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Nuclear Techniques in Food and Agriculture

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To Our Readers

Healthy replacement stock in a Brazilian farm

Dear colleagues,

In this newsletter, we report on some programmatic achievements and actions conducted during 2017. As part of our regular Coordinated Research Project (CRP) activities and technical support given to national and regional Technical Cooperation (TC) projects, the Animal Production and Health (APH) team was fully involved in capacity building through national and regional training courses, where more than 30 courses were held with the participation of nearly 600 professionals and technicians from Africa, Asia, Europe and Latin America. On top of this, several technical meetings were conducted where policies, future actions, work plans and technical requirements from Member States (MS) for improving animal health and livestock production were discussed and agreed. Similarly, as a result of these meetings sound guidance for sustainable farming systems, for enhancing international trade of animals and animal products and for improving food security was given to policy decision makers and national health authorities.

Just to mention a few examples, national, regional and interregional training courses were delivered on sampling, data collection, laboratory techniques and interpretation of results for a number of viral diseases, differential diagnosis of infectious animal diseases using multiparametric pathogen detection technologies for African and Asian participants, characterization of bacterial and viral animal pathogens for Asian countries, workshops for detection and differentiation of avian influenza viruses focused on the European region, the use of the genetic sequencing services for Member States, and the early and rapid detection and differentiation of the Middle East respiratory syndrome in camels for scientists from Middle Eastern Member States. In response to the call of several Member States for technical assistance, APH in cooperation with the IAEA's Department of Technical Cooperation held a technical meeting on surveillance and data management of emerging and re-emerging zoonotic diseases including Ebola virus in Vienna with 150 participants from 40 African countries to discuss communication, early warning and response schemes for these diseases as well as the gaps and needs to strengthen national and regional capacities for prevention and control of zoonotic diseases.

In addition, and as part of the VETLAB activities, a coordination meeting was conducted in Vienna with 18 directors of veterinary African laboratories and 17 from Asia, thanks to the support of the African Renaissance Fund and the IAEA's Peaceful Uses Initiative. The results of the meeting indicated that most laboratories have improved their capacities, broadened their scope in pathogen detection and are moving towards the implementation of quality management systems and ISO17025 accreditation. Moreover, the access and use of the sequencing service provided by the APH subprogramme to VETLAB partner laboratories to improve disease diagnostic is growing successfully.

We were also involved in the early and effective diagnoses and control of emerging and re-emerging transboundary animal and zoonotic diseases, such as lumpy skin disease in eastern Europe and the Balkans, highly pathogenic avian influenza H5N1/H5N8/H7N9 in western Africa, Europe and Asia, peste des petits ruminants (PPR) in Asia and Africa, Rift Valley fever (RVF) and Ebola in western Africa and African swine fever in eastern Europe and Africa.

On the other side of the coin, the demand of Member States for technical assistance for the establishment and enhancing of semen processing laboratories and for the application of assisted reproductive technologies is shown in the number of TC projects in the current TC cycle. Based on that, capacity building on semen preservation, artificial insemination, on-farm reproduction management services, recording phenotype and performance data, genetic evaluation and selection, assisted reproductive techniques, and animal breeding were conducted through several regional and national training courses in Latin America, Africa and Asia. The regional TC project in Latin America aiming to decreasing gastrointestinal parasite infestation in sheep through the identification of genetically resistant breeding rams based on phenotypic data and related genetic markers and their use in breeding programmes is generating excellent results, especially in Argentina, Uruguay and Brazil, and this is being used as a model in other countries of the region.

The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture has a long history of assisting Member States in the application of simple and robust nuclear and related technologies for diagnosing and controlling infectious livestock diseases including those at the animal and human interface. These technologies have been adapted, validated and standardized through various mechanisms such as CRPs and subsequently transferred, established and applied on a wider scale through TC projects. Their relevance, utility and value were clearly evident from the results and reports of project counterparts. The technical results accumulated from previous years placed the APH as one of the major international contributors towards the improvement of livestock productivity and livelihood of the rural community as well as in food security.

Training on bat captures and sample collection for surveying emerging zoonotic diseases

CRPs on animal health have dealt with molecular techniques for differentiating foot-and-mouth disease (FMD) infected animals from vaccinated animals, PCR and ELISA techniques for the diagnosis of Trypanosoma, RVF, PPR, FMD and avian influenza, use of irradiated vaccines in the control of transboundary animal diseases (TADs), use of stable isotopes to trace bird migrations associated to the epidemiology of avian influenza; the current CRP on animal breeding and reproduction is focussing on the application of genomic tools for the selection of superior breeding stock, based on the success made on the genetic characterization of small ruminants and on the genetic variation on the resistance to internal parasitism. Finally, in the current CRP on animal nutrition, the stable isotope technology has been introduced for the estimation of intake of animals grazing on pasture and ranch land. As you may

recall, one of the major examples of success was the unique contributions towards the eradication of rinderpest through the development and distribution of validated and standardized ELISA kits, the provision of training and a laboratory quality assurance programme to IAEA and FAO Member States.

We are fully committed and pleased by the wide acceptance and participation of animal disease diagnostic laboratories in the Veterinary Diagnostic Laboratories Network (VETLAB Network). The aims and key contribution of this interregional laboratory network is to develop, evaluate, validate and implement serological, molecular, nuclear, nuclear related and nuclear derived technologies for the control of TADs and zoonotic diseases; to support coordination and harmonization of national, regional and global approaches for early warning, efficient detection and early response to animal disease surveillance; to enhance capacity and cross boundary collaborations to enable more effective responses to transboundary animal diseases; to build trust for enhanced transparency and mutual confidence in disease information; and to facilitate a dynamic approach for interaction between countries and enhance information sharing between national veterinary laboratories. Initially, the VETLAB Network included veterinary diagnostic laboratories in Africa and it was later expanded to include Asian laboratories. As of December 2017, the VETLAB Network is comprised of 44 members in Africa and 19 in Asia, with efforts to extend the VETLAB network into western and eastern Europe and Latin America.

It is also important to mention that in this semester, we were involved in close collaboration with many of you in the technical planning of project concepts for new TC projects proposed by Member States for the 2018–2019 biennial project cycle and in the preparation of the IAEA's and FAO's 2018–2019 Programme of Work and Budget.

Both past and future activities are described in detail in this newsletter and are also accessible at our website (https://www.iaea.org/topics/livestock) (http://www-naweb.iaea.org/nafa/aph/index.html). Please contact us if you have any further ideas, comments, concerns or questions. As discussed in previous newsletters, the Animal Production and Health Subprogramme will continue to move progressively forward and in pace with developments within the livestock field to optimally serve our Member States.

