO) called for the limitation in the use of *Colistin* in agriculture stating it was very critical for fighting resistant infections in human beings (WHO 2012). Similarly, Liu et al. (2016) wrote that there is a rising trend and a high positive rate of the mcr-1 gene in the bacteria of animal origin and recommended that the use of *Colistin* should be reconsidered. Additionally, he also noted that due to its prolonged use as a therapeutic drug and feed additive, there is evidence that mcr-1 is being transmitted from animals to humans (Liu et al. 2016).

A considerable number of studies have been carried out in South Africa (SA) to determine the extent of antimicrobial usage in animal farming. Data from these studies depict SA as using large amounts of antibiotics in food producing animals including antibiotics that have been banned in other countries (Moyane et al. 2013) . One particular study showed that *tylosin*, a growth promoter, which is amongst those banned in Europe, was the number one selling antibiotic in poultry and pig farming in SA followed by tetracyclines, sulphonamides and penicillins respectively (Henton et al. 2011). The penicillins and sulfonamides have been respectively put on the WHO's critical and highly important list for human medicine in 2016 (Collignon et al. 2016). There is currently no surveillance system in SA that monitors the antimicrobial usage in animal farming. The only reliable that exists is between 2002 and 2004 where there was some surveillance but from 2004 there was a disinvestment in that project (Eagar et al. 2012). The figures of the antibiotics sold during the 2002-2004 period show that 69 percent of antibiotics sold were used as feed additives and 18 percent were parenteral antibiotics (Eagar et al. 2012). The assumption is that only the 18 percent was used in the treatment of sick animals.

O'Neill's final Report on AMR is an important step in dealing with antimicrobial resistance globally (O'Neill 2016). Out of ten recommendations, the report lists four as the most important in tackling the global emergence of antimicrobial resistance. It recommends that firstly; we need a global public awareness campaign to educate everyone about antibiotic resistance. Secondly, we need to boost the supply side by encouraging pharmaceutical companies to develop new classes of antibiotics and he recommends huge financial incentives to drug developers. Certain funds are already in place. Thirdly, we also need to use antibiotics responsibly in both humans and animals for example, development of rapid diagnostic tools will curb the widespread use of broad-spectrum antibiotics, thus limiting their resistance. And fourthly, we need to eliminate the extensive non-therapeutic use of antibiotics in agriculture;

starting by improving surveillance systems. However, there is a need to review the appropriateness of the recommendations for a country like South Africa.

It is important to gauge how far advanced is the ethical argument on the AMR is amongst ethicists. The following section examines the literature on the ethics of AMR in animal farming.

Ethics Overview

This section is about pioneers of the ethics of AMR.

Rollin (2001) wrote about ethics and science of antimicrobial resistance and raised the issue of the sub-therapeutic use of antibiotics in agriculture. At the time, Rollin (2001) was confronted with conflicting views on whether there was a link between the use of antibiotics in animal farming, the development of resistance in animals, and whether the resistant microorganisms caused infections in human beings or not.

Rollin (2001) argued that "...much informed scientific opinion suggests that use of antibiotics in animal feeds presents a major potential threat to human health if we continue to use them sub-therapeutically" (Rollin 2001: 32). He highlighted the conflict between the need for cheap food and the need to act morally. However, he claimed that the majority of people would rather pay more for a morally defensible agricultural product that demonstrates better husbandry.

At the turn of the 20th century Mepham (2000), also a pioneer in the field looked at a framework that could be used for the ethical analysis of novel foods in agriculture and called it The Ethical Matrix (Mepham 2000). The construction of the Matrix is in principle ethically neutral. It is based on Beauchamp and Childress's principlism. The Matrix is defined as a set of fundamental moral principles upon which to base reasoning in agricultural ethics. It is highly adaptable to any desired degree of complexity. Mepham's Matrix included how treated organisms, farmers, consumers, and biota would fare if the principles of Respect for Persons, Wellbeing of Persons and Animals, Autonomy and Justice were applied in each case. For example, he argued that farmers ought to be given the opportunities to earn an adequate income, better working conditions, freedom to adopt or not adopt novel manufacturing gimmicks, and fair treatment in trade and in law. In this report, each principle in the matrix is used to analyse and develop arguments for and against the use of non-therapeutic antibiotics in animal farming. Most ethicists seem to agree on a number of ethical issues regardless of the period and what was a valid argument in 2000 on the subject remains currently valid.

Duckenfield (2013) agrees with Mepham (2000). He refers to this as an agriculturalist point of view where he says "autonomy is a major factor as farmers' value individualism and independence. Removing an established production technique could be seen as an issue of autonomy" (Duckenfield 2013). However, prevention of harm usurps autonomy in the presence of a global consensus on the harmfulness of the practice. Agriculturalists always held the view that they were behaving morally because they produce the food that is healthy, nutritious and free from poison without any validation by the ethicists (Dundon 2003). According to Duckenfield (2013) "Traditional agricultural ethics is an informal utilitarian system where the end (sufficient food) justifies the means [the sub-therapeutic use of antibiotics]" (Duckenfield 2013: 31). Whitehead et al. (2016) emphasise the morality of maintaining biodiversity saying that pathogens may enter water catchments from different sources including runoffs from livestock (Whitehead et al. 2016). This can lead to the elimination of the normal flora and endangerment of species important for our survival due to the proliferation of pathogenic bacteria.

Littmann and Viens (2015), concur with the other ethicists. They argue that "AMR is more than a problem that arises as a result of the complications of treating infectious diseases; it is a complex, multifaceted global challenge that affects the environment, human and animal health, agriculture and the economy. Given the multitude of persons, institutions, and societies AMR impacts, it presents a distinct and significant ethical issue" (Littmann and Viens 2015: 2). Indeed, they claim that "[t]here are no current or future persons who will not be affected by AMR" (Littmann and Viens 2015: 4). They also claim that "the global burden of infectious disease is distributed highly unevenly and low-income countries are disproportionately affected by AMR" (Littmann and Viens 2015: 4). This means that in order for justice to be served, the distribution of responsibility has to be equitable; each group should pull its own wagon in dealing with AMR. The "antibiotic resistance "is not in the details", antibiotic resistance "is in the ethics" (Duckenfield 2013). The existing literature calls for a study to explore The Ethics of Non-Therapeutic Use in Animal Farming hence this study. The author's ethical analysis will help advance the debate around the role of ethicists in adding their voices to the issue.

1.1.2 The Rationale of the study

A study like this is more relevant for a country like South Africa that has a quadruple burden of diseases namely, the Human Immunodeficiency Virus (HIV)/Acquired Immune Deficiency Syndrome (AIDS) epidemic, Tuberculosis (TB) infections, Non-Communicable Diseases, and High Maternal and Child Mortality (Motsoaledi 2016). This raises the possibility of

catastrophic levels of resistant and untreatable infections. Given that there are no persons who will not be affected by AMR, and that "AMR is now recognised as one of the most serious global threats to human health in the 21st century" (O'Neill 2016). It is surprising that there has been limited ethical debate on the subject. This study aims to contribute to the debate with a systematic and focused ethical analysis of the use of antibiotics in animal farming.

1.1.3 Thesis Statement

The arguments against and for the practice of non-therapeutic use of antibiotics in animal farming are made. This is because as much as the practice is deemed unsafe as it promotes the emergence of superbugs, it also provides us with affordable animal products. However, superbugs are resistant strains of bacteria which are known to cause difficult-to-treat to fatal infections in humans hence the practice is argued to be unethical. Hence, this report argues for a ban on using antibiotics deemed medically important for the humans non-therapeutically in animal farming.

1.2 Research Aim and Objectives

1.2.1 The Aim

To normatively examine the ethics of non-therapeutic use of antibiotics in animal farming

1.2.2 Objectives:

a. To evaluate the ethical and scientific basis of arguments for and against non-therapeutic use of antibiotics in animals

b. To critique O'Neill's 2016 Final Report and his recommendations on AMR

c. To argue for a ban of non-therapeutic use of antibiotics in animal farming in SA

1.3 Research Design

This is a purely normative study. Normative ethics which is a branch of philosophical inquiry is used to systematically justify answers to the research question which is: ***Is non-therapeutic Use of Antibiotics in Animal Farming Morally Justifiable?***

1.4 Research Method

This research report follows a strictly normative assessment thus employing the typical methodologies adopted in philosophical research. An in-depth descriptive analysis of scientific evidence and the ethical issues involved in farming with antibiotics is undertaken. The report follows a typical ethical enquiry of normative ethics where the question being asked is answered in a systematic and critical fashion using the applicable theoretical ethical frameworks (Jeremy and Sulmasy 2010).

1.4.1 Argumentative Strategy

The core ethical issues arising from using antibiotics non-therapeutically in animal farming are responded to by using the Mepham's Ethical Matrix which limits the ethical issues to wellbeing, autonomy, and justice. It is argued that non-therapeutic use of antibiotics is unsafe as it leads to the emergence of resistant microbes in animals which have been shown to cause difficult-to-treat to fatal infections in humans.

Mepham's Ethical Matrix is used to categorise arguments for and against the practice. Mepham's Ethical Matrix is defined as a set of fundamental moral principles upon which to base reasoning in agricultural ethics. The matrix is based on the four ethical principles put together in 1994 by Beauchamp and Childress known as principlism. These four ethical principles are non-maleficence, beneficence, autonomy, and justice. However, Mepham's matrix has combined non-maleficence and beneficence into one principle called Wellbeing. Thus, the matrix refers to three principles and not four, though it is principlism based. The three principles may be considered to correspond with the three major theories of ethics, namely: Utilitarianism (Wellbeing), Kantianism (Autonomy), and Rawlsian Theory (Justice) (Mepham 2000).

Below is a summary of the key areas on how the three ethical principles of Mepham's matrix are used in the arguments. These arguments will be made in chapter two.

Firstly, based on the principle of respect for wellbeing, arguments are made against using antibiotics non-therapeutically based on a risk-benefit analysis. The risks of using antibiotics non-therapeutically outweigh the benefits. The practice of non-therapeutic use of antibiotics is a public health hazard as it promotes the emergence of resistant microbes capable of causing incurable infections in both animals and humans. Hence, it is argued that it is ethically wrong to continue the practice.

Secondly, non-therapeutic use of antibiotics in animal farming is generally acceptable because it curbs the transmission of infectious diseases from animals to humans. This is consistent with the utilitarian approach which seeks to maximise benefits. In this case, farmers may argue that they provide safe food at low cost for the greatest number of people. However, arguments are made against the practice because the harms caused by resistant infections in both animals and humans as a result of the current practices outweigh benefits provided by non-therapeutic use of antibiotics in the long run. Hence, it is morally wrong.

Thirdly, it is argued that the farmer's autonomy to choose to adopt or not to adopt new technologies may be infringed. The principle of autonomy asserts that for an individual to

make an autonomous decision, he or she requires sufficient information. It is argued that if farmers have inadequate information on social harms of non-therapeutic use of antibiotics in animal farming they are not in a position to make informed decisions on the practice. Hence with the right interventions, farmers may be persuaded to change their farming practices, failing which the state may have to intervene. Similarly, consumers do not have adequate information on the current farming practices and their freedom to choose is negatively impacted.

Fourthly, justice as in fairness which is based on Rawls Theory of Justice. Rawls equated this as the utmost moral standard (Rawls 1972). Arguments are made for farmers' fair treatment in trade and law, consumers' right to safe and affordable food, as well as animal and environmental welfare (Mepham 2000). It is argued that allowing farmers to continue the practice of non-therapeutic use of antibiotics in animal farming is unjust as the burden of treating resistant and incurable diseases in animals and humans is enormous. The cost of treatment is not always carried by farmers alone; it burdens the taxpayer as well. Hence, ethically it is unjustifiable.

Finally, O'Neill's report on AMR will be critiqued, more specifically his top four recommendations as mentioned above, which include the need to eliminate the extensive non-therapeutic use of antibiotics in agriculture, starting by improving surveillance systems. A detailed analysis of specific steps deemed important in reducing the demand for antibiotics in both animals and humans is provided.

1.5 Ethics

This is a purely normative study which does not involve any human participants. An ethics waiver from the University of the Witwatersrand's Human Research Ethics Committee (HREC) was obtained.

1.6 Research Outcomes

This research will form a discussion paper that will be presented to the Department of Health as well as the Ministers of Health and Agriculture. The significance of the study is to help give direction into policy formulation on how to farm ethically; on how to re-establish reliable surveillance systems on antibiotic usage in animals; to promote the ban of antibiotics medically important for human beings in animal farming; and to reduce the overall reliance on the use of antibiotics by both animals and human beings through awareness programs, presenting at conferences and through media and a publication.

