



Centre for
Tropical Livestock
Genetics and Health

STRATEGIC PLAN 2030





OUR VISION: More resilient, productive, efficient, and environmentally sustainable tropical livestock production systems.

OUR MISSION:

To develop tools, technologies and innovations to enhance resilience, productivity, efficiency and environmental sustainability of tropical livestock production systems particularly for small holder farmers in low- and middle-income countries (LMICs).





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WHO WE ARE: The Centre for Tropical Livestock Genetics and Health (CTLGH) is a strategic livestock genetics research and development alliance established in 2014 by the University of Edinburgh (through The Roslin Institute), Scotland's Rural College (SRUC) and the International Livestock Research Institute (ILRI).

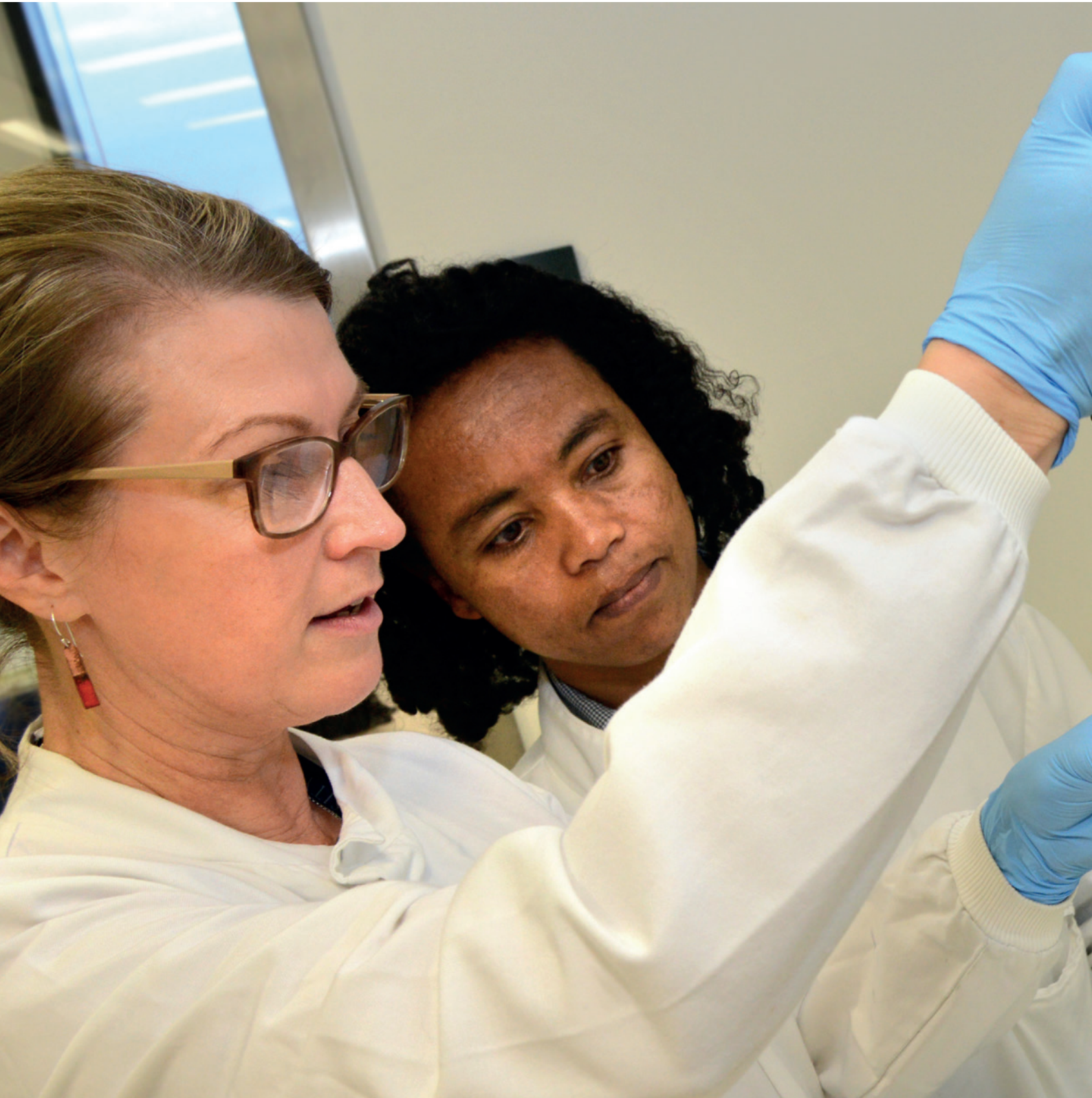
CTLGH's work is about upstream discovery research guided by downstream challenges and opportunities to develop relevant solutions to improve tropical livestock production systems.

We currently have research nodes in the UK, Kenya and Ethiopia.



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EXECUTIVE SUMMARY

The 2030 Strategic Plan for the Centre of Tropical Livestock Genetics and Health (CTLGH) builds on the CTLGH 2030 vision document published in 2020. The 2030 vision highlighted CTLGH's achievements in the first five years of its existence and introduced the key future strategic objectives of the Centre.

This strategic plan intends to outline CTLGH's priority leading up to 2030 as a Hub for tropical livestock genetic improvement research and development, capacity building and knowledge transfer and strategic partnership and collaborations for research into use. CTLGH's efforts will be focussed on the development of tools and innovations for resilient livestock smallholder systems in low- and middle-income countries (LMICs).

The strategic plan is underpinned by CTLGH's unique value proposition and strategic position as an integrator of discovery science, science to practice and applications to deliver livestock genetic solutions in tropical smallholder systems.

The plan highlights both the challenges and opportunities for CTLGH to create interventions brought about by linking genetics, genomics, animal breeding and data science to deliver and sustain genetic gains.

By mobilising CTLGH's founding partners—The University of Edinburgh (principally The Roslin Institute), Scotland's Rural College (SRUC) and the International Livestock Research Institute (ILRI)—CTLGH will focus on research, on capacity building and knowledge exchange to leverage strategic partnerships to deliver on its strategic objectives.



CTLGH OVERVIEW

The Centre for Tropical Livestock Genetics and Health (CTLGH) is a strategic livestock genetic improvement research and development alliance established in 2014 by the University of Edinburgh (through The Roslin Institute), Scotland's Rural College (SRUC) and the International Livestock Research Institute (ILRI)¹.

Current CTLGH activities are primarily implemented through its research nodes in the UK, Kenya and Ethiopia and through a range of collaborators across the globe.

CTLGH was established to harness the advances in genetics, genomics, animal breeding and data science that are driving and sustaining genetic progress in advanced economies, and apply them, in partnership with a global network of farmer facing organisations, to livestock production systems in low- and middle-income countries (LMICs).