Concerning news from the Subprogramme, we want to welcome Mr Tesfaye Chibssa, Mr Francis Chuma and Ms Vandana Manomohan. Mr Chibssa is a veterinarian working at the National Animal Health Diagnostic and Investigation Centre (NAHDIC) in Ethiopia. Under the direct supervision of Mr Charles Lamien in the Animal Production and Health Laboratory (APHL) and the tutorship of Prof Dr Reingard Grabherr at the University of Natural Resources and Life Sciences, in Vienna, Austria, he is developing his PhD thesis on early diagnoses and development of novel vaccines for capripox viruses. Mr Chuma is a senior research technician working at the International Livestock Research Institute (ILRI) in Nairobi, Kenya. Under the direct supervision of Mr Viskam Wijewardana, Mr Chuma will contribute to the development of a repository of monoclonal antibodies useful for immunological and vaccine studies in ruminants and accessible to Member States. Ms Manomohan is doing her Masters at Tamil Nadu Veterinary and Animal Science University, India. She will spend an internship period in APHL under the supervision of Mr Kathiravan Periasamy and train on genetic and population structure analysis of indigenous zebu cattle. We hope that they will have a pleasant and productive time with the Subprogramme. Sadly, we also said goodbye to Ms Juliette Elsan and Ms Anna Gaggl. Ms Elsan and Ms Gaggl spent an internship on animal health and animal genetics, respectively. They are now returning to their studies and respective careers. On behalf of the whole APH team, I would like to wish the best success with the continuation of their careers.

Finally, I wish you all and your families a happy, healthy and safe 2018.

Gerrit Viljoen
Head, Animal Production and Health Section

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The Animal Production and Health Laboratory, Seibersdorf, is an OIE Collaborating Centre for ELISA and molecular technologies in animal disease diagnosis

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VETLAB Network Bulletin

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In this issue:

To the readers

From Gabarone, Botswana

On Wednesday 2nd August 2017, the Botswana National Veterinary Laboratory (BNVL) welcomed the visit of the South African Ambassador to Austria, Slovakia and Slovenia and Chairperson of the IAEA Board of Governors, H.E. Ambassador Tebogo Seokolo and the Director of the Joint FAO/IAEA Division, Mr Liang Qu. They met with the Deputy Director and Head of Laboratory, Dr Chandapiwa Marobela-Raborokgwe and her team. The meeting focused on the implementation of country projects under the Joint FAO/IAEA Programme, especially the VETLAB initiative. It was observed that the BNVL was able to implement the projects successfully and derive benefits through staff capacity building and procurement of equipment, reagents and consumables for testing. Notable achievements are the attainment of World Organisation of Animal Health (OIE) Reference Laboratory status for contagious bovine pleuropneumonia (CBPP) and the introduction of rapid nuclear based techniques for important animal diseases and product quality control for meat and dairy products. The BNVL has come to play a significant role in the Southern African Development Community (SADC), the VETLAB Network and Africa Region by providing training for laboratory personnel and offering quality control testing in the form of ring trials for CBPP.

This visit highlighted the successful role of the whole network and it is with pride that we would like to share this event with our VETLAB partners. We look forward to meeting you all next year and we wish you a happy and prosperous 2018!

VETLAB Highlights

The Central Veterinary Research Institute in Zambia is 17025 accredited

The Central Veterinary Research Institute Laboratory, Lusaka, Zambia has received the ISO/IEC 17025 accreditation by the Southern African Development Community Accreditation Service (SADCAS) in the areas of Chemical Analysis, Serology and Virology.

Emergence of H9N2 avian influenza (AI) in West Africa

The occurrence of low pathogenicity AI H9N2 in poultry has been fully documented in West Africa for the first time. H9N2 viruses of the "Asian G1" lineage were detected in a poultry farm suffering production losses in Burkina Faso. The Laboratoire National d'Elevage de Ouagadougou and the OIE/FAO AI reference laboratory in Padova, Italy (IZSVe) reported that the "identification of H9N2 subtype virus in West Africa, where highly pathogenic H5 strains have been widely circulating is a concern because of animal health implications, negative effects on local economies, and possible emergence of reassortant viruses with unknown biological properties".

VETLAB partners laboratories applied genome sequencing to improve disease diagnosis

The Central Veterinary Laboratory in Windhoek, Namibia, the Laboratoire Central Vétérinaire, Kinshasa, and the Laboratoire National de l'Elevage et de Recherches Vétérinaires, Dakar, Senegal has recently added genome sequencing to their diagnostic portfolio to diagnose and track diseases such as avian influenza, Newcastle disease, infectious bursal disease and rabies.

VETLAB partners laboratories sharing scientific information

- The State Central Veterinary Laboratory in Ulaanbaatar identified PPRV lineage IV in Mongolia. Full report in Arch Virol (2017) 162: 3157. doi: 10.1007/s00705-017-3456-4
- The Central Veterinary Laboratory in Windhoek reported the existence of a novel, virulent Newcastle disease virus subgenotype (VIIk) in Namibia. Full report in Arch Virol (2017) 162: 2427. doi: 10.1007/s00705-017-3389-y
- The Central Veterinary Laboratory in Maputo identified a Clade E Avipoxvirus, in Mozambique. Full report in Emerg Infect Dis (2017) 23:1602-1604. doi: 10.3201/eid2309.161981

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VETLAB Capacity Building Initiatives

Training in Seibersdorf

One fellow from the National Animal Health Laboratory, Vientiane, Laos was trained for two months on the latest techniques for the rapid detection of transboundary animal diseases.

Twenty participants from 19 African and Asian countries attended a VETLAB training course organized in Seibersdorf from 25/9 to 6/10/2017 on the detection of transboundary animal disease pathogens through the application of rapid, multiplexed PCR-based assays.

Training in VETLAB Countries

A VETLAB training course on the "Diagnosis of Transboundary Animal Diseases: Early Detection and Characterization" was organized by IAEA and NVI with the collaboration of AU-PANVAC in Ethiopia (23/10-3/11/2017). Twenty-two scientists from veterinary laboratories in 16 African countries attended the course which focused on poultry (avian influenza, Newcastle disease, and infectious bronchitis) and ruminant diseases (brucella, poxviruses, and Rift valley fever).

Twenty-five laboratory staff from Asia (Viet Nam, Lao, Thailand) attended a two-weeks VETLAB training course organised at the National Centre for Veterinary Diagnosis in Hanoi, Viet Nam from 6 to 17 November. The participants were trained on the rapid detection and sequencing of selected animal and zoonotic pathogens, including clostridium, leptospira, capripox viruses and rabies virus.

VETLAB Networking Activities

Interlaboratory test for the diagnosis of PPR

APHL organizes a yearly PPR interlaboratory test. This year, the test panel consisted of 20 vials in total; 10 for the molecular detection of the virus and 10 for the detection of antibodies against PPRV. In total, 27 VETLAB laboratories out of 31 laboratories in 27 countries (19 Africa, 7 Asia, 1 EU) participated.

2nd Coordination Meeting with Directors of Veterinary Laboratories of Africa and Asia

The laboratory heads from eighteen laboratories in 17 African and Asian countries attended the VETLAB Directors meeting to provide an update on their progress, achievements and the challenges met in 2016/2017 and to formulate their work plans for 2018. The meeting was held in Vienna from 8 to 11 August 2017.

The VETLAB Network Laboratories: Botswana National Veterinary Laboratory (BNVL)

The mandate of the BNVL is to provide laboratory testing services to its customers through animal disease diagnosis, research and quality control testing.

The BNVL provides testing for the diagnosis of animal diseases and for the quality control of animal products.

The BNVL became an OIE Reference Laboratory for CBPP in 2012 and increasingly offers fellowship trainings to laboratory scientists and technicians from other countries. The laboratory has introduced new, rapid molecular diagnostic tests to assist efficient disease control and to support trade in animal products.

The BNVL is an accredited laboratory with 45 accredited tests in five disciplines; Microbiology, Serology, Molecular Biology, Chemistry and Histopathology. The BNVL has successfully conducted a proficiency testing scheme for contagious bovine pleuropneumonia (CBPP) in the form of ring trials from 2012 to 2016 and this has helped to improve the quality of test results for the participating countries.

