Master of Public Health

Integrative Learning Experience Report

POULTRY DISEASE PREVENTION AND ONE HEALTH EDUCATION

by

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MASTER OF PUBLIC HEALTH

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Abstract

Poultry Disease Prevention

Poultry exhibition requires pullorum disease testing, but many people don't understand the significance of the disease or requirement. To address these concerns, this project aimed to better communicate what pullorum disease is and why it testing for it is important. An educational brochure was expanded as a guide to identify, report, and prevent disease in poultry.

One Health Education

One Health focuses on the interface of human, animal, and environmental health. This intersection is linked by many factors of disease, such as proximity and shared resources. Water scarcity is a driving force that pushes interactions between humans, livestock, and wildlife, increasing their close proximity and providing an opportunity for disease transmission. Additionally, approximately 75% of emerging diseases are zoonotic and maintained in a wildlife reservoir, but are transmitted to the human population when disease "spillover" occurs. Risk of disease to humans varies based on occupation, environmental conditions, increased interactions with wildlife, and more. One Health takes a transdisciplinary approach to address numerous factors of disease simultaneously to improve health. As a participant in a Rx One Health training course, I was able to experience and discuss multifactorial causes of disease, challenges to health, and ongoing projects in Tanzania. At the end of the course, my team developed a project proposal to assess antimicrobial resistance in poultry in Iringa Town, Tanzania. The goals of this project were to determine the extent of antimicrobial resistance and create a cost-benefit analysis to persuade poultry raisers to invest in management and facilities for their poultry operations.

Subject Keywords: poultry, prevention, One Health

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Acronyms

Kansas Department of Agriculture (KDA)

United States Department of Agriculture (USDA)

USDA Animal and Plant Health Inspection Service (USDA-APHIS)

High Pathogenicity Avian Influenza (HPAI)

Low Pathogenicity Avian Influenza (LPAI)

World Health Organization (WHO)

Food and Agriculture Organization of the United Nations (FAO)

World Organisation for Animal Health (OIE)

Antimicrobial Resistance (AMR)

Human and Animal Livelihood Improvement (HALI)

Livestock Extension Officer (LEO)

Non-governmental organization (NGO)

Chapter 1 - Literature Review

Poultry Disease Prevention

Backyard poultry flocks can serve as a potential source of disease throughout the United States. To better protect the food supply and commercial poultry operations, it is important that all poultry raisers have basic knowledge surrounding poultry diseases and prevention.

Pullorum-typhoid testing is a requirement for exhibition poultry in most states. Pullorum disease, caused by two different biovars of *Salmonella enterica* subspecies *enterica,* typically only causes symptoms in young birds with high mortality rates, approaching 100%. (Davison, Merck). Symptoms include depression, weakness, inappetence, dropping wings, labored breathing, dehydration, and diarrhea. As adults, the birds previously infected with pullorum disease may have decreased egg production and fertility. (The Center for Food Security & Public Health [CFSPH], 2019).

The disease is currently eradicated in commercial US poultry operations, but may exist in backyard flocks. According to the 2016 American Veterinary Medical Association (AVMA) pet ownership study, the incidence of poultry owned as pets increased 23% from the survey 5 years prior. Throughout Kansas, there are not license requirements to own poultry, only to sell poultry products and eggs. Now, 1.1% of households claimed poultry as pets, with 15.4 million reported birds total. (AVMA, 2018). To better monitor the potential for disease, poultry exhibitions began requiring pullorum-typhoid testing. In 1985, the Kansas Poultry Disease act was enacted and required “all hatcheries, hatchery supply flocks, and poultry entered in public exhibits or shows” meet the standards outlined in the National Poultry Improvement Plan. (Beyer, 2010). Pullorum-typhoid testing in the field is completed using a whole blood agglutination test.

When this requirement was enacted by states for county fairs and poultry shows, many people didn’t understand the reasoning or rationale behind the testing. To better communicate this, I developed two brochures. My rough draft was made after reading information about pullorum disease and revised by state and federal veterinarians working in Kansas. The brochure was reviewed by Drs. Justin Smith, Andy Hawkins, Sara McReynolds, Tarrie Crnic, Paul Grosdidier, Gerald Gibson, John Nelson, and LewAnn Schneider. Following the content edits, a marketing intern found pictures, formatted, and branded the brochure. The Kansas Department of Agriculture (KDA) has several divisions, including Administrative Services, Agricultural Business Services, Division of Animal Health, Division of Conservation and the Division of Water Resources. I worked in the Division of Animal Health and was overseen by Tarrie Crnic, DVM, MPH, Grant Administrator for the Division of Animal Health.

To provide a more comprehensive guide to disease prevention, information on Avian Influenza was included. Avian influenza is caused by type A influenza viruses and can be classified as Low Pathogenicity Avian Influenza (LPAI) or High Pathogenicity Avian Influenza (HPAI). LPAI naturally exists in wild birds, causes none to few clinical signs, and poses minimal threat to human health. (United States Department of Agriculture [USDA], 2017). In contrast, HPAI spreads rapidly and has a high death rate of 90-100% in domestic birds. (Center for Disease Control and Prevention [CDC], 2017). This can present as sudden death without clinical signs, nasal discharge, coughing, sneezing, incoordination, diarrhea, lack of energy and appetite, decreased egg production, misshapen or soft-shelled eggs, and swelling of the head, comb, eyelids, wattles, and hocks. (USDA, 2017).

An outbreak of HPAI occurred in the United States in December 2014 and lasting a few months into 2015. While there was no threat to human health or food safety, this outbreak resulted in depopulation of ten percent of egg-laying hens and three percent of turkeys in the United States. Overall, over 48 million birds in 15 states were affected, causing major economic impact on the producers, cost of poultry for consumers, and international trade. (Committee on Agriculture, Nutrition and Forestry, US Senate, 2015). During this outbreak, HPAI H5N2 was confirmed in the state of Kansas in a backyard poultry flock of chickens and ducks. Following the positive result, an incident command post and control zone were established. (KDA, 2015). Additionally, a separate incidence of LPAI was confirmed in a commercial poultry flock in March 2015. In cases of LPAI, flocks are appropriately depopulated, but don't require setting up a control zone or quarantine. (KDA, 2015).

Recent outbreaks have demonstrated that while commercial facilities may have taken appropriate biosecurity measures and precautions, disease can exist undetected in small backyard flocks, and pose a potential threat to poultry producers. To better manage the risk of avian disease, it is important to educate all poultry owners on biosecurity.

One Health

One Health is the intersection of human, animal, and environmental health. One Health applies an integrated, transdisciplinary approach, addressing multiple interconnected factors of disease, such as resource scarcity, food insecurity, lack of sanitation, and close proximity between humans and animals, simultaneously. (Mazet, et al., 2009).

A growing concern across all health disciplines is antimicrobial resistance. This topic is recognized as a global threat by the World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO), and World Organization for Animal Health (OIE). In

2015, the WHO issued a Global Action Plan on AMR in close collaboration with OIE and FAO. Development of antimicrobial resistance means standard treatments are no longer effective, leading to persistent infections, and increasing the risk of spread to others.

Concerns surrounding antimicrobial resistance include the considerable economic cost, lack of available effective treatments, and impact on both human and animal health. Although most can agree antimicrobial resistance is a concerning topic, there is limited evidence on incidence or impact. Contributing factors include quantity and quality of use of antimicrobials in livestock production and profitability.

In Tanzania, animal production plays an essential role in agriculture; however, due to the poor management, high pressure of diseases, and the limited access to veterinary health care as well as the shortage of veterinary services, many farmers choose to use antibiotics for most diseases without any concern of appropriate dose, duration or withdrawal time. Maasai historically are mobile pastoralists, but some have transitioned to being agro-pastoralists. They have also diverged to include small livestock in addition to their cattle. Maasai who purchase over the counter medicine from shops or use traditional healers are significantly less likely to consult vets for livestock. Furthermore, 74% of Maasai participants self-administered anti-microbials, while 36% consulted veterinarians, and only 7% observed withdrawal of meat and milk during and following treatment. (Caudell, et. al., 2017).