CTLGH focuses on upstream discovery research guided by downstream challenges to create opportunities for step change in livestock genetic improvements.

Since its establishment, CTLGH has evolved into a leading research and development partnership with a mission to develop tools, technologies and innovations to enhance productivity, resilience, efficiency and environmental sustainability of smallholder livestock systems.

CTLGH's value proposition is built in its unique position as an integrator of discovery science with science to practice to develop and deliver genetic solutions to challenges faced by smallholder farmers in LMICs

There are current and probably future external influences that will shape CTLGH's research focus, the targeted beneficiaries and resource mobilisation. The current imperatives associated with climate change will influence CTLGH positioning and bring focus onto both adaptation and mitigation. Threats to the global food systems and economies seen during the current Covid-19 pandemic, the ongoing changes in the CGIAR system constitute some examples.

The Centre will regularly evaluate the landscape jointly with partners and investors to ensure that its work remains relevant and is addressing the needs of smallholder livestock systems.

Since its establishment, CTLGH has evolved into a leading research and development partnership with a mission to develop tools, technologies and innovations to enhance productivity, resilience, efficiency and environmental sustainability of smallholder livestock systems.

¹See Appendix 1 for more information on CTLGH's founding partners.



TROPICAL LIVESTOCK SYSTEMS: CHALLENGES AND OPPORTUNITIES

Livestock development is vital for socio-economic development and a key driver for the agri-food systems. Globally, 1.3 billion people currently rely on livestock for income generation, food and nutritional security. It is estimated that by 2050 there will be 10 billion people living on earth and there will be need to produce over 50% more food. The global population is also becoming wealthier which will lead to a higher demand for animal sourced foods; principally milk, meat and eggs. The importance of livestock is therefore enormous and particularly in LMICs is characterised by tropical production systems that are dominated by smallholder farmers.

Tropical livestock systems face numerous challenges related to animal health, nutrition, and genetics. Addressing these challenges is critical in building resilient agri-food systems, while maintaining social equity, efficient management of natural resources, reduced emission of greenhouse gases and minimising the environmental impact of animal agriculture.

Livestock development is a key contributor for the delivery of the United Nations Sustainable Development Goals (SDGs). In LMICs specifically, livestock contributes directly to seven SDGs and indirectly to several others. Livestock production therefore underpins interventions focused on the following human development challenges:

- Resilience of the poor and the most vulnerable to address climate-related extreme events and other economic, social and environmental shocks and disasters (SDG #1)
- Empowerment of women and girls at all levels (SDG #5)
- Increase agricultural productivity and incomes of small-scale food producers through secure access to relevant resources and inputs (nutrition and health; SDGs #2 and #3)
- Sustainable consumption and production patterns with a particular focus on efficient use of natural resources (SDG #12)
- Resilience and adaptive capacity to mitigate environmental impact and climate-related livestock development challenges (sustainable ecosystems; SDG #13)
- Innovative partnerships, mobilisation of resources, and targeted capacity-building in LMICs to support national development plans (SDG #17)

Global agriculture is at its critical point in the history of humanity. With the world currently at 1°C warmer than pre-industrial levels and projections to reach 1.5°C by 2030, there is a call for urgent actions. Within these actions, livestock must be made part of the climate smart agriculture and used to create solutions to mitigation and adaptation to climate change.

The highest human population growth rates are in LMICs, where food insecurity is already a major problem. It is vital that, as the demand for animal sourced food increases, the efficiency of livestock production, is improved.

Tropical livestock production systems are currently some of the least productive globally. The low level of productivity is attributable to a range of factors; disease, limited access to inputs, variable and challenging climatic conditions linked to environmental

stress (heat, humidity, ...) and social factors such as conflicts, and access to land. The genetic improvement of livestock in LMICs has been in part hampered by limited breeding systems considering important traits linked to productivity, adaptation and socio-cultural preferences. This has limited the ability to drive the long term genetic improvements in livestock performance, seen in more developed countries.

Sustainable tropical livestock systems are therefore needed in order to:

- Provide resilience and support for improved livelihoods of millions of vulnerable smallholder livestock producers in LMICs
- Meet the demand for animal source foods in LMICs and globally and particularly the need to keep up with the increasing demand related to overall population growth
- Reduce emissions derived from agriculture, forestry and other land use
- Support countries and regions to meet their commitments to the Paris agreement
- Reduce and mitigate the impact of climate change on animal agriculture
- Develop and strengthen circular bio-economies and related innovations

To contribute to creating sustainable tropical livestock systems CTLGH will continue to mobilise its founding partners and leverage collaborations to:

- Develop genetic and genomic solutions to identify, select, conserve and disseminate livestock that are productive, resilient, efficient and environmentally sustainable for tropical smallholder systems
- Develop and deploy innovative solutions to support long term livestock performance recording, evaluation and genetic gains focusing on key economic, production, social and environmental considerations
- Support animal breeding programmes and develop the necessary capacity (human and infrastructure) to realise and sustain genetic gains in the targeted systems
- Develop, customise and use integrated data systems to support genetic improvement in the targeted systems
- Assess the trends and drivers to guide the development, dissemination and adoption of relevant technologies and innovations

CTLGH's work will continue to focus on upstream discovery to lead the development of tools and related innovations (in genetics, genomics, data science, animal health, reproductive technologies and animal breeding) to support genetic improvement of tropical livestock.

CTLGH STRATEGIC OBJECTIVES AND CORE RESEARCH CAPABILITIES



Building on its initial achievements, CTLGH has generated relevant and exciting outputs² and strengthened its strategic position to address the following three strategic objectives as part of a 10-year (2020–2030) strategic plan:

STRATEGIC OBJECTIVE 1

Research: CTLGH will lead, catalyse and support research and development for innovation, creating the tools for genetic improvement in tropical livestock production systems. CTLGH will leverage upstream (discovery) and translational (practice and application) research expertise available in its founding organisations to address key livestock development challenges in LMICs.

STRATEGIC OBJECTIVE 2

Partnerships and collaborations: CTLGH will mobilise its partners to strengthen existing and establish new collaborations to deliver and sustain genetic gains in tropical livestock production systems.

STRATEGIC OBJECTIVE 3

Capacity building and knowledge exchange: CTLGH will identify and address key strategic capacity gaps to deliver sustainable and relevant genetic innovations in support of tropical livestock improvement.

It is the Centre's aim to combine discovery science and science into practice and application in order to address critical gaps in the genetic improvement continuum in tropical livestock systems.

