Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Animal Production & Health Newsletter

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To Our Readers

N'Dama herd at pasture in Côte d'Ivoire

Dear colleagues,

COVID-19 restrictions are being lifted around the world, but the virus is still a threat to humanity and continues to affect thousands of people every day. The Animal Production and Health Section through the Zoonotic Disease Integrated Action (ZODIAC) project has been providing technical advice, support and guidance to Member States. Several webinars, workshops and meetings were organized in addition to the supply of equipment, reagents and consumables to Member States. Two training courses were conducted in April 2022 on the use of the IAEA genetic sequencing services and attended by several hundred staff of the more than 150 ZODIAC National Laboratories. Four Coordinated Research Projects (CRPs) on "Enhancing laboratory preparedness for the detection and control of emerging and re-emerging zoonotic diseases", under ZODIAC, for Africa, Europe and Central Asia, the Americas and the Caribbean, and Asia and the Pacific, respectively, were approved in March 2022. We will call for research applications and proposals shortly.

The main objective of these CRPs is to empower the national and regional disease surveillance programmes in each of the four regions to identify potential sources of pathogen spill-over to humans and identify emerging- and/or re-emerging pathogens with zoonotic risk.

The iVetNet platform, a key component of the Veterinary Diagnostic Laboratory (VETLAB) Network, and a supportive component of the ZODIAC project continues expanding the number of institutions and people affiliated to it. Currently 1969 institutions worldwide from 199 countries and territories are benefitting from laboratory information, standard operating procedures and facilities for getting ISO certification.

The world is now facing a new disease challenge: the monkeypox virus, while we still fight COVID-19. This disease is not new as it has been observed in monkeys in the fifties and in humans in the seventies in the Democratic Republic of Congo. There are two clades: the central African (Congo Basin) clade and the West African clade. The natural reservoir of monkeypox is still unknown with rodents and monkeys most probably involved in the spread to humans. Due to transcontinental travel and adventure tourism, the disease is spreading beyond its endemic area in Africa. Fortunately, the number of human cases worldwide is still low.

The monkeypox virus is not the only one that demands our concern. Lassa virus, that causes Lassa fever, an acute viral haemorrhagic illness, is also affecting people in the same regions of Africa. In this case, the reservoir is a rat that often lives near or inside houses, contaminating the food and environment with the virus. Fortunately, this time we are better prepared compared to the early phases of the COVID-19 pandemic. The IAEA promptly organized a workshop in June 2022 with the participation of the Food and Agriculture Organization of the United Nations (FAO) and the World Health Organization (WHO) plus several experts to discuss the impact of these two viruses and the steps to follow in terms of research in laboratory diagnostic techniques. This will help to determine the natural reservoir of the monkeypox virus and to understand the environment-animal-livestock-human interface of these viruses.

Several of the technical meetings of our Technical Cooperation Projects (TCPs) and CRPs have continued in the virtual format in the first semester. On a positive normalization note, the first coordination meetings of the CRPs in the area of animal breeding and genetics (D31030) and animal nutrition (D31031) were successfully held in person in Vienna in April. It is planned to organize more and more in-person meetings this year. Moreover, we have been busy implementing more than 40 TCPs that started in the 2022-2023 Technical Cooperation cycle plus finishing the implementation of the ongoing TCPs.

The Animal Production and Health Section continues its efforts in developing early and rapid diagnostic tests for zoonotic and transboundary animal diseases. A novel multiplex real time PCR-based assay for the detection and differential diagnosis of abortive disease caused by important bacterial zoonotic agents (brucellosis, Q fever, listeriosis and leptospirosis) was developed, laboratory validated and transferred to Botswana, Indonesia, Lesotho, and Senegal.

In addition, the Animal Production and Health Section continues its focus on enhancing food security by supporting sustainable livestock production systems in developing countries. This is to be achieved by strategic and applied research, technology transfer and capacity building. The three principal components of the subprogramme are animal nutrition, animal reproduction, breeding, and genetics, and animal health. Animal production and health problems are identified, and solutions developed by strategically applied isotopic, nuclear, nuclear-based, and nuclear-derived tools, in conjunction with conventional technologies to:

- Characterize and optimally utilize the nutritional value of locally available feed and feed resources to enhance energy conversion whilst protecting the environment and minimizing greenhouse gas emissions;
- Enhance animal reproduction and breeding through the introduction of artificial insemination, embryo transfer and productive breed selection, and the characterization of livestock genetic make-up to drive the integration of locally adapted animal breeds with trait selected exotic breeds to satisfy the increasing demand for more and better-quality animals and animal products;
- Assess and reduce the risk of transboundary animal and zoonotic diseases to livestock and livestock owners through the implementation of early and rapid diagnosis and control technologies and their use in national and international control and eradication programmes.

The above activities are complemented by tools developed for computerized data management in disease diagnosis and animal production, use of geographic information systems in management of farm resources and diseases, and distance learning through information communication technologies in the related areas. The FAO/IAEA Veterinary Diagnostic Laboratory (VETLAB) Network is instrumental to the development, validation and dissemination of technologies, know-how and expertise worldwide.

Gerrit Viljoen

Head, Animal Production and Health Section

Thinking About the New Generation

Daughter's Day

On 28 April 2022, over 100 girls between 11 and 16 years of age visited the Vienna International Centre, where the IAEA Headquarters is, to take part in the Daughter's Day Programme. The girls participated in activities designed to inspire them to consider pursuing studies or a career in STEM fields and to demonstrate how the work of the UN transforms lives around the world.

As part of the programme, Mr Ivancho Naletoski, the Animal Production and Healthy Section (APH) prepared an interactive session in which he presented what the section does in the field of animal nutrition, reproduction and breeding.

Specifically, for the work done on early detection and characterization of transboundary animal and zoonotic diseases, Mr Naletoski presented how personal protective equipment is used when field veterinary services are sampling and packing animal samples. Some of the visitors took part in the practical exercise to wear the PPE and try the process of sampling using "trial samples" (pieces of paper and vacutainer tubes). Mr Naletoski explained how the samples are further processed in the laboratories and tested using nuclear and nuclear-related technologies, as well as how these technologies are disseminated to the laboratories of the VETLAB network.

Ivancho Naletoski with participants on Daughter's Day

Long Night of Research

On 20 May 2022, APH was present at the Long Night of Research which took place in the Vienna International Centre (VIC).

The Long Night of Research is an Austria-wide event supported by the government with over 280 exhibition locations across the country that seeks to promote science and research.

The APH stand in the VIC emphasized section work during the COVID-19 pandemic when emergency equipment for rapid diagnostic of the virus and training courses were delivered to Member States. Approximately 100 children visited the stand and were taught as part of a game how to use laboratory equipment while mixing primary colour substances inside a mock safety cabinet.

Hands-on "training" for kids

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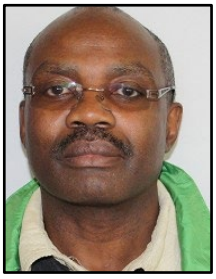
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Joint FAO/IAEA Programme

VETLAB Network Bulletin

02/2022

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VETLAB is an initiative of the Joint FAO/IAEA Centre

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- Training Course on TADS: Early diagnosis and pathogen characterization focus on NGS technology

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To the readers

The first semester of 2022 was marked by the emergence, re-emergence, and spread of transboundary animal and zoonotic diseases in several VETLAB Network partner countries and beyond. In Asia, animal viruses previously considered exotic for the region, such as lumpy skin disease and African swine fever, have emerged during the past few years and have kept spreading despite all attempts to contain and control the infections. Notably, foot-and-mouth disease recently re-emerged in Indonesia after about 30 years, threatening the livestock economies of the entire region. Similarly, goat pox virus has reemerged in Bangladesh after 20 years (see Highlights).

Monkeypox virus (MPXV), a zoonotic pathogen endemic in some parts of Africa, is currently of great concern after causing hundreds of human cases in Europe and the Americas. The recent incidence resulted in an international health alert. Although MPXV has been known for decades, the recent spill-over highlighted that many knowledge gaps still exist in its epidemiology, including the identification of animal reservoirs and transmission pathways.

The examples mentioned above highlight the importance of the veterinary services and their laboratories for early warning, rapid detection, and preparedness for the emergence of new diseases in animals and humans. In addition, veterinary laboratories can provide essential contributions towards filling research gaps for many diseases. Concerning preparedness, a key factor is data and information sharing among the scientific community, veterinary services, and laboratories. The VETLAB Network works with all its partners to facilitate communication and exchange between the laboratories and promote research and the transfer of technologies to ensure adequate laboratory preparedness and response. The information provided in this issue is a clear example of this.

VETLAB Highlights

The Veterinary Laboratory in Kinshasa (Democratic Republic of Congo – DRC) is conducting surveillance of Monkeypox virus

The Veterinary Laboratory is currently involved in national surveillance of Monkeypox (MPX), a zoonotic disease endemic in the Congo basin and some West African countries. In the first semester of 2022, more than 1200 human cases were reported in DRC. Most cases are present near or within forest areas, in populations hunting wild animals, handling, and consuming bush meat. Passive surveillance focuses on provinces with unusual high mortality and in regions where the presence of the disease is already established. Active surveillance is conducted through several projects supported by international partners.

Molecular Detection of Goat Pox Virus (GTV) in Bangladesh

The Central Disease Investigation Laboratory (CDIL), Department of Livestock Services (DLS), in Bangladesh, diagnosed Goatpox. Unfortunately, after about 20 years, the disease has re-emerged in this country and was diagnosed in December 2021 in the Rangamati district. Samples were collected and submitted to CDIL for confirmative diagnosis by classical and real-time PCR. Clinical observation of the affected goats revealed common goat pox disease signs, and PCR confirmed the presence of the viral DNA in the samples.

The Bacteriology Laboratory of the Animal Health Institute (AHI), Sebeta, Ethiopia uses state-of-the-art techniques to analyse bacteria

The AHI regularly performs bacterial isolation, identification for outbreak investigation, certification for exported and imported animals, and disease surveillance activities. The laboratory also performs conventional bacteriological analyses for zoonotic pathogens using a BSL-3 laboratory facility. Of note, MALDI-TOF and OmniLog technologies are currently applied in AHI to identify animals and zoonotic bacterial pathogens rapidly and accurately. The laboratory took part in several proficiency tests (PT) on AMR, opening the opportunity for accreditation and becoming a PT provider for AMR tests in the region.

OIE launched the new OIE Reference Laboratory network for PPR

The three OIE Reference Laboratories [CIRAD (France), Pirbright Institute (UK), and Animal Health and Epidemiology Center (China)] are managing a new network for PPR. It is a platform open to all laboratories actively performing PPR diagnostics. Its website provide updated information on protocols, vaccines, reference material, training, proficiency tests, diagnostic services, and expertise available to the community, including those implemented through the VETLAB Network. Visit: https://www.ppr-labs-oie-network.org

02/2022

VETLAB Network Bulletin

VETLAB Capacity Building Initiatives

Training course on detection and differential diagnosis of PPR (IAEA, 17-28 Oct 2022)

To strengthen capacities for diagnosing and monitoring PPR and other respiratory diseases in sheep and goat and other non-conventional hosts. It will cover both diagnostics and molecular characterization of the targeted pathogens.

Training Course on TADS: Early diagnosis and pathogen characterization focus on NGS technology (IAEA, 19-30 Sep 2022)

It aims to strengthen the capacity in applying NGS and the bioinformatics tools for the accurate identification of pathogens causing zoonotic and TADs.

Genome sequencing fellowship training running in APHL (May-July 2022)

APHL is currently hosting a group fellowship on the use of Next-Generation Sequencing (NGS) using Ion S5 NGS system for scientists from three selected Zodiac National Laboratories

VETLAB Networking Activities

Interlaboratory test for the diagnosis of PPR and LSD

The 2021 interlaboratory comparison (ILC) exercise to assess countries' diagnostic capacity for the accurate detection of PPR was organized in early 2022 (delayed due to past pandemic-related restrictions). Due to the current epidemiological situation in the East Asian region, a panel for LSDV molecular detection was added for some Asian laboratories this year. This year, 34 laboratories have participated in the exercise.

Coordination Meeting of the Veterinary Diagnostic Laboratory (VETLAB) Network with Directors of African and Asian Veterinary Laboratories (22-26 August 2022)

The purpose of the meeting is to update partners on the activities of the VETLAB Network and to discuss the main challenges and gaps in implementing animal and zoonotic disease diagnoses. After two years, we are pleased to announce that the meeting is expected to take place on-site at the IAEA-HQ.

VETLAB Network Laboratories:

Yangon Veterinary Diagnostic Laboratory, Myanmar

As part of the Veterinary diagnostic services of the Livestock Breeding and Veterinary Department (LBVD), the Yangon Veterinary Diagnostic Laboratory (YVDL) established in 1977, provides pathology with post-mortem findings, virology, serology, bacteriology, biochemistry, microbiology, parasitology and histopathology testing for the benefit of the livestock sector. Laboratory diagnostic services are mainly for TADs and zoonotic diseases such as Avian influenza viruses (highly pathogenic or low pathogenic), Newcastle disease, rabies, foot-and-mouth disease, porcine reproductive and respiratory syndrome, swine influenza, African swine fever, peste des petits ruminants, anthrax, tuberculosis, brucellosis, zoonotic parasitic diseases, lumpy skin disease and zoonotic COVID-19.

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YVDL has performed PPR surveillance since 2017. In addition, YVDL has been participating in proficiency testing programs for avian diseases, swine diseases, peste des petits ruminants, lumpy skin disease, and African horse sickness organized by FAO/IAEA, Australian Center for Disease Preparedness (ACDP), and Spain (European Reference Laboratory).

More recent VETLAB publications

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8.Sidi M, Zerbo HL, Ouoba BL, Settypalli TBK, Bazimo G, Ouandaogo HS, Sie BN, Guy IS, Adama DD, Savadogo J, et al. Molecular characterization of African swine fever viruses from Burkina Faso, 2018. BMC Vet Res 2022. 18: 69. doi:10.1186/s12917-022-03166-y

Yangon Veterinary Diagnostic Laboratory, Myanmar

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Forthcoming Events

Regional Training Course on the Nuclear and Nuclear Derived Techniques for Early Diagnosis and Detecting of Lumpy Skin Disease, Sheep and Goat Pox and Peste des Petits Ruminants

Ivancho Naletoski

A training course on the Lumpy Skin Disease (LSD) of cattle, Sheep pox and goat pox (SGP), as well as the Peste des Petits Ruminants (PPR) will take place at the Croatian Veterinary Institute in Zagreb, Croatia, from 11 to 15 July 2022.

The purpose of the training is to upgrade the knowledge of participating laboratories in serological screening and detection of LSD, SGP and PPR by means of ELISA and PCR techniques. The training will include a reviewby experts of the epidemiological situation on LSD, SGP, and PPR, laboratory techniques for serological screening (ELISA), detection and strains differentiation (PCR, sequencing), as well as international regulations and control measures.

During the laboratory sessions, the participants will engage hands-on in laboratory techniques under the supervision of international experts.

The expected outputs of the meeting are a) strengthened technical and expert capacities in the counterpart laboratories with knowledge of the epidemiological situation, diagnostic techniques, international regulations, and control measures for LSD, SGP and PPR, and b) improved practical skills in serological screening, diagnostic techniques application and differentiation of vaccine and field strains.

The training course will be supported by experts from the Pirbright Institute in the UK, CIRAD-France and experts from FAO.

First Research Coordination Meeting on Novel Test Approaches to Determine Efficacy and Potency of Irradiated and Other Vaccines (D32037)

Viskam Wijewardana and Carla de Bravo de Rueda

This is a first meeting of the new Coordinated Research Project (CRP) on novel approaches to determine the efficacy of vaccines and immune mechanisms underlying novel vaccines, taking place at the IAEA Headquarters in Vienna, Austria, from 18 to 22 July 2022. The purpose of the event is to discuss proposed work plans of the participants in this new CRP, which focuses on methods to evaluate irradiated and other novel vaccines by using innovative tools to determine their immune response.

