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NVI-NORAD Knowledge Bank Collaboration - Proposal for Africa

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Content

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Introduction

The Norwegian Veterinary Institute has signed in 2020 a cooperation agreement with the Norwegian Agency for Development Cooperation – Norad – to contribute with expertise in Norad's Knowledge Bank.
Many low-income countries are increasingly asking for support in topics related to food safety and animal/fish health, and this has also been prioritized by the Norwegian government action plan on sustainable food systems in the context of Norwegian foreign and development policy1 (Box 1). In connection with an official visit of the Royal Norwegian Ministry for Food and Agriculture to the Republic of Malawi in January 2020, the Norwegian Veterinary Institute undertook a visit to Ethiopia and Malawi to discuss with relevant entities and partners. The potential for relevant collaboration projects were discussed within the frame of the Knowledge bank and the Norwegian action plan on sustainable food systems.

BOX 1 - Norwegian government action plan on sustainable food systems
Animal husbandry, fisheries and aquaculture are important in many low-income countries, both because they provide vital nutrients in people's diets, and because they are good source of income for small-scale producers. However, in many areas, animal husbandry is not very productive, partly due to a lack of systematic breeding programmes and scarcity of feed. Poor animal welfare is also a problem in many countries. It is important to find sustainable sources of animal feed that do not compete with foods for human consumption. Diseases in farm animals and fish are a significant risk factor in food production. A number of infectious farm animal diseases can be transmitted between animals and humans, and the spread of disease among animals can lead to huge economic losses. A lack of or inadequate extension and veterinary services is a widespread problem in several of our partner countries.

This report summarizes the major findings/conclusions of that visit, and presents a framework for collaboration focusing on ONE HEALTH initiatives aimed at promoting sustainable food systems. These initiatives are based on interventions in the field of animal health that can contribute to improved human and environmental health, more resilient rural communities and improved economic viability of production systems.

Background

Livestock systems have been a major concern for sustainability science in recent decades[1] and play a significant role in rural livelihoods and the economies of developing countries. They occupy 30% of the globe's ice-free surface and contribute to the livelihoods of billions of people[2]. On the African continent diseases along with predation and drought cause the preventable deaths of one in four young ruminants and one in 10 adult ruminants every year[3], and even higher losses in poultry. The global cost of livestock disease has been estimated in billions of dollars[4], and interventions targeting animal health will directly contribute to health sustainability. Firstly, by reducing major negative externalities especially zoonotic diseases, antimicrobial resistance and emerging diseases. Secondly, by improving the efficiency of production, reducing the negative environmental impacts and contributing to economic gains at multiple levels.

Zoonotic diseases, particularly because they occur at the animal – human interface are the focus of much attention. However, because they bridge two sectors (humans and animals) they often end up somewhat neglected. The Global Burden of Disease captures the impact of zoonoses on human health in terms of disability-adjusted life years (DALYs) and according to a study by Grace and colleagues: "in low income countries, zoonoses and diseases which recently emerged from animals make up 26 % of the DALYs lost to infectious disease and 10 % of the total DALYs lost. In contrast, in high income countries, zoonoses and

[1] Perry BD, Robinson TP, Grace DC. Review: Animal health and sustainable global livestock systems. Animal. 2018;12(8):1699-1708. doi:10.1017/S1751731118000630

[2] Herrero, M.; Grace, D.; Njuki, J.; Johnson, N.; Enahoro, D.; Silvestri, S.; Rufino, M. C. The Roles of Livestock in Developing Countries. animal 2013, 7 (s1), 3–18.

[3] Grace D, Gilbert J, Randolph T, Kang'ethe E. The multiple burdens of zoonotic disease and an Ecohealth approach to their assessment. Trop Anim Health Prod. 2012;44 Suppl 1:S67-S73. doi:10.1007/s11250-012-0209-y

[4] Grace D. The business case for One Health. Onderstepoort J Vet Res. 2014;81(2):E1-E6. Published 2014 Apr 23. doi:10.4102/ojvr.v81i2.725

diseases which recently emerged from animals represent less than 1 % of DALYs lost to infectious disease and only 0.02 % of the total disease burden"[5]. DALYs have so far only been used to measure human health outcomes, completely ignoring the impact of a range of risk factors on other animals' welfare or health, or the impact on environmental health, as it not easy to combine animal health, zoonotic interaction and economic losses.

Function health systems must also include a bridge of collaboration between human- and veterinary authorities if they shall efficiently target zoonotic disease for the good of public health. Indeed, this is recognised in the international health regulation of 2005[6], which is an overarching legal framework designed to reduce the burden of public health events and emergencies that have the potential to cross borders. The drivers of emerging zoonotic diseases are bringing human and animal health ever closer together. However, there is uncertainty about the mechanisms for this collaboration and weaknesses in many developing countries. Particularly within development of functional veterinary systems to ensure proper monitoring and surveillance of animal diseases.

