



**FEED THE FUTURE INNOVATION LAB FOR ANIMAL HEALTH**

FY21 Annual Report

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Collaborating Institutions:

Washington State University (Prime)

University of Nairobi

International Livestock Research Institute

Feed the Future Innovation Lab for Animal Health,  
Paul G. Allen School for Global Health, Washington State University

**Feed the Future Innovation Lab for Animal Health  
Annual Report: Fiscal Year 2021 (Year 1)**

**Management Entity Information**

Washington State University’s Paul G. Allen School for Global Health is the Management Entity (ME) for the Feed the Future Innovation Lab for Animal Health (hereafter referred as the Animal Health Innovation Lab). The Animal Health Innovation Lab’s core activities are funded through a cooperative agreement Number 7200AA20CA00022 from United States Agency for International Development (USAID) Bureau for Resilience and Food Security (RFS).

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### Map of Focus Country and Project Sites

The Animal Health Innovation Lab funded activities are focused on Kenya. The sites for the field studies are two counties namely Narok County and Busia County. These study field sites were selected based on the high prevalence of East Coast fever among cattle and high prevalence of malnutrition among children and women of reproductive age.

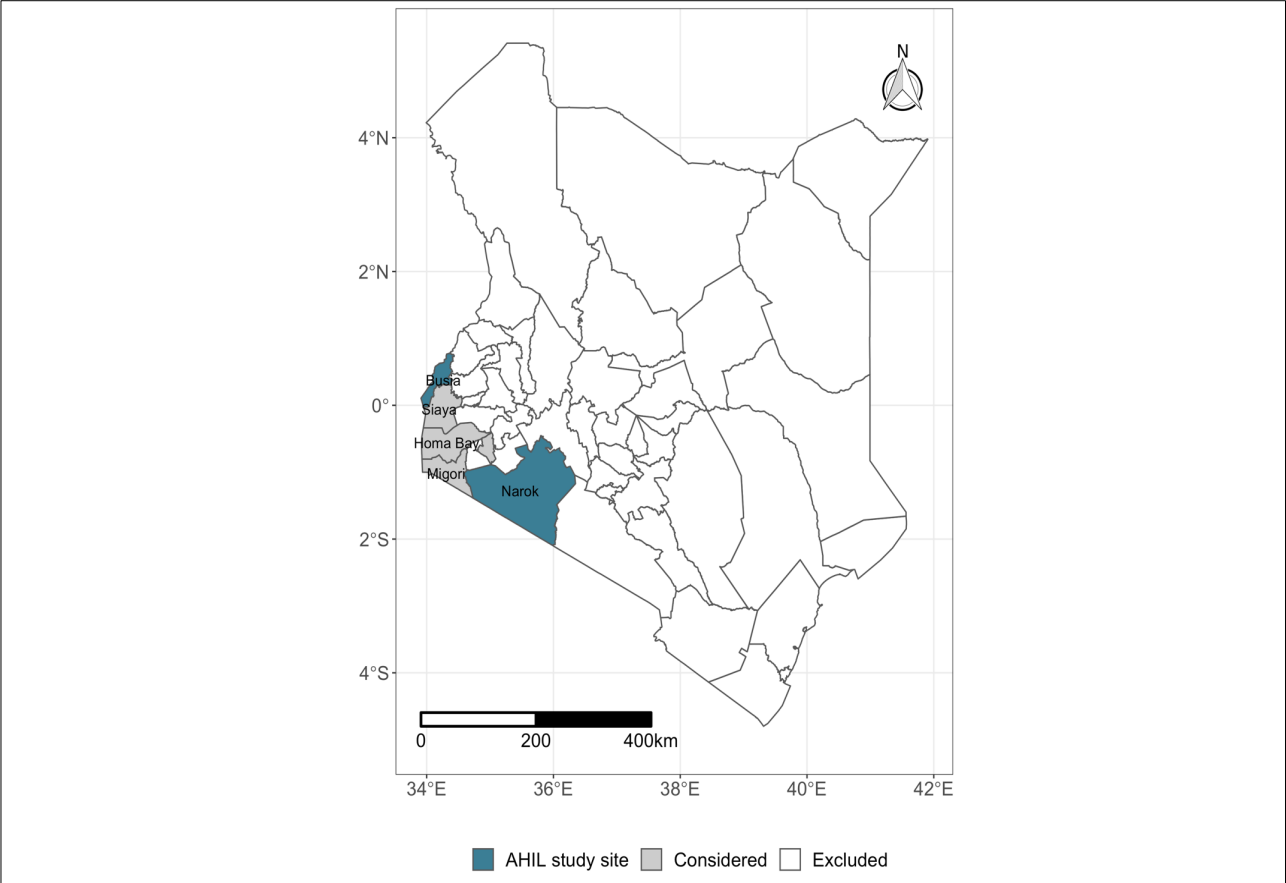


Figure 1: Map of Kenya showing the Animal Health Innovation Lab field study sites.

## List of Program Partners

The project is implemented as a collaborative consortium of partners based in Kenya including the University of Nairobi (UoN), International Livestock Research Institute (ILRI), and scientists from the Kenya Medical Research Institute (KEMRI) and Kenya Agricultural and Livestock Research Organization (KALRO).

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		nutritional status in livestock keeping households	
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## Acronyms

AHIL	Feed the Future Innovation Lab for Animal Health
ASF	Animal Source foods
A-WEAI	A Women Empowerment in Agriculture
COP	Chief of Party
CTTBD	Centre for Ticks and Tick-Borne Diseases
ECF	East Coast fever
ME	Management Entity
USAID	US Agency for International Development
RFS	Bureau for Resilience and Food Security
EMMP	Environmental Management and Mitigation Plan
DMP	Data Management Plan
UoN	University of Nairobi
ILRI	International Livestock Research Institute
KEMRI	Kenya Medical Research Institute
KALRO	Kenya Agricultural and Livestock Research Organization
ITM	Infection and Treatment Method
UN	United Nations
FY	Financial Year
NGO	Non-Governmental Organization
IEE	Initial Environmental Examination
GALVmed	Global Alliance for Livestock Veterinary Medicines
TRL	Toll – Like Receptor Agonist
SERU	Scientific and Ethics Review Unit
NACOSTI	National Commission for Science, Technology and Innovation
IACUC	Institutional Animal Care and Use Committee
ELISA	Enzyme Linked Immuno-Sorbent Assays
FGD	Focus Group Discussion
KDHS	Kenya Demographic Health Survey
DHIS	District Health Information System
IPD	Institute of Protein Design
MEL	Monitoring Evaluation and Learning
WSU	Washington State University

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## Executive Summary

The Feed the Future Innovation Lab for Animal Health (AHIL) research is focused on: i) Development and improvement of vaccines and diagnostics for East Coast fever (ECF) – a fatal disease and a major impediment for dairy and beef industries in Central and Southern Africa, ii) Development of a sustainable model for production and scale-up of ECF vaccines, improving their availability and accessibility to farmers, iii) Improving the adoption of animal health innovations and interventions, and the measurement of their effect on household economics, food consumption and nutritional status of children and women and iv) Strengthening the capacity for linked animal– human health research in the East Africa region through training of the next generation of researchers and development of research infrastructure for animal health. The FY2021 was AHIL’s first year and involved setting up the structures of collaboration, research and management, recruitment of the graduate students, identification of research questions and defence of their doctoral research proposals, selection of study sites, development and sourcing of study materials, ethical clearance and laying the foundation for project activities to be implemented during the program period.

The Management Entity (ME) convened an inception meeting immediately after the award bringing together all consortium partners, USAID, and the technical advisory committee. The meeting reviewed the project implementation modalities, roles, and responsibilities of each consortium member and workplans.

