

Hazards Associated with Zoonotic enteric pathogens in Emerging Livestock meat pathways (HAZEL)

Principal Investigators: Prof. Ruth Zadoks (University of Glasgow), Prof. John Crump (University of Otago)

Abstract

Tanzania has been identified as a hotspot for bacterial foodborne disease due to zoonotic enteric pathogens including non-typhoidal *Salmonella* and *Campylobacter*, with livestock (ruminants and poultry) as confirmed source of *Campylobacter*. Most livestock meat supply chains are informal but commercial supply chains and markets are expanding rapidly to meet growing demand from consumers. Increased industrialisation may affect occurrence of food-borne pathogens, particularly in poorly-managed systems, with risks of product contamination and human infection likely to increase with scaling-up of production systems and increasing complexity of supply chains. This project applies modular process risk modelling (MPRM) to understand and address hazards for human health associated with the specified zoonotic enteric pathogens in emerging livestock meat pathways in Tanzania. The research is multidisciplinary and transnational, engaging expertise from social science, veterinary and human health, conventional microbiology, molecular epidemiology, and statistics and modelling to develop the MPRM. Supply chain mapping, value chain analysis, prevalence and quantitation studies, standardized molecular typing methods, Monte Carlo methods and Bayesian belief networks will be used to support decision-making concerning control points for intervention, and to provide source level inference or biotracing opportunities that complement risk assessments. By collaborating with an East African human diarrhoeal disease surveillance system, preliminary source attribution may be possible. Finally, policy scientists will conduct systematic reviews of national and international regulations and policy as well as key informant interviews to identify strengths, weaknesses, opportunities, and threats (SWOT) in current Tanzanian food safety policy. SWOT analysis will be informed by MPRM findings to identify gaps and suggest improvements to national, regional, and international food safety policies.

Summary

Context: Meat from livestock (cattle, goats, sheep and poultry) is a key protein source for poor farmers, their families and communities. As countries develop, populations grow and move to urban areas and the nature of livestock systems has to change to keep up with consumer demand for meat. This presents an economic opportunity for poor farmers who may seek to produce meat for commercial markets but it also presents a potential threat to public health. Centralization of slaughter and processing facilities and growth of distribution networks that serve wholesalers, retailers and consumers may have major implications for food-borne diseases because risks of infection and contamination are likely to increase with scaling-up of production systems and increasing complexity of supply chains. Already, bacterial food-borne pathogens, including *Salmonella* and *Campylobacter*, have been described as the 'forgotten zoonoses' of Africa and changes in the meat supply chain may aggravate the problem. At the same time, improvements in policy, regulatory systems and technical capacity are potential tools to alleviate such problems.

Aims and Objectives: Our aim is to develop a robust understanding of how zoonotic enteric pathogens flow through the meat chain in Tanzania and to use this information to develop policies to improve food safety. We focus on Tanzania because the country has been identified as a hotspot for bacterial foodborne zoonoses and because its National Livestock Policy promotes intensification of livestock production systems to meet growing demand for meat. Furthermore, our team can build on existing infrastructure and laboratory capacity and years of interdisciplinary research collaboration in the livestock dense areas of Arusha and Kilimanjaro. Thus, there is both a need and the capacity to conduct this research. To achieve our aim, we will use an approach called modular process risk modelling (MPRM) to describe livestock meat pathways and hazards in these pathways. In the initial step, each stage of meat production from farm to retail is described by social and veterinary scientists. Local scale commercial production will be compared with wider markets to identify hazards that may emerge as meat production, processing and distribution is scaled up. Once the meat supply chain is charted, microbiologic techniques are used to establish the presence and concentration of non-typhoidal *Salmonella* and *Campylobacter* at each step in chain. By studying the genetic fingerprint of the bacteria, it is possible to track flow of bacteria from pre- to post-harvest. Comparison of DNA fingerprints of livestock and food isolates with those from bacterial isolates obtained from people with diarrhoea or other diseases will give an indication of the role of meat in human illness. Whilst mapping emerging livestock meat pathways and their associated hazards, we will conduct a formal review of current food safety policies and regulations in Tanzania and assess how they are implemented. Knowledge of the strengths and weaknesses of existing policies, combined with opportunities and threats identified through analysis of the meat value chain and hazards in the livestock meat pathway will enable scientists and policy makers to develop new food safety policies.

Potential applications and benefits: Through its combination of social, biological and quantitative sciences and collaboration with policy makers, this project will contribute to improved food safety policy and reduction in food-borne exposure of people to non-typhoidal *Salmonella* and *Campylobacter*. This will provide economic and health benefits to producer and consumer communities in Tanzania. In addition, improved product safety may help farmers to access new retail markets. Finally, the approach developed in this project can serve as a model for other diseases and countries where changes in livestock production systems may affect the availability and safety of our food.

Impact Summary

This project addresses presence of foodborne pathogens (*Salmonella* and *Campylobacter*) in livestock meat (ruminants and poultry) because they have specifically been identified as a public health threat in the United Republic of Tanzania in preparatory reviews by the UK Department for International Development. Beneficiaries of the project will include producers, processors and consumers of livestock meat and policy makers with responsibility for food safety and public health. The project will benefit poor farmers in Tanzania and in similar agro-ecologic settings by informing improvements in the microbiologic safety of meat derived from their livestock, resulting in mitigation of risk for zoonotic bacterial enteric infections (diarrhoea, sepsis) in poor communities and potentially increased economic opportunities. SNV, the Netherlands Development Organization,

has been exploring ways to support red meat value chain development in Tanzania since 2009, but limited analysis and understanding of microbiological risks and management strategies has been a major obstacle to the development of adequate food safety practices at meat production, processing and retail level. Through collaboration with HAZEL, SNV will be able to provide better support to local and national stakeholders such as producers' and butchers' associations and the Tanzania Meat Board. Food safety and livestock development policy makers from the Ministry of Livestock and Fisheries Development in Tanzania will participate in a formal policy and regulatory review. Through this process they will identify and have the opportunity to resolve gaps in existing food safety policies that are discovered during the project. Through its contribution to policy development, the project has the potential to endure well beyond the period of the research and to provide benefits throughout the meat supply system, including a large consumer and livestock-keeping population. In the long term, enhanced food safety is hoped to contribute to reduction in diarrhoeal and systemic illness due to zoonotic enteric pathogens among the Tanzanian population. Collaboration with the CDC's regional diarrhoea surveillance programme based in Kenya will allow for preliminary source attribution, which will indicate the contribution of meat to human disease problems and help to prioritise disease prevention methods and messages. The interdisciplinary approach adopted by HAZEL will benefit all researchers interested in food safety through its drawing together of insights from quantitative and qualitative researchers in medical, veterinary and social sciences. The project will apply modular process risk modelling of the meat supply chain in a low resource country for the first time, which will generate new methodologies and insights for researchers worldwide with applications in other countries and food supply systems. Currently, capacity for food safety research and social science in Tanzania is limited, and a major impact of this project will be the establishment of local capacity for social, epidemiological and microbiological approaches to food safety in collaboration with the Nelson Mandela African Institute for Science and Technology and Sokoine University of Agriculture and enhancement of laboratory capacity for isolation, identification, and quantitation of pre- and postharvest microbiologic hazards in the food chain at the Kilimanjaro Christian Medical Centre. Tanzanian post-graduate students will be encouraged to develop projects within the HAZEL platform, which will allow them to benefit from mentorship provided by senior Tanzanian and international experts and academics. In this way, the project will benefit Tanzania by helping to develop the next generation of social scientists and food safety experts and will model a science-based and interdisciplinary approach to food safety in a One Health context.