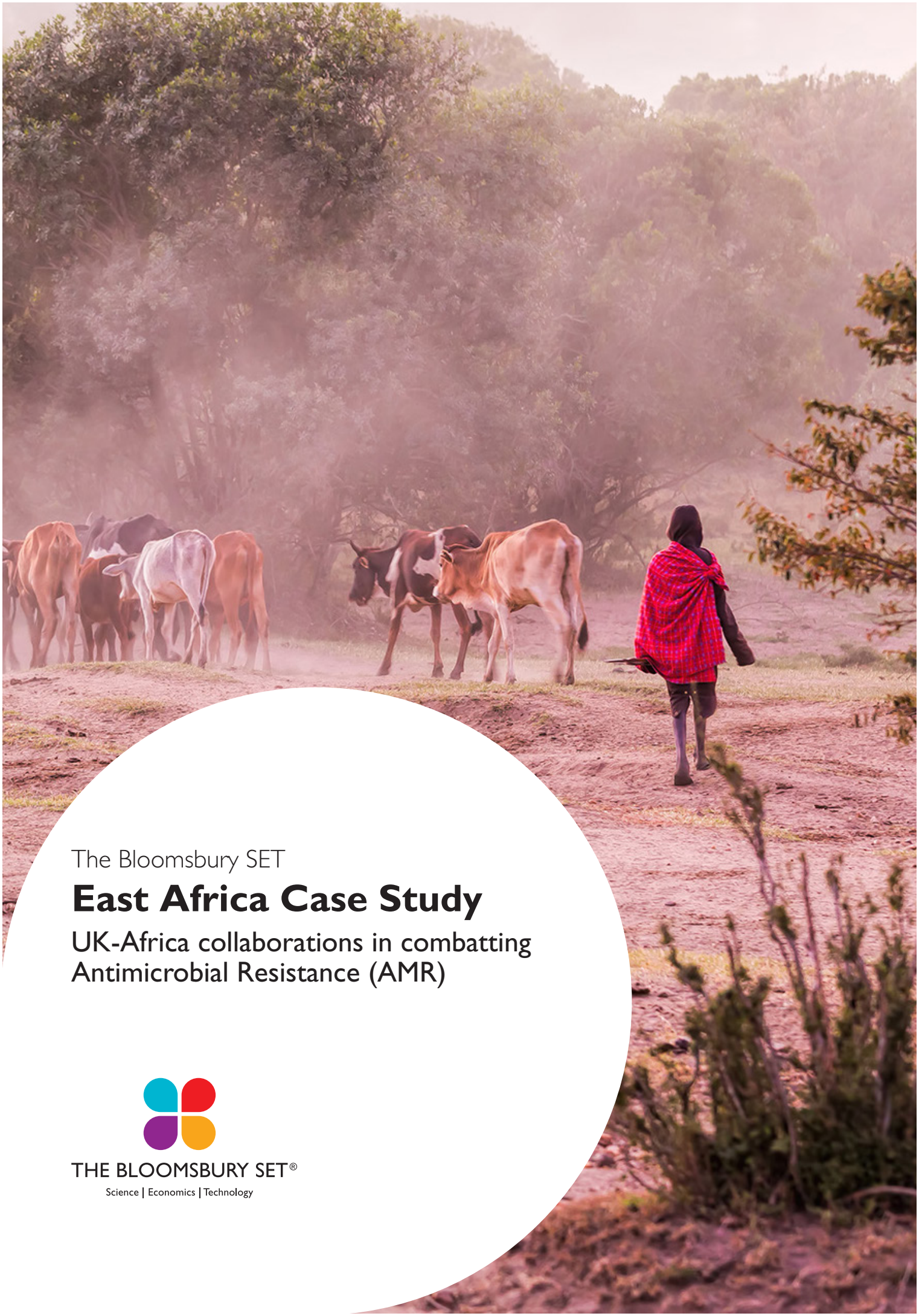

The Bloomsbury SET

East Africa Case Study

UK-Africa collaborations in combatting Antimicrobial Resistance (AMR)

THE BLOOMSBURY SET®

Science | Economics | Technology

Prepared for

The Bloomsbury SET

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1 Introduction

1.1 Purpose and Scope

This report was commissioned by the Royal Veterinary College (RVC) the lead investigator of the £5-million Research England funded Bloomsbury SET Programme to Combat the Threat from Infectious Disease and Antimicrobial Resistance.

The Bloomsbury SET programme aims and objectives are to provide solutions for combatting antimicrobial resistance (AMR) that could be translated for use in both developed and developing countries with the emphasis on transferred and translatable solutions. The partners of the Bloomsbury SET have had extensive and long-term working partnerships with organisations and institutions in East Africa – Kenya, Uganda and Tanzania on various aspects of AMR. The uniqueness of the Bloomsbury SET is bringing together the different skill sets of the four institutions to provide holistic solutions to AMR that affect both developed economies but predominately low- and middle-income countries (LMICs). Further details on the Bloomsbury SET programme and its outputs are presented in section 1.2.

The remit of this report is two-fold:

Firstly, to provide a mapping exercise to measure the state of UK-Africa collaboration in knowledge exchange in infectious disease surveillance and control in animals and humans, and combatting antimicrobial resistance (AMR) in East Africa and

Secondly, a foresight study to identify opportunities for strengthening UK collaboration with countries in East Africa for knowledge exchange relating to combatting infectious diseases in humans and animals, and antimicrobial resistance.

The first part of the report will seek to establish the following:

- The types of UK- Africa collaborations in AMR with a special emphasis on collaborations with East African countries.
- How these collaborators interact and how effective are the collaborations.
- The challenges of such collaborations.
- The knowledge gaps and finally,
- The capacity (research and technical skills) and infrastructure (facilities) issues in the host countries.
- Opportunities for strategic intervention.

The second part of the report will present a set of recommendations for The Bloomsbury SET partners, on what the main opportunities are (type of knowledge transfer, countries involved), how they could best be taken forward (e.g. joint projects, skills training, improved access to facilities), and on what timescales – short-term, medium-term and longer-term.

Although the key emphasis of this report is not about a review of AMR in Africa and East Africa this information has been provided to a limited extent to set the scene in order to address the key questions above.

1.2 Bloomsbury SET Project

The Bloomsbury SET is a £5-million programme of translational research activities funded by Research England's Connecting Capability Fund with support from industry, UK and overseas government agencies, NGOs and charities. The programme is led by The Royal Veterinary College in partnership with the London School of Economics and Political Science (LSE), the London School of Hygiene and Tropical Medicine (LSHTM), and the School of Oriental and African Studies (SOAS), University of London.

The Bloomsbury SET ('Science, Economics, Technology') aims to connect place, people, businesses, ideas and infrastructures in pursuit of innovative scientific / technical solutions that will help safeguard human health.

This interdisciplinary programme supports a One Health approach to deliver major human health benefits, improvements in animal health, welfare and productivity, and in biosecurity and food safety.

The focus of the programme is on AMR including the development of low-cost, portable diagnostic tools, surveillance and monitoring tools and vaccines to counter infectious diseases and the increasing resistance to antimicrobials.

Challenges of Public Health Issues and Potential Solution

Current public health emergencies caused by *'pathogen emergence'* – encompassing unknown or 'neglected' pathogens entering the human population, established pathogens invading a new population, and the evolution of drug resistance – have become increasingly high-profile in recent years (e.g. H1N1 swine influenza pandemic in 2009; emergence of Middle East Respiratory Syndrome-associated coronavirus in 2012; West African Ebola outbreak in 2014/15; Zika virus in the Americas in 2016 and most recently the current global COVID 19 pandemic in 2019/20).

Co-ordinating an effective response to the challenge of emerging infectious diseases particularly in LMICs requires low-cost, portable diagnostic tools, with the ability to collect data that can be used to quickly and accurately identify the pathogen(s) responsible for the disease in livestock, and ideally without the need for a scientist / veterinarian to be present at the site of data collection. The same need occurs in relation to infectious diseases that are endemic within livestock populations.

Alongside the rising demand for diagnostic tools and improved vaccines, is the need for better mathematical models to forecast the likely spread and persistence of diseases in animal populations, and their entry into human populations.

As part of the possible solutions the Bloomsbury SET has proposed three complementary initiatives to address these challenges, leading to major human health benefits, as well as improvements in animal health, welfare and productivity, improved biosecurity and food safety:

1) Development, testing and deployment of **low-cost, mobile diagnostic tools** for a range of endemic and emerging infectious diseases;

2) Development of **new, more efficacious vaccines**, leading to a significant reduction in the use of antimicrobials in food animals (thus helping stem the rise in AMR); and

3) Application of machine-learning (artificial intelligence, AI) techniques to integrate large data sets, leading to the development of **improved mathematical models of infectious disease**. These models will allow more accurate forecasting of case numbers, investigation of transmission mechanisms and evaluation of options for disease control.

The Bloomsbury SET which links Scientists, Economists and Technologists will act as a focal point for these initiatives. It is particularly well placed to address infectious disease challenges, bringing together for the first time the scientific strengths of the LSHTM and RVC (expertise in comparative biological sciences, human and veterinary diagnostics, epidemiology, vaccine development, health economics including AMR, mathematical modelling of infectious disease, disease surveillance and public health); and integrating these with the expertise of social scientists at the LSE and SOAS (expertise in health economics, international development, governance, evidence-based policy-making, linguistics and agricultural economics).

Within the context of this report a main aim of the Bloomsbury SET is to function as a Knowledge Exchange (KE) platform, underpinned by open innovation to support AMR management capable of being adopted elsewhere particularly in LMICs.

1.3 Knowledge Exchange and Public Engagement

Knowledge exchange can be defined as a two-way exchange between researchers and research users, to share ideas, research evidence, experiences and skills. It refers to any process through which academic ideas and insights are shared, and external perspectives and experiences are exchanged.

Knowledge exchange and public engagement cover all activities engaging non-academic audiences with academic, for example as partners, participants, collaborators and co-producers, or as audiences and users. These activities make it more likely that research and expertise will make a difference to the ways in which questions, events or problems are understood and addressed around the world thereby providing benefits to wider society.

Knowledge Exchange	**Public Engagement**
• Sharing knowledge, experience, ideas, evidence or expertise with non-academic communities • Intended to be mutually beneficial • Goes beyond just telling people things • Can happen at any time in the research process	• A two-way process of listening and interaction with a targeted audience • Goal to generate mutual benefit • Can be achieved in many ways

There are many approaches to Knowledge Exchange as depicted in figure 1.1 below and include:

- **Collaborative research:** academic research undertaken in partnership with other universities or research organisations, with business, with government and/or with the third sector (e.g. charities). Collaborative research can take a number of forms, from a basic grant between two partners, through to a complex multi-partner research programme.
- **Provision of facilities and equipment services:** access to and use of specialised facilities and equipment not readily available to collaborators.
- **Collaborative training:** enabling researchers to develop the relevant skills to undertake excellent research, work effectively in business (and/or the government or other important sectors), and exploit the outcomes of their research.
- **People and information exchange**: exchange of researchers between academia and industry/other research organisations to stimulate partnerships the between business/organisation and the researchers; brokering and networking activities, fellowship schemes that enable researchers to work in a commercial/other environment.
- **Commercialisation and development activities**: encouraging researchers to take their ideas further down the route to commercialisation and rewarding them for high quality innovation.

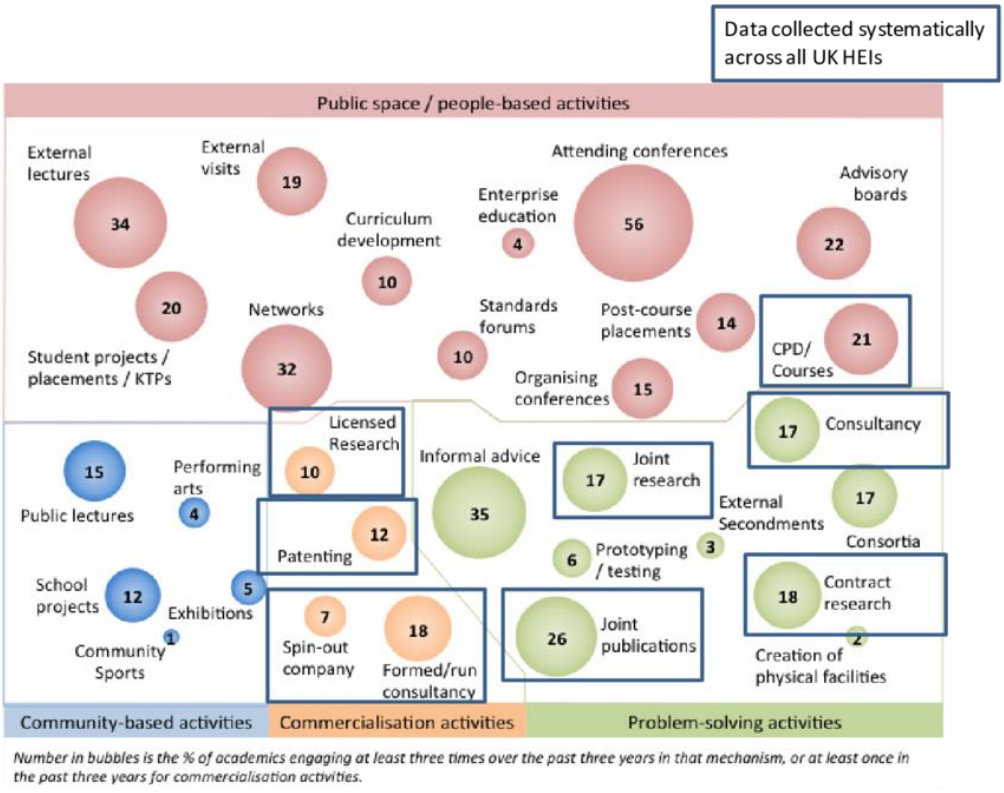


Figure 1.1. The Different Forms of Knowledge Exchange

Source: Adapted from PACEC (2012) Strengthening the Contribution of English Higher Education Institutions in the Innovation System: Knowledge Exchange and HEIF Funding, a report for HEFCE.

Knowledge Exchange (including collaboration) between academic and non-academic institutions/organisations can provide a number of very significant benefits to both parties including:

- Joint projects very often give access to extensive datasets/expertise/equipment that would be either impossible or very expensive to obtain individually.
- The opportunity to work with non-academic experts who have different working methods and ways of looking at research problems provides an important learning experience for both sides.
- Collaborations can lead to new funding opportunities, either by direct funding from the collaborating organisation(s) or funding from a range of sources aimed at promoting knowledge exchange activities.
- Successful collaborations can lead to a significant increase in the impact of the research.
- Potential benefits to teaching activities, including the development of student projects, access to case study materials for projects and practical classes, and opportunities to visit partner organisations as part of the students, career development.

Although there are many benefits of KE and collaborations, in the context of the Bloomsbury SET programme, there are potentially a number of barriers which should not be overlooked and are addressed in this report. Such barriers as cited by Abreu et al[1] could include:

- Lack of knowledge of potential partners, collaboration mechanisms and funding opportunities,
- Differences in research culture and language,
- Differences (or perceived differences) in research drivers,
- Financial constraints, Intellectual Property (IP) and confidentiality issues,
- Timescales, with universities often operating on significantly longer time scales than potential outside collaborators.

However, these barriers can be easily overcome by the collaborating parties being aware of such potential issues and addressing these prior to the commencement of a project.

1.4 Methodology

The stakeholders for this assignment were UK researchers but most importantly researchers and policy makers from East Africa (Kenya, Uganda and Tanzania), the recipients of UK-Africa collaborations.

The assignment has been conducted with a combination of desk-based study (publications, data-sets) and original fieldwork (e.g. semi-structured interviews and questionnaires) in East Africa. The interview and survey questions and the breakdown of respondents can be found in Appendices 1 and 2.

Although the field work was limited and restricted due to the Covid-19 pandemic, sufficient information was obtained to address the key questions listed in section 1.1 and to provide the necessary recommendations for the second part of the report.

2 General Overview of AMR

2.1 Introduction

Antimicrobial resistance is the ability of infectious organisms, including bacteria, to survive the agents designed to kill them and save patients from infection. Resistance can spread quickly across different bacterial species, from bacteria in animals to those in humans, and across national borders. As a result, many types of bacteria causing human illnesses have become resistant to multiple antibiotics, leaving healthcare professionals in all countries with few treatment options.

Healthcare systems until now have kept pace with antimicrobial resistance by means of introducing new antibiotics. This strategy worked well during the early years of the antibiotic revolution, but as resistance to more and more antibiotics developed, the pharmaceutical innovation engine has been unable to keep up. Over the past 25 years, while antimicrobial resistance has continued to rise, the number of new antibiotics has been in sharp decline, and 80 percent of the pharmaceutical companies that were conducting research and development in antibiotics have abandoned the quest due to unattractive returns[2].

The compounding effect of these two factors – increasing resistance to existing antibiotics and a slowdown of new antibiotics discovery – is that many bacterial infections today are very difficult to treat. A person contracting an infection caused by some of these "superbugs" has a 30-50 percent chance of dying[3].

The rise and spread of AMR is creating a new generation of 'superbugs' that cannot be treated with existing medicines. The impacts of leaving AMR unchecked are wide ranging and extremely costly, not only in financial terms but also in terms of global health, food sustainability and security, environmental wellbeing, and socio-economic development.

Already, AMR infections are estimated to cause 700,000 deaths each year globally[4]. This figure is predicted to rise to 10 million, alongside a cumulative cost of $100 trillion, by 2050 if no action is taken[4]. These figures make AMR a threat that public health officials, politicians, healthcare professionals, and the public can no longer ignore.

AMR is a global problem that impacts all countries and all people, regardless of their wealth or status. Resistant organisms respect no borders, neither geographical nor ecological: the organisms and their resistance genes can easily spread through movements of people, animals, food or water; and certain resistance genes can transfer from one species into another. This means that containing and controlling AMR requires coordinated national and international action across all stakeholders, including governments, international organisations, private businesses, investors, civil society, academia and philanthropy.

Low and middle-income countries are at higher risk of the emergence and spread of AMR due to the high burden of infectious diseases and factors such as poor water and sanitation, limited access to antibiotics, weak health systems and underdeveloped antibiotic stewardship[5, 6]. AMR could also affect LMICs by potentially undermining recent progress against global killers such as malaria, Human Immunodeficiency Virus (HIV) and Tuberculosis (TB) [7].

AMR Ecosystem – Humans, Animals & Environment

AMR is a complex and multi-sectoral issue spanning human, animal and environmental health, and social, economic and political factors and has been increased and accelerated by actions such as inappropriate use of antimicrobial drugs in healthcare; poor infection prevention and control practices; and non-prudent use of antimicrobial drugs in agriculture amongst other factors. In addition, the potential for AMR to spread rapidly across countries due to global travel, trade and migration, has transformed it into a major global challenge to international development[8].

To combat the threat to human health and biosecurity from antimicrobial resistance, an understanding of its mechanisms and drivers is needed. Emergence of AMR in microorganisms is a natural phenomenon, yet AMR selection has been driven by antimicrobial exposure in health care, agriculture, and the environment. An article by Holmes et al[9] summarised in table 2.1 below provides insights as to some of the reasons for the emergence of AMR and the inter-relatedness of transmission in humans, animals and the environment.

Table 2.1 Some reasons for AMR and the inter-relatedness of transmission in humans, animals and the environment.

Emergence of Resistance	
Why does resistance emerge within a micro-organism?	• The emergence of antimicrobial resistance is a natural evolutionary response to antimicrobial exposure • At a societal level, complex and interlinking drivers are increasing the prevalence of antimicrobial-resistant microorganisms, predominantly arising from use in human beings and agriculture and the pollution of the environment
Why does antimicrobial resistance emerge at the individual human level?	• Use of antimicrobials in clinical medicine has exposed the human microbiota to unprecedented high concentrations of these drugs
Why does resistance emerge at the population level in humans and animals?	• **Antimicrobials are among the most commonly prescribed drugs used in human medicine**, yet up to 50% of all antimicrobials prescribed to people are considered unnecessary • **This use, misuse, or overuse of antimicrobial drugs** is considered to be a **major driving force towards antimicrobial resistance** • Various studies have shown that antimicrobial resistance has, at least in part, emerged as a result of the selective pressure exerted by antimicrobial use outside of human medicine, namely in veterinary medicine, food-animal and fish production and agriculture

Transmission of Resistance	
How does human-human transmission drive resistance?	• Modelling of transmission dynamics has improved understanding of how human–human transmission contributes to the spread of pathogens and antimicrobial resistance • In the community, **faecal–oral transmission**, often through **failures in sanitation**, plays an important part, for example resistant Enterobacteriaceae • Transmission can also occur through **sexual encounters**; for example, for Neisseria gonorrhoeae, core groups have contributed to widespread dissemination of resistant clones • The dynamics of **transmission** are best understood is in the context of **health-care-associated infections**. Using methicillin-resistant Staphylococcus aureus (MRSA) as an example, modelling suggests **duration of patient stay** and **contamination of health-care workers'** hands both contribute to continuing transmission
What is the role of animals and the environment in driving transmission of resistance?	• The potential for **transmission of antimicrobial-resistant microbes from animals to human beings**, and the **association between use of antimicrobial growth promoters in farm animals** and transmission of resistant bacteria, were recognised in the 1960s • Antimicrobial resistance that arises in animal husbandry is now well established and affects zoonotic pathogens such as Salmonella serovars and Campylobacter spp the mechanisms of resistance are indistinguishable in bacteria isolated from animals or human beings • The contribution of the environment to antimicrobial resistance is also concerning • The **use of metals in agriculture** (for example when copper is applied directly as a bactericide or fungicide), and even natural occurrence of metals in certain geographical areas, **can select for resistance**; of more concern is that many metals co-select for antimicrobial resistance • The importance of **sewage and waste processing in environment–human transmission** is also clear. This stems from antimicrobials and antimicrobial metabolites entering not only from human waste processing, but also from pharmaceutical industry pollution

In summary, the worldwide acquisition, persistence, and transmission of antimicrobial-resistant microbes by people, animals, and the environment is hugely affected by a number of factors (figure 2.1), no access to clean water, open rather than closed sewage systems, variation in healthcare infection control practices, inadequate provision of antimicrobials and diagnostics, farming systems with suboptimum regulation of antimicrobials, and high population densities.

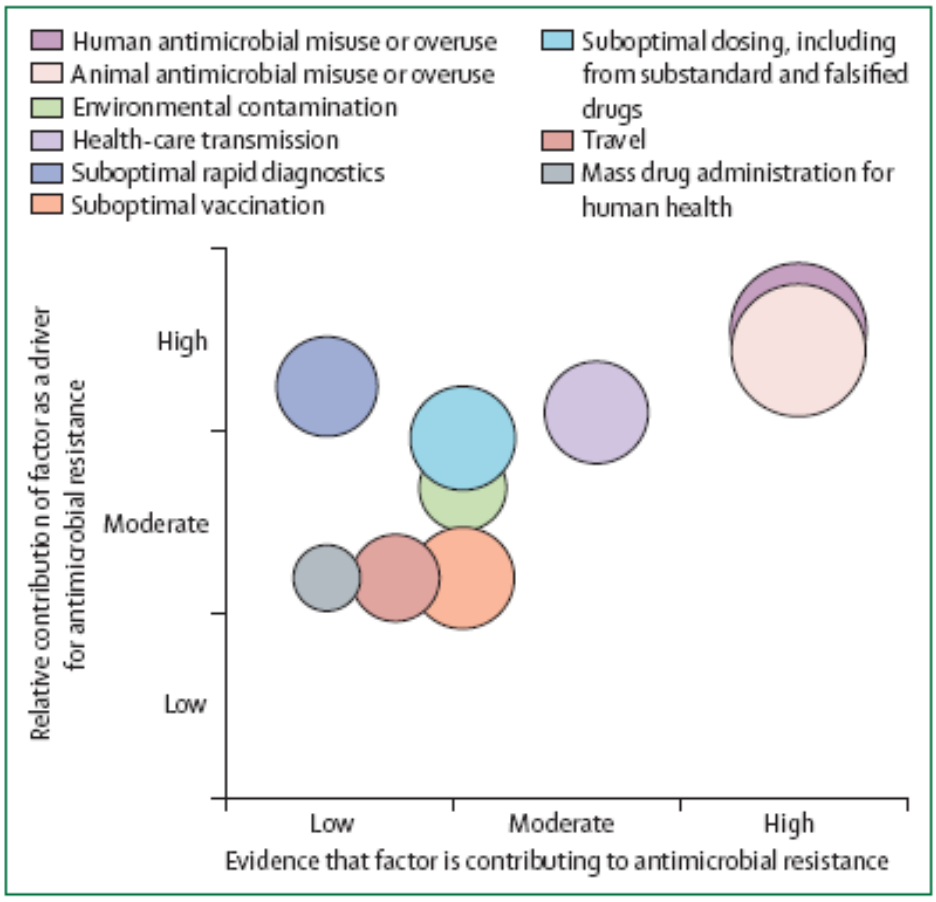


Figure 2.1: Role of modifiable drivers for antimicrobial resistance: a conceptual framework[9]

The infographic shows the considered potential contribution of each factor as a driver for antimicrobial resistance. Associated relative contribution, supporting evidence, and potential population affected (diameter of bubble) was created from a two round Delphi method of contributing authors. Factors were identified from review of the national and international antimicrobial resistance literature. The Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) approach was used to identify the quality of the evidence (the study with the highest GRADE estimate was cited) supporting each driver as being contributory to the rise in antimicrobial resistance[9].

Although some of these issues exist in high resource settings, they are likely to represent particularly important drivers of antimicrobial resistance in low-income and middle-income countries.

2.2 AMR Challenges and Solutions

To avoid the thousands of deaths and millions of illnesses, and to tackle the global AMR challenge that spares no region of the world, simultaneous and collaborative action between policymakers, healthcare professionals, industry and the public is needed along five fronts:

1. Awareness
2. Antibiotic conservation
3. Sanitation, hygiene, infection prevention and control
4. Surveillance and monitoring
5. Research and development

These areas have been highlighted as the key areas of focus by the World Health Organisation (WHO) [10] and many countries in both developed and developing countries follow these guidelines in the development of their National Actions Plans (NAP) for AMR.

2.2.1. Challenges

Awareness

Every time an antibiotic is used inappropriately, the development of resistance accelerates. Often, inappropriate use stems from behaviours by healthcare professionals, patients, pharmacists, public health officials, and the broader community. To curb inappropriate use, all stakeholders must be made aware of the severity of the antimicrobial resistance threat, the importance of their own actions, and encourage behaviour change.

Antibiotic conservation and stewardship

Antibiotics are necessary for the containment and management of infections with limited and appropriate use. The more they are used, the higher the chance that resistance will develop. Therefore antibiotics should be reserved for situations in which they are the most effective way to treat infection. However, lack of conservation is probably the leading root cause behind the antimicrobial resistance threat. To enhance conservation, stronger regulation aimed at limiting non-prescription use in humans and use for growth promotion in farm animals is needed. Regulation should be complemented with diagnostics and treatment protocols to foster appropriate use in the healthcare setting, and with communications campaigns co-ordinated with the broader awareness efforts described above.

Inappropriate antibiotic usage in the healthcare setting is severe in developed as well as developing countries.

Inappropriate antibiotic usage

- **United States: over half** of ambulatory care visits for acute respiratory infections **not needing antibiotic treatment** do actually **result in an antibiotics prescription**[11]

- **India and Kenya:** although the **treatment of choice for diarrhoeal disease** in children is **oral rehydration**, a **high proportion of children** with that condition are **treated with antibiotics**[12]

- **China:** a recent study in China found that **two-thirds of hospitalised patients** received antibiotics, when the rate of usage in other countries was **30 percent**[13]

Some reasons for inappropriate prescription of antibiotics

- Lack of knowledge
- Delay in laboratory results or lack of trust in them
- Desire to meet patient demand, and
- Economic incentives based on prescription volume instead of patient outcomes[13, 14]

Lack of stewardship: distribution/dispensing of antibiotics[15]

- In some countries, including Nigeria, Sudan, and Bangladesh, **nearly all antibiotics consumed** are apparently acquired **without a prescription**
- **Not only a developing country issue** - Italy, Spain and Greece, for example, have levels of over-the-counter non-prescription use that **approach 20 percent of the antibiotics** courses sold

Widespread distribution of counterfeit antibiotics[16]

- **5 percent** of antibiotics sold worldwide are **counterfeit**
- **28 percent** of all **counterfeit medicines** are **antibiotics**

Conservation of antibiotics not just a human use issue

- More than **70 percent of all antibiotic production** is probably destined for **animal use**[17]
- Most antibiotics for animals are **not used for therapeutic purposes**, unlike in humans – that is, to cure infection – but instead are **used to promote growth**
- The estimates are that almost **75 percent of all antibiotics** given to **animals** are **not used for treating infections**[18]

Sanitation, hygiene, infection prevention and control

Preventing and avoiding infections is a public health priority that has the additional benefit of reducing the need for antibiotics. This, in turn, preserves antibiotic efficacy by delaying the development of resistance. Sanitation and hygiene in the community and the food industry, together with infection prevention and control mechanisms in healthcare settings, are one of the most effective ways to prevent infection.

The sources of infections are varied and are of great concern such as:

- Those (sometimes already antibiotic-resistant) acquired in healthcare facilities and then transferred to the community.
- Infections in the community that transfer to the healthcare setting.
- Infections transmitted from farm animals to humans, and
- The contamination of the food chain with infectious bacteria.

In the above setting, healthcare facilities, farms, the food industry and the community behaviours are at the centre of the problem.

Hygiene and sanitation in the food industry and at the community level particularly in LMICs is a much bigger undertaking requiring serious government intervention in areas such as water quality, proper sewage and so on.

Surveillance and monitoring

The challenge of the antimicrobial resistance problem, its evolution, and the impact of efforts to reduce antimicrobial resistance is essential to shape interventions and manage performance. Surveillance of resistance and monitoring of antibiotics usage in humans, animals and agriculture are the main mechanisms to reach such an understanding.

Surveillance is often described as the set of activities aimed at tracking antibiotic resistance and supports guideline development and performance management. Monitoring, on the other hand, is the set of activities aimed at tracking the use of antibiotics in healthcare, animal husbandry and agriculture. In essence, surveillance is about measuring the output, and monitoring is about measuring the input.

Both surveillance and monitoring activities are undertaken at the local level, but they generate data that can be aggregated and interpreted at the regional, national, and global level. At the local level, surveillance and monitoring rely on effective data-collection systems that operate under common standards allowing for data aggregation and comparison. At higher levels, surveillance and monitoring become dependent on data analytics able to manipulate and visualise the data in a way that supports drawing insights and conclusions.

Without surveillance mechanisms, an outbreak could go undetected until it is too late to act.

At the global level, finally, effective surveillance can determine the source of new emerging "superbugs," and support containment in the event of an epidemic.

Research and development

Despite the clear need for new antibiotics, diagnostics, and vaccines, the current market incentives for research and development (R&D) in these areas are not attractive for large pharmaceutical companies.

Companies that have historically been active in this space are retreating due to low potential return on investment in R&D, limited public funding for microbiology, challenging regulatory requirements, small patient populations and low prices compared to other disease areas. As a consequence, there is a gradual reduction in the rate of new antibiotics introduction.

As the antimicrobial resistance threat is already causing a significant number of deaths across the world affecting all countries, it is essential that international collaborative efforts are pursued and supported to tackle the antimicrobial resistance threats.

As these antibiotics are gradually rendered obsolete by the emergence of resistance, it is absolutely essential that development of novel antibiotics should continue using a range of development and business models.

2.2.2. Solutions

The first step in tackling the antimicrobial resistance threat is raising awareness and understanding amongst all stakeholders making them fully aware of its existence, magnitude, and impact. This obvious first step is often neglected, in favour of an immediate engagement with the technical aspects of the solution. Without adequate awareness of the problem by healthcare professionals and administrators, politicians, scientists, agricultural producers and the community AMR cannot be effectively tackled.

Action to increase awareness among politicians, scientists, hospital administrators, healthcare professionals, agricultural producers, and the community.

Evidence from successful awareness campaigns suggests that successful action should include the following set of features:

- **Commitment and constancy over time, including funding** – behavioural change can take a long time.
- **Awareness supported by regulatory change** – incentives and enforcement accelerate behavioural change.
- **Campaigns with tailored messages directed to each target group**.
- **Use of the appropriate channels to reach each stakeholder group**.
- **Prominent figures as champions within each stakeholder group**.
- **A small group of fully dedicated people, measured on their impact** – planning and implementation of any campaign is a full-time job with the clear objective of changing behaviours in a measurable way.

Actions to improve conservation and stewardship

While potential solutions vary from country to country, strong national action is needed in all countries. Many developed countries have stewardship guidelines and recommendations in the healthcare setting yet lack proper enforcement. Some countries, despite prohibiting over-the-counter antibiotic sales, still have a high proportion of non-compliance. This situation is more acute in LMICs.

The difficulty is not in designing the solution but in implementing it in all the sectors of society involved. The solution itself is relatively simple, with the following key components:

- **Stronger regulation and mechanisms to enforce antibiotic conservation**:
  - Regulate sales of antibiotics, to ensure that they are dispensed only on valid prescription and are unavailable through over-the-counter sales.
- **Set up track-and-trace mechanisms to reduce counterfeits in the market**.
- **Enforce more stringent penalties and controls in regard to distributors and sellers of counterfeit antibiotics**.
- **Engage pharmacies and drug stores by making them responsible for enforcing the regulations at the point of sale**.
- **Impose a ban or control of internet sales of antibiotics.**
- **Ban the non-therapeutic use of antibiotics in agriculture and aquaculture** or, at a minimum, enforce testing and appropriate labelling of products containing antibiotic residues or derived from animals raised in the presence of antibiotics.
- **Diagnostics and treatment protocols to enforce appropriate use**.
- **Develop guidelines for appropriate treatment and prescription**; for example, guidelines on avoiding the use of antibiotics to treat viral infections, or guidelines on ensuring that the appropriate antibiotic is prescribed. In Thailand, the antibiotics 'smart use program' combined guidelines with patient awareness to reduce dramatically the level of inappropriate antibiotics prescriptions[19].
- **Awareness-raising for professionals, patients and consumers**[2].

Actions to improve sanitation, hygiene, infection prevention and control

While Awareness and Antibiotic Conservation and Stewardship are aimed at reducing the inappropriate use of antibiotics, one needs to remember that appropriate use too can also contribute to the development of resistance. Although the benefits of appropriate use of antibiotics far outweigh that risk, the ideal situation is the prevention and control of infection in the first place in healthcare and agricultural systems which reduces the requirement for antibiotics, and hence reduces the chance of resistance developing.

The action for sanitation, hygiene, infection prevention and control should begin with awareness campaigns at all stakeholder levels with guidelines and recommendations (see the Awareness section).

- **Establish infection control protocols and tracking mechanisms at the healthcare level**.
- **Educate the community**:
  - Encourage education in healthcare, schools, the workplace and other community setting.
- **Develop and enforce sanitary regulations for the food industry**.
- **Map progress on implementation of international prevention programs**.

Actions to improve surveillance and monitoring

At present, human pathogen surveillance and human antibiotics monitoring still reveal significant gaps, which compromise the usability and comparability of the data. The main problems are a lack of common standards for data collection, and the persistence of areas where no data collection is conducted at all, for either surveillance or monitoring, particularly in LMICs. The surveillance and monitoring situation in humans is unsatisfactory and could be said as critical in the case of animals where the collection and analysis of samples are even more fragmented

A concerted and collaborative international effort to exploit the existing infrastructure and standards could proceed along the following lines:

- **Standardise guidelines for data gathering**:
  - Leverage those that already exist and maximise their compatibility.
- **Co-ordinate national and regional interpretation and sharing of sales and usage data**:
  - Engage pharmaceutical companies, hospitals, clinics, pharmacies and veterinarian clinics to ensure data availability.
- **Develop a co-ordinated global surveillance and monitoring program**:
  - Harmonise standards across existing regional networks and develop capabilities to analyse, interpret and report results.

Actions to incentivise R&D

An alternative to R&D in antibiotics is R&D on new vaccines. This would have the additional benefit of reducing the need for antibiotics use, thereby extending the efficacy of the antibiotics that are still in use and being prescribed today.

The main challenge with the development of new antibiotics is the return on investment for the pharmaceutical industry which is particularly low in this 'drug' area. Therefore, there is the need to provide incentives for R&D or to develop alternative mechanisms in this area to address the return on investment concerns of pharmaceutical companies.

Possible approaches include the following:

- **Increase the price of antibiotics**:
  - This is potentially a difficult and relatively crude intervention as this raises affordability and access issues in LMICs, the groups that most need them.
- **Extend IP or patent protection** to reward the developer of a new antibiotic with a longer period of exclusivity and thus higher overall returns:
  - This would be a difficult proposition to implement.

The challenges and potential solutions for the management of AMR are complex and inter-related. Although the above issues are a global concern the subsequent chapters will further highlight the specific issues facing LMICs and how in albeit in a small way the Bloomsbury SET may contribute in addressing specific issues within the skillset of the four partners, RVC, LSHTM, LSE and SOAS.

3 Antimicrobial Resistance in Low- and Middle-Income Countries (LMICs) in Sub Saharan Africa

3.1 Introduction

In Chapter 2 we discussed the general challenges of and solutions to AMR management from a global perspective. In this section we will address specific issues and challenges facing LMICs in Sub Saharan Africa.

Antimicrobial resistance is widely acknowledged as a global problem, yet in many parts of the world its magnitude is still not well understood particularly in Africa and South East Asia.

Despite the threat presented by AMR, several reports describe significant gaps in surveillance, standard methodologies and data sharing [20, 21]. The 2014 WHO report identified Africa and South East Asia as the regions without established AMR surveillance systems[21]. This lack of quality data is a major problem often leading to treatment guidelines that are not adequate for the local situation. The gap in public health capacity is also an issue given the changing resistance mechanisms and the emergence of multidrug-resistant bacteria that can only be detected through continuous and systematic screening in quality assured microbiology laboratories [22, 23].

The AMR challenge facing Africa has been further highlighted by research carried out by Tadesse et al [24] which concluded that:

1. More than a third of the countries in Africa did not have recent AMR data published in the public domain and only a few of those were surveillance data.
2. A high level of drug resistance exists to commonly prescribed antibiotics on the African continent.
3. The standardisation and quality of the microbiological identification and susceptibility testing methods need to be significantly improved to allow national and international organisations to monitor the extent of the AMR problem.

Additional research[25] to exemplify point 2 above suggests that significant resistance has been reported for previously contained diseases such as cholera, dysentery, typhoid, meningitis, gonorrhoea, TB, malaria and AIDS.