A cross-sectional study in 2009-2012 assessed drug usage by broiler chicken farmers and antimicrobial residues in Zanzibar, Tanzania. While 66% of respondents were aware of drug withdrawal in broilers, only 45.5% reported compliance. Laboratory tests on carcasses indicated 76.4% of the samples contained antimicrobial residues. (Nonga, Sungura, Ngowi, 2013). While these are the results of a single study in a region of Tanzania, the antimicrobial residues indicate a problem and demonstrate a need for intervention.

Antimicrobial resistance has been indicated across several species in Northern Tanzania. One study focused on the distribution of antimicrobial-resistant enteric bacteria from animals, people, and water across three culturally diverse groups. They established a high prevalence of antimicrobial resistance with 50% of the 50,000 isolates displaying resistance to at least one antibiotic. Resistance to ampicillin, streptomycin, sulfamethoxazole, tetracycline, and trimethoprim were consistently higher than for other antibiotics. Furthermore, *E. coli* isolates were widely distributed across hosts, lacking host-specific variation. In rural Tanzania, it is very common for people to consume raw milk, which is one possible source of shared enteric bacteria between livestock and people. Other factors associated with bacterial transmission include shared water sources and distance to urban centers. (Subbiah, et. al., 2020).

The problem surrounding antimicrobial resistance is not specific to Tanzania or a single species of livestock. By investigating the knowledge, attitudes, and practices associated with antimicrobial use and resistance across Ghana, Kenya, Tanzania, Zambia, and Zimbabwe, we see that antimicrobial resistance is a global one health issue. Most participants rely on their own experiences when facing disease issues on their farms. The study included households keeping layers, cattle, sheep, goats, and broilers. They also reported relying on local agrovet shops to purchase antimicrobials without a diagnosis or prescription. This indicates a need for an integrative approach, starting with livestock keepers. (Caudell, et. al., 2020).

Addressing antimicrobial resistance integrates multiple strategies. The objectives laid out by OIE include: improve awareness and understanding, strengthen knowledge through surveillance and research, support good governance and capacity building, and encourage implementation of international standards.

Chapter 2 - Learning Objectives and Project Description

Poultry Disease Prevention

At the Kansas Department of Agriculture, my main objectives were to gain an understanding of the procedure used and significance of poultry testing, to create educational materials. While pullorum testing is required for exhibition poultry, many exhibitors have limited understanding behind the testing requirement. To bridge this gap, my project intended to focus on developing a brochure for youth explaining pullorum testing. This expanded to developing two brochures with targeted audiences: youth and adults. The youth brochure includes information on biosecurity, safe handling, avian influenza, and pullorum. The adult brochure provides more in depth information on biosecurity, disease prevention, safety tips, avian influenza, pullorum, the importance of disease testing, and information on pullorum testing.

During my internship with the Kansas Department of Agriculture, I worked on additional projects within the Division of Animal Health. This included improving the accessibility and readability or an informational document given to certified pullorum testers. In attending weekly staff meetings, I learned more about the organization of KDA's Division of Animal Health, the various roles they filled, how they work with USDA-APHIS veterinarians, and other conflicts they address. I also assisted the disease control office staff with data entry, typing handwritten sale barn records to be easily entered into USA Herds, which serves as a national traceability database. Throughout this time, I was introduced to many topics KDA covers and worked closely with the Emergency Preparedness coordinator, Associate State Veterinarians, and other staff. Additionally, I spent one day in the field with Dr. LewAnn Schneider from USDA APHIS investigating a case of orf in goat kids. Orf is a zoonotic pox virus that causes proliferative lesions, primarily on the mouth of infected goats and sheep. Other names include sore mouth, scabby mouth, and contagious ecthyma.

One Health Education

Rx One Health was an immersive professional development experience that had a learner-centered curriculum and was organized by the University of California at Davis One Health Institute. The overarching course objectives included:

- Explain principles that influence One Health, such as disease transmission, epidemiology, biological complexity, biosecurity, food safety and ecosystem dynamics
- Identify cultural and socioeconomic determinants of health

- Describe the benefits and challenges of One Health approaches to respond to complex health problems
- Discuss One Health problems from a transdisciplinary perspective
- Develop means of implementation of One Health approaches
- Evaluate methods of One Health research and community engagement
- Identify social, ecological, and economic impacts of a One Health approach
- Communicate One Health principles and approaches effectively to a broad range of stakeholders

During the four week course, we traveled throughout Tanzania and covered a wide range of topics. While in Dar es Salaam, the course focused on foundational learning of One Health and the connections between Agriculture and Nutrition. This portion included attending Nkuku 4 U: Nutrition Sensitive Agriculture and Poultry conference with extension officers and other community health workers. At this conference, we got to listen to speakers from around the globe and participate in hands-on activities. One group activity involved making decisions for your household and maintaining a budget. There were various concerns that needed to be balanced such as providing animal source protein for young children, raising crops and livestock, diseases, and the impact of other variables such as weather. This simulation made it very clear how difficult maintaining a budget while making the best decisions for a family can be.

Next, we traveled to Mafia Island where we focused on Marine Conservation & Community Development. During our time at Mafia Island, we traveled to nearby Chole Island to learn about the seaweed cooperative, women's group, education, healthcare and community struggles. Chole Island only has a primary school on the island, meaning anyone pursuing more education moves to Mafia Island, away from family. On Chole Island, they have one health clinic, one doctor, and one dispensary. While this seems limited, they are grateful, as they haven't always had access to a doctor locally. Any more advanced treatments require traveling to Mafia Island or even mainland Tanzania, which is an expensive several hours long journey by ship. The surrounding waters had been overfished, which led the Marine Park to come up with some innovative ideas for income-generating activities, including seaweed farming and bee-keeping. These activities are done primarily by women, enabling them to support their families. On Chole Island, they have solar panels for electricity and all use the same well for water. This small island even has some goats, cows, and chickens raised by families, living in close quarters, right outside their homes. Following this walking tour, we split into groups to develop an innovative solution to improve the community. This included coming up with ideas like rain

barrels to improve clean water access, providing educational support and dewormers to livestock raisers, improving knowledge on malaria, decreasing pollution by offering recycling and starting women's clean-up co-op, and methods to prevent further damage caused by invasive species.

Another unique opportunity we had was to travel to Juani Island, hiking on the single trail across the island to the Indian Ocean to watch green sea turtles hatch. The turtle nests were uncovered during the day at high tide to increase the turtle hatchlings survival rate. The amount of debris and trash washing up on the shore was unavoidable and shocking, as the baby turtles had to climb over straws, flip flops, and plastics. Additionally, we discussed pollution and environmental emergency response protocols and initiatives. Mafia Island has prepared locals for the chance of an environmental emergency, such as an oil spill, and has run simulations to practice.

After returning to the mainland, we visited MilkCom, an urban commercial dairy and processing plant. The dairy had numerous species, including cows, camels, sheep, and goats, but only the cow's milk was pasteurized and processed. Raw camel milk was consumed by workers and owners. On site, they had a massive processing facility. More of the milk was turned into and sold as dry, powdered milk, to improve the shelf-life. Rural Tanzania faces challenges with cold chain, transportation, and distribution. The dry, powdered milk can be more widely distributed and preserved. They also made ice cream and yogurt at the MilkCom dairy. Following the tour, we discussed our concerns. This included limited biosecurity measures, such as lack of footbaths or shoe covers, lack of flow, and not having a single point of entry. We also didn't see any cows with leg bands or spray paint to denote treatment and not allowing their milk in the bulk tank, but we didn't get a chance to ask about antibiotic withdrawal times and protocols.