It is expected that the participants will bring new and original ideas and approaches on designing immunological tools for quality control and efficacy assessment of experimental vaccines. Eight to ten contract holders and interested observers will participate in the first meeting.

Read more about the scope of this CRP on page 31 of this edition.

Coordination Meeting of the Veterinary Diagnostic Laboratory Network (VETLAB Network) with Directors of African and Asian Veterinary Laboratories

Charles Lamien

The fifth coordination meeting of the Veterinary Diagnostic Laboratory Network (VETLAB Network) is taking place in Vienna, Austria, 22 to 26 August 2022.

The purpose of the event is to update partners on the activities of the Veterinary Diagnostic Laboratory Network (VETLAB Network) and to discuss the main challenges and gaps in implementing animal and zoonotic diseases diagnosis

First Research Coordination Meeting on Application of Advanced Molecular Characterization Technologies through the Veterinary Diagnostic Laboratory Network (VETLAB Network) (D32036)

Ivancho Naletoski

This is the first meeting of the new Coordinated Research Project (CRP) on Application of Advanced Molecular Characterization Technologies Through the Veterinary Diagnostic Laboratory Network (VETLAB Network), taking place at the IAEA Headquarters in Vienna, Austria, from 22 to 26 August 2022.

The purpose of the event is to discuss the workflow for service-based whole genome sequencing, data analysis, interpretation and sequence sharing, as well as its wider integration in the VETLAB Network.

Training Course for Veterinary Diagnostic Laboratory Network Partners on Transboundary Animal Diseases: Early Diagnosis and Pathogen Characterization

Charles Lamien

In the context of the VETLAB Network, the APH Laboratory in Seibersdorf is organizing a training course for Veterinary Diagnostic Laboratory Network partner laboratories on Transboundary Animal Diseases: Early Diagnosis and Pathogen Characterization taking place in Seibersdorf, from 19 to 30 September 2022.

The purpose of the event is to strengthen the capacity of the Veterinary Diagnostic Laboratory Network partner laboratories in selecting and applying suitable algorithms and nuclear-derived/molecular assays for the detection of major pathogens causing transboundary and zoonotic diseases.

Regional Workshop on Diagnostic Techniques for Transboundary Animal Diseases (RLA5085)

Carla Bravo de Rueda

The regional workshop on Diagnostic Techniques for Transboundary Animal Diseases, part of the Technical Cooperation project Strengthening the Capacity of Official Laboratories for Monitoring and Response to an Outbreak of Priority Animal and Zoonotic Diseases (ARCAL CLXXIV) (RLA5085) is taking place in Buenos Aires, Argentina, from 17 to 21 October 2022.

The participants of the workshop are the counterpart members from 19 laboratories and health authorities in the region in the following countries: Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, and Venezuela.

The purpose of the event is to discuss the approaches and proposed work plans with all the partners involved in strengthening of laboratory capacities for the surveillance and response to an outbreak of priority animal and zoonotic diseases. We aim to improve the regional transboundary and zoonotic disease emergency response capabilities within a collaborative approach involving communication strategies, regional evaluation and technical implementations.

The expected outcomes of the workshop:

- Laboratory technicians and managers will be trained in the art of diagnostics of five fundamental diseases in the region: Avian influenza, African Swine Fever, Classical Swine Fever, Brucellosis and Newcastle Disease.
- Laboratory managers will be engaged in workshops for exceptional communication and inter laboratory relationships.
- Interlaboratory exercises will be organized for validation of common standard operational procedures in accordance with specific needs.
- Outbreak communication workplans will be conducted in order to inform about future possible outbreaks in an accurate and positive manner.
- A joint OIE-FAO presentation on One Health will be included in the agenda. We are creating a tight regional collaboration for sustainable success.

Training Course on Detection and Differential Diagnosis of Peste des Petits Ruminants in Small Ruminants and Other Non-Conventional Hosts

Charles Lamien

In the context of the Peste des Petits Ruminants (PPR) Global Eradication Program (GEP), the APH Laboratory in Seibersdorf is organizing a training course on Detection and Differential Diagnosis of Peste des Petits Ruminants in Small Ruminants and Other Non-Conventional Hosts, taking place in Seibersdorf, from 17 to 28 October 2022.

The purpose of the event is to strengthen the capacities of Veterinary Diagnostic Laboratory Network partner laboratories for diagnosing and monitoring peste des petits ruminants (PPR) and other respiratory diseases in line with the implementation of the PPR Global Eradication Programme.

Past Events

Virtual Interregional Training Courses on the Generic Verification of new SOPs for (a) Latin America & Europe and (b) Africa and Asia (INT5157 – Pillar 1 of the ZODIAC Initiative)

Ivancho Naletoski

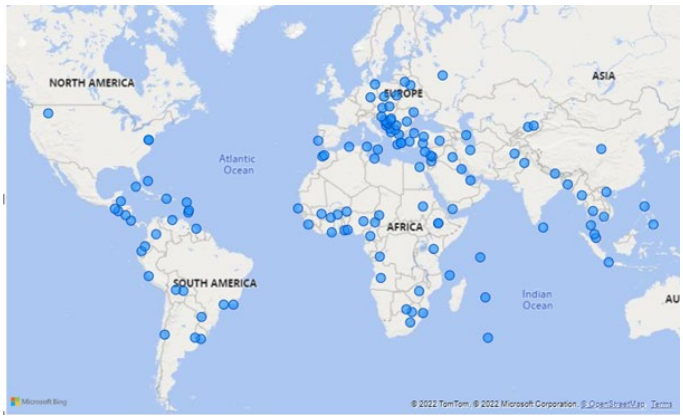
Two interregional virtual training courses were held from 21 to 25 February 2022 for staff members of the ZODIAC National Laboratories (ZNLs). The purpose of the events was to teach the participants how to proceed in verifying SOPs for new serological and molecular techniques for adoption by the ZNLs.

The courses were attended by 538 participants from 95 IAEA Member States (Africa: 29; North America: 2; Asia:21; Europe: 23; Latin America: 20).

Participants attending virtually

The courses covered topics of: a) validation and verification of diagnostic assays for infectious diseases; b) assays by the output result: qualitative and quantitative assays; c) analytical specificity and sensitivity for serological and molecular assays; d) calculation and evaluation of the repeatability and reproducibility; e) measurement of uncertainty; f) robustness (continuous monitoring of assay performance); g) production and calibration of secondary reference standards; h) structure of the verification reports (summary); and i) external quality control – proficiency testing. Each of the above-mentioned topics were supported by practical exercises prepared for the participants and comprehensive discussion on the daily maintenance of the diagnostic assays and problem solving in the end-user laboratories.

The interest for the topic was raised as a consequence of the sudden outbreaks of animal and zoonotic diseases in various regions of the world, such as the outbreaks of Ebola and Rift Valley fever in Africa, avian influenza in Asia, Crimean-Congo haemorrhagic fever in Europe and others. The knowledge obtained during the course will help scientists from the ZNLs to rapidly adopt and verify new diagnostic techniques in the local laboratory and generate quality assured results in short timeframes.



Participating institutions

First Virtual Expert Meeting (Senior Expert Team) to Implement Bio-risk Management System in the ZODIAC National Laboratories (ZNLs) (INT5157 – Pillar 1 of the ZODIAC Initiative)

Ivancho Naletoski

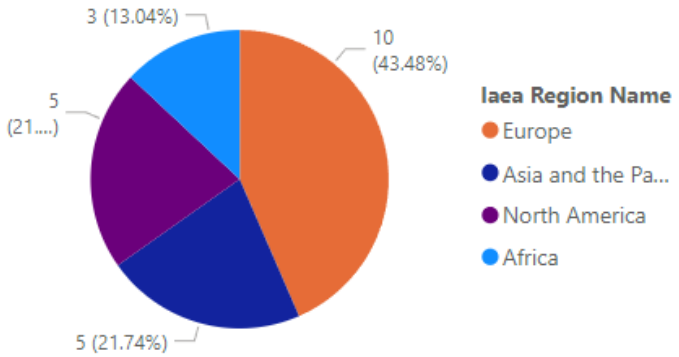
The first virtual meeting with senior expert team members on implementation of bio-risk management systems in ZODIAC national laboratories took place from 2 to 4 March 2022. The meeting was attended by 23 participants from the senior expert team and by relevant International Organizations (FAO and OIE) from fourteen IAEA Member States.

The purposes of the event were to discuss current knowledge, challenges, and needs for bio-risk management in veterinary laboratories within limited resources settings and to establish an expert group to design a set of practical procedures for training and implementation in ZODIAC National Laboratories (ZNLs). Existence of such a bio-risk management system in the ZNLs is expected to minimize the risk of spillover of pathogens within the laboratories, as

well as to prevent any unintentional or intentional threat to the animal and public health due to the routinely used testing and research activities at the ZNLs.

The discussions were focused on existing international standards, guidelines, and recommendations on bio-risk management [primarily developed by the World Health Organization (WHO), Food and Agricultural Organization (FAO) of the United Nations (UN) and the World Organization for Animal Health (OIE)], as well as the existing management systems in the counterpart ZNLs.

Based on the discussions, the experts have identified senior and technical expert groups to support the implementation of the bio-risk management module for the counterparts ZNLs. They also designed a basic skeleton of the bio-risk management systems and suggested follow up actions to further develop and implement such a system in all ZNLs. Based on the recommendation of the senior expert team, the IAEA secretariat will organize a series of workshops, meetings and training courses for the establishment and dissemination of the bio-risk management procedures.



Participation by region

Inter-Agency Coordination Meeting to Discuss Implementation of a Regional Plan in Latin America

Carla Bravo de Rueda and Ivancho Naletoski

As part of the regional Technical Cooperation project for Latin America RLA5085, "Strengthening the Capacity of Official Laboratories for Monitoring and Response to an Outbreak of Priority Animal and Zoonotic Diseases (ARCAL CLXXIV)", an inter-agency coordination meeting was organized on 13 April 2022.

Representatives of the Joint FAO/IAEA Centre, FAO Regional Office for Latin America and the Caribbean (FAO-RLC), World Organisation for Animal Health Regional Representation for the Americas (WOAH-RRA), the South American Network of Diagnostic Laboratories of Avian Influenza and Newcastle Disease (RESUDIA) and the *Servicio Nacional de Sanidad y Calidad Agroalimentaria* (SENASA, Argentina) met virtually to discuss implementation of the regional plan in Latin America.

The APH has been strategically integrating RESUDIA as a counterpart of the project, to facilitate regional engagement and strengthen diagnostic capability and trainings in the region.

Among the key achievements of RESUDIA are:

(a) In May 2016, LFDA-SP (*Laboratório Federal de Defesa Agropecuária, Brazil*), was recognized by the WOAH as a reference laboratory for avian influenza and Newcastle disease diagnosis. Since then, it has been the coordinating laboratory for RESUDIA.

(b) RESUDIA's main responsibilities:

- Training of laboratory staff
- Harmonisation of laboratory methods and biosafety procedures
- Promotion of inter-laboratory testing
- Integration of laboratories in the region and with laboratories in other regions and networks
- Definition of mechanisms for production and distribution of reference materials

(c) RESUDIA is integrated by the National Reference Laboratories from Argentina, Uruguay, Paraguay, Chile, Brazil, Bolivia, Colombia, Ecuador and Perú.

In a coordinated effort, the Joint FAO/IAEA Centre has also engaged in regional efforts with FAO and WOAH to achieve satisfactory goals regarding its project RLA5085.

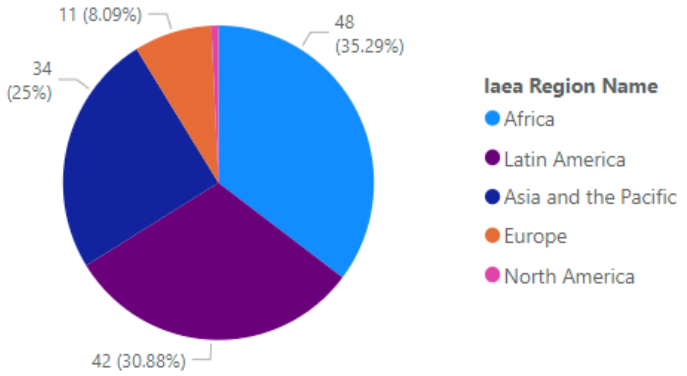
WOAH-RRA (Luis Barcos, Catya Martínez, Martín Minassian, Eugenia Chiment), LFD-SP (Dilmara Reischak), SENASA Argentina (Ana María Nicola), FAO-RLC (Vanessa Max), IAEA (Nicola Schoegl), Joint FAO/IAEA Centre (Carla Bravo de Rueda, Ivancho Naletoski)

Virtual Interregional Training Course on the Use of the Genetic Sequencing Services for Latin America & Europe and Africa and Asia – Pillar 1 of the ZODIAC Initiative (INT5157)

Ivancho Naletoski

Two interregional virtual training courses were held from 19 to 22 April 2022 and 25 to 28 April 2022 for the Latin America and Europe, and Africa and Asia regions respectively. The course was attended by 133 participants from 58 IAEA Member States (Africa:19; North America:1; Asia:14; Europe:10 and Latin America:14).

The purpose of the training courses was for the participants to learn about the use of the Sanger Sequencing service established by the Animal Production and Health (APH) Sub-Programme of the Joint FAO/IAEA Centre with an aim to transfer the knowledge among the ZNL community.



Participation by region

Participating countries

The course covered the following topics: a) registration of the network users with APH; b) sample preparation and quality control; c) sample submission and shipment; d) generating consensus sequence from the forward and reverse readings of the Sanger sequencing; e) sequence alignment on the existing genetic open-source databases; and f) phylogenetic analysis of the obtained results.

Genetic sequencing can significantly contribute towards the understanding of the phylogeny and evolution of locally circulating pathogens and enable the appropriate selection and implementation of disease control and/or eradication measures (source of the infection, similarity with other locally/regionally circulating pathogens; selection of vaccine strains etc.).

First Research Coordination Meeting on Improving Efficiency of Animal Breeding Programs Using Nuclear Related Genomic Information – Practical Applications in Developing Countries (D31030)

Victor Tsuma and Mario Garcia Podesta

The first Research Coordination Meeting (RCM) of Coordinated Research Project (CRP) D31030 was held in Vienna, Austria, from 4 to 8 April 2022. The aim of the meeting was to discuss objectives and major activities of the CRP, share national data on dairy animal breeding programmes, discuss recent advances in animal genomics considering opportunities and challenges for application in animal breeding, and to discuss and update workplans of individual research contracts for the next 18 months. Ten research contract holders (RCH), one technical contract holder (TCH), five agreement holders (AH), and staff from the Joint FAO/IAEA Centre attended the meeting in person, whereas one RCH participated virtually.

Participants of the Research Coordination Meeting, VIC, Vienna, Austria

The work plans were updated, and common research methodologies developed in line with the objectives of the CRP. The technical programme and methodologies were harmonised for each group of countries targeting: development of genomic tools and genome wide association studies (GWAS) in water buffalo (India, Pakistan and China); phenotyping and application of genomics for biodiversity analysis and association studies in dromedary camel (India and Kenya); application of genomics for estimation of indicine-taurine admixture and evaluation of

performance of different crossbred cattle genotypes (Bangladesh, Sri Lanka and South Africa); GWAS and establishing pilot reference population in purebred cattle genotypes (Argentina, Burkina Faso and Peru).

Phenotypic variables were defined and harmonized for each of the research contract holders as per their species of interest and number of animals to be phenotype recorded agreed upon. The RC holders will implement performance/phenotype data as per International Committee on Animal Recording guidelines and use existing tools/applications for data recording. Each country will establish a gene bank of performance recorded animals that can serve as potential reference population in future. The CRP partners (research contract and research agreement holders) will work together with all the interested stakeholders for the development of an upgraded buffalo specific DNA chip. The CRP will continue its efforts to identify, test and validate suitable biomarkers or combination of biomarkers for early detection of pregnancy in cattle through a dedicated technical contract.