² See Appendix 3 for CTLGH's Five Year Highlights published in 2019

CTLGH will bring the benefits of upstream research and innovation and maintain close collaborations with downstream and farmer facing programmes notably ADGG and TPGS (see box below) and the private sector to develop genetic solutions capable of achieving impact at the smallholder farm level with a particular focus on sub-Saharan Africa, South, Southeast and East Asia. Effort will also be dedicated to exploring opportunities for both learning lessons and achieving impact in South America where the same stressors and options for impact apply.

Discovery science: CTLGH will focus on the development of new technologies and strategies to define, measure and improve key performance characteristics (traits) to support livestock breeding for socially, economically and sustainable production systems.

Science to practice and application: CTLGH will focus on leveraging available knowledge and partnerships to create contextualized genetic solutions for smallholder livestock systems.

FARMER FACING PROGRAMMES

African Dairy Genetic Gains (ADGG)

Africa Dairy Genetic Gains (ADGG) is an international Livestock Research Institute (ILRI)-led investment by the Bill & Melinda Gates Foundation (BMGF) that is providing dairy cattle genetic gains with the potential to transform the lives of millions of dairy families across Africa.

Working with farmers in Ethiopia and Tanzania and more recently Kenya, Uganda and Rwanda, ADGG's vision is to see African smallholder dairy farmers continuously accessing more productive dairy genetics, breeding and farmer education services and other related input services enabling their farming enterprises to be profitable and competitive businesses.

Tropical Poultry Genetic Solutions (TPGS)

Tropical Poultry Genetic Solutions (TPGS) is an Africa and southeast Asian-wide collaboration led by the International Livestock Research Institute (ILRI). Formerly known as African Chicken Genetic Gains (ACGG), TPGS co-develops, tests and makes available high-producing, tropically adapted and farmer-preferred genotypes that increase smallholder chicken productivity.

The programme is supported by the Bill & Melinda Gates Foundation, the Australian Centre for International Agricultural Research (ACIAR) and co-financing by national partners and aims to leverage existing research while implementing innovative approaches to the development and supply of genetics in country value chains.



IV CTLGH RESEARCH THEMES

The CTLGH research themes have been designed to deliver impact on a range of areas from discovery to field application. All themes will guide the design and implementation of collaborative research and activities portfolio that respond to identifiable needs. CTLGH projects will leverage both upstream (discovery science) and downstream (science to practice and application) to achieve impact.

CTLGH's six research and development themes are interlinked to build integrated projects ranging from phenotyping and performance recording to the selection and delivery of improved genetics.

THEME 1 Tropical Livestock Phenomics

THEME 2 Tropical Livestock Genomics and Markers Discovery

THEME 3 Animal Breeding and Quantitative Genetics

THEME 4 Reproductive Technologies and Functional Genomics

THEME 5 Data Systems

THEME 6 Capacity Building and Knowledge Exchange

Regular interactions between these specialist themes and the farmer facing programmes and other key partners (i.e farmers groups) will ensure that CTLGH research is appropriately targeted, context-specific and builds on knowledge of future trends and scenarios, including for example linkages between production goals and environmental impact models.

Figure 1 emphasises the relative focus on key research areas to account for the importance of collaborations to support the co-design and co-implementation that ensure relevance of the CTLGH activities portfolio and greater impact of the deliverables.

THEME 1 Tropical Livestock Phenomics

Overall objective: Development and application of comprehensive phenomics tools and integrated strategies for performance recording to support and accelerate genetic improvement.

Background information: The ability to measure the performance of livestock under real-world conditions is fundamental to the characterisation of traits of interest to underpin genetic improvement. Measuring and predicting productivity, adaptation and resilience of all farmed animals remain are considerable challenges especially in diverse and heterogeneous smallholder tropical systems in LMICs. The phenomics challenges constitute a major limitation to defining and addressing important tropical livestock breeding objectives. It is particularly imperative under the current context of building profitable and sustainable livestock systems in LMICS to focus on socially, economically and environmentally important traits.

Recent advances in data capture and analysis can now be harnessed to address this set of challenges in the tropical production systems.

CTLGH areas of focus and selected deliverables:

CTLGH will lead the development of new and application of existing tools to facilitate phenotyping, in its broadest sense. This will include direct measurements of traits, their proxies, and related biomarkers associated with **health, productivity, adaptation, resource use efficiency** and **emission of greenhouse gases** in tropical livestock systems.

These efforts will be highly collaborative and involve farmer facing livestock improvement programmes,