The next portion of the course took place in Bagamoyo and focused on Zoonotic Disease. We learned about and toured the Ifakara Health Institute (IHI) and local hospital, which offers clinical trials. IHI performs laboratory testing, including tuberculosis and Rift Valley Fever virus. They are the main health center and laboratory in Tanzania. IHI is working on developing a malaria vaccine and improving maternal and child health. Here we also learned more about the PREDICT project. The PREDICT project is possible with the support of numerous groups, including USAID and the UC Davis One Health Institute. The Ministries of Health, Agriculture & Environment, Implementing University, and non-governmental organization (NGO) partners work in 35 countries. Focusing on the one health interface, as 75% of emerging zoonoses have wildlife origin, and population growth is higher near protected wildlife areas. The approach is

targeted, risk-based surveillance. Primarily primates, bats, and rodents are the study subjects. The goal is to earlier recognize potentially zoonotic viruses in wildlife, before people are affected. Additionally, they focus their testing on high risk interfaces, such as bat guano farms in Vietnam, Cambodia, and Thailand. To achieve this goal, PREDICT builds laboratory capacity in the countries they are studying in. As of July 2018, they trained over 4,000 field and laboratory staff and sampled 124,000 individual people and animals. At this point, they had also detected 888 novel viruses, by screening viral families.

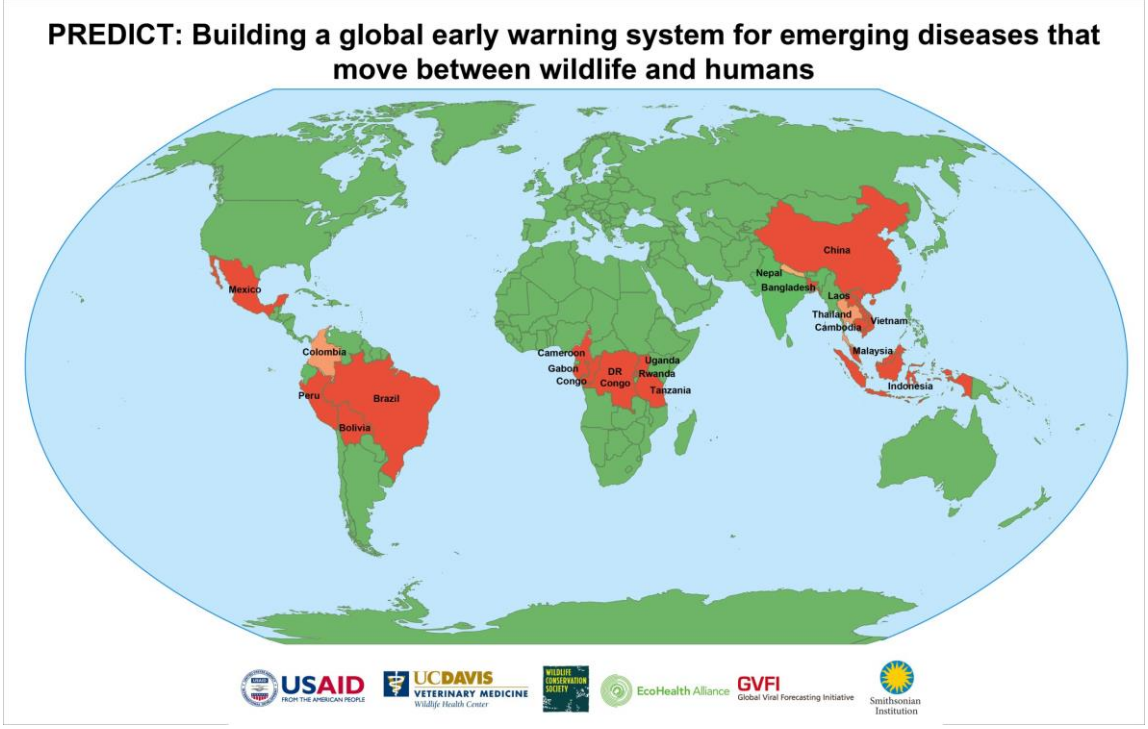

Figure 2.1 Map of countries participating in PREDICT

While in Bagamoyo, we also learned about biosecurity and practiced putting on and off personal protective equipment (PPE). In small groups, we did an outbreak investigation simulation concerning non-human primates in a cave within a National Park that resulted in human illness and death. Working with course instructors, we developed differentials, planned diagnostic testing, and received more information in a step-wise process. The results included pathology smears, physical exam data, and autopsy findings. Following the investigation simulation, we did a mock press conference to practice sharing findings with the public.

Part of the facilities with IHI include an insectary, which raises mosquitoes. This allows them to further study vector borne diseases. They have clinical trial rooms, in which someone

can volunteer to sleep with surrounding mosquitoes and they study the effectiveness of deterrents. It was also interesting to discover that ants are natural predators of mosquitoes, so facilities are often raised with water surrounding the base of structures to prevent ants ruining studies. We also gained field work experience, performing both rodent and insect sampling using traps and bait. There are three primary insect traps, including the CDC light trap, stealth trap, and BG trap. The BG trap requires bait, such as fermenting yeast to attract insects. The rodent traps used peanut butter mixed with flour as bait. The traps were set at dusk and checked in the morning. While examining the rodents, we wore full PPE, species, recorded weight and length, took blood samples, and performed oral swabs.

Traveling on, the next stop was at Sokoine University of Agriculture with tours of the PREDICT Lab and Veterinary College. The PREDICT lab was made out of two stacked shipping containers. We also enjoyed a game drive at Mikumi National Park. Throughout the remainder of the course, the focus shifted to wildlife health and stakeholder engagement, research methods and education, and One Health solutions.

Upon arriving in Iringa, we toured poultry farms. Divided into four groups, each farm visited served different purposes and was managed differently. This lead to a discussion on improvements to livestock management and providing support to the farmers. Management changes included things like cleaner facilities, improved access to food and water, and better ventilation. While in Iringa, we had a panel of experts discussing wildlife and conservation. For example, an organization called STEP focused primarily on elephant conservation in rural villages. As many people don't mind elephants until they cause personal damage and crop loss, the organization worked to provide beehive fences as a deterrent for elephants and source of additional income.

Following our stay in Iringa, we went to Tungamalenga. While there, we went to a Masai pasture to sample goats, sheep, and cattle. As there were no facilities or protocol to have a true random sampling, this was more opportunistic. The Masai boys would select a cow or bull, rope it, and hold it down on its side to be tagged, have blood drawn, take a temperature, and get a milk sample. Additionally, we went to a church in a local village to sample bats. Prior to catching the bats, we were fully dressed in personal protective equipment, and assembled a large net. The bats were then shooed out of the bell tower and flew into the surrounding net. After carefully untangling the bats, full sampling was performed. This included two oral swabs, two rectal swabs, and two blood samples. Personally, I did an oral swab and blood draw. Prior to releasing the bats, they were offered orange juice out of a bottle cap. To release the bats, they

were held upside down and their feet were touched to a branch, until they grasped the branch and were securely let go, before flying off.

To better understand daily life for local tribes, we visited a Masai Boma and Hei-Hei village. The Masai demonstrated cultural songs and dance to greet us. They shared their routine and way of life with us. As they allowed their children to attend school, two of their daughters are now nurses and convinced their father to build a modern home for the children to stay in. While the Masai raise animals and the HeHe focus on crops, both were concerned with wildlife activity. Living nearby Ruaha National Park, they reside in an elephant corridor and many other species pass through their land. The Masai's main problem was with carnivores, as they will attack livestock. The Hei-Hei were more concerned with elephants eating and trampling crops, as well as neighboring livestock.

The Ruaha Carnivore Project works to build and supply fencing and enclosures to keep livestock safe, as the lion population is threatened. While more livestock are killed by hyenas or leopards, lions are disproportionately killed following livestock attacks. Wildlife Connection, another NGO, provided beehive fences to deter elephants, supplemental income activities like chicken farming, and local libraries to encourage the community to save the elephant population as they cross their land. When an elephant walks into a beehive fence, it disturbs the bees, causing them leave the hive and swarm. Elephants don't like the sound of the bees, which provides an effective deterrent.

Next, we stayed in Ruaha National Park. While in Ruaha, we learned about the veterinary services for Tanzania's National Parks. Typically, they try not to intervene unless it is an endangered species. We learned about Giraffe Skin Disease, were split into groups, assigned territories, and did surveillance. In collecting data, we recorded the number of giraffes, surrounding vegetation, gender, approximate ages, the presence of ox peckers and descriptions of the lesions. Following the surveillance game drive, all the groups combined their data and made a presentation.