The FAO/IAEA laboratories, Seibersdorf will provide support on collection and genomic analysis (genotyping/sequencing) of samples. The research contract (RC) holders will implement the work plans as agreed during the first RCM and report progress based on these work plans in the 2nd RCM. It was noted that the level of skills on conventional genetic evaluation is generally low in participating countries and training and technical support is needed. The CRP will allow participating RC holders to initiate/enhance or strengthen pedigree/performance recording systems for progeny evaluation which may permit better tools for selection of bull mothers and potential sires.

First Research Coordination Meeting on Nuclear and Related Techniques to Measure the Impact of Type of Feeding and Production System on Greenhouse (GHG) Emissions and Livestock Productivity (CRP D31031)

Victor Tsuma and Mario Garcia Podesta

The first research coordination meeting of CRP D31031 was held from 25 to 29 April 2022 at the Vienna International Centre (VIC), Vienna, Austria, and it was attended by nine Research Contract holders (RCH) and one Agreement holder (AH), with one RCH and one AH participating on-line. RCH represented Argentina, Brazil, Chile, China, Egypt, Ethiopia, India, Indonesia, Pakistan and South Africa. Agreement holders were from the United States of America and United Kingdom. The main objective of the meeting was to enable IAEA MS, especially developing countries to use nuclear & related technologies & resources to optimize livestock feeding practices that reduce GHG emissions & help mitigate climate change. The specific objectives were a) strengthen seasonal forage/feed quality, biomass, and intake determination in developing countries using established or novel methodologies; b) identify locally available suitable non-human edible feeds, including agro-industrial by-products from food systems for N & E supplementation in cattle feeding; c) evaluate N & E supplementation options in cattle feeding to mitigate enteric & manure GHG emission; d) develop and/or validate nuclear & related tools/resources for nutrition related GHG mitigation in cattle production; and t) provide perspective on applying GHG mitigation strategies to support cattle feeding decisions.

Participants of the First Research Coordination Meeting of CRP D31031, VIC, Vienna, Austria

Individual RCHs presented their national cattle production programmes, feeding practices, management systems, and status of feeding practices on environmental impact & sustainable productivity. In addition, they presented the project objectives and expected research work focusing on laboratory techniques and the existing laboratory facilities. The technical workplans were revised and updated. The CRP team are thankful to Dr Alexander Hristov, AH from Pennsylvania State University, USA, for his valuable inputs in project designs. In most cases, dairy or beef cattle will be used as experimental animals while sheep and yaks will be used in two of the studies.

Virtual Regional Training Course on Evaluation of Current Biosafety and Biosecurity Status of Designated Laboratories (RER5027)

Ivancho Naletoski

As part of the regional Technical Cooperation project for Enhancing Preparedness Capacities of the Veterinary Sector to Confront Emerging and Re-emerging Diseases of Livestock and Wildlife (RER5027) a virtual training course on evaluation of the current biosafety and biosecurity status of designated laboratories was organized from 9 to 13 May

2022. The course was attended by 27 participants from 15 Member States of the IAEA from the European region.

The event was organized as a follow-up on the recommendations of the senior expert meeting held in February 2022 (see above) with the purpose of evaluating the current biosafety and biosecurity status of laboratories in Member States and suggest their modification according to the best and internationally recommended practices.

The participants presented the organizational structures and workflows of the counterpart's laboratories, including ground floor plans, sample and personnel flow.

Participating institutions

Four technical experts were invited to follow the presentations and record the situation with the laboratory infrastructures, sample processing and testing as well as the procedures for biological sample/material removal from the laboratories (waste management). Based on the observations, the experts are expected to compile a set of necessary procedures needed for a solid bio-risk management system in all counterpart laboratories. Based on these recommendations, IAEA will recruit experts to develop procedures and implement a series of training courses for practical implementation of the bio-risk management procedures in the local laboratories.

Wherever possible, participants of the future courses will be offered a certification test to ensure proper dissemination of the theoretical and practical knowledge in bio-risk management, as well as to prove the competence of the local staff in performing the assigned tasks. The planned examiners at these certification tests will be the established experts from the regional and inter-regional biosafety associations.

Expert Meeting and Regional Workshops (RER5027 & RAS5085) as a Virtual Regional Training Course on the Current Developments of the Whole Genome Sequencing Platforms and the Bioinformatics Data Processing – Pillar 1 of the ZODIAC Initiative (INT5157)

Ivancho Naletoski

In the context of the regional projects RER5027 (Enhancing Preparedness Capacities of the Veterinary Sector to Confront with Emerging and Re-emerging Diseases of Livestock and Wildlife) and RAS5085 (Using Nuclear Derived Techniques in the Early and Rapid Detection of Priority Animal and Zoonotic Diseases with Focus on Avian Influenza), two regional workshops and an expert meeting took place virtually from 23 to 26 May 2022. The participants were counterparts of the two ongoing regional projects RER5027 and RAS5085.

For the dissemination of Whole Genome Sequencing (WGS) technologies, the APH is considering three approaches: a) establishment of functional laboratories in Member States in each of the IAEA regions (Africa, Asia, Europe and Latin America) as regional research and training centres, b) establishment of continuous workflow for service based WGS with an external service provider for possible wider coverage of as many laboratories as possible and c) disseminating nanopore Oxford Nanopore - MinION in multiple Member States.

The meeting focused on the essential pre-requisites for the proper functioning of the WGS, such as a) the sample preparation and inactivation; b) library preparation; c) recommended WGS platforms used in the expert laboratories; d) bioinformatic workflows for service based WGS; e) suggestions on bioinformatic workflows for Nanopore MinION sequencing; and f) quick metagenomic analysis. A team of international experts will present on their experiences and recommend the most feasible solution for the APH programmatic activities.

The discussions and outcomes of the meeting were: a) practical recommendations for the individual phases of the WGS/NGS workflows mentioned above; b) general introduction on the existing WGS platforms and bioinformatic data processing; c) options for service based WGS workflows; d) options for Nanopore MinION sequencing workflows present; e) different WGS approaches (Targeted NGS; Family based NGS; WGS; Metagenomics); and f) possible workflows for service based WGS applications and Nanopore MinION sequencing.

Virtual Training Course for National Reference Laboratory for Lumpy Skin Disease (LSD) in Turkey on "Cell Mediated Immunity" in Collaboration with the Royal Veterinary College of London

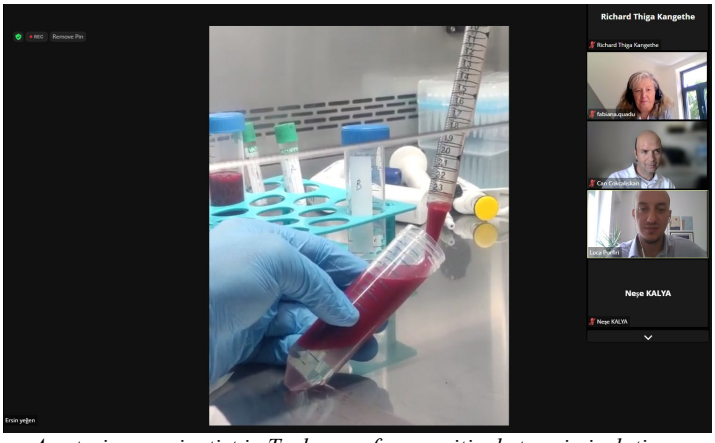
Viskam Wijewardana, Richard Kangethe and Luca Porfiri

The one-week training course on Cell Mediated Immunity took place virtually from 23 to 27 May 2022.

This training represents one of nine training sessions aiming at optimizing and harmonizing the diagnostic methods of LSD used in the laboratories of eight Veterinary Control Institutes (VCIs) of the Ministry of Agriculture and Forestry. It was part of an EU-funded technical assistance project on prevention and control of LSD in Turkey.

Thirty participants from nine veterinary control institutes in Turkey attended the course, which consisted of lectures and practical exercises in the laboratories. The Animal Production and Health Laboratory (APHL) conducted the training course in collaboration with the Royal Veterinary College of London and contributed to it by delivering four presentations on methods to analyse and evaluate cell-mediated immunity by cytokines and other immune markers.

The lectures were followed by a participants' group exercise performed in their laboratories, performing the protocol on "Isolation of Peripheral Blood Mononuclear Cells from whole blood", developed by the APHL team in Seibersdorf, which is pivotal for many immune assays used for the purpose of the project.



A veterinary scientist in Turkey performs critical steps in isolating immune cells from cattle blood instructed by APHL scientists

ZODIAC Workshop on Monkeypox Virus and Lassa Fever Infections in Animal Reservoirs and the Risks for Public Heath Transmission

Gerrit Viljoen

The Animal Production and Health Section (APH) jointly with the Technical Cooperation Department and in coordination with the international member organizations of ZODIAC, such as FAO and WHO organized the workshop on 7 June 2022.

The virtual meeting was organized as part of ZODIAC activities (TC INT5157 – Supporting National and Regional Capacity in Integrated Action for Control of Zoonotic Diseases). The purpose of the workshop was to determine the status of monkeypox virus and haemorrhagic fever caused by the Lassa virus, what is known about these viruses and how people can be infected, research actions that could be taken both locally and internationally, especially at the environment-animal-livestock-human interface, and the existing laboratory techniques for their diagnosis.

Ms Najat Mokhtar, DDG NA, welcomed the nearly 300 attendants and invited experts. IAEA DG, Mr Rafael Mariano Grossi, delivered the welcome address, followed by DDG FAO, Ms Maria Helena Samedo, and WHO Head Smallpox Secretariat, Ms Ropssamund Lewis. Mr Gerrit Viljoen presented the role of the IAEA to fight zoonotic diseases under ZODIAC.

Eight experts presented the current knowledge, actions taken and possible mechanisms for a better understanding of the epidemiology, the reservoirs, and the control of the two viruses in the human population.

The experts were Mr Norbert Nowotny (University of Veterinary Medicine, Austria), Mr Emmanuel Couacy-Nymann (Central Veterinary Laboratory, Côte d'Ivoire), Mr Fabien Leendertz (Helmholtz Centre for Infection Research, Germany), Ms Jacqueline Weyer (National Institute for Communicable Diseases, South Africa), Mr Ismaila Seck (ECTAD FAO, Senegal), Mr Baba Soumare (ECTAD FAO, Rome) Mr, Pierre Formenty (WHO), and Mr Dejan Vidanovic (IAEA).

The main conclusions and the way forward were:

- Research is needed to understand the environment-animal-livestock-human dynamics of these viruses and the trigger for spill over to humans.
- Targeted research is needed to identify and understand the role and maintenance of monkeypox virus and Lassa fever virus in the environment, especially in natural carriers, hosts and reservoirs.
- Development and validation of molecular and serological diagnostic assays is needed to detect and

confirm suspected cases and for studying the circulation of virus in reservoirs and wildlife.

- A strategy for surveillance and screening of the viruses in domestic and wildlife is needed.
- Identifying the mechanisms of transmission from animal reservoirs and carriers to humans and between humans could help to avoid exposure to the infection.
- Investigate the role of bushmeat in the spread and infection of humans in case of monkeypox virus.
- Adoption and application of biosecurity in animals and wildlife value chains.
- The IAEA and FAO are collaborating with a wide range of research institutes and national animal diagnostic laboratories to decipher the unknowns that exist in these zoonoses, especially in monkeypox virus, to react to current and future threats.

Regional Training Course on African Swine Fever Laboratory Diagnosis and Serological Screening (RER5027)

Ivancho Naletoski

Due to the rapid spread of the African Swine Fever (ASF) in the European region, the APH has initiated a training course on ASF for all counterparts in the ongoing Technical Cooperation project Enhancing Preparedness Capacities of the Veterinary Sector to Confront Emerging and Re-emerging Diseases of Livestock and Wildlife (RER5027).

The training course took place at the Faculty of Veterinary Medicine, Veterinary Institute in Sarajevo, Bosnia and Herzegovina from 13 to 17 June 2022.

The scope of the training course was as follows: a) presentations on etiology, pathogenesis, clinical signs, epidemiology and control of ASF and CSF; b) practical classes on sampling, sample transportation/preparation, the most updated molecular (PCR), serological (ELISA) and other related techniques for detection and screening of ASF (and CSF for differentiation); and c) practical classes on the use of the free-of-charge sequencing services for Member States established by APH.

The training course was conducted by the international experts from the national reference laboratory for ASF in Germany, the Friedrich Loeffler Institute at the island Riems, Germany (Acknowledgement to Dr. Sandra Blome and Dr. Ulrike Kleinert).

Participants at the Faculty of Veterinary Medicine, Veterinary Institute in Sarajevo, Bosnia and Herzegovina

Virtual Workshop on Neglected Zoonotic Diseases (RER5025)

Ivancho Naletoski

Following the request of the counterparts in the Technical Cooperation project Improving Early Detection and Rapid Response to Potential Outbreaks of Priority Animal and Zoonotic Diseases (RER5025) the APH organized a virtual workshop on neglected zoonotic diseases from 20 to 24 June 2022.

The event focused on the following priority diseases: tick-borne encephalitis (TBE), Mediterranean spotted fever (Boutonneuse Fever, MSF), Lyme borreliosis, tularemia, anaplasmosis, dirofilariasis, piroplasmosis, besnoitiosis and leishmaniasis.

The experts for each of the priority diseases presented general information about the neglected zoonotic diseases (etiology, epidemiology, clinical signs, pathological findings, diagnostics, treatment and control measures), and described current trends in the geographical distribution, diagnosis and control measures. Furthermore, the experts gave an overview of the modern diagnostic approaches, and shared knowledge about the appropriate diagnostic procedures. Each of the workshop sessions was followed by a 15-minute Q&A session.

Based on the interest of the participants, the APH is considering initiating a training course for neglected zoonotic diseases with practical demonstration and exercise on the diagnostic procedures used for each of the diseases.

Stories

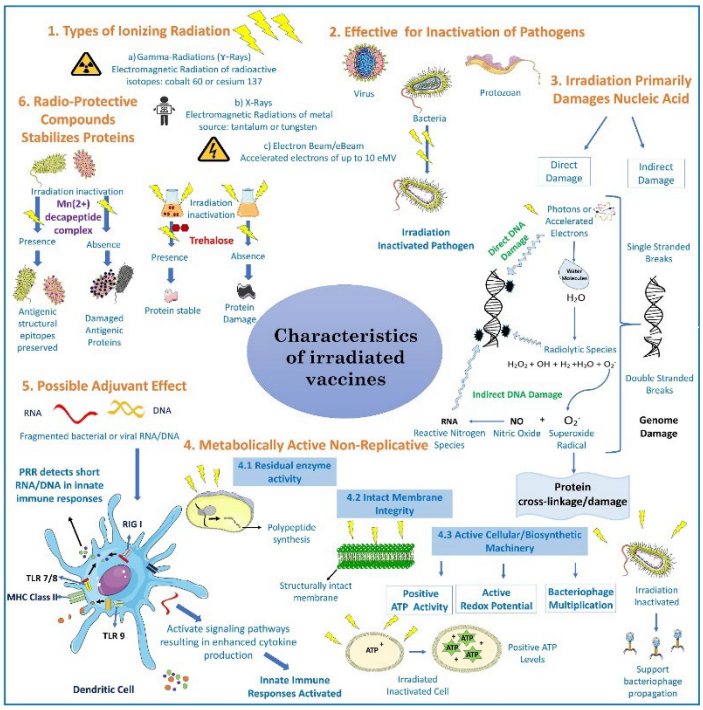
Irradiation of Transboundary Animal Disease (TAD) Pathogens as Vaccines and Immune Inducers (D31033)

This Coordinated Research Project (CRP) started in early 2017 to continue exploring the possibilities of using irradiation in the development of vaccines. The project is built on the noteworthy results of the preceding CRP on the subject, yielding especially strong outcomes on irradiated intestinal and haemo-parasites as vaccine candidates. However, a major shortcoming of the initial CRP was the lack of proper immunological tools to define the elicited immune responses. This issue was addressed by establishing immunology research and development at the APH Laboratory in 2015. Since then, efforts have been made to develop assays and reagents to monitor the immune responses induced by irradiated vaccines, especially in cellular immunology.