In the next 3 years the BNVL aims to: 1) extend its accreditation scope with 20 tests by 2021; 2) be a reference laboratory for at least one additional disease by 2021; 3) train staff on research skills in order to improve the research output of the laboratory; 4) establish a biocontainment laboratory to operate as a Biosafety level 3.

Team members of BNVL in Gaborone with H.E. Tebogo Seokolo and Mr. Qu Liang

Forthcoming events

3rd Coordination Meeting with Directors of Veterinary Laboratories of Africa and Asia

The third joint technical meeting of the VETLAB network with directors of veterinary laboratories in Africa and Asia that are supported by the African Renaissance Fund and the Peaceful Uses Initiative will take place from 6 to 10 August 2018 in Vienna, Austria.

Training Course on TADs Diagnosis: Sequencing and Bioinformatics Analysis of Animal Pathogen Genomes

To strengthen Member State capacities in genomic sequence data analysis for the diagnosis and identification of pathogens causing zoonotic and transboundary animal diseases. The course will be held from 10 to 21 September 2018 at Seibersdorf Laboratories, Austria.

Advanced Training of Trainers on TADs Diagnoses and Molecular Epidemiology

The course will provide in-depth training to staff from the VETLAB Network partner laboratories that are serving or will serve as trainers for other VETLAB Network member countries. The course will be held from 5 to 16 November 2018 at Seibersdorf Laboratories, Austria.

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Forthcoming Events

Mid-term Coordination Meeting of TC RLA5071 Decreasing the Parasite Infestation Rate of Sheep (ARCAL CXLIV)

Technical Officer: Mohammed Shamsuddin

The coordination meeting will take place from 12 to 16 March 2018 in San José, Costa Rica.

All national project coordinators will be invited to review the progress made and to define additional activities based on the project work plan for the final two years of the project.

PPR Global Eradication Programme and PPR Global Research and Expertise Network (PPR GREN) Meeting

Technical Officer: Gerrit Viljoen

The meeting will take place from 16 to 20 April 2018 in Vienna, Austria.

The purpose of the event is to launch the Global Research and Expertise Network on Peste des Petits Ruminants (PPR GREN), to discuss priority research opportunities in the light of the strategic needs of the FAO/OIE PPR Global Eradication Programme and to build strong partnerships between researchers, research institutes, regional organizations and development partners.

Third Research Coordination Meeting on the Early and Rapid Diagnosis and Control of TADs Phase II - African Swine Fever (D32031)

Technical Officer: Hermann Unger

The research coordination meeting will take place from 11 to 14 June 2018 in Greifswald, Germany.

The purpose of the event is to present the results of the coordinated research project 'Early and Rapid Diagnosis and Control of Transboundary Animal Diseases – Phase II: African Swine Fever' and to prepare the final project report.

Past Events

Second Research Coordination Meeting on Early Detection of Transboundary Animal Diseases to Facilitate Prevention and Control through a Veterinary Diagnostic Laboratory Network (D32032)

Technical Officer: Ivancho Naletoski

The research coordination meeting was held from 7 to 11 August 2017 in Vienna, Austria.

Partners of the project discussed the project achievements as well as the future activities of the coordinated research project D32032 'Early detection of transboundary animal diseases (TADs) to facilitate prevention and control through a Veterinary Diagnostic Laboratory Network' (VETLAB Network).

Participants of the Second Research Coordination Meeting of the CRP D32032 at the VIC

The partners in the project designed procedures and started the production of reference materials. The achievements could be divided in three groups: partners with developed working procedures under preparation (Côte d'Ivoire, Morocco and Sudan for PPR, rabies and brucellosis, respectively); partners who have already produced certain amounts of standard reference materials, but have not been able to inactivate and aliquot them appropriately yet (Argentina, Cameroon and Ethiopia for brucellosis, African swine fever and capripox virus standards, respectively); and partners who delivered products (Croatia delivered 4 x 150 aliquoted standards for avian influenza virus (AIV) and Newcastle disease virus (NDV), and the FYR of Macedonia adapted 25 validated SOPs for the priority diseases and 15 other SOPs under finalization).

It is realistic to expect that by the end of the second year of the project we will have products from all partners.

Coordination Meeting with Directors of Veterinary Laboratories in Africa and Asia

Technical Officer: Charles Lamien

The coordination meeting took place from 8 to 11 August 2017 in Vienna, Austria.

This was the second joint coordination meeting of the VETLAB network gathering veterinary laboratories directors supported by the African Renaissance Fund and the Peaceful Uses Initiative to Strengthen Animal Disease Diagnostic Capacities in Africa and Asia.

The laboratory heads from 18 VETLAB partner laboratories in 17 African and Asian countries namely Bangladesh, Botswana, Burkina Faso, Cameroon, Chad, Côte d'Ivoire, Democratic Republic of the Congo, Ethiopia (NAHDIC - National Animal Health Diagnostic & Investigation Center, and NVI - National Veterinary Institute), Lao PDR, Mali, Mongolia, Mozambique, Namibia, Nepal, Senegal, United Republic of Tanzania, Zambia attended the meeting to provide update on their progress, achievements and challenges met in 2016–2017 and to formulate their work plans for 2018.

Participants of the VETLAB Coordination Meeting held in Vienna, Austria from 8 to 11 August 2017

From the presentations and discussions that followed, it appears that each individual laboratory has broadened its scope in pathogen detection, including in some cases the use of advance technology such as multi-parametric pathogen detection. Furthermore, thanks to the sequencing service facilitated by the Joint FAO/IAEA Division, VETLAB partner laboratories from four countries are now using sequencing to improve disease diagnostic and further understand the spread of pathogens.

Another important highlight is that most VETLAB partner laboratories are pushing toward the implementation of quality management system (QMS) and ISO17025 accreditation. QMS in already in place in several VETLAB partner laboratories, with the most advanced having increased the number of assays under ISO17025 accreditation, and the least advanced, having appointed a quality officer and developed their quality manual and SOPs. Regarding laboratory performance and prestige, it was noticed that the local visibility and credibility has improved for most laboratories. This was confirmed by the fact that some VETLAB partner laboratories such as NAHDIC and NVI (Ethiopia) and Laboratoire National d'Élevage (LNE, in Burkina Faso), have received funding from local authorities for laboratory refurbishment and extension expansion.

The improved capacities of the laboratories also led to an increased trust of VETLAB partner laboratories by their local authorities. Three countries, Cameroon, the Democratic Republic of the Congo and Mongolia, notified new outbreaks in 2016–2017 based on local VETLAB partner laboratory results. In addition, through well-structured discussion sessions, the meeting participants exposed their major constraints in disease diagnostics, including the implementation of quality systems. Common strategies and solutions were identified to strengthen their laboratory capacities to cope with the major transboundary animal (TADs) and zoonotic diseases in Africa and Asia and better contribute to their respective national and regional TADs control strategies.

During the meeting, Dr Massimo Scacchia (from IZSAM - Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise Giuseppe Caporale, Teramo, Italy) manager of the project 'Enhancing Research for Africa Network' (ERFAN), presented practical experiences and challenges related to the implementation of the laboratory quality systems in African countries.