1.7 Limitations

The ethics of animal welfare and biota are not discussed in great detail because these are not the main focus of the study. This is a focused 50 percent research report and the scope cannot go wide enough to include other substantive issues in animal ethics and alternative means to antibiotics like vaccination at a deeper level, other than recommend the establishment of appropriate vaccination procedures.

1.8 Overview of Sections

Chapter 1: Background Information and Introduction. The evidence based on the literature review on non-therapeutic use of antibiotics in animal farming is provided.

Chapter 2: Ethical and Scientific evaluation of non-therapeutic use of antibiotics in animal farming. Ethical analysis and scientific evaluation is conducted to assess arguments for and against non-therapeutic use of antibiotics in animal farming.

Chapter 3: Critical analysis of O'Neill's 2016 Final Report on AMR. A critical analysis of O'Neill's report is provided highlighting lessons learned and shortcomings, in particular, his proposal in tackling antibiotic use in animal farming.

Chapter 4: Arguments for a ban of non-therapeutic use of antibiotics in animal farming. A ban of non-therapeutic use of antibiotics in animal farming is proposed based on the ethical arguments of Chapter 2 making use of Mepham's Ethical Matrix, and considering criticism of O'Neill's report in Chapter 3.

Chapter 5: Conclusion and Recommendations. In this chapter, summary of the arguments is provided and recommendations made in order to achieve the intended outcomes of this research for the public good.

CHAPTER 2: ETHICAL AND SCIENTIFIC EVALUATION OF NON-THERAPEUTIC USE OF ANTIBIOTICS IN ANIMAL FARMING

2.1 Introduction

In this chapter, an ethical analysis and scientific evaluation to assess arguments for and against non-therapeutic use of antibiotics in animal farming is provided. The first section covers scientific arguments for the practice, followed by scientific arguments against the practice and lastly, ways to minimise AMR. This is the section that mitigates against AMR which will help determine the alternate viable means of dealing with AMR in animal farming. The second section comprises of ethical analysis using the Mepham's Matrix, which looks at how each interest group may be affected. It is important to clearly identify literature that provides scientific evidence for and against the practice as well an ethical analysis of the subject. This becomes relevant in chapter four where arguments are made for a ban of non-therapeutic use of antibiotics in animal farming.

2.2 Scientific Arguments for Non-Therapeutic Use of Antibiotics in Animal Farming

Non-therapeutic use of antibiotics in intensive factory farming remains the cornerstone of farming practice starting from the 1940's when the deficiency in the basal feed ration in pigs negatively affected reproductive performance and growth. This was corrected by adding different animal by-products to feeds. It is interesting to note that the addition of waste products from tetracycline production to chicken feed yielded similar results. Further studies revealed that the growth promoting effect was due to tetracycline residues (Aarestrup 2015). As much as six percent of the net energy of the pig's diet could be lost due to intestinal fermentation attributed to microbes (Jensen 1998). Controlling microbial population has a potential to divert lost energy during fermentation to growth and weight gain. The mechanism of action is understood to be as a result of cytokines released by the immune system. Their release triggers a release of catabolic hormones which in turn may reduce the muscle mass (Thomke and Elwinger 1998). Pathogens reduce the yield of farmed food animals. Controlling pathogens with low dose antibiotics helps animals digest food more efficiently. Therefore, one is inclined to think that whenever antibiotics of any class are used routinely at low doses, they are most likely to improve feed efficiency, promote growth as well as control infectious diseases. An antibiotic to belong to a group known as "growth promoters" does not have to be registered as such. How the antibiotic is used in practice determines its effect? This phenomenon favours more animals that are kept in close proximity and in unhygienic conditions (Aarestrup 2015). This supports a scientific argument for using antibiotics routinely at low doses in intensive factory farming.

The general consensus is that antibiotic use in animal farming protects both animals and human beings from zoonotic diseases such as Salmonella, Campylobacter and E. coli (Hughes and Heritage 2002). The commonly cited benefits are: animal welfare, increased food production, cheaper cost per unit of food produced, reduced colonisation with zoonotic bacteria and prevention against disease outbreaks (Aarestrup 2015). The argument being made is that stopping non-therapeutic use of antibiotics will result in disease outbreak that will be harmful to animals, farmers (due to loss of income) and humans. However, there is a growing concern that the use may have unintended consequences like the development of antibiotic resistance.

The moral claim is that farmers are responsible for feeding the world with safe, affordable, and nutritious animal products. However, animal welfare groups strongly dispute this claim. For example, it is argued that factory farming uses more food than it produces, therefore, it is failing to feed the world (Compassion in World Farming [CIWF] 2012). It takes an equivalent of ninety water bathtubs to produce one kilogram of beef (CIWF 2012). Water has become a very scarce resource in many areas in the world; therefore, this method of farming may be seen as unsustainable and unethical especially given the current water crisis in SA. Water restrictions impact on hygiene levels negatively, which in turn can lead to infectious diseases outbreak.

Comparing a broiler chicken's life to that of the life of a human being, may help people understand how life is for animals in intensive factory farming and how that may affect us. In SA a broiler chicken's average lifespan is 5 weeks which is about 35 days (South African Poultry Association 2014).This is less than half the time it takes to raise an organic or free range chicken which takes about 12 weeks on average (CIWF 2013). In other countries like the US and Argentina, the average slaughter age is 47 days (Farmers' Weekly 3 Sept 2014). The average weight of an adult broiler chicken ranges between 1.8kg and 2.6kg. Theoretically, this is equivalent to about 150kg of a 2-year old human baby if human beings were subjected to similar conditions as broiler chickens (Compassion Over Killing 2014). The rapid growth of broilers leads to an underdeveloped immune system. Because of this, all broiler chicks including organic chicks get vaccinated against several infectious diseases (CIWF 2013). The problems suffered by broiler chickens include underdeveloped organs like heart and lungs to support their rapid weight gain. The knees are also not strong enough to support their weight, which means the chickens endure a great deal of debilitating pain. Improving husbandry practices will not only help minimise disease outbreaks including AMR

but will also improve ethical concerns of the welfare of animals (Responsible Use of Medicine in Agriculture [RUMA] 2013).

The term antibiotic-growth-promoter (AGP) generally refers to any drug that destroys or inhibits bacteria (Aarestrup 2015). Antibiotics that are used non-therapeutically are administered at sub-therapeutic doses for prolonged periods of time creating a conducive environment for resistance to develop. For this reason, the use of antimicrobials as growth promoters has been completely banned in the European Union (EU) (Grace, 2015). AGPs are still being used in most countries in the world for example in the, SA, and many other countries. Seemingly, the ban of growth promoters in Europe has not resulted in reduced amounts of antibiotics being used in animal farming for purposes not related to the treatment of sick animals (O'Neill, 2016). This may be because a class substitution may have occurred meaning the EU may be using the approved antibiotics in agriculture off-label for non-therapeutic purposes. It is difficult to believe that all the reported amounts of antibiotics used were for treating sick animals only. Hence, in the following section the scientific literature is used to argue against the practice, and to evaluate how that is impacting human lives.

2.3 Scientific Arguments Against Non-Therapeutic Use of Antibiotics in Animal Farming

Data on nine resistant bacteria of global importance was collected by the WHO (WHO 2014). WHO's findings confirmed some of the things that were already known about these nine bacteria like non-typhoidal salmonella is usually acquired from animals or their products, as well as E. coli, Staphylococcus aureus (S. aureus) and Livestock Associated-MRSA (LA-MRSA), are mainly acquired from contact with animals. The remaining six bacteria are primarily as a result of antibiotic use within the medical setting (Grace 2015).

Animal Health Bodies have taken steps to address some of the problems thought to be contributing to the development of resistant pathogens whilst maintaining animal and food safety. They recommend that proper manipulation of nutrition and husbandry practices will help minimise disease outbreaks (RUMA 2013). The reasons given for this recommendation include ethical concerns regarding animals' welfare and production efficiency because when animals are well cared for, the unit cost of producing one kilogram is less than when animals are not cared for (RUMA2013). Due to the high population density of modern farming, food producing animals share both commensal flora and pathogens. The close proximity among animals creates a conducive environment for the rapid spread of pathogens; this results in animals having to be subjected to aggressive infection control strategies which include

administration of antibiotics (Landers et al. 2012). Antimicrobial therapy is regarded as the most important driver of AMR and there is a positive correlation between use of antimicrobials and antimicrobial resistance development (Boerlin and Reid-Smith 2008).

Pathogens often show antimicrobial resistance for a number of reasons. For example, extended exposure to antimicrobials and development of resistance due to selection pressure. They can also acquire resistance from resistant strains as a result of the transfer of resistance-conferring genes by plasmids (Grace 2015). The most common route of administration of antimicrobials in food animals is oral. This route of administration exposes the commensal bacteria in the gastrointestinal tract to antimicrobials (Silbergeld et al. 2008). This can result in a significant portion of commensal bacteria being killed thereby allowing the proliferation of bad bacteria including resistant strains (Aarestrup 2015).

AMR is not only limited to agriculture. It is reported that the overuse of antibiotics in treating human infections has also imposed enormous selection pressure on previously sensitive strains of bacteria. In the US, for example, out of 40 million people who received antibiotics for respiratory related diseases 27 million of them did not require the antimicrobial treatment (O'Neill 2016). This is inter alia because of the lack of rapid diagnostic tools that can be used to confirm or deny bacterial presence. Rapid diagnostic tools are used in other conditions for example, a finger prick test for testing blood glucose, HIV serology detection, and more.

It has long been reported that some of the deadly resistant strains in humans originated from food producing animals, for instance, an outbreak of food poisoning in 1983 was caused by a resistant strain of Salmonella. The outbreak was linked to hamburgers made from beef that was fed chlortetracycline (Bonner 1998).

Side effects caused by direct exposure to antibiotic residuals harm human health in two significant ways. Firstly, there's a worrying number of people who are allergic to penicillins and who may react negatively when exposed even to very minute quantities (Aarestrup 2015). Penicillin allergy may cause anaphylactic shock, a condition that may kill if medical emergency help is not offered immediately. Secondly, the selection of antibiotic resistant strains that subsequently spread to humans. This is how chloramphenicol became ineffective and subsequently stopped being used as an antimicrobial of choice in both animal and human health (Gassner and Wuethrich 1994). Meat products from animals that had been treated with chloramphenicol tested positive for chloramphenicol metabolites and was later suspected to have caused aplastic anaemia in humans (Hughes and Heritage 2002). Its use was later stopped even though it was the most cost effective. Newer classes of antibiotics come at a

much higher cost. Therefore, preserving a class of antibiotics is a moral obligation as it ensures access to healthcare at affordable cost.

In general, the effect of antibiotic residues in the meat itself is not as harmful as the issue of selection and amplification of resistant strains. This may compromise the therapeutic use of antibiotics in various ways for example, selection may occur in strains that are pathogenic for humans. Or resistance may be selected in zoonotic bacteria that subsequently cause human disease. Antibiotics that were effective for decades were rendered ineffective by the emergence of MRSA strains. The four most prolific bacteria associated with the use of antibiotics in animal farming and AMR development originating from animals to humans are Salmonella, Campylobacter, E. coli and the Enterococci (Hughes and Heritage 2002). Salmonella and E. coli are consistent with the WHO's (2014) list.

In general, failing to adhere to withdrawal times has reputational implications for example, food products that fail antibiotic residue test destined for exports in the European Union and the United States of America are always rejected. Withdrawal time is the time needed for an animal to metabolise administered drug in order to reach safe concentration levels in the animal tissue as stipulated for that particular drug; the average time for veterinary drugs ranges between zero to 60 days (Beyene 2016). EU and the USA have a strict policy framework that governs residues in animal products in order to minimise accidental ingestion of residues by humans. Enforcement of withdrawal periods rarely happens domestically for example, antibiotic residues accounted for 28 percent of the EU rejections and 20 percent of USA rejections of aquaculture with Vietnam, China, Thailand, Bangladesh, and Indonesia being most affected (United Nations Industrial Development Organisation 2011). The export rejection has a direct economic impact on the farmer, industry and the country as well as reputational impact (Grace 2015).Research has been published disputing the existing scientific evidence on the subject. Some studies found resistance to be more in human clinical cases than in food-producing animals, suggesting that bacterial populations are unique and not transferrable to humans (Luangtongkum et al. 2009). However, currently there is evidence that pathogens have mutated to form superbugs which transcend all previously known boundaries. This has been illustrated by studies showing similar resistance patterns in pathogens isolated from animals, people and the environment suggesting shared bacterial populations (Sahoo et al. 2012). In general pathogens in animal farming are mostly likely to develop resistance as a result of exposure to antibiotics through these different pathways (Centre for Disease Control [CDC], 2014 as cited by Grace, 2015).