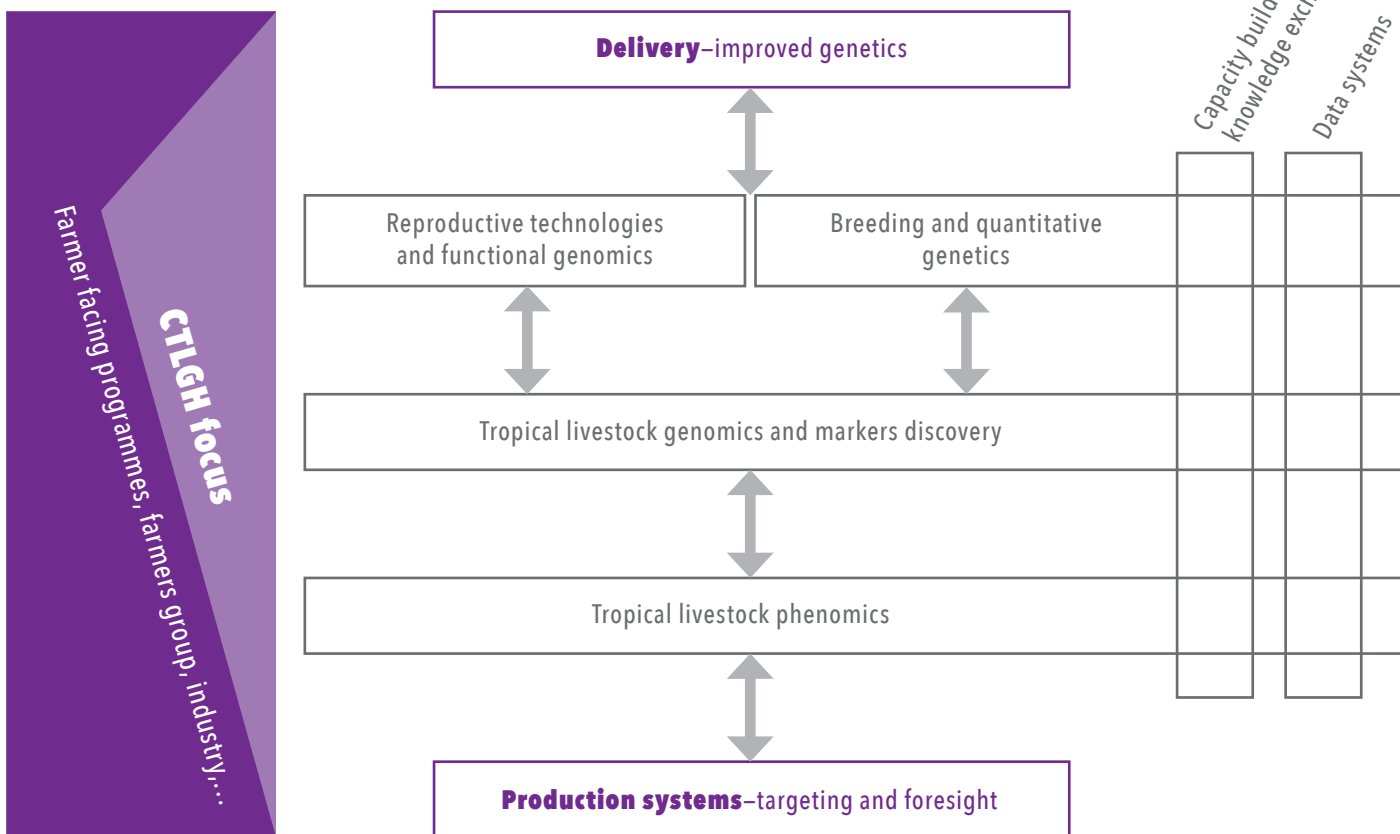


Figure 1: Schematic representation of CTLGH research and development themes.

farmers organisations, industry and breed associations. CTLGH’s focus will be to define and identify methods (from very simple proxies to complex measurements derived from multiple combined datasets) for recording components of key traits. This will include definition of direct measurements and proxies to support recording of parameters linked with the following traits: diseases and pests (individually or as a group), health/immune fitness, productivity, climate resilience, resource use efficiency and low-carbon/low emission.

For complex and hard to measure phenotypes, emphasis will be placed on the development and evaluation of proxies and biomarkers (exploring microbiome communities, biomarkers found in milk, blood and other body fluids, and cellular/immunological assays) to support performance data collection.

Additional dimensions guided by other CTLGH objectives will be considered to further develop approaches for combining traits and their relative

emphasis depending upon local production systems, socio-economic context and relevant policies.

Overall, CTLGH will endeavour to generate and support the delivery of a set of outputs linked to existing livestock improvement programmes and to international networks to harness the power of phenomics to drive and sustain genetic improvement.

Key deliverables to include:

- An agreed set of measurable performance parameters and options for proxies and cellular phenotyping for key traits
- Flexible data systems that allow real time integration across phenotypes, environments and species; ideally in a way that allow automatic pipeline of breeding targets and gene candidates to be subsequently identified
- A comprehensive “phenomics toolbox” for use in low inputs (including pastoralists) and intensive

tropical livestock production systems to enhance various livestock species: large ruminants, small ruminants, poultry and pigs.

Partners and collaborators: University of Edinburgh (The Roslin Institute, Global Academy for Agriculture and Food Security–GAAFS, Supporting Evidence Based Interventions–SEBI), SRUC (EGENES), ILRI and other CGIAR centres (ICARDA), African Animal Breeding Network (AABNet), National Livestock Research Institutes and Universities (Africa and Asia), Global livestock genetic evaluations platforms (INTERBULL, The International Committee for Animal Recording–ICAR), Europe (Wageningen University & Research - WUR, Natural Resources Institute Finland–LUKE, University of Hohenheim), private sector organisations.

THEME 2

Tropical Livestock Genomics and Markers Discovery

Overall objective: Identification and use of genetic and genomic variations to develop tools and resources for use in tropical livestock genetic improvement.

Background information: At the heart of CTLGH's unique contribution to tropical livestock genetic improvement is the identification, functional characterization and use of genetic variants associated with health, productivity, adaptation, resource use efficiency and emission of greenhouse gases. This directly addresses a gap in the existing capacity to create critical resources and tools to drive targeted breed improvement and/or selection for tropical smallholder livestock systems. This research and development theme will take advantage of CTLGH's founding partnerships and a network of collaborators that provide access to both state-of-the-art research infrastructure, expertise and access to *in situ* livestock data, performance recording and biological samples.

Under this theme, a significant focus will be on creating genomic resources and information to enable interventions either through genome modification or innovative breeding strategies, delivered through other themes.

CTLGH areas of focus and selected deliverables:

Priority will be given to traits that include health, productivity, adaptation, resource use efficiency and emission of greenhouse gases. Adaptation and resilience are recognised as important, and most often necessary characteristics of livestock that are used in challenging environments in LMICs. The Centre will contribute to the development of robust systems for genome (host and microbiome) profiling, analyses with performance information and applications to address key biotic and abiotic stresses.

In some instances and to further harness the genetic diversity that exists in tropical production systems, CTLGH will utilise the Landscape Genomics strategy to reveal the relationship between adaptive genetic imprints in genomes and environmental heterogeneity among natural populations.

Through an extensive study of the genomes of tropical breeds and individual animals showing both the desired and undesirable phenotypes, CTLGH and partners will aim to unravel the underlying genetics and markers/genes that underpin important phenotypes/traits. Key deliverables to include:

- Increased understanding of the nature of quantitative genetic variations in available genotypes including locally adapted breeds.
- Develop a basic understanding of the genetic basis, including covariance structure, of productivity, environmental adaptation and disease resistance/tolerance to inform selection in breeding programmes
- Identification of genomic regions associated with

traits of interest that can be used in conventional breeding programmes

- Identification of candidate variants with measurable effect on traits of interest for use by other CTLGH themes for further evaluation and exploitation

Partners and collaborators: University of Edinburgh/ The Roslin Institute, SRUC (EGENES), ILRI and other CGIAR centres (ICARDA), African Animal Breeding Network (AABNet), National Livestock Research Institutes and Universities (Africa and Asia), Global livestock genetic evaluations platforms (INTERBULL, The International Committee for Animal Recording–ICAR), Europe (Wageningen University & Research - WUR, Natural Resources Institute Finland–LUKE, University of Hohenheim), private sector organisations.

THEME 3

Animal Breeding and Quantitative Genetics

Overall objective: Development of tools and methods to support the design of new, and/or the management of existing, animal breeding programmes in LMICs.

Background information: In tropical livestock production systems, most adaptive traits are at least to moderately heritable, hence providing opportunities for improvement through breeding. Simultaneous genetic improvement is therefore feasible to maximize gains and profitability derived from multiple traits.