3.2 Specific AMR Issues and Challenges in LMICs and Proposed Actions

The challenges facing LMICs in Africa are many, varied and complex and include some already described in chapter 2. However, the major ones that require urgent attention include[25]:

- The lack of comprehensive policies and plans to address AMR.
- Weak medicines regulatory capacity and circulation of substandard/ counterfeit antimicrobials.
- The lack of AMR surveillance strategies.
- Weak laboratory capacity on AMR testing and reporting:
    - lack of essential laboratory reagents and consumables,
    - limited quality assurance and control protocols.
- Inadequate access to basic health services coupled with shortages of essential medicines including antimicrobials in public health facilities which lead patients to look for other sources usually through illicit sources of supply (substandard/counterfeit medicines).

Work carried out by the WHO's Regional Office for Africa has proposed that in order to prevent and combat AMR, comprehensive national AMR policies, strategies and plans should be developed and implemented involving policymakers, partners and stakeholders in public health in LMICs. In addition, targeted capacity building activities should be pursued in various areas including AMR surveillance, laboratory services, quality control of test reagents and protocols, effective medicines regulation and the rational use of medicines.

Proposed Actions

Develop comprehensive national policies and plans to prevent and combat AMR

Within the context of national health and medicine policies, governments should develop and implement comprehensive AMR policies and strategies that take into consideration the AMR threat to public health so as to limit the emergence and spread of resistant germs.

Establish national and/or regional policy platforms for management of antibiotic resistance in countries

Countries and health systems in Africa differ and the various barriers specific to each country must be tackled. In order to initiate change in each country, detailed national/regional analysis of the situation on the ground by a multidisciplinary group including the agriculture and animal sectors is required.

Build clinical laboratory capacity

The majority of surveillance programmes are laboratory based. Strategies for ensuring and maintaining the quality of laboratory test results are critical to the value of surveillance initiatives. Facilities should have procedures for ongoing assessment of the quality of test reagents and test performance by clinical laboratory technicians. In addition to internal quality control practices, laboratories should also participate in national and/or external quality assurance (EQA) programmes. Building clinical laboratory capacity will enable the generation of adequate and reliable AMR data that can guide policy actions to combat AMR.

Improve antimicrobial surveillance systems by collecting and sharing information on AMR across networks of laboratories

Surveillance is the primary strategy for tracking emerging drug resistance in the population, thereby allowing for early and appropriate action. Countries should therefore strengthen their capacity for early detection and identification of resistant bacteria that cause diseases of public health importance. Antimicrobial resistance surveillance data help monitor the susceptibility patterns of microorganisms to antimicrobial agents. The regular dissemination of data should be utilised by public health policy-makers to revise the national AMR policy.

Develop a regional framework for collaborative surveillance of antibiotic resistance

A regional framework of collaborative surveillance of AMR could provide a standardised overview of the prevalence of AMR in many countries in a given region. The lack of this regional framework for collaborative surveillance of AMR is a key problem hindering information sharing for decision-making both at country and regional level.

Strengthen national medicines regulatory capacities in the African Region

Within different regions of Africa, example, East or West Africa, member States should establish effective national, regional and interregional cooperation and collaboration mechanisms including reinforcing regulatory networks and exchange of information among public health, law enforcement, professional associations, NGOs and other relevant authorities to improve prevention, detection, investigation and prosecution of cases related to substandard/falsely labelled/counterfeit medical products. This is essential as sub-standard practices in medicines regulation in one country could have spill over effects in a neighbouring country. The quality of medicines circulating within the national pharmaceutical markets should be monitored in order to prevent smuggling and use of substandard/counterfeit antimicrobials that may contribute to increasing AMR[26].

3.3 Status of AMR Management in Kenya, Uganda and Tanzania

This section will address the situational analysis of AMR in Kenya, Uganda and Tanzania with reference to two major organisations, the Fleming Fund and the WHO which are active in AMR management and support in East Africa.

Fleming Fund

The Fleming Fund launched in 2015 is a UK funded initiative to respond to the global threat of drug resistance due to AMR with a special focus on low- and middle-income countries.

The Fleming Fund addresses critical gaps in surveillance of antimicrobial-resistant bacteria in LMICs in Asia and Sub-Saharan Africa. Countries in these areas are set to bear the highest burden of drug resistant infections. A Global Action Plan on Antimicrobial Resistance (GAP-AMR) has been developed by the World Health Organisation (WHO), which acts as the blueprint for a multi-stakeholder global response to averting a global health crisis caused by AMR[27].

The Fleming Fund comprises a number of work streams (see **www.flemingfund.org** for more information). One work stream provides support to the Tripartite Alliance – the Food and Agriculture Organization (FAO), the World Organisation for Animal Health (OIE) and the World Health Organization (WHO) – as part of the One Health (OH) approach. Through funding to the Tripartite Alliance, the Fleming Fund has contributed to the development of National Action Plans (NAPs) in Sub-Saharan Africa, South and South East Asia, and to the building of the evidence base and guidance for AMR surveillance.

The main areas addressed by the Fleming Fund in LMICs and the investment areas and outputs are presented in tables 3.1 and 3.2 below:

Table 3.1 Problem statement addressed by the Fleming Fund

There are **too few trained microbiologists** to undertake the volume of testing required for representative surveillance on AMR.
There are **few health facilities that routinely undertake bacterial culture**; still **fewer facilities** that **meet the requirements for accreditation**, or which do routine antimicrobial susceptibility testing.
There is **no culture of surveillance for AMR in healthcare delivery** and there are barriers to developing it.
There is **little perceived use of surveillance data on any level**, including low demand for the data from policy makers.
There is a **lack of knowledge on the use and consumption of antimicrobial agents across One Health sectors.**
There is a **lack of antimicrobial stewardship**
Logistical challenges are significant: **transporting samples in a safe and secure manner** under challenging transport conditions; ensuring a quality assured and sustained supply chain for reagents and consumables; and ensuring appropriate servicing of equipment are a few examples.
Surveillance systems (national, regional and global) that do exist are often vertical in nature, are **not linked, and are not integrated.**
There are **weak One Health structures** and there is poor inter-sectoral collaboration.
There is a heterogeneous picture across countries and regions in terms of starting points, political will, capability, and donor interest and engagement.
There **are poorly defined and applied quality assurance standards** in laboratory testing.
There is a **lack of understanding on transmission patterns and drivers** such as inappropriate use of antimicrobial drugs across all sectors.

Table 3.2 Fleming Fund investment areas and outputs

Investment Areas	Resulting Outputs
Laboratory infrastructure enhancement.	Improved laboratory skills and conditions for bacterial identification and Antimicrobial Susceptibility Testing (AST); and, therefore, improved data quality.
Human resource strengthening and workforce reforms.	A Strengthened One Health workforce with a range of relevant skills for AMR surveillance
Surveillance systems strengthening.	Stronger AMR surveillance systems and processes at country and regional levels.
Building foundations for AMR surveillance data use.	Higher demand for AMR data at regional, country, subnational and facility levels.
Promoting rational use of antimicrobial medicines.	Better knowledge of country level patterns of prescribing practice and use of antimicrobials (particularly for bacterial infection) across sectors.

3.3.1 The current AMR situation in Kenya

This section is meant to provide a top line overview of the current status of AMR management in Kenya looking at a few key headings. More details could be found in the Fleming's Fund situational analysis on Kenya[28].

Policy and strategy environment/National Action Plan for AMR

- A National Situational Analysis was published in 2011, supported by the Global Antimicrobial Resistance Partnership (GARP), updated in 2016.
- A National Policy on Prevention and Containment of AMR was published in June 2017, identifying several policy issues which were incorporated as strategic objectives in the National Action Plan for the Prevention and Containment of Antimicrobial Resistance.
- The **NAP (2017 – 2022) was published in June 2017** supported by WHO, FAO, OIE, CDC and USAID.
- Creation of the National Antimicrobial Stewardship Interagency Committee (NASIC) the highest policy and governance body responsible for all AMR activities.
- **Five Technical Working Groups (TWGs)** have been established **to support implementation of the NAP**:
    - The AMR Surveillance and Research Technical Working Group has representatives from human health, animal health and other ministries, and has the primary responsibility for strengthening surveillance of AMR and AMU in animal and human health.
    - The other TWGs are for **Awareness and Advocacy**; **Regulation**; **Training and Guidance**; **and Infection Prevention and Control**. All will be expected to draw on AMR data to inform their activities and advice; however, capacity to do this is limited.
- Kenya is involved in **several networks and partnerships working on AMR**.
    - Wellcome programme (KEMRI).
    - Member of the Global Antibiotic Resistance Partnership (GARP) and the
    - Alliance for the Prudent use of Antibiotics (APUA) Chapter Network.
    - ReAct Africa, an independent multidisciplinary network which advocates for global engagement on AMR.

One Health

- Kenya is one of the top 20 countries for endemic zoonoses, partly due to poverty and the frequent human-animal interface. Kenya has a well-functioning zoonotic disease unit with clear terms of reference to support implementation of the International Health Regulations (IHR) 2005 and is in the process of updating the current Zoonotic Diseases Unit Strategic Plan (2012-2017) and the One Health Strategic Plan (2012-2017). However, neither of these directly addresses AMR.
- Recognising the need to harness and include all the data from different research institutes and activities carried out in Kenya on AMR, the ministries are exploring possibilities and are engaged in discussions to come up with structural partnerships with leading research institutes so that relevant AMR research data is incorporated into the national AMR surveillance system, for mutual benefit to the country and the different agencies.

AMR Surveillance – human health

- Some surveillance on AMR is underway in several sites by way of research programmes conducted by Universities with links to referral hospitals, but results are not reported through formal ministry channels.
- **A National Antimicrobial Resistance Surveillance Strategy (2018 – 2022) has been approved**.
- **Priority organisms have been identified** based on the WHO GLASS priority list and additional local priorities; roles and responsibilities have been identified, and surveillance quality and reporting standards have been agreed.
- The Joint External Evaluation (JEE) 20177 reported that although many of Kenya's 128 public health laboratories can detect and report AMR, **several major challenges** remain in the **implementation of the NAP and AMR strategy**:
    - These include **weak technical capacity**, **inadequate and inconsistent laboratory supplies**, **inadequate infrastructure in many hospitals**, and limited financial and material resources.
    - The JEE also noted that despite communication campaigns and efforts, there is still a **lack of clear understanding of the importance of microbiology in hospitals** by management and clinicians.
- The report **advised that technical capacity for the detection and reporting of AMR in laboratories needs to be improved**, especially at subnational level; and a **centralised laboratory surveillance reporting system is needed** (including establishment of a national database), covering the data from both public health and veterinary sectors.

AMR Surveillance – animal health

- Surveillance in animal health is under the direction of the Directorate of Veterinary Services of the Ministry of Agriculture, Livestock, Fisheries and Irrigation.
- A draft surveillance plan, including both active and passive surveillance for AMR and AMU in the agricultural sector, is in its final stages of adoption, although passive surveillance in AMR has not yet started.
- For active surveillance, in collaboration with the FAO, a pilot of the surveillance plan in poultry is in progress, focusing on Staphylococcus aureus, E. coli, and Salmonella spp.
- Kenya has also received support from the Fleming Fund through a grant from the FAO for a review of its legislation relevant to AMU in livestock and a baseline review of antimicrobial use in agriculture, including data on the veterinary medicines supply chain.
- Development partners engaged in AMR surveillance in animal health include FAO and OIE. **FAO was a key partner in developing the NAP and surveillance strategy** and has completed reviews of the legislative framework relevant to AMU, in the animal health sector.

Laboratory capacity – human health

- **Reference laboratory** at **National Public Health Laboratories Services** (NPHLS), and **seven public hospital laboratories** which have been designated as the initial sentinel surveillance sites for human health. These laboratories are at referral and teaching hospitals.
- The **microbiology laboratory at the National Public Health Laboratories (NPHL) is ISO accredited as a clinical laboratory** and for provision of proficiency testing. Currently its main workload is in providing services for outbreak investigation, mainly for diarrhoeal disease.

- Several staff members have Masters Degrees in microbiology and have had training in molecular biology techniques.
- The laboratory is generally well equipped, and space is adequate, and no major structural renovations are required.
- Data aggregation and analyses for the surveillance system will also take place at NPHL.
- An epidemiologist is in post, but more capacity building will be required.
- To fulfil its expanding role as an **AMR reference service, NPHL will need training and ongoing technical support to improve its capabilities** in confirming resistance phenotypes, determining AMR mechanisms, carrying out data analysis, and applying data to inform priorities.
- The **size and capacity of the surveillance laboratories vary** between sites; however, all are performing some culture work and several have automated blood culture instruments.
- **Biosafety and biosecurity** are generally adequate but will **require strengthening in terms of equipment, materials and staff training**.
- **Maintenance of equipment is also variable** between sites and will need strengthening.
- Some sites have reliable stock management systems, others have reported that procurement could take months, leading to long periods without stock.
- Quality of reagent depends on whether laboratories can procure directly from suppliers or are dependent on central procurement services.

Laboratory capacity – animal health

- There is a **reference laboratory** – **Central Veterinary Laboratories (CVL)** and **five surveillance sites**.
- All laboratories are currently performing bacterial culture, identification and AST to some degree, including milk for mastitis and post-mortem samples.
- There is **no comprehensive AMR surveillance system**, and testing is usually performed for diagnosis and outbreak investigation.
- None of the laboratories are participating in a proficiency testing scheme for AMR, and there is **no standardised QA/QC mechanism in place**.
- **Maintenance of equipment is a problem** due to **lack of budget for preventative maintenance** and **limited availability of biomedical engineers**.
- **Procurement of reagents and consumables** is usually via national procurement processes and is **often slow, leading to long periods of no reagents**.
- The quality of the purchased supplies is variable.
- Frequent power cuts and generator issues mean that surge protection will be needed to ensure reliable supply to critical instruments.
- **Biosafety and biosecurity** will also **need strengthening** for all the laboratories.

Appropriate use of medicines

- Pharmaceutical management is overseen by the Pharmacy Division at the Ministry of Health (MOH) Policy and the Pharmacy and Poisons Board (PPB) which has a mandate for human medicines, ensuring quality, safety and efficacy of medicines and advising the government on all aspects of drug regulation.
- In the human health sector, **dispensing antibiotics without prescription is illegal but occurs in practice: one study estimated that 70% of pharmacists dispensed antibiotics without a doctor's prescription** [29]. Self-medication is often driven by financial barriers to accessing formal healthcare.

- Among **healthcare workers in facilities**, there **is insufficient knowledge about appropriate use of antimicrobials.**
- The JEE **recommends more systematic implementation of existing treatment guidelines** and the **development of a training curriculum** for antimicrobial stewardship.
- There has also **been an AMR awareness campaign for hospital IPC teams** and **antimicrobial stewardship training modules are now included in the IPC training** course.
- The regulation for use and trade of medicines in animal health is undertaken by the Veterinary Medicines Directorate (VMD), a semi- autonomous government agency of the state department for livestock in the Ministry of Agriculture, Livestock Production, Fisheries and Irrigation. The VMD was recently established; therefore collaboration and knowledge exchange between PPB and VMD should be enhanced.
- With support from Standards and Market Access Program (SMAP), the directorate of **Veterinary Services has developed and published guidelines for the prudent use of antimicrobials in the livestock sector**.
- It is proposed that adherence to these guidelines will be compulsory by all registered veterinary surgeons and paraprofessionals and will be overseen by the Kenya Veterinary Board, which regulates and advises the government on all matters regarding animal health in Kenya.
- However, **these guidelines need to be published in adequate quantities and disseminated to the intended targets** for them to have the intended impact.
- In the **animal health sector, use of antimicrobials in farm animals is widespread, with 90% of use reported to be for therapeutic applications**[29] although this may, for some farmers, encompass prevention as well as treatment.
- More than half of the antimicrobials used are tetracyclines and sulphonamides. **Growth promotion has not been identified as an important source of antimicrobial use in livestock in Kenya**, and the level of usage in fisheries is currently unknown.
- As in human health, the **use of drugs for treatment is regulated by law, but enforcement and monitoring are inadequate.**
- Veterinarians in rural areas are scarce and the cost of their services are high, meaning that **farmers frequently purchase drugs without prescription**.
- Although legislation exists, in practice the capacity of both PPB and VMD to carry out effective regulation of outlets is very limited.
- There is currently **no national surveillance strategy for AMC or AMU in either the human health or animal health sector**. The MOH has participated in the WHO supported Global Point Prevalence Survey, and in 2018 the University of Nairobi carried out a Point Prevalence Survey in three public hospitals.

Fleming Fund Support for AMR Activities in Kenya

The Fleming Fund has supported a number of AMR activities in Kenya based on their funding criteria and guidelines and areas in Kenya requiring further development in the fight against AMR. One such grant [28] initiated in 2018 is shown in table 3.3 below:

Table 3.3 Scope of Fleming Fund 2018 Country Grant - Kenya

	Objective 1	Objective 2	Objective 3
	A strengthened One Health governance structure for AMR, AMU and AMC surveillance	**A strengthened AMR and AMU/AMC surveillance system in the human health sector**	**A strengthened AMR and AMU/AMC surveillance system in the animal health sector**
Output	• The NASIC functions effectively as the AMR National Coordinating Centre for surveillance in Kenya • The multi-sectoral AMR Surveillance and Research Technical Working Group provides technical support to the AMR surveillance systems in human and animal health • AMR, AMC and AMU surveillance results are shared with other technical working groups to inform their activities • National ownership and alignment of Fleming Fund activities with other inputs is ensured • The existing One Health AMR mentoring scheme is scaled up	• NPHL has increased capacity to function as a reference laboratory and supporting centre for AMR surveillance • The human health AMR surveillance system has improved capacity for data management • Sentinel laboratories function well and are included in an AMR laboratory network • Biosafety and security are ensured at the reference laboratory and at surveillance laboratories • All laboratories have adequate levels of quality assurance and control • Clinical staff at the surveillance sites demonstrate increased utilisation of microbiology services. • A sustainable specimen transportation system is developed and functional • An AMC/AMU surveillance strategy is developed and implemented	• CVL has the capacity to function as a reference laboratory and supporting centre for AMR surveillance • A national database of verified AMR data, with associated metadata, is maintained, data is analysed, and reports on AMR trends are produced • All the laboratories in the surveillance network produce reliable bacterial identification and AST results • Good quality samples from broilers and layers are regularly sent to laboratories from selected counties for culture and AST. • Biosafety and biosecurity are ensured at the reference and surveillance laboratories • Quality management system is improved to ensure reliable results • A sustainable specimen transportation system is developed and functional • An AMC and AMU surveillance strategy is developed and implemented

3.3.2 The current AMR situation in Tanzania

National Action Plan for AMR

- The Tanzanian **National Action Plan (NAP) on Antimicrobial Resistance (2017 – 2022) was launched in April 2017**[30] and was coordinated by the Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) (Pharmaceutical Services Unit) in collaboration with WHO and the Ministry of Livestock and Fisheries (MLF).
- The operational plan includes **10 priority activities to address five strategic objectives** that **align with the five priority actions in the WHO Global Action Plan on AMR**.
- A National **Multi-Sectoral Coordinating Committee (MCC) on AMR** is the **national steering body that oversees and coordinates all AMR related activities in all sectors**.
- Membership of the MCC includes representatives from human, animal, plant and environment health as well as livestock and food production. Membership also includes the Prime Minister's Office One Health Coordination Desk and development partners and international organisations including the World Health Organization (WHO), Food and Agriculture Organization (FAO), US Centres for Disease Control and Prevention (CDC), Management of Science for Health (MSH) and World Organization for Animal Health (OIE) plus representatives from medical and agriculture universities.
- The MCC is supported by a Secretariat which includes the national AMR focal points for the human and animal sectors.
- The **MCC has four technical working groups (TWGs)** which are mandated with specific tasks including providing technical input, conducting situational analyses and development of the NAP in collaboration with the MCC.
- The four TWGs are:
    - Awareness, effective communication and education;
    - AMR knowledge, surveillance, research and sustainable investments;
    - Sanitation, hygiene and infection prevention and control;
    - Antimicrobial use stewardship.

One Health

- A **One Health Strategic Plan was developed in 2015** with the support of the Cooperative Biological Engagement Program (CBEP) of the United States Department of Defence.
- The plan **aims to strengthen the institutional framework supporting One Health implementation to reduce the burden of zoonotic disease**. It does not include any reference to AMR. AMR is a late entrant in the One Health strategies at national level.

AMR Surveillance – human health

- Tanzania strategy for AMR surveillance in human health will be combined with those for Animal Health to form a **unified One Health strategy**. The surveillance plan is under active development. The plan aims to:
    - Conduct routine surveillance on WHO priority pathogens isolated from priority specimens of both in and out- patients.

    - Commence monitoring at each site with urine culture followed by blood culture, other sample type being added as required.
    - Determine antimicrobial susceptibility on WHO suggested antibiotics using either Clinical Laboratory Standard Institute (CLSI) or European Committee on Antimicrobial Susceptibility Testing (EUCAST) methods.
    - Report from the surveillance sites monthly to the national reference laboratory.
    - Report results systematically to clinical providers in the surveillance sites.
    - Produce annual summaries of the surveillance data.
    - Report results to GLASS.
- Tanzania has **several academic institutions which are centres of excellence in microbiology**:
    - **Muhimbili University of Health and Allied Sciences**, which is administratively separate from the Muhimbili National Hospital and has its own teaching hospital (at Mloganzila), which may support surveillance at both hospitals.
    - **Kilimanjaro Christian Medical Centre (KCMC)** in Moshi has a research wing Kilimanjaro Clinical Research Institute (KCRI) which hosts many national and international collaborations. KCRI is involved in consortia that have recently won two awards from the recent "AMR in a Global Context – Development Award" of the UK Medical Research Council.
    - **The Catholic University of Health and Allied Sciences** at Bugando Medical Centre in Mwanza is also a centre of excellence in microbiology in Tanzania with a strong publication record and interactions with the Southern African Centre for Infectious Disease Surveillance in Tanzania (SACIDS) in Morogoro.
- Tanzania has a strong CDC sponsored Field Epidemiology and Laboratory Training Program which has been operating since 2008. This ensures a supply of epidemiologists and laboratory technicians for analysis of surveillance data. However, there is a **lack of knowledge on antimicrobial resistance and its analysis** and this area will **need to be supported**.

AMU Surveillance – human health

- Tanzania is one of four pilot countries for trialling WHO's point prevalence survey tool to collect AMU data in hospitals.

AMR Surveillance – animal health

- There is **no formal surveillance system for AMR in animals** in Tanzania.
- A National AMR Surveillance Plan in food, agriculture and environment is currently being developed with the support of FAO.
- FAO launched a programme to support AMR and AMU surveillance in animals, with Fleming Fund support, in April 2017 at the same time as the NAP launch.

Laboratory capacity – human health

- The Tanzanian healthcare system is organised into a hierarchical system with national hospitals at the top followed by zonal then regional and district hospitals.
- The National Health Laboratory Quality Assurance and Training Centre **(NHLQATC) in Dar es Salaam is the designated national reference laboratory for AMR.** The **current role of the laboratory is to provide diagnostic and confirmation facilities**, to provide oversight and training to low-level facilities. It is **ISO 15189 accredited** by the

South African National Accreditation Service (SANAS) for culture and identification, a significant achievement.

- **NHLQATC provides a national external quality assurance (EQA) program** three times yearly to more than 40 laboratories nationwide.
- **NHLQATC conducts antimicrobial susceptibility testing (AST)** on samples collected during investigation of reportable disease outbreaks, but does not have an ongoing, sustained role in quality assurance of subordinate laboratories.
- NHLQATC does not yet routinely analyse AMR data and requires assistance to improve its capacity to undertake analysis.
- To take an **expanded role as reference laboratory to the AMR surveillance system NHLQATC would require additional personnel**.
- **NHLQATC laboratories are relatively well equipped** and possess adequate biosafety systems. However, they experience inconsistent supply of reagent and consumables and poor maintenance of equipment.

Laboratory capacity – animal health

- The Tanzanian Veterinary Laboratory Agency (TVLA) was established as an executive agency in 2012, merging the Central Veterinary Laboratory (CVL), the Tsetse and Trypanosomiasis Research Institute (TTRI) and the Veterinary Investigation Centres.
- The **Tanzanian Veterinary Laboratory Agency (TVLA) is mandated to undertake diagnosis of animal diseases, regulate veterinary laboratories, conduct research on animal diseases** and vectors, develop and produce vaccines and other biologicals and monitor animal feed quality.
- **TVLA offers laboratory diagnostic services** throughout the country with the **Central Veterinary Laboratory (CVL)** in Temeke, Dar es Salaam and 11 satellite laboratories.
- A national web-based Laboratory Information Management System (LIMS) links data from CVL and the zonal laboratories.
- **CVL conducts diagnostic testing, acts as a referral centre for the satellite laboratories and monitors the quality of animal feed.**
- The **CVL** has been **identified as the AMR reference laboratory** for the **animal health sector**. The **bacteriology laboratory** has **very experienced technicians** who can culture and identify the priority bacteria identified for AMR surveillance, with the exception of Campylobacter.
- The lab can reliably conduct antibiotic susceptibility tests (AST) but needs to more quality control support.
- The **bacteriology lab has not had investment for a very long time** and needs some internal **renovations to improve the workspace**, removal of non-functional equipment, a major tidy-up and reorganisation of the workspace, some new equipment, calibration and maintenance of existing equipment and a continuous supply of good quality reagents and consumables.

Fleming Fund Support for AMR Activities in Tanzania

The Fleming Fund has supported a number of AMR activities in Tanzania based on their funding criteria and guidelines and areas in Tanzania requiring further development in the fight against AMR. One such grant[31] initiated in 2017 is shown in table 3.4 below.

Table 3.4 Scope of Fleming Fund 2018 Country Grant - Tanzania

	Objective 1 A Strengthen One Health AMR and AMU surveillance	Objective 2 Strengthen AMR and AMU surveillance system in humans	Objective 3 Strengthen AMR and AMU surveillance system in food-producing animals
Output	• The multi-sectoral AMR Knowledge, Surveillance and Research Technical Working Group shares with the MCC and AMR stakeholders AMR and AMU surveillance and research outcomes that have been combined across multiple sectors. • MCC integrates the knowledge generated through multi-sectoral AMR and AMU surveillance into decisions that guide the overall AMR programme in Tanzania. • MCC shares AMR knowledge generated through multi-sectoral AMR and AMU surveillance both nationally and internationally.	• MOH AMR and AMU Surveillance TWG oversees and provides technical support to the AMR surveillance system in humans in accordance with an MCC-approved Terms of Reference. • Increased capacity of NHLQATC to perform its function as a national reference laboratory for AMR surveillance. • Surveillance site laboratories are strengthened for AMR surveillance • Enhanced capacity of the national coordinating centre and surveillance sentinel sites to collect, analyse, report and utilise data from AMR surveillance • Improved quality at all surveillance laboratories • Improved biosafety at all surveillance laboratories • Support a functioning AMU surveillance system at selected sites • Clinical staff at the surveillance sites are fully engaged in the surveillance	• Central Veterinary Laboratory (CVL) strengthened as an AMR national reference laboratory • CVL and other specified laboratories to produce reliable quality bacterial culture, identification and Antibiotic Susceptibility Testing (AST) results • Biosafety and biosecurity measures to be adopted within the surveillance laboratories • Good quality samples from broilers and layer hens to be regularly sent to CVL and the zonal laboratories in Mwanza and Arusha • A national database of verified AMR results and demographic data is maintained in at the CVL • TVLA shares quarterly and annual reports of AMR surveillance results with the MLF AMR & AMU Surveillance TWG • Directorate of Veterinary Services shares antimicrobial consumption (AMC) and antimicrobial use (AMU) data with the MLF AMR/AMU surveillance TWG and the zonal laboratories

3.3.3 The current AMR situation in Uganda

National AMR Landscape

- An AMR Task Force was constituted in 2014 overseen by the Uganda National Academy of Sciences (UNAS) on behalf of the Ministry of Health (MOH).
- In 2015, the Task Force, supported by the Centre for Disease Dynamics, Economics and Policy (CDDEP), together with the Global Antibiotic Resistance Partnership (GARP), conducted a situation analysis bringing together the relevant available evidence.
- **MOH provides the political leadership in responding to AMR challenges with support from other government departments including the Ministry of Agriculture Animal Industry and Fisheries, Water and Environment.**
- **Uganda launched its National Action Plan on AMR in 2018** modelled on the WHO and FAO global strategies to combat AMR.
- A **One Health Platform (OHP) has been created** with a memorandum of understanding between the ministries of Health, Agriculture Fisheries and Food, Environment, and the Uganda Wildlife Service. The OHP works in close collaboration with the AMR Task Force.
- The Uganda National Health Laboratory Services (UNHLS) is the laboratory technical arm of the Ministry of Health mandated with the stewardship of medical laboratory services, reference testing for specialised laboratory services and the National Microbiology Reference Laboratory (NMRL).
- A number of development partners are actively supporting AMR surveillance strengthening in Uganda, which is seen as key to the Global Health Security Agenda (GHSA). CDC, USAID and the US Department of Defence (DOD) of the Government in assisting with the GHSA and One Health initiatives.

AMR surveillance

- Several studies have been carried out to determine the extent of AMR in both humans and animals in Uganda.
- The **major causes of AMR have been documented** to be diverse but not limited to; **inadequate diagnostic infrastructure, limited enforcement of policy at the level of relevant professions, and inadequate regulatory instruments to effect change**. Overall, there is a **lack of adequate information, poor sensitisation of consumers, poor coordination of key strategic partners and misuse of antibiotics/antimicrobials in both humans and animals.**
- A number of studies including the study of Kajumbula et al. found that between **60 -100% of human isolates were resistant to the commonly prescribed antibiotics**[32].
- Public health research by Nansinyama[33] has postulated that the **widespread misuse of antimicrobials in the treatment of humans, and for agricultural use in production of fish and animals** has contributed to increased AMR which has been **compounded by a weak regulatory framework and few enforceable guidelines in Uganda**.
- The above findings were further supported by Mukonzo et al [34] who found that **40% of the patients that visited a healthcare facility** were **treated with an antibiotic** and there was **high over the counter dispensing of antibiotics in community pharmacies**.
- **Antibiotics for human and animal consumption are widely available** to the Ugandan public. For humans, they are **available from hospitals, pharmacies, licensed drug shops, and drug sellers**.

- **Limited human AMR surveillance** in Uganda.
- There are **no surveillance systems** for AMR in the microbiota of **livestock or other animals**.

Fleming Fund Support for AMR Activities in Uganda

The Fleming Fund has supported a number of AMR activities in Uganda based on their funding criteria and guidelines and areas in Uganda requiring further development in the fight against AMR. One such grant[35] initiated in 2017 is shown in table 3.5 below.

Table 3.5 Scope of Fleming Fund 2018 Country Grant - Uganda

	Objective 1 (One Health)	Objective 2 (One Health)	Objective 3 (One Health)
	National Action Plan on AMR launched and disseminated.	**AMR Platform and supporting secretariat established and making high-level decisions regarding AMR in Uganda.**	**A well-functioning One Health AMR/AMU surveillance governance structure established to provide technical support for the AMR Platform on AMR and AMU.**
Output	Completed	Completed	• Functional One Health AMR/AMU Surveillance Technical Working Group (TWG). • Terms of reference for the OH AMR and AMU Surveillance TWG to guide roles and responsibilities and reporting relationships. • Results of AMR and AMU surveillance activities collated and reviewed across all donor funded activities (including Fleming Fund, other donor-funded activities and university collaborations). • Reliable quality One Health AMR and AMU surveillance information reported to the AMR Platform to inform future surveillance priorities and policy. • Annual National OH AMR conference to present surveillance information, project updates and Fleming Fellowship updates

Table 3.5 Contd. Scope of Fleming Fund 2018 Country Grant - Uganda

	Objective 4 (One Health)	Objective 5 (Human Health)	Objective 6 (Animal Health)
	Increased collaboration between stakeholders to implement a One Health AMR surveillance programme.	**Establish a MOH-led system of collecting, collating, analysing, reporting and disseminating AMR and AMU data in alignment with the requirements of GLASS.**	**Strengthen AMR and AMU surveillance in animals**
Output	• Safe, secure and value-for-money transportation system for samples and isolates between human and animal surveillance sites and the reference laboratories for confirmatory testing from human and animal surveillance • National media preparation facility that prepares and distributes quality assured media to human and animal surveillance sites. • EQA system established for the UNHLS and National Animal Disease Diagnostics and Epidemiology Centre (NADDEC) reference AMR laboratories and the microbiology laboratories. • Test pilot system for documentation of antimicrobial consumption (AMC) and use data	• A Human Health (HH) AMR and AMU Surveillance TWG • A plan for the stepwise implementation of AMR and AMU surveillance in humans developed. • National guidelines for AMR surveillance systems in humans (both passive and active). • National clinical and laboratory guidelines and Standard Operating Procedures (SOPs), including standardised diagnostics and methodology for antibiotic sensitivity testing, developed. • Workshops, conferences, expert consultations, printing of handbooks and flowcharts, supply and distribution of the latest Clinical Laboratory Standard Institute (CLSI) guidelines or EUCAST system.	• A constituted, established, animal AMR and AMU Surveillance TWG with clear Terms of Reference, a well- defined strategy and a detailed AMR and AMU surveillance plan. • A population-based surveillance system in poultry and/or cattle to generate reliable data on resistance in specified priority zoonotic and commensal bacteria and antibiotics identified by WHO and the TWG. • NADDEC strengthened as the national AMR Reference Laboratory for the animal health sector. • Government microbiology laboratories comply with international biosafety and biosecurity standards. • Quarterly and annual reports of AMR trends for the zoonotic bacteria/antibiotic combinations in poultry and/or cattle • Volumes of antibiotic classes used by poultry and cattle farmers.

3.4 Tripartite AMR country self-assessment survey (TrACSS)

In 2015 a Global Action Plan on Antimicrobial Resistance (AMR) was adopted by all countries through decisions in the World Health Assembly involving the World Health Organisation (WHO), the Food and Agriculture Organisation of the United Nations (FAO) and the World Organisation for Animal Health (OIE). Countries agreed to have a national action plan on AMR that is consistent with the Global Action Plan, and to implement relevant policies and plans to prevent, control and monitor AMR. Since 2016/17 the annual monitoring country progress on AMR in line with the Global Action Plan has taken place. This survey is called the **Tripartite AMR country self-assessment survey (TrACSS).**

The questionnaire has 5 sections[36]. Section one asks for contact details and progress with multi-sectoral working on AMR and completing a multi-sectoral national action plan on AMR. The next sections cover progress on the first four strategic objectives in the Global Action Plan on AMR. The questions include human health, animal health and production aspects of AMR and in specific cases also address AMR as food safety concerns, plant production, and the environment.

The survey findings for Kenya, Uganda and Tanzania (2018/19) are presented below in tables 3.6 a-c with the full data in reference 37.

The findings have been presented on a scale of 1 -5 with **1 being least activity/developed** and **5 the most activity/development** for tables table 3.6a and b and **Yes and No** for table 3.6c. Please see reference 37 for the full details and descriptors.

Table 3.6a Tripartite AMR country self-assessment survey (TrACSS) for 2018/19 for Tanzania, Uganda and Kenya

Metric	Country and Measure*		
	Tanzania	Uganda	Kenya
Multi-sector and One Health collaboration/coordination	3	3	5
Country progress with development of a national action plan on AMR	5	4	5
Country progress on strategic objective: Improve awareness and understanding of AMR through effective communication, education and training.			
Raising awareness and understanding of AMR resistance risks and response	4	3	3
Training and professional education on AMR in the human health sector	4	3	3
Training and professional education on AMR in the veterinary sector	3	3	3
Training and professional education on AMR in farming sector (animal and plant), food production, food safety and the environment	1	1	2
Progress with strengthening veterinary services	3	2	4
Country progress on strategic objective: Strengthen the knowledge and evidence base through surveillance and research.			
National monitoring system for consumption and rational use of antimicrobials in human health	3	2	1
National monitoring system for antimicrobials intended to be used in animals (sales/use)	1	1	4
National monitoring system for pesticide use in plant production	1	1	1
National surveillance system for antimicrobial resistance (AMR) in humans	3	3	3
National surveillance system for antimicrobial resistance (AMR) in animals (terrestrial and aquatic)	3	3	4
National surveillance system for antimicrobial resistance (AMR) in food (animal and plant origin)	3	3	2

*** status of metric - 1 least activity/development and 5 maximum activity/development**

Table 3.6b Tripartite AMR country self-assessment survey (TrACSS) for 2018/19 for Tanzania, Uganda and Kenya

Metric	Country and Measure*		
	Tanzania	Uganda	Kenya
National AMR Laboratory network in animal health and food safety sectors: • **includes laboratories that process samples from food producing terrestrial and aquatic animals and from food.**			
Effective integration of laboratories in the AMR surveillance	2	2	3
Level of the standardization and harmonization of procedures among laboratories included in the AMR surveillance system	3	2	5
Relevance of diagnostic techniques used by laboratories included in the AMR surveillance system	5	3	4
Technical level of data management of the laboratory network in the AMR surveillance system	2	3	3
Country progress on strategic objective: Reduce the incidence of infection through effective sanitation, hygiene and infection prevention measures.			
Infection Prevention and Control (IPC) in human health care	3	1	4
Good health, management and hygiene practices to reduce the use of antimicrobials and minimize development and transmission of AMR in animal production (terrestrial and aquatic)	3	2	3
Good management and hygiene practices to reduce the development and transmission of AMR in food processing	3	2	3
Country progress on strategic objective: Optimize the use of antimicrobial medicines in human, animal and plant health.			
Optimizing antimicrobial use in human health	3	3	3
Optimizing antimicrobial use in animal health (terrestrial and aquatic)	3	1	3

*** status of metric - 1 least activity/development and 5 maximum activity/development**

Table 3.6c Tripartite AMR country self-assessment survey (TrACSS) for 2018/19 for Tanzania, Uganda and Kenya

Metric	Country and Measure		
	Tanzania	Uganda	Kenya
Which sectors are actively involved in developing and implementing the AMR National Action Plan?			
Human Health	Yes	Yes	Yes
Animal Health (terrestrial and aquatic)	Yes	Yes	Yes
Plant Health	Yes	No	Yes
Food Production	Yes	Yes	No
Food Safety	Yes	Yes	Yes
Environment	Yes	Yes	No
Is your country's national action plan on AMR linked to any other existing action plans, strategies or targets related to HIV, tuberculosis, malaria or neglected tropical diseases?			
HIV	No	No	No
Tuberculosis	No	No	No
Malaria	No	No	No
Neglected Tropical Diseases	No	No	No
Country policies and regulation on antimicrobial use.			
Laws or regulations on prescription and sale of antimicrobials, for human use	Yes	Yes	Yes
Laws or regulations on prescription and sale of antimicrobials, for animal use	Yes	Yes	Yes
Laws or regulations that prohibits the use of antibiotics for growth promotion in the absence of risk analysis	Yes	No	Yes

4 UK – Africa Collaborations in AMR

4.1 Review of UK – Africa AMR Collaborations

UK action at a global level to tackle AMR is driven by an underlying commitment to international collaboration, as made in its 2019–2024 AMR strategy[38].