Additionally, we performed non-human primate sampling. This involved cutting cotton swabs into small pieces and placing them in a chunk of banana. We then placed the banana near the baboons and waited for them to pick it up. While eating the banana, they typically chewed on the swab, before spitting it out and throwing it back on the ground. After they discarded the chewed on swab, we collected it, placing it in media. Furthermore, we discussed water resource availability and anthrax in hippos. Anthrax outbreaks occur following prolonged draught, poor health, overgrazing, and stressful environments. While crocodiles and large

carnivores may feed on the dead hippos, they have low susceptibility and do not become infected. To control the outbreaks, carcasses are burned if accessible.

Table 2.1 Summary of Locations and Concerns

Location	Population Size	Risks- human	Risks- animal	Challenges to solutions
Dar es Salaam	4.365 million	Very urban population, pollution, overcrowding, poverty	Close proximity to people	Limited space for expansion of city
Mafia Island	40,801	Limited access to health care, no organized trash or recycling programs	Ocean pollution, limited access to medications for livestock, close proximity of livestock and wildlife	Transportation is expensive and limited
Chole Island	1,000	Limited access to fresh water, health care, unreliable electricity source, no plumbing	Close proximity to people and wildlife, limited fresh water available	Travel by handmade boats, unable to start trash collection or recycling
Juani Island	< 1,000	Very limited access to all resources including health care and fresh water, no plumbing, no electricity	Close proximity of livestock and wildlife, ocean pollution	Travel by handmade boats, unable to start trash collection or recycling, too small of population for health care
Iringa	151,345	Close proximity to other people and livestock	Limited space for livestock, close proximity to people	Large urban population surrounded by rural areas, only one main road from elsewhere in the country
Tungamalenga	9,205	Limited access to resources, close proximity to wildlife, shared water supply, destruction of livelihood by wildlife	Close proximity of livestock and wildlife, shared water supply	Rural location with limited access and transportation
Ruaha	10,873	Close proximity to wildlife, limited and shared water availability	Close proximity of livestock and wildlife, limited and shared water availability	Ruaha River is primary source of water and dries up seasonally, villages are in wildlife corridor

The remainder of the course focused on developing small group capstone projects. Projects were to be designed that could realistically be performed by the Health for Animals and Livelihood Improvement (HALI), considering feasibility, funding, One Health, and stakeholders. We were to use the previous three weeks of experiences to develop a research project that would improve the life of Tanzanians.

Initially, each person wrote down topics they were interested in on sticky notes. The course instructors grouped the sticky notes into the broad categories of infectious disease, environmental health, and community development. From those broad categories, individuals selected the topic they wanted to work on. The group of infectious disease was later divided in two separate groups, because of the large amount of interest. Each of the five groups then came up with a specific topic and project following the capstone guidelines.

A growing concern worldwide is antimicrobial resistance, which my group selected as our focus. In Tanzania, veterinary services are limited based on geographic access, costs, and lack of veterinarians. Furthermore, there are not strict regulations on withdrawal time and a lack of understanding with pastoralists about how antimicrobials work. Many people will give antibiotics without following directions and will consume the products or meat.

To better support our project planning, we interviewed a pastoralist, livestock extension officer, and AgroVet salesman to better identify points to intervene. We developed questions to improve our understanding of the application and concerns regarding antimicrobials, which were approved by course instructors prior to the interviews. At the time of developing this project, there was a lack of data establishing antimicrobial resistance in Tanzania, which guided our project to focus on determining the level or antimicrobial resistance. Our project was designed to focus on antimicrobial resistance in Iringa Town, with samples from poultry, people, and the environment.

Chapter 3 - Results

Poultry Disease Prevention

At the Kansas Department of Agriculture, I developed educational materials. The initial goal was to provide information to 4-H Youth on why pullorum testing is required for exhibition poultry. Many county fair exhibitors don't understand the importance of the regulations, but view drawing blood on each bird as a hassle and inconvenience. Providing more clarity and communication on the significance and public safety component guided this project.

This expanded to developing two brochures with targeted audiences. The youth brochure includes information on biosecurity, safe handling, avian influenza, and pullorum. The adult brochure provides more in depth information on biosecurity, disease prevention, safety tips, avian influenza, pullorum, the importance of disease testing, and information on pullorum testing. As I worked on the brochure, I added information on biosecurity, safe poultry handling, and Avian Influenza. This provides a more comprehensive guide to raising backyard flocks and exhibition poultry. The brochures were reviewed by the State Veterinarian, Associate State Veterinarians, KDA field vets, and USDA APHIS field vets. The graphic design and layout was overseen by a marketing intern. The printed brochures are provided to the field vets when they offer pullorum testing for exhibition poultry.

One Health Education

In the final week of Rx One Health, we formed small groups to develop a project that HALI could potentially pursue. Working with four other participants, our group decided to focus on the growing concern of antimicrobial resistance in agriculture. Following our topic selection, we reviewed relevant literature on AMR, including information by WHO and OIE, and extensively read the National Action Plan on Antimicrobial Resistance published by the United Republic of Tanzania. In our literature search, we found Tanzania lacks data regarding antimicrobial resistance.

We also had the opportunity to speak with a Maasai farmer, Livestock Extension Officer, and AgroVet salesman to better establish the issue with antibiotic access and regulations. As veterinarians are limited in Tanzania and not always capable of travelling in the field, farmers often treat based on clinical signs.

The Maasai expressed his concern with some previous antibiotics not working and claimed they were counterfeit, persuading his use to different brands. The treatment protocol varied on the severity, as they just doubled the amount of injections if the animal didn't show

signs of improvement. Fortunately, they have a good working relationship with their LEO and will call them for assistance. They also deworm their animals every 3 months, once an animal shows signs of illness. When questioned about compliance with withdrawal times, he stated that it depended. If the family consumed treated meat, the carcass would be washed and boiled before consuming. However, nobody would consume blood from a treated animal. If a milking cow was sick, they might wait two weeks before consuming milk again. They do experience treatment failure somewhat regularly, likely related to a misdiagnosis or incorrect dosage.

In speaking with the LEO, he addressed the need to improve preventative measures and management. In this position, he oversees three villages with livestock. He explained that every house keeps antibiotics on hand and pumps them into their animals at the first sign of illness. While he has good relationships with the community members, he recognizes that they often treat for only a few days instead of following the prescription. Furthermore, NGOs will provide prophylactic antibiotics to encourage supporting their cause. The LEO acknowledged the open access to antibiotics as a problem and wants to control distribution of drugs at a clinic. His recommendation was to have forums, as he didn't have the resources to do personal or small group consultations, to provide training on AMR, treatment protocols, disease prevention, and management techniques.

The veterinarian who owned the AgroVet shop explained how people will purchase drugs based on a history, but in terms of poultry productions, all birds would be treated. He also acknowledged a lack of understanding on withdrawal times, under dosing issues, and the lack of restrictions on acquiring antibiotics. Furthermore, not all employees at the AgroVet shop were veterinarians and no requirement of a physical exam or diagnosis was required.

Adhering to the guidelines of making the project feasible, we proposed first determining the extent of antimicrobial resistance genes present in Iringa Town, Tanzania. The project would be implemented over a total of three years. The project was outlined, including creating a budget and concept note. The proposed study planned to recruit a total of 132 poultry operations, with both broiler and laying hen operations classified as intensive commercial poultry, semi-intensive commercial poultry farms, and small non-commercial poultry farms. Samples would be collected twice during the year and tested for antimicrobial resistance of *E. coli* and *Salmonella*. Collection, analysis, and transmission potential would be assessed in poultry and poultry products, poultry water and feed, and in people visiting the local health clinic. Genomic extraction and qPCR would be utilized to assess genes in the samples.

Beyond determining the extent of antimicrobial resistance in Iringa Town, Tanzania our proposal includes plans on strengthening education and training, surveillance, and disease

prevention. In recruiting study participants, semi-structured interviews and observations will be documented to identify needs. Antibiotic use and financial status of the farms, along with their operations purpose and goals, would be recorded. To provide specific feedback, our team would work with an agricultural economist, to develop a model for cost-benefit analysis. This would show the projected outcomes in production based on investments in improvements of the facilities or management.