The meeting was held in parallel with the second RCM of the VETLAB CRP D32032 (Early Detection of Transboundary Animal Diseases to Facilitate Prevention and Control through a Veterinary Diagnostic Laboratory Network) to allow for interaction between the laboratory directors and the CRP experts and their critical assessment of the CRP work plan.

The partner laboratories supported the proposed objectives and new work plan of the VETLAB CRP to promote the production of secondary standards for the implementation of quality system. Moreover, agreement was made on strategies to promote the use of multi-parametric detection of pathogens and the use of sequencing.

Strengthening Capacities for Surveillance, Data Management and Reporting of Emerging or Re-emerging Zoonotic Diseases (EZDs), including Ebola Virus Disease (RAF0042)

Technical Officers: Ivancho Naletoski and Hermann Unger

The meeting was held from 21 to 25 August 2017 at the IAEA headquarters in Vienna, Austria, and brought together over 150 participants from 40 African countries. The main national actors of the One Health (OH) networks comprising representatives from the veterinary, public health and wildlife sectors discussed the communication, early warning and response schemes for emerging and re-emerging zoonotic diseases (ERZDs). Additionally, they discussed the existing infrastructures and procedures in place, as well as the gaps and needs to strengthen national and regional capacities for prevention and control of ERZDs.

Participants in the RAF0042 meeting on Strengthening Capacities for Surveillance, Data Management and Reporting of ERZDs, including Ebola Virus Disease

Based on the presentations and discussions held at the meeting, the participants developed an action plan to strengthen the national strategies and plans for prevention and control of ERZDs, comprised of eight major points as follows: to strengthen the biosafety culture in the field; to strengthen biosafety in laboratories, through biosafety trainings in Member States (MS); to strengthen diagnostic capacities, prioritizing techniques working with inactivated pathogens (such as molecular techniques); to implement procedures that facilitate sample preparation, transport and delivery to designated laboratories; to develop a framework for the implementation of a national OH approach using existing structures and available tools and procedures; to facilitate field exercises to identify shortcomings in the response chain; to establish OH structures at national levels to map the responsible entities and focal points.

Special attention was given to the harmonization and accreditation of designated laboratories (the last major point mentioned above), in which the invited experts presented a clear roadmap for the future guidance of African laboratories towards an international accreditation under ISO 17025 standards.

Consultancy Meeting on Nuclear and Nuclear-derived Techniques for Early Pregnancy Diagnosis in Cattle

Technical Officer: Mohammed Shamsuddin

The meeting was held from 22 to 25 August 2017 at the Vienna International Centre, Vienna, Austria.

The objectives of the meeting were to review and summarize the current state of knowledge on pregnancy related molecules (proteins, interferon tau gene, microRNAs) as candidates for developing early pregnancy diagnosis tools; identify tools and techniques for early pregnancy diagnosis that can be applied along with the artificial insemination (AI) field services in developing countries, develop protocols/guidelines to validate/adapt proven techniques for early pregnancy diagnosis under prevailing dairy production systems in the tropics; and identify requirements in terms of equipment, biologicals, isotope labelling of pregnancy associated glycoprotein (PAG) and others for radioimmunoassay assay.

Five experts, two fellows and five IAEA staff members participated in the meeting. The experts were Professor Jean-Francois Beckers (Belgium), Dr Carlos Lamothe Zavaleta (Mexico), Dr Niamh Forde (UK), Dr Xavier Donadeu (UK) and Professor Matthew C. Lucy (US).

Participants of the consultancy meeting

The updated knowledge on early pregnancy diagnosis in cattle, including proven tools and techniques and promising pregnancy related molecules was reviewed. Results of recent research show that the pregnancy

associated glycoproteins (PAG) can be used to identify pregnant and non-pregnant cows as early as day 25 after artificial insemination or natural mating. Existing methods are mainly used in *Bos taurus* animals under specialized dairy systems, but has not been validated for *Bos indicus* breeds, crossbreds and indigenous breeds in developing countries under low-input production systems. A protocol was prepared on a pilot study using radioimmunoassay (RIA) as gold standard to validate robust enzyme-linked immunosorbent assay (ELISA) protocols in various genetic populations of cattle at different production systems for the determination of PAG concentrations in blood and in milk on days 35–42 after service.

Biological changes in MicroRNAs in the bloodstream and in milk show strong potential for their use as biomarkers to identify pregnancy in cattle as early as 18 days after service. A research protocol was developed where miRNAs will be determined in blood and milk by PCR and progesterone levels and uterine ultrasound examination will be used as gold standards.

The conceptus produces and releases proteins to the uterine environment which can be targeted by direct measure of pregnancy success on day 16 after mating. One gap in our knowledge is to know which of these proteins are actively being synthesized by the conceptus during successful early pregnancy. A research protocol was developed to harness the nuclear technology by culturing conceptuses with radiolabelled amino acids (e.g. sulfur-35) to identify proteins produce during early pregnancy. RIA will be used to test for candidate proteins in serum and or milk.

Nuclear techniques and the use of radiolabelling of hormones, proteins and amino acids play a key role in identifying and monitoring hormones and proteins associated with early pregnancy in cattle.

The participants agreed that the implementation of the pilot studies and research protocols developed in the Consultants Meeting can provide useful tools and methodologies for an effective diagnosis of pregnant and non-pregnant cows in early stages of gestation and facilitate the expansion of artificial insemination services.

Regional Workshop on the Advanced Techniques for Detection and Differentiation of Avian Influenza Viruses, in the Light of Current Outbreaks of Avian Influenza in Europe (RER9137)

Technical Officers: Giovanni Cattoli and Ivancho Naletoski

As a response to the recent outbreaks of avian influenza, predominantly subtype H5N8, IAEA through the Animal Production and Health (APH) Subprogramme and the Technical Cooperation (TC) department organized a training course for the Member States of the European region on the advanced techniques for detection and differentiation of avian influenza (AI) viruses. The course was held from 11 to 22 September 2017 at the IAEA, in the APH laboratories in Seibersdorf, Austria. Twenty-three participants, each from one Member State of the IAEA European region attended the course. The mains topics covered at the training course were: advanced diagnostics of AI viruses (techniques used for screening, confirmation, direct pathotyping and use of techniques for differentiation of vaccine from field virus strains); application of diagnostic techniques in surveillance and early detection, including tracing migration of wild birds using stable isotopes; advanced bioinformatics and genetic characterization (conventional versus whole genome and next generation sequencing); and laboratory networking in the support of the surveillance and control programmes.

Fourteen international experts supported the course with their lectures, presentations and on-the-spot practical exercises.

Participants at the regional training course on the advanced techniques for detection and differentiation of avian influenza viruses, in the light of current outbreaks of avian influenza in Europe (RER9137)

Training Course on Health Management of Small Ruminants with Emphasis on Gastrointestinal Parasitism (RLA5071)

Technical Officers: Mohammed Shamsuddin and Mario Garcia

The regional training course took place from 25 to 29 September 2017. The course was organized by the Universidad Peruana Cayetano Heredia (UPCH) in the city of Huancayo, Peru, and hosted by the Universidad Nacional del Centro, the Agrarian Experimental Station Santa Ana of the National Institute of Agrarian Innovation (INIA), the experimental station of the IVITA Research Center of Universidad Nacional Mayor de San Marcos and

the SAIS Tupac Amaru. Mr Nino Arias was the local organizer.

The course was organized for the Latin American and Caribbean countries participating in TC Project RLA5071. The purpose was to improve the knowledge and skills of the participants in the health management of sheep and goats, with emphasis on diagnosis, control and prevention of gastrointestinal parasite infections.