AMR is a complex, multi-sectoral issue spanning human, animal and environmental health, and social, economic and political factors requiring One Health approaches to tackle it successfully. The UK is playing a leading role in tackling AMR internationally using a One Health approach[39], particularly in LMICs where AMR could reverse recent progress against diseases such as malaria, Human Immunodeficiency Virus (HIV) and Tuberculosis (TB) [7].

The UK Government supports AMR research through the UK Collaborative Development Research (UKCDR) initiative. UKCDR is a collaborative of Government and research funders working on international development with the core contributing members being:

- Department for Business, Energy and Industrial Strategy (BEIS)
- Department for International Development (DFID)
- Department for Health and Social Care (DHSC)
- UK Research and Innovation (UKRI)
- Wellcome

Other members include, Governmental departments such as the Foreign and Commonwealth Office (FCO), Department for Environment, Food and Rural Affairs (DEFRA), GoScience and the devolved Government administrations in the UK. Wider stakeholders include the UK and international research community, research funding delivery partners, the non-Governmental organisation (NGO) sector and private sector.

Examples of UK Government AMR funding initiatives for LMICs in general and a detailed review UK-Africa AMR collaborations are provided in Appendix 3.

5 Findings - Antimicrobial Resistance Management in East Africa

As outlined in chapter 1 the purpose of this report is to gain an insight into AMR management in Sub Saharan Africa with special emphasis on East Africa (Kenya, Uganda and Tanzania) from a UK and East African perspective.

Using a combination of interviews and questionnaires the following insights were obtained from key stakeholders in AMR management in the UK and East Africa (Kenya and Tanzania) including researchers, policy makers and funders.

5.1 Findings from the UK

Insights were obtained from researchers from the following institutions and disciplines.

Institutions	Disciplines
• London School of Economics • London School of Hygiene and Tropical Medicine • Royal Veterinary College • School of Oriental and African Studies • University of St Andrews • The University of Liverpool • Liverpool School of Tropical Medicine • University of Edinburgh • University of Glasgow • University of Strathclyde • UK Centre for Ecology & Hydrology	• Veterinary infectious diseases • Geography and Sustainable Development • Statistics in Biosciences • Epidemiology & Population Health • Development Anthropology • Animal Health & Food System Economics • infectious Disease Epidemiology • Environmental Health • Pathobiology and Population Sciences • Vaccine Epidemiology

Question:
What are the key AMR Management Issues in LMICs particularly in East Africa?

Responses:

- **Misuse of antibiotics is a big problem.**
    - Poor regulation in sale and purchase of drugs particularly in pharmacies
    - Informal sector easy to get drugs and antibiotics -slum markets etc
- Various aspect of **urbanisation a problem** in places like Nairobi, Arusha and Dar es Salaam.
- **Informal use of antibiotics in livestock and in patient care.**
- **Mass drug distribution/administration programmes** funded by donor agencies.
    - No tests/diagnosis before use and distribution – makes the situation worse
- **Stewardship is in a bad state** while access to safe and appropriate medicine is poor.
    - Use of antibiotics in animals is unregulated
- **Poor facilities for hygiene and sanitation** which contribute to driving environmental AMR.
- There is **no doubt that antibiotic stewardship is still a key area of concern**, with over the counter drug provision, informal drug markets and mismanagement of antibiotics.
- Access or restriction of access to drugs.
- **Poor routine surveillance in both animals and people.**
- **Inadequate livestock and human waste management.**
- The key AMR management issues in LMICs, particularly in East Africa, are the **lack of human and animal health infrastructure and health professionals**. There isn't enough access to medical care to keep people and animals healthy.
- **AMR is not the problem in LMICs. It is a symptom of problems with economic development, health, justice and education.**

Question:
Do UK funded AMR collaborative projects with Africa address the key issues on the ground in those countries?

Responses

- **Need to rationalise the investment decision and focus on needed projects.**
- Due to rapid development in these countries, many systems are not functional such as **Public Health systems which do not properly support some of the UK funded projects.**
- **Governments do not have control or resources to implement the outputs of a lot of projects.**
- Yes, in terms of training and upskilling but in terms of infrastructure and equipment no.
    - Good training provided, expensive equipment provided - **issue with this is poor maintenance of the equipment and poor quality assurance**
- **Monitoring and surveillance of AMR needed** but on the ground poor, more support required.
- **Some of the funds wasted** but pound for pound the teams on the ground (i.e. locals) are hard- working and produce a lot for the funds.
- In the main yes. However, the culprit are the poor systems which are not functional and sometimes leads to lack of implementation.
- With regard to technology and equipment no as sophisticated systems are sometimes recommended, simplicity is key.
- **UK funded programmes do not always address key issues** as there are lots of unanswered questions with respect to AMR in LMICs.
- **Funding calls can have very broad themes.**
- **Some recipients of grants in the UK have limited track record in areas of won grants.**

- Some programmes do and others don't. Some funding organisations and programmes have good models and are well structured with priority areas aligned to the needs of the country. Others are more haphazard in their activities.
- **Basic surveillance and monitoring information is lacking in East Africa for veterinary, livestock and aquaculture areas.**
- **Huge gap in data and questions in legislative, political and regulatory areas.**
- We've not found this kind of work in the UK adequately funded, so it's safe to say it's not funded adequately in Africa.
- I believe there **should be a strategic change in these projects to embed interdisciplinary work** (particularly using applied and social sciences) to support outcomes.
- To an extent, yes. Surveillance is being implemented by the Fleming Fund, though the delays, the lack of ambition in the scope of that programme and the administrative hurdles in implementation are problems.
- **Not enough UK and East African partner research going on**. Much more could be done.
- To the extent that UK funded AMR collaborative projects involve collaboration with African partners, they do help to address those issues in a small way. **Some GCRF funding calls allow for inclusion of LMIC collaborators or can even be led by LMIC collaborators**. **Others, for example in the past few years, have not allowed the inclusion of LMIC partners, which is both offensive and counterproductive.**
- Based on my experience, **UK funded AMR collaborative projects do help to build capacity in the medical and veterinary sector in East Africa**, e.g. by supporting laboratory set-up, staff training, enrolment of students on short courses, MSc or PhD programmes, etc. However, given the scale of the challenge, it often feels like a drop in the ocean.
- An area where **UK funded AMR collaborative projects may help to address key issues**, particularly socio-cultural issues, is in the **humanities and social sciences**, which are essential to understand drivers of human behaviour, including cultural, social and economic.
- **Projects tend to begin with a technical fix without adequate understanding of the problem.**
- Areas that **need more support are AMR prevention, access to education awareness and access to clean water.**

Question:

Which of the following AMR management activities should be prioritised for collaborative funding in LMICs in order of priority?
(1 – highest Priority and 5 – lowest priority)

- **Raising awareness of AMR and public health policy**
- **Antibiotic conservation in humans and animals**
- **Sanitation, hygiene, infection prevention and control**
- **Surveillance and monitoring**
- **Research and development**
- **Other** _____

Response:

The findings were inconclusive with respect to the above ranking criteria as the sample size was not sufficiently large. However, **Sanitisation, hygiene, infection prevention and control** and **Antibiotic conservation in human and animals** were the most highly ranked.

Question

What would be the most effective approach for Knowledge Exchange (KE)/ Knowledge Transfer (KT) between UK and LMIC in East Africa for the management of AMR?

Response

- **Capacity/knowledge building** – in some areas expensive equipment but no staff or properly trained staff.
- **Development of rapid diagnostics** to address front line diagnostics and to empower personnel particularly in rural areas.
    - Should be easy to use and inexpensive.
- Mixed approach where all the key elements are addressed in a joined up manner – awareness, local constraints (such as poor Public Health governance of Acts), lack of technical capability and capacity and infrastructure.
- **Need to understand the problem before the technical solution is presented.**
- More **engagement and understanding in public health, policy, social, ethnographic and political issues to understand what is needed**.
- Reframe what works and what does not work.
    - Implement strategies that work
    - Impart information and facts
- There should be a **focus on interdisciplinary projects.**
- There has to be an **organic development of skills and technology.**
- The word 'Aid' needs to be removed from the vocabulary and should be more collaborative and partnership projects.
- There needs to be a **contribution of 'Big Ideas' in AMR in LMICs, still too many unknowns.**
    - An international conference to address for example the 5 big questions in AMR in LMICs
- Joint actions for research and surveillance, collaboration between national authorities in the UK with East African governments for protocol implementation.
- **It is important for different projects to work together**. Some funding bodies in the UK do not support this approach.
- **KE is probably most effective through collaborative working of professionals, including doctors, nurses, pharmacists, veterinarians, drug shop owners and workers, hospital directors, teachers, and others**.
- KE must be contextualised and appropriate for the setting.
- KE requires the development of understanding of the professionals' position and their environment, through collaboration with human geographers, anthropologists etc.
- **For successful KE there is a requirement for social scientists, to understand the drivers of human behaviour and potential levers of behavioural change as part of the AMR project**.

5.2 Findings from East Africa (Kenya and Tanzania)

Insights were obtained from personnel from the following institutions and disciplines.

Institutions/Organisations
• Technical Work Group - National Action Plan on the Prevention and Containment of Antimicrobial Resistance (Kenya) • Ministry of Health (Kenya) • Global Antibiotic Resistance Partnership (GARP- Kenya), • KEMRI Wellcome Trust (Kenya) • International Livestock Research Institute (Kenya) • Ministry of Agriculture, Livestock and Fisheries (Kenya) • Ministry of Health (Tanzania) • Global Antibiotic Resistance Partnership (GARP- Tanzania) • PATH Kenya (Kenya)

KENYA

Question **Apart from the Fleming Fund programmes, do you know of any other UK-East Africa project collaborations in AMR with particular reference to Kenya?**
Responses • Many UK and other **initiatives focus on different areas of AMR management such as general AMR/food safety and there have been projects with institutions such as RVC and LSHTM**. • Initiatives target specific themes in AMR but all from a One Health perspective. • The **Kenyan government's National Inter Agency Committee** addresses the 5 objectives of the National Action Plan of AMR management and **support initiatives that address one of the 5 objectives.** • The Fleming Fund in general supports capacity building and surveillance in both human and animal health with the International Livestock Research Institute (ILRI). • The **Fleming Fund's key area of interest is in surveillance to obtain good quality data** to act upon, formulate policy and carry out active implementation. • **Pfizer has supported AMR surveillance and data analysis and sharing**. • Other programmes include the **Wellcome who are interested in surveillance and epidemiology**. • Fleming Fund was also involved in the initial development of the National Action Plan. • Initiatives such as the **CGIAR AMR Hub in Kenya** are a good development in that it focusses on the 5 objectives areas of the country's NAP. The Hub is led by **ILRI with input from KEMRI and other partners such as LSHTM**.

Question
If so, what form do these projects take – funding only, training, exchange of personnel, equipment, upgrading of facilities?

Responses
- Support in the form of **capacity building and training**.
- Support provided for the **implementation of the NAP**.
- **Provision of equipment** which are used for limited periods, then inactivity due to maintenance issues.

Question
Were such collaborations effective in terms of adoption and implementation?

Responses
- Current projects now effective for the following reasons:
    - **Consultative meetings with all stakeholders** to identify, gaps in knowledge with local team input.
    - Only **projects that are aligned with NAP deemed to be attractive**.

Question
Were there any barriers to adoption or implementation?

Responses
- Still instances where **collaborations are based on research interests of collaborators** and not needs of the host partners.
- **Processes now in place to mitigate 3rd party funders imposing their view in projects:**
    - Project has to fall within the framework of government policy on AMR
    - Supported projects have to be aligned with government focus and policy on AMR
    - Collaborating parties discuss areas of interests before projects are crafted and funded
    - Input & consensus from secretariat before projects start
- There are **normally issues with projects that require ongoing support following completion** for example the adoption of a new technical process requiring use of a particular equipment may falter due to the lack of maintenance of the equipment. This would then lead to abandonment of the process.

Question
In your opinion what type of collaborations would be the most effective – funding only, personnel training etc.?

Responses
- Combination of **funding, personnel training and exchange programmes.**
- Collaboration focussed on **public awareness and education, infection prevention and control and Research and development** as the other areas such as surveillance are addressed by the likes of the Fleming Fund and others.

Question
What is the capacity (research & technical skills) in AMR management in Kenya?

Responses
- **Capacity is lacking:**
  - Needs to be built up,
  - County hospital (second tier hospitals) personnel for example need to be trained to be able to deliver/provide QC/QA data,
  - Policy makers have no reliable data in the regions (outside the major cities) to set policies that would address semi-urban and rural areas.
- Research organisations such as KEMRI provide good data which directs policy to an extent. However, **more needed such as detailed situational analysis** – a comprehensive exercise in the way we look at AMR.
- **Data for only a few of the common infections** e.g. salmonella, E. coli available, but a huge lack of data for other common infections. We need more capacity and trained people to carry this out.
- **Research capacity is lacking** in the following areas:
  - Scientific writing and publishing
  - Sharing of knowledge and dissemination.
- **Research carried out in a few organisations** like ILRI and KEMRI. However, a general criticism is that **data from such labs is fragmented** and not effectively fed into a national database to inform policy.
- There is **limited or no access to data from private laboratories**.

Question
What is the infrastructure (facilities and equipment) like for AMR management in Kenya?

Responses
- Equipment & infrastructure extremely important across the 5 objectives of AMR NAP with infrastructure a particular issue.
- **Major challenges in labs of level 5 hospitals** i.e. county hospital of which there are about 12:
  - No QC,
  - Issue with the supply of quality materials – not reliable,
  - Issues with patient management,
  - Lack of infection surveillance and epidemiology,
  - Wrong media actively marketed.
- There is a **big issue in human health surveillance with only 17 sites in the country**. These surveillance sites are mainly in the bigger hospitals and cover very few regions of the country therefore we do not get an accurate view of the problem.
- There is **limited capacity regarding equipment and laboratories outside the major cities** and another challenge is ongoing maintenance.

Question
In your opinion what are the current knowledge gaps in AMR management in Kenya and East Africa as a whole?

Responses
- Biggest AMR gap - **Awareness which is critical**:
  - Public, professionals and AMR stewardship;

    - **Awareness of AMR issues still lacking in the mass population**:
        - Need complementary effort to address this issue,
        - Need to reach out to the next generation – young children, university students.
- **R&D knowledge gaps**:
    - Information on the economic perspective of AMR lacking,
    - Data quality addressed by the Fleming Fund,
    - Scientific writing and dissemination of scientific content.
- **AMR burden in animal health**.
- **Resistance patterns in animal health** – deaths attributed to AMR.
- **Knowledge attitude & practice of farmers**.
- Limited understanding of AMR in the crop/agricultural sector.

Question

What are the opportunities for strategic intervention for AMR in Kenya and East Africa?

Responses

- **Awareness Communication**:
    - Reach out to the next generation – young children, university students:
        - Use of antibiotics and stewardship which would present a long-term impact
    - Infection Prevention Control (IPC):
        - If properly implemented this could reduce infections by 55-60%,
        - Therefore, use for need of antibiotics reduced.
- **More R&D support**:
    - Need more research into the AMR burden in animal health. This issue if unresolved leads to loss in production and loss in livelihoods. As agriculture makes up approx. 20% of GDP of Kenya, AMR issues impact on the economy and livelihoods.
    - Keen to engage with research institutions to focus on specific research questions to inform policy.
    - Need for rapid diagnostic kits for specific diseases in the animal sector.
- Awareness Programmes - behavioural change communication.
- **Antimicrobial use, stewardship and communication**:
    - Stewardship of medicine/antibiotics by vets and veterinary pharmacists,
    - Disseminate information to professional,
    - Enhance the training curriculum for Vets and pharmacists,
    - Elicit behavioural change in the professions and clients.
- **Training and capacity building** - need to engage more people to understand the AMR challenge.
- Activities to focus of **better communication with farmers and lay people**:
    - Address farmers and lay persons attitude to elicit behavioural change. This requires a communication strategy,
    - Convey advice not to medicate their animals without professional advice.

- **Tools for diagnostics** needed:
    - Simplicity needed,
    - Tools for use in far flung, hard to reach areas with no accessible technology.
- **Early detection of infection** of patients require Point of Care platforms, this will be a paradigm shift.
- **Need very specific simple tools** that can be utilised with serum and plasma and also urine samples for Urinary Tract Infections (UTI) which are high on the list of pathogens of interest:
    - To directly or indirectly measure pathogens of interest.
    - This could address 60-70% of severe infections.

- A **combined approach**:
  - Increase in country capacity,
  - Increase in AMR networks,
  - Access knowledge and expertise from different platforms – local and those from abroad.
- **Public awareness, behavioural change and communication** badly needed for AMU. This could be done in conjunction with the Government's communication strategy and targeted at subset of the population.
- **Provide support in the development of AMU databases** which would help in the creation of guidelines and policies to fight AMR.

Question

What could you envisage as potential opportunities for the Bloomsbury SET collaborations in Kenya

Response:

See above response for strategic intervention – possible opportunities for the Bloomsbury SET

TANZANIA

Question

Apart from the Fleming Fund programmes, do you know of any other UK-East Africa project collaborations in AMR with particular reference to Tanzania?

Responses

- **HATUA is an acronym of Holistic Approach to Unravel Antibacterial Resistance in East Africa:**
  - University of St Andrews lead partner with other partners in the HATUA Consortium Makerere University, Uganda, Catholic University of Health and Allied Sciences (CUHAS), Tanzania, Kenya Medical Research Institute (KEMRI), Technical University of Mombasa, Kenya; National Museum of Kenya; Uganda Virus Research Institute (UVRI), Uganda; Kilimanjaro Clinical Research Institute (KCRI), Tanzania; East African Health Research Commission (EAHRC), Tanzania; Sanger Institute, UK and Brigham and Women's Hospital, Boston, USA.
  - The **project aims to explore the burden and drivers of antibacterial resistance associated with urinary tract infections (UTIs) across East Africa**. The project is funded by the National Institute for Health Research (NIHR), Medical Research Council (MRC) and the Department of Health and Social Care (DHSC).
- **SNAP AMR is an acronym of Supporting National Action Plan for Tanzania** and is a collaboration between University of Glasgow, KCMC Research Institution (KCRI), the Catholic University (CUHAS) in Mwanza, Nelson Mandela University and the Ministry of Health:
  - It is a **research collaboration with a focus on AMR Surveillance, antimicrobial consumption/use and awareness to the community**,
  - The project is funded by UK Department for international Development (DFID).
- **Antimicrobial stewardship project** in collaboration between Kilimanjaro Christian Medical Centre and University of Newcastle:
  - The project is funded by UK Department for international Development (DFID).

Question
If so, what form do these projects take – funding only, training, exchange of personnel, equipment, upgrading of facilities?

Responses
- Training:
    - e.g. under SNAP AMR & HATUA there are PhD and masters programmes,
    - AMR Laboratory capacity building,
    - AMC data training,
    - Antimicrobial stewardship training in the UK,
    - Procurement of vehicles and lab equipment.

Question
Were such collaborations effective in terms of adoption and implementation?

Responses
- Yes and No.
- For the stewardship projects yes because such programmes within hospitals have an implementation stage i.e. a sustainable programme that the hospital benefits from.
- For research based programmes no as they are not implementation projects. In most cases one-off projects.

Question
Were there any barriers to adoption or implementation?

Responses
- Yes
    - **Most of the projects are interested in antibiotics and not antimicrobial resistance** as per our NAP. In our local context resistance to fungi is also a challenge.
    - **A number of the projects are not a One Health approach**. The implementation is bias on the human sector; so the food production is lagging behind.
    - **Ethical clearance**, a need to have a Principal Investigator from Tanzania.

Question
In your opinion what type of collaborations would be the most effective – funding only, personnel training etc.?

Responses
- Capacity building on AMR and antimicrobial stewardship,
- Improve the infrastructure for AMR detection,
- Data management,
- IPC,
- Any collaboration must fall under the One Health approach.

Question
What is the capacity (research & technical skills) in AMR management in Tanzania?

Responses
- **Research technical capacity located in only a few institutions** mainly CUHAS in Mwanza, KCRI in Kilimanjaro, MUHAS in Dar es Salaam Sokoine University of Agriculture (SUA in Morogoro).
- The **research capacity is fragmented** so we need to have a national research agenda on AMR.

Question
What is the infrastructure (facilities and equipment) like for AMR management in Tanzania?

Responses
- There is **inadequate infrastructure and capacity for AMR surveillance**.
- Most of the hospitals **do not perform antibiotic susceptibility tests**.
- Under the Fleming Fund 4 tertiary hospital have been incorporated in AMR/AMU surveillance.
- The Infectious Disease Detection and Surveillance (IDDS) project under USAID is supporting AMR surveillance detection in 5 hospitals.

Question
In your opinion what are the current knowledge gaps in AMR management in Tanzania and East Africa as a whole?

Responses
- Laboratory capacity,
- Surveillance on AMR/AMU,
- AMR/AMU data management,
- Infection Protection and Control e.g. hospital acquired infection is still a challenge in our settings.

Question
What are the opportunities for strategic intervention for AMR in Tanzania and East Africa?

Responses
- **Political will**, **Deputy Minister for health** and the chairperson for the AMR Multi-sectoral Coordinating Committee (MCC) **very receptive to collaborations**.
- AMR Governance under One Health.
- Support with policies and guidelines on AMR e.g. National Action Plan on AMR, National AMR Surveillance Framework, policy on antimicrobial stewardship, regulations on antimicrobial use.
- AMR implementation projects like Fleming Fund project and other USAID funded projects.

Question

What could you envisage as potential opportunities for the Bloomsbury SET collaborations in Tanzania

Responses

Provide support to Tanzania's NAP

Strategic Objective 2:

- Strategic intervention 5.1. Develop a national multi sectoral agenda on AMR:
    - 5.1.1. Engage relevant stakeholders to identify current gaps in knowledge and potential research areas
    - 5.1.2. Develop national research guidelines on AMR
    - 5.1.3. Undertake research related to AMR

Strategic Objective 3

- Strategic intervention 6.4. Strengthening National Linkages and Partnerships for IPC:
    - 6.4.1 Engage the communities on implementation of personal hygiene and environmental sanitation
    - 6.4.2 Enforce the use of International Health Regulations (IHR) through Integrated Disease Surveillance and Response (IDSR) and existing bi-laws for the prevention of outbreaks
    - 6.4.3 Promote Food Chain Hygiene
- Strategic Intervention 9.1. Establish antimicrobial stewardship programmes

6 Discussion

AMR infections are estimated to cause 700,000 deaths each year globally with this figure predicted to rise to 10 million, alongside a cumulative cost of $100 trillion, by 2050 if no action is taken.

AMR is a complex and multi-sectoral issue spanning human, animal and environmental health, and social, economic and political factors. Containing and controlling AMR requires coordinated national and international action across all stakeholders, including governments, international organisations, private businesses, investors, civil society, academia and philanthropy.

To avoid the thousands of deaths and millions of illnesses, and to tackle the global AMR challenge the Tripartite of the WHO, OIE and FAO have provided 5 strategic objectives and guidelines to tackle AMR namely

1. Increased awareness
2. Antibiotic stewardship and conservation
3. Sanitation, hygiene, infection prevention and control
4. Surveillance and monitoring
5. Research and development

These guidelines have been adopted by both developed and developing countries in the development of their National Actions Plans for AMR. The possible actions to support the strategic objectives requires interventions from governments, the medical and clinical field, NGOs, funding agencies, research organisations, the various UN agencies and include the following:

Actions to increase awareness

- Raise awareness among politicians, scientists, hospital administrators, healthcare professionals, agricultural producers, and the community.

Actions to improve conservation and Stewardship

- Stronger regulation and mechanisms to enforce antibiotic conservation.
- Enforce more stringent penalties and controls in regard to distributors and sellers of counterfeit antibiotics.
- Engage pharmacies and drug stores by making them responsible for enforcing the regulations at the point of sale.
- Ban the non-therapeutic use of antibiotics in agriculture and aquaculture.
- Develop guidelines for diagnosis, appropriate treatment and prescription.
- Awareness raising for professionals, patients and consumers [2].

Actions to improve sanitation, hygiene, infection prevention and control

- Establish infection control protocols and tracking mechanisms at the healthcare level.
- Educate the community in hygiene and infection control measures.
- Develop and enforce sanitary regulations for the food industry.
- Map progress on implementation of international prevention programs.

Actions to improve surveillance and monitoring

- Standardise guidelines for data gathering.
- Co-ordinate national and regional interpretation and sharing of sales and usage data.
- Develop a co-ordinated global surveillance and monitoring program.

Actions to incentivise R&D

- Increase the price of antibiotics (potentially difficult).
- Extend IP or patent protection (potentially a difficult proposition).

Antimicrobial resistance is widely acknowledged as a global problem, yet in many parts of the world its magnitude is still not well understood particularly in Low and middle-income countries (LMICs). These countries are at higher risk of the emergence and spread of AMR due to the high burden of infectious diseases and factors such as poor water and sanitation, limited access to antibiotics, weak health systems and underdeveloped antibiotic stewardship.

The challenges facing LMICs in Africa are many, varied and complex. The major ones that require urgent attention include:

- The lack of a comprehensive policies and plans to address AMR.
- Weak medicines regulatory capacity and circulation of substandard/ counterfeit antimicrobials.
- The lack of AMR surveillance strategies.
- Weak laboratory capacity on AMR testing and reporting:
    - lack of essential laboratory reagents and consumables;
    - limited quality assurance and control protocols.
- Inadequate access to basic health services coupled with shortages of essential medicines.

Work carried out by the WHO's Regional Office for Africa has proposed that in order to prevent and combat AMR, comprehensive national AMR policies, strategies and plans should be developed and implemented involving policymakers, partners and stakeholders in public health in LMICs. In addition, targeted capacity building activities should be pursued in various areas including AMR surveillance, laboratory services, quality control of test reagents and protocols, effective medicines regulation and the rational use of medicines.

Status of AMR Management in East Africa (Kenya, Uganda and Tanzania)

The current status of AMR management in Kenya, Uganda and Tanzania is mixed according to the 2018/19 Tripartite AMR country self-assessment survey (TrACSS). This is an interesting survey as it provides an insight as to how individual countries view their progress in AMR management.

Progress on the main tripartite strategic objectives for the region i.e. East Africa ranged from average to below average as outlined below:

- Country progress on strategic objective: **Development of AMR National Action Plan – above average**.
- Country progress on strategic objective: **Improve awareness and understanding of AMR through effective communication, education and training – average**.
- Country progress on strategic objective: **Strengthen the knowledge and evidence base through surveillance and research – below average**.
- **National AMR Laboratory network in animal health and food safety sectors** (including laboratories that process samples from food producing terrestrial and aquatic animals and from food) – **below average**.
- Country progress on strategic objective: **Reduce the incidence of infection through effective sanitation, hygiene and infection prevention measures – below average**.
- Country progress on strategic objective: **Optimise the use of antimicrobial medicines in human, animal and plant health – below average**.

Individually Kenya, Uganda and Tanzania were **above average** for two, one and two respectively of the above metrics.

Collaboration between UK and Africa to support AMR

UK – Africa AMR support occurs in various forms ranging from direct UK Government support, indirect UK Government support via UK research councils or other government initiatives or through NGOs or Charities. All forms of support include the technical input and expertise from UK universities, research, clinical and medical organisations.

The UK is also involved in EU and international AMR research collaborations through other initiatives including UK Research and Innovation (UKRI) for example supporting the National Action Plan for AMR for Tanzania.

One UK Government initiative is the UK Collaborative Development Research (UKCDR) initiative. UKCDR is a collaboration of government and research funders working on international development with the main contributing members being the Department for Business, Energy and Industrial Strategy (BEIS), Department for International Development (DFID), Department for Health and Social Care (DHSC), the UK Research and Innovation (UKRI) and Wellcome.

Another high-profile initiative from the UK Government that supports AMR collaborations in Africa is the Fleming Fund which was launched in 2015. The Fleming Fund was formed to addresses critical gaps in surveillance of antimicrobial-resistant bacteria in low- and middle-income countries (LMICs) in Asia and Sub-Saharan Africa. This fund has a particular focus of addressing the following problems in LMICs:

- too few trained microbiologists to undertake the volume of testing required for representative surveillance on AMR,
- too few health facilities that routinely undertake a wide range of bacterial tests and meet the requirements for accreditation,
- no culture of surveillance for AMR in healthcare delivery,
- little perceived use of surveillance data on any level,
- lack of knowledge on the use and consumption of antimicrobial agents across One Health sectors,
- lack of antimicrobial stewardship,
- lack of surveillance systems and systems that are not linked, and are not integrated,
- weak One Health structures,
- poorly defined and applied quality assurance standards in laboratory testing,
- lack of understanding on transmission patterns and drivers.

The Fleming fund is currently active in Kenya, Uganda and Tanzania supporting these countries in developing surveillance systems for human and animal diseases and providing guidance in antibiotic conservation and stewardship.

As part of our survey we reviewed 28 UK-Africa collaborations mainly with a geographic focus on East Africa (chapter 4 and Appendix 3)

- Antimicrobials in Society (AMIS): A Global Interdisciplinary Research Hub
- Convergence in Evaluation Frameworks for Integrated Surveillance of AMR (CoEval-AMR)
- Umoya Omuhle: IPC for Drug-resistant Tuberculosis in South Africa
- Commonwealth Partnerships for Antimicrobial Stewardship – Overview

- Commonwealth Partnerships for Antimicrobial Stewardship Ghana
- Commonwealth Partnerships for Antimicrobial Stewardship Uganda
- Commonwealth Partnerships for Antimicrobial Stewardship Tanzania
- MRC Centre for Global Infectious Disease Analysis
- MRC Centre for Genomics and Global Health
- Comprehensive Resistance Prediction for Tuberculosis: an International Consortium
- The Fleming Fund, to Tackle the Growing Threat of Antimicrobial Resistance
- Holistic Approach to Unravel Antibacterial resistance in East Africa (HATUA)
- IPC – ABS to Avert Antibiotic Resistance in High-Risk Populations from Resource-Poor Settings
- Partnership for a Cross-disciplinary Approach to the Ecology of Antimicrobial Drug Resistance in Kenya
- Drivers of Resistance in Uganda and Malawi: The DRUM Consortium
- Changing Food Systems in Kenya and Malawi and the Challenge of Tackling Antimicrobial Resistance
- One Health capacity building in sub-Saharan Africa
- Antimicrobial resistance as a social dilemma: Approaches to reducing broad-spectrum antibiotic use in acute medical patients internationally
- Supporting the National Action Plan for Antimicrobial Resistance (SNAP-AMR) in Tanzania
- NEAR-AMR: Network of European and African Researchers on Antimicrobial Resistance
- Uganda: Professional Fellowship
- Towards controlling antimicrobial resistance in global aquatic animal food systems by enhancing collective resilience (AMFORA)
- Tanzania: Country Grant
- South Africa-UK Antibiotic Accelerator Initiative
- An integrated approach to tackling drug resistance in livestock trypanosomes
- Bridging antimicrobial resistance knowledge gaps: The East African perspective on a global problem
- Economic Evaluation support to a trial that assess strategies to address anti-microbial resistance in malnourished children (FLACSAM)
- Professional Diploma in Tropical Medicine & Hygiene (East African Partnership)

The above collaborations involved stakeholders from both the UK and East Africa - including universities (St Andrews, Edinburgh, LSHTM, RVC, University of Nairobi) research organisations (MRC, KEMRI, ILRI, African Health Research Institute AHRI), international funding agencies (Gates Foundation), funding councils (UKRI, ESRC), NGO's government departments (Ministries of Health, Kenya and Tanzania) and hospitals (Kenyatta Hospital, Cambridge University Hospital, Mulago National Referral and Teaching Hospital), International health organisations (UN and WHO.)

Of the collaborations reviewed there were 8 AMR stewardship projects, 2 Infection Prevention and Control, 2 AMR training programmes, 1 AMR in malnourished children, 1 AMR in livestock, 1 AMU in fish farming, 7 AMR surveillance, 1 Antimicrobial drug discovery, 1 Biological, social and cultural drivers of AMR, 1 One Health training, 1 Human behaviour and antibacterial usage, 1 Bacterial transmission in the food chain and 1 AMR strategy development.

Collaborations seemed to focus on antimicrobial stewardship and AMR surveillance. This is not surprising as the WHO and the tripartite have this is a priority for LMICs and is also a focus of the

Fleming Fund. This presents an opportunity for the Bloomsbury SET to explore other areas although important in the fight against AMR that have not been as high profile as AMR surveillance.

The desk-based review provided a snapshot of the type of AMR collaborations between the UK – Africa and in particular East Africa (Kenya, Uganda and Tanzania). However, to get a more in depth insight about the state of such collaborations and AMR management in East Africa interviews and surveys were conducted with key stakeholders in the UK, Kenya and Tanzania.

The stakeholders included researchers from the UK and researchers, policy and government officials from Kenya and Tanzania.

Many Challenging Issues of AMR management in East Africa

Significant issues were raised about AMR management in East Africa from both UK and East African stakeholders. There was the widely held view particularly from the UK stakeholders that although AMR is a global issue the specific issues in LMICs is a symptom of problems with economic development, health, justice and education in these regions.

The areas of greatest concern for all stakeholders were:

- The **misuse of antibiotics and poor stewardship** in both human and animal setting. Poor regulations in the sale and purchase of antibiotics and the ease of obtaining such drugs particularly from the informal sector were cited as a major issue.
- **Mass drug distribution and administration programmes** funded by donor agencies. This was of particular concern to the UK stakeholders as these programmes in their opinion made the situation worse as these drugs were handed out without tests or diagnosis carried out before distribution.
- **Poor facilities for hygiene and sanitation** which contributes to driving environmental AMR. From an East African context, various aspects of **urbanisation are problem** in places like Nairobi, Arusha and Dar es Salaam where hundreds of thousands of people move from rural areas to live in slums (e.g. Kibera in Nairobi) with little or no hygiene and sanitation facilities.
- **Inadequate livestock and human waste management** linked to the above point.
- **Poor routine surveillance in both animals and people** which in effect means if you don't know the extent of the problem it becomes nigh impossible to come up with solutions for its mitigation.
- **Huge gap in data and questions in legislative, political and regulatory areas** which adversely affects and undermines the country's AMR agenda and strategy.
- **Lack of human and animal health infrastructure and health professionals**. There is not enough access to medical care to keep people and animals healthy.

Some collaborations are effective while others are not

The effectiveness of collaborations has been assessed from the perspectives of the effective use of the funds and project implementation.

- The stakeholders from both the UK and East Africa thought that in the main the collaborations were effective with respect to use of funds. However, some funds were wasted but pound for pound the teams on the ground produced a lot for the funds.
- **Reasons cited for ineffective use of funds** in some AMR collaborations are a) some **funding calls have very broad themes** and b) **some recipients of the grants in the UK have limited track record in areas of won grants** which compounds the problem.
- Other reasons for **project ineffectiveness** were the **poor systems in the host country** which are sub-functional and sometimes **lead to lack of implementation of project outcomes**. It is therefore essential that pre-proposal and definitely pre-project commencement, implementation risk analysis is carried to assess whether outputs of the project would be adequately implemented by the recipient country.
- In **Kenya and Tanzania collaborative projects** are now increasingly **becoming effective** as a **result of pre-proposal and pre-project due diligence** carried out i.e. consultative meetings with all potential stakeholders to identify the gaps in knowledge with significant input from local teams. Only **projects that are aligned** with the respective **Government's AMR strategy or National Action Plan** are **supported by the government**.
- Collaborations based on **capacity building with clear objectives** have been **successful**. However, those that require ongoing support from the recipient countries tend to sometimes stall such as those involving facilities and equipment provision. Maintenance of equipment following installation is a major issue which in many instances have resulted in successfully implemented projected abandoned.

UK - East Africa (Kenya, Uganda and Tanzania) AMR collaborative projects only partly address the key issues on the ground in those countries

- There was the view that **UK funded programmes did not always address key issues** on the ground and the immediate needs of the recipient country. The stakeholders in Kenya and Tanzania stated that all current projects particularly those supported by their respective governments have be to aligned with the country's AMR strategy and provide support to further those aims and objectives. A good beacon of this practice is the **Fleming Fund programmes** in **Kenya**, **Uganda and Tanzania** which are **aligned** with the **AMR strategic objectives of those countries.** The Fleming Fund in general supports capacity building in antibiotic stewardship and surveillance in both animal and human health.
- The AMR challenge faced by LMICs is such that UK – Africa collaborations are part of the solution and will never be the complete solution. Therefore, addressing small components aligned with the individual countries AMR strategy contributes to the bigger solution.

- The range of projects identified in the review supports the view that certain elements of need in East Africa are met in part by the collaborative projects.
- UK funded AMR collaborative projects were found to **help to build capacity in the medical and veterinary sector in East Africa**, e.g. by supporting laboratory set-up, staff training, enrolment of students on short courses, MSc or PhD programmes, etc.
- Some of the collaborative projects were perceived to begin with a 'technical fix' without adequate understanding of the problem. This view was raised a number of times by some of the stakeholders. There **should be a strategic change in such projects to embed interdisciplinary work** (particularly using applied and social sciences) to support outcomes. It is therefore essential for this issue to be urgently addressed. However, the 'technical fix' problem does not now happen as often as in the past with recipient countries if their Government is involved as projects have to be aligned with their AMR strategy. For example the **Kenyan government's National Inter Agency Committee** addresses the 5 objectives of the National Action Plan of AMR management and support **initiatives that address one of the 5 objectives.**

Many collaboration challenges – pre and post project

- The main challenges of collaboration tend to happen at the pre and post project stages. We have already addressed pre-project issues such as the 'technical fix' before fully understanding the problem. Although this happens to a less extent in East Africa with collaborations involving the recipient governments it still happens with academic led projects. However, the involvement of multidisciplinary teams at the project proposal stage will be a mitigating factor.
- Another challenge in collaborations is linked to the already mentioned project effectiveness. On completing such projects, implementation can be an issue as some of the necessary systems such as the Public Health systems do not properly support some of the projects outcome. In essence some of the Governments do not have the resources to implement the outputs of a lot of projects.
- There is also the contentious issue although not so much now of instances where **collaborations are based on the research interests of collaborators** and not the needs of the recipient partners. For example, in Tanzania a number of collaborative **projects are interested in antibiotics and not antimicrobial resistance** which is a key objective in the country's National Action Plan.
- There are **normally issues with projects that require ongoing support following completion** for example the adoption of a new technical process requiring use of a particular equipment may falter due to the lack of maintenance of the equipment. This would then lead to abandonment of the process.
- A challenge for UK collaboration with Tanzania termed 'ethical clearance' requires the need to have a Principal Investigator from Tanzania as part of any Government supported collaborative project to ensure that the project aims and objectives are aligned to the country's AMR strategy and NAP.