To provide technical advice and project implementation oversight, the project identified key scientists with expertise in ECF research to guide the technical aspects of the project. The team includes Prof. Patricia Conrad (Distinguished Professor, Associate Dean of Programs School of Veterinary Medicine and Co-Director, University of California Global Health Institute); Prof. Guy Palmer (Senior Global Health Director, and Regents Professor of Pathology and Emerging Infectious Diseases at Washington State University); Prof. Lorne A Babiuk (Past Vice President Research, University of Alberta); Dr. Tyrell Kahan (USAID Bureau for Resilience and Food Security). An initial engagement with the team was conducted through a series of online meetings which comprised of detailed discussions on science and implementation of each of the thematic areas of the project. The technical advisory committee gave recommendations on coordination of various thematic areas, training of PhD students and agreed to quarterly online meetings and one in-person annual meeting.

As part of the commitment for the project to provide training for the next generation of researchers, AHIL advertised and recruited eight (8) PhD fellows (4 male and 4 female). All the fellows were registered to start their PhD training at the University of Nairobi, researching a range of topics including improvement of ECF vaccines, ECF diagnostics, the epidemiology of ECF, the socio-economic impacts of ECF, adoption of animal health innovations, and effect of livestock interventions on malnutrition in children and women.



An official launch of the Feed the Future Innovation Lab was held on May 18<sup>th</sup> 2021. Due to the COVID-19 guidelines and restrictions, the launch of the program was a hybrid (in-person and virtual). Attendants included representatives from the government of Kenya, USAID in Washington, USAID Mission Office, UN agencies, leadership of the consortium member institutions, development organizations, research institutions, media, and community members. Several media articles on the Animal Health Innovation Lab have been published increasing the project visibility, including:

- [Scientists bet on lab to eradicate deadly livestock diseases \(Business Daily Monday 24 May\)](#)
- [Researchers launch Sh600m drive to wipe out cattle fever \(The Star Monday 24 May\)](#)
- [Ticks affect not just milk, money, but school attendance also \(The Standard Monday 31 May\)](#)

During the first year, the project sensitized various stakeholders to the AHIL and received insights from other stakeholders on areas of synergy and ways the AHIL could contribute to the USAID's Mission country development objectives. The AHIL team has participated in the quarterly livestock partner meetings in Kenya organized under USAID's Resilience Learning Activity Platform. We have engaged the USAID Mission identify areas that AHIL can contribute to USAID Mission strategic areas of focus including support to the State Department for Livestock. We developed a project fact sheet that was shared by the Mission to key stakeholders involved in USAID funded projects. The project fact sheet can be accessed through this [link](#).

As part of research infrastructure development, renovations to establish and equip a molecular and diagnostic laboratory at the University of Nairobi Faculty of Veterinary Medicine started in mid-2021 and are expected to be complete by the end of 2021. This molecular and diagnostics lab will be a key resource for teaching and research in Animal Health in the country and the region.

To promote diversity, equity, opportunities, and social inclusion in AHIL activities, AHIL organized a gender training workshop for consortium members and the graduate students. The training focused on gender biases and disparities in science. Twenty-nine individuals (19 men, 10 women) participated in the workshop. Gender experts in the AHIL will continuously sensitize the project implementation team on gender mainstreaming.

To promote impact and scale at a regional level, AHIL convened a stakeholder consultative meeting with participation from the Directors of Veterinary Services from Uganda, Kenya, Tanzania, Rwanda and South Sudan, representatives from private sector and NGOs, UN Agencies, and research institutions. The meeting focused on the current state of production of ECF ITM vaccine stabilates, identified the challenges and opportunities for ECF vaccine production, and explored the proposed new distributed model as an efficient, sustainable model for production and distribution of the ECF vaccine to promote ease of access by small-holder farmers. The meeting resulted in key recommendations of production, registration, distribution of

ECF vaccines in the region and proposed creating a task force to spearhead the process. Some of the recommendations include.

- Determine the real costs of production of ITM stabilates to give private sector investors information for investment decisions.
- Future production models should consider production alongside factors that are constraining uptake including number of doses per straw, availability of a cold chain, pricing, and registration
- Formation and operationalization of a regional taskforce to look into production more critically

The recommendations will be followed up and actioned in year 2.

## Programme Activities and Highlights

Amidst the challenges associated with dealing with the COVID-19 pandemic, the management entity and partners successfully implemented the following project objectives:

**Inception meeting and execution of sub-awards:** Washington State University convened an initial planning meeting bringing together all consortium partners, USAID, and Technical Advisory committee. The meeting reviewed the project implementation modalities, roles, and responsibilities of each consortium member and workplans. Sub-awards for the International Livestock Research Institute and the University of Nairobi were approved by USAID and implemented.

**Engagement with External advisory committee:** The external technical advisory group was engaged through a series of virtual meetings who provided guidance and program implementation coordination recommendations.

**Launch of the project:** The Animal Health Innovation Lab held a successful launch in May 2021, with attendance from several stakeholders including, government, UN Agencies, consortium members, development organizations, research institutions, media, and community members. The launch provided an opportunity for the project team to engage with stakeholders. Several media articles highlighting the project have been published which has increased the project visibility.

**Gender training workshop:** A gender training workshop focusing on gender bias in science was conducted for the AHIL implementation team and graduate students. The gender experts within the AHIL will continue to sensitize the team on gender mainstreaming in project implementation during the project period.

**Stakeholder engagement on sustainable production of ITM stabilates:** This included Directors of Veterinary Services from Uganda, Kenya, Tanzania, Rwanda and South Sudan,

representatives from private sector and NGOs, UN Agencies, and research institutions. The meeting discussed the current state of ECF ITM vaccine stabilates production, challenges and opportunities and explored the new distribution model being proposed by AHIL to ensure efficient and sustainable production and distribution of the ECF vaccine to promote ease of access by smallholder farmers.

**Communicating AHIL objectives, themes, and approaches:** The director of the AHIL and others in ME promoted the project by sharing the main objectives which includes improving ECF diagnostics and control tools and accessibility to small holder farmers. This mainly involved, presentation in webinars, livestock partner meetings organized by USAID mission in Kenya.

The AHIL website (<https://globalhealth.wsu.edu/initiatives/animal-health-innovation-lab/> ) was developed, and a page on AHIL created at the Agrilinks website to include activities and highlights from the program ( <https://agrilinks.org/activities/feed-future-innovation-lab-animal-health>).

The team set up a twitter handle (@animalhealth\_il) and created the AHIL brochure in English which summarizes the AHIL vision, target area and approaches as well as research portfolio descriptions.

## Key Accomplishments

The Animal Health Innovation Lab aims to develop and improve diagnostic products and vaccines for ECF, integrate socioeconomics to improve adoption of animal health innovations and interventions, quantify direct and indirect effects on human nutrition and well-being, set up and operationalize a molecular and diagnostic lab for animal health research at the University of Nairobi Veterinary School, and train the next generation of animal health researchers in the region. For FY2021, we focused on laying the foundation for the research activities to be implemented during the project period, including:

- The Animal Health Innovation Lab held its inception meeting with the consortium members. The objective of the meeting was to introduce the consortium members to one another, understand the areas of focus, expertise required and identify ways to synergize within AHIL. The meeting provided an overview of the AHIL project, description of the thematic areas, and the roles of the consortium members. The consortium also reviewed the workplan, set priorities, and agreed on the mode of operations for AHIL.
- We executed sub-awards and personal service contracts. The AHIL project is implemented by Washington State University (Prime) in collaboration with the University of Nairobi (UoN) and International Livestock Research Institute (ILRI). The consortium includes scientists from the Kenya Medical Research Institute (KEMRI) and the Kenya Agricultural and Livestock Research Organization (KALRO). Subawards for ILRI and UoN and engagement with KEMRI and KALRO scientists through personal service contracts were approved by USAID and executed by Washington State University (WSU).

- The Annual Workplan, Monitoring Evaluation and Learning Plan, Branding and Marking Plan, Initial Environmental Examination (IEE) and the Data Management Plan were developed and subsequently approved by USAID for implementation.
- We convened a series of online meetings with the Technical Advisory Committee. The meetings comprised of detailed discussions on the implementation of each thematic area. The advisory team provided recommendations for strengthening coordination, training, and mentorship programs.
- We participated in monthly coordination and engagement meetings with the USAID team and project consortium partners. These were to review progress made in project implementation, receive guidance and support from the USAID team on key project deliverables.
- We competitively sought and recruited eight PhD fellows (4 male, 4 female) to carry out research in Epidemiology and Economics, Nutrition, Anthropology, and different aspects of laboratory analysis in line with the innovation Lab's objectives.
- Officially launched the Lab which provided an opportunity for the team to engage with stakeholders and provided visibility through media engagement.
- Held a gender training workshop for the team and graduate students focusing on gender bias. The training sensitized the team on the current biases in science and mitigation measures we can take to avoid biases.