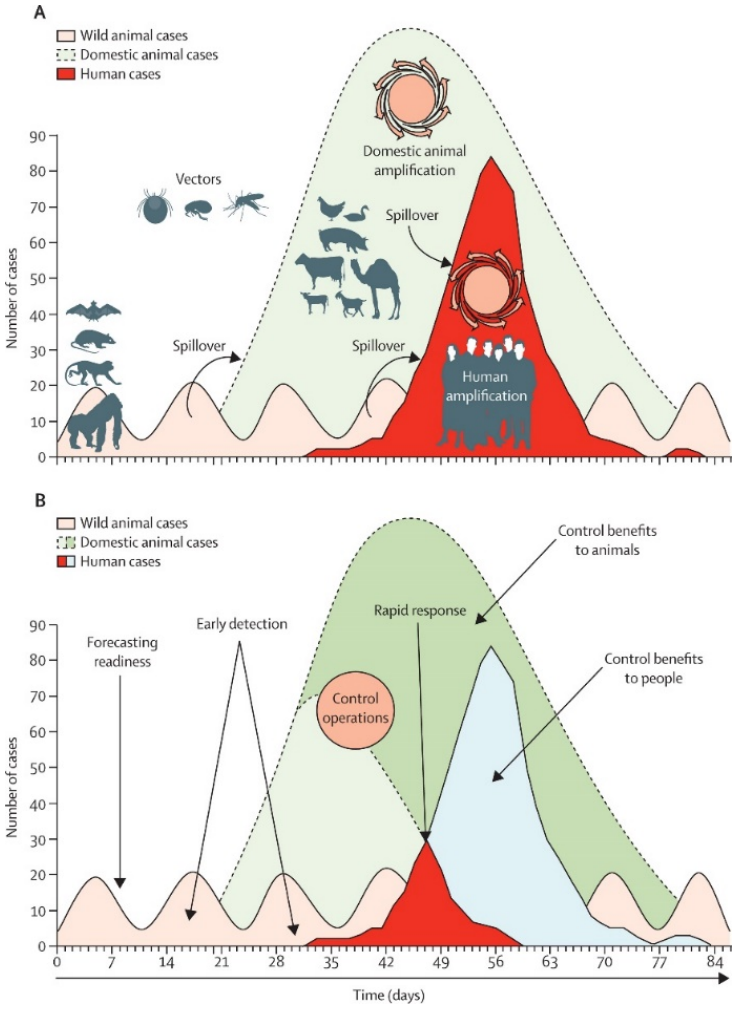


Figure 1(A) Transmission of infection and amplification in people (bright red) occurs after a pathogen from wild animals (pink) moves into livestock to cause an outbreak (light green) that amplifies the capacity for pathogen transmission to people. (B) Early detection and control efforts reduce disease incidence in people (light blue) and animals (dark green). Spill over arrows shows cross-species transmission. © *Karesh et al., 2012*

The concept of "One Health" recognizes the interconnectedness and interdependence of humans, animals, and the environment. The health of all three parties is interlinked, and there is a synergistic benefit of cooperation between the human, animal, and environmental health sciences. This perspective is essential to understand pathogen dynamic and inform on zoonotic disease-control programmes. Figure 1A highlights well the often observed pattern of pathogen transmission between wildlife, livestock and humans, while Figure 1B highlights the benefits (in terms of case reduction) of early detection and control measures applied along the entire chain (wild, domestic and human)[7]. One should also keep in mind that risks are not limited to low-income countries; as global trade and travel expands, zoonoses are increasingly posing health concerns for the global medical community everywhere around the planet as COVID19 unfortunately well illustrates. It is therefore essential to pursue multi-sectorial collaboration, including clinicians, public health scientists, ecologists and disease ecologists, veterinarians, economists, and others for effective management and prevention of zoonotic diseases. This is even of greater importance in LMICs where many hotspots for disease emergence are located.

[5] Grace D, Gilbert J, Randolph T, Kang'ethe E. The multiple burdens of zoonotic disease and an Ecohealth approach to their assessment. Trop Anim Health Prod. 2012;44 Suppl 1:S67-S73. doi:10.1007/s11250-012-0209-y

[6] https://www.who.int/health-topics/international-health-regulations#tab=tab_1

[7] Karesh WB, Dobson A, Lloyd-Smith JO, et al. Ecology of zoonoses: natural and unnatural histories. Lancet. 2012;380(9857):1936-1945. doi:10.1016/S0140-6736(12)61678-X

This can be exemplified with Brucellosis, a zoonotic bacterial disease most often transmitted to humans through the consumption of infected, unpasteurized milk products. Brucellosis can lead to high losses in animal production and considerable negative impacts on human health. Systems to identify and report brucellosis in both humans and animals are core to form the foundation for targeted prevention, and these systems must communicate and collaborate. Already in 2002 FAO pointed out that the estimated additional milk and meat offtake potential, resulting from the elimination of brucellosis in Sub-Saharan Africa, could be substantial, and pointed to Ethiopia as one of the countries with highest potential for benefit[8].

The livestock of Ethiopia and Malawi is fundamental to the livelihoods and resilience of vulnerable families, and to the economy of the countries. In particular Ethiopia has the largest livestock population in Africa, with a huge asymmetry in husbandry systems ranging from high mountains to lowland pastoralism. Livestock production as a whole contributes about 45 percent to agricultural GDP (cattle being the most important generator).

The high incidence of animal diseases, including zoonotic diseases, cause losses and reduced productivity from livestock assets. Major zoonotic diseases, such as bovine tuberculosis, brucellosis and anthrax seriously affect the livestock sector in Ethiopia and most likely also in Malawi, although for the case of Malawi this is not systematically documented. Both countries report challenges with respect to diseases that can be transmitted to humans by consumption of meat or milk products, and diseases that spread by movement of animals or livestock products, such as foot-and-mouth disease (FMD).

Main impressions from the mission to Ethiopia and Malawi – January 2020

In both Ethiopia and Malawi animal diseases constrain livestock production. Although there are differences between the two countries, there are also major similarities with regard to animal health concerns and the burden of zoonotic diseases. Visited partners in both countries suggested milk production, quality and safety, poultry health, antimicrobial resistance and zoonotic diseases as preferred topics for collaboration. In Malawi, Newcastle disease causes epidemics that can wipe out household stocks of poultry. In Ethiopia, FAO pointed to antimicrobial usage and antimicrobial resistance in poultry production as a growing concern.

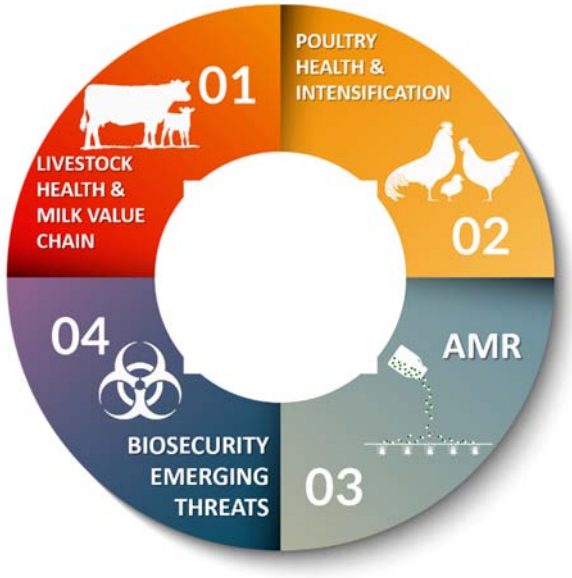


Figure 2 – Topics/thematic areas presented by both Ethiopia and Malawi for collaboration with Norway

The importance of poultry for livelihoods of poor families and economic independence of women were emphasised by several visited organisations in both countries. This is consistent with studies on vulnerability in southern Africa that show that women and female-headed households are more likely to be vulnerable than the general population.

The lack of data and regulation on the use of antimicrobials in both humans and animals continues to be a major gap in the efforts of several African countries to fight antimicrobial resistance. Both Ethiopia and Malawi have highlighted new established plans to tackle the AMR threat, but these remain extremely dependent on functional veterinary systems including regulatory measures, data collection and interpretation, laboratorial capabilities and education of professionals and populations at large.