1. Antibiotics directly administered to animals irrespective of the route or indication

2. Animal waste for example, animal faeces and urine, discarded feed, discarded contaminated water containing traces of antibiotics make its way to the environment. Waste from animal farms is now regarded as one of the important contaminants of the environment and spread of resistant pathogens between animals, environment, and humans.

3. Antibiotics in run-offs from manufacturers of antimicrobial active ingredients, is likely to contaminate the surrounding environment including nearby rivers.

4. Resistant pathogens have been found in livestock that has never been exposed to antibiotics for example, backyard chickens and scavenging pigs suggesting that livestock may have acquired the pathogens from people or exposure to antibiotics in human excreta (Onyango et al. 2014).

In short, there is growing evidence to suggest that agricultural use of antibiotics can have a negative health impact in developing countries. This can cause human illness from pathogens acquired from direct or indirect contact with animals and their waste or through consumption of animal products. A good example in a SA context is a national study that was conducted by Stellenbosch University to determine the levels of contamination in SA's rivers. The study found 10 000 more than WHO's acceptable levels of microbes. The microbes found included commensal and diarrhoeagenic E. coli, Intestinal enterococcus, Klebsiella, Listeria, diarrhoea causing viruses (Britz et al. 2013). Water from many of these rivers is used for crop irrigation and these pathogens can be ingested if fruits and vegetables are not washed properly or are eaten raw. However, while there is no direct link to antibiotics made by the study as a cause of these high levels, their contribution cannot be ruled out. The following section considers how the situation can be addressed.

2.4 Ways to Reduce the Risk of AMR

This section considers the various means possibly available to farmers to curb the development and spread of AMR. According to the literature, several means exist to minimise the risk of AMR. These are however most likely to succeed if implemented in parallel with other interventions for a synergistic effect to occur. For example, improved biosecurity, [biosecurity refers to means to minimise the risks of introducing and spreading diseases on a farm the (DEFRA 2005)]; use of vaccines where applicable, and strict adherence to guidelines are most likely to yield a better outcome rather than only focusing on reducing the

consumption of antibiotics. Biosecurity in pig fattening, for instance, recommends that pigs should be kept in small compartments with solid walls which limit the number of pigs in each pen. It is also recommended that the slurry is emptied, cleaned and disinfected, the pens are adequately ventilated and that there should not be age group mixing (RUMA 2013). Different options recommended include a complete antibiotic withdrawal or ban, modifying prescriber behaviour and taxation (Aarestrup, 2015; Boerlin and Reid-Smith 2008). It should be borne in mind that the abrupt withdrawal of antimicrobial prophylaxis, may have disastrous consequences for animal health, welfare and to some extent human health. Insufficient documented evidence exists for or against effects of reducing usage under real life conditions. Some may argue that countries like Denmark and Netherlands have managed for years to successfully reduce the amount of non-therapeutic antibiotics used in their pig farming with no disastrous consequences. Threats of havoc may be baseless and only delay the implementation of biosecurity measures because these may come at an additional cost to the farmer in terms of implementing good animal husbandry where bigger spaces to control crowding may be needed.

Many researchers support better animal husbandry, and it is acknowledged that interventions using education, regulation and economic approaches alone have been found to be ineffective. The combination of strategies to uplift farmers like providing incentives yielded better outcomes (Grace 2015). Developing countries like SA have long adopted the modern farming systems that require increasing use of antibiotics in agriculture. Animal agriculture in developing countries could have an increasing role in the development of AMR because the main driver of resistance is in the use of antibiotics (Grace 2015). Salmonella, Campylobacter and E. coli are the most common zoonotic pathogens transmitted through livestock and food to humans (WHO 2014). Livestock are cited as important reservoirs for these pathogens. They are responsible for causing gastro-intestinal illnesses in developing world and globally. They are responsible for 30 percent of all diarrhoea (Grace 2015). Though foodborne pathogens contribute to resistant infections in developing countries not much is quantified about the role played by the use of antibiotics in agriculture due to lack of surveillance systems (O'Neill 2016). Without doubt, comprehensive surveillance systems are ethically imperative.

The levels of awareness and concern over antibiotic use in developing countries are much lower compared to the developed world. The issues are mostly limited to practitioners and professionals directly involved in the AMR stewardship. In addition, counterfeit drugs are a major concern for developing countries for both animals and humans. Some counterfeit drugs contain no active ingredients at all and some contain very little active ingredient(s).

Substandard drugs may also contribute to the development of resistance and developing countries may be more exposed to counterfeit drugs due to lack of sophisticated systems to close loopholes that allow the counterfeit drugs to enter formal distribution channels, for example in SA it is estimated that 20 percent of all drug purchases are counterfeit (Essack et al. 2011). Strategies to develop awareness of these issues are necessary.

Poor integration between human and animal health sectors is more pronounced in the developing countries even though this is a problem in some developed countries too. There's better integration at an international level, where collaboration among WHO, World Organisation for Animal Health (OIE) and Food and Agriculture Organisation of the United Nations (FAO) exist in AMR stewardship (Grace 2015). Integration needs to be improved towards that seen at international level.

Concerns regarding a ban of antibiotics in animal farming in developing countries are that it could bring more challenges than solutions. The EU countries were able to impose a ban successfully because alternatives to antibiotics were readily available in Europe. The feed industry was very responsive in the development of alternative growth promoters. This, coupled with good farming practices minimised anticipated losses due to animals falling sick and dying at alarming rates. The farmers remained profitable and animal health and welfare remained in check. However, a concern in developing countries is that alternatives may not be as readily available as in Europe and that farmers may struggle to raise healthy animals and as a result turn to the black market for solutions, thereby compounding the AMR problem (Grace 2015).

To summarise, ethicists have already spent adequate time and ought to know enough to provide moral leadership to the rest of the world on the way forward instead of being paralysed by analysis and critiquing what is happening all around them (Aarestrup 2015). The same level of debate and analysis took place when the SA government was in the process of implementing a smoking ban in public places. It was said that restaurants would go out of business yet the hospitality industry is very much thriving today with new outlets opening regularly. This suggests that there is growth in the industry. In a similar view, it is possible that the purported pleas and challenges about an outright ban of non-therapeutic antibiotic use in animals could be unfounded. The next section, provides an ethical analysis using Mepham's Matrix to help formulate an objective opinion in chapter four.

2.5 Ethical Analysis for Non-Therapeutic Use of Antibiotics in Animal Farming

2.5.1 Introduction

This section categorises arguments for and against the practice using Mepham's Ethical Matrix. The Matrix is a sound modality for principlist reasoning in agricultural ethics. The three principles may be considered to correspond to the three major theories of ethics, namely: Utilitarianism (Wellbeing), Kantianism (Autonomy), and Rawlsian Theory (Justice) (Mepham 2000). Take for example respect for wellbeing which corresponds to issues prominent in utilitarian theory. The cost-benefits analysis will assist to decide what the right action is. Utilitarianism can justify gross inequality as long as the majority of people are happy for example, the suffering of penned animals is justified if it is to feed masses of people.

The interest groups included in the matrix are farmers, consumers, farm animals and biota. The basis of their inclusion is that they all have an ethical standing on their own. Of course, there is sometimes disagreement over whether animals and biota have ethical standing (Mepham et al. 2006). Biota and farm animals are included in the matrix, but not discussed in detail as they are not the focus of this research as previously explained under limitations in chapter one. Respect for Autonomy and Respect for Justice are summarised to assist the reader understand the context of the discussion when interest groups are being subjected to the matrix.

Respect for Autonomy

The principle of Autonomy originates from Immanuel Kant (1724-1804), a German philosopher whose moral theory is famously known as Kantian Deontology. Deontology is a duty-based moral theory or the science of duty. Kantian Deontology "places emphasis on adhering to ethical principles or duties and fulfilling obligations", that actions are categorically "always right or wrong"(Beauchamp and Childress 2001). Kant defined autonomy as respect for persons. According to Kant, a rational human being ought to be afforded the moral right to make their own decision and the freedom to choose or a right to an informed consent. In the case of the farmer and consumer, it would mean there needs to be reasonable knowledge and understanding of the scientific and ethical issues associated with the use of non-therapeutic antibiotics in animal farming.

Respect for justice

The Justice principle corresponds to Rawls notion of "justice as fairness". The Theory of Justice guides us to reject or revise laws that are unjust no matter how efficient they may be. However, fairness can be very subjective and at times difficult to define for example there may be competing interests between justice for consumers and farmers. In this instance, whoever has most power will determine the cause of justice. However, this does not necessarily translate to ethical actions.

It should be borne in mind that even though WHO, FAO OIE possess such a wealth of expertise, it is safe to assume that not all stakeholders would receive adequate protection simply because it is impossible to consider all relevant areas of concern (Mepham et al. 2006). Some committee members within these organisations may be biased towards a particular viewpoint for example, a desire to protect an industry. The committee members are predominantly from a scientific background and very few ethicists if at all (Mepham et al. 2006). This argument supports a claim that was made by Rollin (2001) earlier on that the problem with science is that it relies solely on facts often presented as data and it has very little room for ethics (Rollin 2001). Its quest for absolute certainty ignores "value judgment and research will only give us more facts. The issue is not that we need more facts or more detailed explanations of mechanisms, but rather what we need is a rational, social consensus moral position to accommodate the facts we already know" (Duckenfield 2013: 31). Mepham's matrix is the appropriate tool for deriving the moral position as illustrated below.

The value of the matrix is that it appeals to common morality. For example, in relation to farm animals principlism is interpreted as freedom from pain and distress and freedom of behavioural expression (Mepham et al. 2006). Ethical evaluation, requires weighing of different impacts, for example, the animal rights advocates may find any form of animal distress totally unacceptable. On the other hand, farmers and the general public may find minimal suffering inflicted on animals acceptable if that is regarded as standard practice. This is a view that will be supported by utilitarianism. The main aim of the matrix is to help formulate public policy. It allows decision makers to evaluate each ethical concern in a fair and transparent manner (Mepham et al. 2006) .

2.5.2 Mepham's Ethical Matrix: In Non-Therapeutic Use of Antibiotics in Animal Farming

Respect for:	Wellbeing (Health & Welfare)	Autonomy (Freedom & Choice)	Justice (Fairness)
Farmers	*Income & Working Conditions:* +Ability to produce food at affordable cost.	*Freedom of Action:* +Freedom to adopt or not adopt new technologies.	*Fair Trade Laws & Practices:* +Limited government interference.
Consumers	*Food Safety & Quality of Life:* -Residuals may affect public health negatively.	*Informed Choice:* -Current labelling practices infringe on consumer autonomy.	*Availability of Affordable Food:* -The cost of AMR negates present cheaper prices.
Farm Animal	*Animal Welfare:* -Physical state of animals is negatively affected by over-crowding.	*Behavioural Freedom:* -Animals' ability to freely express normal instinctive behaviour is negatively impacted.	*Intrinsic Value:* -Animals' status as sentient beings may be negatively affected.
Biota	*Conversation:* -Unnecessarily use of antibiotics in farming is impacting the overall environmental wellness negatively.	*Maintenance Biodiversity:* -Urbanisation and agricultural intensification are amongst the global threats to ecosystems.	*Sustainability:* -Antibiotics in run-offs enter ecosystems thereby, threatening sustainability of some species.

Table 2.1 Depicts the interests' groups as represented in the matrix and how current practices may impact them. (-) represents negative impact and (+) represents positive impact.

The following section deals with each interest group as depicted in the matrix, starting with farmers, followed by consumers, biota and finally the farm animals. The three principles namely: Wellbeing, Autonomy and Justice are applied in each interest group.

2.5.2.1 Farmers' Wellbeing

How would a restriction on non-therapeutic use of antibiotics in animal farming affect farmers? The most important thing in a commercial farm is the ability for a farmer to generate a reasonable income to cover all operational costs and servicing of existing loans where applicable.

Agricultural ethics is a perfect example of the competing interest between public health and business values (Duckenfield 2013). A perfect example is that of intensive factory farming where space is utilised to capacity in order to maximise profitability at the expense of animal welfare, environmental sustainability and in this case development and spreading of resistant pathogens to humans. Society ultimately pays for the cost of the resultant infections and this can be interpreted as a social injustice (Duckenfield 2013).