## Research Program Overview and Structure

The Animal Health Innovation Lab research is based on four key focus areas: laboratory-based research, vaccine production and scale-up, field-based research and strengthening capacity for linked animal-human health research. The research is implemented within six research pillars:

- Vaccines:** The Animal Health Innovation Lab will conduct research aimed at development and improvement of Infection and Treatment Method (ITM) vaccines and sub-unit vaccines for East Coast fever.
- Diagnostics:** Development of field based rapid diagnostics for tick borne diseases.
- Epidemiology:** Impact of East Coast fever on animal survival and productivity, milk availability and household incomes.
- Social anthropology:** Adoption of animal health interventions and link between gender, livestock nutrition and economics.
- Economics:** Development of new technologies, impact evaluation of livestock interventions and business innovations for sustainability and social benefit.

**Nutrition:** Consumption of animal source foods, nutritional status of women and children and food security and nutrition.

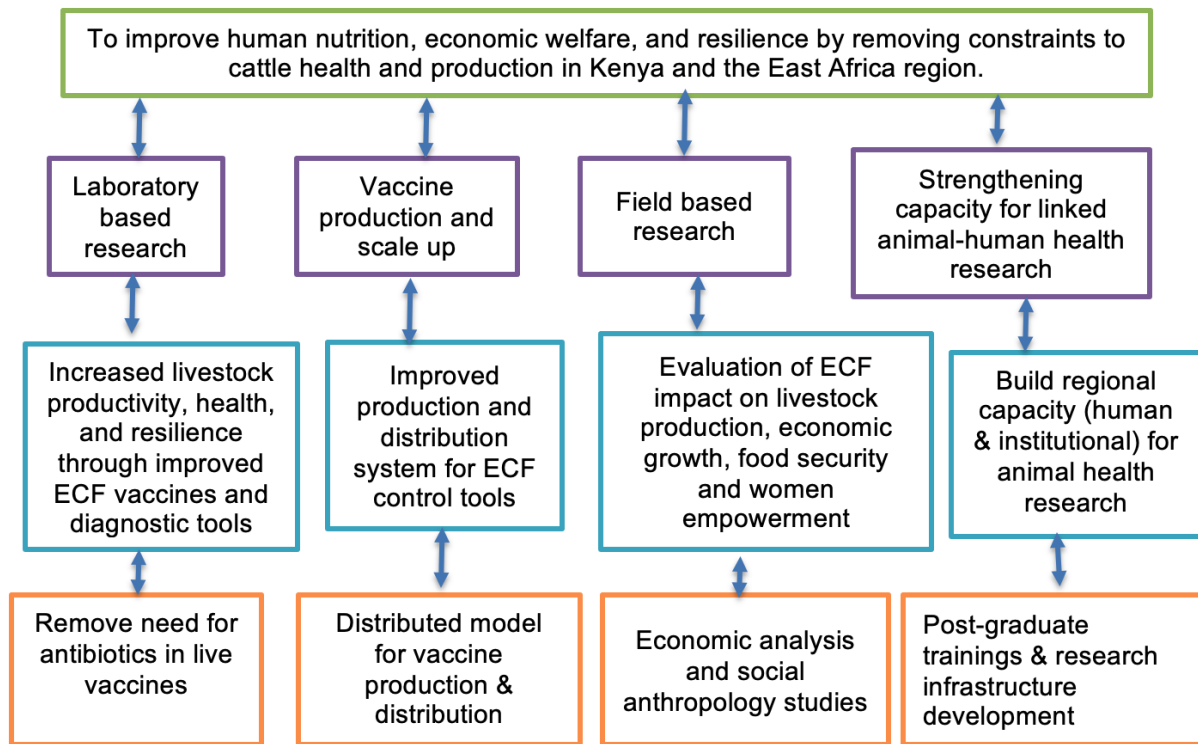
Following these focus areas, the Animal Health Innovation Lab work is framed by the following over-arching aims, namely: i) To develop and improve vaccines and diagnostics for East Coast fever (ECF) ii) To develop a sustainable model for production and scale-up of ECF vaccines, improving their availability and accessibility to farmers iii) To improve the adoption of animal health innovations and interventions and the measurement of their effect on household economics, food consumption and nutritional status of children and women and iv) To strengthen the capacity for linked animal – human health research in the East Africa region.

Washington State University’s Paul G. Allen School of Global Health serves as the Management Entity (ME). Washington State University implements the program of work in collaboration with University of Nairobi, International Livestock Research Institute, Kenya Medical Research Institute and Kenya Agricultural and Livestock Research Organization which are based in Kenya.

### Theory of Change and Impact Pathway(s)

The Animal Health Innovation Lab program theory of change draws from evidence generated through previous research conducted in Kenya and elsewhere on the control and impacts of ECF on livestock keeping households. Previous research has identified the key constraints in ECF control to include limited availability, accessibility and use of the ECF vaccines and diagnostic tools.

The Animal Health Innovation Lab utilizes a research framework that links multidisciplinary interventions that combine laboratory-based research to improve ECF vaccines and diagnostics, field-based research to improve adoption, gender integration in the uptake of ECF interventions, measuring the impact of animal health interventions on human nutrition, health and welfare, human and institutional capacity development for animal health research (Figure 1).



**Figure 1:** Research framework for the Animal health intervention lab

The framework serves as the organizing structure for integrating all the studies to be undertaken by the Innovation lab.

To understand the linkages and the impact pathways across the innovation lab research framework, the animal health innovation lab pursues four streams of research, which individually address key elements of the framework:

- i) Improving ECF vaccines and diagnostic tools pathway. This research includes the Animal Health Innovation Lab's innovative focus on **laboratory-based research pathways** involving gene editing to remove the need for antibiotics in the live vaccines and non-inferiority trials for replacement of ITM-antibiotics with ITM-toll like receptor agonist.
- ii) **Vaccine production and scale up pathways** that are believed to play a key role in accessibility of disease control products for ECF control to the small holder farmers in Kenya and the region. This focuses on the establishment of a private sector-led production and distribution model for ECF vaccines which is aimed at improving affordability and accessibility to the small holder farmers.
- iii) **Adoption of animal health interventions and quantifying socio-economic effects on human nutrition and wellbeing.** This element focuses on development of a private-public partnership model for sustainable production and scale up of ECF vaccines, economic analysis of production and distribution costs, and market demand for ECF vaccines.
- iv) **Capacity development for research**

through training the next generation of researchers and research infrastructure development. Capacity building is a key component of the Animal Health Innovation Lab's theory of change. Activities to achieve capacity include:

- Improving awareness and understanding through workshops, webinars, training activities and scientific meetings.
- Building local capacity to conduct multidisciplinary research involving local academics and professionals. The Animal Health Innovation Lab will provide opportunities for graduate fellowships (Masters, PhDs, Post-doctoral fellowships), research exposure, seminars, and modular courses for students.
- Establish a molecular and diagnostic laboratory at the University of Nairobi faculty of veterinary medicine.

## Research Project Reports

### Objective 1: Improvement of the Infection and Treatment method (ITM) Vaccine

East Coast fever (ECF) is estimated to affect approximately two thirds of the 75 million cattle in East, Central and Southern Africa impacting nearly 20 million smallholder livestock keepers in 12 countries in the region. Immunization with the Infection and Treatment Method (ITM), developed in the 1970s, is now distributed commercially in Kenya, Tanzania, Malawi and Uganda. Although other control options such as frequent application of chemical acaricides and treatment of sick animals with antitheatrical drugs have played a critical role in the past, they remain expensive and difficult to sustain.