CTLGH areas of focus and selected deliverables: CTLGH and collaborators will co-develop tools and algorithms to underpin selection in breeding programmes linked to appropriate decision support

systems. The collection, integration and application of large amounts of data will be critical in driving the genetic improvement of livestock with desired phenotypes/traits and the overall performance. A vital component will be the development and integration of the tools necessary to store, manage and analyse large data sets to support genetic improvement.

A long-term effort leveraging the CTLGH capacity building theme will focus on sustained genetic improvement activities and delivery of innovations through key farmers facing organisations and relevant continental breeding platforms in Africa (i.e. The African Animal Breeding Network–AABNet) and in Asia (through BAIF). Possible collaborations under these arrangements will focus on conducting and deploying Multiple Across Country Evaluation (MACE) and support national or regional livestock genetic evaluations.

In collaboration with the data theme, develop systems to support animal breeders and breeding programmes to link their livestock systems to the global databases for genetic evaluations. Further establish technical capabilities to conduct comparative analyses to support decision making on best bet genotypes for targeted production systems and/or agro-ecologies.

Partners and collaborators: University of Edinburgh/ The Roslin Institute (Global Academy of Agricultural and Food Security (GAAFS), SRUC (EGENES), ILRI and other CGIAR centres (ICARDA), African Animal Breeding Network (AABNet), National Livestock Research Institutes and Universities (Africa and Asia), Global livestock genetic evaluations platforms (INTERBULL, ICAR, ...), Europe (WUR, BOKU, LUKE, Uni Hohenheim, ...), private sector (Hendrix Genetics).

THEME 4

Reproductive Technologies and Functional Genomics

Overall objectives: Characterisation, conservation and development of improved genetics for tropical livestock production systems. Development of cell or organoid based systems for characterization and validation of candidate markers associated with key traits.

Background information: Advanced reproductive technologies combined with modern animal biotechnology can underpin and drive genetic gains in all livestock species. In the tropical smallholder livestock systems particularly, there are pressing challenges that require step changes for which interventions to accelerate genetic gains are urgently needed. Genome editing for precision breeding, advanced reproductive technologies (including the possibility to improve and increase efficiency of artificial insemination), advanced in vitro systems and resources for further screening and identification of candidate genes/markers are all well established in all livestock commodities and will readily be harnessed to improve health, productivity, adaptation, resource use efficiency and emission of greenhouse gases.

CTLGH areas of focus and selected deliverables

CTLGH and collaborators will target all major livestock species including large and small ruminants, poultry and other monogastric farmed animals.

- Development of robust and multi-species screening systems for genomic targets and genome editing pipeline to support tropical livestock genetic improvement
- Development of robust and multiplex editing strategies, protocols and resources to introgress multiple markers/variants to drive genetic improvement.

- Conceptualisation and development of prototype animals for anticipated production systems (based on climate change, emerging diseases, feed pattern/type, consumer preferences)
- Exploration of technology options (including surrogate sires) for rapid and scalable dissemination of improved germplasms
- Innovations to improve reproductive technologies (i.e. artificial insemination, embryo transfer, stem cells isolation and transplantation).
- Large scale characterisation, conservation and use (short, medium and long term) of indigenous and other important germplasms.

Partners and collaborators: ILRI, University of Edinburgh/The Roslin Institute, Washington State University, University of Missouri, Recombinetics Inc., African Union Inter-African Bureau for Animal Resources (AU-IBAR)

THEME 5

Data Systems

Overall objective: Development of data systems, tools, resources and innovations to support tropical livestock genetic improvement.

Background information: Livestock genetic improvement is dependent on data reporting performance of defined genotypes under specific environments. Initiatives with demonstrable and sustained genetic gains have been built upon performance recording systems that are currently very limited in CTLGH target geographies. In LMICs where the overwhelming majority of animal source food production is generated from smallholder farms, data capture remains the missing link. However, recent successes highlighted in the famers facing programmes are promising and offer opportunities to capture,

CTLGH's work will be continuously guided and shaped through interactions with farmer facing programmes and through access to information on tropical livestock production systems. This will further support targeting, foresight and delivery of genetic solutions co-developed by CTLGH.

integrate, share, analyse and use data to guide genetic improvement. CTLGH and closely related farmer facing programmes have demonstrated the critical importance of data.

Data driven innovations can lead to step changes and transform smallholder agriculture. For example, mobile-based systems provide rapid access to highly targeted information to farmers. Such platforms also provide data for use to detect important performance parameters and ultimately drive genetic improvement. This is especially true with the current transition to an era with limited human-to-human contacts hence the need to collect information remotely but in a highly dynamic and flexible way. It will also be essential to ensure that data is collected and used equitably avoiding biases (e.g. gender-based).

CTLGH ambitions are therefore to further develop, integrate and mainstream relevant information management systems with tools that combine new and existing data sources and support on-farm phenotypic characterisation, biological sampling and biorepository conservation and curation. These systems in turn will provide highly tailored information for feedback and engagement with farmers and other producers.

In delivering early CTLGH outputs, important lessons have been learned on the requirements for integration, visualisation and use of diverse data types across CTLGH research programmes.

Beyond the internal needs of CTLGH, there are capacity and infrastructure gaps in LMICs to systematically gather, integrate and use livestock data. This limits the

ability to identify gaps and tailor solutions to particular contexts and needs. It also limits the ability of national partners to build sustainable livestock research and breeding initiatives and to own and manage data.

CTLGH areas of focus and selected deliverables:

Integrating external (i.e. partner-generated or public domain) information pipelines within CTLGH planning and phenotyping, to allow for high resolution phenotyping in heterogeneous environments.

The following deliverables will be generated through short- and long-term activities:

- Development, integration and exploitation of data systems to support genetic improvement across key livestock commodities.
- Generation and curation of data and bioresources to maximise the impact of new and existing knowledge on tropical livestock genetics, health and feed systems.
- Integrated data systems and analytical functionalities to support their use
- Platforms to support genetic evaluations.
- Platforms for communication from farmer to researcher and researcher to farmer

Partnership and collaborators: ILRI (livestock genetics, health, and environment programmes), UoE (Global Academy for Agriculture and Food Security (GAAFS), Supporting Evidence Based Interventions (SEBI)), SRUC (EGENES), The University of Queensland (Australia), African Animal Breeding Network (AABNet), National Livestock Research Institutes and Universities, private sector (Hendrix Genetics, Amazon) and others.

THEME 6

Capacity Building and Knowledge Exchange

Overall objective: Capacity development and technical training programmes to support key actors contributing to tropical livestock genetic improvement.

Background information: The limited human capacity in LMICs continues to pose challenges for livestock development. The development of human and infrastructural capacity will be essential for achieving CTLGH strategic objectives. Building capacity will be a vital component and will be integrated into all research and development efforts. The overarching capacity building driver will be to create opportunities for livestock scientists and other practitioners based in LMICs to mobilise, adapt and apply innovations to improve and sustain genetic gains in tropical livestock.