This is an area that has been neglected in livestock immunology but is of immense importance. Six research contract holders (RCH) participated in this CRP working on various parasitic, bacterial and viral diseases coming from Asia and African regions. Among them the irradiated avian flu vaccine which was developed by Iran achieved much success. This RCH showed the gamma irradiated flu vaccine could prevent the occurrence of low pathogenic avian flu in broiler chickens and the protection achieved is superior to the traditional formalin killed vaccine (https://doi.org/10.1002/vms3.680).

Completing these findings, a technical contract holder (IZSVe, Italy) conducted animal trails for the APHL and confirmed the protection induced by the gamma irradiated flu vaccine and showed its potential use as a mucosal and a DIVA (differentiating infected from vaccinated animals) vaccine (publication accepted in Frontiers in Veterinary Science). Among candidate vaccines for bacterial diseases, the research which was done by Ethiopian and Egyptian counterparts showed considerable protection for avian salmonellosis (DOI: 10.4314/evj.v24i2.8) and *Mannheimia haemolytica* in sheep (doi: www.doi.org/10.14202/vetworld.2022.1261-1268).

The irradiated vaccine developed against Haemonchosis in goats achieved very good results. Currently, a large field trial is being conducted involving 240 goats. The APHL produced a technical report compiling results from this CRP and other irradiated vaccine and published in a high-impact peer reviewed journal: Advances in Irradiated Livestock Vaccine Research and Production Addressing the Unmet Needs for Farmers and Veterinary Services in FAO/IAEA MS (https://doi.org/10.3389/fimmu.2022.853874). This publication discusses the characteristics of irradiated vaccines as discovered through this CRP and other research.



Characteristics of irradiated vaccines (https://www.frontiersin.org/articles/10.3389/fimmu.2022.853874/full)

New Communication Contact Point for One Health of the Joint FAO/IAEA Centre

The new communication contact point of the Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture for One Health in the FAO is Carla Bravo de Rueda, veterinarian and virologist.

One Health is an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems. The approach recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent. The global impact and response to the COVID-19 pandemic, a human health crisis caused by a virus passed from animals, highlighted the need for coordinated action across sectors to protect health and prevent disruption to food systems.

The role of the new communication contact point is to support the activities of the FAO One Health Technical Working Group while collaborating with a myriad of partners to enhance the visibility of FAO One Health outputs internally and externally.

"Communication and dissemination of the One Health approach within the FAO's One Health family is an integral part for tuning our multidisciplinary divisions' work to foster well-being and to tackle threats to animals, humans and plant health as well as ecosystems. I am looking forward to intense collaboration with internal and international stakeholders to strengthen coordination in dissemination of information on the Joint FAO/IAEA

Centre of Nuclear Techniques in Food and Agriculture involvement in One Health activities. I feel that by showcasing the synergies within the FAO's One Health family we are able to maximize the impact of the One Health mission," says Carla Bravo de Rueda.

For more on the One Health: https://www.fao.org/one-health/en/

Sequencing Pathogens to Support Animal Disease Control

In 2019, an outbreak of foot-and-mouth disease (FMD) and an ineffective vaccine put an untold number of cattle, sheep, pigs, goats and other cloven-hoofed livestock in Morocco at risk. A highly contagious viral disease, FMD causes fever and vesicles in the mouth and on the feet of infected animals. This can lead to lameness and other symptoms, making the animals unfit for consumption, causing losses for farmers. The end of the outbreak began with a genetic comparative analysis that resulted in the selection of a different vaccine – a solution made possible thanks to IAEA support to local authorities, in partnership with the Food and Agriculture Organization of the United to Nations (FAO), in building capacity in advanced molecular techniques.

To date, the sequencing service has received over 4200 samples and sequences for 54 different animal diseases (such as FMD and African swine fever) and zoonotic diseases (such as rabies, brucellosis and Rift Valley fever). The scientists that contribute to the sequencing service network's database come from 25 laboratories around the world and rely on the service to perform genetic sequencing.

"Purchasing a machine makes sense for laboratories that have very large loads to process, but it is uneconomical for most country laboratories," said Naletoski. "We're helping small laboratories in poorer countries avoid the capital costs by offering the resources to work with established sequencing companies and obtain the same information as if they had the sequencing hardware locally."

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Stopping Pig Black Death – African Swine Fever

Looking back at 2018 might bring back memories of South Korea's Winter Olympic Games or the British royal wedding of Prince Harry and Meghan Markle, but for pig farmers in China, the year was marked by a single event: the arrival of African swine fever (ASF). That year, the disease – once endemic to only sub-Saharan Africa – broke out among Chinese piggeries, resulting in the death or culling of over a quarter of the world's domestic pig population. A year after its appearance, ASF was estimated to have directly cost China over a trillion yuan (US $141 billion) according to the dean of the College of Animal Science and Technology at China Agricultural University in Beijing and caused the country's pork prices to spike by 85 per cent.

While China, the world's second largest economy, has been able to weather the ongoing ASF outbreak, not all countries are able to do so. The IAEA, in collaboration with the Food and Agriculture Organization of the United Nations (FAO), is working closely with China, as well as with Cambodia, Indonesia, Malaysia, Mongolia, Myanmar, Thailand and Viet Nam in Asia, and Burkina Faso, Mali, Namibia, Nigeria and Senegal in Africa, in using nuclear techniques to create early detection mechanisms for ASF and to control its spread - saving pigs and farmers' livelihoods.

With no vaccination or treatment available for ASF, early detection is essential in controlling it. "Enabling laboratories to detect ASF as soon as possible is the most efficient way to take appropriate measures in containing the virus before it spreads further within a country or even to new countries," Charles Lamien said. Nuclear techniques allow scientists to detect and trace where the virus originates and determine how it's transmitted.

Since 2012, the FAO/IAEA Animal Production and Health Laboratory has been working on ASF, developing what's called syndromic surveillance tools — the collection, analysis and interpretation of data to provide an early warning system for the disease — as well as characterizing the virus from different countries. There are currently 24 known variants of the ASFV. Understanding their different characteristics allows experts to determine how outbreaks of ASF are linked, if they have previously been detected in a country, and where they may have originated.

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Strain of Foot and Mouth Disease in Tunisia Identified in Record Time with IAEA/FAO Support

Earlier this year, a virology laboratory in Tunisia received the oral samples of cows suspected by veterinarians of having foot and mouth disease (FMD). FMD is a highly contagious disease that affects cloven-hoofed animals, such as cows, pigs and goats, and it can lead to the disruption of regional and international trade of animals and animal products. The disease is characterized by fever and blister-like sores between the hooves, in the mouth and on the tongue and lips.

Within days of submitting the samples to a genetic sequencing service, Soufien Sghaier, a virologist at the Virology Laboratory at the Institute of Veterinary Research of Tunisia (IRVT), received results that helped confirm the circulating strain of FMD. Sghaier was able to notify veterinary authorities to implement control measures to prevent the disease from spreading. The timely confirmation was made possible by the IAEA, in partnership with the Food and Agriculture Organization of the United Nations (FAO), which facilitates the sequencing service and provides the training needed to process the results.

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ZODIAC Helps Labs Prepare for Early Detection of Future Pandemics

When there is an outbreak of a zoonotic disease – an animal disease that can spill over from animals to humans, for example Ebola, Zika or COVID-19 – it is important to identify and characterize the causative agent quickly. A new IAEA initiative launched last year helps laboratories around the world to further enhance their capabilities and prepare to do exactly that with the use of nuclear and related techniques.

A virtual training course, organized by the IAEA in partnership with the Food and Agriculture Organization of the United Nations (FAO) late last month, focused on training laboratory technicians and experts in improving their testing procedures by aligning them with those of global veterinary diagnostic reference laboratories.

For more than five decades, the IAEA has been transferring technologies to laboratories worldwide in the use of veterinary diagnostic techniques. These include nuclear and related serological and molecular technologies (such as ELISA and PCR) for the early and rapid detection and characterization of transboundary animal and zoonotic pathogens.

"Before implementing any disease-detecting technique, laboratories need to ensure that a series of technical parameters are verified, so as to certify that the techniques are performing according to their intended purpose and at levels and margins expected from the reference laboratory," said Ivancho Naletoski, a technical officer at the Joint FAO/IAEA Centre of Nuclear Techniques in Food and Agriculture.

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Always on Alert - The IAEA's Record in Tackling Zoonoses Globally

In 2005, following a spate of African swine fever outbreaks in the Democratic Republic of the Congo, Gerrit Viljoen, working for the Food and Agriculture Organization of the United Nations (FAO) and the IAEA, visited a piggery outside Kinshasa. Viljoen was there to train local scientists in disease sampling techniques and prepare them for potential outbreaks. What he witnessed still preys on his mind.

Over a dramatic three days, the highly contagious swine pathogen causing the disease swept through the farm, killing all of its 5000 pigs. As tragic as that outbreak and the devastation it wrought on livelihoods were, African swine fever fortunately stops at pigs and does not infect people. But that's not true for all animal diseases. Many of today's most contagious and deadly infectious diseases – seven out of every ten – originate from animals. We call them zoonotic diseases or zoonoses.

By providing training, equipment, chemical reagents and technical expertise, the IAEA, in partnership with the FAO, has contributed to bringing some of the world's most dangerous and damaging diseases, including COVID-19,

under control. The IAEA's response to the ongoing pandemic is the latest in a string of efforts to combat zoonoses, including Zika, severe acute respiratory syndrome (SARS), Middle East respiratory syndrome (MERS), Rift Valley fever, avian influenza, brucellosis and Ebola.

Click here to read more

Strengthening the Capacity of Official Laboratories for Monitoring and Response to an Outbreak of Priority Animal and Zoonotic Diseases (ARCAL CLXXIV)

APH staff was mentioned in social media regarding their efforts to improve regional capabilities. The project has been launched successfully and is gaining a lot of interest across the region.

"The IAEA RLA5085 project will support participating member countries with specialized training, also providing technical support to their laboratories, to promote early detection of animal and zoonotic diseases such as avian influenza, Newcastle disease, classical swine fever, African swine fever, and brucellosis. In this framework, our interest is to motivate the region to strengthen its ties regarding activities consistent with the control of animal health. Our goal is to get each of the participating laboratories to strengthen their diagnostic techniques, considering international quality standards and share their successful experiences with other laboratories in the region, strengthening the region in unison" said Carla Bravo de Rueda, technical officer for animal health.

The article also mentions APH activities such as ZODIAC, the iVetNet platform and how APH could help these countries harmonizing their laboratory techniques for the detection and characterization of animal and zoonotic diseases.

The article has been shared on Facebook, Twitter and LinkedIn. Full article (in Spanish) can be found here: Laboratorios de la región inician cooperación para enfrentar brotes de enfermedades animales y zoonóticas | ARCAL (www.arcal-lac.org)

Empowering Rural Women in Sri Lanka's Dairy Industry

In Sri Lanka, women play a critical role in driving rural communities' economic development and ensuring food security. According to the Food and Agricultural Organization of the United Nations (FAO), Sri Lanka is largely self-sufficient in animal products except in dairy, where national consumption has steadily grown since the 1970s, outpacing supply. Boosting dairy production in the country will help empower women in rural areas and improve the country's self-reliance.

The Department of Animal Production and Health, Faculty of Veterinary Medicine and Animal Science at Peradeniya, Sri Lanka through the TC Project SRL5046 is assisting farmers, especially in the northern part of the country with embryos of superior genetic quality that are transferred to local crossbred cows.

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Strengthening Disease Detection Across Countries with iVetNet

iVetNet is an information platform run and maintained by the IAEA, in full cooperation with the Food and Agriculture Organization of the United Nations (FAO), for compiling, disseminating and harmonizing techniques for the detection and characterization of transboundary animal and zoonotic pathogens. Through the sharing of disease detection procedures, results where applicable and other technical data, the platform aims to support responses by the FAO and the World Organisation for Animal Health (WOAH) to animal and zoonotic disease outbreaks. Launched in 2021, iVetNet will bring together over 1000 laboratories across the globe and offer its users access to information and validated and verified procedures for the detection and characterization of animal and zoonotic pathogens, such as foot-and-mouth disease, African swine fever, lumpy skin disease, Ebola, Zika, COVID-19 and others.

Click here to read more.

Study Proves Effectiveness of Alternative Test Kits for COVID-19

The primordial days of the COVID-19 outbreak led to a rapid surge in demand – and subsequent shortage – of many consumables, from household goods and protective equipment to the ingredients and substances needed to test for the virus. As the world grappled with the newfound need to mass-test for COVID-19, laboratories turned to real-time reverse transcription-polymerase chain reaction (real-time RT-PCR). Real-time RT-PCR is the most accurate laboratory method to detect, track and study COVID-19; however, its widespread use strained resources and led some laboratories to seek more readily available and cheaper alternatives.

A study to test the performance and quality of some of these alternative resources was recently conducted by the IAEA and the Food and Agriculture Organization of the United Nations (FAO), in collaboration with the Austrian Agency for Health and Food Safety (AGES). Its results have implications for the ongoing fight against COVID-19 in developing countries and beyond.

The procedures and results of the study have been shared with the IAEA Veterinary Diagnostic Laboratory (VETLAB) Network, in which some labs have been requested by national authorities to provide testing for COVID.

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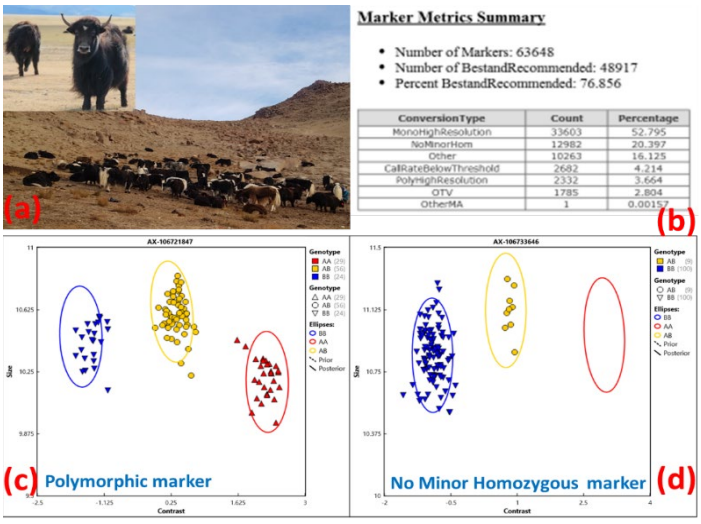
Research Activities of the Animal Production and Health Laboratory

Animal Genetics

Testing and Validation of Bovine Specific Single Nucleotide Polymorphic (SNP) Markers for Genomic Evaluation of Yak

Yak (*Bos grunniens*) is an agriculturally important species of domestic animals that supports livelihood of people living at high altitude environments. Yaks have developed physiological and anatomical adaptations to survive hypoxic conditions of high altitude and foraging in extremely cold conditions. They are raised mostly in the Himalayan region including India, Pakistan, China, Bhutan, Myanmar including North of Himalayas as far as Mongolia and Siberia. Yaks provide important products such as meat, milk, transport and hide (for protective clothing and tent preparation). Availability of genomic tools and resources are very limited for yaks.

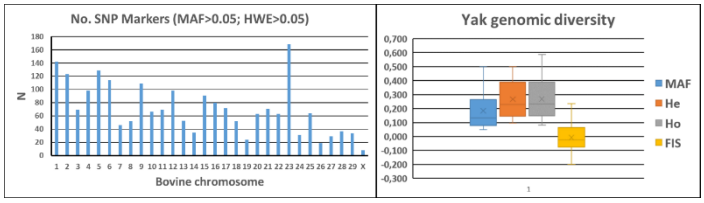
The Animal Production and Health Laboratory (APHL) of the Joint FAO/IAEA Division in collaboration with the Research Institute of Animal Husbandry (RIAH) initiated the testing and validation of bovine specific single nucleotide polymorphic (SNP) markers for genomic evaluation of yak.