Furthermore, teaching core principles such as biosecurity, stocking density, or proper ventilation of facilities could lead to a reduction in the disease burden and reduce the need for antimicrobials. This would encourage poultry farmers to invest in improving management techniques and disease prevention. To ensure sustainability of the project, strategic implementing partners would provide support to local poultry farmers, emphasizing the economic and livelihood benefits. The multifaceted approach to address antimicrobial resistance is consistent with the United Republic of Tanzania National Action Plan on Antimicrobial Resistance.

Our project was presented within a ten minute limit to a panel of stakeholders including Dr. Jonna Mazet, Dr. Rudovick Kazwala, a local government representative, and a representative from a non-governmental organization. The presentations were followed with questions, a score, and feedback. Following this, our project was selected to move forward to receive funding and support.

Chapter 4 - Discussion

Poultry Disease Prevention

Avian disease prevention is a widely discussed topic with numerous resources provided by the USDA. Their “Biosecurity for the Birds” campaign and the National Poultry Improvement Plan are referenced often as resources. The KDA poultry brochures are an introductory resource to get basic information in hand and direct poultry raisers where to find more information. While they focus primarily on the diseases that are currently of concern, it could be amended in the future to include other diseases or species.

By better educating backyard poultry raisers, we can reduce the risk of avian disease and prevent outbreaks. Improving communication and education is an important step to take to improve the health and safety of all poultry.

One Health Education

Tanzania published “The National Action Plan on Antimicrobial Reistance 2017-2022” in April 2017. While the government is able to recognize antimicrobials as a concern and take measures to reduce the impact of AMR, there are limited studies establishing prevalence, as there is no surveillance on the subject.

If the proposed project “Antimicrobial Resistance in poultry in Iringa Town, Tanzania” received funding and was implemented, it would provide the foundation for subsequent studies. Initially, antimicrobial resistance surveillance could be expanded to surrounding villages and rural chicken operations. After establishing incidence and prevalence of resistant genes in select pathogens of *E. coli* and *Salmonella*, information could be collected on additional pathogens.

Furthermore, education on disease prevention could be shared across the country. By improving management techniques, nutrition, and biosecurity, the need for antimicrobials would be reduced, along with improvement of animal health and welfare, and profits.

Ultimately, the goal of this project would be to improve antimicrobial stewardship in Tanzania. By developing relationships with active non-governmental organization and partnering with Livestock Extension Officers (LEOs), antimicrobial distribution could be better overseen and controlled. Additionally, influencing governmental policy to develop stricter regulations regarding use and access to antimicrobials. Since many livestock keepers do not fully understand or follow withdrawal times, targeted communication through community

education and outreach, offered by LEOs and NGOs could improve the presence of antimicrobial residues in animal products for human consumption.

In order to improve human health, it is critical to determine factors of disease, and address them in a multifaceted approach. Overall, to better prevent and control disease outbreaks on a global scale, it is critical to implement a One Health approach and include evaluations of animal and environmental health. By identifying key factors that increase disease risk, communicating preventive measures, and instituting better surveillance, we will be able to determine an outbreak earlier on and better manage it.

Chapter 5 - Competencies

Student Attainment of MPH Foundational Competencies

Table 5.1 Summary of MPH Foundational Competencies

Number and Competency		Description
2	Select quantitative and qualitative data collection methods appropriate for a given public health context	In developing the AMR project proposal, we incorporated both qualitative and quantitative methods. The qualitative methods included surveys and interviews to perform a community based needs assessment and gain information for a cost-benefit analysis. The quantitative methods are reflected in the sample collection and analysis.
6	Discuss the means by which structural bias, social inequities and racism undermine health and create challenges to achieving health equity at organizational, community and societal levels	In Tanzania, we saw and heard firsthand how limited access to facilities, such as hospitals and health clinics are, especially during the rainy season. People in rural areas face more challenges, as roads may be inaccessible and transportation limited. Another key point we learned, is that if you are having a public meeting or forum, to make sure it is not during the same day or time as the weekly market or another event.
8	Apply awareness of cultural values and practices to the design or implementation of public health policies or programs	In regards to the AMR project, we were warned how insensitive and taboo it would be to ask people for fecal samples, indicating a need to obtain samples collected at a health clinic. Furthermore, the development of a strong working relationship and trust are critical to recruiting participants. There needs to be small talk and a meal prior to getting to the business portion in the Tanzanian culture.
20	Describe the importance of cultural competence in communicating public health content	When speaking with the Maasai family, our group needed to meet certain cultural expectations. Females needed to wear long skirts, we needed to be greeted by the men prior to asking questions, respond correctly, and ask permission to speak directly to the women.
21	Perform effectively on interprofessional teams	Rx One Health included 19 participants from five different countries with different backgrounds. My capstone team included a Tanzanian laboratorian, MPH from California, Nigerian veterinarian, and a vet student from Vietnam. This interprofessional and cross cultural team demonstrated the importance of communication.

In developing the project proposal, “Antimicrobial Resistant Genes in Poultry in Iringa Town, Tanzania” we made the choice to utilize multiple data collection methods. Qualitative methods included surveys and interviews to perform a community based needs assessment. This information would also be shared with an agricultural economist to develop a cost-benefit analysis personalized for each poultry raiser. Quantitative methods would be used in sample collection and analysis to determine the presence of antimicrobial resistant genes in poultry, products, the environment, and people.

In Tanzania, we saw, heard and discussed the means by which structural bias, social inequities, and racism undermine health and pose challenges in achieving health equity. People in rural areas especially face health disparities as roads may be inaccessible during seasonal changes, not everyone has access to transportation, and health services may be too far to reach by walking. When implementing health campaigns, it is critical to involve locals and to reduce as many barriers as possible. In hosting a town hall meeting or forum for a community, it is important to have a time, location, and place that doesn’t exclude certain demographics. For example, having it on a market day or in a remote location that is harder for more people to attend, adds barriers and undermines health equity.

Tanzania has different cultural values and practices than the United States. In preparation of our trip, we created a Globe Smart profile and looked at how our individual values compared to the US and Tanzania. For example, Tanzanians place more value on relationships than task, prefer certainty over risk, and typically use indirect communication over direct communication. When planning the AMR project, we considered these characteristics. Prior to asking farms to participate in the study or answer surveys, a friendly working relationship and trust would be necessary. Furthermore, it is generally more difficult to persuade Tanzanians to invest finances in upgrades, which is where the cost-benefit analysis would come in. In obtaining samples, we discussed wanting to include human samples to assess the spread and burden of AMR, however, asking someone would be a very taboo topic and would likely lead to their withdrawal in the project. To still include human samples without jeopardizing relationships, we decided to work with a local health clinic to use already collected samples.

The Rx One Health course included 19 participants from five different countries with varying backgrounds. The small group capstone project included Kelly Hagadorn a recent MPH graduate from the United States, Walter Simon a laboratory technologist from Tanzania, Buba Maryam Ibrahim, a Senior Veterinary Officer from Nigeria, and Han Ly a veterinary student from Vietnam.

Student Attainment of MPH Emphasis Area Competencies

Table 5.2 Summary of MPH Emphasis Area Competencies

MPH Emphasis Area: Infectious Diseases & Zoonosis		
Number and Competency		**Description**
1	Pathogens/pathogenic mechanisms	Evaluate modes of disease causation of infectious agents.
2	Host response to pathogens/immunology	Investigate the host immune response to infection.
3	Environmental/ecological influences	Examine the influence of environmental and ecological forces on infectious diseases.
4	Disease surveillance	Analyze disease risk factors and select appropriate surveillance.
5	Disease vectors	Investigate the role of vectors, toxic plants, and other toxins in infectious diseases.

Pathogens and pathogenic mechanisms were addressed in several of my courses. Specific pathogens of interest in poultry include Avian Influenza, Pullorum, and *Salmonella*. The mode of disease causation is critical, as it relates to the primary methods of prevention. Transmission modes can vary, such as direct contact, aerosolized, fecal-oral or venereal, with the preventive methods being tailored to fit transmission. To decrease the risk of diseases mentioned in poultry, it is recommended to limit contact with sick birds, migratory waterfowl, and equipment. Biosecurity is the most practical way to prevent disease and reduce the spread of pathogens.