CTLGH areas of focus and selected deliverables: CTLGH will address capacity challenges relevant to livestock genetic improvement interventions by targeting a range of beneficiaries in academia, National Agricultural Research Systems and other stakeholders including the private sector.

In Africa, CTLGH will, in collaboration with farmer facing programmes, support key components of the African Animal Breeding Network (AABNet) thus ensuring long-term capacity and its mobilisation to support livestock genetic improvement. Similar approaches will be taken in Asia to address critical capacity gaps clearly identified by local actors. Options for training will include short courses, Masters and PhD programmes and postdoctoral fellowships, research placements and other formal fellowships programmes.

In other regions, CTLGH will collaborate with local actors (BAIF in India) to deliver on similar objectives.

Partners and collaborators: University of Edinburgh/ The Roslin Institute (Global Academy, Centre for Data Driven Breeding), SRUC (EGENES), ILRI and other CGIAR centres (ICARDA), African Animal Breeding Network (AABNet), National Livestock Research Institutes and Universities (Africa and Asia), Global livestock genetic evaluations platforms (INTERBULL, ICAR, ...), Europe (WUR, BOKU, LUKE, Uni Hohenheim, ...), private sector.

Delivering the CTLGH Strategy

The CTLGH research plan to underpin the 2030 strategic plan will focus on the development and application of modern genetics and genomic technologies, animal breeding technologies and data science to support partner organisations in the selection, breeding and dissemination of livestock adapted to the unique tropical production systems in developing countries.

Globally, livestock production systems are rapidly changing due to multiple drivers including changing consumers' demands, animal welfare concerns, climate change, impact of production on the environment, public perception, emergence of anti-microbial resistance, human health and socio-economic development factors and more recently the Covid19 global pandemic.

These drivers will continuously define the challenges that all actors along the livestock development value chain are required to address. This will guarantee that inputs from social sciences, gender, market analysis and business development are considered thus ensuring that CTLGH's innovations are appropriately targeted and have a route to adoption and impact. This explicit interface will help inform CTLGH priorities and support the development of a research portfolio while ensuring that relevant stakeholders are engaged.

CTLGH will seek awareness of relevant production systems to:

- Understand future trends and scenarios that influence where farmed animals are and how they will be used (from both a societal consumer perspective and a climate change impact prospective).
- Understand (spatially) where animals are, where diseases occur, and what are the associated challenges
- Collate, and if required commission, socio-economic analyses to identify genetic solutions that will have the greatest impact
- Signpost and provide access to studies and groups that analyse tropical livestock production systems to establish trade-offs, demonstrate and support cases for genetic improvement and other interventions.
- Provide evidence on the key drivers for productivity, resilience and efficiency gaps of smallholder livestock systems (genetics, health and nutrition)
- Collaborate with founding partners to collate, and if required commission, targeted studies and evaluations to align selected countries and regions with the environmental commitments and the sustainability agenda of agri-food systems
- Create access to groups and resources that provide greater understanding of the changes (including the environment) and dynamics in the livestock sector; to support sustainable livestock productions
- Develop context-relevant knowledge (i.e. technical evaluation and adoptions scenarios) about existing and proposed technologies, tools and innovations for genetic improvement

CTLGH will actively leverage its partners, collaborators and other key players to identify the right interventions for defined production systems. These efforts will continuously define CTLGH research and appropriate linkages to downstream beneficiaries.

By considering geo-locations, related performance data, the resulting "tropical agrimetrics" will also integrate a range of external data sources including:

- Countries/regional production statistics and targets
- Disease incidence, distribution and modeling of emerging patterns and trends
- Models of greenhouse gas (GHG) emission and other environmental factors
- Models of future climate and societal changes
- Localized feed options—both market availability and options to cultivate
- Distribution and characteristics of animal genetic resources
- Household level socio-economic data
- Other data types including: weather, climate, soils information, impact of future scenarios on human nutrition, and impact of future scenarios on animal welfare

Given the alignment and commonalities on research themes, core research capabilities, expertise and the required research infrastructure, CTLGH will leverage BBSRC strategic funding of the Roslin Institute, the Scottish Government funding of SRUC, and the OneCGIAR initiatives and allocated resources for the delivery of key elements of its strategic plan. These opportunities will further ensure greater efficiency and broader impact.

V STAKEHOLDER ENGAGEMENT

CTLGH is positioned for upstream discovery research guided by clearly identified downstream challenges and opportunities to create genetic solutions for tropical livestock smallholder systems. CTLGH will continuously mobilise its founding partners (The University of Edinburgh/The Roslin Institute, SRUC and ILRI) and collaborators to achieve its mission.

These strategic engagements will also create opportunities to advocate for the importance and contribution of livestock in agri-food systems by tackling imminent and anticipated challenges of the sector including resilience, productivity (to meet the needs of the growing number of consumers), social equity, natural resources management and environmental impact.

In addition, CTLGH will establish and maintain strategic alliances and other forms of engagement with development partners, investors, research organisations and universities, government agencies and the private sector to further explore and refine key genetic improvement interventions that are necessary for livestock development in general and targeting smallholder farmers in LMICs particularly.



VI RESOURCE MOBILISATION

As part of the CTLGH 2030 strategy, a resource mobilisation approach will be centred around:

- Leveraging core partners' institutional programmes to maximise on the resources from UKRI, United Kingdom and Scottish Government, and the OneCGIAR system
- Capitalising on earlier investments³ by The Bill & Melinda Gates Foundation (BMGF), the UK Foreign, Commonwealth and Development Office (FCDO), UKRI/BBSRC and Jersey Overseas Aid (JOA)

- Establishing partnerships with the private sector, regional organisations and other livestock development entities for the development of joint activities and mobilisation of resources to support key components of CTLGH strategic objectives

³The foundational investments in CTLGH includes core partners funding (The University of Edinburgh/Roslin Institute, SRUC and ILRI) and subsequent awards from BMGF, FCDO, UKRI/BBSRC, and Jersey Overseas Aid (JOA) to support the following objective (2015-2022): **Development and application of genomic tools to improve productivity of tropical livestock and to increase climatic resilience, adaptation, and mitigation for the benefit of smallholder farmers in Sub-Saharan Africa.**

VII CTLGH THEORY OF CHANGE

The high-level Theory of Change (ToC) shown in Figure 2 on the following page outlines how CTLGH will endeavour to achieve maximum impact, linked to each of its three strategic objectives. For each theme and related projects, impact pathways will be developed and mapped onto the high-level Theory of Change.