The knowledge gaps

- Stakeholders in Kenya and Tanzania cited many knowledge gaps with general **AMR awareness and AMR stewardship** being the most critical particularly amongst the public and professionals. There was the view that the awareness of AMR issues was lacking in the mass population with the need to reach out to the next generation, school children and university students.

- Other knowledge gaps mentioned were in **R&D** with specific reference to the lack of Information on the economic impact of AMR, Scientific writing and dissemination of scientific content, AMR burden in animal health, resistance patterns in animal health (i.e. deaths attributed to AMR), Knowledge attitude & practice of farmers and limited understanding of AMR in the crop/agricultural sector. Areas such as surveillance and monitoring of AMR cited as a knowledge gap is been adequately addressed by programmes such as the Fleming Fund.

The capacity (research and technical skills) is variable in Kenya, Uganda and Tanzania

- **Capacity is lacking in all countries with respect to research and technical skills in AMR management and needs to be increased.** This is most lacking in hospital and clinical testing laboratories settings.
- The **lack of reliable data from different regions of the countries** (outside the major cities) makes it difficult for policy makers to set out AMR policies that would address semi-urban and rural areas.
- In Kenya quality research is carried out in a few organisations like ILRI and KEMRI which provide good data that directs policy to an extent. In Kenya there is **data for only a few of the common infections** e.g. salmonella and E. coli and no available or limited data for many of the other common infections. Additional capacity and trained people are required to address such issues.
- Stakeholders in Kenya have suggested that **more support is needed such as detailed situational analysis** – a comprehensive exercise in the way we look at AMR.
- In Tanzania as with Kenya **research technical capacity and expertise** is **located in only a few institutions** mainly CUHAS in Mwanza, KCRI in Kilimanjaro, MUHAS in Dar es Salaam Sokoine University of Agriculture (SUA in Morogoro). The **research capacity is fragmented** therefore there is a need for a national research agenda on AMR.
- Research and technical capacity are also lacking in the areas of scientific writing and publishing, sharing of knowledge and its dissemination.

The infrastructure (facilities) issues in the host countries

- Infrastructure and equipment are extremely important across the main objectives of AMR NAP of Kenya, Uganda and Tanzania with infrastructure a particular issue. For example **in Kenya there are many challenges in the laboratories of level 5 hospitals** i.e. county hospital of which there are about 12. Challenges include, **lack of QC, reliable supply of quality reagents and materials**, **issues** with **patient management**, **infection surveillance, epidemiology studies** to name a few.
- Also in Kenya there is a big issue in human health surveillance with only 17 sites in the country. These surveillance sites are mainly in the bigger hospitals and cover very few regions of the country therefore Public Health do not get an accurate picture of outbreaks when they occur.
- In general in Kenya, Uganda and Tanzania there is **limited capacity regarding equipment and laboratories outside the major cities** and another challenge is ongoing maintenance. There is inadequate infrastructure and capacity for AMR surveillance although the Fleming Fund programme is addressing this in Kenya and Tanzania.

Conclusion

There are wide ranging collaborations involving the UK and the East African countries of Kenya, Uganda and Tanzania in AMR management. The East African countries now have a focus on projects that support their AMR strategy and NAP. The Fleming Fund a major UK initiative to support AMR in LMIC has a main focus on AMR surveillance, monitoring and antibiotic conservation in both human and animals.

Progress in AMR management in all three countries has improved over the past 5 years. However, there are many areas that are still below average according to the Tripartite AMR country self-assessment survey (TrACSS). These and other areas not currently supported by the UK or other collaborative projects present opportunities for the Bloomsbury SET and will be addressed in the Foresight report.

7 Foresight Study - Knowledge Exchange Opportunities for the Bloomsbury SET in East Africa

7.1 Introduction

The purpose of this section of report is to identify opportunities for strengthening UK collaboration with countries in East Africa for knowledge exchange relating to combatting infectious diseases in humans and animals, and antimicrobial resistance.

In the first part of this report a mapping exercise was carried out to assess the state of UK-Africa collaborations in AMR management. As part of our survey we reviewed 28 UK-Africa collaborations mainly with a geographic focus on East Africa (Kenya, Uganda and Tanzania).

This part of the report will be structured as follows: a statement of the findings of the first part of the study, i.e. areas of AMR that have identified as either lacking, not currently well supported in East Africa or have been suggested as areas of interest from East African stakeholders. The skill set and expertise of the Bloomsbury SET will be briefly reviewed and finally opportunities for possible KE strategic interventions will be assessed with possible time frames.

The findings from the AMR East Africa landscape desk review in part 1 were as follows:

- There is significant UK – Africa collaboration in AMR research particularly in the region of interest, East Africa.
- The UK government is a major financial supporter directly and indirectly of AMR projects in the LMICs including East Africa.
- The Fleming Fund an initiative of the UK Government is a beacon of AMR support and KE in Kenya, Uganda and Tanzania. The fund has a focus on microbial surveillance and monitoring, antibiotic stewardship and conservation and the development of country National Action Plans.
- Collaborations have included universities, research organisations (MRC, African Health Research Institute AHRI), funding agencies, funding councils (UKRI, ESRC), NGO's government departments and hospitals.
- There was a wide range of collaborative projects supporting the strategic objectives of the Global Action Plan on AMR as overseen by the Tripartite of the World Health Assembly. Projects included:
    - AMR stewardship,
    - Infection Prevention and Control,
    - Capacity building and AMR training programmes,
    - AMR in livestock,
    - AMU in fish farming,
    - AMR surveillance and monitoring,
    - Antimicrobial drug discovery,
    - Biological, social and cultural drivers of AMR,
    - One Health training,
    - National Action Plan development,
    - Human behavior and antibiotic usage,
    - AMR transmission in the food chain.

- The Tripartite AMR country self-assessment survey (TrACSS) revealed that Kenya, Uganda and Tanzania were below average for the following strategic objectives of the Global Action Plan on AMR (1-4) and non-existent for 5.

    1. Strategic objective: Strengthen the knowledge and evidence base through surveillance and research.
    2. Strategic sub-objective: Improved National AMR Laboratory network in animal health and food safety sectors.
    3. Strategic objective: Reduce the incidence of infection through effective sanitation, hygiene and infection prevention measures.
    4. Strategic objective: Optimise the use of antimicrobial medicines in human, animal and plant health.
    5. Alignment of National Action Plan on AMR with other existing action plans, strategies or targets related to HIV, tuberculosis, malaria or neglected tropical diseases.

Feedback from Stakeholders in UK and East Africa

- Significant misuse of antibiotics and poor stewardship in both human and animal setting - **UK and East African stakeholders**.
- Poor facilities for hygiene and sanitation which contributes to driving environmental AMR – **UK stakeholders**.
- Inadequate livestock and human waste management linked to the above point –**UK stakeholders**.
- Poor routine surveillance in both animals and people – **UK stakeholders**.
- Huge gap in data and questions in legislative, political and regulatory areas – **UK stakeholders**.
- Lack of human and animal health infrastructure and health professionals. There is not enough access to medical care to keep people and animals healthy – **UK and East African stakeholders**.
- Knowledge gaps in the following areas:

    - general AMR awareness and AMR stewardship being the most critical particularly amongst the public and professionals - **East African stakeholders**,
    - R&D with specific reference to the lack of information of the economic impact of AMR, scientific writing and dissemination of scientific content- **East African stakeholders**,
    - AMR burden in animal health, resistance patterns in animal health (i.e. deaths attributed to AMR) – **East African stakeholders**,
    - **attitude & practice of farmers – East African stakeholders**,
    - **limited** understanding of **AMR in crop/agricultural sector** – East Africa stakeholders.

- Research technical capacity and expertise is located in only a few institutions many more trained laboratory personnel needed in microbiology techniques – **East African stakeholders**.
- Capacity is lacking in all countries with respect to research and technical skills in AMR management and needs to be increased. This is most lacking in hospital and clinical testing laboratories – **East African stakeholders**.

- In Tanzania the **research capacity is fragmented** therefore there is a need for a national research agenda on AMR - **East African stakeholders**.
- There is a lack of adequate infrastructure including lack of QC, reliable supply of quality reagents and materials, issues with patient management, infection surveillance to name a few – **East African stakeholders**.
- In general, in Kenya, Uganda and Tanzania there is limited capacity regarding equipment and laboratories outside the major cities and another challenge is ongoing maintenance – East Africa stakeholders – **East African stakeholders**.
- In Tanzania there is inadequate infrastructure and capacity for AMR surveillance – **East African stakeholders**.
- In Tanzania most of the hospitals do not perform antibiotic susceptibility tests - **East African stakeholders**.

Potential areas of interest for collaborations based on stakeholder feedback

- Personnel training and exchange programmes.
- Public awareness and education of AMR, infection prevention and control and Research and Development.
- Training in research capacity in scientific writing and publishing and the dissemination of knowledge.
- Data for only a few of the common infections e.g. salmonella, E. coli available, but a large number of other common infections. Support is needed in this area – capacity building to carry out these activities.
- R&D in AMR burden in animal health.
- R&D in resistance patterns in animal health – deaths attributed to AMR.
- R &D in AMR in the crop/agricultural sector.
- Antimicrobial use, stewardship and communication programmes.
- Training and capacity building - need to engage more people to understand the AMR challenge.
- Activities to focus on better communication with farmers and lay people.
- Development of simple diagnostics tools needed for use in far flung, hard to reach areas with no accessible technology.
- Early detection systems of infection of patients. Require Point of Care platforms.
- Require very specific simple tools that can be utilised with serum and plasma and also urine samples for Urinary Tract Infections (UTI) which are high on the list of pathogens of interest. This could address 60-70% of severe infections.
- Public awareness, behavioural change and communication badly needed for AMU. This could be done in conjunction with the Government's communication strategies and targeted at subset of the population.
- Support in the development of AMU databases which would help in the creation of guidelines and policies to fight AMR.
- The Ministry of Health of Tanzania was particularly interested in collaborations in the following areas of their NAP.

Strategic Objective 2:	Strengthen the Knowledge and Evidence Base through Surveillance and Research
Priority action 3:	Establish a national surveillance system for antimicrobial resistance
Priority action 4:	Lab capacity
Priority action 4:	Build laboratory capacity to produce high-quality microbiological data for patient management and support surveillance activities in both human and animal sectors
Priority Action 5:	Research & Development
Objective 5.1	Develop a national multi sectoral agenda on AMR 5.1.1. Engage relevant stakeholders to identify current gaps in knowledge and potential research areas 5.1.2. Develop national research guidelines on AMR 5.1.3. Undertake research related to AMR

Strategic Objective 3:	Reduce the Incidence of Infection through Effective Sanitation, Hygiene and infection Prevention Measures
Priority Action 6:	Infection Prevention and Control in Health Care 6.4. Strengthening National Linkages and Partnerships for IPC 6.4.1 Engage the communities on implementation of personal hygiene and environmental sanitation 6.4.2 Enforce the use of International Health Regulations (IHR) through Integrated Disease Surveillance and Response (IDSR) and existing bi-laws on prevention of outbreaks 6.4.3 Promote Food Chain Hygiene
Priority Action 9	Antimicrobial Stewardship Programmes 9.1. Establish antimicrobial stewardship programmes

Potential Areas of Collaborations based on status of NAP of Kenya, Uganda and Tanzania.

The review of the current status of the AMR Nation Action Plans of Kenya, Uganda and Tanzania highlighted areas of the strategic and sub-strategic objectives that had been achieved, were in progress or had not yet been addressed. A number of the objectives that had not yet been addressed were in the main as revealed from the interviews with stakeholders due a lack of resource and expertise.
The following areas below were either non-existent in that they had not yet been addressed or significantly inadequate (below average based on Tripartite Global Action Plan).

Global Strategic Objectives	Kenya	Uganda	Tanzania
Improve awareness and understanding of AMR thro ugh effective communication, education and training	Training and professional education on AMR in the farming sector (animal and plant), food production, food safety and the environment	Training and professional education on AMR in the farming sector (animal and plant), food production, food safety and the environment	Training and professional education on AMR in the farming sector (animal and plant), food production, food safety and the environment
Strengthen the knowledge and evidence base through surveillance and research	National monitoring system for consumption and rational use of antimicrobials in human health	National monitoring system for consumption and rational use of antimicrobials in human health	
		National monitoring system for antimicrobials intended to be used in animals (sales/use)	National monitoring system for antimicrobials intended to be used in animals (sales/use)
	National monitoring system for pesticide use in plant production	National monitoring system for pesticide use in plant production	National monitoring system for pesticide use in plant production
	National surveillance system for antimicrobial resistance (AMR) in food (animal and plant origin)		
National AMR Laboratory network in animal health and food safety sectors including laboratories that process samples from food producing terrestrial and aquatic animals		Effective integration of laboratories in the AMR surveillance	Effective integration of laboratories in the AMR surveillance
		Level of the standardisation and harmonisation of procedures among laboratories included in the AMR surveillance system	
			Technical level of data management of the laboratory network in the AMR surveillance system

Global Strategic Objectives	Kenya	Uganda	Tanzania
Optimise the use of antimicrobial medicines in human, animal and plant health		Optimising antimicrobial use in animal health (terrestrial and aquatic)	
Active Development and Implementation of AMR National Action Plan for Plant Health		Limited or non-existent	
Active Development and Implementation of AMR National Action Plan for Food production	Limited or non-existent		
Active Development and Implementation of AMR National Action Plan for the environment	Limited or non-existent		
Alignment of national action plan on AMR to any other existing action plans, strategies or targets related to HIV, tuberculosis, malaria or neglected tropical diseases	Limited or non-existent	Limited or non-existent	Limited or non-existent

7.2 Consolidated areas of Potential Opportunities for the Bloomsbury SET

Based on the feedback from stakeholders and the current status of the NAPs of Kenya, Uganda and Tanzania a number of areas have been identified as possible opportunities for the Bloomsbury SET support and intervention in the short and medium term. Large infrastructure support has been discounted as we believe this is best provided by international funding through international funding agencies, Governments, Government initiatives and agencies such as the Fleming Fund, Charities and NGOs. The potential opportunities should also be aligned with the skills set and capabilities of the Bloomsbury SET members.

The possible opportunities for the Bloomsbury SET are broadly aligned with the WHO's five strategic objectives of its Global Action Plan for AMR and include the following:

WHO Strategic Objective 1 - to improve awareness and understanding of AMR

Opportunity:

- Public awareness, behavioural change and communication badly needed for AMU. This could be done in conjunction with the respective Government's communication strategy - **Kenya**
- Public awareness and education of AMR , infection prevention and control - **Kenya, Uganda and Tanzania**
- Training and professional education on AMR in the farming sector (animal and plant), food production, food safety and the environment – **Kenya, Uganda and Tanzania**

WHO Strategic Objective 2 - to strengthen knowledge through surveillance and research

Opportunity:

- R&D in AMR burden in animal health - **Kenya**
- R&D in resistance patterns in animal health – deaths attributed to AMR - **Kenya**
- R &D in AMR in the crop/agricultural sector – **Kenya and Tanzania**
- Development of national research guidelines on AMR - **Tanzania**
- Capacity building and training of personnel in infection surveillance and monitoring – **Kenya and Tanzania**
- Capacity building and training of personnel in scientific writing and publishing and the dissemination of knowledge – **Kenya**
- Alignment of national action plans on AMR to other existing action plans, strategies related to HIV, tuberculosis, malaria or neglected tropical diseases - **Kenya, Uganda and Tanzania**

WHO Strategic Objective 3 - to reduce the incidence of infection

Opportunity:

- Strengthening National Linkages and Partnerships for IPC - **Tanzania**
- Capacity building and training of personnel in infection prevention and control – **Tanzania**

WHO Strategic Objective 4 - to optimise the use of antimicrobial agents

Opportunity:

- Antimicrobial use, stewardship and communication programmes – **Kenya, Uganda and Tanzania**
- Provide support in the development of AMU databases which would help in the creation of guidelines and policies to fight AMR - **Kenya**
- National monitoring system for consumption and rational use of antimicrobials in human health – **Kenya and Uganda**
- Optimising antimicrobial use in animal health (terrestrial and aquatic) – **Uganda**

WHO Strategic Objective 5 - develop the economic case for sustainable investment that takes account of the needs of all countries, and increase investment in new medicines, diagnostic tools, vaccines and other interventions

Opportunity

- Development of simple diagnostics tools needed for use in far flung, hard to reach areas with no accessible technology - **Kenya, Uganda and Tanzania**
- Early detection systems of infection of patients. Require Point of Care platforms which will be a paradigm shift - **Kenya, Uganda and Tanzania**
- Development of inexpensive diagnostics that can be utilised with serum and plasma and also urine samples for Urinary Tract Infections (UTI) which are high on the list of pathogens of interest - **Kenya, Uganda and Tanzania**

7.3 Skillset of the Bloomsbury SET

The Bloomsbury SET (RVC, LSHTM, LSE and SOAS) have the required skillset, capability and experience to collaborate in the above identified potential opportunities in East Africa. Within the group are strengths in depth and significant expertise in human, veterinary sciences and social science particularly in human and veterinary diagnostics, comparative biological sciences, epidemiology, vaccine development, health economics, mathematical modelling of infectious disease, disease surveillance and public health, agricultural economics, anthropology, health economics, international development, governance, evidence-based policy-making and linguistics.

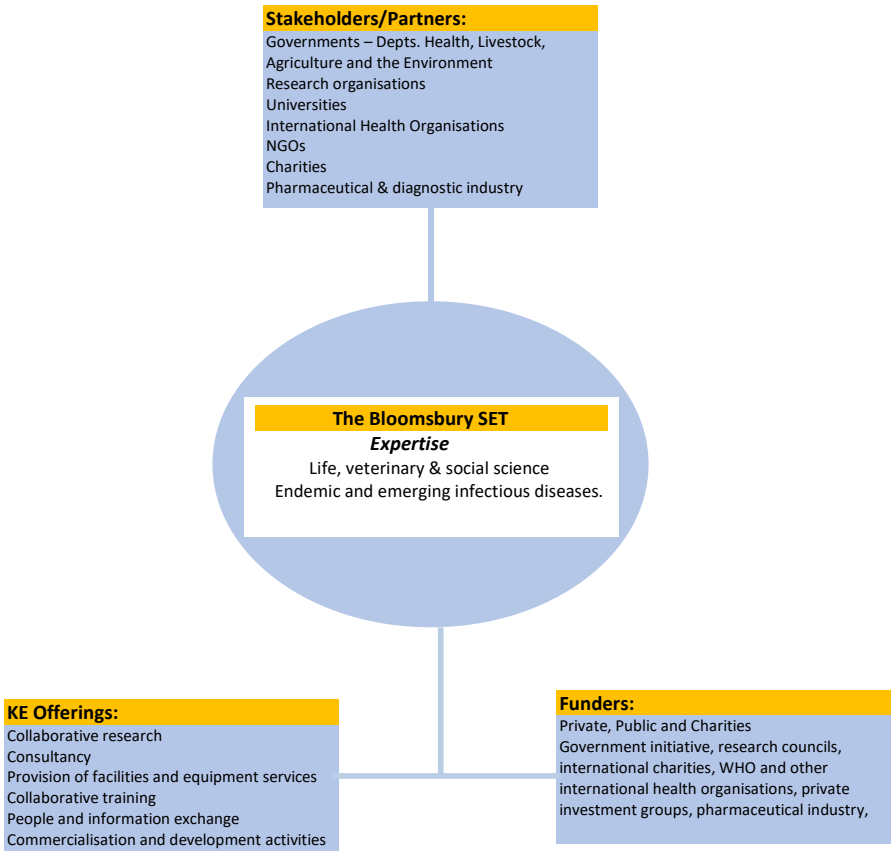
The Bloomsbury SET members have worked extensively in AMR research in Kenya, Uganda and Tanzania with a range of research organisations such as ILRI (Kenya), KEMRI/Wellcome Trust (Kenya), Makerere University of Health Sciences (Uganda), Aga Kahn University (Kenya) and Kilimanjaro Clinical Research Institute (KCRI) (Tanzania).

7.4 Development of Collaborations.

Feedback from the interviews with stakeholders in Kenya and Tanzania from the Ministries of Health (Kenya and Tanzania), KEMRI, ILRI, Ministry of Agriculture, Livestock and Fisheries (Kenya), Global Antibiotic Resistance Partnership (GARP- Kenya) and Global Antibiotic Resistance Partnership (GARP- Tanzania) suggests that there is goodwill to collaborate with research institution in the UK particularly members of the Bloomsbury SET as they recognise the expertise and experience of the individual institution members and are familiar with their work in AMR in East Africa. A recurring theme from the key stakeholders in the region was the requirement for collaborative programmes to be aligned with the respective country's NAP on AMR. Proposals meeting this criterion will be strongly supported by the respective Governments and research institutions.

A number of the potential opportunities identified are multidisciplinary in nature which play to the strengths of the Bloomsbury SET. This feature should be exploited in the process of developing these collaborations.

In the broadest sense potential collaborations will be a form of Knowledge Exchange (KE) between the Bloomsbury SET and the research institutions and organisations in Kenya, Uganda and Tanzania. KE refers to any process through which academic ideas and insights are shared, and external perspectives and experiences are exchanged and can take one of many forms such as collaborative research, provision of facilities and equipment services, collaborative training, people and information exchange or commercialisation and development activities. It is anticipated that the potential opportunities will cover most of the forms of KE based on the feedback and suggested areas of support mentioned by the stakeholders in East Africa. A schematic representation of the KE ecosystem for the Bloomsbury SET possible engagement in East Africa is shown below:



The funding to support the above identified opportunities will come from a combination of the public, private and charitable sectors and will depend on the project and the best KE model for delivery.

For effective KE with East African organisations and institutions the Bloomsbury SET must

- **Select the area of AMR collaboration** from the **potential opportunities** or others **aligned with the NAP** of the respective country – Kenya, Uganda or Tanzania.

- **Identify the appropriate Bloomsbury SET members** to offer a strong multidisciplinary team to effectively address the opportunity.

- **Select the method of collaboration:**
  - Collaborative research
  - Collaborative training
  - People and information exchange or
  - Other

- **Provide an outline of the proposed collaboration:**
  - Aims, objectives and outcomes.
  - Key stakeholders* and potential partners** from selected country.
  - Potential funders.

  * including Country National Action Plan coordinator
  ** UK and recipient country

- **Contact key stakeholders* and potential partners** with the outline proposal summary to obtain feedback and assess Go/No-Go status of the proposal:
  - Level of interest.
  - Alignment with country's NAP.
  - Areas of concern.
  - Suggested amendments.

  * firstly, contact Country National Action Plan coordinator

- Based on the feedback **abandon or further develop the proposal**. Further development would include continued discussions with stakeholders and potential partners and initial discussions with potential funders.

The review carried out in part 1 of this report highlighted a number of research institutions in East Africa active in AMR collaborative activities that could be potential collaborating partners. These include:

- KEMRI/Wellcome Trust – Kenya
- ILRI - Kenya
- International Development Research (Centre) - Kenya
- Sokione University of Agriculture – Tanzania
- Makerere University College of Health Sciences - Uganda
- College of Veterinary Medicine, Animal resources & Biosecurity (CoVAB), Makerere University - Uganda
- Mbarara University of Science and Technology - Uganda
- Uganda Virus Research Centre (Uganda)
- Jomo Kenyatta University of Agriculture and Technology – Kenya
- University of Nairobi – Kenya

- The International Food Policy Research Institute (IFPRI) - Uganda
- African Institute for Development Policy (AFIDEP) – Kenya
- Infectious Disease Research Collaboration (IDRC) – Uganda
- Mulago National Referral & Teaching Hospital –Uganda
- Kilimanjaro Christian Medical Centre (KCMC) – Tanzania
- Kilimanjaro Clinical Research Institute (KCRI) – Tanzania
- Bugando Medical Centre – Tanzania
- Aga Kahn University Hospital – Kenya

Recent funders of AMR research in East Africa include UKRI/ERSC, UKRI/MRC, UKRI/BBSRC, UKRI/AHRI, Wellcome, Bill & Melinda Gates Foundation, Newton Fund and UKCDR

The Bloomsbury SET presents a unique offering to address infectious disease challenges in both developed countries and LMICs through its four institution partners RVC, LSHTM, LSE and SOAS. The four institutions have some of the best life scientists and social scientists in the UK and with the multidisciplinary expertise unrivalled in the area of the control and management of endemic and emerging infectious diseases.

The Bloomsbury SET should be projected as a single unifying entity with the relevant skills and expertise. For this to happen a truly collaborative culture should be developed within the four institution partners which can be a challenge in itself for internationally renowned institutions. The Bloomsbury SET management team should dedicate time and resource to this task.

To further a collaborative culture with the Bloomsbury SET the management team should include senior academic representatives from each institution and a dedicated coordinator responsible for promoting the group's offering and expertise in the UK and abroad. The coordinator should in effect be the business development manager of the group and be involved in

- Developing a competency register of the group with examples of past projects
- Conducting market intelligence of AMR collaboration opportunities in East Africa and in other territories
- Exploring the most effective KE models to exploit the expertise of the group in East Africa but also in the UK and in other territories and regions
- Promoting the services and expertise of the group to key stakeholders and potential collaboration partners in East Africa - Governments, international funding agencies, UK funding agencies, research organisations, NAP coordinators, AMR leads in the Ministries of Health, Agriculture & Livestock, Public Health, Environment & Sanitation etc.

7.5 Proposed Timescale of Opportunities

This section addresses possible time scales for some of the identified opportunities based on the current understanding of the need. However, the availability of resources for delivery by the Bloomsbury SET is unknown. Discussions with the stakeholders in Kenya, Uganda and Tanzania will be required for confirmation of project priorities.

Short – medium term (1-3years)	Medium term (3-5 years)	Long term (5 years plus)
• Public awareness, behavioural change and communication for AMU. This could be done in conjunction with the Government's communication strategy - **Kenya** • Public awareness and education of AMR, infection prevention and control – **Kenya, Uganda and Tanzania** • Training and professional education on AMR in the farming sector (animal and plant), food production, food safety and the environment – **Kenya, Uganda and Tanzania** • Capacity building and training of personnel in scientific writing and publishing and the dissemination of knowledge – **Kenya**	• Development of simple diagnostic tools needed for use in far flung, hard to reach areas with no accessible technology - **Kenya, Uganda and Tanzania** • Development of inexpensive diagnostics that can be utilised with serum and plasma and also urine samples for Urinary Tract Infection (UTI) - **Kenya, Uganda and Tanzania** • Strengthening National Linkages and Partnerships for IPC in Tanzania – **Tanzania** • Capacity building and training of personnel in infection prevention and control – **Tanzania**	• R&D in AMR burden in animal health - **Kenya, Uganda and Tanzania** • R&D in resistance patterns in animal health, deaths attributed to AMR – **Kenya** • R &D in AMR in the crop/agricultural sector – **Kenya and Tanzania**

7.6 Recommendations

One	**The multidisciplinary offering of the Bloomsbury SET is a unique feature and a strong 'selling' point and must be exploited.**
Two	**Bloomsbury SET should position itself as a multidisciplinary group with the expertise and experience that addresses the five strategic objectives of the WHO Global Action Plan on AMR.**
Three	**To further a collaborative culture within the Bloomsbury SET the management team should include senior academic representative from each institution.**
Four	**The Bloomsbury SET should appoint a dedicated KE/collaboration coordinator with a remit of promoting the group and actively engaging with key stakeholders in UK and East Africa including the NAP coordinators of Kenya, Uganda and Tanzania. The NAP coordinators reside in the Ministries of Health and Ministries of Livestock and Agriculture of the respective countries.**
Five	**The Bloomsbury SET collaboration coordinator should be the interface between the stakeholders in East Africa and Bloomsbury collaboration delivery team to initially identify the needs and structure of possible collaborations.**
Six	**There is a lot of good will and interest from the research organisation and governments in East Africa to work with the Bloomsbury SET on the activities mentioned. The Bloomsbury SET should address some the potential opportunities identified in this exercise and validate the short, medium- and long-term opportunities.**
Seven	**To make the greatest impact the Bloomsbury SET should engage with the main stakeholders in AMR in Kenya, Uganda and Tanzania to clearly understand the problems prior to any project proposals.**

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Appendix 1

Questions from stakeholder interviews and survey (UK and East Africa)

UK stakeholders – Interview and survey

1. What in your opinion are the key AMR management issues in LMICs particularly in East Africa?
2. Do you think that the UK funded AMR collaborative projects with Africa address the key issues on the ground in those countries?
3. Which of the following AMR management activities would you prioritise for collaborative funding in LMICs in order of priority? 5 -highest and 1 lowest

    - Raising awareness of AMR and public health policy
    - Antibiotic conservation in humans and animals
    - Sanitation, hygiene, infection prevention and control
    - Surveillance and monitoring
    - Research and development
    - Other _____

4. In your opinion what are the current knowledge gaps in AMR management in East Africa as a whole?

5. What are the possible opportunities for strategic intervention in AMR management in East Africa?

6. What would be the most effective approach for Knowledge Exchange (KE)/Knowledge Transfer (KT) between UK and LMIC in East Africa for the management of AMR?

East Africa stakeholders – Interview and survey

UK – East African Collaborations

1. Apart from the Fleming Fund programmes, do you know of any other UK-East Africa project collaborations in AMR with particular reference to your country and East Africa?
2. If so, what form do these projects take – funding only, training, exchange of personnel, equipment, upgrading of facilities?
3. Are such collaborations effective in terms of adoption and implementation?
4. Are there any barriers to adoption or implementation?
5. In your opinion what type of collaborations would be the most effective – funding only, personnel training etc.?

Skills & Infrastructure in Kenya, Uganda and Tanzania

6. What is the capacity (research & technical skills) in AMR management in your country and East Africa?
7. What is the infrastructure (facilities and equipment) like for AMR management in your country and in East Africa?

Current Knowledge gap and potential opportunities for strategic intervention

8. In your opinion what are the current knowledge gaps in AMR management in your country and in East Africa as a whole?
9. What are the opportunities for strategic intervention in AMR in your country and in East Africa?
10. What could you envisage as potential opportunities for the Bloomsbury SET collaborations in your country and in East Africa?

Appendix 2

Breakdown of respondent from stakeholder interviews and survey

Stakeholder Group	No. of Respondents	Response Format
Research Providers (UK) Research Institutions	8	Interview & Survey
Research Providers (East Africa) Research Institutions	3	Interview
Wider Stakeholders (East Africa) Government institutions Policy Makers Funders Science Networks	6	Interview
Total Number of Stakeholders	**17**	

Appendix 3
Review of UK-Africa AMR Collaborations

A3.1 Examples of UK Government AMR Funding Initiatives for LMICs

Through initiatives like the Fleming Fund, the UK supports LMICs **to collect and share globally high-quality surveillance data** on AMR as well as **antimicrobial use and quality for human and animal health** (see 'The Fleming Fund' Case study), **strong surveillance in LMICs** (see **'Grant for Ghana'** Case Study) and to **improve the quality of and approach to medicines** (see **'Supporting Nepal'** case Study).

The UK is also involved in EU and international AMR research collaborations through other initiatives including UK Research and Innovation (UKRI) for example Supporting the National Action Plan for AMR programme. (see the **'SNAP –AMR for Tanzania'** case study below).

The Fleming Fund

The Fleming Fund is a £265m UK Aid programme established to **help low- and middle-income countries tackle AMR focusing on surveillance:**

- The fund finances **activities to collect and share data (on antimicrobial quality, use and resistance, alongside burden of disease)** with relevant decision makers globally
- Working through the WHO, FAO and the OIE, the fund has **supported more than 30 countries to develop NAP** and to roll out protocols and tools needed to survey antimicrobial use and resistance in humans, animals and the environment
- Through its 'Country and Regional Grants Programme', the fund **helps 24 countries across Sub-Saharan Africa, South and South-East Asia** to build sustainable One-Health surveillance systems
- To **sustain progress**, the fund builds the capacity of AMR leaders through a **range of fellowships that offer mentorship, secondments, training and networking opportunities** for individuals in both scientific and policy fields

Supporting Nepal

In Nepal, the UK supports work to **reduce the risk of AMR** through **technical assistance to the Ministry of Health and Population.**

- This includes **support to update Standard Treatment Guidelines/Protocols** and roll them out; and to define a basic package of health cases services - those provided free of charge at the point of use – drawing on local and international evidence; as well as work to help define, implement and monitor minimum service standards at primary and secondary level.
- The UK also **support Nepal's efforts to strengthen the procurement of medicines and supply chain managemen**t through, for example, work to develop a technical specification bank as part of the quality assurance process for the procurement of health commodities. This will help ensure that patients in Nepal have access to safe, effective and affordable treatments

Grant for Ghana

Through a Fleming Fund country grant, the UK is **helping Ghana implement its NAP on AMR** within the wider context of UK support for Ghana health system strengthening. In particular, the **fund is supporting Ghana to collect, analyse and share data on AMR and antimicrobial use in humans and animals**

Key activities supported by the grant include:

- Development and use of the FAO Assessment Tool for Laboratories and Antimicrobial resistance Surveillance Systems (ATLASS)
- Use of the ATLASS tool to facilitate the assessment of capability in veterinary laboratories; giving a baseline level to support plans for capacity building
- Participating in the WHO Tricycle Protocol for surveying drug-resistant *E.coli* in humans, animals and environments
- Setting up governance structures to strengthening the Ghana Food and Drugs Authority as it accesses data on antimicrobial use
- Providing technical information and recommendations for the Ghana AMR Platform, a national information resource

The Fleming Fund funding has also been used to **help the government review its regulatory frameworks for antibiotic use and management.**

SNAP – AMR Tanzania

- The Supporting the National Action Plan for AMR in Tanzania (SNAP-AMR) project is one example of how **UKRI and the Department of Health and Social Care (DHSC) use research and capacity building efforts to understand and address AMR in LMICs**.
- The project team, led by the University of Glasgow, is made up of researchers and policy experts in both UK and Tanzania. Working together, the team will be **providing novel insights into the socio-economic, cultural and biological drivers of AMR in Tanzania**. These will then be used to identify and prioritise workable approaches to behaviour change in hospitals and communities to alleviate the country's burden of AMR-related illness and help deliver its NAP

3.2 Detailed Review of UK – Africa AMR Collaborations

Methodology Adopted

A three-stage process was adopted for conducting this analysis. The first step involved identifying AMR collaborations between UK and Africa, followed by shortlisting of the important collaborations based upon certain parameters, and finally analysing the shortlisted collaborations.

Step 1 - Identification of UK-Africa collaborations

Step 2 - Shortlisting the collaborations

Step 3 - Analysing the shortlisted collaborations

Selection Parameter

Universities of Interest

Priority given to universities with a track record or interst in AMR research in the developing world.

Government Participation

The involvement of UK or African Governments through funding or research. The reason being the involvement of Government enhances the scale of research and presents a chance for wider adoption and implementation of the project.

Active Research

We prioritised active collaborations over the ones that are already completed, reason being that these projects will be a better yardstick for gauging the current and recent challenges facing AMR research on the African continent.

Based upon these parameters, we identified **28 collaborations, 7 collaborations were selected for detailed analysis; and for the remaining 21 collaboration, a brief overview provided**.