Host responses were addressed during many in-depth discussions guided by readings throughout Rx One Health. In particular, discussions on pathogens including Rift Valley Fever, bovine tuberculosis, human immunodeficiency virus (HIV), and Plasmodium (which causes malaria disease) fit in with host responses. Host immune response is related to infection, disease, and prevention. One preventive method discussed was the development of a malaria vaccine. A malaria vaccine would lead to a reduction in concerns regarding compliance, drug resistance, and continual costs.

Environmental and ecological influences have a significant impact on the infectious diseases. This was examined in depth while staying at Ruaha National Park and in Chogela. During the dry season, there is limited water, as parts of the Great Ruaha river dry up. During

this period, contact is increased between humans, livestock, and wildlife. This can dramatically increase the number of negative interactions between livestock and wildlife. As large carnivores move closer to bomas (Maasai homesteads), there are more incidents of attacks on livestock, which then lead to retaliatory attacks by humans on the large carnivores. In addition to the impact on population, this impacts the spread of diseases between wildlife and livestock. Furthermore, when the river dries up and hippopotamuses graze on shorter vegetation, there are more outbreaks of *Bacillus anthracis*, as spores may be re-exposed to the air from roots being ripped out of the dry riverbed. This is a concern for the veterinarians and rangers, as spores can survive in the environment in extreme conditions for a long time. This also requires educating villages about the concern for their livestock coming in contact with anthrax spores and appropriately managing the diseased carcasses.

In relation to applying analysis of disease risk factors and surveillance, we discussed the PREDICT project overseen by groups including the United States Agency for International Development (USAID), University of California Davis One Health Institute, EcoHealth Alliance, Wildlife Conservation Society, Smithsonian Institution, Metabiota, the Center for Infection and Immunity, Columbia University, University of California San Francisco, Health Map, and ProMed. The focus of PREDICT is “to combat pathogens at their source at the first stage of emergence of zoonotic diseases that pose a significant threat to public and animal health.” To achieve this goal, targeted risk-based surveillance was performed on primarily primates, bats, and rodents, along with surveillance on birds, suids, carnivores, and ungulates. Typically, zoonotic viruses originate in wildlife, spreading to livestock, and humans. To better mitigate outbreaks, the goal of PREDICT was early recognition of potentially zoonotic viruses in wildlife. Furthermore, the surveillance focused at high risk interfaces around the world, such as bat guano farms. Increasing sustainability and local support was supported with building laboratory capacity in countries participating in PREDICT, such as the shipping container lab at Sokoine University of Agriculture. During the laboratory analysis, samples were screened for viral families enabling the discovery of novel viruses. This surveillance program took place in over 35 countries, over eight years, and detected nearly 900 novel viruses. Over 4,000 field and lab staff were trained, 60 laboratories developed, and nearly 125,000 individual people and animals sampled. To focus efforts, viral risk was assessed through the risk of spillover, based on virus specific traits and virus independent factors.

When identifying the role of vectors, toxic plants, and other toxins in infectious diseases there are an abundance of examples and applications. In particular, we talked about mosquito borne diseases including malaria and Rift Valley Fever. Preventive methods for mosquito

diseases include nets and repellant sprays. One of the greatest current threats is insecticide resistance, which would cause a lack of effect on insects. If the repellant sprays don't work as a deterrent, there is an increased risk to humans for mosquito borne disease. Heavy rain, urbanization, and contact with animals are all risk factors for malaria. At the Ifakara Health Institute in Bagamoyo, we were able to tour a mosquito breeding and experiment laboratory. The studies involve testing different preventive methods, such as slow release ivermectin implants and pyrethroid nets. The rooms are on elevated platforms surrounded by a moat to prevent the ants from eating the mosquitoes. The mosquito rearing facility had various stages of the life cycles. We also set mosquito traps including the CDC Light Trap, Stealth Trap and BG Trap, discussing the importance of a lure, such as fermenting yeast which provides CO_2 and is an excellent attractant. By better managing the vector burden of mosquitoes and developing preventive methods, the disease burden and costs related to malaria could be reduced.

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Appendix 1

PREVENTION FOR YOUR BIRDS: Biosecurity Steps

1. **Keep your distance.** Limit contact between your birds and wild birds.
2. **Keep it clean.** Always wash your hands before and after being near your birds. You can pick up germs from anything in the birds' living area.
3. **Don't bring disease home.** Isolate new birds for at least 30 days and keep birds who have been to an exhibition separated from the flock for two weeks after the event.
4. **Don't borrow disease from your neighbors.** Don't share equipment or supplies with other poultry owners.
5. **Know the warning signs.** Check your birds and let an adult know if something is wrong.
6. **Report sick birds.** If your birds are sick or dying, ask an adult to call your extension office, veterinarian or the state veterinarian.

Questions? Visit the USDA website for more information on biosecurity and bird health: healthybirds.aphis.usda.gov

AVIAN INFLUENZA

Avian influenza, or bird flu, is a respiratory disease in birds. There are two main types of bird flu:

1. **Highly Pathogenic Avian Influenza (HPAI)** is severe, easily spread and can cause illness in other species.
2. **Low Pathogenic Avian Influenza (LPAI)** is mild and birds may seem healthy, but it can mutate to become HPAI.

Bird flu can be spread from contact with sick birds, migratory waterfowl, or even from people and equipment.

Symptoms of avian influenza:

- Lack of energy or appetite
- Lower egg production
- Swelling of the head, comb, eyelids, wattles or legs
- Purple coloring of the wattles, comb or legs
- Diarrhea
- Runny nose, coughing or sneezing

SAFE HANDLING

Poultry, including chickens, ducks, geese and turkeys, carry many germs, like bacteria and viruses. One bacteria they carry is salmonella – which is zoonotic, meaning it can cause illness in people. Disease can spread to people after touching birds or anything in the area where birds live.

Safety Tips for You

- Always **wash your hands** with soap and water after touching birds or anything in the birds' living area.
- Don't eat or drink around poultry.
- Don't let poultry live inside your house, especially in the areas where you cook or eat.
- Keep the shoes you wear around poultry outside to avoid bringing germs into the house.
- Don't kiss your birds or snuggle them to your face.
- Clean poultry equipment outdoors.
- Refrigerate eggs after collection and cook them thoroughly before eating.

Questions? Visit the CDC website for more information: www.cdc.gov

Kansas Department of Agriculture
Division of Animal Health
1320 Research Park Drive
Manhattan, KS 66502
Phone: 785-564-6601
agriculture.ks.gov/animalhealth

PULLORUM

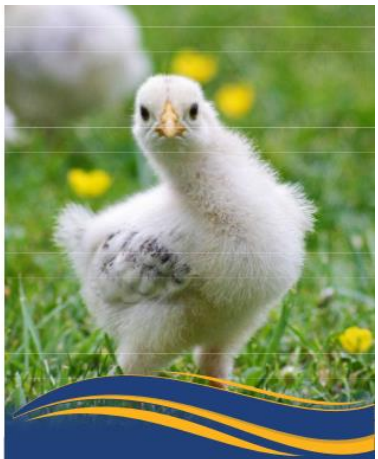
Salmonella is a bacteria that causes the disease pullorum and can result in the death of many chicks.

Birds most commonly get sick by eating eggs infected with the pullorum bacteria. Other methods include contact with infected birds and dirty food or water.

Signs of disease in young poultry:

- Huddling near heat source
- Weakness
- White diarrhea
- White fecal paste around vent

Adult poultry may carry the pullorum disease without showing any clinical signs, which may result in death.



POULTRY TESTING

For Avian Influenza and Pullorum

Why test?

Avian influenza and pullorum tests help veterinarians find sick birds earlier, prevent the spread of disease and protect other birds. If birds get sick with avian influenza or pullorum, they could die.

Testing is important to guarantee birds are healthy before going to exhibitions. This prevents pullorum and avian influenza from spreading to other birds and keeps your poultry healthy and safe.