There was also a generalized agreement that the emergence of infectious diseases (EIDs) remains a major challenge for most African countries. Among other reasons, the lack of adequate biosecurity capability at

[8] Mangen, Marie-Josée & Otte, Joachim & Pfeiffer, Dirk & Chilonda, P. (2002). Bovine brucellosis in sub-Saharan Africa: estimation of sero-prevalence and impact on meat and milk offtake potential. Food and Agriculture Organisation of the United nations, Rome.

both animal and human levels constitutes a major hindrance to the prevention and efficient detection/response to EIDs. The delivery of adequate veterinary services in Ethiopia and Malawi are hampered by inadequate laboratory facilities, in particular at district level and by lack of adequate well trained and qualified staff (both field and laboratory) to handle emerging livestock issues. Both countries also recognised the need for improved monitoring of animal diseases and prevention and control programs.

Collaboration framework – focus areas for project development

Healthy animals contribute decisively to the elimination of hunger, to more healthy people and to sustainable food production systems. This collaboration proposal aims to contribute to improve animal health, to make livestock production more productive and sustainable, and to implement a One Health approach linking animals, humans and the environment. The suggested approaches are designed with the identified challenges of Ethiopia and Malawi and the potential collaborative partners. However, the approaches can easily be adapted and generalized for other countries in sub-Saharan Africa

Several guiding premises have been considered in the development of the suggested areas for project development:

1. A holistic ONE HEALTH approach that focuses on infectious diseases and antimicrobial resistance in the shared environment between animals and humans and food systems.
2. An approach that is in line with national and international strategies within the field as highlighted throughout this report.
3. An approach that contributes to relevant SDGs targets as highlighted in Figure 3
4. An approach that is in line with FAO goals for sustainable food systems:
   - Increase productivity, employment and value addition
   - Protect and enhance natural resources
   - Improve livelihoods and foster inclusive economic growth
   - Enhance the resilience of people, communities and ecosystems
   - Adapt governance to new challenges
5. An approach that in focused on the predict-prevent-detect-respond strategy, as established in Global Health Strategies and international framework for emerging threats and shown in Figure 4.

Figure 3 - Sustainable development goals considered central to the projects proposed in this report.

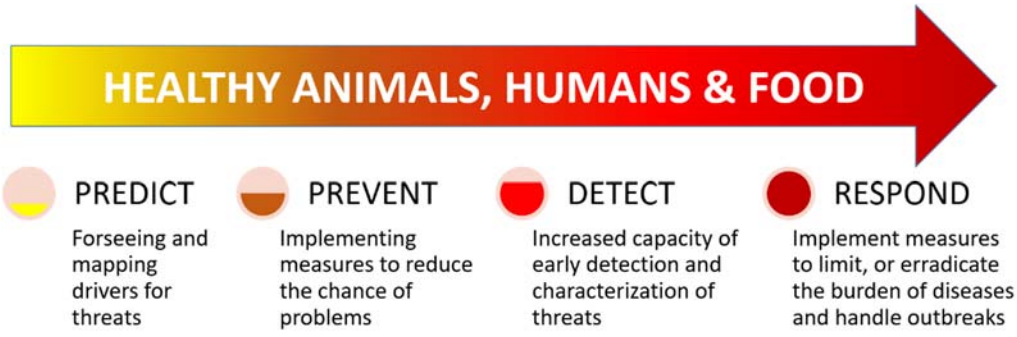


Figure 4 – Conceptual framework to achieve healthy animals, humans and food in the face of emerging health threats

Based on the premises indicated and in close coordination with relevant African partners, NVI proposes three thematic projects covering different topics within animal health and food systems as summarized in Figure 5.

The proposed projects can stand alone and be implemented in one or several countries simultaneously. While able to stand alone, the projects are synergetic and build upon each other. Implementation of all proposed solutions on a middle-long term will represent the most effective way to ensure a true transformative change on animal and public health capacity in these countries and considerably contribute to achieving more sustainable and safe food systems. These small projects may well represent important add-ons to other ongoing initiatives both national coordinated or internationally supported.

Some common aspects for all suggested projects:

1. All strengthen veterinary services through the whole chain, from the farm, local animal health personnel to central laboratory facilities, using a few selected examples as prototype (eg. Milk chain, poultry production etc.).
2. Proposed prototypes are just indicative examples for production areas and pathogens of relevance. These can easily be adjusted to a larger number of topics/agents based on an analysis of what is most relevant in different countries and situations. Within NVI scope of action, among other topics to which these prototype projects can easily be adjusted to, we would name: AMR-testing; Molecular diagnostics; Vaccine development; Pathology; Wildlife disease surveillance.
3. All will have an impact on preparedness and competence related to animal- and public health, and will lead to improvements on national biosecurity capacity in animal health and food safety.
4. All will provide a measurable benefit for the countries they are implemented in.
5. All have a time frame of a 1 to 2 year period and although executable by itself are designed for synergism with the other projects.
6. All take advantage of new digital solutions whenever feasible.
7. All have a balanced component of capacity building, awareness raising, technical/laboratorial improvements and fieldwork.
8. All have contact points to ongoing Norwegian projects and activities in both countries.
9. All are developed in cooperation with local partners they can ensure feasibility of the different tasks (both technical, scientific and logistic). For these projects we indicate partners in Malawi and Ethiopia but NVI has contacts and collaboration networks also with Tanzania, Kenya, Uganda, Mozambique and Zambia.