For the detailed analysis the following areas were reviewed:

- The purpose of the partnerships
- The adopted approach
- The challenges or gaps from the research conducted by these partnerships
- The output from the partnership and insights gained
- The factors that helped in making the partnerships a success
- The main achievements of the partnerships

For the holistic overview the following areas were reviewed

- The purpose of the partnerships
- The challenges or gaps from the research conducted by these partnerships
- The factors that helped in making the partnerships a success
- Insights from the partnership

Table 1 - List of the collaborations that warranted detailed analysis as per the selection parameters

Research Projects	Participating University	Participating Government Entity	Research Period	Status of Research	Figure(s)
Anti-Microbials In Society (AMIS): a Global Interdisciplinary Research Hub	London School of Hygiene and Trop Medicine (and more universities from UK)	Economic and Social Research	2017 – 2021	Active	1
Convergence in evaluation frameworks for integrated surveillance of AMR	Royal Veterinary College	Medical Research Council	2019 – 2020	Active	2
Umoya Omuhle: IPC for Drug-resistant Tuberculosis in South Africa	London School of Hygiene and Tropical Medicine (and more universities from UK)	Economic and Social Research	2017 - 2021	Active	3
Commonwealth Partnerships for Antimicrobial Stewardship	London School of Hygiene and Tropical Medicine (LSHTM)	UK Government	2019 – 2020	Active	4 -7
MRC Centre for Global Infectious Disease Analysis	Royal Veterinary College London School of Hygiene and LSHTM	Medical Research Council	2018 - 2023	Active	8
MRC Centre for Genomics and Global Health	LSHTM	Medical Research Council	2008 - 2014 & 2015 – 2020	Active	9
Comprehensive Resistance Prediction for Tuberculosis: an International Consortium (CRyPTIC)	LSHTM	Medical Research Council	2016 - 2020	Active	10

Table 2 - List of the collaborations provided with a holistic overview of the collaboration

Research Projects	Participating University	Participating Government Entity	Research Period	Status of Research	Figure(s)
The Fleming Fund, a programme by UK Aid to tackle the growing threat of drug resistance – referred to as antimicrobial resistance (AMR) – in low and middle-income countries around the world	NA	UK Government	2019 – 2021	Active	11
Holistic Approach To Unravel Antibacterial resistance in East Africa (HATUA)	University of St Andrews	Medical Research Council	2018 – 2021	Active	12
Infection Prevention and Control and Antibiotic Stewardship to Avert Antibiotic Resistance in High-Risk Populations from Resource-Poor Settings	University of Oxford	Economic and Social Research	2017 – 2019	Completed	13
Partnership for a cross-disciplinary approach to the ecology of antimicrobial drug resistance in Kenya	University of Liverpool	Medical Research Council	2017 – 2018	Completed	14
Drivers of Resistance in Uganda and Malawi: The DRUM Consortium	University of Liverpool, University of Strathclyde	Medical Research Council	2018 - 2021	Active	15
Changing Food Systems in Kenya and Malawi and the Challenge of Tackling Antimicrobial Resistance	Newcastle University	Arts and Humanities Research Council	2019 - 2021	Active	16
One Health capacity building in sub-Saharan Africa	Royal Veterinary College London School of Hygiene and Tropical Medicine	Southern African Centre for Infectious Disease Surveillance (SACIDS)	NA	NA	17

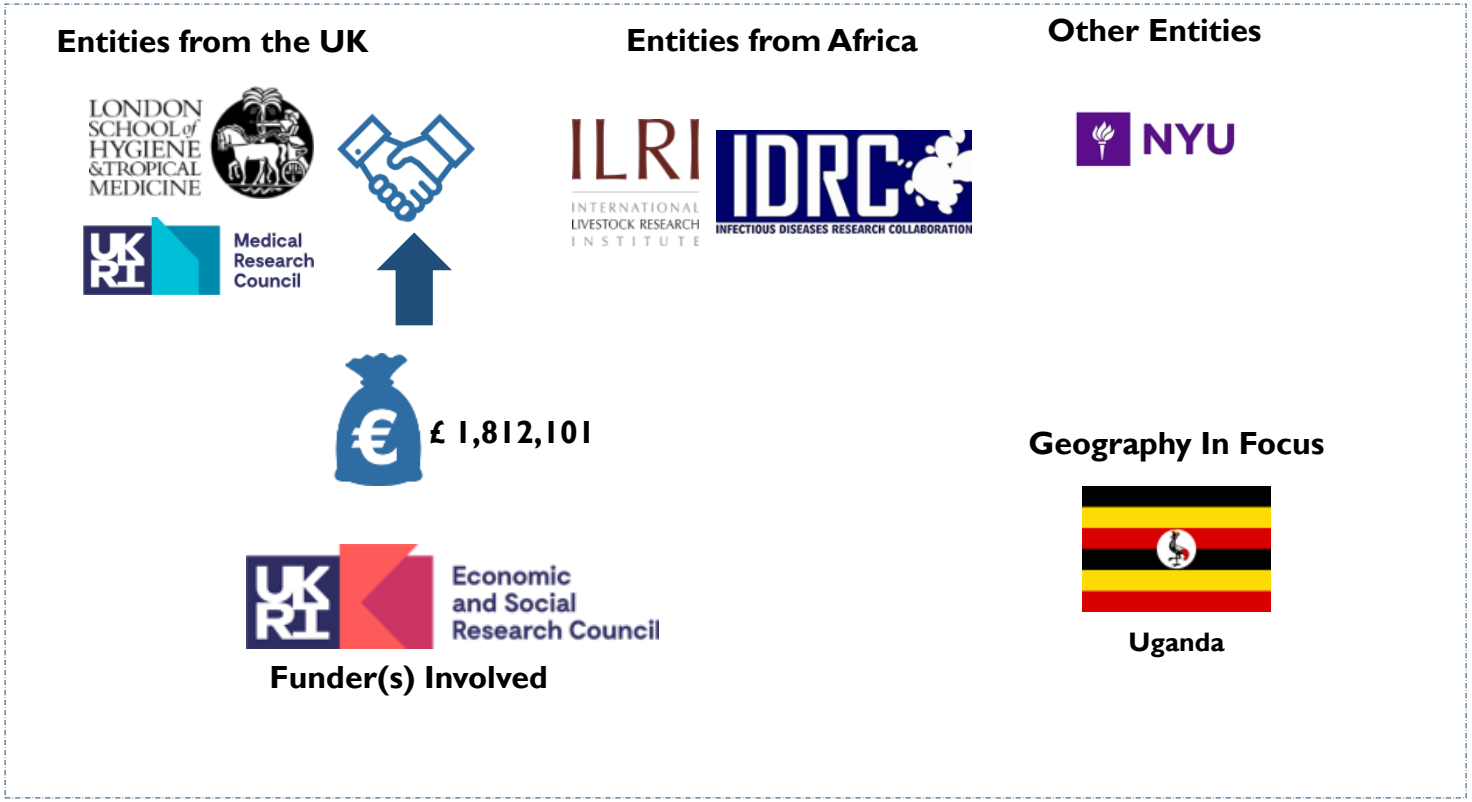
Table 2a - List of the collaborations provided with a holistic overview of the collaboration

Research Projects	Participating University	Participating Government Entity	Research Period	Status of Research	Figure(s)
Antimicrobial resistance as a social dilemma: Approaches to reducing broad-spectrum antibiotic use in acute medical patients internationally	University of Leicester University Hospitals of Leicester NHS Trust	Economic and Social Research	2017 – 2018	Completed	18
Supporting the National Action Plan on AMR in Tanzania (SNAP-AMR)	University of Glasgow	Medical Research Council	2018 – 2021	Active	19
NEAR-AMR: Network of European and African Researchers on Antimicrobial Resistance	University of Liverpool	JPIAMR	2019 - 2020	Active	20
Uganda: Professional Fellowship	UK Government University of Edinburgh	UK Government	NA	NA	21
Towards controlling antimicrobial resistance in global aquatic animal food systems by enhancing collective resilience (AMFORA)	Royal Veterinary College LSHTM	MRC	2017 - 2018	Completed	22
Tanzania Country Grant	NA	UK Government	2019 onwards	Active	23

Table 2b - List of the collaborations provided with a holistic overview of the collaboration

Research Projects	Participating University	Participating Government Entity	Research Period	Status of Research	Figure(s)
South Africa-UK Antimicrobial Resistance (AMR) Drug Discovery (DD) Partnership Hub	NA	Medical Research Council	2019 – 2020	Active	24
An integrated approach to tackling drug resistance in livestock trypanosomes	University of Edinburgh	Biotechnology and Biological Sciences Research Council	2019 - 2021	Active	25
Bridging antimicrobial resistance knowledge gaps: The East African perspective on a global problem	NA	UK Government	NA	NA	26
Economic Evaluation support to a trial that assess strategies to address anti-microbial resistance in malnourished children (FLACSAM)	LSHTM	NA	2016 - 2019	Completed	27
Professional Diploma in Tropical Medicine & Hygiene (East African Partnership)	LSHTM	NA	NA	NA	28

Figure 1: Antimicrobials in Society (AMIS): A Global Interdisciplinary Research Hub



1 Goals of the Partnership

I. To understand the role of antibiotics in every-day life.[1]
II. To evaluate the impact on the care of imperatives to restrict antibiotics i.e. analysing the alternatives to the antibiotics and its consequences.[1]
III. To identify and rehearse situations for antibiotic use i.e. identifying conditions when antibiotics should be used and when not.[1]
IV. **To launch 'AMIS Hub'— an online platform for developing, implementing, and disseminating research on the prevalence of antimicrobials in society.**[1]

2 Execution of the Partnership

- To analyse the rate of consumption of antibiotics, **they collected granular level information (from Thailand and Uganda) through research papers.**[1,2]
- To gain an in-depth understanding of the research papers and to clarify any issues they conducted **Skype interviews with the authors of the papers to learn the nuances of their research.**[2]

3 Activities to Date

The research has led to the development of **a common digital platform that brings together research relevant to AMR from across different social science disciplines—the AMIS Hub.** The Hub materials include research summaries, blogs 'from the field', and reviews of existing and ongoing research and theory. It has the potential to act as a mechanism for policy-makers and life scientists to engage with social science research on AMR, to forge future collaborations and to inspire new ways to address AMR.[3]

4 Limitations of the Partnership

The research done during the partnership relied heavily on the already published studies, and papers on AMR. However, one thing that needs to be taken note of is that **the literature pertaining to AMR is poor in coverage, and skewed (especially, in case of livestock).** The research highlights that the geographies were not properly covered in the publications analysed during the collaboration. Only a few hospital studies in towns or cities were included with non in rural settings. The sample size of livestock studies was very small (and skewed), leading to a difficulty in creating a proper review matrix for livestock. There were no studies containing data related to AMR for all varieties of livestock.[2]

Information Sources: Source[1], Source[2], Source[3]

1 Takeaways — Opportunities in Uganda

- **Health professionals are overburdened and face a lack of infrastructure.** The health professionals described the shortages of human resources coupled with high patient load (i.e. the number of patients for a single doctor is more than a doctor can handle).[1]

  Uganda's doctor-to-patient ratio is estimated at 1:25,725, with a nurse to patient ratio of 1:11,000.

- The doctors also **face challenges in recognising the resistance patterns in patients[1] and have requested from devices from the research team that can be used to track resistance patterns.[1]**
- The health professionals reported that **medical or pharmaceutical authorities usually visit their healthcare units and influence the prescribing pattern of antibiotics** to be used while treating the patients. In addition, **the availability of fake drugs and side effects of some types of drugs, complicated the prescription** (of antibiotics) for the patients because of the

2 Potential Lessons Learned

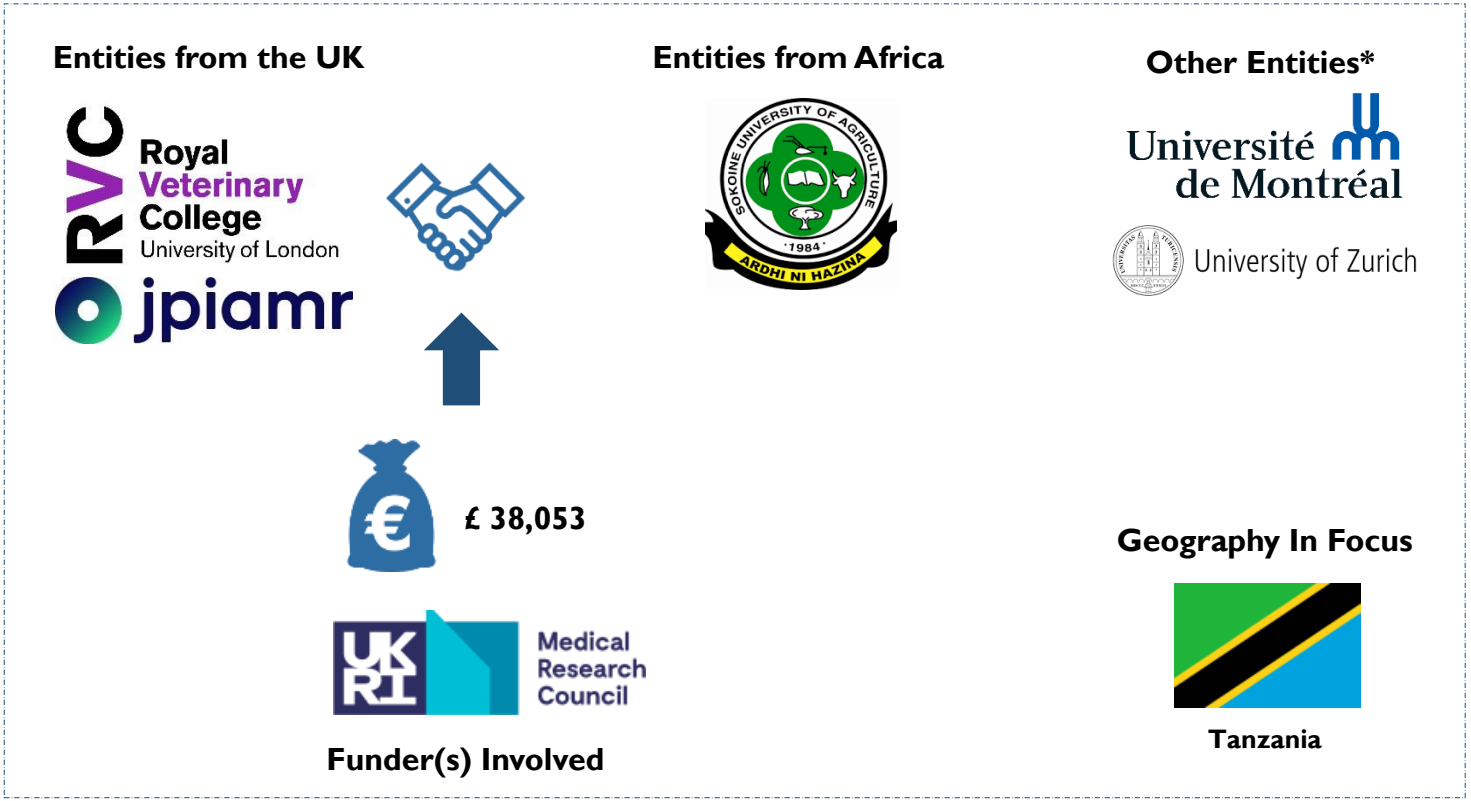
- Involve individuals from diverse research backgrounds to provide a broad view of social sciences and life sciences in understanding the AMR.
  This research was executed by **excellent researchers from the UK, Thailand and Uganda. The research team in Uganda has substantial experience in antibiotics and associated fields** *—antimicrobial resistance in Uganda, medical anthropology, and health care delivery in low resource settings.*[2]
  The programme is guided by researchers (AMIS Mentors) from reputable universities such as LSHTM, Harvard and Royal Veterinary College.[2]

- Utilise effective communication strategies involving all the stake-holders and maximise the outreach with the help of local community groups.
  They employed a central communications operation which supported each country's engagements with target audiences (as well as reaching out to international audiences). They organised inception meetings with each target group to refine the project plans to address specific concerns. **In Uganda they utilised established community advisory groups and hosted centralised meetings to address their communication needs.**[3]

- They've also received **further funding and support from global organisations and leading UK entities operating in the AMR space** including World Health Organisation and Medical Research Council.[3]

Information Sources: Source[1], Source[2], Source[3]

Figure 2: Convergence in Evaluation Frameworks for Integrated Surveillance of AMR (CoEval-AMR)



1 Problem to be Solved

Multiple research groups worldwide are currently working on the evaluation of integrated AMR surveillance looking at how approaches and methods can be refined to provide information that is relevant for making decisions on what surveillance approaches to use and thereby support the management of antimicrobial use and resistance development. So far, **the work of different research and implementation groups has resulted in multiple frameworks and disjointed recommendations for evaluation and measurement (for integrated surveillance of AMR), which can be confusing for users.**[2]

2 Goals of the Partnership

The collaboration aims **to develop guidance for a harmonised evaluation framework that will address the specific needs of integrated surveillance systems for AMR.** The use of this evaluation framework will provide an **understanding of what works and does not work in AMR surveillance and thereby helping to set up improved, cost-effective surveillance processes for AMR.**[1]

3 Execution of the Partnership

The JPIAMR funded, and RVC-led network, **brings people together to harmonise and refine existing frameworks and approaches for the evaluation of AMR surveillance.** Research partners are from Belgium, Canada, Denmark, Thailand, Tanzania, United Kingdom, and Vietnam. By reviewing existing frameworks and approaches and assessing their usefulness and validity, the network will produce an overview of existing protocols and develop supporting guidance to evaluate the performance and value of integrated surveillance systems for AMR.[2]

Further, it builds on the projects RISKSUR and Santero.[2]

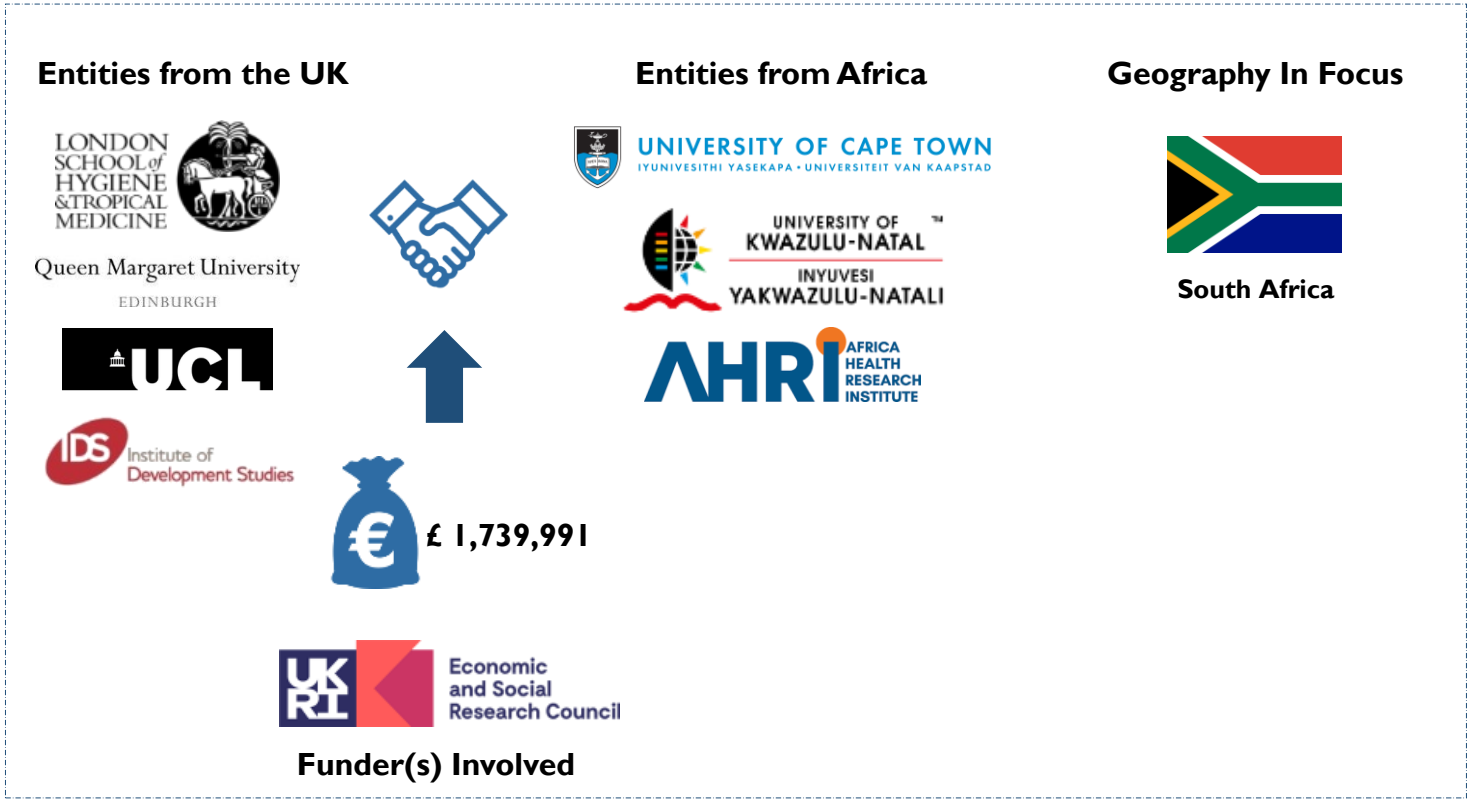
4 Potential Lessons Learned

- One of the major challenges in the current understanding of AMR is the **highly varying literature and opinions amongst experts; to tackle this, the project involves researchers and policy-experts across geographies.** This allowed them to arrive at a harmonised framework for AMR surveillance.[2]

- Further, it is always helpful to build on previously executed projects that yielded useful results. This **project builds on the work of successful projects** RISKSUR (i.e. Risk-based Animal Health Surveillance Systems) and Santero (i.e. Risk-based Surveillance for Animal Health in Europe).[2]

Information Sources: Source[1], Source[2]

Figure 3: Umoya Omuhle: IPC for Drug-resistant Tuberculosis in South Africa



1 Problem to be Solved

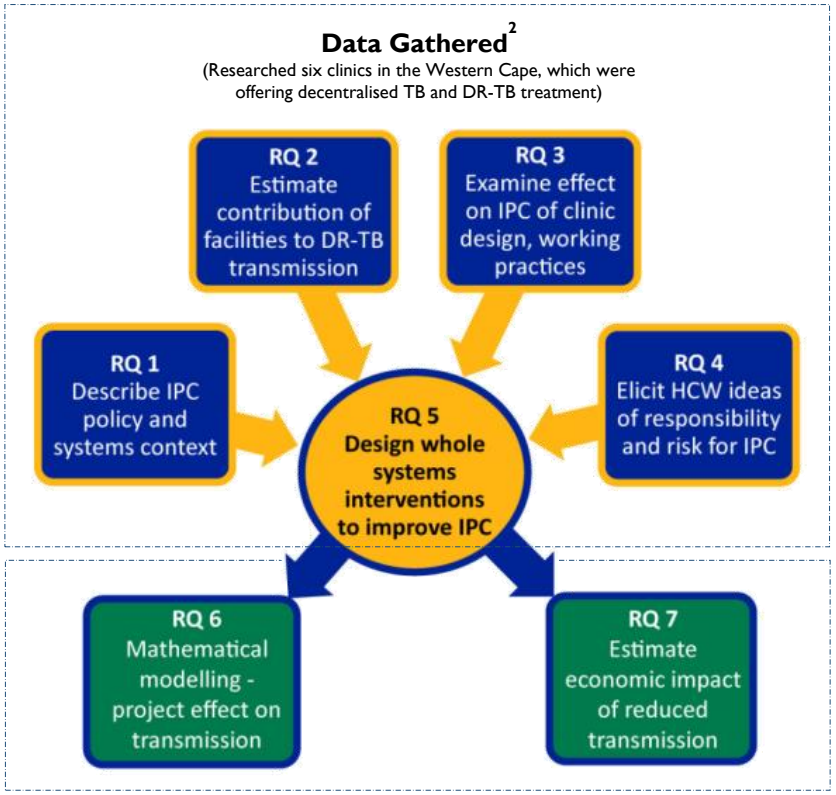
Research studies suggest that Drug-resistant Tuberculosis (DR-TB) (in South Africa) is acquired during the treatment of the patients rather than beforehand i.e. **the DR-TB, at times is acquired by patients in medical premises.** This further increases the concern as DR-TB services in South Africa are decentralised from hospitals to primary care clinics. Besides this, studies also suggest that **guidelines for clinics concerning infection prevention and control (IPC) measures to reduce DR-TB transmission are widely available; however, recommended measures are not put into practice.**[1]

2 Goals of the Partnership

This research aims to contribute to[1]:

1) the development of evidence-based policies for the **more effective reduction of nosocomial transmission of DR-TB in health facilities in high burden settings**; and
2) **a paradigm shift towards IPC measures for DR-TB in health facilities that are grounded in a whole systems approach.**

3 Execution of the Partnership



Information Sources: Source[1], Source[2]

1 Takeaways — Opportunities in South Africa

- **Healthcare units are poorly designed—they do not offer appropriate ventilation, hence, escalating the risk of infection for non-infected patients.**[1]

Until 2017, none of the government's 3,477 clinics were compliant with the Ideal Clinic standards. The Ideal Clinic framework, requires the PHC (i.e. primary healthcare) clinics to meet the minimum quality standards to be accredited for National Health Insurance. Appropriate ventilation is also one of the many criteria that must be met under Ideal Clinic Standards.
In addition, the healthcare facilities do not even provide separate waiting times for the DR-TB infected patients or non-DR-TB ones.[1]

- **Irregular use of personal protective equipment for TB by healthcare workers and the patients pronounces the threat of TB (and other infectious disease) outbreak.**[1]

It was observed that the healthcare workers avoided wearing N95 respirators due to the inconvenience caused in communicating with patients. Similarly, the patients avoided wearing the appropriate medical clothing and equipment because they were concerned of being seen as social outcasts.[1]

- **Lack of awareness w.r.t. the precautionary steps both in the healthcare facilities and for the patients.**[1]

Study highlights that the patients were not aware of the proper hygiene conditions, the risk related to not wearing the masks or respirators.[1]

Information Sources: Source[1], Source[2], Source[3], Source[4]

2 Potential Lesson Learned

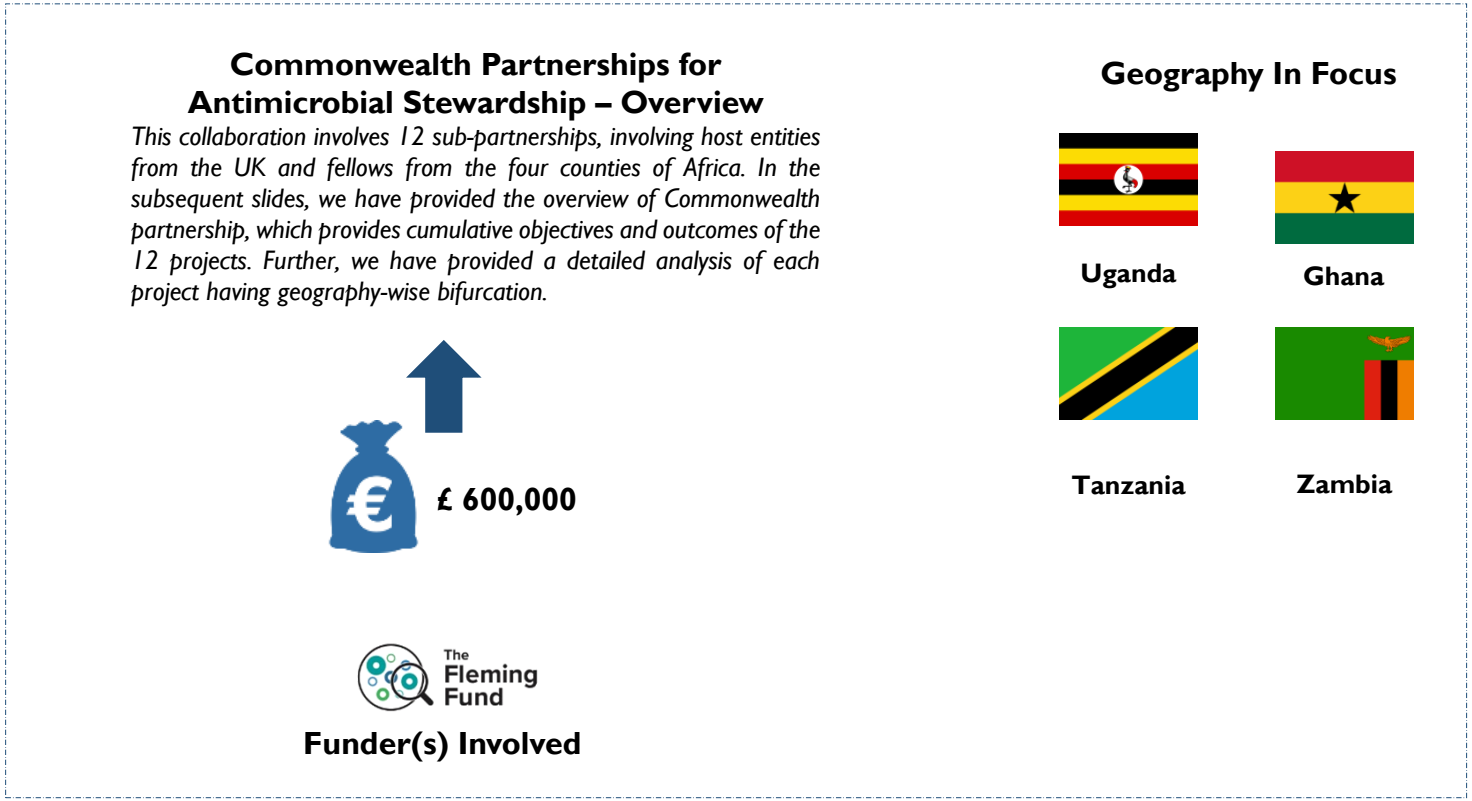
- Involve researchers with strong background in AMR and associated fields, along with the geography specific understanding of the AMR requirements.

Led by Alison Grant, who was initially trained as a physician specialising in infectious and tropical diseases and HIV medicine, and later on continued to work in HIV medicine in London. She further **studied epidemiology at LSHTM with particular interests in care for people with HIV in developing countries (particularly South Africa).** *Currently she is (also) supervising research degree students working on use of Xpert MTB/RIF, which is used to diagnose TB, determinants of TB infection among young people in South Africa.*[2]

- Having researchers and mentors from the leading universities is helpful in executing effective partnerships, because of the high-quality faculty and researchers available.

The research involved ***the top universities of South Africa University of Cape Town and University of KwaZulu-Natal. The University of KwaZulu-Natal has also formed the AHRI (Africa Health Research Institute), a tuberculosis and HIV research institute, in collaboration with Howard Hughes Medical Institute, US.***[3,4]

Figure 4: Commonwealth Partnerships for Antimicrobial Stewardship – Overview



1 Background of the Partnership

The Commonwealth Partnerships for Antimicrobial Stewardship (CwPAMS) programme is a project within the Fleming Fund (£265 m programme funded by The Department of Health and Social Care of the UK Government). **The Fleming Fund aims to support countries in collecting high quality data for antimicrobial resistance (AMR).** This data can then be shared with other researchers nationally or globally. **Gathering of AMR surveillance data helps in understanding the scale and scope of the problems related to AMR and tackles them more effectively.** The Fleming Fund has led **12 Commonwealth partnerships with the help of various hospitals in the African regions of Ghana, Uganda, Tanzania and Zambia.**[1,2,3]

2 Goals of the Partnership

CwPAMS (Commonwealth Partnerships for Antimicrobial Stewardship) contributes in achieving the following objectives of the Fleming Fund[1]:

- **Providing guidance for conducting AMR surveillance and analysing antimicrobial use.**
- **Collating and analysing data for the use of antimicrobial medicines.**
- **Promoting or advising rational use of antimicrobials.**

3 Execution of the Partnership

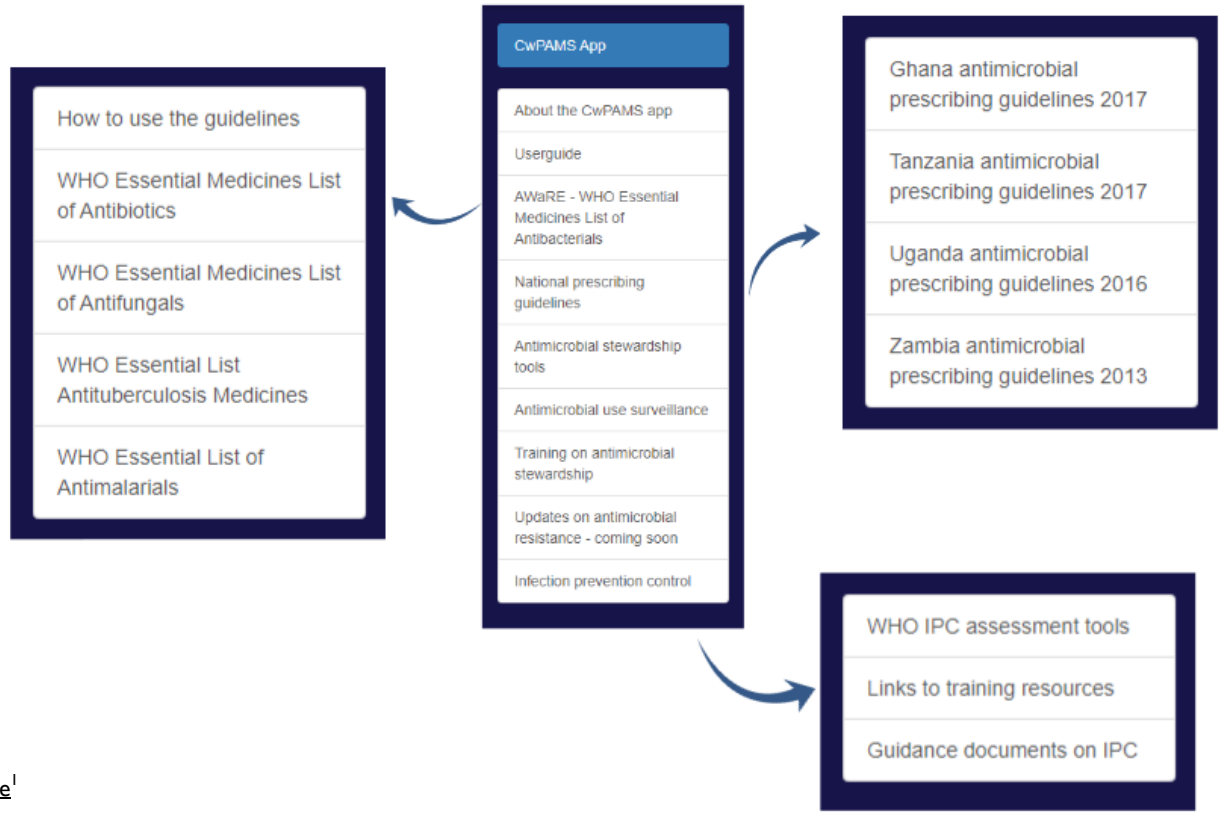
- **The health institutions of the UK sent their own AMR technical experts to work with national healthcare institutions in four Commonwealth countries in Africa**—Ghana; Tanzania, Uganda and Zambia, to address various challenges identified in AMR National Action Plans.[1]

- **The NHS (UK) health workers will also contribute in developing strategies and share skills and knowledge to address issues related to: antimicrobial stewardship (AMS).** This includes surveillance, antimicrobial pharmacy expertise, capacity and infection prevention control (IPC) measures.[1]

Information Sources: Source[1], Source[2], Source[3]

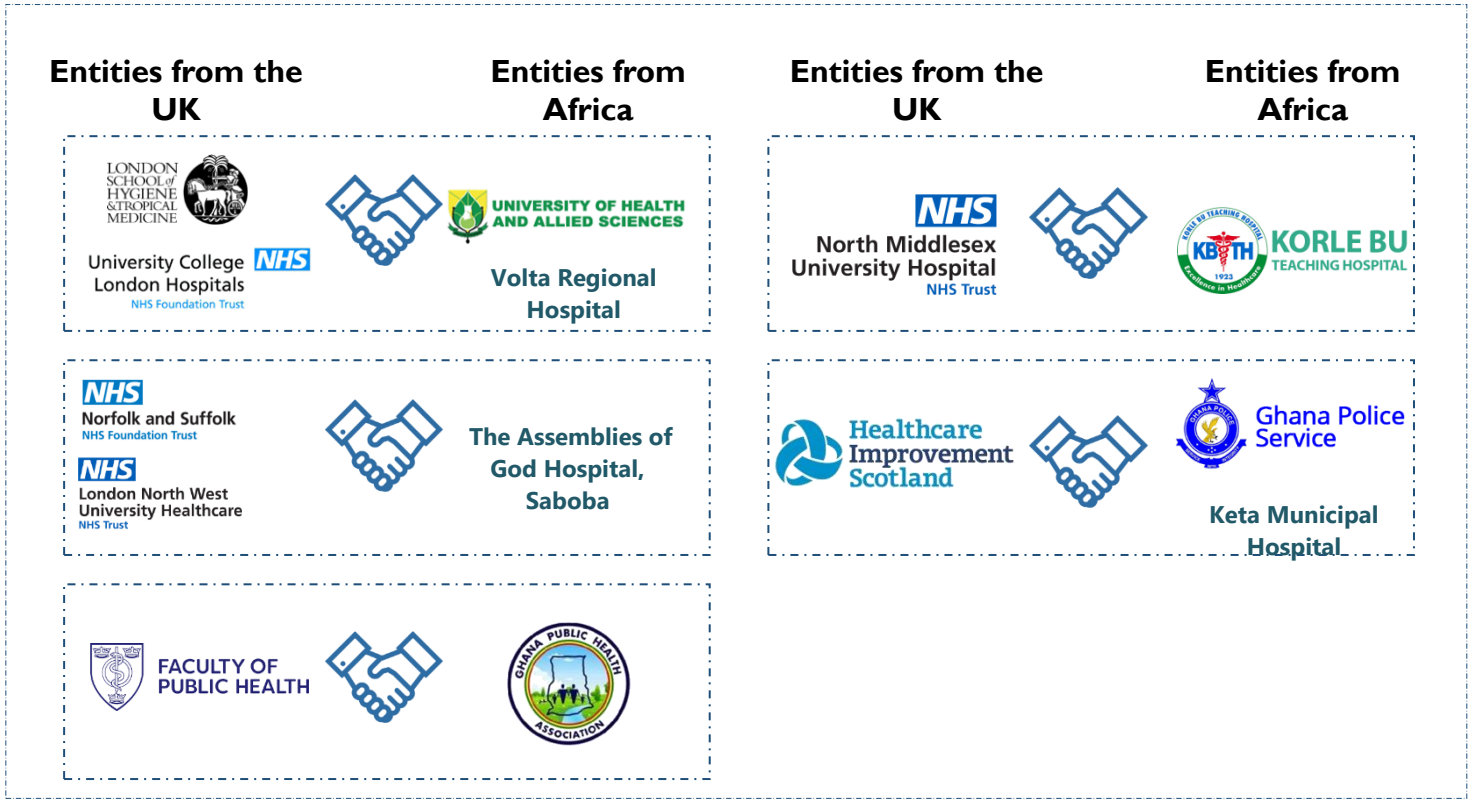
4 Activities to Date

This stewardship program has led to the generation of **mobile applications that will provide information on antimicrobials and their use.** The CwPAMS app provides easy access to medicines and the management information to support appropriate antimicrobial stewardship. The app has been launched in each of the commonwealth regions.[I]



Information Sources: Source[I]

Figure 5: Commonwealth Partnerships for Antimicrobial Stewardship – Ghana Collaboration Network



Note: Not enough literature was available for the research work of LSHTM and University College London Hospitals.

Norfolk and Suffolk NHS Foundation Trust – The Assemblies of God Hospital, Saboba

1 Execution of the Partnership

The UK team has worked with Samuel Odonkor, Pediatric Surgeon, and Samrina Bhatti. **They conducted occasional visits to the hospital, along with the help of Skype, phone and email.**[1]

2 Takeaways — Opportunities in Ghana

- The team **conducted interviews of local chemist shop owners, and they found that they were also very supportive of the drive to tackle overprescribing of drugs.**[2]
- They also **found that mothers were giving adult doses to their babies which not only is potentially dangerous but will lower the child's natural defences.**[2]
- Finally, **many antibiotics were being prescribed for treating dysentery and diarrhoea, however, the antibiotics have no effect on these illnesses.**[2]

3 Findings of the Partnership

As part of their research the following conclusions have been reached[2]:

- Up to **two billion people in low and middle-income countries lack access to antimicrobials**.
- There has been **an increased and inappropriate use of the drugs and the global consumption is expected to triple by 2030**.
- **123 countries are reporting extensive multi-drug resistant TB**.