For farmers, the cost-benefit analysis for the use of antibiotics in agriculture is complex due to lack of concrete data on specific uses up until now. The same challenge is posed by the lack of concrete data in determining the cost-benefit of non-therapeutic use of antibiotics in food production, its healthcare costs and environmental impact (Anomaly 2009). Growing evidence suggests that antibiotics used as growth promoters do not lower the unit cost of production as much as once thought, especially where advanced farming techniques exist (Graham et al. 2007; Laxminarayan et al. 2015). Therefore, this weakens the economic argument for using antibiotics as growth promoters because evidence exists to suggest a decline in growth advantages offered by sub-therapeutic use of antibiotics due to a changing microbial composition of animals that are fed antibiotics (O'Neill 2015). The opposite is only true in instances where animals are kept under very poor sanitary conditions, with low standards of infection control. Without the routine use of antibiotics, they would die of infectious diseases before slaughter age. This supports the argument that if animal husbandry is improved there would not be as much need to routinely feed animals antibiotics. Studies in this area to determine impact on developing countries are highly recommended because farmers in these countries may be impacted differently by the restriction of antibiotic use in animal farming.

The rise of superbugs poses a long-term risk to meat production from livestock reared using antibiotics because livestock may develop resistant infections and could lead to higher mortality where the whole herd or flock may be lost. This could pose a threat to global food security as well as farmers' profitability (O'Neill 2015). There is also a potential trade issue, as the EU now bans sub-therapeutic use of antibiotics and may ban the import of meat products from countries that still use growth promoters (US General Accounting Office [GAO] 2004). EU has previously imposed a ban of the US beef raised using growth-promoting hormones (Johnson 2015).

The cost of eliminating non-therapeutic use of antibiotics will initially increase the production costs as was the case in the EU when growth promoters were banned (Duckenfield 2013). The

estimated total cost to the livestock industry would be $1.2 to $2.5 billion per year which is about $4.82 to $9.92 per capita annual consumer cost increase (Duckenfield 2013). This increase is not seen as a deterrent from a consumer's point of view and the cost may further be reduced by export subsidies (Duckenfield 2013). Of course, policy frameworks should be country specific in addressing the issue. At least now there is some form of benchmarking from Denmark and the Netherlands case studies where the two countries were able to reduce the antibiotic use quite significantly whilst retaining their commercial competitiveness (O'Neill 2015).

Farm Workers' Working Conditions

The farm and its workers are particularly vulnerable to diseases because they are constantly exposed to the farm pathogens including the resistant strains. These can enter their bodies through cuts and abrasions and can develop into serious infections that are costly to treat (Duckenfield 2013). Farm workers rank amongst the lowest paid and are less likely to have health insurance and only seek treatment once the problem is almost out of hand, which, increases the rate of mortality. Farming with antibiotics is no longer justifiable because of the extent of the harms it causes or may cause on the farmers and their communities including staff. In the long run, they are definitely most likely to start losing their competitive advantage thus eroding their profits. This will lead to many of them consolidating or closing down and further disadvantaging their workers who are already struggling.

Farmers Autonomy

Kant argued that all rational persons have an unconditional worth and can reasonably make their own morally right decisions. To violate one's autonomy is to interfere with his or her right to make own independent choices. It is to treat other persons merely as means to others' ends (Beauchamp and Childress 2001). Respect for autonomy recognises that individuals have a right to hold their own views and make choices according to their own determination based on personal belief and values (Schroeder and Palmer 2003). For Kant, ethics was about respecting others as individuals, and not about calculating costs and benefits in contrast to utilitarianism, irrespective of outcome (Mepham et al. 2006).

Producer autonomy is regarded as the farmers' choice to make their own independent decisions. Farmers appreciate the freedom to adopt or not adopt new farming practices or technologies (Mepham 2000). Restricting or banning the use of antibiotics prophylactically may be seen as interfering with their freedom to choose farming mechanisms suited to their

farming needs. In the context of antibiotics stewardship, failing to adopt may lead to business failure and financial losses as the fight against non-therapeutic use of antibiotics in animal farming intensifies. Consumers are becoming more informed in the developed world and are starting to put pressure on companies like McDonald's and Kentucky Fried Chicken (KFC) to heed the call to only source from farmers that use antibiotics prudently (Gaynor 2016).

The farmers' autonomy is also not quite as independent. Each farmer would find it economically constraining to make an independent decision to adopt or not adopt the restricted use of antibiotics because of the "Prisoner's Dilemma" (Anomaly 2009). This means that a farmer on his own cannot decide to abandon the practice because if other farmers do not, he is most likely to suffer financial losses while other farmers continue thriving. Moreover, some farmers may have long running contracts that require them to use antimicrobials to suppress proliferation of pathogens. Therefore, it is a moral imperative to call for a framework or policy that will be binding to all farmers at once.

According to Mill's Principle of Harm, to constitute harm one's action has to result in some form of injury or negatively affect interests of particular person(s). Only this sort of harm warrants restricting one's liberty, for example, the farmers' freedom to choose their preferred farming practices. Using Mill's principle of harm one can then expect that governments impose restriction(s) to anyone's liberty that has a potential of harming others by contributing to the development and spread of the resistant pathogens. There has been a call for strong paternalism from governments by some. Paternalism is defined as the "interference of a state or an individual with another person, against their will, and defended or motivated by a claim that the person interfered with will be better off or protected from harm" (Dworkin 1972).

Mill and Dworkin agree that one can be held accountable for causing harm to others like failing to take care of your family, but not for being a drunk if it affects nobody else. Though Mill only had support for weak paternalism (a less restrictive form of paternalism) citing that there ought to be other supplementary principles. In our case, this would include the Ubuntu Principle which can be defined as "An African Theory of Right Action" (Metz 2007). According to Ubuntu, individual rights are less important than the collective rights of the whole community and the whole of humanity (Nkondo 2007; Letseka 2012). Metz (2007; 2017), differs slightly because he does not ascribe primacy to the collective rights over individual rights. He argues that one ought to relate to other individuals communally by cooperating with them and seeking to make them better off ideally both at the same time (Metz 2007; Metz 2017). Simply put, people should commune with each other or enter into community with each other. He explains this as meaning that both the state and society are

obligated not merely to avoid harming others but also "to work to enable people to live objectively better lives". He carries on to say that if a better life for an individual can result from minimal subordination, then this kind of understanding of Ubuntu justifies paternalism (Metz 2017). Therefore, if farmers were to apply the Ubuntu principle, they would refrain from farming with antibiotics if there was a chance that it may cause disharmony and suffering in the community.

In short, governments are mandated to exercise strong paternalism to prevent harm by anyone whose action has a predictable outcome. For example, the spread of resistant pathogens from farm animals to humans causing difficult to treat infections is now foreseeable. This harm results without any consent from the consumer as the consumer is completely oblivious of this phenomenon and those who know often have limited alternative sources to animal protein. Prevention of harm usurps farmers' autonomy to choose whether to farm with antibiotics or not.

Justice for farmers

The Justice principle is based on Rawls Theory of Justice. He referred to justice as fairness with that as the utmost moral standard (Rawls 1972). Justice or fairness for farmers refers to fair trade laws and practices. Is there justice in the proposed interventions for farmers? Farming incentives that reward good animal husbandry and prudent use of antibiotics can be seen as justice. On the other hand, providing subsidies to farmers that continue with intensive factory farming practices that rely on use of antibiotics as their main infection control strategy would be wrong and unjust.

If farmers are given information, time, and assistance to reform how they do farming that is fairness. The injustice would be if governments drew up policies and started implementing them without preparing the industry and developing strategies to counter the negative social aspects of disease outbreak, an increase in black market procurement, under-reporting of antibiotics usage and more. However, if processes and strategies are implemented in partnership with the farming community, the approach would be just and fair. Failing to reform an industry may become attractive to new farmers entering the industry for the first time as they spot an opportunity to circumvent restrictive laws. It is probably easier to start a new farm than to sanitise, or renovate an old farm to have bigger spaces, better ventilation etc. This will result in higher costs initially which will then be passed on to consumers. This is still not as significant as the threat posed by superbugs to humanity (Duckenfield 2013).

2.5.2.2 Consumers Wellbeing

Food safety and quality of life of consumers is at the centre of any farming community. One of the reasons for the emergence of the practice of using antibiotics in animal farming was to prevent the spread of infectious diseases from animals to humans. Agriculturalists have a duty to provide humanity with safe food by taking reasonable steps to prevent any foreseeable harm.

As previously mentioned antibiotic residuals can have significant harms on human health, for example, side effects caused by direct exposure to the drug. Consumers' quality of life may be compromised by acute reactions, chronic exposure, and resistant pathogens. The cost-benefit assessments fail to account for the possibilities of cumulative impact on human health from the use of antibiotics (Mepham 2000). It is almost impossible to predict potential allergenicity problems or its extent; therefore, this places an obligation to farmers to prevent any foreseeable harms to consumers.

Consumer Autonomy

Consumer autonomy is the choice consumers have to make their own independent buying decision based on quality of ingredients and affordability. Labelling should clearly identify meat products coming from farms where antibiotics are used non-therapeutically. This will provide peace of mind to conscientious consumers who might have taken a decision to protect themselves from direct exposure from foods that may contain traces of antibiotics. A good example to draw from is the case of regular antiseptic bath soaps that claimed to kill 99 percent of the bugs found on the human skin have now been banned in a few countries because it is believed that they were contributing to the development of resistant skin infections by eliminating the necessary commensal bacteria on the skin (Anomaly 2016). This could only be achieved because the presence of an antiseptic ingredients was seen as a differentiator hence it was emphasised. Its emphasis provided consumers and law makers with enough information to come to an informed decision that the products concerned were not safe for public use. The consumer autonomy is infringed when it comes to meat products because antibiotic residues are not advertised as differentiators because that would likely turn consumers away.

In most cases, humans form symbiotic relationships with bacterial colonies (Anomaly 2016). Most bacteria on human skin and gut use humans for shelter and food without causing any harm to humans. Bacterial colonies also help humans by crowding out the pathogenic bacteria. Some bacteria extract benefits from humans but also help humans synthesize

vitamins, and modulate their immune system (Anomaly 2016). Hence, when commensal bacteria in the human gut are disturbed one would have gastrointestinal disturbance for example, diarrhoea. Another example is the activation of oral contraceptives in women's gut by bacteria, when on antibiotics. The antibiotics sometimes do not differentiate between commensal and pathogenic bacteria in our gut. They kill everything including the bacteria responsible for activating the oral contraceptive. Women can fall pregnant because of this failed mechanism. Antibiotics affect the end user in more ways than we would like to admit. Many other roles played by commensal bacteria are not yet known to humans.

In general, humans carry very few pathogenic bacteria compared to the trillions of "good" bacteria unless an invasion occurs and the pathogenic bacteria somehow enters a human body and multiply exponentially in a very short space of time overpowering the human's immune system from destroying them (Anomaly 2016). Once the immune system has been weakened then the pathogenic bacteria can result in serious illness and if the infection is too powerful for existing antibiotics the infection can become fatal (Anomaly 2016).

There is also ongoing argument amongst ethicists about how consumers would feel and react if they perfectly understood the entire situation and what their contribution is towards the development of resistance (Anomaly 2016). Some consumers may choose to change their buying and eating habits, by buying only ethically sourced meat products and observing meat free days. Labelling should be as explicit as possible so that no consumer could ever claim ignorance for supporting farming practices that have a potential to wipe out generations. Ethicists have a moral duty to raise the level of consciousness of an average consumer through promoting informative awareness programs that will help reduce demand for antibiotic prescriptions even when not warranted (O'Neill 2016). Hence, there is a need to intervene with policies and frameworks that will raise the level of awareness on certain issues as and when the need arises. A call to ban AGPs in farming in the US, SA and around the world has been made a number of times. If the EU did it, why cannot the rest of the world? (Lessing 2010). Or even if it is only for protecting the consumer autonomy.

Consumer Justice

The principle of justice is best applied by looking at the impact of antibiotics in animal farming across different generations (Millar 2011). This is because the effects of AMR may be irreversible and therefore, may create problems for future generations. The problem may grow in scope as the current and future cost of the practice is presently unquantifiable.

It is envisaged that humans will suffer increased morbidity and mortality. Presently the winners are the manufacturers of antimicrobials and the farming community. The consumers stand to lose more through reduced health outcomes and rising healthcare costs (Duckenfield 2013). The disparity in costs and benefits goes far beyond social justice. It involves deliberate harms to vulnerable populations such as those who are immune-compromised for example, HIV/AIDS, TB, patients, and those undergoing chemotherapy for various cancers or transplant patients on immunosuppressant therapies, paediatrics and geriatrics. Development of a resistant infection to any of these groups can lead to treatment complications and fatalities (Klevens et al. 2007) . More importantly, the public bears the cost of treatment through taxes. Consumers can reclaim justice by boycotting antibiotic fed animal products until the industry reforms to provide healthier animal products. The use of antibiotics comes with specific withdrawal periods and often these are not adhered to (Eagar et al. 2012). There are inspectors that are meant to enforce these regulations but they have not been successful in curbing the practice.