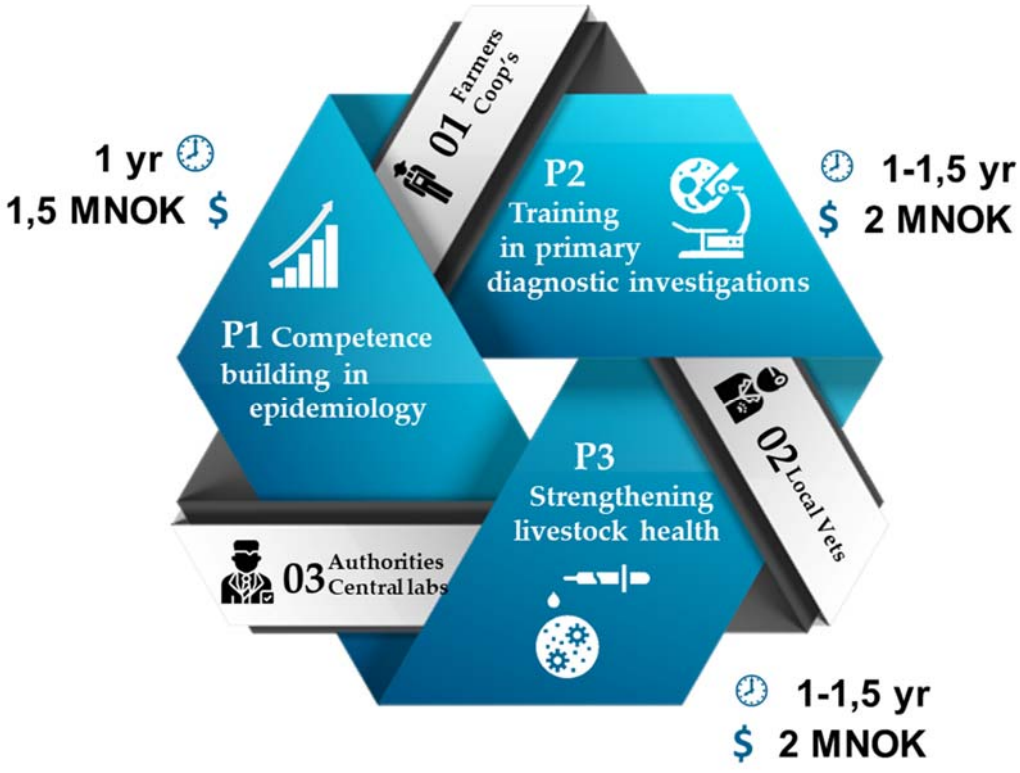


Figure 5 – Framework for collaborative projects proposed in this report presented as P1-2-3 with integration of all levels of the veterinary services (01 farmer to 03 central government).

Thematic area 1 - Competence building in epidemiology for veterinarians – strengthening veterinary public health in articulating with public health

BACKGROUND: disease surveillance and reporting is core to monitoring and functional disease control. It relies not only on recognition of disease (diagnostics), but also on adequate reporting and data management. Surveillance should provide continuous information on the national and regional disease situation, detect changes in the form of disease outbreaks, form a grounds for decision makers to impose measures such as targeted vaccination, antibiotic usage policies etc. These data also affect trade by documenting disease status of a country or a region. Because many diseases of animals affect human health directly or indirectly public health and veterinary sectors must collaborate. Systems for disease surveillance in humans should collaborate and communicate with the systems for surveillance in animals.

Good quality data are essential for formulating policies and programmes that support the sustainable development of the livestock sector. In particular, the ability to measure the returns on investments made for the containment and management of such zoonotic diseases depends on the availability of data and information on:

- the incidence and prevalence of zoonotic diseases by livestock production system;
- the use of antibiotics in livestock, disaggregated by production system;
- the incidence and prevalence of zoonotic diseases in humans, by category of people;
- the use of antibiotics and antimicrobial resistance in humans, by category of people;
- the reduction in the quantity and value of livestock production due to zoonoses;
- the causes of zoonotic disease emergence and spread, which include inadequate vaccination coverage, inefficient biosecurity and biosafety measures, and lack of advocacy.
- the feasibility – in terms of financial resources and technical competencies of possible interventions to tackle the root causes of the emergence and spread of zoonoses and of, livestock-driven AMR.

We propose the development and implementation of training courses in practical field epidemiology to strengthen veterinary epidemiology and reporting, while also binding together public health and veterinary sectors in the countries. These can pave the way for establishing and/or strengthening the implementation of basic surveillance systems e.g. for emergent or neglected zoonosis.

AIM: Increase competence in field epidemiology, reporting systems and data management.

IMPLEMENTATION: In collaboration with local partners the NVI will contribute to setting up basic surveillance systems through design, development and implementation of field-based and central level epidemiology courses. Courses will mainly be designed for on-line learning, but will include practical work with personal supervision of course-attendees. Courses will be aimed at all levels of the veterinary and public health services to ensure a well-functioning surveillance chain in animal health including 1) first-line animal health personnel in the field 2) regional and central laboratory levels 3) central veterinary and public health authorities. For this purpose three courses will be designed to build knowledge, understanding and competence within 1) field data collection for animal population statistics, animal health statistics and reporting 2) data collection from field observations and laboratory data and data management 3) data analyses, interpretation and use in decision-making for practical interventions. For the purpose of bridging veterinary and human health sectors in zoonotic diseases surveillance, collaborations will be maintained with the public health sectors. Furthermore, it may be resource efficient to build on courses already organised by the public health sectors in relation to implementation of international health regulations, incorporating relevant veterinary perspectives.

Task 1: map the gaps in existing epidemiology competence at all three levels to clearly define needs.
Task 2: in collaboration with partners, design and develop training courses.
Task 3: implement training courses
Task 4. Individual study projects and supervision of these
Task 5. Summary and conclusions – preparing a continuation plan for future training competence building.

BENEFITS: Increased competence in epidemiology is needed at all levels of the veterinary services, and bridges to public health sectors must be maintained and strengthened. Courses can improve both basic reporting from the field and more advanced epidemiological methods for key personnel to present for decision makers. The project will build collaborations through the chain of veterinary services.

STRATEGIC PARTNERS: Ethiopia: The Veterinary Faculty of Addis Ababa University, International Livestock Research Institute, Ethiopian Institute of Public Health. Malawi: Central Veterinary Laboratory, LUANAR and Central Public Health Laboratory of Malawi.

RESOURCES AND DURATION: 1,500,000 NOK during 2 years. Includes the funding of a frontline-and central epidemiology courses in Ethiopia and Malawi with Norwegian epidemiologist assisting in adapting the course for the veterinary sector and partake in training and supervising field-work.

Thematic area 2 – Training in primary diagnostic investigations

BACKGROUND: Lack of good-quality diagnostics for infectious diseases prohibits control of infectious diseases in the developing world. The importance of basic diagnostic competence, ranging from clinical evaluations, reporting and laboratory diagnostics, are core in treating and preventing diseases and reducing animal suffering, disease burden and production losses. We propose to focus on diagnostics on selected diseases in cattle and Newcastle disease in poultry, and to use these as diagnostic models for other diseases.
Epidemic situations of serious infectious diseases in many African countries require specialised laboratory with biosafety containment facilities. However, molecular based diagnostics have evolved to overcome some of these difficulties. However, sample transport is a major obstacle and it is challenging to get high quality samples from the districts to the central laboratories. A portable lab solution may therefore be a benefit. NVI has expertise in using a rapid and transportable sequence technology (Minion/Flongle) to perform WGS-whole genome sequencing. It can be used to detect bacteria, parasites or virus in a wide range of samples, and is not dependent on advanced laboratory facilities. The technology has already been used in remote areas in Africa for surveillance and outbreaks of zoonotic infection such as Ebola, salmonella and tuberculosis.