Course participants of the training course held in Puno, Peru (25 to 29 September 2017)

Seventeen participants from nine countries and six local staff from the Universidad Nacional del Centro attended the course. Lectures and laboratory work were carried out by Dr Zully Hernández from the Universidad de la Republica, Uruguay, the technical officer and six professionals from local host institutes. The course involved theoretical presentations and practical work on the productive performance and management of production diseases of sheep and goat, internal and external parasites in small ruminants, processing of biological samples, including blood and faeces for pathogen detection, parasitological laboratory techniques, including faecal egg counts, and drug-resistance parasites. In addition, a field trip was conducted to one of the largest livestock cooperatives in the country located at 4000 meters above the sea level to get an on-site understanding of the local health management programme. Laboratory material, including McMaster chambers for parasite egg counting was handed over to all participants.

The course participants highly appreciated the course modules, especially the printed manual which the participants considered a useful guide for investigations of gastrointestinal parasite infection in the farm and confirmatory diagnosis in the laboratory. Based on the discussions, gastrointestinal parasitism was considered a serious health problem in sheep and goat in all the participating countries. However, parasite species vary greatly among participating countries. *Fasciola hepatica* was common and a major concern while the severity of *Dictiocaulus viviparus* depended on the country and regions within countries. Brucellosis was the most common infectious disease in sheep and goats in the participating countries where national programmes for its control are in place.

The various venues and facilities provided by the local organizer were effective for the success of the training and the participants were highly motivated and participated actively in discussions with lecturers and technical staff.

Training Course on the Diagnosis of Transboundary Animal Diseases: Multiple Pathogen Detection

Technical Officer: Charles Lamien

The purpose of this training was to strengthen the Member States (MS) veterinary diagnostic and research laboratory capacities for differential diagnosis of infectious animal diseases using multiparametric pathogen detection technologies. With these techniques, it is possible to detect and differentiate pathogens causing infectious diseases which have similar clinical signs using a single reaction vessel. The continuous expansion of transboundary animal diseases (TADs) and zoonotic animal diseases into new geographical areas and the emergence of new diseases required the adaptation of disease diagnostics and disease surveillance techniques to face these new challenges. Recent scientific advances have allowed the development of technologies adapted to identify emerging/re-emerging pathogens or provide a more accurate identification of pathogens (e.g. pathotyping, genotyping). Therefore, multiplex serological and molecular tests which can be effectively implemented in MS veterinary laboratories will broaden the scope for infectious disease diagnostics by allowing for differential diagnosis of diseases presenting similar clinical symptoms and a more accurate identification and characterization of the pathogens.

Participants of the VETLAB training course on multiple pathogens detection, held in Seibersdorf, Austria

The training consisted of lectures on the principles and practical sessions on the applications of multiparametric technologies for the diagnosis of the major transboundary

and zoonotic animal diseases threatening the livelihood and the health of the population in several Member States in Africa and Asia. The trainers were experts from the Institut de Recherche pour le Développement (IRD), France; Federal Research Institute for Animal Health, Germany; Luminex Corporation, Netherlands and the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture.

Twenty participants from VETLAB partner laboratories in 19 African and Asian countries (Bangladesh, Botswana, Burkina Faso, Cameroon, Chad, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Ethiopia, Kenya, Lao P.D.R., Mali, Mongolia, Mozambique, Namibia, Nepal, Senegal, United Republic of Tanzania and Zambia) attended this training course which took place from 25 September to 6 October 2017 at the laboratories in Seibersdorf, Austria.

Training Course on the Diagnosis of Transboundary Animal Diseases: Early Detection and Characterizations

Technical Officer: Charles Lamien

Transboundary animal diseases (TADs) have a serious impact on the global economy of several African countries, threatening the food security and the livelihoods of livestock farmers. In addition, some TADs of zoonotic nature, such as avian influenza (AI), Rift Valley fever (RVF) and brucellosis have recently emerged or re-emerged on the continent. The emergence of H5N8 AI on the African continent and the increasing incidence of RVF, with the lastest human fatalities recorded in Niger in 2016, are concrete examples. To mitigate the spread of these TADs within country and between countries and the spillover of zoonotic diseases to humans, the capacity of veterinary diagnostic laboratories must be improved through the constant update of new diagnostic tools developed to identify and track the evolution of the pathogens responsible for the diseases.

With that in mind, the main purpose of this training was to strengthen the participants' ability to detect and conduct surveillance of major viral and bacterial pathogens affecting poultry and ruminants including those of zoonotic nature, as well as performing their corresponding epidemiological studies. The training course took place from 23 October to 3 November 2017 at the National Veterinary Institute (NVI), Debre Zeit, Ethiopia.

The training consisted of lectures and practical sessions on applications of molecular and serological diagnostics, differential diagnostics and molecular epidemiology for highly pathogenic Influenza viruses, Newcastle disease virus, and infectious bronchitis virus in poultry and RVF, Brucella and pox diseases in ruminants and camels. The trainers were experts from the National Institute for Communicable Diseases, South Africa; the Istituto Zooprofilattico Sperimentale delle Venezie (IZSVe), Italy; the Istituto Zooprofilattico Sperimentale dell'Abruzzo e del Molise (IZSAM), Italy; the African Union Pan Veterinary Vaccine Centre (PANVAC), Ethiopia; the National Veterinary Institute (NVI), Ethiopia and the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture.

Participants of the training course

Twenty-two scientists from veterinary diagnostic laboratories in 16 African countries (Botswana, Burkina Faso, Cameroon, Chad, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Ethiopia, Kenya, Mali, Mozambique, Namibia, Senegal, United Republic of Tanzania, Zambia and Niger/PANVAC), all members of the VETLAB Network, attended this training course.

Regional Training Course on the Diagnosis of Transboundary Animal Diseases (VIE5019)

Technical Officers: Gerrit Viljoen and Giovanni Cattoli

The training course took place from 6 to 17 November 2017 at the National Centre for Veterinary Diagnostic (NCVD), Hanoi, Viet Nam. The course was organized by NCVD and by the International Atomic Energy Agency (IAEA) through the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture with the support of the Department of Technical Cooperation, Division of Asia and the Pacific.

The purpose of this training was to strengthen diagnostic capacities in the national veterinary laboratories of the region for the identification and classification of pathogens responsible for animal infectious diseases of major interest, including rabies, capripox infections, leptospirosis and animal clostridiosis.

Twenty participants from veterinary laboratories in Viet Nam, Myanmar, Lao PDR and Thailand attended this course. During the first week, the participants were trained

on qPCR techniques for detection of *Clostridium perfringens*; MAT, ELISA and the LAMP techniques for detection of Leptospirosis. In addition, the discussions were on implementation of quality parameters including documentation, auditing, quality check of qPCR data, antigen titrations, use of quality controls, assay validations and their advantages. The second week of training course was focused on Capripox detection and genotyping using real time PCR and differential diagnosis using multiplex PCR and rabies detection using IFA, RIAD, Real-time PCR and characterization by sequencing.

Participants of the training course on the diagnosis of transboundary animal diseases (VIE5019) held in Hanoi, Viet Nam

National Training Workshop on the Development of Teaching Modules on Delivering Herd Health Services at Smallholder Dairy Production (BGD5030)

Technical Officers: Gerrit J. Viljoen and Mohammed Shamsuddin

The event took place from 13 to 17 August 2017 at the Bangladesh Agricultural University, in Mymensingh, with Professor Musharraf Uddin Bhuiyan as the Course Director.