The ITM technology offers an alternative long-term solution to the control of ECF. It provides lifelong immunity to homologous or related *T. parva* infections, is highly efficacious (over 95%) and immunization allows reduced frequency of acaricide application by as much as 75%. In pastoral livestock systems, vaccination allows the use of grazing lands which were previously avoided and the introduction of improved breeds and crossbreeds. Despite these benefits, adoption of ITM across the region has been extremely slow. To date, only about 2 million animals have been vaccinated using the Muguga cocktail based ITM.

Our hypothesis is that lack of investments in the technology of ITM vaccine production, in both the public and private sector, has resulted in inconsistent and low supply of the vaccine, and the observed low adoption. Furthermore, the production process of ITM is long and requires highly specialized facilities, which is a disincentive for private sector engagement.

To eliminate the need for a single entity investing in all the highly specialized facilities, and to reduce the risks for the private sector, we propose a multi-site production model for ITM stabilates.

In this model, it is envisaged that:

- Public and private institutions are contracted to produce different components of the stabilate.

- Participation is based on the comparative advantage of the institution involved.
- As much as possible, production of the component is carried out alongside other activities of the institution, without limiting or interfering with their core operations.
- A private company invests in coordinating production, quality assurance, and marketing of the product.

Activities carried out under this objective during the reporting period are as below:

**a) Establish a regional public private consortium to develop a sustainable model for production of ITM stabilates.**

The concept was presented to the AHIL Technical Advisory Committee for inputs in January 2021. Key issues raised included:

- Need to understand current usage of the vaccine in the region.
- Research on tick vaccines and the efficacy of the vaccines.
- Consideration of other tick-borne diseases in the model to increase commercial advantage.
- Incentives to stakeholders to get involved.
- Coordination of the activity.
- Costing the business model.

Based on the recommendations, potential stakeholders were identified, and an analysis based on the entire value chain from production to delivery was carried out (Annex 1).

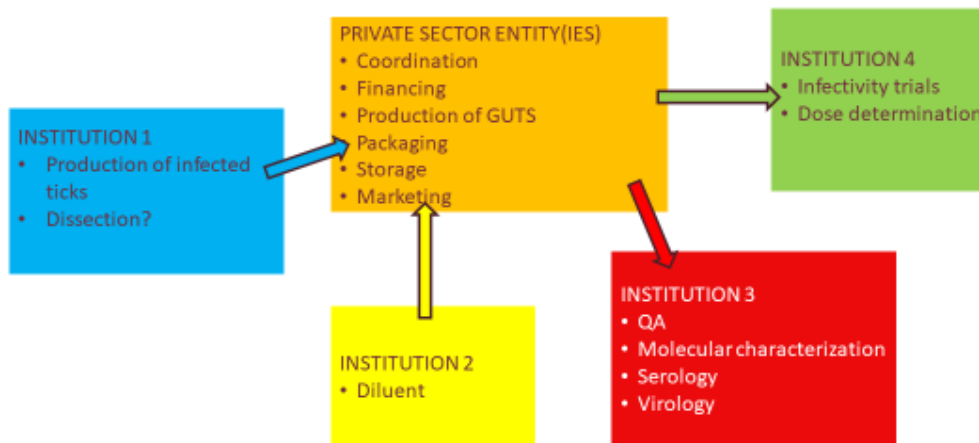
Given the previous central role played by Global Alliance for Livestock Veterinary Medicines (GALVmed) in the production and distribution of ITM, the project sought their input on the proposal and information on the future plans on ITM stabilates production. The concept of the proposed model was shared with the Board of GALVmed, and their comments were received and considered.

Potential producers of the vaccine were engaged through a simple online questionnaire to seek views and gauge their interest in participating in the consortium. A total of ten responses were received and seven of the respondents were willing to be involved in an aspect of production.

A stakeholders' consultative meeting on sustainable ITM ECF stabilates production was organized and the idea of a distributed model of ITM ECF vaccine production shared.



## Proposed Solution: A distributed production



**Figure 2:** Schematic diagram of the proposed distributed model

Stakeholders included potential producers, regulators, veterinary authorities, researchers in AHIL and development partners. The ITM ECF vaccine is important in the region and the issue of sustainable production is crucial. However, production should be considered alongside factors that are constraining uptake. These include number of doses per straw, maintaining of a cold chain, price, and registration among others. The proposed distributed model of production is feasible, but it faces potential challenges of coordination and quality assurance. A regional taskforce to investigate production more critically was recommended. The AHIL should consider supporting the formation and operationalization of the taskforce.

### **b) Test the efficacy and safety of toll-like-receptor (TLR) agonist-ITM vaccine combination compared to ITM-antibiotic combination.**

In collaboration with the UoN, one suitable female candidate was selected to carry out this work as part of a PhD program. We had four applicants interviewed for this position, the PhD student has developed a proposal, presented to the University of Nairobi, and received approval.

Ethical clearance: One general ethical clearance will be obtained for the project. The clearance will be obtained from Kenya Medical Research Institute's Scientific and Ethics Review Unit (SERU). The protocol has been submitted to SERU for ethical clearance consideration. The KEMRI ACUC has approved the study. Once ethical approval is obtained from KEMRI SERU, a reliance agreement will be sought and obtained from WSU. An Institutional Animal Care and Use Committee (IACUC) will be obtained from ILRI for the specific studies involving use of animals. A National Commission for Science, Technology, and Innovation (NACOSTI) research permit and county approvals will also be obtained for the study. For the work involving gene editing, a permit will be sought from the National Biosafety Authority.

**c) Develop a new live attenuated vaccine through the clustered regularly interspaced short palindromic repeats (CRISPR)-Cas (CRISPR-associated proteins) technology.**

Recruitment of PhD student: In collaboration with UoN, applicants for the position were shortlisted and six candidates were interviewed online. One suitable candidate (female) was selected. The candidate has developed a proposal, presented to the University of Nairobi, and received approval.

Production of sporozoites: Sporozoites have been produced and are ready for use.

Identification of suitable gene target and collation of relevant data: The latest annotation of *T. parva* genome assembly was downloaded from IGS Jbrowse. Transcriptome data from Atchou et al. (2020) and Tonui et al. (2018) were re-analyzed using new tools, differential expression analysis performed on the transcriptomes and signal peptides were predicted. All data, including proteomics data from Nyagwange et al. (2017) has been compiled into one Excel spreadsheet for ease of querying.

Transfection optimization of plasmids: We have designed an initial plasmid to study the feasibility of successful transfection of sporozoites leading to expression in the schizonts and possibly in the cytoplasm of infected cells. We will use enhanced green fluorescent protein (eGFP) with the Proviral Integrations of Moloney (PIM) signal sequence and the PIM promotor region, which has been identified as the untranslated region (UTR) upstream from the PIM coding sequence. This will be ordered with codon optimization and an eukaryotic selection marker. This plasmid will be used to generate a version without the signal sequence. Besides the transfection experiments, these plasmids will be used for studying the feasibility of applying selection to the infected cells. Further, GFP messenger ribonucleic acid (mRNA) is in-house. This will be immediately tested for transfecting sporozoites.

Bioinformatics: A reanalysis of *T. parva* transcriptome studies (Atchou et al. 2020, and Tonui et al., 2018) using the most recent annotation of the *T. parva* genome (Tretina et al., 2020) and improved versions of the analysis software to measure gene expression in sporozoites, sporoblasts, schizonts and piroplasms has been performed.

Experimental: An important part of the process of editing *Theileria parva* is to have a good transfection system. Several optimization experiments of electroporation using NEPA21 super-electroporator has been performed using two plasmids, the pCMV-GFP plasmid which expresses GFP under the CMV promoter and the motif\_EF1alpha100\_TMAG plasmid, which GFP under the elongation factor alpha promoter. HeK 293 cells were successfully transfected using both the NEPA21 super-electroporator and lipofectamine with both plasmids. For PBMC, some fluorescence was obtained using the pCMV-GFP plasmid and currently we are working on optimizing *T. parva* infected PBMC. A *T. parva* codon-optimized plasmid, a variant of motif\_EF1alpha100\_TMAG, has been designed and received from GenScript. It was tested in

Hek293 using Lipofectamine 3000, and some fluorescence signal was obtained, not as bright as with the original motif\_EF1alpha100\_TMAG. This may be due to the optimization for *T. parva* expression – this will be tested in *T. parva* infected cells and eventually sporozoites.