AIM: to establish primary diagnostics at the district level and to strengthen the national reference function of selected infections at the central level. To achieve this we will:

Task 1: Establish simple diagnostic tools in rural areas in collaboration with the already existing agricultural and veterinary offices
Task 2: Strengthening the diagnostic capacity of zoonotic infections and preparedness function at relevant central veterinary laboratories (national level)
Task 3: Support training of staff in biosecurity and laboratory methodologies
Task4: Quality assessment of the specific laboratory assays
Task 5: Introductory courses for third generation sequence technology (web course)

The first two tasks will focus on setting up relevant diagnostics focussing on the pathogens relevant to the milk production chain (synergy with project 3). We will implement a first-line screening laboratory diagnosis for brucellosis (milk) and tuberculosis (milk and organ material), implement molecular methods for these (and other) diseases and bacteriological diagnostics and AMR-testing focussing in particular on those relevant to udder pathogens. This will include training of staff in biosecurity and basic laboratory methodologies (task 3) and may include some upgrading of basic laboratory equipment. Basic methodologies will be taught at both district and central levels, while more advanced testing will be implemented at central level. The safety of handling contagious zoonotic agents without proper training may be hazardous. Biosecurity and quality assurance of methods and procedures will therefore be a target for training (task 4).
The practical skills in task 5 involved with portable sequencing, and the experience with identification of the correct hardware, protocols, kit and procedures for data analyses is essential to ensure good quality data generated. Introductory courses in the technology will ensure that new users can use it to generate new data that will be valuable in practical settings. The courses that can be set up, will span from online

meetings/seminar, to more practical hands on laboratory training. A combination of using NVI trained staff will ensure the necessary competence.

IMPLEMENTATION: Together with central and regional veterinary laboratories, scientists will implement a project to strengthen diagnostics of important animal diseases including AMR-testing using milk as a model (synergy project 3). Training and strengthening of diagnostics using feasible screening methods at district level and more advanced molecular based diagnostic methods (eg Newcastle Disease) at central level. In order for the training to be valuable in decision making and disease management, reporting and guidance to veterinarians and herders will also be included (synergy project 1).

BENEFIT: By using a practical approach this project will improve competence and methodology within primary diagnostic investigations in key laboratories. Establishing rapid diagnostics of Newcastle disease will enable the smallholder farmers to take the right measures in order to prevent further spread of the disease. Importantly it will improve diagnostic capacity, which is fundamental to decision making in animal production and targeted and correct antibiotic treatment.

STRATEGIC PARTNERS: Malawi: CVL, Luanar, TAPP. Ethiopia: AHRI, ILRI, University of Addis Ababa, National Animal Health Diagnostic and Investigation Center

RESOURCES AND DURATION: 2,000,000 NOK during one to one and half years

Thematic area 3 - Strengthening of veterinary services for improving livestock health

BACKGROUND: Livestock health affects the volume and efficiency of food production and food safety. Without well-functioning veterinary services at all levels from field to central veterinary authorities, disease in livestock cannot be efficiently targeted. The system includes field competence in animal health, laboratory diagnostics, reporting and data analyses, and advisory functions for treatment and prevention of diseases. The diagnostic process includes not only sample analyses in the laboratory (synergy project 2), but also requires recognizing disease in the field, examination of diseased animals and flocks and correct sampling. Diagnostic results must be reported, interpreted and provide a basis for advice and appropriate follow up. Both Malawi and Ethiopia suffer from inadequate veterinary services at several of these levels. Targeting only one level of the veterinary services will be insufficient if the remaining system fails.

While veterinary services in Malawi and Ethiopia face some different challenges, many are also common to the two countries. One of these is the need improve milk production and milk safety by addressing ruminant health. Milk is an important source of nutrient for humans. By improving milk production, resilience in poor communities can be increased. However, milk is also a potential health hazard as it can be a source of zoonotic infections, antimicrobial resistance and antimicrobial residues. Udder infections are an important reason for antibiotic usage, reduced milk -quality, -quantity and -safety worldwide. Milk from cows with mastitis may contain a large number of pathogenic bacteria, and when such milk is consumed raw it can constitute a significant public health hazard. This is of particular concern for diseases such as tuberculosis and brucellosis. Representatives from both countries brought up the importance of improving the milk production chain and milk safety as a means of reducing production losses, improving animal health, securing nutrition of humans, and improving public health.

AIM: This project will aim to build competence and the functioning of the veterinary service chain, and will do so by focusing on one selected topic or area, namely the milk production chain. It will provide a synergy with projects 1 and 2, and tie these together adding the field perspective and demonstrating the strength that lies in collective action through the chain which encompasses the veterinary services.

IMPLEMENTATION: All levels of the veterinary services will be targeted to build their ability for collective action, including field animal health personnel that have supportive and advisory functions for farmers; sampling and diagnostic capabilities including field and laboratory (project 2) levels, data management ad reporting (project 1), interpretation, treatment and control. Not only can this improve production and milk safety, but it can also reducing and improving antibiotic usage.

The project would be organized as a small surveillance project at province and central levels, with a strong involvement of smallholder farmers, dairy factories, abattoirs and their veterinary staff. The project would encompass training in topics such as basics of ruminant health relevant to milk production, correct sampling, sample transport, choice of and production of culture media in laboratories, bacterial culturing techniques, AMR testing and finally, interpretation and reporting of results. In order for the training to be valuable at production level, reporting and guidance to veterinarians and herders will also be included. Competence-building within udder infections of ruminants, zoonotic milk-borne diseases (brucellosis, tuberculosis etc.) will be prioritized.

BENEFIT: The project will improve competence and methodology relevant to milk production and safety targeting competence in farmers/small-holders, veterinary or animal health advisors, and laboratory staff. By choosing milk as a matrix and base training around a small surveillance project valuable data will also be generated in addition to competence. By choosing milk as a matrix and base training around a small surveillance project valuable data will also be generated in addition to competence. Ultimately the project will fill in gaps on mastitis and milk safely that can benefit animal health, efficiency of milk production and milk safety, and form a model for improving other animal health and food safety production systems.