Information Sources: Source[1], Source[2], Source[3]

UK Faculty of Public Health (FPH) – Ghana Public Health Association (GPHA)

1 Execution of the Partnership

The UK team **conducted their research at the LEKMA Hospital**. They visited the hospital and conducted workshops for awareness of AMR. They have also collected data on how much antimicrobials are being prescribed by the doctors. Also, during their surveillance they have included pharmacies, which were helping them in collating the data from the distribution of their sales of antibiotics.[3]

2 Impact of the Partnership

- This partnership has **led to the establishment of an AMS advisory Committee.**[3]
- **They have also initiated the IPC guidelines review based on the WHO infection prevention control and hand hygiene assessment tools.**[3]
- **They have reviewed the prescribing national guidelines and constructed simpler and more accessible local prescribing guidelines, i.e. within the context of the National AMR Plan and Prescribing Guidelines.**[3]
- **They have also planned laboratory data surveillance processes and regular production surveillance outputs, with a focus on drug-resistant organisms.**[3]

North Middlesex University Hospital NHS Trust, London– Korle-Bu Teaching Hospital

1 Execution of the Partnership

The UK team will be **conducting one day hospital-wide surveys in all the wards to assess their current practices in antimicrobial use and infection control.**[1]
Further, there is the vision to build professional capacity for effective AMS and Infection Prevention Control. For this, they have implemented the following antimicrobial strategies within the hospital[1]:

- They **are keenly working and investigating the use of antibiotics in humans.**
- They are **routinely conducting surveillance of antibiotics using activities such as the point prevalence surveys**.

2 Takeaways — Opportunities in Ghana

- Their collected **Point prevalence surveillance is continuously contributing to the Global Point Prevalence survey,** thereby providing data to help in formulating evidence-based strategies.[1]
- The **partnership includes a team from Ghana and the UK. The pharmacists involved in this partnership have expertise in developing data collection tools for operational use and research in pharmaceutical care**. In addition, they have skills in identifying and documenting care issues which includes antimicrobial use problems as well as experience in implementing and promoting adherence to clinical guidelines.[1]

Healthcare Improvement Scotland – Ghana Police Hospital & Keta Municipal Hospital

1 Execution of the Partnership

- The team **conducted Point Prevalence Surveys (PPS) in which they visited the wards and reviewed all the documents kept within the patient folders**, including medical notes and medicines prescribing/administration charts.[2]

2 Takeaways — Opportunities in Ghana

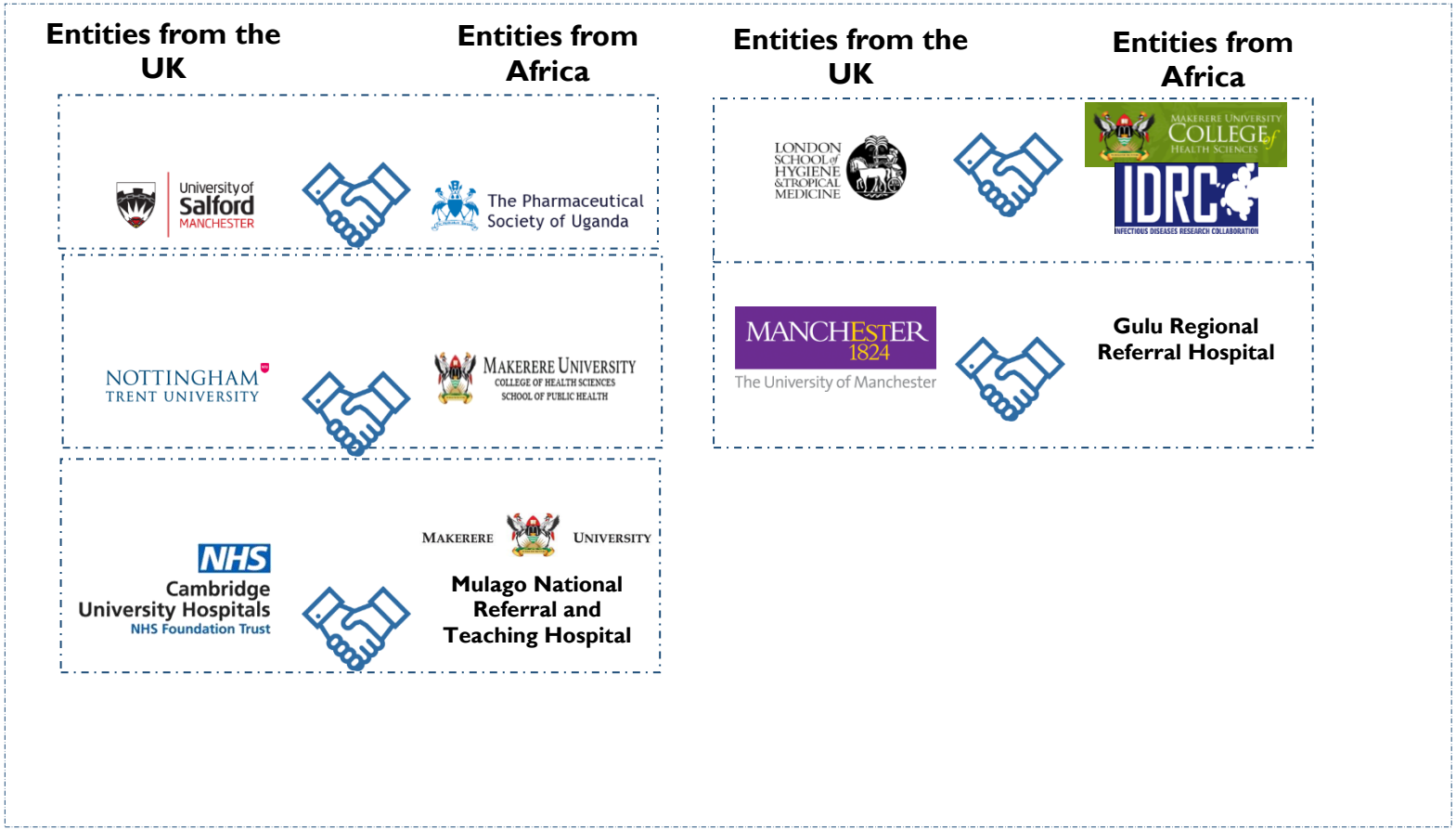
- During the visit at Keta Municipal Hospital, **they found that there was no guidance for reducing transmission of the infections. Also, the required bed capacity exceeded the available number of beds.**[2]
- During their visit at the Ghana Police Hospital**, they encountered challenges in collecting data, as there were no computerised records for prescribing.**
- They **also found difficulty in accessing notes as there were no national guidelines for some common infections e.g. sepsis and wound infection, so it was difficult to assess compliance with guidelines for some patients.**

3 Findings of the Partnership

- The **prevalence of antibiotic use** in adults and infants in the **Ghana Police Hospital was 57.1% in adult wards, 70 % in the children's ward and 100 % in the neonatal ward**. Similar findings at the **Keta Municipal Hospital, antibiotic use in adult wards - 55.6% and that of children's ward was 100%.**[2]

Information Sources: Source[1], Source[2]

Figure 6: Commonwealth Partnerships for Antimicrobial Stewardship – Uganda



Note: Not enough literature was available for the research work of—Nottingham Trent University, University of Manchester, and NHS Cambridge University Hospitals.

University of Salford – Pharmaceutical Society of Uganda

1 Execution of the Partnership

The University of Salford in partnership with charity Knowledge for Change (K4C), have been awarded funding to work on anti-microbial 'stewardship' in Uganda, working with healthcare professionals in low resource settings to improve antibiotic use.

The Knowledge for Change's Chair, Professor Louise Ackers, said—*"Anti-microbial resistance is a pandemic that is threatening to overtake cancer as a major cause of mortality in the UK. The impact of fast-growing resistance to antibiotics will especially hit low income countries, where infection and antibiotic control is often poor."*

Therefore, to support the reduction in the emergence of AMR, a number of students from the University of Salford travelled to Uganda to assist the work of Knowledge for Change.[1]

2 Takeaways — Opportunities in Uganda

Lack of proper antibiotic use: In Uganda, antibiotics such as Amoxicillin can be easily purchased over the counter and are frequently being handed out unnecessarily without verifying the prescription.[1]

3 Outcomes

To **reduce the transmission of the diseases they are promoting the use of hand sanitisers as well as providing hand sanitiser gels.** Further, they are providing better hygiene and sanitisation practices to prevent the transmission of infectious diseases.[1]

Information Sources: Source[1], Source[2]

LSHTM – Makerere University College of Health Sciences and IDRC

1 Execution of the Partnership

The experts from the UK went to Uganda to support colleagues from Makerere University to conduct antibiotic stewardship along with the aim of collecting surveillance data. While, conducting research they have found a number of challenges while collecting data for the usage of antimicrobials in the hospitals of Uganda.[2]

2 Takeaways — Opportunities in Uganda

- **Lack of Data Collection Resources**: In Uganda hospitals, the main challenge in collecting data was that they do not have registers (or other media to store hospital or patient data), with limited resulting data.[2]
- **Lack of Expertise of Doctors and Other Hospital Staff**: There was lack of expertise among medical personnel - improper tracking and reporting of data.

Figure 7: Commonwealth Partnerships for Antimicrobial Stewardship – Tanzania

Entities from the UK

NHS Northumbria Healthcare NHS Foundation Trust

Entities from Africa

K.C.M.C

Geography In Focus

Tanzania

Northumbria Healthcare NHS Foundation Trust – Kilimanjaro Christian Medical Centre (KCMC)

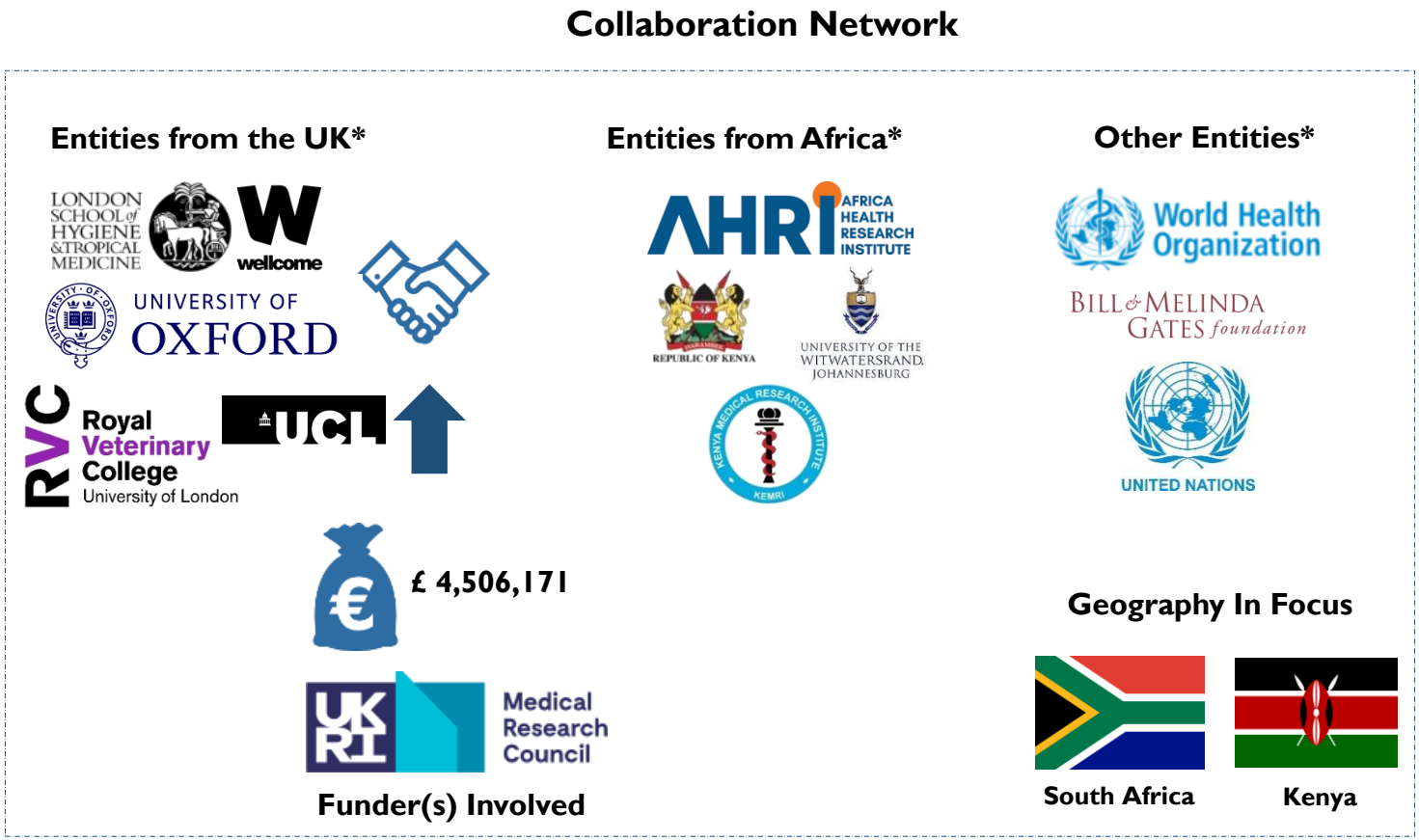
Execution of the Partnership

The project objective to deliver training to healthcare professionals in KCMC and evaluate their prescribing practices and therapeutic decision making to improve antimicrobial stewardship in Tanzania.[1],

Dr. Sarah Urassa, the director of hospital services and internal medicine consultant at KCMC, was part of the group. **She visited the trust's hospitals, spending time in a wide range of departments including pharmacy, wards and laboratories gaining knowledge in best practices in the UK.**[1,2]

Information Sources: Source[1], Source[2]

Figure 8: MRC Centre for Global Infectious Disease Analysis



**Only a few of the entire list of entities have been shown here.*

1 Background of the Partnership

The threat from new infectious diseases is continuously increasing, a few years ago there was the emergence of MERS-coronavirus in the Middle East, Ebola in West Africa and Zika in Latin America and now again another pandemic of COVID-19 is disrupting society. Therefore, the need to be prepared for such outbreak of diseases remains a priority for public health agencies and governments around the world. Also, the new vaccines or drugs, which are being developed for diseases, such as malaria, HIV and TB, should be extrapolated from the clinical trial results to analyse the effect of interventions, for a specific disease in a particular setting.[1]

2 Goals of the Partnership

To develop a system that will analyse the patterns behind the outbreak of diseases and will prepare a predictive analysis of infectious diseases outbreak.[1]

3 Execution of the Partnership

As part of this project **with the help of technical experts of Lancet Countdown, 35 leading academic centres and UN agencies across the world**, they have created a system that[3,4]:

1. tracks climate change impacts, exposures and vulnerability.
2. adaptation, planning, and resilience for health
3. the health changes in response to climate change.
4. economic losses due to climate-related extreme events
5. public and political engagement in health and climate change.

4 Activities to Date

- **They intended to organise workshops on Antimicrobial Resistance (AMR)**; one of which was scheduled from late February to March 2020 but this was cancelled due to COVID-19.[2]
- The team has **launched a 4-year MRes+PhD programme, in Epidemiology, Evolution and Control of Infectious Diseases.**[3]
- **They have prepared a database with information regarding Drug-Resistance—Molecular Markers of Anti-malaria Partner Drug-Resistance, which provides a systematic review of mutations.**[1,5]

Information Sources: Source[1], Source[2], Source[3], Source[4], Source[5]

1 Impact of the Partnership

- They have been members of multiple advisory committees and have influenced and contributed to various policies & guidelines.

Collaborating partners are **members of the regional WHO advisory committee on multi-drug-resistant TB** in South East Asian Region.[1]

They have successfully launched new guidelines for the treatment of STI (Sexually Transmitted Infections) Mycoplasma Genitalium (MG), which has prevented it to be transformed into a superbug. Initially, MG was treated with antibiotics, as it usually gets misdiagnosed as Chlamydia and treated as such. However, this was not clearing the infection which led to AMR in MG patients. If practices were not changed and new tests were not introduced then MG had the potential to become a superbug within a decade.[1,2]

2 Outcomes

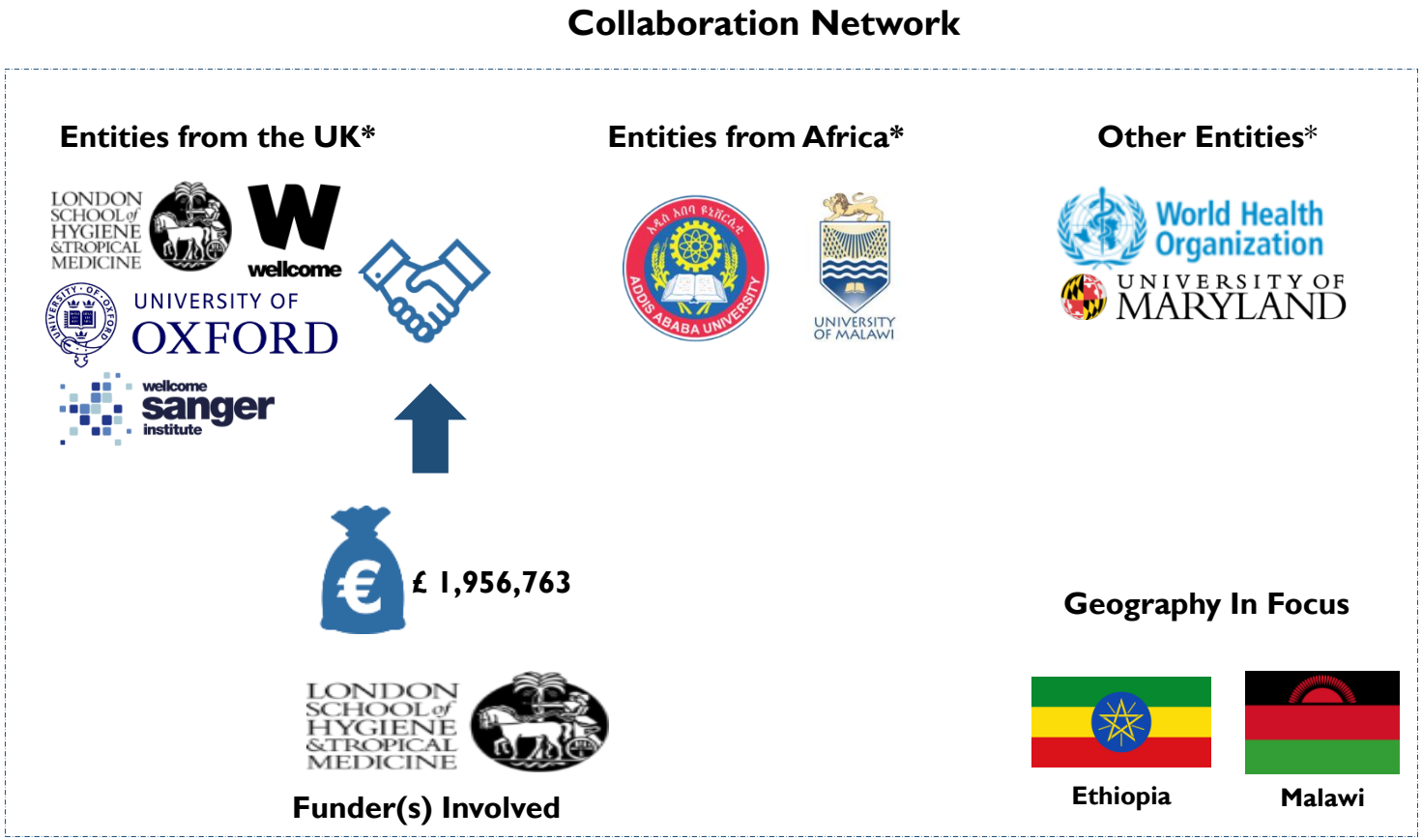
- **This has been a truly collaborative project with close to 200 researchers from many universities all over the world, with an expertise in infectious disease modelling.**[3]

- **Research is supported by various global entities such as The Centre for Global Infectious Disease Analysis, World Health Organisation (WHO), Public Health England (PHE), Bill and Melinda Gates Foundation (BMGF), The Global Fund, Gavi** and various other research centres and public health agencies.[1]

- Other complementary projects by the group have been **funded as a result of the true collaborative nature of this project** including—"Antibiotic Resistance: Mathematical modelling simulating the evolutionary response of genococcus within human populations to gepotidacin use", with an amount of £ 151,716 (GBP) from GlaxoSmithKline (GSK).[1]

Information Sources: Source[1], Source[2], Source[3]

Figure 9: MRC Centre for Genomics and Global Health



**Only a few of the entire list of entities have been shown*

1 Background of the Partnership

A fundamental dilemma in controlling endemic disease is that the whole purpose is to attack an established pathogen or vector population by all means possible, including large-scale public health interventions, but this strategy may backfire by creating a new evolutionary landscape that causes more virulent or resistant forms to emerge. **There are many examples of control efforts that have reduced disease burden for a short period of time but have eventually led to the emergence of resistant pathogen strains and the rebound of disease in a less controllable form.**[I]

2 Goals of the Partnership

Their goal is to provide **web-based tools to help the disease control programs: to plan and monitor the progress of their interventions. This requires changes in pathogen and vector populations, which are to be captured at high spatial resolution in real-time.** This collaboration will help the Centre to develop the tools which enables groups in the field to research genetic micro-epidemiology.[I]

3 Challenges Identified in the Partnership

- **Parasites and insect vectors have much larger and more complex genomes than viruses and bacteria, thus, require more advanced sequencing technologies and analytical methods.**[I]
- **Lack of training and tools to analyse genome variation data**: The study found that training was required to impart the knowledge of genome variation. Also, the clinics and researchers did not have the proper tools and training to make use of large-scale genome variation data.[I]

4 Solutions Aligned with the Challenges

- **The Centre has developed statistical and population genetic methods to solve these analytical problems.** The researchers around the world have collaborated to work together for genomic surveillance to identify common forms of variations in the global population. The Centre has developed methods for collecting data from multiple sources to construct integrated maps of the different factors that determine disease transmission and the spread of resistance.[I]
- They are **supporting an African led research initiative**, the Plasmodium Diversity Network, **by providing financial support, training and management guidance to provide training in data analysis for specific areas of their research goals.**[I]

Information Sources: Source[I]

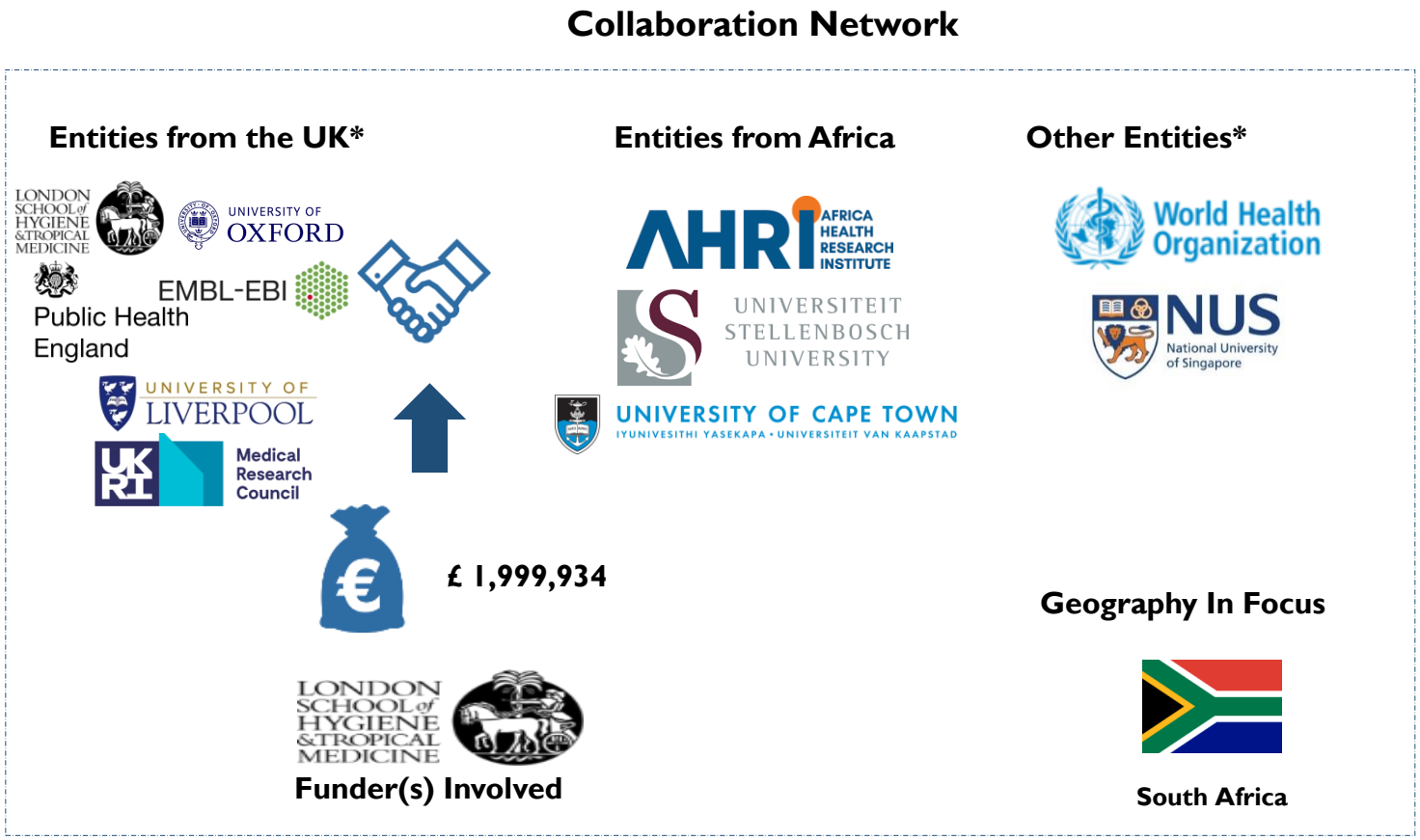
1 Potential Lessons Learned

- **Working with Global Entities**: This is a global collaborative approach led by Oxford University and it involves universities from the USA, Africa and UK and some Asian universities. Further, it involves Wellcome a global charitable foundation which support researchers to solve the health challenges.[1,2]

- **Extended Research with Wider Geographical Outreach for Better Understanding of Genome Variations**: The project was primarily initiated in 2008, for a six year period. During this period, they cultivated a technical environment to apply genomic epidemiology to learn about the diseases. Later on they extended their study to a global level to learn how genome variations are being followed across borders and developed a web tool for analysing it.[3]

Information Sources: Source[1], Source[2], Source[3]

Figure 10: Comprehensive Resistance Prediction for Tuberculosis: an International Consortium



**Only a few of the entire list of entities have been shown*

1 Problem to be Solved

Tuberculosis infects nearly 10 million people each year and kills 1.5 million, making it one of the leading causes of deaths in the world. Moreover, almost half a million people each year develop Multidrug-resistant TB (MDR-TB), which defies common TB treatments. **And, to diagnose this disease, patients undergo time consuming tests to determine whether they have MDR-TB, and if so, which drugs will suit and which will not. These delays in diagnosis and uncertainty about the best drugs to prescribe to individual patients pose a huge threat to the patients and disease control.**[1]

2 Goals of the Partnership

The collaboration's objective is to achieve accurate genetic prediction of resistance to all anti-tuberculosis drugs for whole genome sequencing (WGS) to replace slow, cumbersome, culture-based drug susceptibility testing (DST) with the faster Mycobacterium tuberculosis complex (MTBC) test. This will enable rapid recognition of drug-resistant TB and identification of the drug which will be most effective for treating this form of TB.[2]

3 Execution of the Research

The research involves **a large cohort of TB patients from 16 countries across six continents** where whole-genome sequences for each isolate and associated phenotype to anti-TB drugs were obtained using drug susceptibility testing recommended by the World Health Organisation. **They then worked on an end-to-end multi-task model with a deep denoising auto-encoder (DeepAMR) for multiple drug classification and developed DeepAMR_cluster, a clustering variant based on DeepAMR, for identifying clusters in latent space of the data.** This will aid in rapid recognition of drug-resistant TB and identification of the drugs which will be effective for treating this TB.[1,4]

4 Activities to Date

- The research has led to **the implementation of an online platform Bash the Bug, for collecting millions of data sample of TB infections.** They have performed WGS across 9 genes associated with drug susceptibility and resistance on 10,290 tuberculosis samples from people in 16 different countries across six continents. The research output has used the WGS to predict whether each of the four drugs (isoniazid, rifampicin, ethambutol and pyrazinamide) could be used to cure the infection and then compared the results with the known drug-susceptibility profiles.[3]

- The research was highlighted as a 'ground breaking publication in NEJM', for using DNA sequencing for drug resistance prediction in TB.[5]

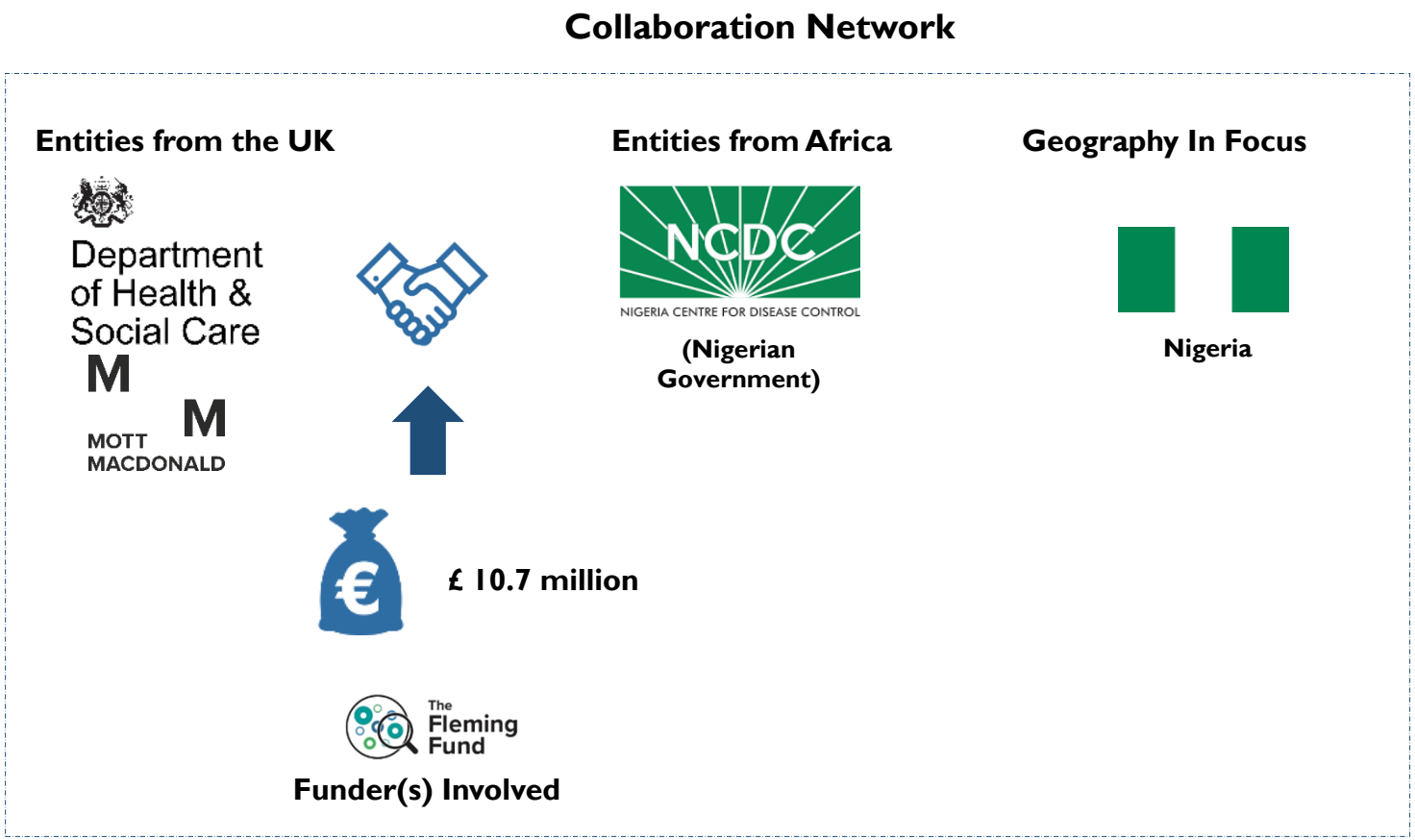
Information Sources: Source[1], Source[2], Source[3], Source[4], Source[5]

Other Collaborations – A holistic view

This section of the review presents an overview of other collaborations that were identified during our study. An analysis of each collaboration is summarised to provide a holistic overview. The analysis offers the following information:

- An Overview of Research and its Outcomes
- Gaps in the Research
- Research Enablers

Figure 11: The Fleming Fund, to Tackle the Growing Threat of Antimicrobial Resistance



Background
Of The Fleming Fund

The Fleming Fund, managed by the UK Department of Health and Social Care in partnership with Mott MacDonald, the Fleming Fund Grant Management Agent, **targets the core of the AMR issues by improving surveillance of antimicrobial resistance and drug use in humans and animals.** The Fund also supports laboratory infrastructure development, global technical expertise advancement in AMR, and encourages appropriate use of antibiotics in humans, animals and the environment.

Goals
Of the Partnership

The Government of Nigeria **aims to improve its understanding of the AMR problem and to prepare appropriate strategies to tackle it via the partnership.**

Activities to Date

In Nigeria, the Fleming Fund has **appointed DAI to support Nigeria's surveillance system, in partnership with the Nigerian AMR coordination committee** and other key partners. Investments and activities in Nigeria to date include:

- The appointment of ten professional fellows who are receiving training on specific skills including data management, microbiology, epidemiology and biosafety to help tackle AMR.
- Investment in 18 laboratories across the country.

Imminent Activities

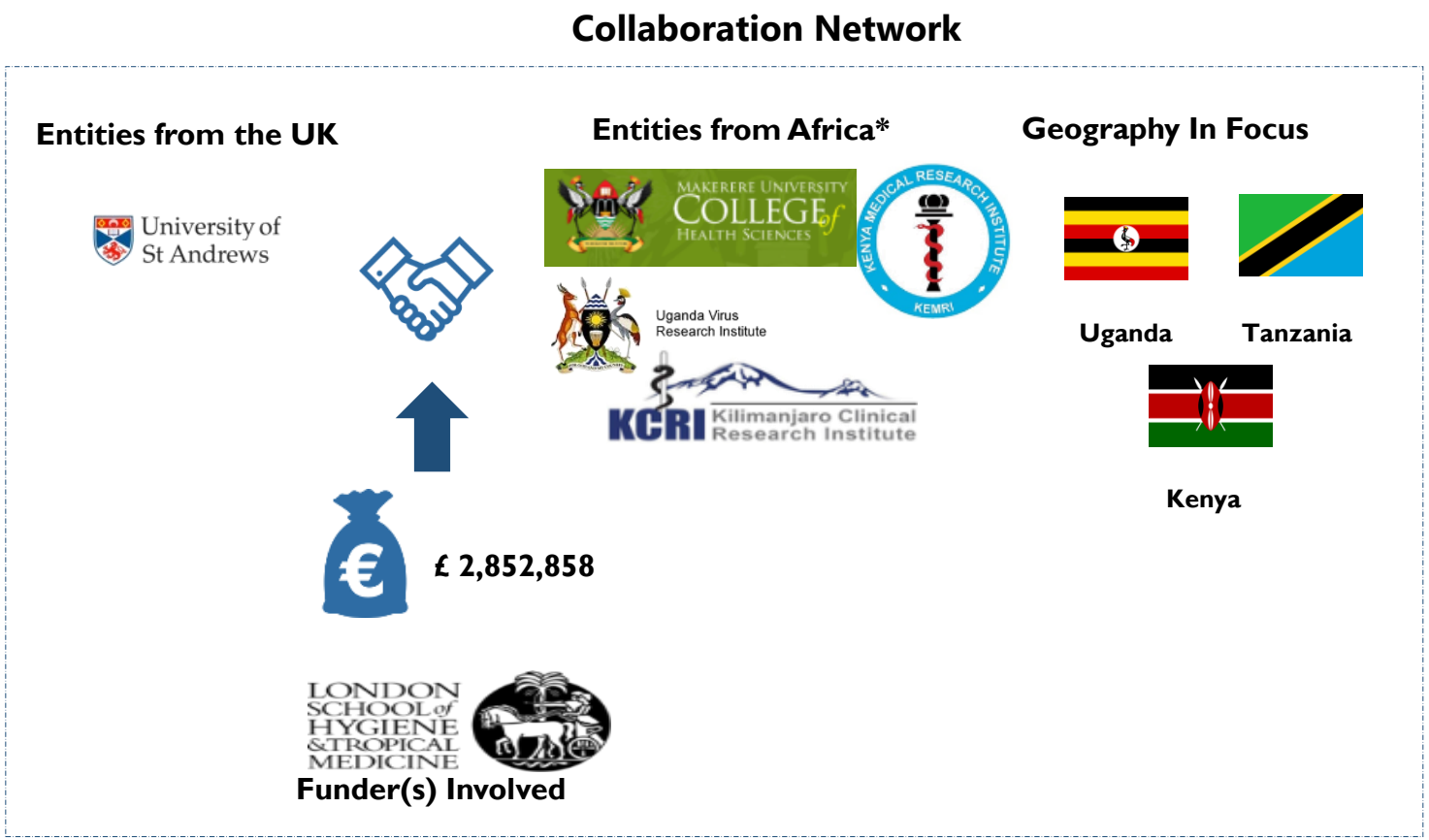
There will be an influx of £10.7m into the Nigerian health ecosystem **to improve public health surveillance systems, upgrading laboratory equipment, and training technicians and scientists.**

Takeaways
Opportunities in Nigeria

- **Insufficient laboratory capacity to diagnose AMR** — and, it also plays a critical role in AMR surveillance.
- **Poor AMR surveillance across the country and lack of optimum utilisation of available data** to tackle AMR and develop one health approach.
- **Lack of professionals and experts** in data management, microbiology, epidemiology and biosafety that can eventually help in mitigating the risk of AMR.

Information Sources: Source[1]

Figure 12: Holistic Approach to Unravel Antibacterial resistance in East Africa (HATUA)



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Goals
Of the Collaboration

This project objective is to address ABR in Africa and fill the gaps in knowledge. The research targets the three main areas (improving knowledge pertaining to): the bacteria that are antibiotic resistant and cause disease; the number of antibiotics used to treat the disease; and the behaviour of humans that govern antibiotics use and supply.

Imminent Activities

- **Development and provision of a microbiological surveillance network in East Africa.** The network will provide a mechanism for antibacterial resistance (ABR) surveillance, gathering high quality diagnostic and phenotypic data for ABR pathogens, and will allow stakeholders to identify and provide early warning of resistances spreading within the region.
- **A high-resolution view of ABR pathogens** provided by whole gene sequencing (WGS), to allow stakeholders to identify the genetic basis of resistance in isolates, and also identify high risk clones that are spreading locally, or are imported into the region from elsewhere.
- Study will benefit governmental organisations and NGO's involved in the provision and management of public health, providing both country-specific and regional perspectives of ABR. This will inform where resource should be targeted, and also where policy co-ordination is required.