(a) Mongolian yak (b) Marker metric summary of yak genotyping (c, d) sample SNP cluster-plots

A total of 231 samples of yak located in four different provinces (Arkhangai, Khovd, Khuvsgul and Umnugovi) were collected. Of these, 111 samples were genotyped on Affymetrix Axiom BovMDv3 array that consisted of 63648 cattle specific SNP markers. The results revealed ~24% of SNP markers (>15300) were polymorphic in yak while 52.8% of the markers (>33600) were monomorphic.

Among those polymorphic markers, the majority of them (>12000) showed a very low minor allele frequency (MAF<5%). Hence, the genotype data were further pruned for MAF and significant Hardy-Weinberg deviations, resulting in identification of 2110 markers suitable for genomic evaluation of yak. Distribution of these markers across different bovine chromosomes are given below:

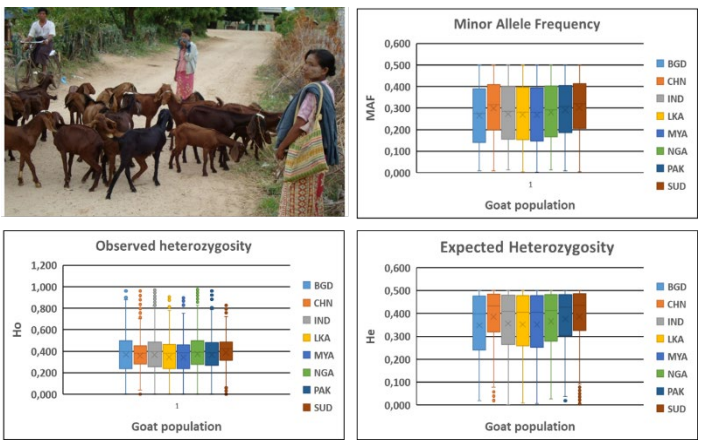


Chromosome wise distribution of potential SNP markers for evaluation of yak (left); Genomic diversity of Mongolian yak (right)

The minor allele frequency ranged from 0.051 to 0.500 with a mean of 0.184 across these markers. The mean observed and expected heterozygosity in Mongolian yak population was 0.269 and 0.267 respectively. Estimation of inbreeding coefficient revealed mean negative F_{IS} of -0.008 and varied between -0.199 and 0.236. The overall results of the study indicated the potential suitability of around 2100 bovine specific SNP markers for genomic evaluation of yak.

Testing Commercial Goat SNP Array for Genomic Evaluation of Indigenous Asian and African Goat

When SNPs selected for designing and developing an array are ascertained from only select breeds/populations, an ascertainment bias occurs that can affect inferences about larger and distinct populations. Sub-population bias can inflate the heterozygosity estimates in populations closely related to the SNP discovery panel. It may also increase or decrease the estimates of F_{ST} as compared to the expected estimates from unbiased data, thus obscuring information on population differentiation.



Genomic diversity of indigenous Asian and African goat populations

APHL initiated the testing of commercial goat SNP array to estimate the level of ascertainment bias and assess their suitability for genomic evaluation of indigenous Asia and African goat breeds. A total of 633 goats belonging to 18 indigenous breeds located in eight countries (Bangladesh, China, India, Sri Lanka, Myanmar, Nigeria, Pakistan and Sudan) were genotyped on Affymetrix-Axiom-Goatv1 array. The results revealed more than 38000 polymorphic markers in Asian and African goat with overall mean MAF, observed and expected heterozygosity estimated to be 0.305, 0.389 and 0.347 respectively.

The observed heterozygosity varied between 0.343 (Myanmar goat) and 0.388 (Sudanese goat) while expected heterozygosity ranged from 0.348 (Bangladeshi goat) and 0.387 (Sudanese goat). The overall diversity observed in Asian and African goat was comparable to European goat breeds (e.g., Italian goat breeds). Genotyping of additional Asian, African and European goat breeds is currently ongoing to assess the ascertainment bias and diversity.

Genomic Characterization of Cashmere Goat Populations of Mongolia

Mongolia is the second top producer of Cashmere fibers next to China. There are several indigenous Cashmere goat populations in Mongolia. Under IAEA Technical Cooperation Project MON5025 "Improving breed characterization of Cashmere goats to facilitate the establishment of strategic breeding program", various fiber quality parameters (fiber length, fiber thickness, greasiness, etc.) were recorded on 2035 goats of 11 breeds and four non-descript populations.

Fig 4. Indigenous Cashmere goat population of Mongolia

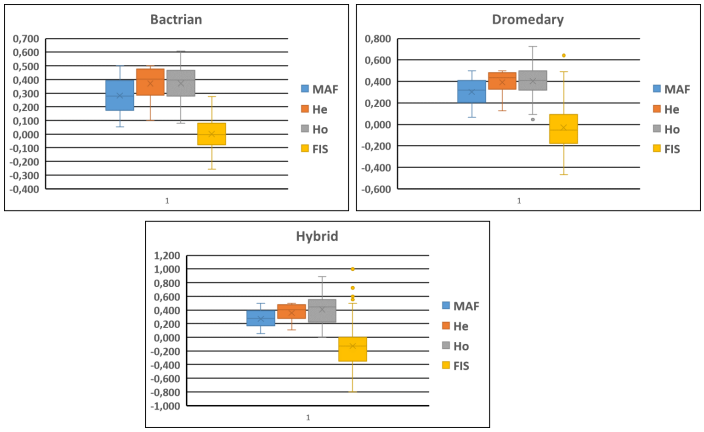
Of these, 1358 blood samples from 14 goat populations were utilized for genotyping. All the samples were sent to Animal Production and Health Laboratory, FAO/IAEA division, Seibersdorf, Austria for genome wide typing. Genotyping of all the goat samples were completed on Affymetrix-Axiom platform (Goat Genotyping v1 Array that contains 58655 SNP markers).

Upstream analysis of raw signal data files and extraction of genotypes date were completed. Although the SNP ascertainment panel used to design the array did not include Mongolian goat populations, genotypes at ~41K SNP loci were generated successfully. About 38K markers were fully polymorphic and showed all the three possible genotypes while ~1.8K markers did not show homozygous genotypes of minor allele. Further downstream analysis of data is under progress to estimate genomic diversity, level of inbreeding, genetic admixture, population structure and selection signatures related to fiber characteristics and adaptability traits.

Genomic Evaluation of European Bactrian, Dromedary and Hybrid Populations

APHL in collaboration with Altweltkamele e.V initiated genomic analysis of European Bactrian, Dromedary and Hybrid camels. The purpose of this collaborative study is to utilize genomic information (genome wide SNP genotypes) for individual animal identification, paternity testing, estimation of inbreeding and inference of genetic diversity. In the absence of stud books, Altweltkamele e.V intends to use this information to formulate effective strategies for preventing inbreeding and its negative consequences.

A total of 106 camel including 75 Bactrian, 22 Dromedary and 9 Hybrids were genotyped using multi-species camelid array on Affymetrix Axiom platform. The preliminary results revealed overall mean MAF, expected heterozygosity, observed heterozygosity and estimated inbreeding of 0.281, 0.372, 0.371 and 0.001 respectively. Similarly, the estimated mean values of these parameters for dromedary were 0.302, 0.392, 0.403 and -0.030 respectively while for hybrids the estimations were 0.269, 0.356, 0.409 and -0.128 respectively. Further analysis is currently under way.



Genomic diversity indices in European Bactrian, dromedary and Hybrid camels

Animal Health

Syndromic Surveillance of Zoonotic Diseases

Syndromic surveillance of respiratory viral pathogens in clinical samples

Respiratory infections caused by viruses, are among the most common global infectious diseases. They are primarily confined to the upper respiratory tract, causing symptoms such as coughing, fever, runny nose, sneezing, and sore throat, but can also infect the lower respiratory tract leading to complications such as pneumonia and bronchiolitis. The majority of these viruses originate from animal reservoirs/hosts and cross the species barrier causing a spill over to humans. Therefore, there is a need for effective, versatile, and relatively inexpensive tools for rapid detection and identification of respiratory infecting viruses through syndromic surveillance in specific animal species to help prevent the spill over. The Animal Health and Production Laboratory has designed and evaluated a syndromic surveillance assay for Alpha- and Beta-Coronaviruses and influenza type A and D Orthomyxoviruses by integrating multiplex RT-PCR and nanopore sequencing technology.

The optimized multiplex RT-PCR conditions showed the expected PCR products of an upper band (~200 bp) representing Coronavirus and Influenza D virus, a lower band (~166 bp) for Influenza A virus, and no band on the negative control. Further processing of the PCR products by nanopore sequencing technology using a portable MinION sequencer, did not only identify and confirm the multiplexed viruses but it also verified its detection specificity.

In addition, the analysis of the nanopore generated sequences is simple and quick using a user friendly nanopore technology EPI2ME software that was compared to minimap2 program analysis. In conclusion, we have developed a rapid syndromic surveillance assay for respiratory viruses that is cost effective, quick, and applicable for field diagnostics.

Syndromic surveillance of zoonotic abortifacient agents in in clinical samples

Abortifacient pathogens induce substantial economic losses in the livestock industry worldwide, and many of these pathogens are zoonotic, impacting human health.

Brucella spp., *Leptospira* spp., *Listeria monocytogens* and *Coxiella burnetii* are leading causes of abortion in ruminants, requiring a rapid differential molecular test for an accurate diagnosis to enable the implementation of effective control measures.

A multiplex HRM assay developed earlier at APHL to detect these four zoonotic bacteria was further evaluated for its cross-platform compatibility and used to directly detect bacterial pathogens in clinical samples.

The results indicated that the assay could easily be performed on the CFX96 Touch Real-Time PCR Detection System (Bio-Rad Laboratories), LightCycler® 480 Real-Time PCR Systems (Roche), and QuantStudio™ 6 Flex Real-Time PCR System (Life Technologies).

Furthermore, using the assay on a hundred and fifty-one culture and clinical samples enabled *Brucella* spp. to be detected in 17 samples, *Coxiella burnetii* in 42 samples, Leptospira spp. in 11, and *Listeria monocytogenes* in five samples.

In addition, co-infections with *Brucella* spp. and *Coxiella burnetii* were detected in forty-five samples.

This assay will be very suitable for investigating the cause of abortions in ruminants and other animal species.

COVID-19 in Animals

Comparison of LIPS and ELISA laboratory assays to detect antibodies against SARS-CoV-2 in Mink

To investigate the accuracy of Nucleo (N) or Spike (S) protein-based assays to reveal the presence of SARS-CoV2 antibodies in animal serum, APHL compared four assays, two commercial N-based enzyme-linked immunosorbent assays (ELISA) validated for animal sera and two luciferase immunoprecipitation systems (LIPS-N, LIPS-S), with Plaque Reduction Neutralization Test (PRNT).

Since anthropo-zoonotic outbreaks have only been reported in mink farms to date, samples tested derived from a naturally infected mink population. The assays were compared by performing a correlation analysis using Pearson's coefficient, Fleiss' and Cohen's kappa for analysis of agreement with PRNT and an UpSet chart was created to visualize the number of shared positive samples between assays.

Cohen's kappa test on categorical data showed excellent strength of agreement between PRNT and LIPS-S, while agreements between PRNT and N-based methods decreased from fair for LIPS-N to poor agreements for the ELISA kits (table below). In addition, LIPS-S revealed the highest number of true positive SARS-CoV-2 samples compared to N-based methods.

Cohen- Kappa					
Method	LIPS-S	LIPS-N	PRNT	IDV	Eradikit
LIPS-S	1	0.2845	1	0.08501	0.162
LIPS-N	0.2845	1	0.2845	0.4267	0.56
PRNT	1	0.189	1	0.08501	0.162
IDV	0.08501	0.4267	0.08501	1	0.414
Eradikit	0.162	0.56	0.162	0.414	1

Cohen kappa agreements between LIPS-S, LIPS-N, PRNT, IDV, and Eradikit

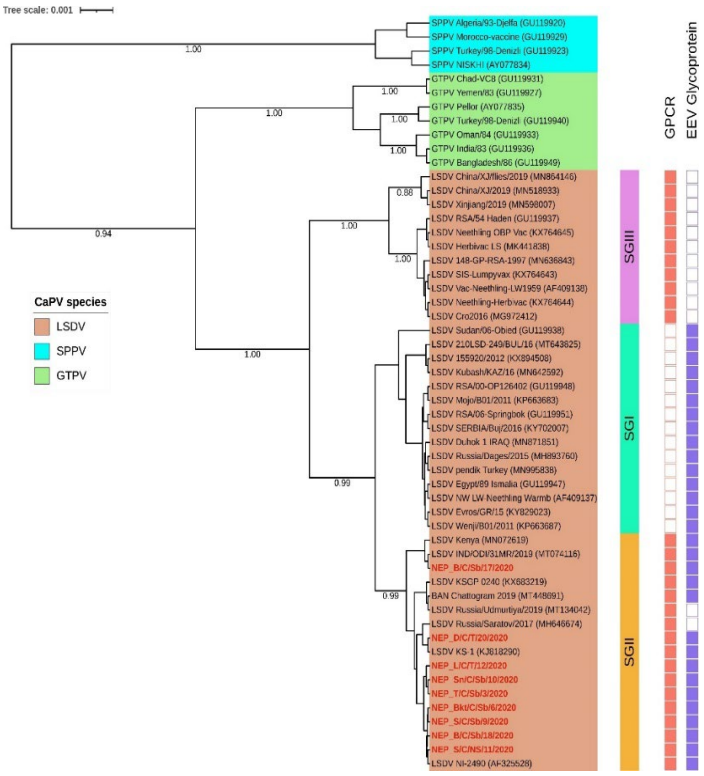
Despite an excellent qualitative agreement between LIPS-S and PRNT, no correlation was detectable between PRNT-titres and relative light units from LIPS-S. This study shows that the LIPS-S assay can be used for serological surveillance within a naturally exposed mink population, while N-based serological assays are less accurate providing higher number of false negative results.

Molecular Characterization of Lumpy Skin Disease from Recent Outbreaks

Asia (Nepal, Myanmar, Indonesia, and Mongolia)

Lumpy skin disease (LSD) is a transboundary viral disease of cattle and buffaloes transmitted by blood-feeding vectors and causes high morbidity and low-to-moderate mortality. Since the 2000s, LSDV has spread from Africa to several countries in the Middle East, Europe, and Asia, including several south-east Asian countries, starting in 2019.

Bangladesh, Nepal, Bhutan, Myanmar, Indonesia, and, more recently, Indonesia are Asian countries that received support for diagnostic confirmation and molecular characterization of the local isolates. While most countries experienced LSD mainly in cattle, Nepal also reported the disease in buffaloes and submitted samples to APHL. The collected samples were first tested for the presence of LSDV by real-time PCR. We further applied molecular tools, RPO30, GPCR, EEV glycoprotein gene, and B22R, for additional characterization of the LSDV isolates.



Maximum clade credibility (MCC) tree based on the complete RPO30 gene sequences of CaPVs with LSDVs from Nepal (in red) visualized on iTOL, together with isolates clustering based on the presence (filled box) or absence (empty box) of sequence insertion in the GPCR and the EEV glycoprotein genes.

The molecular characterization result showed that the Bhutan, Nepal, and Myanmar LSDV sequences clustered with LSDV isolates from Bangladesh and India, implying a common introduction source. They were also identical to LSDV Kenya and LSDV NI-2490, two historical LSDV strains collected in Kenya before the 1960s.

Contrasting with the findings in Nepal, Bhutan, and Myanmar, the analysis of the samples from Mongolia and Indonesia revealed more similarity to recombinant-like LSDVs described in China, Hongkong, and Vietnam. These findings inform the diagnosis and development of control strategies, shedding light on the strategies to differentiate vaccine viruses from field viruses circulating in each of these countries. The findings on LSDV in Nepal and Myanmar have been recently published (Microorganisms 2022, 10(3), 539; https://doi.org/10.3390/microorganisms10030539 for Nepal and Microorganisms 2022, 10(5), 897; https://doi.org/10.3390/microorganisms10050897 for Myanmar).