STRATEGIC PARTNERS: In Ethiopia: ILRI, Addis Ababa University, Faculty of Veterinary Medicine, National Animal Health Diagnostic and Investigation Center, National Veterinary Institute and AHRI. In Malawi: Luanar, Public Health Institute of Malawi, Central Veterinary Laboratory, TAPP.

RESOURCES AND DURATION: 2,000,000 NOK during one to one and half years. Includes planning, followed by three steps of training, practice and implementation:

1) Training: short courses in cattle health and milk production for farmers and persons in the field, training of advisory persons on diagnostic procedures and advisory functions, training of laboratory staff
2) Setting up diagnostic testing in selected laboratories including immunological methods, basic bacteriology and antimicrobial resistance testing
3) Performance of a small surveillance project and reporting of results.

Final remarks

During the preparation of this report we have had two meetings with NORAD which have helped to clarify different issues related to goals, possibilities and framework options for future collaboration. Having in mind the solutions proposed here we would like to provide some final comments:

- While options presented result from discussions with partners in Malawi and Ethiopia, NVI has continuous contact with partner institutions in several other countries in the area, such as Tanzania or Uganda. Topics framed here are just as equally relevant for other African countries even if priorities or level of logistic capacity will vary from country to country. Especially for project 1 solutions framed in this report could take on several countries simultaneously (depending on budget, human resources and logistics). Projects 2-3 require more hands-on the ground but, if relevant for several countries, it may be also be beneficial to run these in parallel (or in close time sequence) to optimize resources.
- NVI acknowledges a renewed interest from NORAD on the ONE HEALTH approach. This can indeed be a "game changer" in the way we support African countries in topics related to animal health and food safety. We have a good cooperation with FHI, which also has several projects in Africa. This ONE HEALTH partnership between NVI-FHI can probably be easily activated for some of the solutions proposed in this report.
- Many of the institutions visited highlighted ongoing activities where they believed NVI-NORAD could provide an input. These "added components" can have the advantage of building on well-established partnerships with all necessary logistics in place. NVI strongly believes that these "added projects" such as framed e.g. FAO, World BANK, LUANAR, should also be considered under the Knowledge Bank framework. These are cost effective projects with potential for high impact.
- There is a broad range of topics on animal health and food safety that require attention in many African countries. For some of these there is already large investments from international organizations and other national supported development programs (e.g. Foot and mouth disease eradication under FAO/OIE/Welcome Trust). NVI has therefore chosen topics and examples where there is a true lack of action and where short-medium term initiatives can provide a significant contribution to the improvement of the livelihood of local communities, the protection of animal and human health, and the strengthening of food systems.

Discussion with key partners – meetings summaries

Visit to Ethiopia 12th to 19th January

The Royal Norwegian Embassy in Addis Ababa
During our visit to the embassy we had the opportunity to be better familiarized with the different ongoing programmes for development under the coordination of the embassy. The focus seems to be on low land pastoralist communities, but our impression was that most actions are on plant/crop production and forestry with little or no current work on animal health and diseases or food safety. The Embassy referred to several ongoing initiatives with FAO and the World Bank. These are addressed further below in relevant chapter.

Armauer Hansen Research Institute (AHRI)
The biomedical research institute, AHRI, named after the Norwegian medical doctor who first described *Mycobacterium leprae,* was established in 1970 by Norad, Sida, and the Ethiopian government. The institution receives financial support, but no longer core funding, from Norad. AHRI's core functions are to build and develop biomedical competence, diagnostic- and epidemiological tools, research and technology. AHRI is well-run, well-equipped and have solid international- and national networks. Some recent and ongoing activities relevant to one-health include bovine TB, Rift Valley fever, Brucellosis, Rabies, human-environmental interface and wildlife, milk safety and one-health in pastoralist communities, antimicrobial resistance in a one-health perspective, parasitic disease, water safety etc.
AHRI prioritised the following topics for potential future collaborations with the NVI:

- Milk quality and safety: relevant in pastoralist communities and intensive production.
- Antimicrobial resistance in a one-health perspective, including stewardship
- Improving diagnostic tools.

International Livestock Research Institute (ILRI)
The institute receives its funding from CGIAR – a global partnership for International organisations working on food security. It is co-hosted by Kenya and Ethiopia with headquarters in Nairobi. ILRI works to reduce poverty through research and capacity building within animal health and agriculture. Infectious diseases of livestock, zoonotic disease and food safety are among the focus areas. ILRI works in many African countries, including Kenya, Ethiopia, Senegal, Zambia, Tanzania, Uganda, Burkina Faso, and Mali.
ILRI has a good local infrastructure with laboratory facilities, efficient networks and relevant ongoing activities. The NVI can easily offer "add-ons" to ongoing projects, utilising project infrastructure. Several areas are relevant within the framework of increasing sustainability through intensification of poultry and sheep production in highland communities, and improving resilience in lowland pastoralist communities.
The ongoing projects "Health of Ethiopian Animals for Rural Development (HEARD)" and "One health Units for Humans, Environment, Animals and Livelihoods - OH4 HEAL" both aim to increase deliverance of veterinary health services to vulnerable communities. The NVI could add elements within diagnostics and milk safety.
Peste des Petit Ruminants (PPR) – goat plague - is a transboundary disease that compromises livelihoods of millions of small-scale livestock farmers. The NVI could add components within diagnostics, or epidemiological competence e-g within risk modelling to ongoing ILRI projects.
The Livestock CRP: a program to translate livestock research into impact – the NVI could contribute to adding a component within this topic to improve extension systems to pastoralist farmers within her health and milk production
ILRIs project" Food safety in informal markets" addresses risk-based approaches to improving food safety and market access in smallholder meat, milk and fish value chains in sub-Saharan Africa. The NVI could add a component on zoonotic disease and milk safety in this project.