## Objective 2: Improvement of East Coast fever Diagnostic Tools

This objective involves two main activities; 1) Development of a pen-side diagnostic test for *T. parva* using CRISPR-Cas technology and 2) Development of multiplex CRISPR-Cas diagnostic assay to support vaccine and epidemiological research. The second activity will commence year 2 of the project.

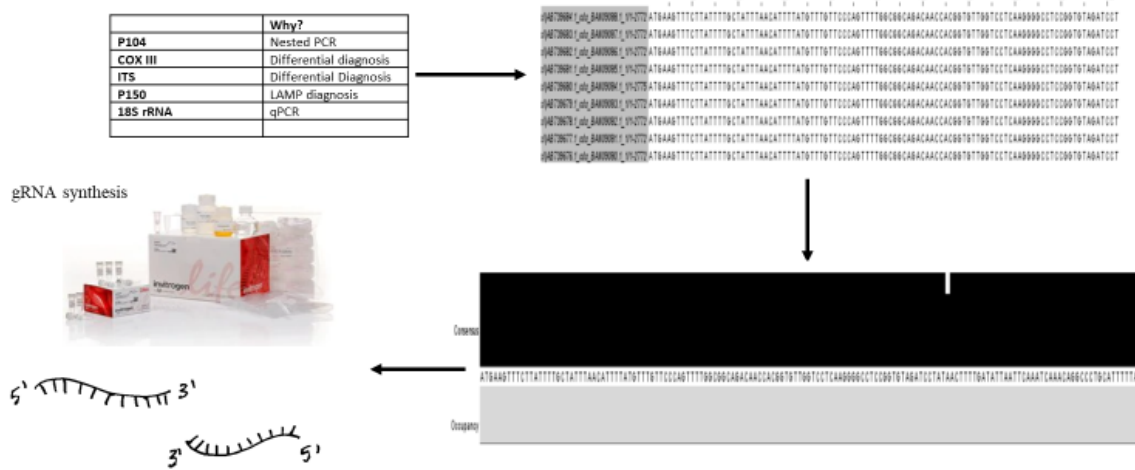
### a) Development of a pen-side diagnostic test for *T. parva* using CRISPR-Cas technology

AHIL met with the Technical Advisory Committee to discuss the scientific details of the project and receive constructive feedback to improve the ECF pen-side diagnostic component.

Recruitment of PhD student: Applicants for the position were shortlisted and six candidates were interviewed online. One suitable candidate (male) was selected. The candidate developed a proposal, presented to the University of Nairobi and received approval. With mentorship from his PhD supervisor at ILRI, the student designed strategies and steps to follow to design recombinase polymerase amplification (RPA) primers and RNA guides (gRNA) (Figure 3) and the strategies to employ to test these primers/gRNAs *in vitro* (Figure 4). These strategies include a first step of working with a cloned gene of interest to optimize the conditions, followed by testing these conditions with DNA or RNA extracted from *T. parva*-transformed lymphocyte lines (TpM), and then validate the assay with lymphocytes transformed with other *T. parva* strains to test the universality of the assay. The assay will then be tested with clinical samples (Figure 4).

# Developing a Pen-side assay for *T. parva* – Bioinformatic Analysis

## Bioinformatics Analysis of Genes



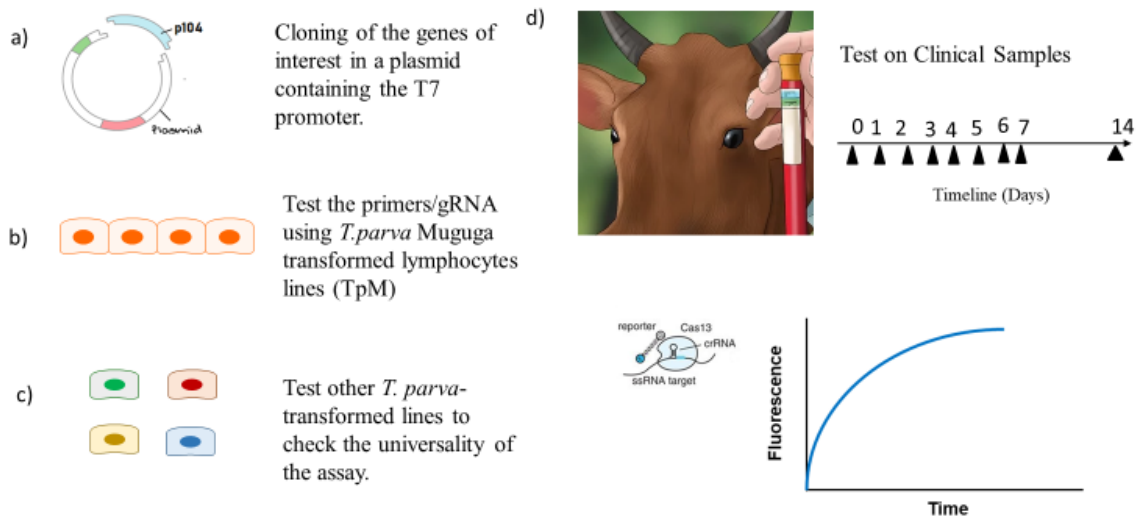
**Figure 3:** Bioinformatic analyses to be performed to design the primers in conserved regions using the p104 gene as an example.

Purchase of Initial reagents: This was procured through ILRI procurement systems as the activity is domiciled at ILRI.

Bioinformatics analyses of target genes in *T. Parva* with best CRISPR ability profile: Performing bioinformatic analyses on a panel of *T. parva* genes has been carried out. We have selected the p104, CoxIII, ITS, p150, 18S ribosomal RNA (rRNA), and Tp5 as the first list of nucleotide sequences from several *T. parva* genome to work with for the design of the different primers. The first bioinformatic analyses were performed with the p104 gene, and RPA primers as well as cloning primers were designed and ordered. The first set of p104 RPA primers were tested, and we are awaiting reagents from Europe, including the Cas enzymes and fluorescent probes required for the optimization of the following steps of the reaction, that will soon be dispatched to Nairobi. Once the reagents are received the following will be done:

- Analysis of the other genes to identify ideal regions for the design of RPA and cloning primers, and optimal gRNA sequences.
- Clone the first set of genes to be inserted in a plasmid that will serve as a template to test the enzymatic reactions with both Cas12a (DNA-specific) and Cas13 (RNA-specific) enzymes.
- Test the initial conditions of the enzymatic reactions with both Cas enzymes and respective fluorescent probes needed to develop the pen-side diagnostic test.
- Identify the optimal protocol suitable for the field to extract the nucleic acids from clinical samples which will be tested in parallel with the enzymatic reactions.

# Optimizing the CRISPR-Cas Based Assay with Fluorescent Probes



**Figure 4:** Different steps and strategies to test and validate the CRISPR-Cas based assay.

## Objective 3: Improvement of the subunit vaccines-anti-sporozoite antibody-mediated vaccine solutions

PhD student recruitment and training: In collaboration with UoN, applicants for the position were shortlisted and six candidates were interviewed online. One suitable candidate (female) was selected. The candidate developed a proposal and presented to the University of Nairobi and received approval. She has started her training in the lab to be familiar with the lab techniques relevant for her experimental work. She is also attending the weekly ILRI Journal Club sessions and the weekly ILRI Scientific Seminars.

Outsource expression of antigens in soluble form: The 4 soluble antigens Tps1, Tps2, Tps3 and Tps4 were outsourced to GeneScript. The proteins were expressed in *E. coli* and shipped to Kenya. The parcel arrived in June 2021 and the proteins are ready to be used in the different lab assays related to this project, such as ELISA, proliferation assays, ELISpot, among others.