In addition, APHL has received and processed samples from Nigeria, Uganda and Lesotho. The sequencing of the RPO30, GPCR, EEV glycoprotein gene, and B22R revealed that all the LSDV samples from these countries had the common LSDV field virus profile.

Molecular Characterization of African Swine Fever Viruses

APHL supported BKF, Nigeria and Cote d'Ivoire in characterizing ASFV isolates from recent outbreaks (2019-2021). The characterization of the isolate based on both p72, p54, 9 RL and CD2v showed the introduction of ASFV genotype II, serogroup 8 which is now co-circulated with genotype I serogroup 4 in all these countries. Furthermore, APHL received wild boar samples and sequenced the whole genome confirming ASFV genotype II closely related to ASFVs circulated in China.

Highly Pathogenic Avian Influenza (A/H5N1) Virus Outbreaks in Lesotho and other African Countries (2021 -2022)

On 28 May 2021, the death of 300 (10%) layer chickens in a farm of 3000 layers (Farm A) located in Ha Penapena, Maseru District, Lesotho was reported to the Central Veterinary Diagnostic Laboratory (CVDL) in Maseru, Lesotho. The farmer confirmed that the 3000 point-of-lay chickens had been recently sourced from a poultry supplier located in the Free State province of neighbouring South Africa. The chickens started dying shortly upon arrival from South Africa. On 1 June 2021, a second farm (Farm B) located at Mahobong, Leribe district, reported high mortality (5%) in 2000 chickens which were also recently sourced from the same supplier in South Africa as Farm A.

Nasopharyngeal samples were collected from both farms for further analysis.

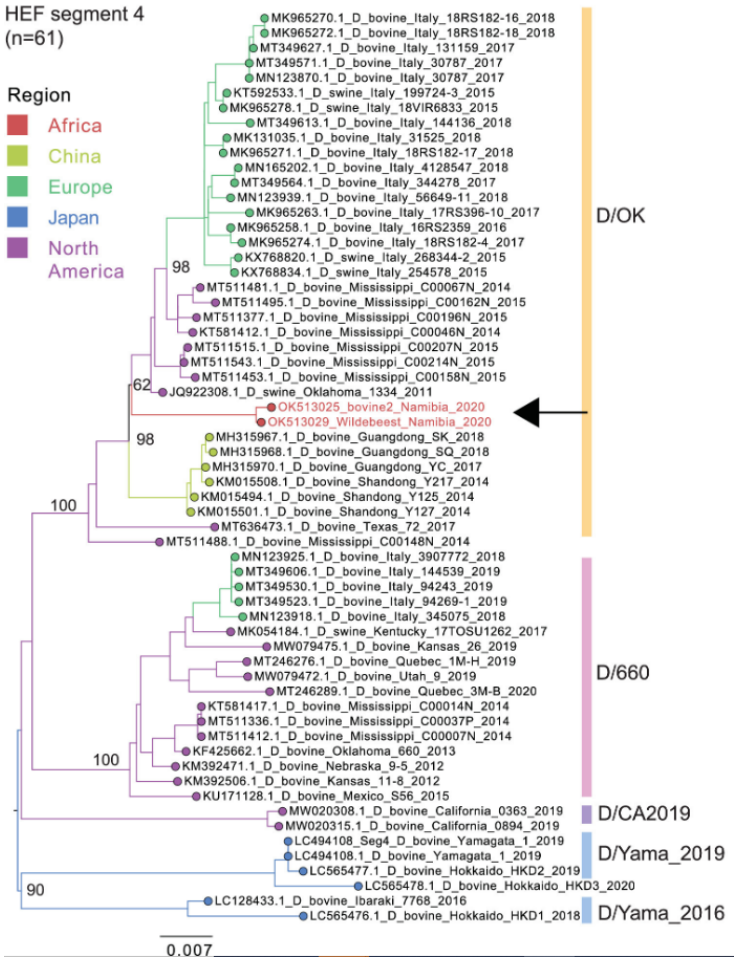
Twelve samples from Farm A and ten samples from Farm B were confirmed positive for influenza A using standard protocols. Full genome sequencing analysis was performed on two positive samples and revealed that both viruses belonged to subclade 2.3.4.4b and that they were very similar (98.93–99.93% nucleotide identity) to A/H5N1/H5N8 viruses identified in Nigeria and Senegal in 2021. The cleavage site of the HA was PLREKRRKRGLF confirming that the viruses were highly pathogenic. In addition, the HA protein possessed QRG motif (positions 222–224 -H5 numbering) at the receptor-binding site indicating a preference for avian-like α2-3 receptors.

In conclusion, this is the first characterization of an HPAI virus from southern Africa in 2021 and has important implications for the management and control of the disease in the region.

In addition, full genome sequences have been generated from samples received from Botswana (2021), Guinea (2022), Mauritania (2022) and Namibia (2022). Data is being analysed and compiled for publication.

Identification of Influenza D Virus in Namibia

In Africa, there is limited data on the epidemiology of Influenza D virus (IDV) and, so, the presence of IDV among domestic ruminants and wild animals in Namibia was investigated by screening nasal swabs using an IDV-specific molecular assay. IDV RNA was detected in bovines (n=2), giraffes (n=2) and wildebeest (n=1). The hemagglutinin-esterase-fusion (HEF) gene from one of the bovine and the wildebeest samples was successfully sequenced as well as the full genome for the second bovine sample. Phylogenetic analysis of the HEF gene positioned that the African virus variants within the D/OK lineage (Fig X). The African variant had an amino acid diversity of 2.41% and most likely represents a distinct genotype within the lineage. Notably, the polymerase acidic protein gene (PA) was more closely related to a different lineage (D/660), indicative of potential reassortment. This is the first genetic characterization of IDV in Africa and it adds important data to our understanding of the global IDV distribution.



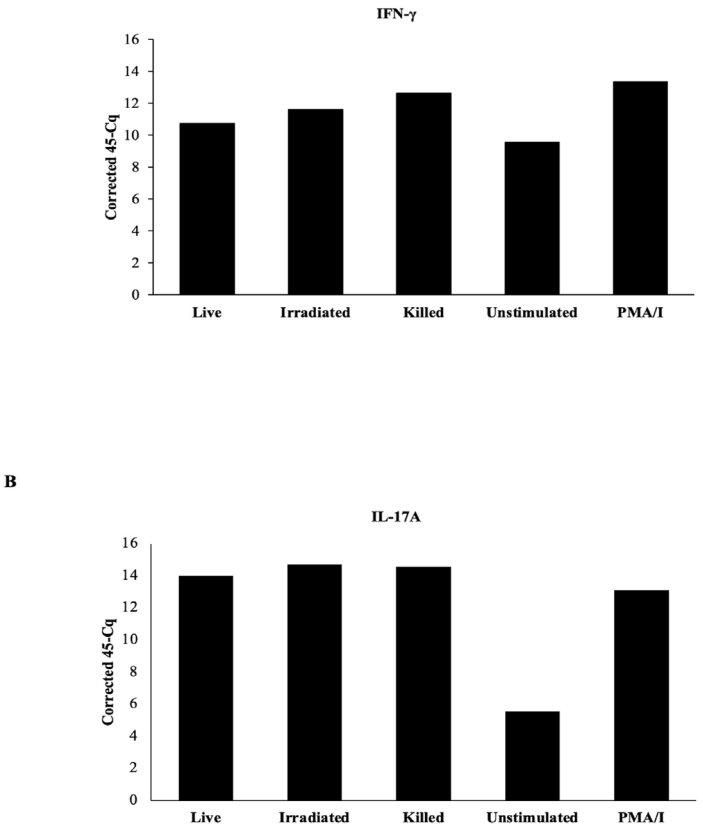
Maximum likelihood tree of IDV HEF nucleotide sequences

Irradiation to Develop Novel Vaccine Prototypes

Irradiated *Escherichia coli* is immunogenic and can be used as vaccine candidate against colibacillosis in chickens

Escherichia coli causes colibacillosis in chickens, and attentions have been focused on developing prophylactic measures rather than treatment of the disease due to concerns on antibiotic resistance and public health. Colibacillosis has different clinical manifestations and associated with compromised animal welfare and results in substantial economic losses in poultry production worldwide. immunological mechanisms of protection against colibacillosis are not comprehensively resolved.

APHL collaborated with the University of Veterinary Medicine Vienna to investigate if irradiated *E. coli* has the potential to induce immunity in order to use it as a vaccine candidate. As the first step of these experiments, a series of experiments were conducted to identify the irradiation dose that is needed to inhibit the replication of *E. coli* which was identified as 1200 Gy. Such irradiated *E. coli* was found to preserve metabolic activity while being replication incompetent (NL). In the next step, the immunogenicity of irradiated *E. coli* was assessed.



Relative gene expression of IFN-γ and IL-17A. Expression of IFN-γ (A) and IL-17A (B) mRNA determined by RT-qPCR in splenocytes after 4h stimulation with live, irradiated and killed E. coli as well as PMA/ionomycin. The results are expressed in 45-Cq values after normalization with reference genes. (Production of interferon gamma and interleukin 17A in chicken T-cell subpopulations hallmarks the stimulation with live, irradiated and killed avian pathogenic Escherichia coli, Developmental & Comparative Immunology, Volume 133, 2022. https://doi.org/10.1016/j.dci.2022.104408)

To perform this investigation, the immunogenicity of irradiated E. coli was investigated in-vitro using chicken mononuclear cells in comparison to live and formalin-killed (killed) E. coli. For this purpose, an 8-color flow cytometry panel was set up to target viable chicken immune cells including CD45+, CD8α+, CD4+, TCR-γδ+, Bu-1+ cells and monocytes/macrophages along with the cytokines interferon gamma (IFN-γ) or interleukin 17A (IL-17A). The 8-color flow cytometry panel was applied to investigate the effect of live, killed and two irradiated E. coli on the cellular immune response. Mononuclear cells from spleen, lung and blood of 10-week-old specific pathogen-free layer birds were isolated and stimulated with live, irradiated or killed E. coli. Intracellular cytokine staining and RT-qPCR assays were applied for the detection of IFN-γ and IL-17A protein level, as well as at mRNA level for splenocytes. Ex vivo stimulation of isolated splenocytes, lung and peripheral blood mononuclear cells (PBMCs) from chickens with live, irradiated or killed E. coli showed an increasing number of IFN-γ and IL-17A producing cells at protein and mRNA level (Fig XX). Phenotyping of the cells from blood and organs revealed that IFN-γ and IL-17A were mainly produced by CD8α+, TCR-γδ+ T cells as well as CD4+ T cells following stimulation with E. coli. These results indicate that irradiated E. coli can be used to induce immunity against colibacillosis in chickens. Encouraged by these results, further experiments were done to investigate the efficacy of an irradiated E. coli vaccine in chicken and results of those studies already shows positive outcomes and will be published soon.

Irradiation induced changes in the *Trypanosoma evansi* transcriptome affect how the parasite infects Mice

The protozoan parasite *Trypanosoma evansi* is responsible for causing Surra in a variety of mammalian hosts and is spread by many vectors over a wide geographical area making it an ideal target for irradiation as a tool to study the initial events that occur during infection. Parasites irradiated at the representative doses 100Gy, 140Gy and 200Gy were used to inoculate BALB/c mice revealing that parasites irradiated at 200Gy were unable to establish disease in all mice.

Cytokine analysis of inoculated mice showed significantly lower levels of interleukins when compared to mice inoculated with non-irradiated and 100Gy irradiated parasites. Irradiation also differentially affected the abundance of gene transcripts in a dose-dependent trend measured at 6 and 20 hours post irradiation. A gene ontology (GO) term analysis was carried out for the three representative doses at 6 hours and 20 hours post irradiation revealing different processes occurring at 20 hours when compared to 6 hours for 100Gy irradiation.

These processes fell in significance at 140Gy and even further at 200Gy, revealing that they were least likely to occur at 200Gy, thus may have been responsible for infection in mice by 100Gy and 140Gy irradiated parasites. When looking at 100Gy irradiated parasites 20 hours post irradiation processes with a positive Z score, we identified genes that were involved in multiple processes and compared their fold change values at 6 and 20 hours. We postulated that these were necessary for repair from irradiation damage at 6 hours, and possibly in the establishment of disease in mice at 20 hours post irradiation. A potential strategy using this information describes the development of a whole parasite vaccine shown below.

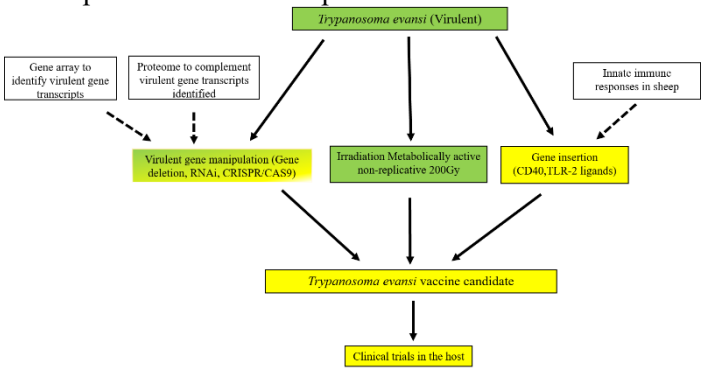


Figure source: Kangethe at al. (2022) Low dose gamma irradiation of trypanosoma evansi parasites identifies molecular changes that occur to repair radiation damage and gene transcripts that may be involved in establishing disease in mice post-irradiation. Front. Immunol. 13:852091. doi: 10.3389/fimmu.2022.85

Fellows, Interns and Consultants

Mr Artem Metlin joined the Animal Production & Health Section; Animal Production and Health Section as a consultant on 3 January 2022. He will work with the APH team in developing and implementing the ZODIAC project. Mr Metlin is a veterinarian virologist. He worked for several years as Deputy Director for Research at the Federal Centre for Animal Health in Vladimir, Russia.

Mr Mame Thierno Bakhoum

Mr Mame Thierno Bakhoum is an early-career researcher at the LNERV/ISRA, Senegal. With a Ph.D. in Evolution and Biodiversity Science, he works especially on vector-borne zoonotic diseases such as Rift Valley fever (RVF), West Nile (WN), and Crimean Congo hemorrhagic fever (CCHF) using molecular biology techniques (DNA and RNA extraction, real-time as well as classical PCR, DNA gel analysis, etc.) and phylogenetic/phylogenomic data analysis programs. As part of the ZODIAC project, Mr Bakhoum joined the Animal Production and Health Laboratory, Seibersdorf, Austria, as a fellow on 9 May 2022 for training NGS using the S5 platform.

Ms Salma Barbaria Ben Yahia

Ms Salma Ben Yahia EP Barbaria is a veterinarian at the animal health laboratory at Tunisian Veterinary Research Institute (IRVT), a laboratory responsible for controlling avian salmonella and other Enterobacteriaceae in the poultry production by isolation, serotyping and antimicrobial resistance evaluation. As part of the ZODIAC project, Ms Salma Ben Yahia EP Barbaria joined the Animal Production and Health Laboratory, Seibersdorf, Austria, as a fellow on 16 May 2022 for training in NGS using the S5 platform.

Ms Diana Nurjanah

Ms Diana Nurjanah joined the Animal Production and Health Laboratory as a fellow on 8 May 2022. Ms Nurjanah is a veterinarian researcher in the Veterinary Research Center, National Research and Innovation Agency Republic of Indonesia and currently pursuing a master's degree in Biomedical Science at the University of Indonesia. She will work within the domain of Next Generation Sequencing (NGS) and bioinformatic analysis for RNA/DNA virus in animals.