Wold Bank
World Bank is currently leading several initiatives in Ethiopia. Given the very broad portfolio of supported actions they suggested us to focus on a few examples where they believe NVI-NORAD could provide an important add-on to ongoing initiatives. With this approach they believe that issues related to establishment of collaborations, logistics, security and know-how could be quickly bypassed as these are already accounted

for on ongoing activities. Discussions therefore focused on their project Livestock and Fisheries Sector Development Project which aims at *"Increase productivity and commercialization of producers and processors in selected value chains, strengthen service delivery systems in the livestock and fisheries sectors, and respond promptly and effectively to an eligible crisis or emergency".* The World Bank thought synergies could be built around 2 topics:

- Sustainable Animal Health, Extension, and Advisory Services - *reinforce the capacity of the public Veterinary Services (VS) through the establishment of private animal health services networks and the development of partnerships between the public authorities, the private veterinarians, and the groups of VC actors; and the strengthening of the surveillance and diagnostic capacities of the National Animal Health Diagnostic and Investigation Centre and regional laboratories.*
- Development of Strategic National Programs - *Priority Animal Disease Prevention and Control Program to support the prevention and control of major devastating diseases in the targeted value chains such as the Newcastle Disease (ND) and the Peste des Petits Ruminants (PPR), by supporting the preparation of a ND control strategy and the implementation of said strategy in targeted areas; the extension in the highlands of the PPR Control Program currently implemented in the lowlands; and supporting the MoLF's One Health program*

NVI considered both concepts extremely relevant to the proposed scope of the NORADs knowledge bank and well aligned with NVIs competences and activities.

FAO
FAO presented a broad range of ongoing activities in Ethiopia, emphasising the need for further systematic efforts to strengthen animal health, and animal disease surveillance in Ethiopia. In particular they mentioned antimicrobial resistance as a major focus area and pointed out that there is a need for surveillance of antimicrobial resistance and antimicrobial usage in poultry production, and specifically requested support from the NVI to help set up such systems. They also described collaborative opportunities within efforts to improve animal and human health in the one-health perspective in lowland and highland pastoralist communities. Finally, FAO brought up the ongoing efforts to control dog-mediated rabies and suggested that the NVI might be able to contribute ongoing work to improve and validate a rabies vaccine and in Ethiopia.

National Veterinary Institute, Ethiopia
The National Veterinary Institute of Ethiopia is in Bishoftu, approximately 40 km from Addis Ababa. Their main activities are development and production of vaccines for animals and development of diagnostic tests. They also perform some diagnostics and manufacture anthelminthics. The institute has relatively well-equipped laboratories. They export some vaccines. Possible areas for collaboration include:
Development of diagnostic tests for use in the field (cow side tests) which could improve veterinary services to e.g. to pastoralist communities. Improvement of vaccines and vaccine production, for example in production of the rabies vaccine to improved deliverance and contribute to control and eradication of rabies

Faculty of Veterinary Medicine, Ethiopia
The Faculty of Veterinary Medicine of Ethiopia is in Bishoftu, approximately 40 km from Addis Ababa. We were well familiarized with this institution as we have a joint signed MoU. There is a well-established scientific work on zoonotic diseases and livestock diseases at the Faculty, and during our meeting they highlighted the importance of AMR in production systems and the need to improve mapping of resistance in both production and wild animals. The Faculty was also very interested in capacity building especially in epidemiology and molecular diagnostics.

Pan African Veterinary Vaccine Control Center
The Pan African Veterinary Center of the African Union (AU-PANVAC), also in Bishoftu, is a specialized technical office of the African Union Commission under the Department of Rural Economy and Agriculture. It is the only AU organization mandated to provide International Independent quality control of all veterinary vaccines either produced or imported into Africa, and the production of essential biological reagents for animal disease diagnosis and surveillance. AU-Panvac provides assistance to member states with respect to vaccine production, quality control and Good Laboratory Practice.

AU-Panvac is a relevant partner for the NVI, with strong competences, good laboratories and international networks within and outside of Africa. Particularly relevant are:

- Development of diagnostic tests for use in the field (cow side tests) which could improve veterinary services to e.g. to pastoralist communities
- Guidance and assistance in relation to vaccine production, development and usage, as well as import regulations in different projects relevant to Africa.

Visit to Malawi 19th to 24th January

Trustees of Agricultural Promotion Programme-(TAPP)
TAPP is a non-Governmental Organization which has the purpose of transforming rural livelihoods in Malawi by promoting sustainable agriculture, gender equality, education, public health and nutrition as well as agribusiness through active community participation. They led projects funded by Norad, Flemish International Cooperation Agency, EU Commission and others.

TAPP represents a potential collaborator for the NVI because they have long experience on community participation as well as sustainable agriculture projects improving livelihoods for smallholder farmers. For example TAPP would like to engage in consultancy by recruiting subject matter specialists for specific assignments. In addition, TAPP operates a breeding centre in Mvera, Dowa and intends to commercialise this facility.

Central Veterinary Laboratory, Malawi (CVL) and Livestock department
CVL provide a large range of veterinary services in Malawi including diagnostics, research, advisory function for the Government, food and feed control, training of field and laboratory staff and provision of epidemiological data for science based decision making and policy direction. It is the only laboratory in Malawi doing laboratory diagnostics for notifiable diseases in animals.
Livestock department is one of the sections in the Ministry of Agriculture, Irrigation and Water Development. Their mandate is to promote sustainable livestock development and protect the general public from zoonotic diseases through the delivery of animal production and veterinary services.
CVL is a relevant partner for NVI, and several potential areas for collaboration were identified:

- Livestock health & milk value chain: projects to improving animal health, milk- yield, quality –and –safety. Focus on diagnostics, advisory competence and biosecurity.
- Improving diagnostic capacity for better detection to aid early warning and response
- Poultry health & intensification: Newcastle Disease is a major cause of mortalities (80%) in chickens that hampers sustainability of production in rural poultry industry. Projects to improve diagnostic and control tools are warranted (both field& lab).
- AMR: there is a lack of surveillance and monitoring on Antibiotics use (particularly in poultry). Projects to improve and implement bacteriological culturing and antibiotic sensitivity tests are needed.
- Biosecurity emerging threats: biosecurity measures in relation to animal health threats are poor and compromised. This increases the threats of zoonosis (Rabies, Brucellosis, TB , Trypanosomosis etc).
- Climate change impact on livestock

LUANAR
Discussions with LUANAR focused on how NVI could provide added value the ongoing programmes between LUANAR and NMBU. LUANAR showed interest for a vast range of topics such as milk safety, small ruminant health, aquaculture etc… NVI believes that considering the large ongoing programme with NMBU the possible areas of collaboration may be better discussed with NMBU and will depend on the possibility to join the new programme between LUANAR and NMBU, currently under evaluation with NORAD.

Public Health Institute of Malawi
The Ministry of health has been building up a Health Services delivery system in the country to address the needs of treatment and care of patients. Health Services are delivered through community, health centre

and District Hospitals level. The Norwegian Institute of Public Health (NIPH) has partnered with Malawi to strengthen health preparedness through supporting the implementation of the International Health Regulations. Strengthening surveillance systems is one of the core capacities under this programme.
Relevant areas for collaboration with NV:

- Bovine TB, Brucellosis, Rabies, and Avian Influenza.
- Field epidemiology training of veterinarians together with medical doctors. This would strengthen one-health collaborations and build necessary competence on zoonotic disease, reporting and biosecurity in Malawi.