CTLGH's Theory of Change will also be used for the development of all activities, for monitoring their implementation, and to develop the overall impact of the Centre.

While only high-level outputs to be generated from CTLGH's research and technologies, and the positive development impacts intended are mapped, the Theory of Change will guide all CTLGH activities and interventions and the evaluation and monitoring of progress towards the desired impacts.

VII CTLGH THEORY OF CHANGE (CONT.)

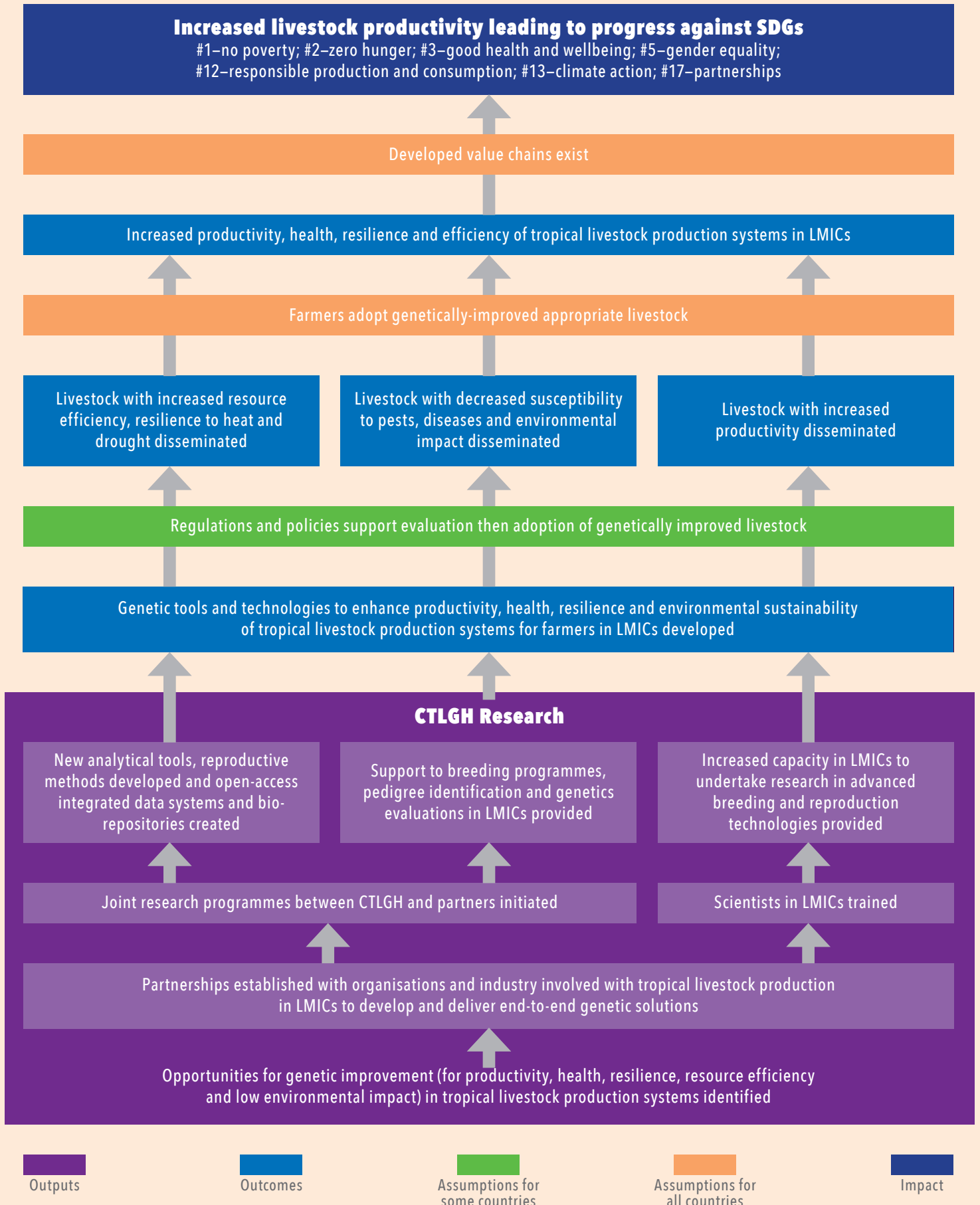


Figure 2. CTLGH high level theory of change

VIII MONITORING, EVALUATION AND LEARNING



CTLGH will implement a robust monitoring, evaluation and learning system. Regular efforts will focus on monitoring the impact of technologies and innovations generated by the Centre and its collaborators. The results of the monitoring and evaluation programme will then form a “feedback loop” to enable projects to be adjusted and improved where required and ensure that the optimum impact is realized.

A long-term evaluation of impact will be guided on one hand under each of the three strategic objectives of the Centre and on the other hand under the main strategic challenges that have guided the development of the strategic plan and the development of CTLGH interventions.

IX RISK REGISTRY AND MITIGATION STRATEGY

CTLGH will keep a central risk registry that will be regularly monitored for changes in both levels and types. The Centre will take specific actions to mitigate high and moderate risk areas.

Risk	Scale	Mitigation measures
Founding partners no longer committed to CTLGH	Low	<p>The CTLGH leadership team will continuously work with the Roslin Institute and the University of Edinburgh, SRUC and ILRI for regular evaluation of progress to ensure that the remit of CTLGH remains i) aligned with institutional missions and ii) responsive to the changing landscape.</p> <p>In 2019, the three founding partners recommitted to a second 5-year agreement (2019-2024) to support CTLGH existence and its operations.</p> <p>The leaders of the three founding partners form the CTLGH Principals Group and will continue to meet regularly to oversee the management and strategic orientation of the Centre.</p>
Little or no alignment of CTLGH activities with genetic improvement challenges of tropical smallholder livestock systems in LMICs	Moderate	<p>This is a common difficulty associated with managing a wide range of collaborations and occasionally unintentional “mission creep” can occur leading to unaligned activities.</p> <p>There will be multiple opportunities to identify and correct such instances as early as possible should they occur. CTLGH will continue to hold regular meetings of the funders, the Principals Group and the International Science Advisory Committee to review progress and assessment of CTLGH overall strategic orientation and its activities portfolio.</p>
Reduction or loss of interest of key collaborators	Moderate	<p>Beyond the founding partners, CTLGH has secured a range of collaborators across the world. The Centre will constantly assess the relationships to ensure that each collaborator contributes effectively and has clear incentives to remain a collaborator with the Centre.</p>
Failure to effectively align CTLGH's efforts with those of other actors	Moderate	<p>CTLGH's niche in a large and complex ecosystem of actors will be carefully delineated in order to avoid duplications and the unnecessary competition and conflict with collaborators and other actors.</p>
Reduction/loss of funding to deliver on CTLGH strategic objectives	High	<p>This is an inherent challenge faced by all externally funded research centres. The CTLGH funding strategy will continuously be evaluated to ensure diverse sources of funding and proactively pursue new funding opportunities to respond to emerging needs. In addition, the collective CTLGH scientific power will be constantly mobilised to seek additional funding.</p>

X GOVERNANCE AND MANAGEMENT

The overall governance of CTLGH is guided by the Second Collaborative Framework Agreement signed in September 2019 between the University of Edinburgh/ The Roslin Institute, SRUC and ILRI for a 5-year period (2019–2024).