If current patterns of antibiotic use cannot be sustained for future generations then the patterns are unjust (Millar 2011). Present generations enjoy the benefits of antibiotics and future generations carry the adverse risks of facing untreatable bacterial infections. An impartial point of view is that if we did not know which generation we would be we may have a greater interest in preserving the antibiotics (Millar 2011). The problem we have is no longer in the future-it is today and every day. A few years ago it was thought that antibiotic resistance would narrowly escape this generation (Millar 2011). There is a need to guard against the abandonment of antibiotics use by consumers when clinically indicated because that would not be fairness. Instead, that will result in undesirable health outcomes where morbidity and mortality would increase as a direct trade-off between consumption and preservation. Therefore, consumer justice can be partly achieved by reprimanding farmers who fail to reform by charging them tax. The revenue raised from tax should go towards the development of new classes of antimicrobials, vaccines and repurposing of the existing antimicrobials (Anomaly 2013).

2.5.2.3 Animal Welfare

This section discusses animal welfare and not claims of animal behavioural freedom and intrinsic value in great detail as is the latter is not the focus of this research as previously mentioned. "Factory farming is the single biggest cause of animal cruelty, one of the greatest social and environmental challenges of our time and utterly fails to meet the needs of the planet's seven billion people" (CIWF 2012).

According to Gonyou (1993), there are 3 types of animal welfare, namely legal, public and technical (Gonyou 1993). The legal definition helps the judicial system to determine established minimum standards acceptable to society. The standards assist the justice system with prosecution of cases where animal abuse has reportedly taken place. The standards are also used extensively by animal rights' groups for example, Society for the Prevention of Cruelty to Animals (SPCA) in SA. The public definition is derived from societal understanding of how animals should be treated for example, empathy shown towards certain species of animals differs. Dogs and cats are shown more empathy than broiler chickens. The two are incomparable. Only people with very high levels of consciousness view and believe that all animals have an equal standing in society and every animal should be treated humanely. Some members of society accept minimum suffering as justified in food-producing animals and show more sympathy for domestic, marine, or wild animals instead.

The technical definition is often used by scientists to determine the well-being of an animal by assessing the absence or presence of functionality impairment for example physical injuries, diseases, malnutrition, distress etcetera (Swanson 1995). Wellbeing and welfare are terms that are used interchangeably even though they have specific meaning. Welfare refers to long-term implications of said animals and wellbeing describes the current state of a particular animal to cope with its present environment (Gonyou 1993; Swanson 1995).

The assessment of an animal's current state of being should involve both the physiological and psychological aspects. Physiological well-being should include the absence of diseases and or injuries (Swanson 1995). The psychological wellbeing is far more challenging to determine and requires exceptional expertise of particular species behaviour but a general rule can be applied. The general rule may include the absence of distress, and the ability to cope with the environment (Swanson 1995). Some of the factors that can contribute to animal distress are predictable for example, animals that enjoy covering ground while grazing may be distressed by being caged. Physically they may look healthy but their overall wellbeing may be affected by psychological distress caused by lack of freedom to graze as they please.

Intensive factory farming practices include what is termed as physical alterations. This is a practice where physical amputation or trimming of certain animal parts is involved. The theory behind this is to control undesirable animal behaviour like tail biting, cannibalism, fighting and other aggressive behaviour associated with enclosed animals (Swanson 1995). The alterations include beak trimming, castrations, tail docking, and teeth clipping. Some of

these alterations result in chronic suffering for example, in beak trimming suffering is both acute and long-term (Lee and Craig 1991).

Animal Welfare Approved (AWA), (2016) a leading certifier of high-welfare, sustainable farming in the US requires that every farm should consult a vet for health management and planning of the farm. Their experience is that farmers either have very little access to vets or none whatsoever. They require a qualified expert which is defined as someone with comprehensive and authoritative knowledge of livestock in pasture-based systems. They also require farms to have low animal densities per square meter and sub-therapeutic use of antibiotics is prohibited. When animals are treated with antimicrobials for example, farmers ought to apply double legal withdrawal times before slaughter. This allows fair and humane treatment of animals and safeguarding of consumer health. It also ensures that there is very little residual of any drug and preservation of antibiotics. AWA does not penalise farmers for treating sick animals with antibiotics when needed. AWA firmly believes that confinement feeding operations are the cause of resistant bacteria and not farmers whose animals graze freely. In the US, there are proposed changes in farming practices including the establishment of the Veterinarian-Client-Patient-relationship (VCPr) before farmers can use antibiotics at all. This requires that the vet has sufficient knowledge of the animals involved to be able to properly diagnose and treat. But AWA is opposed to VCPr. They insist that some livestock like poultry and pigs still require effective treatment in feed or water. This could be perceived as approval of sub-therapeutic use of antibiotics for some of their animals and somehow not seen as a great contributor to the development of resistant strains (Animal Welfare Approved 2016).

The general concern is that the present intensive factory farming practices and systems are the cause of mass suffering of farm animals (Swanson 1995). The behavioural freedom of farm animals which is the animals' ability to freely express normal instinctive behaviour is impacted. For example, the freedom to graze and mate as independently as possible (Mepham et al. 2006) . The same applies to the animal's intrinsic value which is fairness granted to farm animals as sentient beings and not merely as means to our ends (Mepham et al. 2006). Hence, intensive factory farming is regarded as the single biggest cause of animal cruelty in many possible ways (CIWF 2012).

2.5.2.4 Biota

Understanding environmental wellness includes an understanding of the impact of our interactions with nature, a behaviour that respects the environment and minimises harm done.

Harm to the environment includes air pollution, water pollution and littering. Biota refers to the living organisms of an area, the flora for plants and fauna for animal life combined. Biota is not the main focus of the research; therefore, how conservation, biodiversity and sustainability will be affected is only discussed briefly below.

Maintenance of Biodiversity

Biodiversity refers to biological diversity among living organisms from all sources of life on earth including biota and aquatic systems. Included in this is variability within species, between species and ecosystems (Pett et al. 2016). Urbanisation and agricultural intensification are listed among the global threats to species and ecosystems (Pilgrim et al. 2008).

The lack of ecological knowledge is cited as a main contributing factor against the preservation of biodiversity in big cities (Dallimer et al. 2012). As previously mentioned Grace (2015) states that the contamination of biota in animal farming is by animal waste through urine, faeces, and discarded contaminated water containing traces of antibiotics which make its way to the environment. Waste from animal farms is now regarded as one of the important contaminants of the environment and causes the spread of resistant pathogens between animals, environment and humans (O'Neill 2015). Antibiotics in run-offs from manufacturers of antimicrobial active ingredients, is likely to contaminate the surrounding environment including nearby rivers. The lack of ecological knowledge may have led to the disconnect between biota and humans possibly resulting in more environmental harm in the future as humans continue to fail to recognise how societal actions contribute to the deterioration of conservation, maintenance of biodiversity and sustainability of certain species (Cracknell et al. 2016). Livestock production accounts for about 18 percent of total greenhouse gas emissions, far more than emissions produced by cars, aeroplanes and trains put together (CIWF 2012).

In summary, the arguments against non-therapeutic use of antibiotics in animal farming are more convincing even though the possible solution being lobbied may not be implementable right away by all countries. The next chapter discusses the most appropriate and likely recommendation around tackling AMR globally in both animals and humans.

CHAPTER 3: SUMMARY AND CRITIQUITING OF O'NEILL'S 2016 FINAL REPORT ON AMR

3.1 Introduction

In this chapter, O'Neill's (2016) final report on AMR is summarised and critically discussed. The focus is on his recommendations which are the nidus of the entire report. Only the top five recommendations are summarised and the other five are listed. O'Neill's (2016), was chosen because it is a very comprehensive report that has delved into the causal effects of antimicrobials in agriculture. Over and above that it looks at AMR in its entirety engaging WHO, FAO and OIE, as well as suggests implementable recommendations.

O'Neill's (2016) report is based on a series of interim published papers that looked at specific aspects of AMR over an 18-month long consultative process. The AMR review included analysing 280 published papers that addressed the antibiotic resistance issue in agriculture. The review team found that an overwhelming 100 of 139 (72 percent) academic papers reviewed found that there was a link between antibiotic use in animals and resistance in human beings. The overall objective of the report is to reduce the demand for antimicrobials in order to respond to the rapidly growing demand for antimicrobials because the frequency and quantities have a direct impact on resistance development. By restricting the use, the rate at which resistance occurs can be reduced. O'Neill's (2016) report is mainly about offering workable recommendations so as to quickly move towards the right direction.

The review team used a set of guiding principles to develop final recommendations. These principles are summarised and compared to Mepham's Matrix's core principles as illustrated in the following table:

O'Neill's Review Team Guiding Principles for Developing Recommendations	Mepham's Matrix' Corresponding Core Principle
1. A globally adaptable solution, so that all nations can benefit from its implementation.	This principle corresponds with the principle of well-being (utilitarianism) in Mepham's Ethical Matrix. Utilitarianism where the principle of well-being originates, states that an action is morally right if it benefits the greatest number of people, hence if a solution can be adapted to benefit all nations it can be regarded as morally right.
2. The proposed solutions should be achievable, affordable and should support local economic development.	This principle aligns very well with the Justice principle or Fairness. If the solution is affordable and able to support local economic development it can be regarded as just.
3. Implementation to utilise existing International Systems and National Health Systems in order to avoid creating new	This principle supports collaboration and cost effectiveness, therefore aligns well with both justice and well- being principles because it preserves funds

institutions that may divert funding intended for combating the global AMR unnecessarily.	for the greater good.
4. To bolster research capacity relevant to AMR by institutions and individuals.	Capacity building resonates with the principle of autonomy because it empowers both individuals and institutions to make independent decision that may change the course of AMR in the future.
5. The solutions should promote collaboration among public and private institutions, civil society, and academia.	This principle again aligns well with both principles of justice and well-being because it promotes shared responsibility and encourages unity for the benefit of all of humanity.
6. To identify and address market failures by allocating resources accordingly. To also manage risk effectively via any means possible for example, by controlling the price through subsidies, taxes, or regulation.	This principle aims to promote well-being by being proactive in identifying gaps timeously. It also promotes justice through the use of subsidies, taxes, and regulations where appropriate in order to make sure that resources are equitably distributed.

Table 3.1 O'Neill's guiding principles for developing recommendations versus Mepham's Principles.

3.2 The Ten Recommendations

The recommendations are equally important but the first five are most likely to yield results much quicker than the rest. For example, an awareness campaign if handled appropriately has a potential to reduce demand from prescribers as well as consumers. Below are the summary and analysis of the recommendations.

Recommendation 1: A global public awareness campaign

AMR being of scientific and clinical use, knowledge and awareness are only prevalent amongst professionals working in the healthcare sector and those in veterinary services. The general public is the one mostly impacted by AMR but yet still unaware of the problem. Public awareness and buy-in can have a significant impact on the direction that AMR takes. If the proposed campaigns are able to change behaviour, there will be a sharp decrease in the demand for antibiotics from all fronts. Essentially, reducing demand for antibiotics is the main objective of the campaign. Campaigns have been very effective in changing behaviour and enlightening people as have campaigns that warn against smoking and use of alcohol in pregnancy. It is now common knowledge that a pregnant woman should never smoke or drink. The campaigns against combating communicable diseases like Ebola, Zika, HIV infections have raised the level of consciousness of the general public. The same can be achieved for AMR. This is because patients often demand antibiotics and other medicines from their doctors without understanding the implications of their demands. Therefore, for a campaign to be successful it should change behaviour.

Over and above creating awareness, public campaigns are regarded as the most cost-effective mechanisms of driving behavioural change. For example, "one study showed that in Belgium, campaigns to reduce antibiotic use during the winter flu season resulted in a 36 percent reduction in antibiotics prescriptions. Over 16 years, the cumulative savings in drug costs alone amounted to around 130 Euros (150 USD) per Euro spent on the campaign" (O'Neill 2016) p.19. This recommendation perfectly aligns with the principles of justice and well-being as per Mepham's matrix because it is regarded as most cost-effective and aims to benefit the greatest number of people.

How Would a Global Campaign Work?

It is important to have an understanding of how the envisaged recommendation would work if implemented. The following paragraphs give an account on what is expected of the global campaign.