NVI Team - CVs

Curricula of the members of NVI's mission to African in January 2020

HANNAH JOAN JØRGENSEN graduated as a veterinarian from the Norwegian School of Veterinary Sciences in 1998. She worked in clinical veterinary practice for two years before starting her PhD project within food bacteriology, which she completed in 2005.

From 2005 to 2014, she worked within research, diagnostics, and outbreak investigations in the fields of food safety, and infectious bacterial diseases in terrestrial animals with emphasis on bovine mastitis and ovine footrot.

From 2014 to 2017 she worked at the Norwegian Public Health Institute on diagnostics and vaccines against meningococcal diseases in humans, and ran a surveillance project for meningococcal disease in Ethiopia.

After 2017, Hannah J. Jørgensen has been responsible for coordinating activities within diagnostics, surveillance, and reporting on zoonotic infections at the Norwegian Veterinary Institute. She coordinates support to the authorities on questions relating to zoonoses, leads surveillance- and research projects, and is also involved in the handling outbreaks of infectious diseases in animals with zoonotic potential. Hannah's main interests lie within bacteriology, zoonotic diseases and control of infectious disease. She also has a keen interest in international work, and is particularly interested in finding practical solutions for laboratory diagnostics and disease surveillance in low income settings.

SIV KLEVAR graduated as a veterinarian from the Norwegian School of Veterinary Sciences in 1995. She worked in clinical veterinary practice for six years before starting her PhD project within parasite immunology in 2004, which she completed in 2011.

From 2009 she started to work as a Researcher at the Norwegian Veterinary Institute and has many years of experience within diagnostic serology and vaccinology. She also has experience from research projects in Africa and has been co-supervisor for PhD student Cand med vet Coletha Mathews in collaboration with NMBU and Sokoine University of Agriculture (SUA) in Tanzania. She was also co-supervisor on Master's Thesis of Cand med vet Muhammad Azher Bhatti (NMBU) "Climate change resilience through enhanced reproduction and lactation performance in Malawian Zebu cattle" collaborating with The Trustees of Agricultural Promotion Programme and Central Veterinary Institute in Malawi where she also participated in fieldwork.

Dr. Klevar has also been head of the BSL3 facilities at the Norwegian Veterinary Institute and has been in charge of preparedness exercises at the institute organized by EMERGE (EU project). She has experience with experimental studies on infectious diseases in animals and has studied cellular and humoral immune responses to various agents including rabies vaccine response. In addition, she has long experience with serological diagnostics in terrestrial animals, including surveillance programmes and preparedness functions.

CARLOS GONÇALO DAS NEVES graduated in Veterinary Medicine, from the Technical University of Lisbon in 2004, and obtained his doctorate (PhD) in veterinary science, specialty Virology in 2009 from the Norwegian School of Veterinary Sciences.

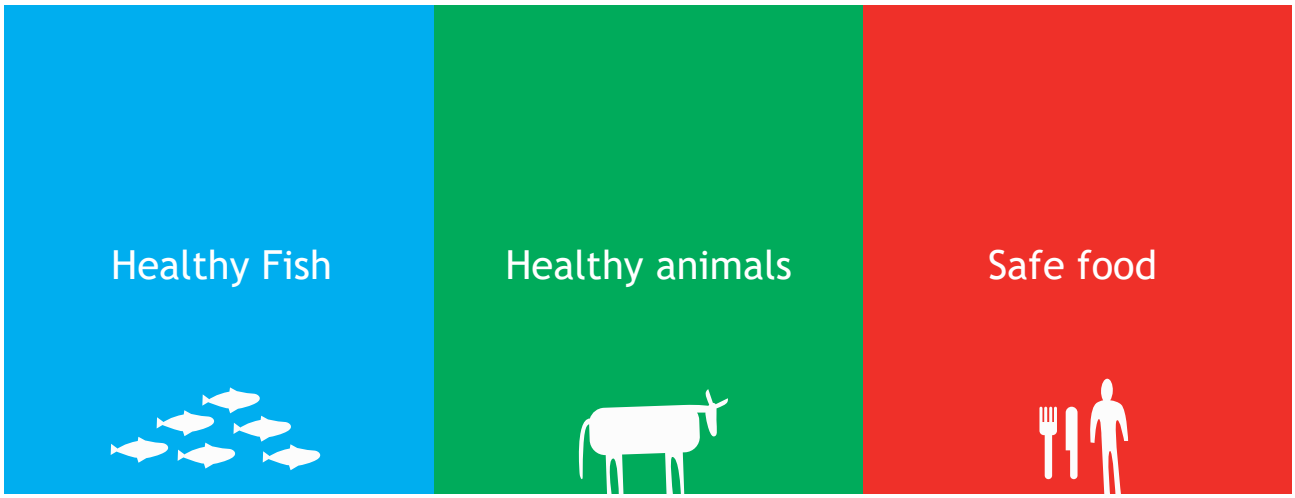
With scientific papers published in international scientific journals and extensive experience of scientific project coordination Dr. Carlos das Neves is currently the Director of Research and Internationalization at the Norwegian Veterinary Institute in Oslo, responsible for coordination of research staff of more than 150 researchers working in more than 20 different disciplines.

He served previously for 3 years as Head of Virology and 2 years as Head of Emerging Threats. He holds a joint position on ONE HEALTH and wildlife at the Faculty of Medical Sciences at the University of Tromsø and has been promoted to research professor in 2018.

Dr. das Neves has developed his scientific research in the field of virology in wildlife species and accumulated over these years extensive experience of fieldwork across the Arctic. We works today with topics related to ONE HEALTH and emerging threats, especially viral zoonoses and antimicrobial resistance with a focus also on LMICs.

In 2013 he obtained the diploma of specialist of the European College of Zoological Medicine in the area of Wildlife Population Health and was appointed by the Norwegian Government in 2014 as an expert in animal welfare and health of the National Food Safety Committee. In 2020 he was designated by Norway as a scientific expert to the IPBES Scientific Panel on Pandemics and Biodiversity.

He is the current President of the International Wildlife Disease Association. Dr. Carlos das Neves has also served as Honorary Consul of Portugal in Norway between 2010 and 2017.



Scientifically ambitious, forward-looking and collaborative- for one health!

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