Nanoparticle expression by Institute for Protein Design (IPD) for the four new antigens, p67C and p67N: Monthly meetings with the Institute for Protein Design (IPD) to track their progress in the expression of six *T. parva* antigens in nanoparticle format for the immunogenicity studies are being held. IPD has ordered different constructs for the expression of the antigens as nanoparticles. The IPD is in the process of optimizing the expression of the antigens with the carrier proteins and the assembly of the different building blocks into stable nanoparticles.

Internal source of sporozoites from the ILRI tick unit: The PhD student is still under training and is yet to begin the selection of best antigens using archived sera under a seroneutralization assay. Once training is complete, we will go ahead with the proposed milestone. In line with this, we did not get the supply of sporozoites from the ILRI tick unit because we are not in a position to use them. We are in discussion with the ILRI tick unit to schedule the supply of sporozoites in January 2022. We have also booked space in the ILRI farm for the immunogenicity studies that should happen in quarter two of FY22.

#### Objective 4: Integrating economics to quantify direct and indirect effects of ECF vaccine innovations and interventions on human nutrition and wellbeing

We will estimate the economic effects of ECF morbidity and mortality, then evaluate downstream impacts on household outcomes such as maternal and child nutrition. During the current reporting period, we met with the Technical Advisory Committee to discuss the scientific details of the project and receive constructive feedback to improve the ECF economics study component.

##### a) Evaluate the economic effects of East Coast fever

- PhD student recruitment and training: In collaboration with UoN, applicants for the position were shortlisted and five candidates were interviewed virtually for this position. One suitable male candidate was selected. The student has developed a proposal for presentation at the University of Nairobi.
- Develop survey instruments to measure household income, maternal and child nutrition, women's empowerment: Data collection tools have been developed which will be used for ethical clearance and for field data collection. The data collection tools developed include a household socio-economic questionnaire on impact of ECF and a Women Empowerment in Agriculture (A-WEAI) questionnaire. Specific focus will be on the Women's Empowerment in Livestock Index (WELI) which facilitates assessment of the impact of livestock interventions on the empowerment of women involved in the livestock sector. Development of survey questions on willingness to adopt new technologies is ongoing.

#### Objective 5: Integrating gender and youth in the Feed the Future Innovation Lab for Animal Health

A gender-sensitive approach is critical to understanding willingness to adopt new animal health technologies as well as the impacts of those technologies on household wellbeing. We will adopt a gendered lens throughout our evaluation of the impacts of innovation lab activities on human well-being. As a baseline, farmer knowledge, attitudes, beliefs, and practices on ECF vaccinations including the gendered perspective of the same will be explored.

During the current reporting period, we met with the Technical Advisory Committee to comprehensively discuss the scientific details of the project and receive constructive feedback which would improve the gender aspects of the project. Valuable inputs were received from the

advisory team and will greatly improve the project implementation. Below is a progress summary of the activities undertaken in FY21.

- Gender sensitization workshop: The aim of this activity was to sensitize the project team on gender inclusivity in all the different stages of the AHIL project, from recruitment of project personnel to project implementation. Due to covid-19 restrictions, a virtual gender sensitization workshop was held targeting participation from AHIL project implementation team and graduate students. Twenty-nine individuals (19 men, 10 women) participated in the AHIL gender training workshop. Additionally, gender experts were part of the team planning and conducting the AHIL PhD interviews to ensure gender and inclusivity was adhered to and will continue to sensitize the team during project implementation to ensure gender is mainstreamed in all aspects of the project.
- Develop a gender action plan: The process of developing a gender action plan for AHIL is ongoing. Once complete, it will be submitted to USAID and sensitization of the research team on the action plan will be conducted. The team will be continuously sensitized and evaluated on its processes on gender and inclusivity.
- Recruitment of PhD student: We shortlisted and interviewed six candidates. One suitable candidate (female) was selected. The student developed a proposal but has yet to present to the university due to departmental changes which require students to go through course work before project proposal presentation.
- Develop field data collection tools: Data collection will involve use of focus group discussion (FGDs), in-depth interviews, and key informant interviews. The focus group discussion will involve both ECF technology users and non-users. Data on producer–value chains will also be collected during the FGDs. In-depth interviews will capture workloads, access, and control profile, working skills, knowledge and capabilities, technology identification and utilization and decision making. A detailed checklist for the focus group discussion, in-depth interviews and key informant interviews has been developed and will be used for the baseline surveys once ethical clearance is obtained.

#### Objective 6: Assessment of maternal and child nutritional status in livestock keeping households

Animal-Source Foods (ASF) are a good source of various nutrients, and a source of highly absorbable and bioavailable micronutrients that are lacking in cereal-based diets commonly consumed in low and middle-income countries by women and children who are most vulnerable. This objective will mainly focus on assessing the effect of the project interventions on nutrient intake and health outcomes in children and women of reproductive age. Access to animal source foods (ASF) will be championed through nutrition education and social and behavior change communication.

During the current reporting period, we met with the Technical Advisory Committee to discuss the scientific details of the project and received constructive feedback to improve the nutrition studies component. Valuable inputs were received from the advisory team and will greatly improve the

project implementation. Below is a summary of the activities planned under the current reporting period.

**a) Selection of AHIL field study sites**

The process of selecting the field study sites for AHIL involved mapping both the malnutrition rates and ECF occurrence. The following criteria was used to select the study sites.

- High incidence of East Coast Fever.
- High rates of malnutrition (underweight) in children 0 – 59 months.
- Accessibility and logistical concern – areas accessible to field research teams and with field laboratory infrastructure.
- Presence of Feed the Future resilience programs for complementarity.

Six counties namely, Narok, Nyamira, Migori, Homabay, Siaya and Busia were considered, and the following data sources were reviewed and used to select the final two AHIL field study sites:

- Nutrition data from Ministry of Health – Standardized monitoring and Assessment of Relief and Transitions (SMART) surveys.
- Kenya Demographic Health Survey (KDHS) and District Health Information System (DHIS) data – to identify counties with high malnutrition levels.
- Health Information System data on children under the age of 5 years - to assess the proportion of underweight children up to the ward administrative level.
- Consultation with local County officials from the Ministry of Agriculture, Livestock and fisheries and Ministry of Health.

From these six counties, Narok and Busia counties were selected for inclusion into the study.

Narok county selection was based on:

- High rates of malnutrition.
- High in incidence of East Coast Fever.
- Availability of different livestock production systems (pastoral, agro-pastoral and large-scale farming).
- Presence of other Feed the Future projects for complementarity and
- Easy accessibility by field research teams.

Busia county selection was based on:

- High rates of malnutrition.
- Presence East Coast Fever challenge.
- A livestock production system characterized by emerging dairy production system with both indigenous breeds and improved dairy breeds.

**b) Recruitment of PhD fellows**



In collaboration with UoN, applicants for the position were shortlisted and eight people were interviewed online. One suitable candidate (male) was selected. The student developed a proposal and presented at the University of Nairobi and received approval to carry on with the study once ethical clearance is obtained.

### c) Ethical clearance

One general ethical clearance will be obtained for the project. The clearance will be obtained from Kenya Medical Research Institute Scientific, and Ethics Review Unit (SERU) and a reliance agreement sought from WSU. The protocol for the ethical clearance consideration has been developed and sufficient details on the design and methods for the nutrition studies included. The protocol has been presented to the Ministry of Health research in nutrition committee which cleared it for submission to the KEMRI Centre for Public health scientific research committee. Following clearance by the Centre scientific committee, the protocol was submitted to the KEMRI SERU for review and ethical approval. Research permits and approvals from NACOSTI and the county will also be obtained once ethical clearance from KEMRI SERU is obtained. Once the ethical clearance is obtained, the baseline survey will commence.

### Objective 7: Improve human and institutional capacity for animal health research

The objective of this research project is to improve human and institutional capacity for animal health research at the Faculty of Veterinary Medicine, University of Nairobi. Human capacity improvement will be achieved through establishment of research training programs for postgraduates (PhD/MSc) and undergraduates while institutional capacity development will be achieved through establishment and equipping of a molecular and diagnostic laboratory at the faculty. The following activities have been accomplished during the FY21.