Takeaways
Opportunities in Africa

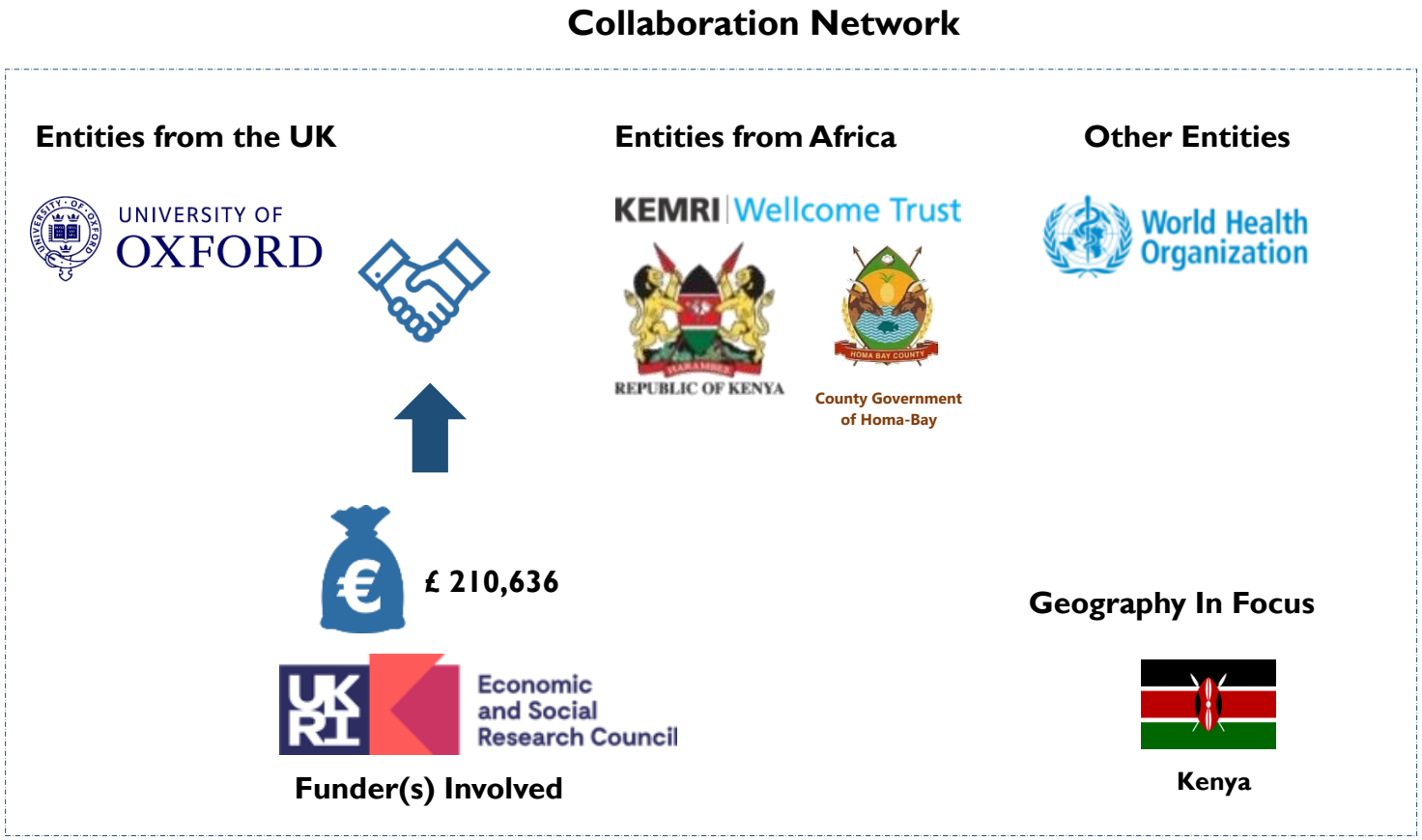
- The **availability of antibiotics through regulated channels is patchy**, and **the routes of access to antibiotics are variable**, which includes the traditional medicine prescribers, public, and private medical practitioners and over-the-counter antibiotic providers
- There is **very little information regarding the ABR across the African region** and **researchers have faced challenges while collecting data, their linkages and resolution.**

Potential Outcomes

- **Utilisation of data collection and analytics software**: In order to gather antibiotic usage data across multiple sites the researchers plan to employ mobile devices running EpiCollect software, to record quantitative and qualitative antibiotic data gathered from interviews. EpiCollect allows the generation of custom questionnaires, and uploading of data in the field, to a remote server which displays the data on a project website that can be used for data analysis and visualisation. The software also records geospatial information to enable geographically mapping of data. Simulated scenarios and in-depth interviews can be conducted to examine attitudes and behaviours around antibiotic prescription, administration and adherence.

Information Sources: Source

Figure 13: IPC – ABS to Avert Antibiotic Resistance in High-Risk Populations from Resource-Poor Settings



Goals
Of the Partnership

This study aims to **provide measures that will optimise the practices for preventing the hospital-acquired infection as well as to reduce the antibiotic resistance in sick newborns.**[1]

Execution
Of the Partnership

This study involves the gathering of evidence-based interventions based on the critical analysis of the policies being followed, organisational facilities and current management practices, as well as individual behaviours towards the implementation of IPC-ABS.[1]

Takeaways
Opportunities in Kenya

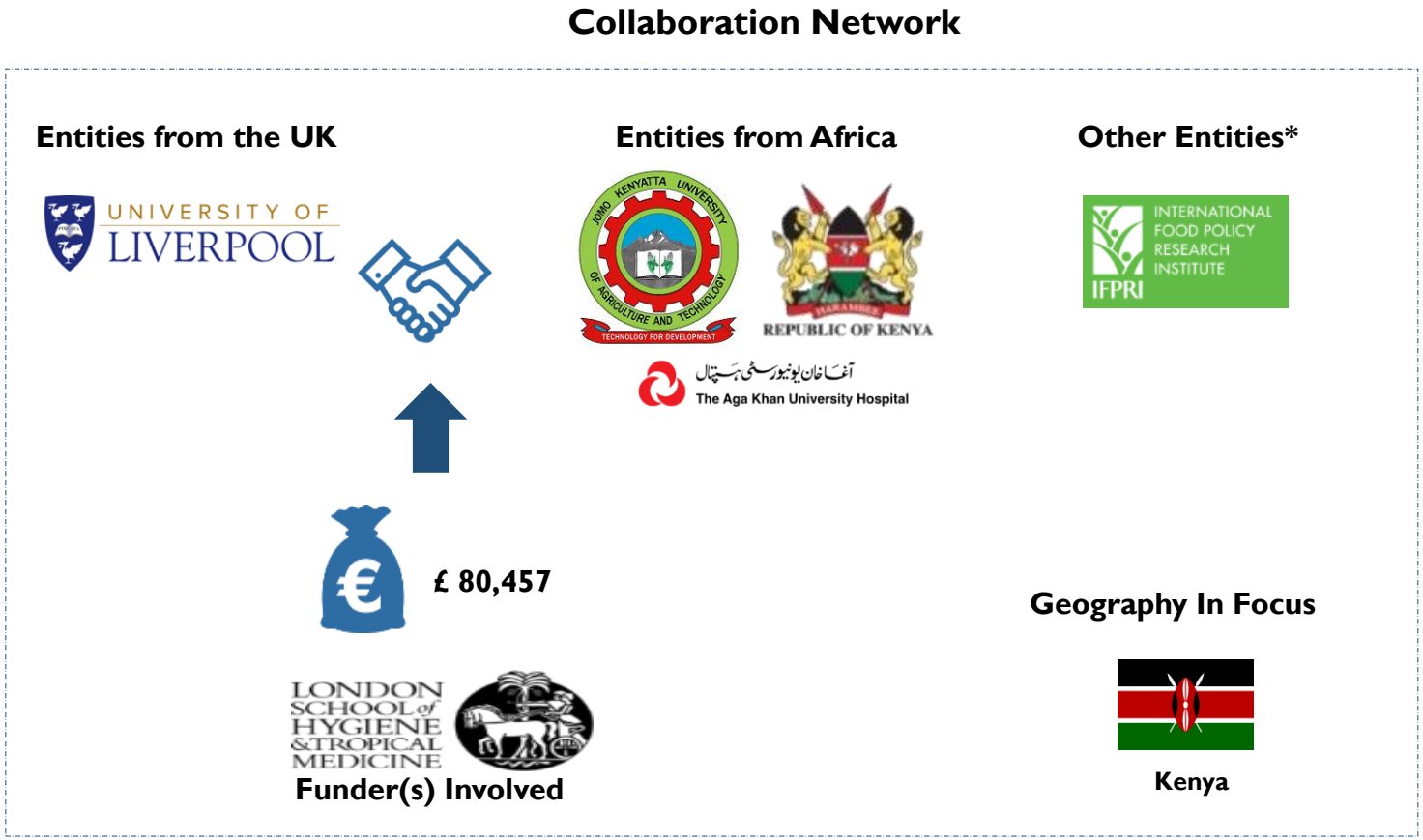
High Variance in the budget allocated for implementing IPC measures and WASH (Water Sanitation and Hygiene) across the healthcare centres. In some cases **the budget provided by Governments is not adequate** so that the requirement for WASH materials is unfulfilled leading to **shortage in supply or having sub-standard materials.**[1]

Outcomes

Developing research capacity in Kenya: The University of Oxford has developed links in Africa which has helped them in transferring the skills from their University to help build research capacity amongst young investigators in Kenya.

Information Sources: Source[1]

Figure 14: Partnership for a Cross-disciplinary Approach to the Ecology of Antimicrobial Drug Resistance in Kenya



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Goals
Of the Partnership

This study aims to **analyse the food value chain, to find out the parameters and factors that persist in the food chain that are increasing the chances of antimicrobial resistance among the humans and animals.** The study also aims **to build a strong network of antibacterial surveillance** to monitor the transmission of microbes among various participants of the food chain. They also conducted a national agricultural value chain survey for antimicrobial drugs in Kenya.[1]

Takeaways
Opportunities in Kenya

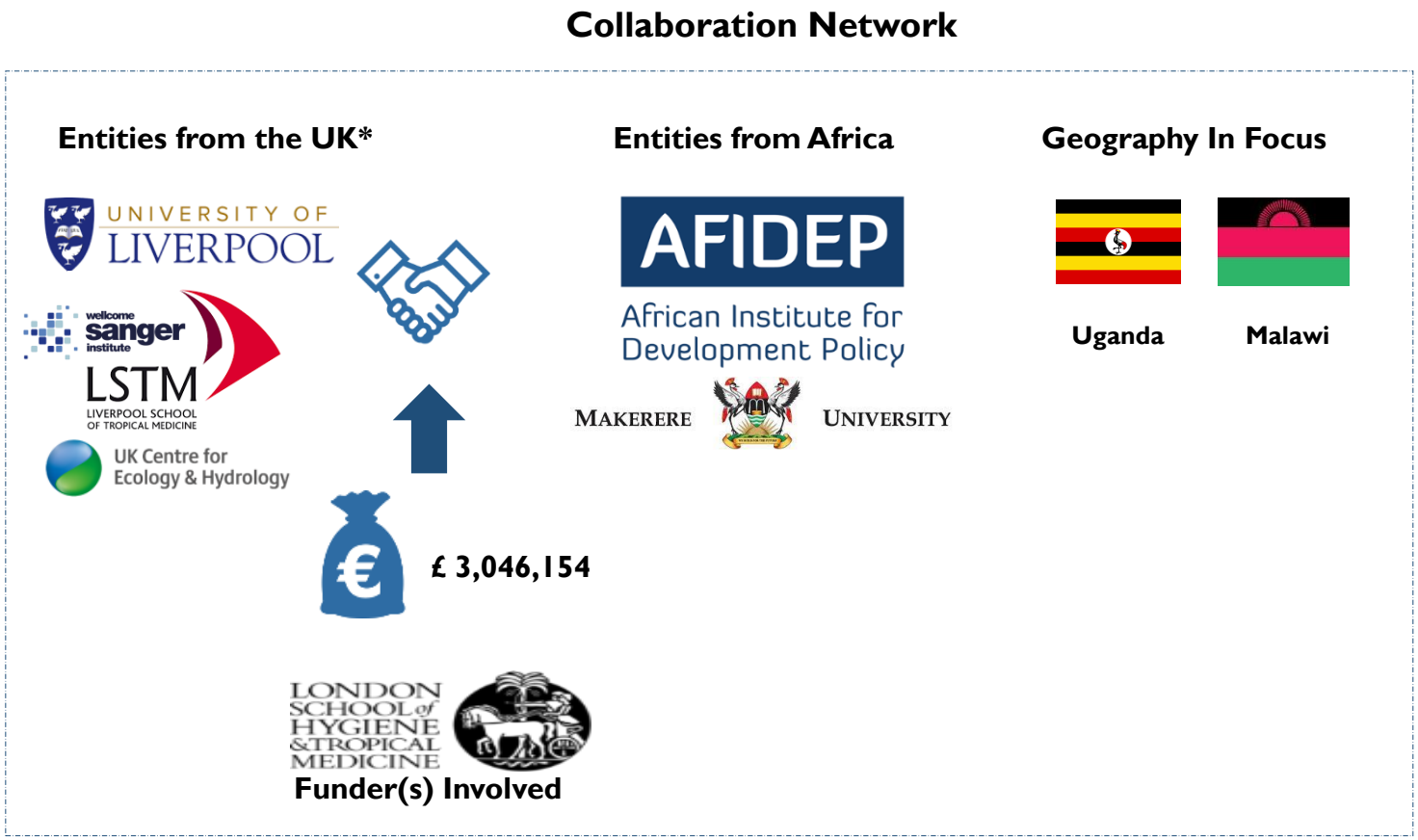
- **The literature available is not comprehensive, and suffers from multiple gaps.** It provides evidence for the transfer of resistive genes such as E.coli and their AMR determinants from animals to humans. However, there are **gaps in the methodologies of the studies that were analysed during the collaboration: half of the studies did not consider spatiotemporal relationships between human and food animal isolates, a fundamental requirement for investigating transmission.**
- Further, there is a similarity in AMR bacteria and the AMR resistance determinants which generate a **problem in identifying the direction of transfer of resistive genes** and it has been observed that the transfer can be in either direction.

Outcomes

- They have initiated **partnerships with the ABR policy community in Kenya.**[1]
- **The researchers involved have a strong background in Antimicrobial resistance.** The prime investigator of this research Eric Maurice Fevre from the University of Liverpool has expertise in Medical & Health Sciences and Public Health & Health Services. He is a well known researcher in AMR and has published a number of papers on Antimicrobial Resistance in collaboration with Universities and Research Institutes in Kenya[2].

Information Sources: Source[1], Source[2]

Figure 15: Drivers of Resistance in Uganda and Malawi: The DRUM Consortium



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Goals
Of the Partnership

The "Drivers of Resistance in Uganda and Malawi" or DRUM collaboration **aims to address human behaviour and their antibacterial usage in urban and rural areas of Uganda and Malawi, which contributes to the spread of antibiotic resistance.** The study focusses on the common bacteria E. coli and K. pneumoniae. E. coli is an example of bacteria that often causes infections in the community, but may also spread around hospitals, whereas K. pneumoniae is a key cause of hospital-acquired infections, particularly amongst premature babies. The reason for choosing these bacteria for the study is that they share similar traits that make them resistant to antibiotics.

Takeaways
Opportunities in Africa

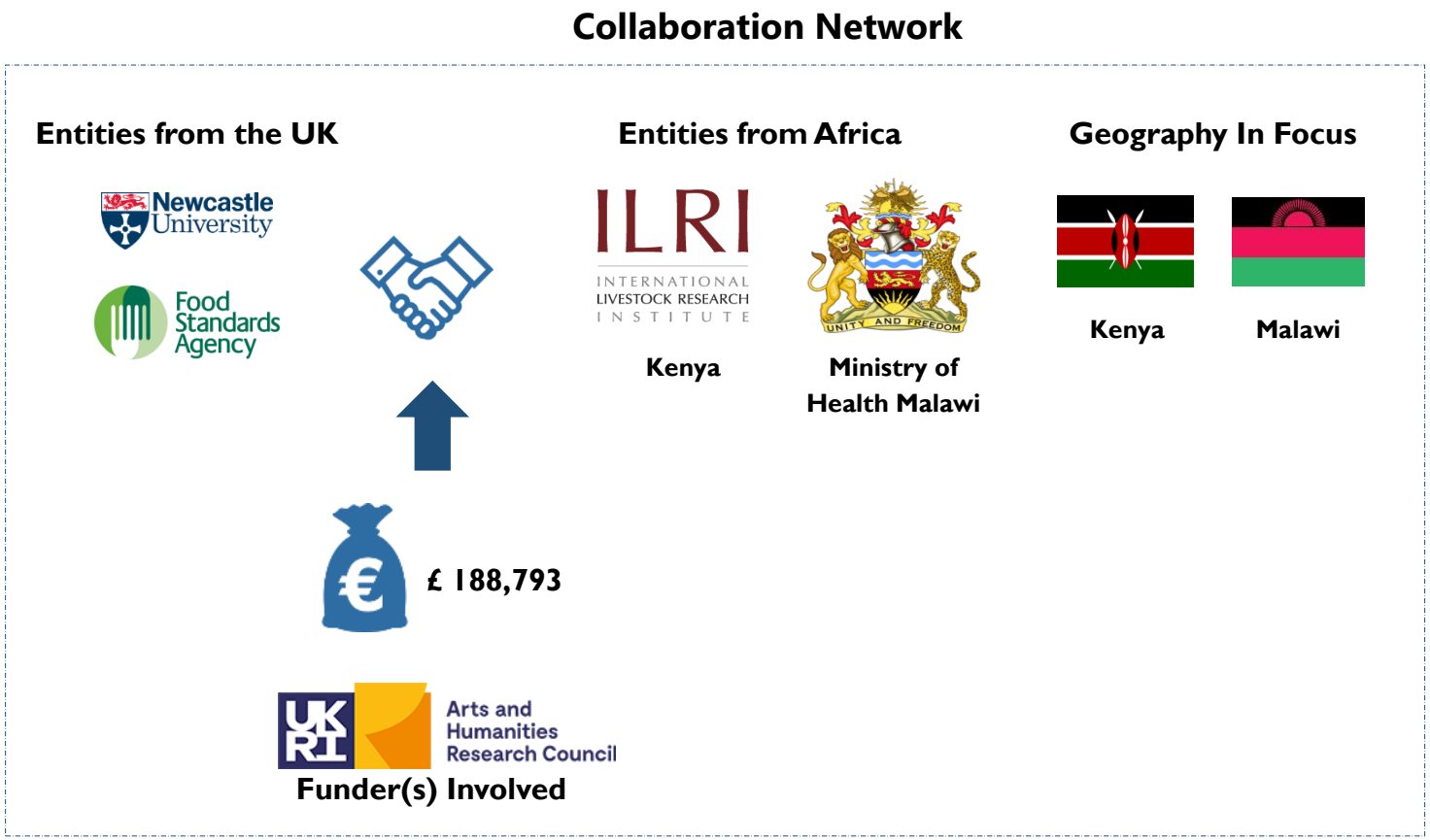
- It has been observed that Low and Middle-Income countries (LMIC) are **prone to severe bacterial infection and a lack of accessible health system infrastructure to diagnose and appropriately treat bacterial infections.**
- In addition, there is **widespread availability of antimicrobials without prescription**, such a situation is increasing pressure for the emergence of AMR pathogens.

Potential Outcomes

- The study has a **wider geographical outreach** — including the urban, semi-urban and rural areas. This will help in evaluating AMR transmission among different human and animal populations and at different levels. Further, it will provide an overview of WASH infrastructure and how the different areas are managing hygiene to prevent access to antimicrobials.
- The **research has also received further funding for other projects** which includes:
  - BMGF/African Academy of Sciences (AAS)-Alliance for Accelerating Excellence in Science in Africa (AESA), funded $100,000 by The Bill and Melinda Gates Foundation.
  - JPIAMR Network of European and African Researchers on AMR (NEAR-AMR), funded £44,000 by the Medical Research Council (MRC)
  - MRC Doctoral Training Programme x 3 studentships, funded £57,000 by the Medical Research Council (MRC).

Information Sources: Source

Figure 16: Changing Food Systems in Kenya and Malawi and the Challenge of Tackling Antimicrobial Resistance



Problem
To be Solved

The antibiotics are a necessary tool to maintain health and welfare on the farm, however, **their inappropriate and disproportionate use in animals is reducing availability for humans and also causing resistance. AMR has become a grave area of concern in agriculture and food systems**, pronounced even more with the increasing (reported) strains of bacteria such as *E. coli*, Campylobacter and Salmonella developing resistance to particular groups of antibiotics.[I]

Goals
Of the Partnership

The primary aim of this research partnership is **to evaluate the diet of the people including the consumption of meat, transformations in the food systems as well as evaluating the use/misuse of antibiotics in agriculture.** Its second aim is to **generate strategies for reducing the use of antibiotics as well as enhancing the stewardship initiatives to improve the implementation of their Governments' AMR National Action Plans**.[I]

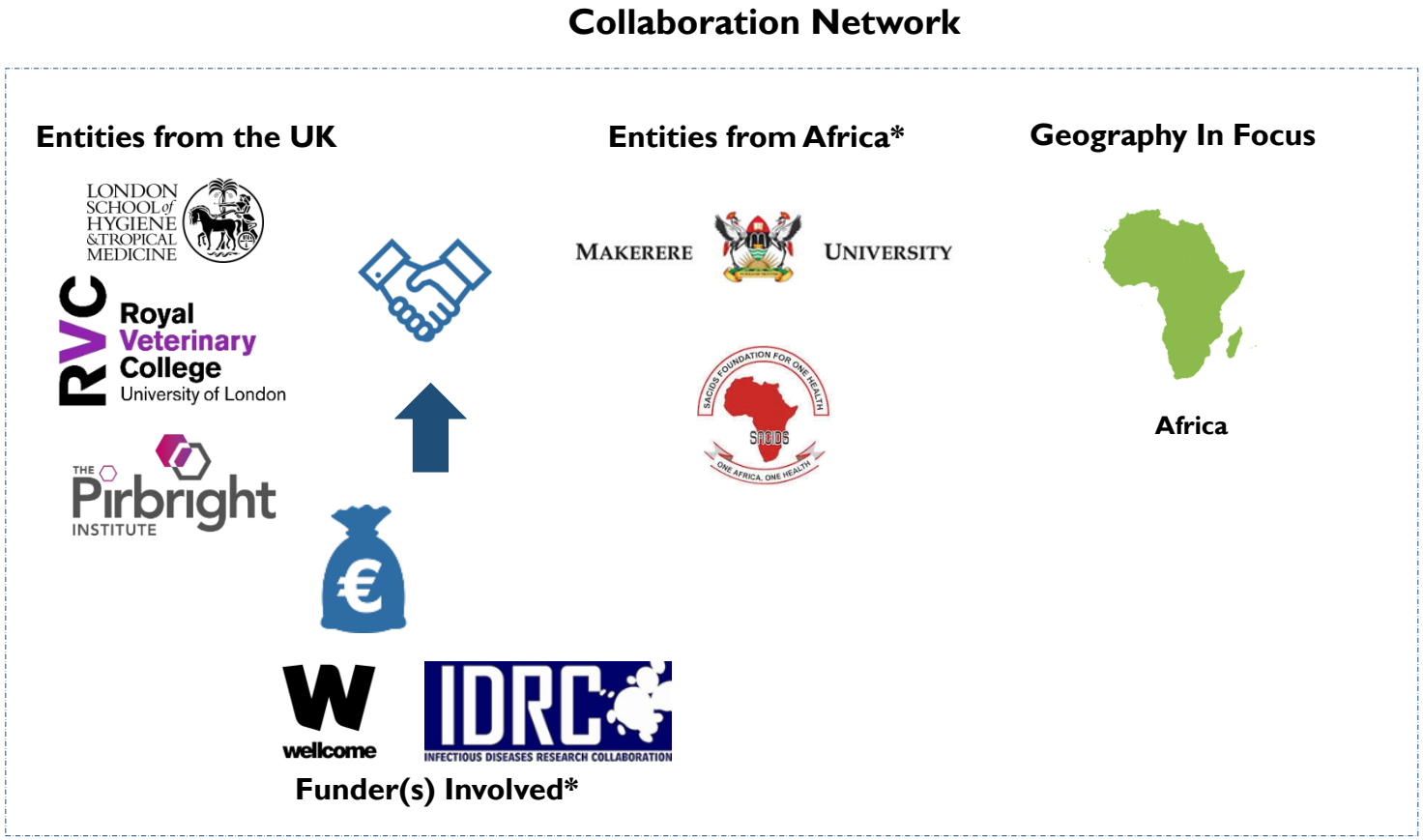
From this research, **recommendations will be made to Kenyan and Malawian AMR policy-makers regarding effective approaches to antibiotic stewardship and reducing the irrational use of antibiotics.**[I]

Potential Outcomes

- The research **involves national parties, such as the Ministry of Health of Kenya and other ministries including the Ministry of Agriculture.** Further, it involves the County governments, who are involved in the implementation and monitoring of the use of antibiotics. The involvement of public parties is helping them in evaluating and monitoring the research at each stage of implementation. [I]
- The **objectives of this partnership are aligned with the recently-formed AMR National Action Plans of Kenya and Malawi**, which is framed according to the WHO's Global Action Plan for AMR. Therefore, the implementation of the research will be at a wider scale and it will also involve the interests of large organisations such as, WHO, FAO—who have a strong research background in AMR.[I]
- **The partnership has been able to supply information to its target audience, which involves farmers and policy makers.** They have piloted educational materials that can be used by the farmers for communicating AMR awareness and prudent use of antibiotics.[I]

Information Sources: Source[I]

Figure 17: One Health capacity building in sub-Saharan Africa



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Goals
Of the Partnership

The research was based upon analysing academic and non-academic institutions, involved in the trainings of One Health Approach to citizens of Africa. **The objective of this study is to document all the networks and organisations conducting One Health training, research, and outreach in Africa. As well as analysing which challenges are being faced by Africa and the supporting organisations.**[1]

Execution
Of the Partnership

The **data for this study was collected from the organisations providing training. In addition, the research also involved contacts of authors and their networks (i.e. the groups with which they have worked).** To further enhance the research, web searches were also carried out using keywords such as: One Health, training, and research, work done in Africa.[1]

Outcomes

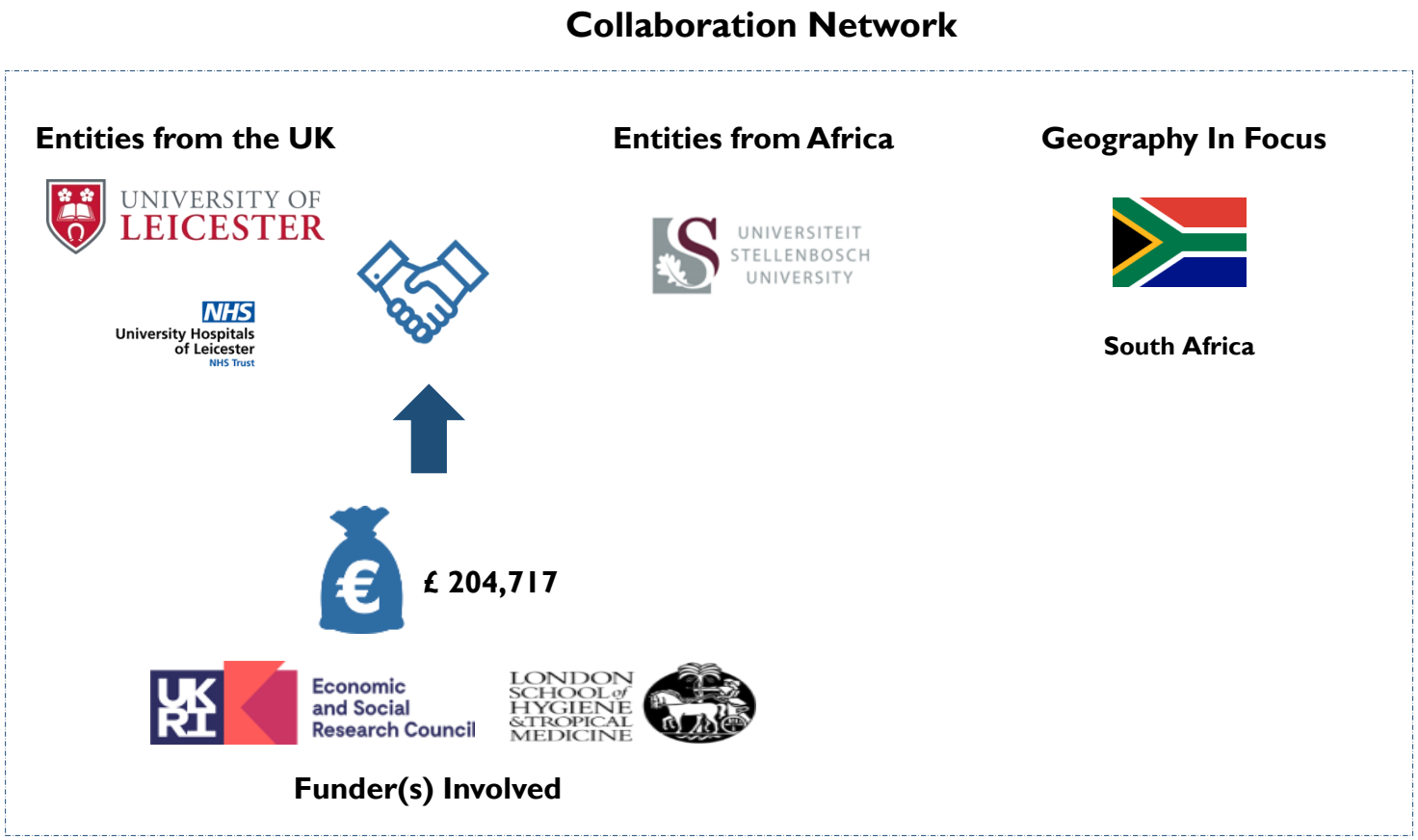
With the help of networks such as Afrique One, Southern African Centre for Infectious Disease Surveillance (SACIDS), and One Health Central and Eastern Africa (OHCEA), Africa is providing One Health training, research, and outreach, thereby increasing awareness among the people.

Takeaways
Opportunities in Africa

The study showed that, **Africa is facing challenges in preventing infectious diseases, which are prevalent in animals**. The pathogens creating infectious diseases are transmitted through the wildlife, livestock, and human interface.

Information Sources: Source[1]

Figure 18: Antimicrobial resistance as a social dilemma: Approaches to reducing broad-spectrum antibiotic use in acute medical patients internationally



Problem
To be Solved

The overuse of antibiotics is a major cause of Antimicrobial Resistance and it is influenced by the ways in which antibiotics are prescribed. Further, the prescription of antibiotics is widely dependent on social, cultural and organisational factors. **The healthcare providers usually take prescribing decisions based on the moral values and the customs of the healthcare community.**[1,2]

Goals
Of the Partnership

The collaboration aimed to achieve the following [1,2]

- To **develop an international group of academics and clinicians who will work together to use social science theories and methods to look at the use of antibiotics** in treating seriously ill patients.
- To **build a model that describes the use of broad-spectrum antibiotics in treating seriously ill patients**. *[The model will identify the risks, tensions, and elements of social and cultural contexts that affect the way antibiotics are prescribed.]*
- To **work on a future proposal that would use two types of mathematical models to predict the effect of various antibiotics and to improve the use of antibiotics.**

Execution
Of the Partnership

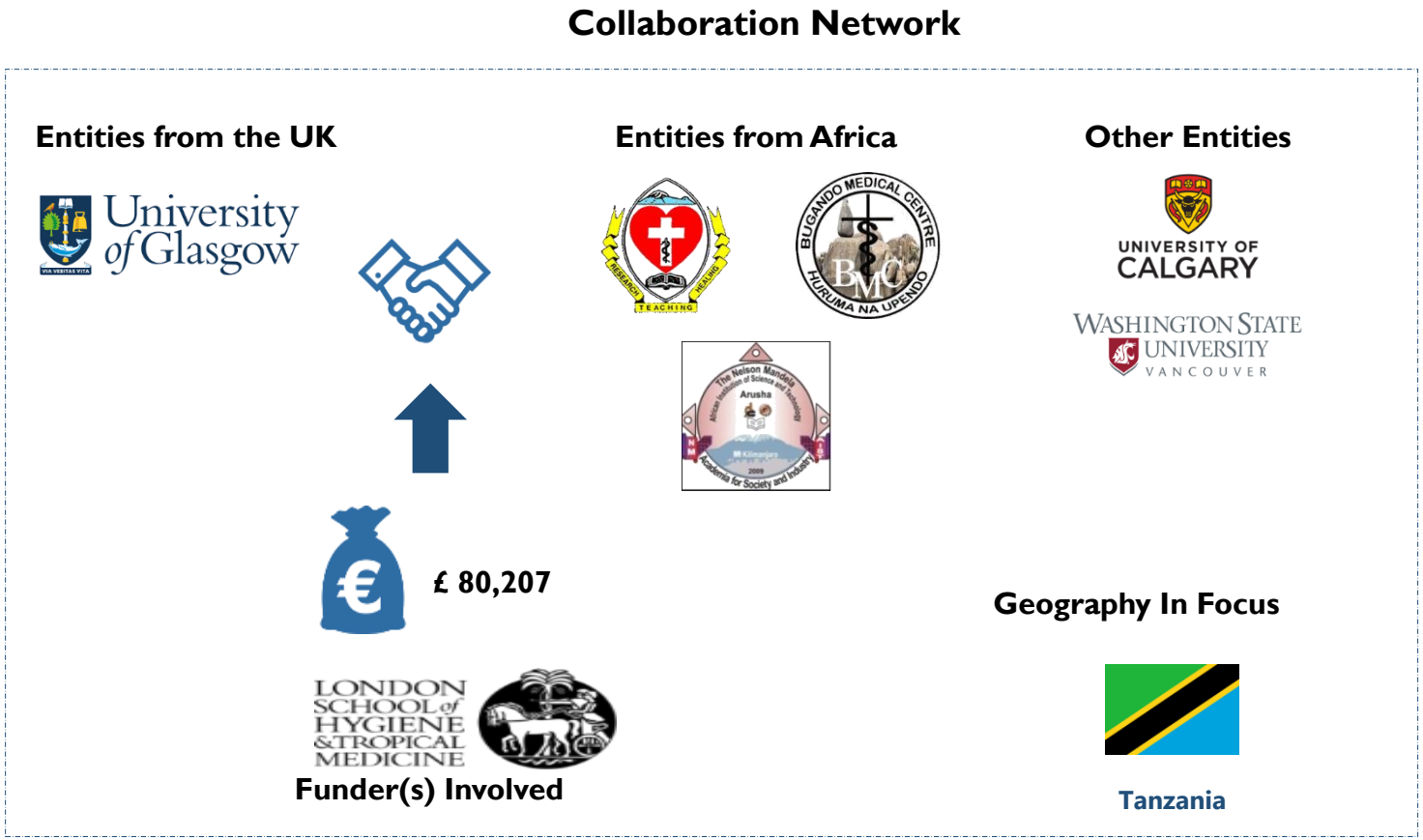
They conducted interviews with hospital prescribers of antibiotics in the UK, Sri Lanka, and South Africa. Their analysis during the study included symbolic factors such as the cultural role of doctors and the meaning of antibiotics; material factors such as hospital size, sanitation levels, laboratory facilities and availability of high-quality drugs; and relational factors including social hierarchies of hospital staff and complex doctor-patient relationships. **The collected information will help in the development of interventions and approaches for tackling antibiotic overuse.**[1]

Activities to Date

- The probability of a bacterial infection resistance depends upon the prescribers' habits of prescribing the antibiotics. For this, **they have developed a mathematical model which will help in improving the prescribing decisions** and this will automatically reduce the infection resistance.[1]
- They have also **developed an agent-based model, which has the potential to predict what factors may reduce the overprescribing and help to address AMR**. Further, they are **planning to build on these models in the future and turn them into predictive tools, which will be used to inform new antibiotic prescribing interventions and thus resolving the problem of improper prescriptions**.[1]
- They **have collaborated with an interdisciplinary research group based in Sweden.** The CeCAR group at the University of Gothenburg (Sweden) consists of political scientists, economists and philosophers who will investigate the problems pertaining to antimicrobial resistance (AMR) and aid in enhancing the research.[1]

Information Sources: Source[1], Source[2]

Figure 19: Supporting the National Action Plan for Antimicrobial Resistance (SNAP-AMR) in Tanzania



Background
Of this Partnership

The World Health Organisation is taking action in combating the AMR, and many countries are involved in its initiative to reduce the extent of AMR as much as possible. **Tanzania is also amongst one of the countries with an ambitious National Action Plan to tackle AMR.**[I]

Goals
Of this Partnership

The partnership aims to provide novel insights into biological, social, and cultural drivers of AMR within and out of the hospitals at an individual (inherent), micro (community), meso (institutional) and macro (policy) level. **The insights will aid in identifying and prioritising factors to reduce AMU and limit the risk and impact of AMR.**[I]

Execution
Of this Partnership

- The **researchers have examined the factors that influence the prescription and usage of antibiotics, e.g. availability of antibiotic drugs**, diagnostic facilities, to establish how best to create change in prescribing behaviour or use.[I]
- They **have also surveyed the use of antibiotics in livestock by individuals with different levels of knowledge about AMR**, e.g. district vets, community livestock officers, and livestock holders.[I]
- They have analysed **DNA-sequencing using genomic tools to establish whether resistant commensal bacteria found in fecal samples in the community are those responsible for illness** (respiratory infections, diarrhoea, sepsis, and urinary tract infections) in hospitalised children.[I]

Takeaways
Opportunities in Tanzania

- **Lack of human and financial resources to control AMR** is a major threat to the successful implementation of the NAP.[I]
- **The inadequate public awareness and communication programs** are recognised as a major weakness for implementing the National Action Plan.[I]