The objectives of the training workshop were to review the current modules in use for teaching theriogenology to veterinary undergraduate students; to identify essential resources and required changes in implementing effective teaching modules; to enhance the skills of participants in teaching theriogenology; and to suggest a step by step development of theriogenology teaching modules where students will have more time to invest in practicing animal reproduction in clinics and farms.

Professor Christian Hanzen, from the University of Liège, Belgium, and Mr Mohammed Shamsuddin, an IAEA staff member, were facilitators of the training workshop. Fifteen participants, nine from nine veterinary faculties in the country and six veterinarians working in the field of dairy production, attended the event. The training involved theoretical lectures, demonstrations and practical exercises while the workshop included a series of participatory sessions to analyze the current theriogenology education in Bangladesh and recommend a step by step development of modules mobilization of resources for more effective teaching-learning of theriogenology across veterinary faculties.

Participants and guests at the opening of the training-workshop

All veterinary faculties teach students on similar subjects and topics in theriogenology. However, a large variation exists among institutes in the distribution of hours between theoretical and practical classes and resources available to conduct practical sessions. To improve students' learning and minimize variations, coordination among heads of veterinary faculties was identified as the first prerequisite. In addition, a four-step action plan was proposed.

Participants and guests in the closing of the training-workshop

Step 1 defines the main domains for clinical animal reproduction and the number of hours to dedicate to each domain. Suggested core domains were clinical methods to investigate reproductive problems, disorders of reproduction (male and female), obstetrics, reproductive biotechnology, udder health management and management of reproduction at the herd level. Reproductive anatomy and physiology were considered prerequisites for the theriogenology students. Step 2 defines specific objectives of each chapter and for each practical exercise. Step 3 identifies specific contents with associated hours given by demonstration (the teacher shows to the learners) or by practical exercises (the learners are doing). Resources,

movability and farm connections must be organized beforehand to save time and to maintain student enthusiasm during the teaching and learning process. Step 4 develops questions and evaluation processes to address each defined objective.

The bovine theriogenology education in Bangladesh needs more resource allocation to enable students to practice by themselves in the clinics and farms with reduced number of theoretical lectures. Veterinary faculties in the country should put in place a platform for continued discussion and coordination for more hands-on practice.

Experts Meeting on the Preparation of a Manual for Genetic Evaluation and Selection of Small Ruminants for Breeding to Enhance Resistance to Gastrointestinal Parasites (RLA5071)

Technical Officer: Mohammed Shamsuddin

The experts meeting took place from 6 to 10 November 2017 in Cochabamba, Bolivia.

The objectives of the meeting were to finalize the manual for small ruminant breeding that was outlined in an earlier meeting in Asuncion, Paraguay in 2016.

The present meeting was attended by five experts: Mr Mario Poli (Argentina), Mr Jose Fernando Garcia (Brazil), Mr Victor M. Montenegro (Costa Rica), Mr Riccardo Negrini (Italy), and Ms Virginia Goldberg (Uruguay). Mr Mohammed Shamsuddin coordinated the event. The meeting was opened by Professor Freddy Espinoza, Dean of the Agronomy Faculty, Universidad Mayor de San Simon.

Participants of the experts meeting

The experts presented outlines of individual chapters that were assigned to them. This was followed by a focussed discussion where contents of individual chapters and of the manual as a whole were agreed. Thereafter, the experts worked individually and completed drafting of the chapters. The chapters were uploaded to Goggle Docs and peer reviewing was conducted.

The manual includes four chapters: Chapter 1 describes the small ruminant populations in Latin American and Caribbean countries, their uses in the regional economy, the current breeding situation and the challenges to address sustainable production increases of the small ruminants. Chapter 2 describes the identification and definition of animal breeding tools to be used and the organization of small ruminants breeding programmes in the region addressing the diverse production systems. Chapter 3 focuses on the principles and practices for the collection, quality management and integration of data and various tools for the analysis of phenotypic data to make breeding decisions. Chapter 4 describes the tools and guidelines for genomic analysis to further enforce genetic evaluation and breeding decision and the way forward for research and practices in small ruminants breeding.

The manual will not only be a practical guide for young professionals who are planning to initiate a new breeding programme but also a good tool for training students and professionals. The meeting recommended immediate publication of the manual.

National Training Course on Tools for Genetic Evaluation and Selection for Breeding Alpacas (PER5032)

Technical Officer: Mohammed Shamsuddin

The training course took place from 11 to 22 September 2017 at Universidad Nacional del Altiplano, Puno, Peru.

Some of the course participants

The course was organized by the Instituto Peruano de Energía Nuclear (IPEN) with Mr Juan Carlos Agapito Panta as the Course Director. The IAEA appointed an external lecturer, Dr Ricardo Negrini, from the Università Cattolica del Sacro Cuore, Milano, Italy. The IAEA Collaborating Centre on Animal Genomics and Bioinformatics at São Paulo State University – UNESP, Araçatuba, Brazil assigned Dr Yuri Tani Utsunomiyaas as a cost-free lecturer.

The objective of the course was to increase the knowledge and skills of participating professionals on the collection

of phenotypes, processing of data and basics for the development of a breeding programme for alpacas and analyses of such data using public domain software.

Forty-four participants from the Universidad Nacional del Altiplano (Puno), Universidad Peruana Cayetano Heredia (Lima), Universidad Nacional Agraria la Molina (Lima) and the company Inca Tops attended the course.

Theoretical lectures, practical demonstrations and hands-on sessions were conducted at the research facilities of the National University of the Altiplano. The lectures included basic concepts of classical genetic selection, lessons on whole genomic sequencing, application of genomic selection, genomic selection (advantages and pitfalls), application of GWAS (genome-wide association study), selection for disease resistance, conservation of genetic diversity, and the power and promises of genome editing. The practical sessions included demonstrations and hands-on exercises on the management and statistical analysis of data using various statistic tools.

Supporting University of Abomey-Calavi to Strengthen its Newly Introduced MSc Programme in the Region on Feed Resources and Animal Nutrition (BEN5010)

Technical Officer: Mohammed Shamsuddin

The training course took place from 27 November to 1 December 2017 at the University of Abomey-Calavi (UAC), Benin.

Participants of the MSc-RANA programme

The course was organized by the Faculty of Agronomic Sciences (FAS), UAC with Professor Mankpondji Frédéric Houndonougbo as the course director. The IAEA appointed an external lecturer, Dr. Paulo Salgado from CIRAD Antsirabe, Antsirabe, Madagascar.

The objective of the course was to reinforce the newly introduced MSc programme on Feed Resources and Animal Nutrition (MSc-RANA: Ressources Alimentaires et Nutrition Animal) of FAS-UAC by providing students exposure to additional knowledge on animal production in the region, especially through the connection of CIRAD's activities in Africa. An additional objective was to contribute to the teaching modules of the MSc programme of FAS-UAC.

Twelve students from three countries (Benin, Gabon, Togo) currently studying MSc-RANA. This MSc programme is an outcome of a recommendation adopted at a regional workshop organized by the Specialization Centre in Livestock in Niger through a Word Bank Project (WAAPP/PPAAO). The enhanced capacity of FAS-UAC developed through its partnership with the IAEA and FAO was identified in the workshop and the UAC was given the task of offeri the MSc-RANA course to post graduate students from the region. 'Capacity building support to FAS-UAC through IAEA TC projects enabled us to introduce this new MSc programme and we are thankful to IAEA for that', said the Course Director.