- a) Establishment of research training programs for postgraduates (PhD/MSc) and undergraduates at the University of Nairobi.
  - Advertised the PhD Fellowships, shortlisted, interviewed and selected the eight (8) most suitable candidates for the award of the fellowships by June 2021. The process was competitive as it attracted about 300 applicants in the eight thematic areas.
  - Registered all the students who received the PhD Graduate Fellowships as full-time graduate students at the University of Nairobi in their respective Faculties and Departments and identified the supervisors. The year 1 tuition fee was paid in full, and the students are receiving their monthly stipend.
  - All the eight graduate students developed their full PhD proposals by 30<sup>th</sup> September 2021, 4 out of 8 had successfully presented the proposals to their respective Faculties/Departments. The other three are in their final stages while one will present in May 2022 due to the student's department requirements to take four (4) units of coursework.

The summary of selected PhD candidates for the different thematic areas discussed above is provided (Table 1)

Table 1: Summary of the selected PhD fellows under the Animal Health Innovation Lab

PhD position thematic area	No. of shortlisted candidates	Selected candidate code	Gender
PhD in Applied Human Nutrition	8	001	Male
PhD in Clinical Studies (ECF Epidemiology)	6	002	Male
PhD in Veterinary Parasitology (Pen-Side Diagnostics)	6	003	Male
PhD in Veterinary Epidemiology and Economics	5	004	Male
PhD in Veterinary Epidemiology-Field Trials (ECF-TLR Agonist)	4	005	Female
PhD in Veterinary Parasitology (Sub-unit Vaccine)	6	006	Female
PhD in Veterinary Parasitology (Gene Editing)	6	007	Female
PhD in Anthropology (Gender Aspects)	5	008	Female

- Procurement of laptops for the eight PhD graduate students was completed. The laptop specifications were developed by the UoN project team with the support of the UoN ICT Department, the tender for the supply was floated and followed by a technical evaluation. The winning bidder supplied the laptops in early September 2021 and all the students have received their laptops.
- The positions of a Postdoctoral Fellow and Technologist were advertised in August 2021. The process of shortlisting and setting dates for interview is ongoing and the most suitable candidates will be selected in October 2021.
- One Masters position to work on the cost of production of ECF vaccine was advertised regionally, interviews conducted and a suitable candidate from Uganda selected.

Table 2: Summary of the selected MSc fellow(s) under the Animal Health Innovation Lab

MSc position thematic area	No. of shortlisted candidates	Selected candidate code	Gender
MSc on Estimating the cost of production of stabilates used in the Infection and Treatment Method (ITM) of immunization against ECF	6	009	Female

- b)** Establishment and equipping of a molecular and diagnostic laboratory at the Veterinary School.

Laboratory space has been identified at the Department of Clinical Studies, Faculty of Veterinary Medicine. The drawings/plans for the Innovation Lab were completed, the BQs were generated, and these were approved by both the UoN and USAID.

The tender for the renovation works for the establishment of the molecular and diagnostic laboratory was floated, bids were received from several construction companies and evaluated, and the award was given to the lowest bidder through a rigorous competitive process. The renovation works started in August 2021 and as at 30<sup>th</sup> September 2021, 95% of the work had been completed.

The laboratory equipment specifications were developed by the UoN project team and thereafter presented for advertisement in an open tender process. Thirteen (13) companies that provide lab supplies and equipment expressed interest and quoted for the various equipment. Following a very thorough technical evaluation process, the successful bidders were awarded the tender and contracts to supply the equipment by UoN. As of 30<sup>th</sup> September 2021, one company had delivered two pieces of equipment while the rest were in the process. The Lab is expected to be fully functional during the last quarter of 2021.

### Human and Institutional Capacity Development

Long-term PhD trainings started with recruitment and registration of eight (4 male and 4 female) PhD students at the University of Nairobi. No short term and modular trainings were carried out during the FY2021 as the ME was focused on laying the foundation and generating resources for trainings. The modular trainings will begin in our second year (FY2022).

## Technology Transfer and Scaling Partnerships

No technologies were ready to be transferred or scaled during the FY2021 as the Management Entity was engaged in preparatory work and formative research for the technologies to be developed in the subsequent years.

However, during the reporting period, the director, Feed the Future Innovation Lab for Animal Health participated and presented a webinar series organized by the Food Safety Innovation Lab (FSIL) titled “Food Safety and One Health: Approaches to Reducing Foodborne Pathogens and Zoonotic Diseases”. His presentation was titled “Food Safety and Zoonoses in East Africa” and focused on recent/ ongoing zoonotic disease research that impacts food safety and current research needs.

Similarly, AHIL personnel participated in the quarterly livestock partners meetings organized and convened by USAID Mission in Kenya, under the USAID-Resilience Learning Activity (RLA). The quarterly meetings are intended for coordination and collaboration to strengthen livestock sector performance in Kenya and the region. During the meeting on 20<sup>th</sup> November 2020, the AHIL director gave a presentation to livestock partners on the Animal Health Innovation Lab which generated significant interest from attendees. Areas of synergy and future collaborations will be explored.

## Environmental Management and Mitigation Plan (EMMP)

As per the USAID regulations, the ME has approved the Initial Environmental Evaluation (IEE). During the FY2021, no field research activities were carried out and therefore there are no mitigation and monitoring activities to report. The activities conducted by the ME fall under the Initial Environmental Examination.

## Data Management Plan (DMP)

In December 2020, the Animal Health Innovation Lab developed its data management plan (DMP), which was approved by USAID. In FY2021, the Animal Health Innovation Lab reviewed the DMP, and no changes were made.

## Governance and Management Entity Activities

The Management Entity (Washington state University, Paul G Allen school for Global Health) has a presence in Kenya, the focus country for the Animal Health Innovation Lab. The Director AHIL, is based full time in Kenya making the coordination and decision making timely and efficient. The Project Manager was approved by USAID in September 2021. The project is implemented in collaboration with ILRI and University of Nairobi which are all based in Kenya.

Sub-awards to ILRI and University of Nairobi were approved by USAID and executed by WSU. ILRI will co-lead work on development and or improvement of ECF vaccines and diagnostics while University of Nairobi will co-lead work on human and institutional capacity development. Personal service contracts for scientists from KEMRI and KALRO supporting the nutrition work and ECF ITM vaccine work respectively were also executed.

To strengthen governance structures and AHIL engagements with the USAID mission and policy, consortium members meetings were held on monthly basis to track performance of key research thematic areas and coordinate administrative procedures. The external advisory board represented expertise from diverse backgrounds and disciplines to ensure AHIL achieves its goal. The advisory committee agreed to meet on a quarterly basis virtually and have one annual in-person meeting.

- AHIL Technical Advisory Committee: A Technical Advisory Committee of experienced researchers working on East Coast Fever has been identified to serve as external advisors to the program. The team includes Prof. Patricia Conrad (Distinguished Professor, Associate Dean of Programs School of Veterinary Medicine and Co-Director, University of California Global Health Institute); Prof. Guy Palmer (Senior Global Health Director, and Regents Professor of Pathology and Emerging Infectious Diseases at Washington State University); Prof. Lorne A Babiuk (Past Vice President Research, University of Alberta); Dr. Tyrell Kahan (USAID Bureau for Resilience and Food Security). A series of meetings were held with the advisory team and an overview of the AHIL project including key objectives of each research thematic area was presented by the lead principal investigators. Valuable inputs were obtained from the advisory team and incorporated in project implementation. Weekly coordination meetings were also held with the USAID team to support the AHIL team in setting up the project. Click [here](#) to view the presentations.
- Launch of the Animal Health Innovation Lab: As part of increasing awareness of AHIL's target audience about the Innovation Lab activities and accomplishments, the project planned a launch meeting. Initially, the launch meeting was planned for March 2021. However, due to a surge in Covid-19 cases in Kenya the launch event was postponed and held on the 17th of May 2021. To adhere to Covid-19 recommendations, the event was held both virtually and physically (hybrid). This enabled wide participation from government, USAID Washington and Mission Office, development partners, universities, private sector actors, professionals, and community members. Speakers at the launch lauded AHIL for the collaborative and inter-disciplinary nature of the program.