Capacity Building

Establishment of a phenotyping facility for Cashmere goats in Mongolia

A facility for phenotyping Cashmere goats was successfully established under the IAEA Technical Cooperation project (MON5025) with installation of advanced *"Optics based Automatic Fiber Measurement System"* at Research Institute of Animal Husbandry (RIAH), Ulaanbaatar, Mongolia. This automatic platform is now helping to record phenotype data on Cashmere goats (e.g., fiber diameter, fiber length, etc.) in a fast and efficient way. The new portable OFDA system measures Cashmere fibers ten times faster and more efficiently than the existing system available at RIAH (new portable OFDA takes 3 minutes per sample, while the old equipment took 30 minutes per sample to measure fiber diameter). Establishment of this facility is a significant step towards largescale phenotyping of goats and smooth implementation of a national breeding program for the improvement of Cashmere wool productivity in Mongolia.

Establishment of a molecular genetics laboratory facility in Mongolia

A facility for molecular genetic characterization of local livestock in Mongolia was established at Research Institute of Animal Husbandry (RIAH), Ulaanbaatar, Mongolia. Equipment was procured for (i) the DNA extraction area (ii) the Polymerase chain reaction (PCR) preparation area (iii) the PCR area and (iv) the Post-PCR area. The major equipment related to DNA extraction and PCR were installed and the installation of other equipment is ongoing. The facility will help prepare the samples for genomic analysis and evaluation of Cashmere goats and other livestock breeds.

Coordinated Research Projects (CRPs)

Project Number	Title	Project Officers
D31028*	Application of Nuclear and Genomic Tools to Enable the Selection of Animals with Enhanced Productivity Traits	V. Tsuma M. Garcia Podesta
D31029*	Quantification of Intake and Diet Selection of Ruminants Grazing Heterogeneous Pasture Using Compound Specific Stable Isotopes	V. Tsuma M. Garcia Podesta
D31030	Improving Efficiency of Animal Breeding Programs Using Nuclear Related Genomic Information – Practical Applications in Developing Countries	V. Tsuma G. Viljoen
D31031	Nuclear and Related Techniques to Measure the Impact of Type of Feeding and Production System on Greenhouse Gas (GHG) Emissions and Livestock Productivity	V. Tsuma G. Viljoen
D32032*	Early Detection of Transboundary Animal Diseases (TADs) to Facilitate Prevention and Control through a Veterinary Diagnostic Laboratory Network (VETLAB Network)	I. Naletoski C. Lamien
D32033*	Irradiation of Transboundary Animal Disease (TAD) Pathogens as Vaccines and Immune Inducers	G. Viljoen V. Wijewardana
D32034	Use of Stable Isotopes to Trace Bird Migrations and Molecular Nuclear Techniques to Investigate the Epidemiology and Ecology of the Highly Pathogenic Avian Influenza - Phase II	I. Naletoski G. Viljoen
D32035	Improvement of Diagnostic and Vaccine Tools for Emerging and Re-emerging Animal Health Threats	C. Bravo de Rueda V. Wijewardana
D32036	Application of Advanced Molecular Characterization Technologies Through the Veterinary Diagnostic Laboratory Network (VETLAB Network)	I. Naletoski G. Viljoen
D32037	Novel Test Approaches to Determine Efficacy and Potency of Irradiated and Other Vaccines	V. Wijewardana C. Bravo de Rueda

*In the process of closure

Improving Efficiency of Animal Breeding Programs Using Nuclear Related Genomic Information – Practical Applications in Developing Countries (D31030)

Victor Tsuma and Gerrit Viljoen

Eleven research contracts were awarded to institutes from various developing countries to commence project activities of this new Coordinated research Project (CRP) in 2022. The CRP aims to enable use of nuclear and related genomic technologies in Member States to enhance the efficiency of national breeding programs for increased milk productivity and dairy animal adaptability to the production environment. Specifically, the CRP aims a) to develop nuclear and related genomic tools/resources such as radiation hybrid maps and DNA microarrays for tropical dairy species; b) to identify genomic regions of importance for milk and adaptability traits in local dairy animal population; c) establish strategies to incorporate genomic information for selection and breeding of dairy animals; and d) develop and validate radiolabelled biomarker assays for early pregnancy diagnosis in cattle. Three major dairy animal species viz. cattle, buffalo and camel have been targeted.

Nuclear and Related Techniques to Measure the Impact of Type of Feeding and Production System on Greenhouse Emissions and Livestock Productivity (D31031)

Victor Tsuma and Gerrit Viljoen

Ten research contracts have been awarded to institutes from various developing countries for this CRP, whose aim is to

enable the Member States of the IAEA, particularly among the developing countries, to use nuclear and related technologies and resources to optimize livestock feeding practices that reduce greenhouse gas (GHG) emissions and help mitigate climate change. Specifically, the CRP aims to evaluate nitrogen and energy supplementation strategies in cattle feeding to mitigate enteric and manure GHG emission, and to develop and/or validate nuclear and related tools/resources for nutrition related GHG mitigation in cattle production, and c) to provide MS with tools and mechanisms to monitor livestock GHG emissions. Targeted are dairy cattle production systems.

The research contract (RC) will last for five years. Two Research Agreements were awarded to institutes with expertise in specific areas of importance to the CRP.

Use of Stable Isotopes to Trace Bird Migrations and Molecular Nuclear Techniques to Investigate the Epidemiology and Ecology of the Highly Pathogenic Avian Influenza Phase II (D32034)

Ivancho Naletoski and Gerrit Viljoen

The aim of this Coordinated Research Project (CRP) is to evaluate the origin of wild birds that carry avian influenza (AI) and other potentially dangerous pathogens at their stopover places and match the obtained results with the knowledge obtained through conventional migration monitoring approaches.

Stable isotopes (SI) are promising huge potential when the origin (migration) of individual wild birds is required, because the probability of capturing a labelled bird with specific characteristics (disease carrier) using conventional methods is negligible.

Knowledge and experience obtained through the previous project (D32030 - Use of Stable Isotopes to Trace Bird Migrations and Molecular Nuclear Techniques to Investigate the Epidemiology and Ecology of the Highly Pathogenic Avian Influenza) will be of great value for the success of this project.

The use of SI in migration studies of wild animals, including wild birds, primarily in environmental protection studies and conservation activities, has attracted the attention of the scientific community; however, this technique can also be used in epidemiological studies that target long-range transmission of animal pathogens.

The development and maintenance of the IAEA Global Network of Isotopes in Precipitation (GNIP) became a significant facilitator of these studies, as it offered geo-spatial reference values for correlation of the SI ratios in the animal tissues (especially metabolically inert tissues like beaks, claws and feathers) and the SI ratios in the environment (especially open waters).

During the first phase of this CRP, several important steps in the linking of SI ratios of feather samples (bird migrations) with the epidemiology of AI were established. Achievements of project D32030 have shown not only that the isotope assignment works but have delivered a full package of techniques that will strengthen and supplement (SI component) the official wild bird monitoring programmes of Member States.

In the current project, the partners will focus on two critical issues:

a) detecting birds that carry avian influenza viruses and eventually other dangerous pathogens, and

b) evaluating stable isotope ratios in feathers of these birds (only the pathogen carriers) to understand their origins and migration pathways.

The third research coordination meeting is foreseen for 2023.

Improvement of Diagnostic and Vaccine Tools for Emerging and Re-emerging Animal Health Threats (D32035)

Carla Bravo de Rueda and Viskam Wijewardana

Background: Vaccination has proven to be the best preventive measure against infectious diseases. Despite significant successes, there are several limitations to the currently practiced approaches. In veterinary medicine, the application of vaccines by injection frequently limits their use for small ruminants in rural areas. This practice requires well-trained staff taking care to practice the utmost hygiene and maintain vaccine cold chain. Further, also in poultry rearing it is not easy to inject individual birds. In addition to that, injected vaccines rarely induce production of specific mucosal antibodies (IgA) covering the mucosal tissues in the nose, mouth and lungs, which are the primary site of multiplication for bacteria or viruses before they provoke a systemic infection. Such IgA antibodies can efficiently be induced by ‘mucosal’ vaccines, i.e. formulations that are applied to the nose, mouth or eyes. These mucosal vaccines, especially eye drop vaccines, have the big advantage of requiring small vaccine dose volumes. Therefore, the application can be done by village vaccinators and the cold chain will be relatively easy to maintain.

Recent experiments on formulating such mucosal vaccines for ruminants have presented a number of challenges: a) low viscosity leading to spills; b) unsuitable components for freeze drying; and c) the process of formulating the components appropriately. Additionally, the measurement of IgA is still done by a ‘research tool’ and existing general

laboratory tools must be adapted to allow their measurement in standard laboratories. Among the latest development of this Coordinated Research Project is the research on Fowl cholera (FC) caused by *Pasteurella multocida* conducted in Ethiopia. When the irradiated FC vaccine was administered to chickens through intranasal and intraocular routes, a 100% protection was observed, as compared to a much lower rate with intramuscular injection.

This work is now published in the major research journal "Frontiers in Immunology". Other's work is also being prepared for publications.

Development of a mucosal vaccine from irradiated Gumboro virus combined with I-2 Newcastle vaccine for use in chicken; A. Research group: Dr. Harrison Lutta (KALRO-BioRC, Kabete), Dr. Irene Ogali (KALRO-VSRI, Muguga) and Dr. Erick Mungube (KALRO-VSRI, Muguga). B) Coordination meeting, C and D) Samples collection for vaccine production

Application of Advanced Molecular Characterization Technologies through the Veterinary Diagnostic Laboratory Network (VETLAB Network) (D32036)

Ivancho Naletoski and Charles Lamien

The Animal Production and Health Section (APH) of the Joint FAO/IAEA Centre has established a free-of-charge Sanger sequencing service for all counterparts of the subprogramme. So far, over 4000 samples have been submitted for Sanger sequencing by 30 counterpart laboratories (mainly partners in the VETLAB Network) and the results were published in 27 articles in peer reviewed journals.

The APH intends to upgrade this service with additional workflows which should enable counterparts' access to service-based Whole Genome Sequencing (WGS) including the possibility for metagenomic analysis.

Such workflows need to be validated, primarily for biological inactivation of the field samples prior to submission, as well as regarding the quality of the DNA / RNA extracted from the field samples. Additionally, standardized bio-informatic package for processing of the raw data and further phylogenetic analysis needs to be validated and verified for use by the counterpart community. In order to perform these activities, a new Coordinated Research Project (CRP) was developed and approved by the management of IAEA. Priority targets for this CRP will be the established users of the Sanger sequencing service of APH. However, the final objective of the CRP is to further disseminate the validated workflows to the wider counterparts' community.

Novel Test Approaches to Determine Efficacy and Potency of Irradiated and Other Vaccines (D32037)

Viskam Wijewardana and Carla Bravo de Rueda

The aim of this new Coordinated Research Project (CRP) is to complement the evaluation efforts of irradiated and other novel vaccines, as well as application of innovative tools, to determine the immune response and design immunological tools for quality control and efficacy. The overall expected outcomes are a) new *in vitro* procedures for vaccine efficacy testing replacing or reducing animal challenge trials based on *in vitro* assays ideally employing irradiated antigens; b) evaluation of immune marker mRNA qPCR and gene expression assays; c) cytokine protein assays like ELISPOTS or ELISA; and d) cell-based quantification assays that employ flow cytometry etc.

This CRP will not support the development of technical capacities, instead it requires the inputs from each participant for us to be able to understand the immune response delivered by the specific vaccine and the basic methods of their evaluation. It is expected that these new procedures will in the future help vaccine producing labs to perform better quality control of their products. They will allow a higher confidence in the results due to a more technical approach. The research contracts, research agreements, and technical contracts will be awarded only to applicants that have an ongoing vaccine production and/or research and preferably an active tissue culture lab, among other eligibility criteria.

Submission of Proposals

Research contract proposal forms can be obtained from IAEA, the National Atomic Energy Commissions, UNDP offices or by contacting a Project Officer. The form can also be downloaded from http://cra.iaea.org/cra/index.html

Technical Cooperation Projects

Country TC Number	Description	Technical Officer(s)
Albania ALB5008	Improving and Enhancing National Capabilities for Early Detection of Vector Borne Diseases through the Application of Conventional and Molecular Methods	I. Naletoski
Algeria ALG5032	Strengthening the Capacity of the Central Veterinary Laboratory, Regional Laboratories and the Early Warning Laboratories in the Detection, Confirmation of Diagnosis and Surveillance of Animal and Zoonotic Diseases	I. Naletoski
Angola ANG5016	Recovering the Vaccine Production Unit and Monitoring Active Animal Immunity	V. Wijewardana C. Bravo de Rueda
Angola ANG5017	Optimizing Pasture Utilization for Improved Livestock Productivity	V. Tsuma
Burundi BDI5002	Improving Animal Production Through Enhanced Application of Nuclear and Related Techniques	C. Bravo de Rueda I. Naletoski V. Tsuma
Benin BEN5014	Improving Sheep and Pig Productivity and Livestock Traceability	V. Tsuma
Burkina Faso BKF5021	Improving Local Poultry Production Through Incorporation of Nutraceuticals in Feeds and Genetic Characterization	V. Tsuma
Burkina Faso BKF5022	Improving Local Poultry and Local Goat Productivity through Health, Diet, Reproduction, Genetic Markers for Selection and Breeding Management	V. Tsuma
Bosnia and Herzegovina BOH5002	Strengthening State Infrastructure for Food and Animal Food Control and Protecting Animal Health	I. Naletoski
Botswana BOT5018	Reducing the Incidence and Impact of Transboundary Animal and Zoonotic Diseases	C. Lamien
Botswana BOT5021	Improving Reproductive and Productive Performance of Crossbred Dairy Cattle	G. Viljoen
Botswana BOT5022	Strengthening Animal Health and Production	G. Viljoen C. Lamien
Bulgaria BUL5017	Enhancing the National Diagnostic Capabilities for Detection of Hepatitis E Virus in Pigs and Pig Products	I. Naletoski
Belize BZE5010	Strengthening National Capacities to Control Animal Diseases	G. Viljoen
Central African Republic CAF5010	Building National Capacities for the Diagnosis and Control of Animal Diseases and for Increasing Animal Production	C. Bravo de Rueda G. Viljoen
Chad CHD5008	Improving Bovine Productivity Using Artificial Insemination	V. Tsuma
Chad CHD5010	Eradicating Pests in Small Ruminants Using Nuclear Technology	M. Garcia C. Bravo de Rueda
Chile CHI0022	Building Capacity for Nuclear Science and Technology Applications	C. Bravo de Rueda
Cameroon CMR5022	Controlling Transboundary Animal diseases with Special Emphasis on Peste des Petits Ruminants	V. Tsuma

Country TC Number	Description	Technical Officer(s)
Cameroon CMR5024	Improving Goat and Sheep Productivity in Rural Areas Using Nuclear-Derived Techniques for Genetic Marker Identification, Reproduction Harnessing and Feed Analysis	V. Tsuma
Colombia COL6017	Establishing a New Oncology Unit at the Carlos Ardila Lülle Hospital for the Improvement of Quality of Life in Children and Adult Patients with Cancer	I. Naletoski
People's Republic of China CPR5025	Developing Integrated Strategies to Improve Nitrogen Utilization and Production Efficiency in Dairy Cows	G. Viljoen
Dominican Republic DOM0006	Building and Strengthening the National Capacities and Providing General Support in Nuclear Science and Technology	C. Bravo de Rueda
El Salvador ELS5014	Strengthening National Capacities for the Control of Brucellosis	I. Naletoski
Eritrea ERI5010	Increasing Small Scale Dairy Production Through Improved Feeding, Cattle Management and Higher Conception Rates, Thereby Improving Rural Livelihood and Contributing to Food Security	V. Tsuma
Ethiopia ETH5020	Enhancing the Livelihood of Rural Communities through Addressing Major Zoonotic and Economically Important Small Ruminant Diseases	C. Lamien
Grenada GRN0001	Building National Capacity through the Applications of Nuclear Technology	V. Tsuma
Indonesia INS5042	Improving Cattle Productivity Through Improved Feeding and Enhanced Reproduction	V. Tsuma
INT5155	Sharing Knowledge on the Sterile Insect and Related Techniques for the Integrated Area-Wide Management of Insect Pests and Human Disease Vectors	I. Naletoski
INT5157	Supporting National and Regional Capacity in Integrated Action for Control of Zoonotic Diseases	I. Naletoski
Côte d'Ivoire IVC5038	Studying Small Ruminant Respiratory Diseases	C. Lamien
Côte d'Ivoire IVC5043	Applying Nuclear and DNA-Based Techniques to Improve Productivity of Local Livestock	V. Tsuma
Cambodia KAM5003	Supporting Sustainable Livestock Production	M. Garcia
Cambodia KAM5009	Improving Livestock Productivity and Control of Transboundary Animal Diseases	G. Viljoen
Kenya KEN5038	Using Nuclear Techniques to Evaluate and Improve the Impact of Mutated Forages on the Performance of Smallholder Dairy Cows	M. Garcia
Kenya KEN5039	Using Nuclear and Nuclear Related Technologies for Sustainable Livestock Productivity	V. Tsuma
Kyrgyzstan KIG5001	Establishing Effective Testing and Systematic Monitoring of Residues and Food Contaminants and of Transboundary Animal Diseases	I. Naletoski
Lao P.D.R. LAO5003	Using Nuclear and Molecular Techniques for Early and Rapid Diagnosis and Control of Transboundary Animal Diseases in Livestock	G. Viljoen
Lao P.D.R. LAO5004	Enhancing National Capability for Crop Production and Controlling Trans-Boundary Animal Diseases	G. Viljoen