Outcomes

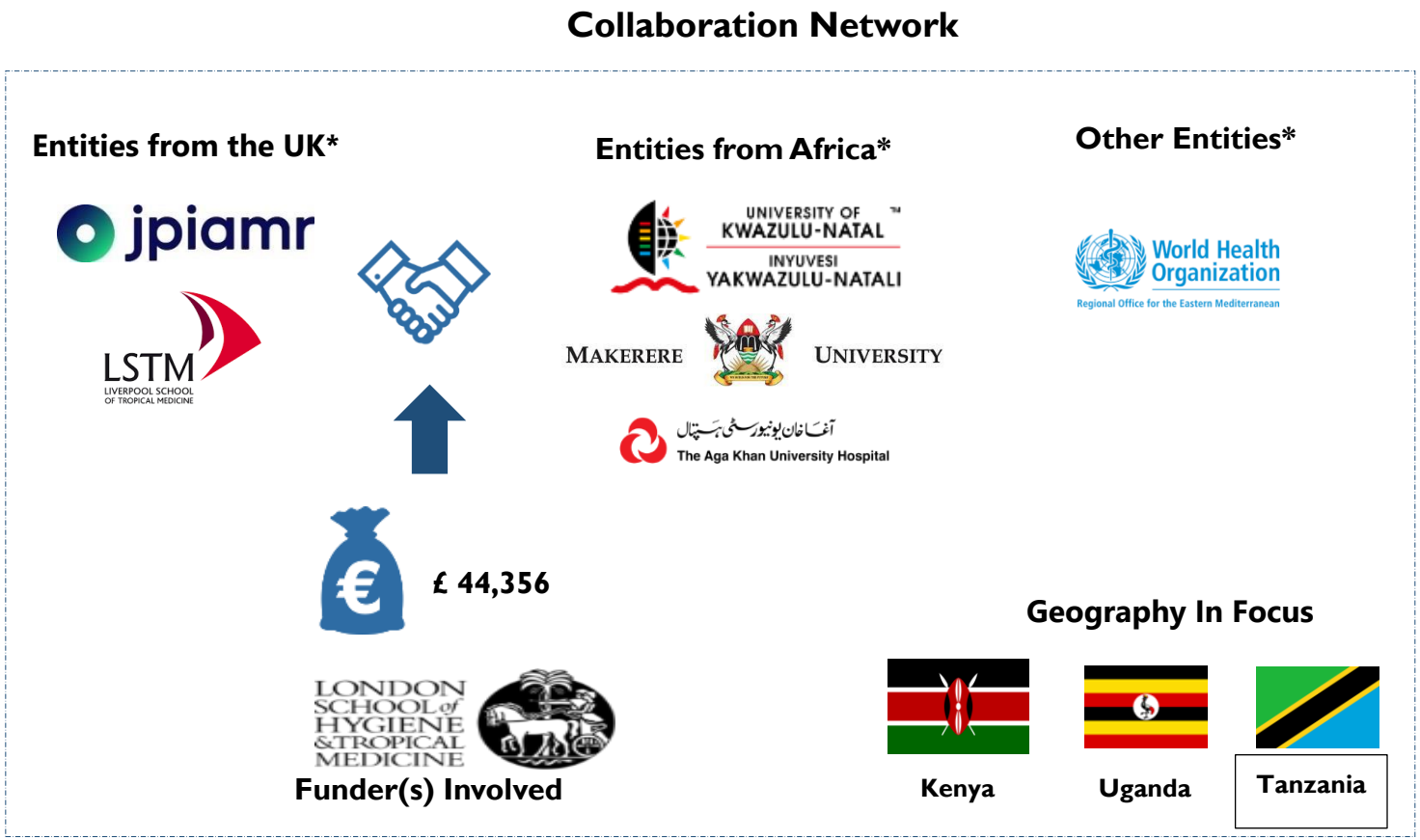
To improve the socio-economic investigations, **they have used the DNA-sequencing of the hospital or livestock-associated bacteria in combination with mathematical modeling approaches to analyse the relative contribution of different sources and transmission routes to the clinical and economic burden of AMR**.[I]

Activities to Date

- They **have designed a mass media campaign to create awareness and behavioural change that will help Tanzania to combat the threat posed to its future by AMR.** Through this, they will be sharing the areas where the use of antibiotics is high, the methods through which the antibiotic usage can be reduced (e.g. via improved training or education, diagnostic facilities or a social-norm based 'nudge').[I]
- The **research has provided the information to the priority audience i.e. the farmers and the policymakers** who will be making decisions while using antibiotics and it will finally impact the reduced usage of antibiotics.[I]

Information Sources: Source[I]

Figure 20: NEAR-AMR: Network of European and African Researchers on Antimicrobial Resistance



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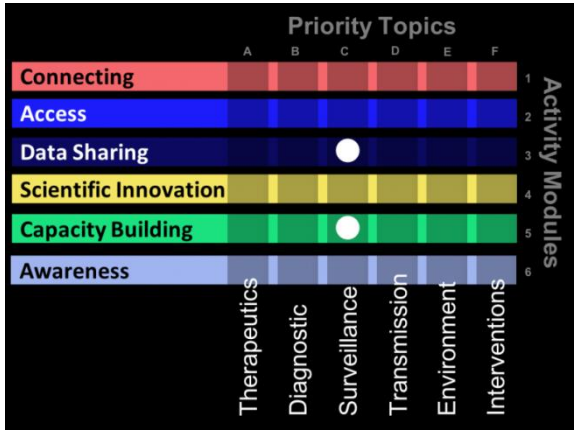
Goals
Of this Partnership

This **network aims to focus international efforts on the key priorities of AMR management for maximum benefit to ensure that outputs are translatable on an international scale.**
This collaborative approach has reviewed the various geographical areas and has divided the country-specific insights into the following focal areas:

- One - **determines which common capacity and capability training needs exist for young investigators**, who want to establish themselves within any area of AMR research from Europe and Africa.[I]
- Two **- Informing the realistic limitations, on the global surveillance data sharing platforms.**[I]
- Three - Informing what is possible within the range of existing healthcare infrastructures facilities and from multiple geographies.[I]



Execution
Of this Partnership

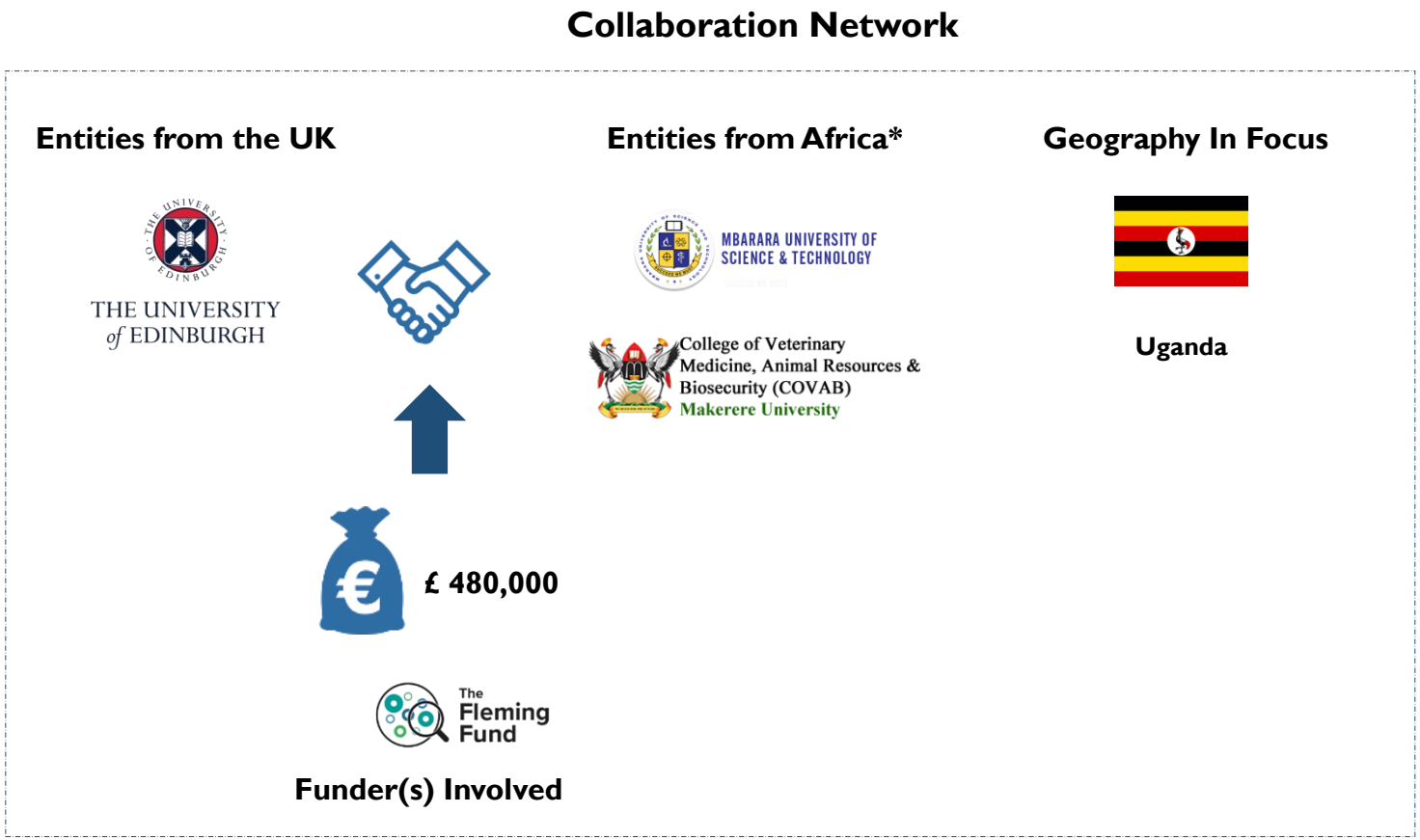
The **research involves 24 partners from 16 countries carrying out research in their respective areas**. They **are working on research papers that can be used by junior researchers.**[I]
The publications are open access for sharing and analysing the resource limitations, capabilities (current and future) of the different health systems and geography.[I]

Outcomes

- **Collaboration of a group of experts from leading institutions throughout Europe and Africa, with multidisciplinary skills (clinical, pharmacy, veterinary, environmental microbiology, epidemiology, molecular biology, and evolution) encompassing a One Health approach to AMR**.[I]
- The **researchers are continuously sharing their work on an online platform to update colleagues on any findings or challenges they have encountered**. This platform helps in continuously improving the surveillance strategies and in identifying limitations and providing solutions.[I]

Information Sources: Source[I]

Figure 21: Uganda: Professional Fellowship



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Background
Of Fleming Fund

The aim of the Fleming Fund is to address critical gaps in surveillance of antibiotic resistance in low-and middle-income countries (LMICs) in Asia and Sub-Saharan Africa. Countries in these areas are set to bear the highest burden of antimicrobial resistant infections. The Fleming Fund Grants Programme includes the Fleming Fellowship Scheme. **Fleming Fellowships provide mentorship and career enhancement opportunities for professionals in LMICs who are working in fields relevant to the national AMR response**.[2]

Goals
Of this Partnership

The Professional Fellowship scheme aims to support the professional development of key practitioners in Fleming Fund countries, in both human health and animal health sectors, who play an important role in implementing AMR and AMU surveillance. The scheme provides mentoring and support to improve fellows' skills and leadership capacity in gathering quality AMR diagnostic data, AMR and AMU data collection, management and analysis and use of surveillance results.[1]

Execution
Of this Partnership

Fellowship activities are likely to include the following[2]:

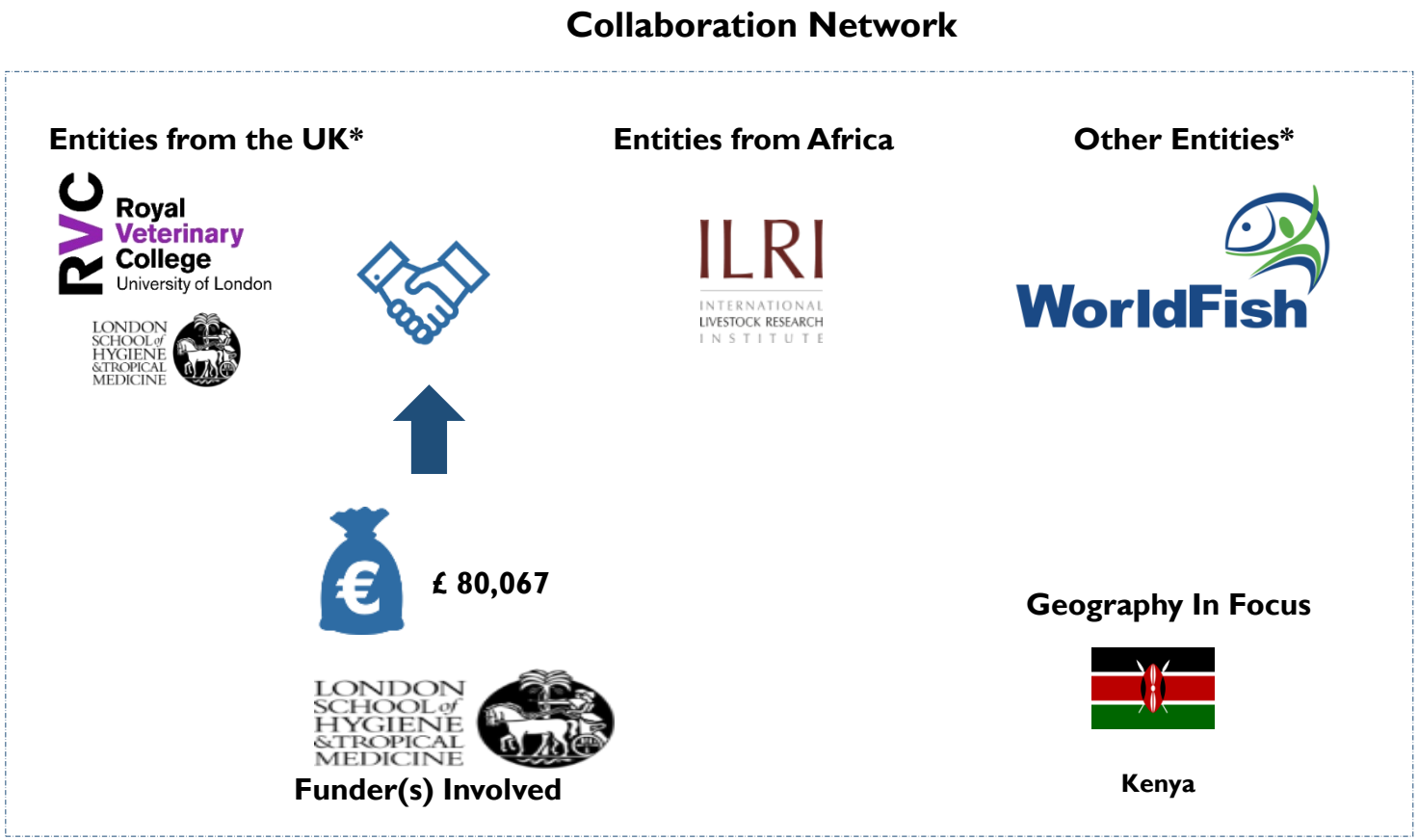
- **Mentorship:** The mentor from the host institution (The University of Edinburgh) is the main point of contact within the Fellowship Scheme. The mentor is expected to work with the fellow to define their learning objectives and outcomes, and to plan a programme of activities that delivers on these.
- **Secondments:** Each fellow is expected to spend some time seconded to another workplace setting at the host institution supervised by the mentor.
- **Collaborative projects with colleagues and/or other Fellows:** Host institutions have worked with fellows and other institutions to identify relevant projects for applied learning that involve working collaboratively to complete them.
- **Specialist training:** Fellows have benefited from specialist training in laboratory, surveillance or data analysis methods including One Health principles and approaches**.**

Outcomes

- **Thematic meetings, workshops and symposia:** The programme has conducted workshops locally or regionally for exchanging skills, sharing of lessons, and presentation of relevant data.[2]
- **Virtual networking and information exchange**: They have used virtual networks through online fellowship portal for sharing and communicating of information. This has supported information exchange through resource sharing, social networking, blogs, webinars and access to key publications, including clinical and operational research and data maps.[2]

Information Sources: Source[1], Source[2]

Figure 22: Towards controlling antimicrobial resistance in global aquatic animal food systems by enhancing collective resilience (AMFORA)



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Problem
To be Solved

Fish are often intensively farmed with heavy antibiotic (AB) use, and **these aquatic animals are traded worldwide, but their contribution to the burden of consumer exposure to AB resistance genes is not being addressed because of the complexity of global food systems** (producers, suppliers, intermediaries), **the lack of knowledge of the drivers of resistance** in aquatic systems (i.e. the influences, e.g. through animal husbandry and farm management, that result in the emergence of resistance in bacteria) **and the fragmented responsibilities**.[I]

Goals
Of this Partnership

This collaborative research will identify[I]:

i) The **drivers of AB usage in fish farming systems** and ways in which they impact on resistance development and global public health.
ii) The **knowledge gaps that currently preclude assessment of the consequences of AB usage in fish farming**.
iii) The **practices in fish farming leading to the threat of AB resistance**.

Execution
Of this Partnership

They have **conducted a combination of desk research** (literature review, data synthesis), **two workshops** (at Vietnam and Egypt) **and stakeholder interviews**. They have also **used innovative systems-based research to implement and evaluate strategies that have the potential of reducing the vulnerability of fish farming that may pose a threat to AB resistance**.[I]

Outcomes

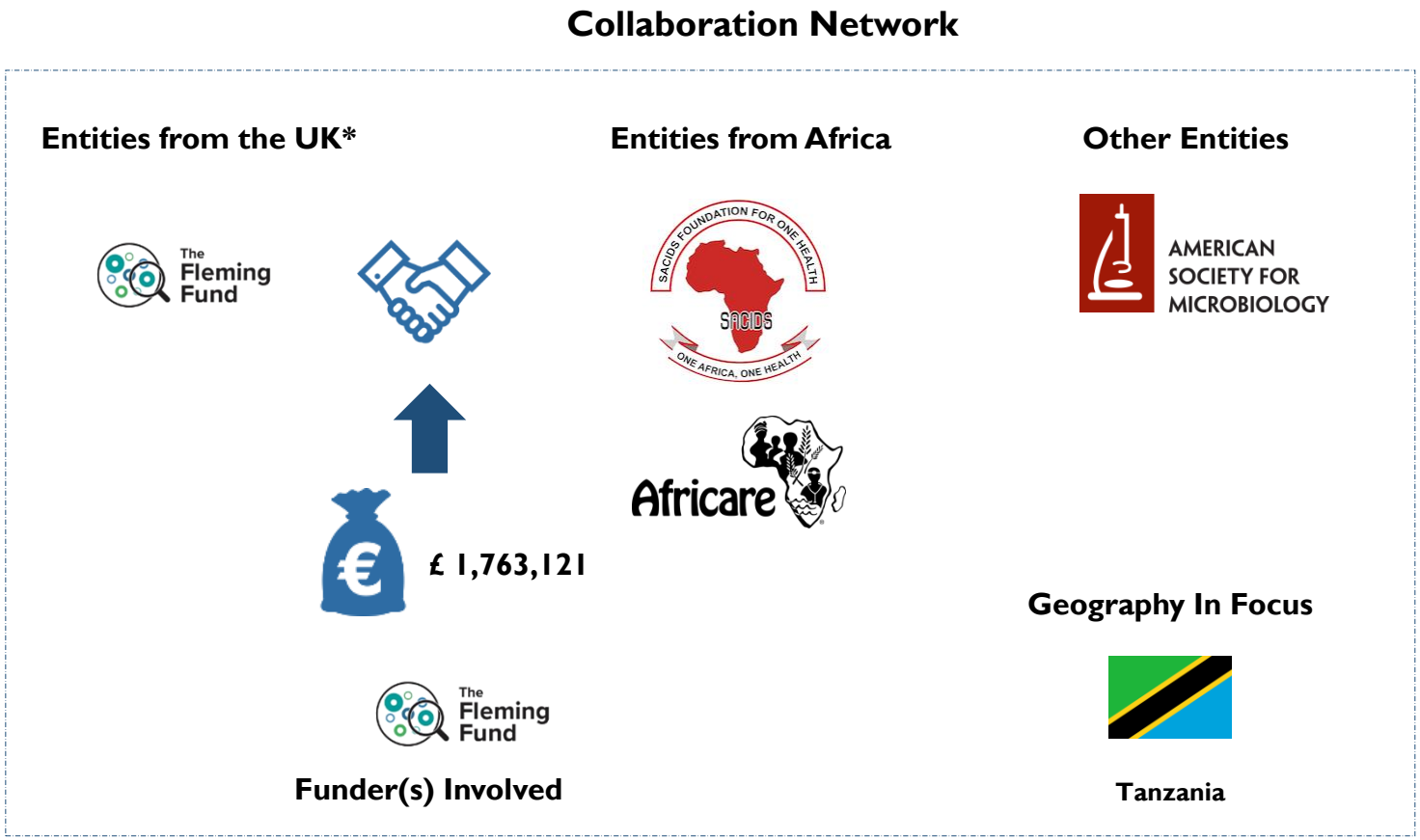
The in-depth interviews with key stakeholders, together with evidence collated through literature reviews and the mapping of risk factors and drivers for AB use and ABR **have led to the development of a framework tool to assess the resilience of fish production and surveillance systems in the context of ABR.**[I]

Takeaways
Opportunities in Kenya

- ABR is an **important biological threat to these countries, could threaten animal and public health infrastructures and also impact on global food systems via trade.**[I]

Information Sources: Source[I]

Figure 23: Tanzania: Country Grant



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Background
Of the Partnership

ASM (American Society for Microbiology) will lead a One Health focused partnership with the Southern Africa Centre for Infectious Disease Surveillance (SACIDS) and Africare **to deliver the Fleming Fund Country Grant for Tanzania**. **This consortium aims to strengthen Tanzania's national Antimicrobial Resistance (AMR) surveillance strategy by addressing the gaps in AMR data and strengthening antimicrobial stewardship.**[1]

Problem
To be Solved

The main issues being addressed by Fleming Fund Country Grants are outlined below:

- There are too **few trained microbiologists to undertake the volume of testing required for surveillance on AMR**.
- **Routinely AMR surveillance in healthcare delivery is not practiced** or there is no culture of surveillance for AMR in healthcare delivery and there are barriers in developing it.
- There is a **lack of antimicrobial stewardship**. Surveillance systems (national, regional and global) that do exist are often vertical, are not linked, and are often unwilling to integrate.
- There **are inadequately defined and applied quality assurance standards in laboratory testing**.[2]

Goals
Of this Partnership

The objectives are developed and agreed in partnership with the Government of Tanzania.

- They will **train microbiologists to conduct required AMR surveillance testing**.
- They will **provide access to laboratory supplies across the country**.
- Strengthening antimicrobial stewardship to **enhance the knowledge of the people**.[1]

Execution
Of this Partnership

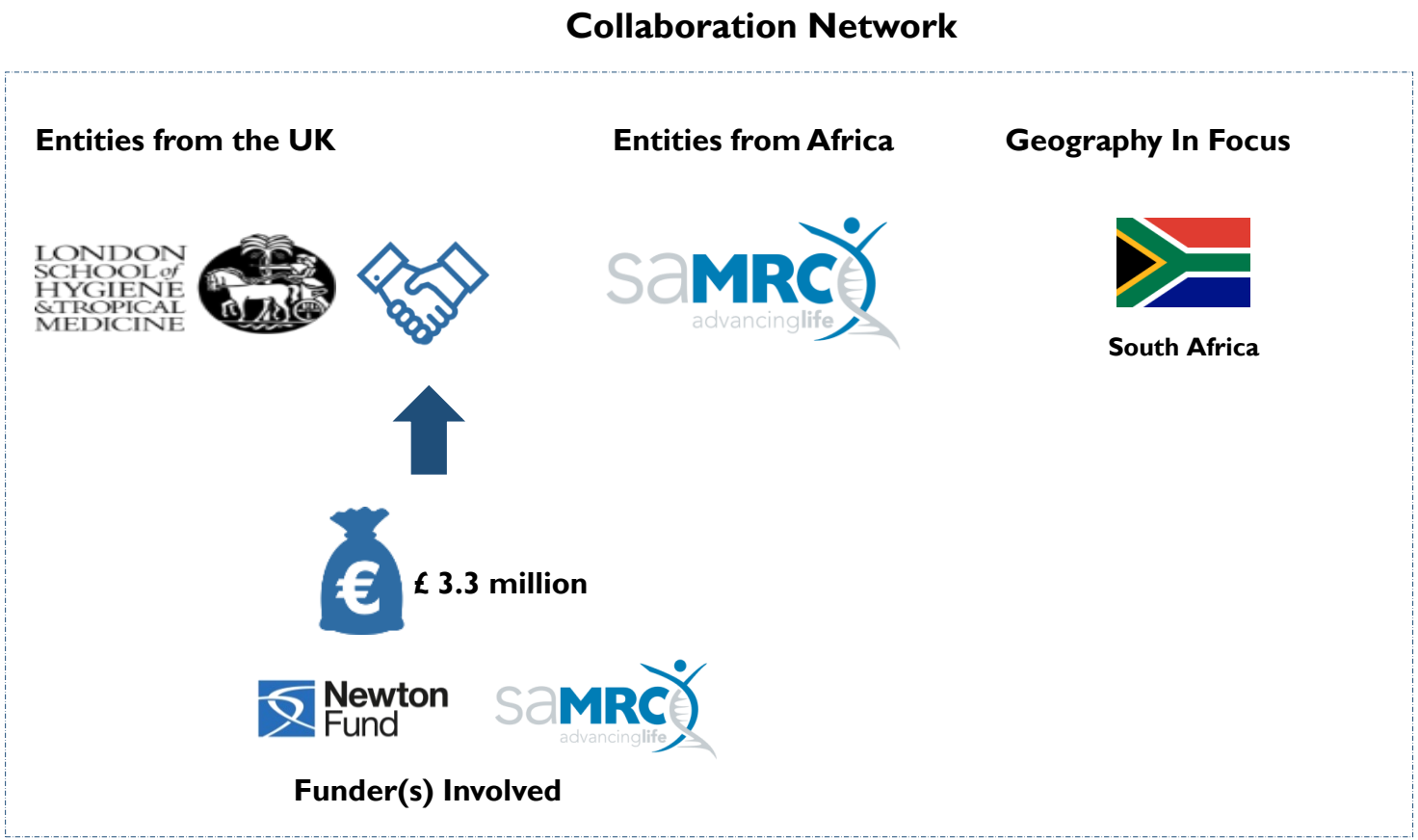
The **partnership is providing 18 months of training of the microbiologists of Tanzania**. It will **include training-of-trainer approach, and implementation includes access to expert trainers who can further train and mentor the laboratory workforce beyond the period of the project**. In addition to training, the partnership has ensured that laboratories can maintain essential equipment and supplies.[3]

Impact
Of the Partnership

- This partnership **has led to an increase in the quality and quantity of collected AMR data.**[2]
- AMR **data has been shared across the country to support evidence-based policy and practice**. Further, it will support the basis for awareness campaigns in the future on AMR/AMU. Finally the data is shared internationally to improve the global awareness.[2]

Information Sources: Source[1], Source[2]

Figure 24: South Africa-UK Antibiotic Accelerator Initiative



Background

Of the Newton Fund and Antibiotic Accelerator Initiative

The **Newton Fund builds research and innovation partnerships with 17 active partner countries to support their economic development and social welfare, and to develop their research and innovation capacity for long-term sustainable growth**. It has a total UK Government investment of £735 million up until 2021, with matched resources from the partner countries. It is a collaboration with SAMRC and funds the Antibiotic Accelerator initiative.

The Antibiotic Accelerator is made up of one hub in the UK and one in South Africa. Each hub comprises researchers/research groups from multiple research disciplines. Within the hubs, the research nodes contribute in an integrated way, with clearly defines work streams.[I]

Goals

Of this Partnership

This initiative is focused on drug discovery addressing one of the main challenges of AMR in South Africa with the aims[I]:

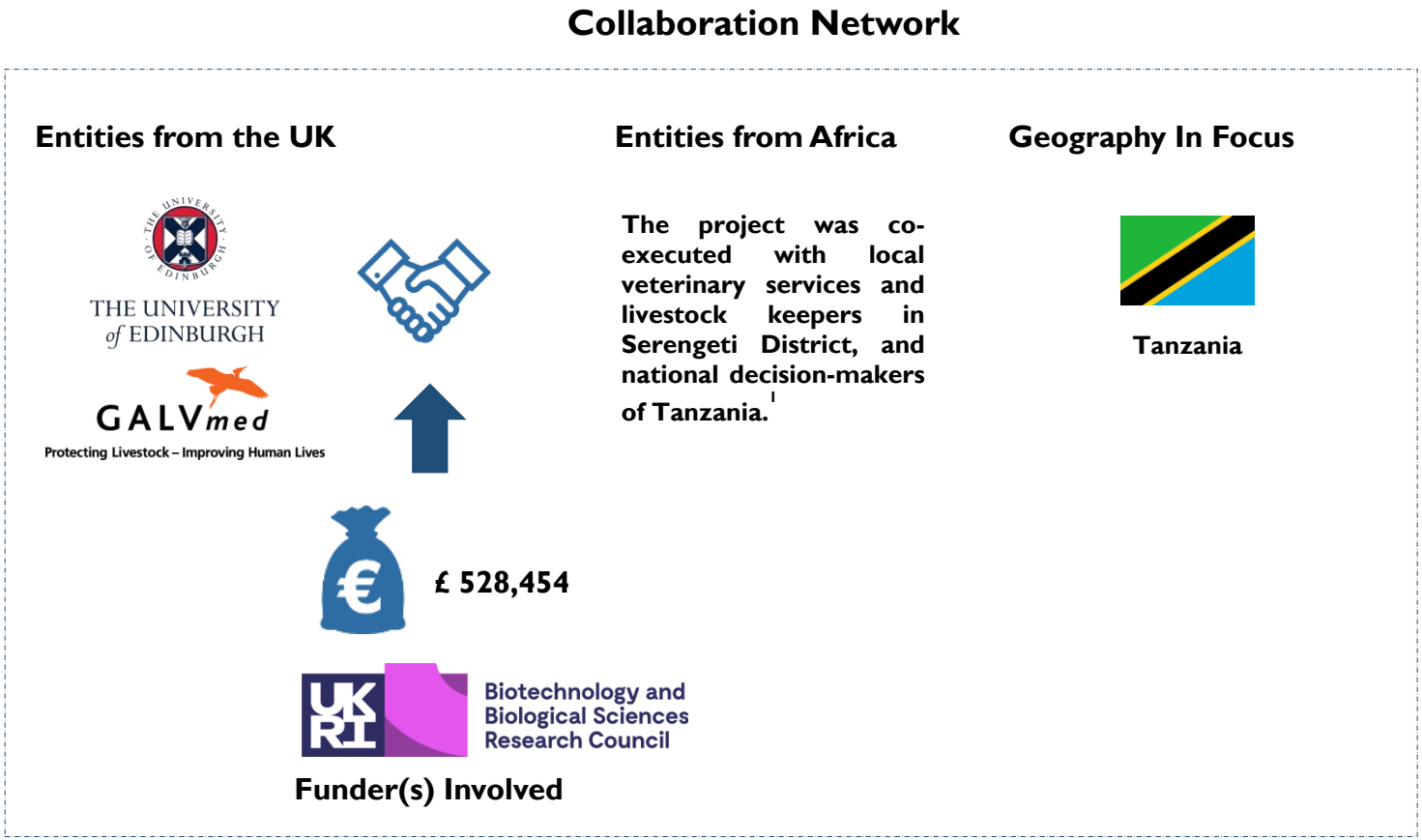
- To **support research in antibacterial drug discovery for pathogens of relevance to human health in South Africa**.
- To support **the mobility and exchange of UK and South African researchers to enhance links between researchers in both countries**.
- To **build capacity within antibiotic drug discovery**.
- To **build a global pre-competitive drug discovery consortium**.
- To **strengthen the strategic relationship between the UK and South Africa**.

Outcomes

- They **have conducted face to face communication with the research partners for effectively executing the research. For this, they did research staff exchanges,** including short and long term visits, exchange of technicians, masters or Ph.D. students, post-doctoral researchers and visiting fellows.[I]
- To enhance the flow of information among the researchers they has been **sharing of key resources (for example datasets, training guides, protocols for data collection and management) across the partner institutions.**[I]
- For strengthening the links and channelling the research information, they have **carried out supporting activities, for example symposia, workshops, seminars, meetings ,**etc.[I]
- For communicating the research output to the public and the interested audiences they **have provided open access to data and reports**.[I]

Information Sources: Source[I],

Figure 25: An integrated approach to tackling drug resistance in livestock trypanosomes



Information Sources: Source[I]

Problem
To be Solved

Trypanosomes are tsetse-fly transmitted single-celled organisms that cause serious disease in cattle, also known as African Animal Trypanosomiasis (AAT). **In sub-Saharan Africa, ~60 million cattle are at risk and AAT kills 3 million each year**. The farmers have to combat AAT, but to treat this, they only have two main drugs, which are >50 years old and widely used. **Resistance to these drugs is increasing, and there are very few drugs in the development phase. Despite being such a large issue, there is very little information about how trypanosomes resist the effect of the drug and there are very limited strategies which can be deployed to mitigate this problem.**[I]

Goals
Of this Partnership

This project aims to generate data and resources to bridge these knowledge gaps. And, the research partnership will investigate and answer the following questions[I]:

(i) What are the mechanisms by which resistance to ISM (Isometamidium Chloride) occurs and can we identify a marker?
(ii) What is the extent and cause of ISM failure?
(iii) What are the epidemiological consequences of ISM failure?
(iv) How might resistance to Trypanocides, including new drugs, be prevented?

Execution
Of this Partnership

To cover the knowledge gaps and identify the answer to their questions, the following research was carried out [I]:

- Identified **ISM resistance mechanisms by generating resistant parasites in the laboratory and comparing resistant and susceptible parasites using biochemical, molecular and genomic analysis**.
- **Collected the field data in the same area** to assess drug use and drug quality, isolate drug-resistant parasites, and assess the epidemiology of drug use and drug resistance in the field.
- With the combined data from the laboratory and the field, **they have generated a mathematical model that will accurately assess how resistance emerges and spreads and finally apply the model and predict scenarios** and will provide information to the industrial partners, GALVmed.

Takeaways
Opportunities in Tanzania

AAT has a large impact, for instance, reduced milk yields, meat production, fertility, and as well as mortality, and it is estimated to cost $2.5 billion to Eastern Africa alone. The disease severely impacts sub-Saharan regions where livestock rearing is the main livelihood of small communities.

Outcomes

- These analyses will be extended to explore resistance in the benzoxaboroles, and **it will lead to the development of strategies to maximise the lifetime of ISM, and new trypanocides such as the benzoxaboroles**.[I]
- This project has **provided local (veterinary services), national (Ministry of Agriculture, Livestock and Fisheries), global (AU-PATTEC, FAO) and donor (GALVmed, DFID, BMGF) organisations with evidence to back up their decisions on sustainable use of drugs** in AAT control.[I]

Information Sources: Source[I]

Figure 26: Bridging antimicrobial resistance knowledge gaps: The East African perspective on a global problem

Entities from the UK

UK NEQAS
International Quality Expertise

Entities from Africa

KNH
QUALITY HEALTH CARE

UNIVERSITY OF NAIROBI

Geography In Focus

Kenya

1 Goals of the Partnership

This study was conducted in Kenya to fill in the knowledge gaps for antimicrobial resistance, **the research was conducted in the Kenyatta National Hospital of Kenya and the entity from UK was involved only for quality testing and assurance.**[1]

2 Problem to be Solved

There is a lack of resistance surveillance data and updated antibiograms in Africa. Through the available literature, a pattern has been observed that **data from different sources on a particular topic**, are suggesting different figures for example, in 2014 it was documented[1] that the median prevalence of E. coli and K. pneumoniae resistance ranged from 0–47% and 8–77% respectively, while the World Health Organisation (WHO) estimated about 60% E. coli resistance to cephalosporins from incomplete data surveillance in 2012.[1]

3 Execution of this Partnership

They **conducted a 12 months survey of the patients in the Kenyatta National Hospital**, situated in Nairobi, Kenya, which is estimated to have 1,800 beds. The survey described the antimicrobial susceptibility patterns of bacterial isolates from the medical wards in KNH, and **therefore built a bridge across existing knowledge and practice gaps relevant to the patient, clinician, hospital, and community at large.**[1]

4 Takeaways — Opportunities in Kenya

The **resistance to commonly used antibiotics such as penicillins and cephalosporins was investigated** and the **increasing resistance to potent antibiotics such as carbapenems noted which is a cause for concern.**[1]

5 Outcomes

The survey conducted at the Kenyatta National Hospital was not restricted to the local patients, rather covered a large geography of patients. **The diverse population at the hospital helped the researchers in identifying a mix of community-acquired and healthcare-associated infections.**

Information Sources: Source[1]

Figure 27: Economic Evaluation support to a trial that assess strategies to address anti-microbial resistance in malnourished children (FLACSAM)

Entities from the UK

Entities from Africa

Geography In Focus

Kenya

1 Background of the Partnership

The research has been conducted by the staff of London School of Hygiene and Tropical Medicine—Gabriela Gomez and Anna Vassall. It is conducted in a partnership with KEMRI-Wellcome Trust Research Programme, and has been funded by Joint Global Health Trials Scheme (DFID, Wellcome & MRC.

Gabriela Gomez Guillen is the lead researcher of this project, who has over ten years of research experience in economic and impact evaluation of new technologies, most of it in infectious diseases such as HIV and TB. She is a member of the Global Health Cost Consortium (GHCC), a consortium that aims to improve the resources for better estimating the costs of TB and HIV programs. She is also involved in TB modeling and analysis consortium (TB-MAC), this aims to increase the effectiveness and efficiency of TB care and prevention policy.[I]

Information Sources: Source[I]

Figure 28: Professional Diploma in Tropical Medicine & Hygiene (East African Partnership)

Entities from the UK

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Entities from Africa

MAKERERE UNIVERSITY

Geography In Focus

Africa

1 Goals of the Partnership

The aim of this professional development programme is to build capacity for postgraduate training and clinical research in Africa, including for doctors from outside the region who intend to work locally. It is designed to introduce physicians to the knowledge and skills needed to practice medicine and promote health effectively and to inspire them to develop their own careers in the field.[I]

2 Impact of the Partnership

Through this programme, students have gained an insight in to the practical realities of health care in East Africa and are able to[I]:

- **Compare and contrast the management of infectious diseases in different contexts**.
- Critically **evaluate the evidence for health interventions in resource-limited areas**.
- **Provide a safe and competent assessment of sick patients (infected with AMR)** in African areas.

Information Sources: Source[I]

THE BLOOMSBURY SET

A knowledge exchange platform bringing together four partner Colleges of the University of London, together with the London International Development Centre, to accelerate the delivery of innovative scientific and technical solutions to help safeguard human and animal health.

CONNECTING CAPABILITY FUND

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Partners

Royal Veterinary College University of London

London School of Hygiene & Tropical Medicine

LSE The London School of Economics and Political Science

SOAS University of London

LIDC London International Development Centre

Supported by the Connecting Capability Fund

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