The MSc programme is composed of theoretical lectures, demonstrations, practical and hands-on exercises and a small research projects. All these endeavors are targeted to developing effective skills on animal feed resources management in students, laboratory analysis of feeds and forages, building a database on locally available feed resources and on farm feed formulation and feeding to increase animal productivity.

The expert lecturer discussed and reviewed the MSC-RANA programme with the FAS-UAC colleagues and has provided his inputs for further effective learning and skill development of the students.

Mid-Term Coordination Meeting Improving Livestock Productivity through Strengthened Transboundary Animal Disease Control using Nuclear Technologies to Promote Food Security (RAF5068)

Technical Officer: Hermann Unger

The meeting was held in Livingstone, Zambia, from 27 to 31 March 2017. The objective was to review the progress and the results achieved by the representatives of 17 Member States (MS) that took part in the meeting.

The participants presented the activities conducted in the first part of the project. Relevant topics such as vector borne disease monitoring, vector trapping identification and mapping, and peri-urban small scale livestock production were addressed. In addition, discussions were taken on the characteristics and accomplishments of training courses held during the year, the overall work plan for the second part of the project was agreed and this

included individual work plans for each Member State, the implementation of a training course on poultry disease diagnostics with a side event on Newcastle disease vaccination in early 2018.

The feedback from delegates on the activities carried out so far was positive, despite the lack of national funding for some of the activities in the countries. Vector monitoring for West Nile fever (WNF) and Rift valley was carried out in two countries and will continue. Some of the challenges reported by meeting participants were the suspension of field activities and services of entomology sections; the limitation of feedback from farmers because the veterinary service for peri-urban farmers are now offered by the private sector; and the lack of national funding. Funding for national field activities was seen as the major stumbling block to achieve a bigger impact. The participants agreed that some additional effort must be made to call the attention of national authorities to the importance of supporting AFRA activities in the field of animal health.

Participants of RAF5068 Mid-term Meeting in Livingstone, Zambia

National Training Course on Standardized Diagnostic Methods and Sampling Procedures for Animal Diseases (UGA5038)

Technical Officer: Hermann Unger

The training course took place from 10 to 14 October 2017 at the Ministry of Agriculture, Animal Industry and Fisheries, Entebbe, Uganda. Mr Alfred Wejuli was the course director and the IAEA appointed an external lecturer, Mr Louis Fischer.

The purpose of the course was to harmonize diagnostic methods and sampling processes for animal diseases. Theoretical sessions covered diagnostic methods and epidemiological aspects of avian influenza, Newcastle, peste des petits ruminants (PPR), African swine fever, and brucellosis as well as biosafety and quality control in veterinary diagnostic laboratories. Sixteen participants from various laboratories participated in the training.

Training on sample collection

Regional (AFRA) Training Course on Vector Mapping and Surveillance (RAF5068)

Technical Officer: Hermann Unger

The training course was conducted at the National Animal Disease Diagnostics and Epidemiology Centre in Entebbe, Uganda from 22 to 26 May 2017. The course was officially opened by Dr Ademun Rose, Acting Commissioner Animal Health. Mr Girma Urgeacha Kussa (AU/IBAR-Addis Ababa) and Mr Joseph Opio (MAAIF) acted as course facilitators.

The course participants were acquainted with data collection techniques (GPS with some examples of a tsetse entomological survey). Furthermore, practical exercises on the use of GPS devices, installation of QGIS, hands-on exercises to learn QGIS interface and basic operations and how to use the GPS device were conducted. The participants were taught how to explore and understand coordinate systems. This was followed by a practical exercise on setting projections in QGIS and a session on understanding vector data and rasta data in GIS.

There was a practical exercise on spatial data collection from public domains, creating new vector layers in QGIS, creating point vector observations, working with raster layers, plugins and geoprocessing tools. There were exercises on data management in QGIS including query by example, spatial querying, spatial selection, joining, buffering (point line), intersection, reclassification, raster calculation, and vectorization.

Finally, there was a presentation on map elements on how to create maps using the QGIS map composer. Lectures and practical work was conducted by two experts from Ethiopia and two from Uganda. The course was attended by 20 participants from 15 African countries.

Training Course on Wildlife (Bats) Capture and Sampling for Surveying Emerging Zoonotic Diseases (RAF5073)

Technical Officer: Hermann Unger

The training course was conducted in Njala University, Sierra Leone, from 22 November to 2 December 2017. The objective of the training was to teach participants good practices, including biosafety, for capturing bats and sampling them for surveying emerging zoonotic diseases.

The training activities included biosafety in the field for bat collection and sampling equipment. Course participants were requested to prepare a new manual on bat ecology, biology and capture procedures. The manual is planned to be ready by April 2018, before the next course takes place. The course was attended by 23 participants from 12 African countries.

National Training Courses on the Diagnosis and Control of Transboundary Animal Diseases

Technical Officer: Gerrit Viljoen

- Training course for the early and rapid diagnoses and control of foot-and-mouth disease and contagious bovine pleuropneumonia, held at the Botswana National Veterinary Laboratory in November 2017 in Gaborone, Botswana (BOT5015)
- Training course for the diagnoses and control of animal brucellosis and animal rabies, held at the National Animal Health Laboratory in August 2017 in Vientiane, Laos (LAO5003)
- Training course on the identification and diagnoses of avian influenza and Newcastle disease held at the Department of Livestock Services, Ministry of Agriculture and Food Security in June 2017 in Maseru, Lesotho (LES5006)
- Training course on the diagnosis and control of transboundary animal diseases at Belize Agricultural Health Authority (BAHA) from 6 to 10 March 2017 in Belmopan, Belize (BZE5007)
- Training course on the use of molecular diagnostic technologies to detect African swine fever and avian influenza, held in Maputo at the Agricultural Research Institute of Mozambique (MOZ5006)

Stories

Latin American and the Caribbean Countries Move to Animal Breeding for Resistance to Parasites

"Use anthelmintic and kill animal parasites" – the statement no longer stands true because parasites often become resistant to chemicals that are being used as anthelmintic in animal health management. Besides, chemicals are expensive and they pose threats to human health by adding toxic drug residues in the food chain. All these have emerged as a big challenge against sheep and goat farming in the Latin American and the Caribbean (LAC) countries. Small ruminant rearing is not only the second most important livestock industry in many countries but also provides subsistence family income to hundreds of thousands of smallholder families across the Andes ecosystem.

Sheep flock in in industrial production system, Argentina

Two examples below show how serious parasite infections and the issue of drug resistance are. In Argentina, due to gastrointestinal parasites (GIP) infections, a sheep produces between 15 and 20% less wool, which equals 1 kg of fleece/year – or US$ 2/animal/year. Besides, losses due to death or poor body condition in breeding stocks can be as high as US$ 70 and US$ 400 per ewe and ram, respectively. Similarly, Uruguay has recorded up to 50% death in lambs, 24% live weight loss and a loss of 29% greasy fleece weight due to parasite infections. The anthelmintic resistance in Uruguayan sheep farms is so serious that except for Monepantel, a new drug introduced seven years ago, none of the drugs efficiently work against GIP.