CTLGH's International Science Advisory Committee

The International Advisory Committee (IAC) provides advice to the CTLGH Directorate on the scientific quality and relevance of its joint research projects, the future directions of its programmes and the overall development of the Centre. The IAC is comprised of six members with senior or leadership roles in academia, industry and agriculture scattered across the globe.

Professor Ed Rege, Emerge Centre for Innovations–Africa (ECI–Africa), Kenya–Chair

Professor Heather Burrow, University of New England, Australia–Vice Chair

Professor Susan Lamont, Iowa State University, USA –Member

Professor Neil Hall, Earlham Institute, UK–Member

Dr Victor Olori, Aviagen Ltd, UK–Member

Dr Alfred de Vries, Bill & Melinda Gates Foundation–Member/Observer (donors' representative)



XI APPENDICES

Appendix 1 CTLGH's Strategic Partners

CTLGH is a strategic alliance of the Roslin Institute at the University of Edinburgh, Scotland's Rural College (SRUC) and the International Livestock Research Institute (ILRI). Strategic partners are crucial to the success of CTLGH and the mobilisation of research and resources to the development and delivery stage.

The University of Edinburgh is a centre of academic excellence and one of the world's leading research and teaching universities. It measures its performance against the highest international standards and provides the highest quality learning and teaching environment for the greater wellbeing of its students. It aims to produce graduates fully equipped to achieve the highest personal and professional standards, make a significant, sustainable and socially responsible contribution to Scotland, the UK and the world, promoting health and economic and cultural well-being.

Visit the University of Edinburgh website

The Roslin Institute is an animal sciences research institute is part of the University of Edinburgh. It is funded by the Biotechnology and Biological Sciences Research Council (BBSRC). The Institute undertakes research within the framework of BBSRC Institute Strategic programmes focussed on the health and welfare of animals, and applications of basic animal sciences in human and veterinary medicine, the livestock industry and food security.

Visit the Roslin Institute website

Scotland's Rural College (SRUC) delivers comprehensive skills, education and business support for Scotland's land-based industries, founded on world class and sector-leading research, education and consultancy. The integration of these three complementary 'knowledge

exchange' services is of significant value to all with an interest in land-based activities—be they learners, businesses, communities or policy-makers.

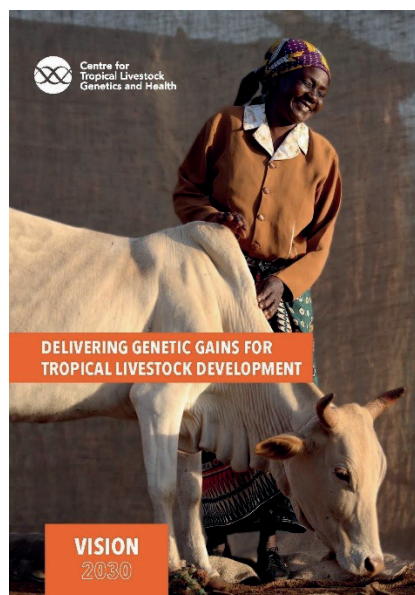
Visit the SRUC website

The International Livestock Research Institute (ILRI) works with partners worldwide to enhance the roles that livestock play in food security and poverty alleviation, principally in Africa and Asia. The outcomes of these research partnerships help people in developing countries keep their farm animals alive and productive, increase their livestock and farm productivity in sustainable ways, find profitable markets for their animal products, and reduce the risk of livestock-related human diseases. **Visit the ILRI website**

Appendix 2 CTLGH Vision

Building on the achievements it has made in its first five years, this publication, launched in 2020, highlights the key strategic objectives and future focus of CTLGH for the next 10 years.

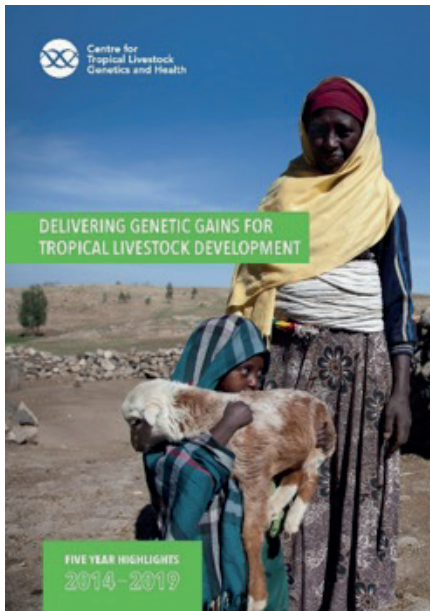
Link to CTLGH's Vision document



Appendix 3 CTLGH Five Year Highlights

This publication, launched in 2019, celebrates some of the research achievements that the Centre's scientists have made since CTLGH was established in 2014 and the collaborations and partnerships that have been established in that time.

[Link to CTLGH's Five Year Highlights document](#)



Appendix 4 The African Animal Breeding Network



The African Animal Breeding Network (AABNet) is a new consortium launched in 2020. It was established to support the genetic improvement of livestock and help make livestock production systems in Africa more efficient, profitable and sustainable.

AABNet brings together leading experts in academia, government agencies, breeding companies and international research organisations to develop practical breeding solutions to help tackle this problem.

AABNet aims to deliver multi-country genetic evaluation of livestock across Africa and develop targeted advanced breeding innovations that can be disseminated and adopted in multiple countries.

The Network is also committed to capacity building and will support the professional development and training of animal breeders across the continent so that they can develop livestock breeding programmes for their own countries that are both profitable and environmentally sustainable.

AABNet recognises the importance of collaboration and in addition to the founding member organisations, the Network has a growing number of programme partners in Cameroon, Burkina Faso, Ghana, Nigeria, Ethiopia, Uganda, Kenya, Rwanda, Tanzania, Malawi and South Africa.

In addition to genetic improvement, AABNet hopes to play an advocacy role and help drive awareness and increase business development for livestock development in sub-Saharan Africa.

[Link to AABNet's website](#)

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OUR FUNDERS

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GATES *foundation*