The design and implementation of sustained public awareness campaigns to change behaviours are recommended because a single global campaign is unlikely to produce the desired outcome. But it is also important to have a global theme that can be adapted for local content, however, symbolism should remain constant throughout. For example, India has adopted a "Red Line Campaign" for its antibiotic packaging. The red line is the symbolism used in India to caution patients about the importance and responsibility associated with being prescribed antibiotics. It can be taken to mean "red for danger" this is to make sure that once antibiotics are rightly prescribed the patient should be able to easily identify them from the rest of the medicine because it is always important to finish the course of antibiotic. This is an idea that can be adopted globally. Though important to stick to a global theme it is also important for each country to tailor the message to suit its people. All available media should be utilised from traditional print to social media, at home, schools, healthcare centres and should include celebrities (O'Neill 2016). A private-public partnership could potentially cover the costs of running a very successful campaign.

As part of the campaign, it is also very important to alert the public about the dangers of procuring antibiotics online, without a prescription from unauthorised sources or the Black Market. This is because internet sales bolster the sale of antibiotics without a prescription on an unprecedented scale. "A coordinated, global effort is required by domestic regulators and international bodies (like International Criminal Police Organization [INTERPOL] or the World Customs Organization) working in harmony to limit opportunities for unregulated online sales within countries and across international borders" (O'Neill 2016). The author

believes that an awareness campaign is the most significant and effective way of dealing with AMR problem over and above investing in research and development of new classes of antibiotics. From experience, it can be deduced that bacterial mutation will always be a step ahead of any new class of antibiotics. Therefore, the development of new classes of antibiotics cannot be relied on because this is not sustainable despite the funding and need.

Recommendation 2: To promote the development of new antibiotics, and make better use of existing ones

It is crucial to increase the supply of new classes of antimicrobials to keep up with rising resistance demand. There is insufficient private and public investment in Research and Development in support of new drugs and other areas relevant to the global AMR challenge.

O'Neill (2016) recommends an influx of funding towards early stage cutting edge scientific research on new antibiotics classes' discoveries. It is an area referred to as high risk because it also includes investing in research that deals with an understanding of drug resistance. Without fully understanding the mechanism of microbial resistance it will be difficult to develop antibiotics that will deliver the desired effect. Learning the proper dosing of antimicrobials for example, some types of resistance are dose dependent, for example at higher doses one may achieve a bacteriostatic effect (Droege et al. 2016).

Repurposing old antibiotics and trying out different combinations of antibiotics to create synergies that may be useful for a while is the best alternative at present as microbes will always mutate. This is as important as finding new classes of antibiotics. New classes of antibiotics are only temporarily immune to resistance because as soon as they are widely used they develop resistance rapidly. But such work is often not seen as attractive to funders because it is not expected to produce blockbusters. It is my opinion that this recommendation should be supported because AMR is a different kind of a problem and the approach should be less conventional. A constant supply of researchers is required, whose job is to repurpose the old antibiotics and create new synergies. Doing so is in our best interest and definitely requires substantial funding.

Since the O'Neill's review started there has been some encouraging developments in terms of priority given to AMR and its Research and Development funding by some governments and other funding bodies (O'Neill 2016). For example, in February 2016 the US Government launched the Biomedical Advanced Research and Development Authority, a Biopharmaceutical Accelerator, which will form partnerships with organisations that play a

role in the value chain of antibiotic development. The Chinese and the UK governments partnered to form the Global Innovation Fund to provide funding for AMR-related research in 2015. The Bill and Melinda Gates Foundation has also committed its support as have many other initiatives (O'Neill 2016).

This recommendation possesses elements of all three core principles. It is a just recommendation because the influx of funds will ensure that continued research in areas otherwise previously neglected. It also resonates with the principle of autonomy because it empowers researchers to have the freedom to repurpose old classes of antibiotics, use synergistic therapies as well as play around doses. And lastly, the principle of well-being, all the initiatives mentioned above are for the betterment of all of humankind.

Recommendation 3: To support the innovation and uptake of rapid point-of-care diagnostics

The problem with the general use of antibiotics is that they are often prescribed empirically. The diagnosis is seldom definitive except in cases of resistance where practitioners are forced to do cultures to isolate causative organism(s). Common practice is to initiate antibiotics treatment with the broad-spectrum antibiotics and de-escalate upon receiving the specific causative organism(s). That reduces the effectiveness of the broad-spectrum antibiotics and exposes the patient to unnecessary antibiotic types. The ability to conduct an equivalent of a rapid diagnostic test, much like a finger prick test for blood glucose, HIV, Hepatitis screening, where one can get results within minutes is critical in fighting AMR. Innovation in this area is as important as reducing the demand for antibiotics. To reiterate, in the USA alone it estimated that approximately 68 percent of patients with respiratory issues received antibiotics unnecessarily (O'Neill 2016). This challenge is not only limited to the USA, it remains a common problem in most countries and will continue to be so until rapid diagnostic tools are developed. A funding mechanism for such innovation already exists (O'Neill 2016). This recommendation could not have come at a better time and the funding directed towards its development. Researchers do not have influence on obtaining funding over such a limited space of time. Raising funds even for the noblest of causes is never easy.

This recommendation resonates with the justice and well-being principles because just antibiotic prescribing practices can only be achieved by prompt identification of the causative pathogen(s). This in turn will result in the preservation of antibiotics and reduction in AMR which is of great benefit to humanity.

Recommendation 4: Improve global surveillance of drug resistance and antimicrobial consumption in humans and animals

Monitoring usage and usage patterns are crucial for any infectious disease management. Therefore, a significant investment to surveillance systems is of paramount importance. This will allow researchers to pool and collate data accurately to limit the margin of error. The critical step is monitoring of data on consumption of antibiotics in both humans and animals. This will help us understand the link between antimicrobial use and the development of resistance better. This is laborious and time consuming therefore the sooner it gets underway the better.

International bodies and the Non-Governmental Organisation sector are listed as key in the development and implementation a global surveillance network. Governments are called to increase funding to develop and expand current surveillance systems. Once surveillance systems are in place data should be user-friendly and easily accessible to policy makers, formulary compilers and healthcare professionals in general. Data sharing should be at the centre of any surveillance systems. This is often the problem in the private sector, sharing of clinical data should not be seen as sharing of trade secrets. Effective data sharing is the only way to defeat AMR failing and governments may have to intervene to make sure that information generated is more representative of the data and picture on the ground. Having accurate records and sharing of data effectively is in best interest of all of humanity, therefore this recommendation is just and of utilitarian origin.

Recommendation 5: To reduce the unnecessary use of antibiotics in agriculture, and the emission of antibiotic waste into the environment

Antibiotic use in agriculture should be more prudent just like in humans. All countries should move to restrict antibiotic use as feed additives for growth promotion and diseases prevention. There are instances where antibiotics are needed for treating sick animals and not to purely compensate for poor farming practices. Another critical point O'Neill makes is that intensive factory farming where a large number of animals is kept in close proximity to each other breeds unhygienic conditions and is a good precursor for harbouring reservoirs of resistance and is conducive for resistance to spread rapidly amongst animals. This is the point echoed by many researchers as seen in the scientific literature review.

The report also highlights the fact that WHO and other organisations like FAO and OIE have elevated the issue of antibiotic use in agriculture. In July 2016 for example, WHO released a

list of antibiotics that are deemed medically important and critical for humans and their use in agriculture should be closely monitored and at best eliminated (Collignon et al. 2016). O'Neill also pleads with the World Bank, International Non-Governmental Organisations, and Development Agencies to work together in helping low to middle-income countries like SA. These countries are still struggling with primary health care issues plus TB, HIV/AIDS, high Maternal and Child Mortality rate and non-communicable diseases. It is critical that these countries get all the help they need in improving and evaluating existing regulatory frameworks for antibiotics and to build reliable surveillance systems and develop capacity.

The antibiotics stewardship is, however, more comprehensive, and robust in some developed countries like the UK where O'Neill is resident. They already have specific targets to reduce the unnecessary use of antibiotics in agriculture for example, the 10-year target to reduce the global use to be introduced in 2018. The UK and other developed countries are most likely to fare better than for example SA. SA has already begun the Veterinary Antibiotics Stewardship about two years ago (Vuuren 2014). The strides made are good but nowhere near the level required to solving the problem. The O'Neill's report also calls for Improved Transparency from food producers, for example, to fully comply with labelling standards for example, a claim on the label that reads "this product may contain traces of antibiotics". This will help consumers make informed buying decisions. The recommended targets should be country specific, meaning governments should take ownership of the whole process and work a plan according to the local needs and circumstances. The report also specifies making ambitious targets which are a good thing because if implemented properly the reduction may happen quickly. In fact, any reduction will be most welcome because as things stand the trajectory is upward.

There is a strong case being made for antibiotics deemed medically critical for humans like *Colistin* not to be used in agriculture at all because it is the last line of defence in ESBLs. It may be too late for this call to make because it is already resistant to mcr-1 gene producing organisms. *Colistin's* resistance was first detected in animals and the same strain of animal origin is now causing difficult to treat infections in humans. The *Colistin use* is more rampant in agriculture for example in pig farming in China. Tons of *Colistin are* used each year (Shen et al. 2016)

The other important facts highlighted by the report is that antibiotics can reach the environment through three principal channels namely animal waste, human waste, and manufacturing waste. They can contaminate soil, crops and water sources and encourage the

development of drug resistance amongst the pathogens with which they interact. It is difficult to predict how quickly they degrade, as they are very diverse chemically. This is an area where gaps in our understanding need to be addressed to help us identify the antibiotics of greatest risk in an environmental context.

Recent studies on animal waste show that as much as 75 to 90 percent of tested antibiotics remain un-metabolised when excreted from animals. These un-metabolised antibiotics then enter the sewage and water systems. The same goes for human waste too, much of antibiotics consumed by humans are excreted un-metabolised. The manufacturers of antibiotics active ingredients are also seen as a contributing factor in contaminating the local environment where their processing plants are situated. The waste water is identified as the most significant contributor. This also needs care and attention because it adds to the development of resistance by creating environmental reservoirs of resistant microbes.

O'Neill (2016) quotes a study that examined a wastewater treatment plant in India that received effluent from manufacturers of active ingredients. This revealed the presence of high concentration of active ingredients including antibiotics like ciprofloxacin an antibiotic belonging to a class of antibiotics called the quinolones deemed critical for human medicine by WHO (Collignon et al. 2016). The concentration levels were a 1000 times higher than those required to kill some bacteria and far higher than the blood levels of a patient taking that antibiotic. The problem does not only affect communities surrounding manufacturing sites who are exposed to polluted water because resistance spreads far and wide, therefore, it is a global problem that requires urgent attention.

The other remaining recommendations which are as equally important are:

- To improve sanitation and prevent the spread of infection
- To promote the development and use of vaccines and alternatives
- To close the skills' gap in AMR-related research, and infectious diseases clinical practice
- A Global Innovation Fund to re-invigorate early-stage Research and Development
- Ensuring a globally-coordinated and sustainably-funded response

The less antibiotics used in animal farming the greater are the chances of preserving the long-term effectiveness of antibiotics and well-being of biota. This recommendation encompasses all three core principles. It resonates with the well-being of the consumers and biota. It also resonates with principle of autonomy for the consumers which is indirectly infringed by the use of antibiotics non-therapeutically without their consent or knowledge. It is a just

recommendation because an unwarranted use of antibiotics is not fairness because it puts humans, animals, and biota at risk. In the next section, the proposed recommendations are critiqued, together with how these may impact the overall objectives to reduce demand for antibiotics and boost the supply side.

3.3 Critiquing of the Report

In my opinion the O'Neill's (2016) report ought to be supported, a few areas may be seen as contentious, for example, the animal farming fraternity may feel that a global reduction target runs the risk of being manipulated for profit gains which in turn can result in a much worse situation for both animal and human health. For example, it may result in false reporting where the use of antibiotics continues but record keeping is manipulated to reflect reduced volumes or quantities. It can also act as a catalyst for farmers to procure antibiotics from unauthorised sources or the black market. This is the area that authorities are currently battling with because it is rampant in some areas and not only limited to antimicrobials (Essack et al. 2011). This will have a double impact for example surveillance will be severely affected, while resistance may be getting worse. The report does make a recommendation though, that international bodies like INTERPOL ought to be on the alert to monitor such activities online and elsewhere.

There is definite consensus though by both animal and human health organisations on reducing the demand for antibiotics use in agriculture by improving farming practices for example, the adherence to protocols that are produced by antibiotics stewardship teams. The correct dosing being key which means that a complete review and regular assessment of protocol effectiveness should be implemented. The effectiveness of all antibiotics, diminishes over time especially those that are widely used. Tetracyclines contributed over 40 percent of total sales for use in animal farming (FDA 2015). Because it is an old class that is less effective so huge quantities are required to achieve the same effectiveness as modern classes of antibiotics (FDA 2015). It could also be that the high levels of resistance are driving incremental doses to achieve the same level of care as in previous years. Some may argue that if the objective is to have as little milligrams per kilogram of the meat produced perhaps using more potent antibiotics often from the newest classes critical for human health will achieve that. This would be counter-intuitive because use in this context should be strictly reserved for humans and its wide use would make a bad situation worse.