While the U.S. commercial poultry facilities are pullorum free, this disease may still be present in backyard flocks.

In an outbreak of poultry disease, many birds die. Limiting the sale of birds and eggs helps stop the spread of disease.

Appendix 2

DISEASE PREVENTION: Biosecurity Steps

1. **Keep your distance.** Prevent contact between your birds and wild birds. Limit visitor access to your flock.
2. **Keep it clean.** Always wash your hands before and after being near your birds. Clean and disinfect your shoes, clothes and equipment.
3. **Don't bring disease home.** Isolate new birds for at least 30 days and keep birds who have been to an exhibition separated from the flock for two weeks after the event.
4. **Don't borrow disease from your neighbors.** Avoid sharing equipment or supplies with other poultry owners.
5. **Know the warning signs.** Take notice if something seems wrong with your birds and ask for help.
6. **Report sick birds.** If your birds are sick or dying, call your extension office, veterinarian or the state veterinarian.

For more information on biosecurity and bird health, visit the USDA website at: healthybirds.aphis.usda.gov.

SAFE HANDLING

Poultry, including chickens, ducks, geese and turkeys, carry bacteria and viruses, also known as pathogens. Salmonella is a common pathogen spread by live poultry. Young children, elderly and immunocompromised individuals are more susceptible to illness caused by salmonella. They should not handle or touch poultry.

Safety Tips for Your Family

- Always **wash your hands** with soap and water after touching birds or anything in the birds' living area.
- Don't eat or drink around poultry.
- Don't let poultry live inside, especially in the areas where you cook or eat.
- Keep the shoes you wear around poultry outside to avoid bringing pathogens into the house.
- Don't kiss your birds or snuggle them to your face.
- Clean poultry equipment outdoors.
- Refrigerate eggs after collection and cook them thoroughly before eating.

Salmonella illness in people can cause:

- diarrhea
- vomiting
- fever
- abdominal cramps

If you suspect salmonella infection, please contact your health care provider. For more information on safe handling, visit the CDC website at: www.cdc.gov.

Kansas Department of Agriculture
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POULTRY TESTING

For Avian Influenza and Pullorum

AVIAN INFLUENZA

Avian influenza (AI) is a respiratory disease in birds. There are two main types of bird flu:

1. **Highly Pathogenic Avian Influenza (HPAI)** is severe, easily spread and can cause illness in other species.
2. **Low Pathogenic Avian Influenza (LPAI)** is mild and birds may seem healthy, but it can mutate to become HPAI.

Bird flu can be spread from contact with sick birds, migratory waterfowl, or even from people and equipment.

Symptoms of avian influenza:

- Lack of energy or appetite
- Lower egg production
- Swelling of the head, comb, eyelids, wattles or legs
- Purple coloring of the wattles, comb or legs
- Diarrhea
- Runny nose, coughing or sneezing

PULLORUM

The bacteria salmonella causes pullorum disease in poultry and can result in the death of many chicks.

Birds most commonly get sick by eating eggs infected with the pullorum bacteria. Other methods include contact with other infected birds or ingesting food or water contaminated with feces from infected birds.

Signs of disease in young poultry:

- Huddling near heat source
- Weakness
- White diarrhea
- White fecal paste around vent

Adult poultry may not show symptoms while carrying the disease, but pullorum may still result in death of adult birds.

To reduce your risk of pullorum, be sure to purchase birds or fertilized eggs from a National Poultry Improvement Plan (NPIP) certified flock. These birds have a lower incidence of pullorum.

Importance of Testing

AI and pullorum tests are used for surveillance. This allows veterinarians to know if and where disease is present, which may warrant limitations on poultry sales, exhibition and travel.

While U.S. commercial poultry facilities are pullorum disease free, it may still be present in backyard flocks. Testing birds prior to exhibition limits the potential spread of disease.

Outbreaks of either AI or pullorum would cause significant damage to the U.S. poultry industry, including massive economic losses, restrictions on exports, and reduced supply of poultry and eggs.

Testing Information

Birds must be pullorum tested by a certified tester within 90 days of exhibition. For information on when or where poultry testing will take place, contact your local extension office.

Appendix 3

Antimicrobial Resistant Genes in Poultry in Iringa Town, Tanzania

Team Members: Kelly Hagadorn, Rebecca Tomasek, Ly Han Mai, Walter Simon, Buba Maryam Ibrahim

Executive Summary

Antimicrobial resistance is defined by the World Health Organization as "resistance of a microorganism to respond well to an antimicrobial medicine that was originally effective for treatment of infections caused by it." In the development of antimicrobial resistance, standard treatments are no longer effective, leading to persistent infections, and increasing the risk of spread to others. This topic is recognized as a global threat by the World Health Organization, Food and Agriculture Organization of the United Nations, and World Organization for Animal Health. In Tanzania, animal production plays an essential role in agriculture; however, due to the poor management, high pressure of diseases and the difficulty of access to veterinary health care as well as the shortage of veterinary services, many farmers choose to use antibiotics for most diseases without any concern of appropriate dose, duration or withdrawal time. With the lack of data and systematic surveillance plan in Tanzania, AMR is a growing concern. This project will address the issue of antimicrobial resistance by implementing a One Health approach, through identifying resistance in people, poultry, and the poultry environment. In strengthening education and training, surveillance, and prevention, and proving AMR as a national concern, we hope to reduce the burden of disease and influence policy regulating the access to and use of antimicrobials.

Goals

Through the implementation of this project, we plan to determine the extent of antimicrobial resistance genes present in poultry in Iringa Town, Tanzania. Furthermore, we want to improve the health and management of poultry through education, training, and cost-benefit analysis. Upon the conclusion of this study, we plan to disseminate the results to government officials with the intention of influencing policy. Currently, there are no strict regulations on the use of or access to antimicrobials. We have determined strengthening regulations and policy enforcement on antimicrobials to be one method to reduce antimicrobial resistance genes.

The project is expected to confirm the transmission of resistant genes from farm-to-fork, determine the prevalence of resistance, as well as provide training for farmers on proper management to improve poultry health instead of using antibiotics, in order to enhance the poultry-depending income and decrease prevalence of AMR.

Surveillance

Firstly, the project locally focuses on the antimicrobial resistance of two significant food-borne pathogens in poultry (*E.coli* and *Salmonella)* in Iringa, Tanzania. We plan to collect, analyze information, and determine transmission potential for these two pathogens in poultry and poultry products (meat and eggs), water and feed given provided to the poultry, and poultry owners. A genomic extraction kit and qPCR will be utilized to assess antimicrobial resistance genes present in the samples.

Community Engagement and Sustainability

Community engagement will be targeted to fulfill the gaps identified in the needs assessment. We plan to focus on providing education and training regarding poultry keeping practices, poultry health, and poultry breeds best suited for the needs of each individual. While recruiting poultry farms to participate in the study, semi-structured interviews and observations will be documented to assess areas to target for health and management improvement. Antibiotic use and financial status of the farmers depending on the poultry production will be recorded. This information will be provided to the agricultural economist, who will develop a model for cost-benefit analysis. Through the dissemination of this information, we hope to encourage poultry farmers to invest in the health and management of their flocks. This aims to reduce the burden of disease, thereby reducing the use of antimicrobials in livestock raising and development of resistance genes.

Partners

We anticipate working with the University of California Davis, Sokoine University of Agriculture, and the Health and Animal Livelihood Improvement project. Additionally, we may reach out to NGOs as implementing partners.

Sustainability of the project will be guided through strategic implementing partners. We plan to engage the Tanzanian government and train HALI members to carry out the work of the project. By demonstrating economic and livelihood gains, the project will be sustainable.

Potential Funders

The potential funders currently identified include the Tanzanian government, Bill & Melinda Gates Foundation, United States Agency for International Development, and the International Society for Infectious Diseases. Including Tanzania as a funding source improves the sustainability of the project. The other three identified potential funders were selected as they have been identified by the World Health Organization as funding providers on the topic of Antimicrobial Resistance and have a specific interest in working with developing countries regarding research in this field.