Country TC Number	Description	Technical Officer(s)
Lao P.D.R. LAO5005	Reducing the Incidence and Impact of Transboundary Animal and Zoonotic Diseases	G. Viljoen
Lao P.D.R. LAO5007	Strengthening National Animal Health Laboratory Network	G. Viljoen
Lesotho LES5006	Enhancing Animal Production and the Health of Sheep and Goats in Lesotho	G. Viljoen
Lesotho LES5007	Enhancing Livestock Production and Health	G. Viljoen
Lesotho LES5010	Using Nuclear and Molecular Technology to Improve Livestock Production and Health	G. Viljoen
Madagascar MAG5020	Improving Stockbreeding Productivity Through the Application of Nuclear and Related Techniques for Reducing Rural Poverty	I. Naletoski
Madagascar MAG5024	Applying Nuclear and DNA-Based Techniques to Improve Productivity of Local Livestock	V. Tsuma
Madagascar MAG5027	Improving Livestock Production through Artificial Insemination and Disease Control	V. Tsuma
North Macedonia MAK5011	Improving National Capacities for Early Detection and Characterization of Emerging and Re-emerging Animal Diseases with Strong Economic Consequences and Upgrade of the Bio Risk Management at the National Laboratory	I. Naletoski
Malaysia MAL5034	Strengthening National Capacity and Capability in Nuclear and Molecular Techniques in Supporting Transboundary Animal and Zoonotic Diseases of Veterinary Public Health Significance	C. Bravo de Rueda
Mauritania MAU5007	Supporting Genetic Improvement of Local Cattle Breeds and Strengthening the Control of Cross-Border Diseases - Phase II	M. Garcia
Mexico MEX5033	Sustainable Production of Sheep and Goats in Mexico using Nuclear and Nuclear Related Techniques	V. Tsuma
Mali MLI5026	Improving the Diagnosis of Livestock Diseases	I. Naletoski
Mali MLI5027	Using Nuclear and Molecular Techniques for Early and Rapid Diagnosis, Epidemiological Surveillance and Control of Transboundary Animal Diseases	I. Naletoski
Mali MLI5029	Upgrading Capacities to Differentiate Priority Animal and Zoonotic Diseases Using Nuclear Related Molecular Techniques	I. Naletoski
Malawi MLW5002	Strengthening Capacity for the Diagnosis, Prevention and Control of Animal Diseases of Public Health Importance	C. Bravo de Rueda
Malawi MLW5004	Strengthening Capacity for the Diagnosis and Control of Mastitis in Dairy Cattle	C. Bravo de Rueda
Montenegro MNE5005	Enhancing Capacity of the National Veterinary Laboratory for Detection of Highly Contagious Animal Diseases	I. Naletoski
Mongolia MON5023	Enhancing Livestock Production Through the Improved Diagnosis and Prevention of Transboundary Animal Diseases	C. Bravo de Rueda G. Viljoen
Mongolia MON5025	Improving Breed Characterization of Cashmere Goats to Facilitate the Establishment of Strategic Breeding Programmes	G. Viljoen

Country TC Number	Description	Technical Officer(s)
Mongolia MON5026	Improving the Diagnosis and Treatment of Transboundary Animal Diseases with Potential Pandemic Patterns	G. Viljoen
Morocco MOR5039	Strengthening National Capacities for the Control and Prevention of Viral Pandemics and Drug Resistant Pathogens	I. Naletoski
Mozambique MOZ5008	Strengthening National Capacity for the Application of Nuclear and Related Techniques to Improve Animal Health and Production	G. Viljoen
Mozambique MOZ5009	Strengthening National Capacity to Control the Incidence and Impact of Transboundary Animal and Zoonotic Diseases	G. Viljoen
Mozambique MOZ5011	Using Nuclear and Nuclear Related Techniques to Improve Animal Health and Breeding	G. Viljoen
Myanmar MYA5026	Improving the Livelihoods of Smallholder Livestock Farmers by Developing Animal Feeding Strategies for Enhanced Food Security	G. Viljoen
Myanmar MYA5028	Reducing the Incidence and Impact of Transboundary Animal and Zoonotic Diseases	G. Viljoen
Myanmar MYA5030	Advancing National Capacities to Detect and Respond to Transboundary Animal Diseases	G. Viljoen T.B. Settypalli
Namibia NAM5018	Strengthening Animal Health and Food Safety Control Systems	G. Viljoen
Nepal NEP5004	Improving Animal Productivity and Control of Transboundary Animal Diseases using Nuclear and Molecular Techniques: Phase II	I. Naletoski
Nepal NEP5005	Strengthening Capacity in Veterinary Diagnosis	I. Naletoski
Nepal NEP5008	Reducing the Incidence of Brucellosis in Animals and Humans through Surveillance and Control	I. Naletoski
Vanuatu NHE5003	Enhancing Livestock Production and Health	V. Tsuma C. Bravo de Rueda
Nigeria NIR5040	Controlling Parasitic and Transboundary Animal Diseases to Improve Animal Productivity in Smallholder Farms Using Nuclear and Molecular Techniques	I. Naletoski
Nigeria NIR5041	Improving Livestock Productivity through Enhanced Nutrition and Reproduction Using Nuclear and Molecular Techniques	V. Tsuma
Pakistan PAK5052	Improving Livestock Productivity Using Nuclear and Related Techniques by Exploiting Indigenous Feed Resources while Reducing Enteric Greenhouse Gas Emissions	M. Garcia C. Bravo de Rueda
Palestine PAL5007	Upgrading Animal Feeding Laboratory in Terms of Human Capacity Building and Infrastructure	I. Naletoski
Papua New Guinea PAP5004	Improving Reporting of the Incidence and Prevalence of Animal Health and Diseases Using Nuclear Derived Techniques	I. Naletoski G. Cattoli
Paraguay PAR5011	Improving the Conservation of Germplasm of High-Performance Livestock and Native Cattle	M. Garcia
Peru PER5035	Improving Pasture Production Through Best Soil Nutrient Management To Promote Sustainable Livestock Production in the Highland Region	V. Tsuma
Palau PLW5004	Establishing Technical Capability in Animal Production and Disease Control	C. Bravo de Rueda

Country TC Number	Description	Technical Officer(s)
Congo PRC5001	Monitoring Livestock Diseases and Certifying Animal Health	C. Bravo de Rueda
Congo PRC6002	Contributing to the Epidemiological Surveillance of Neglected Tropical Diseases	C. Bravo de Rueda
RAF0042	Promoting the Sustainability and Networking of National Nuclear Institutions for Development	I. Naletoski
RAF0051	Supporting Specific Needs in the African Region Due to Emergencies	I. Naletoski G. Viljoen
RAF5068	Improving Livestock Productivity through Strengthened Transboundary Animal Disease Control using Nuclear Technologies to Promote Food Security (AFRA)	C. Lamien
RAF5073	Strengthening Africa's Regional Capacity for Diagnosis of Emerging or Re-emerging Zoonotic Diseases, including Ebola Virus Disease (EVD), and Establishing Early Warning Systems	I. Naletoski
RAF5082	Enhancing Veterinary Diagnostic Laboratory Biosafety and Biosecurity Capacities to Address Threats from Zoonotic and Transboundary Animal Diseases (AFRA)	I. Naletoski
RAF5089	Strengthening the Capacities of National Veterinary Laboratories for the Early Warning, Control and Prevention of Outbreaks of Animal and Zoonotic Diseases (AFRA)	C. Bravo de Rueda G. Cattoli
RAF5090	Supporting Climate Change Adaptation for Communities Through Integrated Soil–Cropping–Livestock Production Systems (AFRA)	V. Tsuma
RAS0081	Supporting Human Resource Development and Nuclear Technology Including Emerging Needs	G. Viljoen
RAS5078	Enhancing Food Safety Laboratory Capabilities and Establishing a Network in Asia to Control Veterinary Drug Residues and Related Chemical Contaminants	G. Viljoen
RAS5085	Using Nuclear Derived Techniques in the Early and Rapid Detection of Priority Animal and Zoonotic Diseases with Focus on Avian Influenza	I. Naletoski
RER5025	Improving Early Detection and Rapid Response to Potential Outbreaks of Priority Animal and Zoonotic Diseases	I. Naletoski
RER5027	Enhancing Preparedness Capacities of the Veterinary Sector to Confront with Emerging and Re-emerging Diseases of Livestock and Wildlife	I. Naletoski
RLA5071	Decreasing the Parasite Infestation Rate of Sheep (ARCAL CXLIV)	M. Garcia
RLA5084	Developing Human Resources and Building Capacity of Member States in the Application of Nuclear Technology to Agriculture	C. Bravo de Rueda
RLA5085	Strengthening the Capacity of Official Laboratories for Monitoring and Response to an Outbreak of Priority Animal and Zoonotic Diseases (ARCAL CLXXIV)	C. Bravo de Rueda I. Naletoski
RLA5086	Decreasing the Mortality Rate of Rainbow Trout Associated with Infectious Pancreatic Necrosis Virus and Emerging Diseases Using Molecular and OMIC Techniques (ARCAL CLXXV)	M. Garcia
Senegal SEN5036	Controlling Mycoplasma Mycoides Infection — Contagious Bovine Pleuropneumonia (CBPP) and Contagious Caprine Pleuropneumonia (CCPP)	C. Bravo de Rueda
Senegal SEN5042	Using Nuclear and Related Techniques in Improving the Productivity of Domestic Ruminants	V. Tsuma
Sierra Leone SIL5019	Strengthening Capacities for the Diagnosis and Control of Zoonoses to Improve Public Health Services and Livestock Production	C. Bravo de Rueda G. Viljoen

Country TC Number	Description	Technical Officer(s)
Sierra Leone SIL5022	Enhancing Livestock Production and Artificial Insemination Programme to Increase Milk and Meat Production in Cattle	V. Tsuma
Serbia SRB5004	Strengthening of National Reference Laboratories Capacities for Early Detection, Epidemiological Surveillance and Control of Transboundary Animal Diseases in Emergency Situations	I. Naletoski
Sri Lanka SRL5046	Improving Livelihoods Through Dairy Cattle Production: Women Farmers' Empowerment	M. Garcia
Sri Lanka SRL5049	Supporting Control of Stomach Worm Infection in Goats	C. Bravo de Rueda V. Wijewardana
Kingdom of Eswatini SWA5001	Reducing the Incidence and Impact of Transboundary Animal and Zoonotic Diseases	G. Viljoen
Syrian Arab Republic SYR5025	Enhancing the Nutritive and Reproductive Characteristics of Small Ruminants by Means of Nuclear and other Related Techniques Using Locally Available Unconventional Feed Resources	M. Garcia
Tajikistan TAD5006	Applying Nuclear and Molecular Techniques for Diagnosis and Control of Transboundary Animal Diseases	I. Naletoski
Thailand THA5056	Strengthening Food Safety Laboratory Capacities	G. Viljoen
Togo TOG5001	Improving and Promoting Bovine Milk Production through Artificial Insemination	M. Garcia
Togo TOG5003	Improving Livestock Production and Milk Quality Using Artificial Insemination	V. Tsuma
Togo TOG5005	Enhancing Animal Production Using Artificial Insemination	V. Tsuma
Tunisia TUN5030	Enhancing Feed and Food Safety by Appropriate Management of Livestock Feed Resources for Safer Products	M. Garcia
Tunisia TUN5032	Establishing a National Certified Pipeline to Produce Aquaculture Vaccines by Irradiation	V. Wijewardana R. Kangethe
Ukraine UKR5001	Building Laboratory Capacity for Diagnostics, Surveillance and Prevention of Emerging Animal Diseases	I. Naletoski
U.R. of Tanzania URT5031	Improving Indigenous Cattle Breeds through Enhanced Artificial Insemination Service Delivery in Coastal Areas	V. Tsuma
U.R. of Tanzania URT5036	Enhancing Artificial Insemination Services and Application of Radioimmunoassay Techniques to Improve Dairy Cattle Productivity	V. Tsuma
Viet Nam VIE5023	Reducing the Incidence and Impact of Transboundary Animal and Zoonotic Diseases	G. Viljoen
Viet Nam VIE5024	Strengthening Diagnosis, Surveillance, and Control of Emerging Transboundary Animal and Zoonotic Diseases with Emphasis on African Swine Fever and Severe Acute Respiratory Syndrome Coronavirus 2	G. Viljoen
Viet Nam VIE5025	Applying Nuclear Related Technology for Selecting Climate Adapted Indigenous Swine and Chicken Breeds	G. Viljoen V. Tsuma
DR Congo ZAI5027	Developing Early and Rapid Diagnosis and Control of Transboundary and Zoonotic Diseases	C. Bravo de Rueda

Country TC Number	Description	Technical Officer(s)
Zimbabwe ZIM5024	Establishing an Artificial Insemination Center to Enhance the Rebuilding of the National Herd	V. Tsuma
Zimbabwe ZIM5025	Producing Theileriaparva and Other Tick-Borne Disease Vaccines	C. Bravo de Rueda

Publications

Publications in Scientific Journals

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VETLAB Network

The Veterinary Diagnostic Laboratory (VETLAB) Network is a global network of national veterinary laboratories coordinated by the Animal Production and Health Section (APH) and supported through IAEA and FAO programmatic activities as well as by South Africa through the African Renaissance Fund (ARF) and by the USA and Japan Peaceful Uses Initiative (PUI). To date, the network comprises 72 laboratories in 46 African and 19 Asian countries and is now working to expand to Central and Eastern Europe, the Caribbean and Latin America. The laboratories work with each other and experts from the Joint FAO/IAEA Centre to use nuclear, nuclear-derived and other methods for monitoring, early detection, diagnosis and control of diseases.

Every year the VETLAB Network organizes ring trials, training courses and one meeting of the Directors of African and Asian laboratories.

In 2022, the meeting of the Directors of the partner laboratories will be held conducted at the IAEA Headquarters in Vienna from 22 to 26 August. From 19 to 30 September and from 17 to 28 October 2022, two laboratory training courses will be organized sat the Seibersdorf laboratories, Austria.

In the first semester of 2022, network partner laboratories in Africa and Asia have been supported for the detection, confirmation, and control of transboundary animal diseases such as avian influenza H5N1, Foot-and-Mouth Disease, African Swine Fever (ASF) and Lumpy Skin Disease (LSD).

More information can be found in other sections of this newsletter. APH is issuing on a regular basis the VETLAB Network Bulletin in the hope of providing a forum for participating laboratories and other stakeholders to communicate and exchange knowledge/information, to showcase achievements and to share expertise within the VETLAB Network. The latest highlights of the VETLAB Network bulletin can be found on pages 6 and 7 of this issue.

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