The key really is the most effective use for example, latest guidelines in human health suggest that it is good practice to have a loading dose. Loading doses often result in better outcomes

because of high doses and shorter courses with exceptions which depend on the type and site of infection (Droege et al. 2016).

The *Colistin* resistance reports demonstrate that gaps in surveillance systems truly exist as rightly indicated in O'Neill's (2016) report. This is because the mcr-1 gene has been around for at least since 2011 without being detected. If anyone still doubts the link and the extent of the contribution made by antibiotic use in animals and resistance development, this alone should convince them. Of course, the antibiotic use in humans still remains a very significant contributor to resistance as mentioned that in the USA alone, 27 million people studied who had respiratory issues were found to have been given antibiotics unnecessarily (O'Neill 2016). There is no one single intervention that will turn things around but synergies have a potential to impact positively while there is still time. There always will be disputes around the origins and main contributors of the antimicrobial resistance development for example, publications that claim that AMR is primarily due to antibiotics in humans than in animals (UK Department of Health & Department for Environment Food and Rural Affairs 2013).

In some instances, a ban of one antibiotic can result in another antibiotic being widely used and exposing it to develop resistant much quicker for example, elimination of avoparcin in animals was followed by an increase in Vancomycin-Resistant Enterococci (VRE). Vancomycin is a critical antibiotic for humans especially in the treatment of diarrhoea caused by *Clostridium Difficile (C. Diff)* which is often as a result of being on antibiotics for longer periods, that often depletes your intestinal flora and giving proliferation to *C. Diff* which is treated with Vancomycin powder for injection taken orally or by other treatment regimens. If conventional treatment fails, the other extreme alternative is faecal transplant. Faecal transplant is a process where stools from a donor ideally a family member are mixed with saline strained and administered to the patient rectally or via a nasogastric tube (Sbahi and Di Palma 2016). The reason is to treat diarrhoea by replacing the normal flora. The condition is debilitating and sometimes fatal especially in elderly people. SA has no bank for frozen stools so one relies on donors for stools (Medical Brief 2015). This is just one highlight on how dire the problem of AMR is regardless of where the resistance originated. Those in the animal health industry argue for appropriate use of antibiotics rather than a ban of antibiotic classes for fear of new infections or resistance patterns development. Their emphasis is also on providing training to veterinarians to act as gatekeepers and training of farmers on how to correctly administer the antimicrobials once prescribed. The approach is similar to human antibiotics stewardship.

O'Neill's report uses weight per weight comparison in determining the quantities used in both animals and humans. The animal health fraternity often raises this point that it is inaccurate to use this comparison because a cow, for example, can weigh up to six average adult humans and therefore if a human being takes one gram a cow will need at least six grams depending on the nature of infection. They also argue that there are more animals and pets than there are human beings, therefore, it is logical that the use in animals would be significantly higher than in humans. One example given is that the UK has a population of 64 million people and about 18 million broiler chickens are slaughtered per week hence antibiotic usage in animals is expected to be higher in animals than in human beings. To be fair to the review team, the question being asked here is a moral one. Is it morally justifiable to carry on using antibiotics non-therapeutically and not for treating sick animals even if we are aware that we could be fuelling the spread of antimicrobial resistance? Because of the large number of animals currently in the world the call to restrict the use of antibiotics in animal farming is supported by many. This is because their sheer volume commands that tons of antibiotics are used in animals each year thus contributing to the development and spread of resistant pathogens.

The increasing demand for animal protein is also a contributing factor in promoting intensive factory farming to keep up with the demand. The report does not make mention of this important factor. It is because of our insatiable demand for animal protein that animals are kept in close proximity, given growth promoters, live in poor sanitary conditions and are routinely fed antibiotics to keep them from getting sick and infecting each other and possible passing their infection to humans.

The moral claim being made by critics is that the use of antimicrobials prophylactically is limited to diseases for which vaccines do not exist (O'Neill 2016). In cases where vaccines exist, vaccination does not always provide full protection against pathogens. This acts as a disincentive against vaccination for farmers. This then becomes a definite disincentive to vaccination. Another claim is that vaccines are readily available for a majority of viral diseases and fewer vaccines are available for bacterial diseases where the prophylaxis is most needed (O'Neill 2016).

Public awareness should also include the highlight of basic food safety principles like the proper handling, cooking, processing, and storage of meat products to minimise the risk of pathogen transmission amongst animals and humans via the food chain (United Kingdom's National Office of Animal Health (NOAH) 2016).

Lastly, some critics argue that attempts directed at antimicrobial free animal products may have unintended consequences like neglect of sick animals. Many people would rather pay more for a morally defensible agricultural product that demonstrates better husbandry (Rollin 2001). The problem with paying premium for organically produced foods is that during the economic downturn sales of such products plummet (O`Neill 2016). Given the context of this report, that should not matter because if all farmers abandon farming with antimicrobials then the cost of production should come down sooner or later. In the next chapter, all the evidence and arguments for a ban of non-therapeutic use antibiotics in animal farming are considered.

CHAPTER 4: ARGUMENTS FOR A BAN OF NON-THERAPEUTIC USE OF ANTIBIOTICS IN ANIMAL FARMING

4.1 Introduction

In this chapter, the ban of non-therapeutic use of antibiotics in animal farming is argued for. The arguments are based on the ethical and scientific arguments of Chapter 2 making use of Mepham's Ethical Matrix, and considering criticism of O'Neill's report in Chapter 3. The first part is based on the scientific review evidence and its arguments. The second part is based on the ethical analysis using Mepham's matrix. This is to help the reader understand which considerations justify a ban. This chapter is written such that it summarises previously mentioned points and the fundamental issues underlying non-therapeutic use of antibiotics in animal farming are brought to the fore.

4.2 Scientific Literature in Support of the Ban

Having reviewed the applicable scientific literature on the effects of non-therapeutic use of antibiotics in animal farming, the following are the findings that support arguments for a ban: Firstly, I argue that using antibiotics in low doses contributes to the development of resistant strains that can cause fatalities in humans. Notwithstanding the general view that the antibiotic use in animal farming protects both animals and human beings from zoonotic diseases such as Salmonella, Campylobacter and E. coli (Hughes and Heritage 2002). This has amplified the AMR problem and therefore, the view ought to be refined.

Secondly, the close proximity of animals creates a conducive environment for pathogens to spread (Landers et al. 2012). What this means is that there ought to be good animal husbandry which includes better ventilation, sanitation, and less cramping all of which minimise the spread of pathogens amongst animals. A ban of non-therapeutic use of antibiotics would force people to practice good animal husbandry. When good animal husbandry is in place the need to routinely use antibiotics is diminished; therefore, one can ban the use of non-therapeutic antibiotics without compromising safety of animals or humans. This would mitigate against development of resistance of antimicrobials.

Thirdly, antimicrobial therapy is regarded as the single most important driver of AMR, because there is a positive correlation between use of antimicrobials and antimicrobial resistance development (Boerlin and Reid-Smith 2008). This statement supports the argument for a ban. Therefore, the overall use of antimicrobials ought to be reduced. For this to be completely achievable, the reduction in the use of antibiotics should be accompanied by a reduction in the number of intensive factory farms.

Fourthly, it is argued that the duration of antimicrobial therapy is just as important in the development of resistance. The prolonged exposure even at therapeutic levels can cause resistance. Hence, it is important to ban the routine exposure of farm animals to antibiotics.

Fifthly, there is enough evidence that some of the deadly resistant strains originated from food producing animals, for instance, an outbreak of food poisoning in 1983 caused by a resistant strain of Salmonella (Bonner 1998). This highlights the problem that if there are over 70 billion farmed animals at any given point (CIWF 2012). Most of these animals are intensively farmed which means that they are mostly exposed to antibiotics. This phenomenon makes it easier for the pathogen transmission amongst animals and humans to occur. The overuse of any type or class of antibiotics leads to resistance. It is now known that pathogens are capable of mutating to suit any environment so there are no longer exclusive animal specific pathogens. Human infections have been caused by pathogens that have acquired copies of a resistance gene from antibiotic-resistant bacteria acquired from animals or animal products.

Lastly, antibiotic residuals can result in significant harms in human health for example, side effects caused by direct exposure to the drug for example, anaphylactic shock from penicillin allergies which could be fatal if a medical emergency is not available at once (Aarestrup 2015). This alone is enough to impose restrictions

In short, because the animals affected are generally much larger than humans they therefore, require much larger quantities of antibiotics than humans at any given point. Hence, animals can have more influence in the pattern of AMR in some areas. A good example is chloramphenicol when it became ineffective and was subsequently stopped as an antimicrobial of choice in both animal and human health (Gassner and Wuethrich 1994). Newer classes of antibiotics come at a much higher cost; therefore, preserving a class of antibiotics is a moral obligation because it ensures effective access at affordable costs and the only way to best preserve classes of antibiotics is with a ban.

4.3 Outcomes of Mepham's Ethical Matrix

The matrix has provided adequate evidence that in theory supports arguments for the ban of non-therapeutic use of antibiotics in animal farming. The previous findings and how they justify a ban are summarised below.

Farmers' Wellbeing, Autonomy, and Justice

Growing evidence suggests that antibiotics used as growth promoters do not lower the unit cost of production as much as once thought, especially where advanced farming techniques

exist (Graham et al. 2007). Therefore, this weakens the economic argument for antibiotics as growth promoters. Banning use of antibiotics prophylactically may be interfering with farmers' freedom to choose farming techniques suited to them. Nevertheless, if farmers are given enough information, time, and assistance to reform how they farm they may see value and justice in the reforms. The injustice would be if governments drew up policies and started implementing them without preparing the industry, as it may have negative social consequences.

Consumers Wellbeing, Autonomy, and Justice

Food safety and quality of life of consumers is at the centre of any farming community. The duty lies with agriculturalists to provide humanity with safe and nutritious food and reasonable steps should be taken to prevent any foreseeable harm now or in the future.

Consumer autonomy as a choice for consumers to make their own independent buying decision may be affected by current farming practices. The consumer lacks insight into production practices with good reason; it is a specialised area and not always open to the public. The only common interaction among consumers and farmers is a virtual one at the retail shop. There's sufficient evidence to suggest a ban because of the harms posed by farming with antibiotics. It is not an unreasonable call to make because a ban already exists in Europe. The next two paragraphs provide evidence that supports the existence of avoidable animal cruelty and contamination of *biota*.

Animal Welfare

Adequate evidence exists to suggest that intensive factory farming practices include the most inhumane but necessary physical alterations like amputation or trimming of certain animal parts where applicable to control mortalities and injuries due to undesirable animal behaviour. This interferes with the animal's "birth-right to bodily integrity" as each part is responsible for a particular purpose when animals are reared in their natural habitats (Swanson 1995). The fact that intensive factory farming uses animals merely as means to ends is in itself questionable. Animal suffering is the greatest deterrent. A modern society has evolved enough to understand that all animals suffer and their unnecessary suffering is unethical.

Biota

Preservation of all living organisms including those not yet fully understood seems an ethical way of dealing with environmental matters. We could only achieve this by avoiding all things

known to cause harm to our environment. As many would have experienced if oral antibiotics are prescribed a probiotic is often added to replace commensal flora which is sometimes eroded by the course of the antibiotic, resulting in side-effects like diarrhoea and vaginal thrush in females. Waste from animal farms is now regarded as one of the important contaminants of the environment and spread of resistant pathogens between animals, environment, and humans. The extent of the impact cannot yet be accurately estimated due to resource constraints. It appears every single living organism beyond human beings may now be affected by antibiotics. Lastly, the next section is a reflection on O'Neill (2016) Report.

4.4 O'Neill (2016) Report

Drawing from this report has helped put things into perspective. Like all proposals and recommendations, they are either supported or not supported depending on how one will be affected. Take for instance the animal farming fraternity may feel that a global reduction target of antibiotic use runs a risk of being manipulated for profit gains which in turn can result in a much worse situation for both animal and human health. For example, it may result in false reporting where the use of antibiotics continues but record keeping is manipulated to reflect reduced volumes or quantities. It also can act as a catalyst for farmers to procure antibiotics from illegal suppliers, commonly known as the black market.