To strengthen Monitoring & Evaluation, Reporting & Environmental compliance, the ME designed activities to track project performance and ensure all set deliverables are met through documents that were prepared and submitted to USAID for approval. These AHIL approved documents include:

- I. Initial Environmental Examination (IEE) – It describes a preliminary review of the foreseeable effects on the environment of the intervention, recommends determinations and, as appropriate, conditions, for these activities. It also documents the results of the project/activity level climate risk management process.
- II. The annual workplan – This document describes all activities planned for the first year (1<sup>st</sup> October 2020 – 30<sup>th</sup> September 2021).
- III. Activity Monitoring Evaluation and Learning (MEL) Plan – It illustrates the program throughout the project lifetime and keeps track of the lab’s activities with the aim of ensuring the stated goals and objectives are achieved. The MEL plan will monitor program performance, provide evidence of successes of the Innovation Lab, generate lessons learnt from key program implementation components including the implementation of effective and efficient processes to promote adoption and upscaling of the innovative technologies and interventions to yield maximum development impact. A data management plan was also submitted alongside the MEL plan.
- IV. Branding and marketing plan – This document describes the implementation of effective strategic communication and marketing activities that promote, inform, and support the activities of the Innovation Lab in the East and Central Africa region, where the program plans to impact, as well as in the United States. The goal is to inform AHIL’s domestic and international audience and partners on the critical research problems in animal health addressed by the Innovation Lab, and application of evidence-based solutions to complex problems challenging social, economic, and nutritional outcomes in developing economies.
- V. Communicated AHIL objectives, themes, and approaches – the director AHIL and others in ME promoted AHIL and communicated on its aim of improving ECF diagnostics and control tools and making them easily accessible to small holder farmers. This included presentation in webinars, Livestock partners meetings organized by USAID Mission in Kenya. Management Entity established the AHIL website (<https://globalhealth.wsu.edu/initiatives/animal-health-innovation-lab/>), set up the AHIL page on Agri links website (<https://agrilinks.org/activities/feed-future-innovation-lab-animal-health>) created a twitter social media handle (@animalhealth\_il) and developed the AHIL brochure in English which summarizes its vision, target area and approaches as well as research portfolio descriptions
- VI. Submitted quarterly financial reports.

### Other Topics (Impact Assessment, Gender Initiatives)

N/A

## Issues and how they are being addressed (Financial, Management, Regulatory)

During the reporting period, the principal investigators (PIs) cited numerous challenges in their efforts, including:

- Covid-19 pandemic led to restrictions in travel and physical meetings which negatively affected some of the preparatory activities, especially in the first quarter. Some of the affected activities include the gender sensitization workshop, the AHIL launch event and traveling to selected AHIL field sites for preparatory activities and logistics planning.
- Communication challenges with partners across different time zones are being overcome through accommodating meeting times outside of normal working hours.
- Complexity of coordination and consensus building in multi-partner project team consortia. We are addressing this through scheduled meetings between the consortium members.

## Future Directions

In FY 2022 the ME plans to finalize the renovations works and equipping of the molecular and diagnostic laboratory at the University of Nairobi and plan for an official in-person launch of the laboratory. The launch is envisioned to be held together with AHIL annual scientific meeting to allow for participation of the external advisory committee members in person.

The management entity also plans to engage in field-based research activities as well as laboratory research to develop and innovate ECF diagnostic tools and vaccines for future scaling. The ME will look forward to supporting work to establish a private sector-led consortium through a multi-stakeholder taskforce to improve production and distribution of ECF control tools

## Appendices

### Annex I: Potential stakeholders for production and distribution of the ITM ECF vaccine

The listed stakeholders have been identified as potential stakeholders for production and distribution of ITM ECF vaccine. An initial engagement was made through a simple online questionnaire to seek views and gauge their interest in participating in the consortium. Further engagement has been made through a stakeholders' consultative meeting on sustainable ITM ECF stabilates production where the idea of a distributed model of ITM ECF vaccine production was shared.

Stakeholder	Past involvement in ECF control or vaccine work	Current interests or focus	Potential role along the vaccine production chain	Existing capacity (infrastructure, finances, expertise etc.)	Why they might have an interest
Medsell	Not aware	Manufacture of antitheilerial drug. Want to venture in vaccine manufacture	Leader & coordinator of production	Manufacturing infrastructure	Diversification of business, wide range of tick-bone disease control products
VISAK (Intervet, Metrovet, Coopers, Ultravetis, Cosmos, Highchem)	Attempted distribution under the Agrochemicals Association of Kenya	Some members could have interest	Distribution	Marketing network, mobilize personnel & finances	Diversify disease control products
ILRI	Produced ECF vaccine in the past	Adoption of ITM, research in better ECF	Production of ticks, quality assurance, production of	Labs, farms, animal houses, expertise /personnel	Proven interest in disease control, research mandate



		control products	diluents, efficacy tests		on poverty alleviation
KALRO	Produced ECF vaccine in the past	Adoption studies of ITM, research in better ECF control products	Production of ticks, efficacy trials, production of diluent	Labs, farms, animal houses, personnel	Proven interest in disease control, national mandate in developing disease control products, dissemination
College of Agriculture and Veterinary Sciences (CAVS)	Training, research, diagnosis	Research, training	Quality assurance	Labs, personnel	Research, national mandate for skills development
Global Alliance for Livestock Veterinary Medicines (GALVmed)	Funded vaccinations & vaccine development, promoted private sector distribution	Support to private sector in disease control	Coordinate fundraising, support distributors, support registration of veterinary vaccines	Fund raising skills and networks, skills in vaccine delivery	Continued support to ECF control initiatives
Kenya Livestock Finance Trust (K-LIFT)	-	-	Finance distributors	Business plans	Expand the reach of its clients
Kenya Veterinary Vaccines Production Institute (KEVEVAPI)	-	-	Quality Assurance, produce diluents	Manufacturing facility, labs	Expand portfolio and product range
Centre for Ticks and Tick-Borne Diseases (CTTBD)	Produced ECF vaccine stabilates	Sustain production,	Quality assurance, produce ticks,	Labs, manufacturing	Sustain production

		stock for the region	efficacy trials, produce diluents, storage	capacity, animal houses, farm	
African Union- Interafrican Bureau for Animal Resources (AU- IBAR)	Regional coordination, Political support	-	Quality assurance (PanVac), political support, coordination	Country links, political support	Regional mandate for disease control
Food and Agriculture Organization of the United Nations (FAO)	Funding (research, manufacture, delivery)	Research, dissemination, economic studies	Economic studies, influence policy	Personnel, funds, regional presence	Mandate on food security, poverty reduction
Hester Biosciences Limited	Involvement with CTTBD and Bill & Melinda Gates Foundation	Not aware	Leader & coordinator of production, quality assurance, produce diluents	Manufacturing facilities, personnel, labs, finances	Diversify products, expand market base
Distributors (SIDAI, VetAid, Bora Biotech, Kenya Dairy Farmers Federation, Ronheam (TZ), UG representative)	Distribution of vaccine	Distribution	Distribution, vaccinations	Marketing skills, distribution networks	Sustained vaccine supply
Directorates of Veterinary Services (Kenya, Uganda, Tanzania, South Sudan)	Licensing, in-country regulation	Disease control	Regulation, policy	Personnel, field data/feedback on vaccine performance	Legal mandate, readily available effective vaccines for disease control

Regulatory authorities (Veterinary Medicine Directorate in Kenya)	Registration of vaccine	Registration of quality products	Registration of products, policy direction	Personnel, quality assessment tools	Mandate to register
Professional bodies in the East African region	Individual members involved in vaccine delivery	Vaccine delivery	Distribution, delivery	Network of members, inter-country links, continuous professional development activities	Business for members, disease control focus
Veterinary boards	Regulates vaccinators & veterinary practices, inspects laboratories, continuous professional development activities	Regulates vaccinators & veterinary practices, inspects laboratories	Certification of vaccine production facilities	Inspectors, legal mandate, records of businesses and practitioners, accredits continuous professional development providers	Well-regulated profession, standard facilities



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