Budget

<table>
<tr><th colspan="3">Budgets</th></tr>
<tr><td>Year 1</td><td>Year 2</td><td>Year 3</td></tr>
<tr><td>$375,000</td><td>$415,000</td><td>$110,000</td></tr>
<tr><td>• Identify and recruit LEOs
• Organize workshops in town
• Recruit poultry farms
• Create survey
• Purchase supplies
• Develop modeling program
• Establish and test lab protocols
• Collect survey information</td><td>• Sample collection
• Make recommendations regarding cost-benefit analysis outcomes for participating farms</td><td>• Analyze and disseminate results
• Impact assessment
• Look into future expansion of project</td></tr>
<tr><td colspan="2">Personnel:
• Principle Investigator: Project lead
• Investigators: molecular epi, zoonotic disease epi, bacteriology, genomics, bioinformatics, health coordinator, financial analyst
• Technician: lab, field veterinarian/technicians
• Drivers

Travel:
• Domestic travel (mainly)
• International travel (inviting experts)</td><td>Materials and supplies:
• Field supplies for collecting and transporting samples
• Laboratory chemicals and tools
• PPE

Miscellaneous:
• Communication: phones, data, etc.
• Licenses
• Workshop expenses: projectors, venue, photocopy, printing, meals and tea breaks, accommodation, etc.</td></tr>
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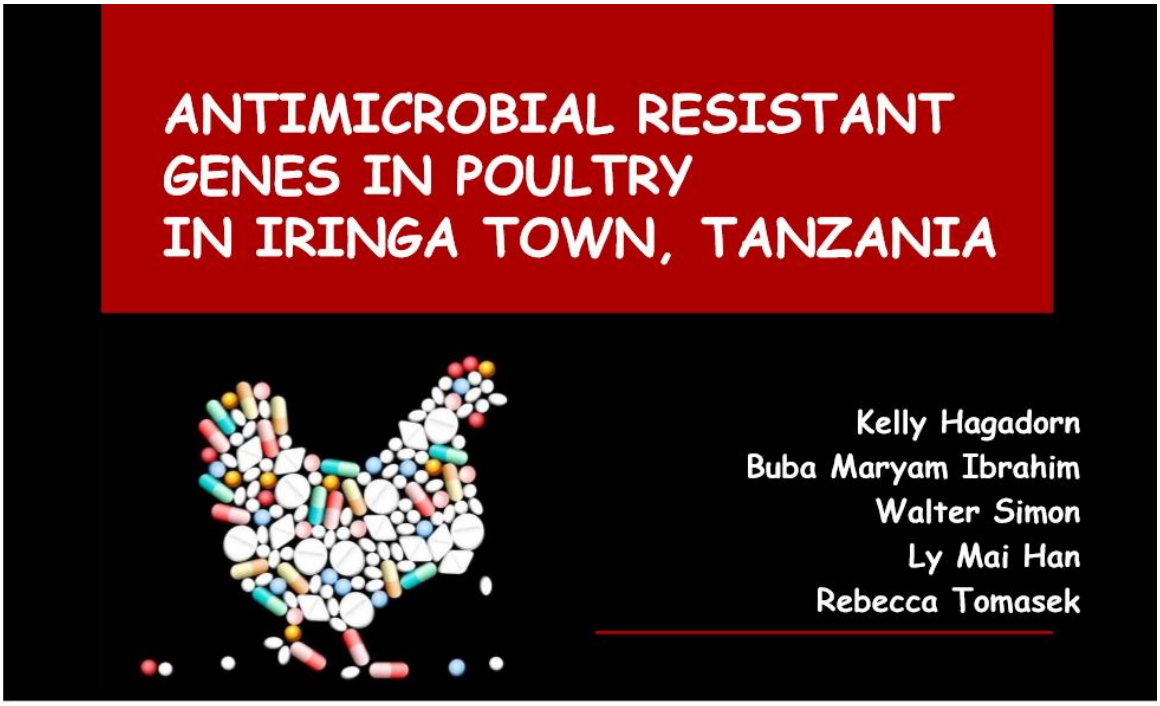
Appendix 4

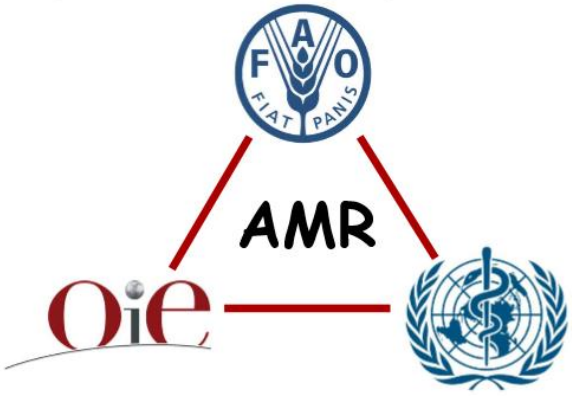


1. THE PROBLEM
2. OUR PROJECT
3. FUTURE PROJECT

CONTENTS

"Antimicrobial resistance is resistance of a microorganism to respond well to an antimicrobial medicine that was originally effective for treatment of infections caused by it."

-WHO



↑ Awareness + understanding

Optimize the use of AB

OBJECTIVES

↑the knowledge + evidence base

Develop the economic case for sustainable investment

↓ the incidence of infection

Tanzania's AMR National Action Plan

limited studies!!!

- Antimicrobial resistance in Tanzania is driven by:
  - Inappropriate use of antibiotics in humans and animals
  - No systematic surveillance for common pathogens
  - Regulations are not strict or enforced
  - High level of disease
  - Poor waste management and hygiene

The Problem

2. OUR PROJECT

a) Goals
b) Timeline
c) Methods
d) Budget
e) Potential funding sources

- Determine the extent of antimicrobial resistance
- Develop a cost-benefit analysis

a) Goals

YEAR 1

- Identify and recruit LEOs
- Recruit poultry farms
- Create survey
- Purchase supplies
- Develop modeling program
- Establish and test lab protocols
- Collect survey information

YEAR 2

- Sample collection
- Make recommendations regarding cost-benefit analysis outcomes for participating farms

YEAR 3

- Analyze and disseminate results
- Impact assessment
- Look into future expansion of project

COMMUNITY ENGAGEMENT

- Cost-benefit analysis
  - At the sample sites, an assessment will be completed to identify weaknesses in animal husbandry and management.
  - Improvement plans will be developed, through modeling, and projected cost will be determined.

Community Outreach

- Poultry Farms in Iringa Town: (n=132)
  - Intensive commercial poultry farms (n=19)
    - Broiler (n=11)
    - Laying hens (n=8)
  - Semi-intensive commercial poultry farms (n=37)
    - Broiler (n=22)
    - Laying hens (n=15)
  - Small non-commercial poultry farms (n=192)
    - Broiler (n=115)
    - Laying hens (n=77)

Methods: Surveillance

- Samples Collected (2 twice during sampling year)
  - Poultry
    - Fecal
  - Poultry products
    - Meat
    - Eggs
  - Environmental
    - Water the poultry are drinking
    - Food the poultry are consuming
  - Human
    - Fecal sample of poultry keepers

Methods: Surveillance

- Laboratory Processing
  - Pathogens: E. coli and Salmonella
  - DNA extraction (Genomic DNA extraction kit)
  - qPCR (Screening for resistance genes)

Methods: Surveillance

- Obtaining human fecal samples
- Molecular techniques based on different types of PCR amplification and especially on real-time PCR
- Technical and economic nature

Potential Shortcomings

Potential funders

INTERNATIONAL SOCIETY FOR INFECTIOUS DISEASES

BILL & MELINDA GATES foundation

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3. FUTURE PROJECTS

- Expanding antimicrobial resistance surveillance in the surrounding villages to compare the rural chickens to Iringa town farms.
- Providing education on disease prevention for poultry.
- Improving antimicrobial stewardship in Tanzania.
  - Developing relationships with active NGOs to partner with Livestock Extension Officers in providing antimicrobials to livestock keepers.
  - Influencing governmental policy to develop stricter regulations regarding use and access to antimicrobials.
  - Improving the knowledge on withdrawal times of livestock keepers.

Future Projects

ASANTE SANA!

Questions