The moral claim being made by critics is that prophylactic antimicrobial usage is often towards diseases for which there are no vaccines. Vaccination cannot protect against all pathogens and so a farmer may vaccinate and still see diseases. This then becomes a definite disincentive to vaccination. Despite all this there is definite consensus on the need to reduce the demand for antibiotic use in agriculture by improving farming practices for example, the adherence to protocols that are produced by Antibiotics Stewardship teams.

4.5 Conclusion

The critical finding of this research is that the evidence gathered is sufficient to suggest an immediate restriction to a ban of antibiotics in animal farming deemed medically important for human beings as defined by the WHO. This ban should be national. Other antibiotics can be given with restriction while government puts together a framework or policy on how to deal with the problem. The farming industry can play a much bigger role in helping government as they may be more familiar with alternatives. The problem is that if a ban is not made into law the compliance levels will be low and will work as a disincentive. Other farmers may carry on making profits while the rest struggle with new farming techniques and setbacks. In literature, the author could not find convincing enough reasons not to go ahead

with the ban of the antibiotics deemed medically important for humans. A ban remains a necessity even if it results in the suspension of all intensive animal farming activities. The impact of that will still be much smaller compared to the global threat faced by healthcare daily while trying to treat virtually untreatable infections. It had to take an economist, O'Neill (2016), to elevate the issue to the UN. In the twenty-first century, there have only been a few times where health issues have been elevated above ministers of health to heads of states by the UN for example, in 2001 the HIV/AIDS and in 2011 the burden of Non-Communicable diseases before the Ebola epidemic and the Zika Virus outbreak, now the AMR as declared by the UN's General Assembly (2016).

This alone supports the claim that it is no longer appropriate to highlight what could be the issues. It is more about taking a stand and committing to actions that are most likely to change the course of the resistance like preservation of certain classes or types of antibiotics so they could regain their efficaciousness. Every single rational being has a moral obligation to act at once.

In summary, the critical finding of this research is that the evidence suggests an immediate ban of non-therapeutic use of antibiotics in animal farming. This finding, however, poses further challenges because it implies that the Intensive Factory Farming model should seize to exist. This is because infections cannot be organically contained where animals are kept in close proximity without intervening. In this instance the "cost-effective" way has been the routine addition of antibiotics to animal feed and water. In the following chapter, a summary of the conclusion is offered and recommendations are suggested.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter is a summary of arguments based on the literature and recommendations.

5.2 Summary

Scientific Arguments For and Against Non-therapeutic use of Antibiotics in Animal Farming

It is not difficult to understand why there is general consensus that the antibiotic use in animal farming under the current conditions of intensive factory farming protects both the animals and humans from zoonotic diseases. It has always been a utilitarian belief that the benefits of such practices are good for human kind. The perceived benefits are that farmers can afford to produce more food at cheaper rates and also prevent disease outbreak thereby reducing chances of zoonotic diseases developing. However, in my opinion this claim is partly untrue because it is fiercely disputed by some of the animal welfare groups for example; it is argued that factory farming uses more food than it produces, therefore, is failing to feed the world (CIWF 2012). The amount it takes to produce one kilogram of beef is extraordinary compared to a kilogram of plant protein. Water has become a very scarce resource in many areas in the world including SA, as of September 2016, the Vaal dam which supplies the whole of Johannesburg had reached catastrophic levels at below 30 percent capacity. This triggered a crisis intervention plan. This kind of farming may be seen as unsustainable and unethical. We need to stop relying on antibiotics where alternatives exist. This is because we are sitting on a time bomb which is threatening the whole of humanity if the current farming practices remain unchanged.

Ethical Concerns

Banning the prophylactic use of antibiotics in animal farming should not be seen as interfering with farmers' freedom to choose farming techniques suited to them. It should rather be seen as a means to empower farmers so they could provide the world with even safer food. The fact that there is some evidence against farmers' practices, that alone should make the farmers want to reform. Agriculturalists are good people who care about the impact of their products (Dundon 2003). It is about time they are empowered with tools that are adequate to help reform their industry.

Food safety and quality of life of the general public is at the centre of any intervention. Whilst the industry ponders on the way forward agriculturalists have a duty to provide humanity with safe and nutritious food but also ought to take reasonable steps to prevent any foreseeable

harm now or in the future. This means that consumer autonomy should not be infringed by the lack of transparency on how the industry operates. The easiest way of disseminating information to consumers is via packaging and labelling. Enough thought has to go into finding ways of communicating clearly and effectively all that is essential in persuading consumers to adjust behaviour. Labelling, for now, is most critical until the whole industry reforms.

Animal Welfare is not at the centre of this study but is critical in resolving the issue at hand. It would be far easier to use less antibiotics if food producing animals in confined spaces are treated in the manner that other animals are generally treated. Their suffering matters; the fact that intensive factory farming uses animals merely as means that is in itself questionable.

Lastly, the preservation of all living organisms including those not yet fully understood seems an ethical way of dealing with environmental matters. Waste from animal farms is now regarded as one of the important contaminants of the environment and spread of resistant pathogens between animals, environment, and humans.

5.3 Conclusion

The arguments above are supportive of the fact that farmers should no longer continue to farm with antibiotics but only use them in the care of sick animals. Intensive factory farming poses the greatest risk in the preservation of all classes of antibiotics. It is inherent to use antibiotics where intensive factory farming is involved for example, in poultry it is almost impossible to identify and isolate sick birds in time before all others are affected hence it is easier for the farmer to routinely add antibiotics in drinking water and feeds. Therefore, a ban is necessary but it must go hand in hand with preparation for abandonment of intensive factory farming systems, otherwise, it will not work well. Recommendations as informed by the analysis using the matrix and the literature follow.

5.4 Recommendations

Recommendation 1: Adoption of O'Neill's Recommendations

The recommendations put forward echo most of O'Neill (2016)'s recommendations as listed in chapter 3. His recommendations are very comprehensive and go into great detail on how things are to be done and include the estimated costs it will take to achieve them. The recommendations in this report are prescribed by the question this research attempted to answer, that is whether non-therapeutic use of antibiotics in farming is justifiable or not. We now know that the reduced demand for antibiotics will also erode the pharmaceutical industry

profits, which could further limit the amount spent in developing new classes of antibiotics (Anomaly 2009). Therefore, providing lucrative incentives and taxing the companies that do not invest in the development of new antibiotics come highly recommended (O'Neill 2016). This recommendation ought to be extended to the farming industry. Lucrative incentives should be provided to farmers who would like help transitioning from intensive factory farming to more sustainable forms of farming and the taxing of those the farmers who are opposed to this that is those who carry on with intensive factory farming.

Recommendation 2: Biosecurity

Biosecurity should be at the centre of every farming community. Key steps of good biosecurity include good hygiene practices and these must be observed throughout the lifespan of a particular farm and not only during disease outbreaks. The benefits of biosecurity include the reduction of zoonotic diseases like Salmonella development and cutting costs of disease treatment and keeps mortality rate in check which is essential for any farm to remain profitable.

Recommendation 3: Intensive Factory Farming Abolition

The CIWF (2012) would like to see factory farming completely abolished and they see this as key to humane sustainable food production and farming policy. At first glance, the objective seems drastic but then it starts to make sense. Perhaps it is easier to do away with intensive factory farming than stopping farming with antibiotics realistically. As highlighted in the literature perhaps it is much easier to start a new farm than to renovate the existing one in order to comply with minimum requirements of good animal husbandry. To support this recommendation, it is critical to explore alternative means to intensive factory farming. This should not be a problem for SA at all because there is an abundance of land available that lies dormant and which could be effectively utilised for all farming purposes. The problem is not the resources but the will.

Recommendation 4: Responsible Procurement by Food Corporations

Big food corporations like McDonalds and KFC should procure from farmers that can provide evidence of the prudent use of antibiotics and good animal husbandry. Without improved animal husbandry, it is not possible to reduce the antibiotic use without compromising the health of animals and humans.

Recommendation 5: More Transparent Labelling

Transparent food labelling is not a luxury requirement; it is a matter of food safety and this is legislated under The South African Food Labelling Regulations (R146/2010) currently under review (South African Department of Health 2010). The label has to accurately reflect its contents including the origins and farming system from where the animal product concerned was produced. It is a legal requirement to put a disclaimer on that label that pronounces on widely acknowledged food allergens like the words "this product was made in a factory that handles nuts". This is by no means saying that the said product contains nuts but it warns those that are super sensitive to any nuts exposure of the danger. Depending on the severity of the allergy or sensitivity one can decide to consume the particular product or not. This is already used by the fishing industry, for example, endangered fish species are also protected in some way, where the label reflects the source where the fish came from. The most considerate may take an ethical decision not to deal in endangered species.

A good initiative in SA involves a Jeff Van Zyl pig farm which is reportedly moving all pregnant pigs into a new loose housing farm (Animal Voice South Africa 2016). These pigs will be held in a sow stall for 5 days during the impregnation period and be allowed enough space to move around for the duration of their pregnancy. Subsequently, the industry has come up with the label that will read "Sow Friendly or Pork 360" to indicate that the pork product concerned comes from a farm that supports better lives for pregnant pigs (Animal Voice South Africa 2016).

Recommendation 6: Meat Free Days

It is important for all South Africans to have days where no animal products are consumed. This is commonly referred to as Meat Free days. The reduction of animal protein by consumers will not only improve animal husbandry or welfare but will save the environment and reduce the high levels of cholesterol in our bodies mainly associated with excessive consumption of animal products. Further, this will also contribute to the management of non-communicable diseases which form a list of the burden of diseases in SA.

Recommendation 7: A Tiered Ban of Non-Therapeutic Use of Antibiotics in Animal Farming

A ban should be tiered, it should start with antibiotics deemed medically important and critical for human beings. This will give farmers time to learn to rely less on antibiotics, and more restrictions could then be introduced. Constant exposure of microbes to antibiotics at sub-therapeutic levels will always result in the development of resistance. Currently, we have

no way of effectively treating the superbugs, day in and out people are dying from untreatable resistant infections. The money that is being channelled into developing the new classes of antibiotics is only an attempt and not a guarantee that we will soon get a constant supply of new classes of antibiotics onto the market. Even if we could produce new classes of antibiotics the rate at which pathogens mutate is faster than the average it takes to develop and register new molecules. Without effective antibiotics, the future is bleak. Simple infections and minor operations have started to kill again. Therefore, banning antibiotics of medical importance is paramount. Even if there were no animals in all the factory farms life would still be sustainable from alternative sources of protein. But life without effective antibiotics is elusive. It may just take one flu season to halve SA's population.

Recommendation 8: Public Awareness

In all our corrective attempts creating public awareness about the extent of the problem caused by superbugs should take precedence. The message ought to reach each and every single citizen, if everyone did their bit in tackling the problem it may suffice to buy us time. The funding for awareness should be everyone's responsibility because there is no single person who will not be affected by the resistance. Everyone includes corporate SA not only companies active in the Health Sector but all companies as this affects everyone.

Recommendation 9: Policy or Framework Development

Government and all other stakeholders involve should formulate policies or frameworks to deal with the problem with the urgency it requires. Special tasks teams comprising of government, industry experts, academics, ethicists, and activists who are well versed on the subject should be established.

5.5 Recommendations for Future Research

Research is needed to development of an amicable solution into the current farming challenges. It would be more effective to propose an alternative model to non-therapeutic use of antimicrobials in animal farming for the government to implement.

Concluding Paragraph

A convincing argument for a ban of non-therapeutic use of antibiotics in animal farming has been made. It is now up to the relevant stakeholders to implement my recommendations.

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APPENDICES

APPENDIX A: ETHICS WAIVER

Human Research Ethics Committee (Medical)

Golden Jubilee: October 1966 - October 2016
Research Office Secretariat: Faculty of Health Sciences, Phillip Tobias Building, 3rd Floor, Office 301,
29 Princess of Wales Terrace, Partktown, 2193 Tel +27 (0)11-717-1252 /1234/2656/2700
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Website: www.wits.ac.za/research/about-our-research/ethics-and-research-integrity/

Ref: W-CJ-161104-1 04/11/2016

TO WHOM IT MA Y CONCERN:

Waiver: This certifies that the following research does not require clearance from the Human Research Ethics Committee (Medical).

Investigator: Ms P P Ncayiyana (Student No 1421959)
Project title: The ethics of antibiotic use in animal farming.

Reason: This is a review of information in the public domain. There are no human participants.

UNIVERSITY OF THE WITWATERSRAND
PROF PE CLEATON-JONES
HREC (MEDICAL)
2016 -11- 04
JOHANNESBURG

Professor Peter Cleaton-Jones

Chair: Human Research Ethics Committee (Medical)

Copy — HREC (Medical) Secretariat: Zanele Ndlovu, Rhulani Mkansi.