But there is good news. Research from the Joint FAO/IAEA Programme of Nuclear Techniques in Food and Agriculture and collaborating Members States have resulted in the development of tools for selecting sheep and goats that are more resistant to parasites. The LAC countries introduce breeding programmes to enhance the resistance of national sheep and goat flocks against GIP.

Breeding animals with higher resistance is a natural and sustainable method of controlling parasites because the method is free of impact on the environment and public health.

The project activities were planned and implemented to enable participating institutes to apply both conventional and nuclear-derived, innovative molecular techniques for a proper genetic evaluation and selection of superior animals for breeding to enhance their resistance to GIP. The activities involved sharing information and experiences, adoption of proven tools and techniques in animal reproduction, breeding and health, development and distribution of guidelines and manuals and building human and laboratory capacities. Conventional techniques used for on farm and laboratory investigations and diagnoses of parasitic diseases were also included in the capacity building package.

Sheep-goat flock in the smallholder production system in Andes Altiplano, Bolivia

LAC countries are better prepared for the selection of small ruminants for resistance to GIP

Argentina and Uruguay have incorporated GIP resistance-related phenotypes in the selection of rams for breeding. The proven phenotypes, visible inheritable characters that can be measured, that reflect resistance are the counts of worm eggs in the affected animal's faeces (FEC), scoring the anaemic status of an animal's conjunctiva using a proven colour chart called FAMACHA and the animals' body weight gains. Brazil and Cuba have further improved their animal genetic evaluation and selection processes specifically to focus on resistance to GIP.

Before implementing the project, except for the countries referred to above, the LAC countries did not have an effective breeding programme in place to increase resistance and improve productivity of small ruminants.

After two years of activities, all participating LAC countries have piloted animal identification and data acquisition for a proper genetic evaluation and selection of superior animals for breeding.

Through four regional training courses, 88 professionals from 12 countries were trained on animal identification and collection of records on phenotypes and pedigree information and of DNA samples for further analysis and identification of markers related to parasites resistance; tools and techniques on genetic evaluation and selection; sheep and goat health management with emphasis on parasite control; and application of assisted reproductive techniques for rapid dissemination of selected traits in the population. Laboratory capacities were enhanced in 12 countries through the provision of minor equipment, tools and expert services where needed for farm and laboratory diagnosis of GIP infections in animals. To conduct a breeding programme on the ground, a guideline and a manual were developed and distributed among the participating LAC countries.

The project has had a significant impact on the development of human resources and laboratory capacity together with guidelines, manuals and protocols for the genetic evaluation and selection of superior animals with higher productivity and resistance to GIP. Data on this document are generated from the ARCAL Regional Project on controlling parasite by increasing animal resistance (RLA5071).

Lanzhou University Supports Capacity Building on Animal Production Research Using Nuclear Techniques

Under the Technical Cooperation (TC) programme of the IAEA, five professionals, two from Cambodia, two from Palestine and one from Papua New Guinea, received trainings on the operation and application of modern equipment and proven technologies on the state of the art in animal nutrition research from Lanzhou University. This six-week training also created a platform for sharing information, knowledge and proven technologies that work in the region. As the Head of the School of Life Sciences of the Lanzhou University states, "This is not only a training, but it also provides a medium for exchanging ideas and sharing experiences. Through this, we understand better the background and needs of trainees in the regional context. New ideas and technology applications are learned from each other, which are helpful for future collaborations"

Professor Ruijun Long of the School of Life Sciences was the Supervisor of the fellows. The principal instructor of the group training was Dr Xi Li. The main objective of the training was to get participants proficient in using HPLC (high-performance liquid chromatography) technology in feed analysis. The additional objective was to increase their skills on conventional feed analysis and on-farm feed formulation to enhance animal production.

Participants practice the operation of the HPLC

Besides learning principles and procedures, the fellows are now capable of using HPLC to analyse micronutrients, toxins and drug residues in feeds. Further, the training on conventional feed analysis involved determination of crude protein, neutral detergent fibre, acid detergent fibre, ether extract and gross energy in locally available feed and forage samples. The combination of advanced and conventional feed analysis methods made the training very useful in the context of fellows' country needs.

The training was funded by three IAEA TC projects: KAM5003, PAL5007 and PAP5002.

The fellow group joins at a theoretical lecture

Benin Introduces Artificial Insemination in Cattle, Improving Animal Breeding and Nutrition

November 2017. For the first time, the government of Benin is introducing artificial insemination in cattle.

https://www.iaea.org/newscenter/news/benin-introduces-artificial-insemination-in-cattle-improving-animal-breeding-and-nutrition

Lesotho, Better Prepared to Fight Animal Diseases

September 2017. Diagnosing animal diseases early and rapidly is now possible in Lesotho, a country of two million in southern Africa that up until recently relied on foreign laboratories for analysis. Thanks to the support of the IAEA and the Food and Agriculture Organization of the United Nations (FAO), veterinary scientists in the capital Maseru are, since June 2017, using nuclear and nuclear derived technologies to identify and characterize viruses that affect livestock and humans.

https://www.iaea.org/newscenter/news/lesotho-better-prepared-to-fight-animal-diseases

DR Congo Scientists Control Avian Influenza Outbreak Using Nuclear Techniques

August 2017. Scientists in the Democratic Republic of the Congo have identified a new outbreak of avian influenza using highly specific and sensitive nuclear-derived techniques. Thanks to a quick detection and characterization of the virus and subsequent local response, the outbreak is currently under control and limited to the Lake Albert region, near the border with Uganda, scientists have said.

https://www.iaea.org/newscenter/news/dr-congo-scientists-control-avian-influenza-outbreak-using-nuclear-techniques

Artificial Insemination Doubles Value of Cambodian Cows, Increasing Farmers' Income

June 2017. Rolling out the artificial insemination programme for cattle in Cambodia would open up market opportunities and increase farmers' income, according to researchers and veterinary officials in the province where a pilot programme is under way with support from the IAEA and the Food and Agriculture Organization of the United Nations (FAO).

https://www.iaea.org/newscenter/news/artificial-insemination-doubles-value-of-cambodian-cows-increasing-farmers-income

Using Nuclear Science to Expand the Vaccines Portfolio (video)

July 2017. The discovery and production of vaccines were a breakthrough in efforts to protect people and animals from infectious diseases. Through vaccination, smallpox in humans and rinderpest in animals, have both been eradicated from the planet. However, the portfolio of preventable diseases must expand. A number of innovative vaccines is now in development, using an approach that calls for irradiating the pathogens.

Video available in English, Spanish, French and Arabic

http://www-naweb.iaea.org/nafa/aph/aph-multimedia.html#

FAO-AG Confers an Outstanding Teamwork Award to the Animal Genetic Resources Team

January 2017. The Animal Genetic Resources Team receives Outstanding Teamwork Achievement Award from FAO's Agriculture and Consumer Protection Department for its superior accomplishments in supporting the Global Plan of Action for Animal Genetic Resources and enhancing Member State capacities on characterization, conservation and sustainable improvement of locally-adapted livestock. The team is comprised of staff from the Joint FAO/IAEA Division's Animal Production and Health Section and FAO's Animal Production and Health Division.

http://www-naweb.iaea.org/nafa/news/2017-fao-ag-award-animal-genetic.html

IAEA Director General Highlights IAEA Support for Development during Myanmar Visit

July 2017. IAEA Director General Yukiya Amano highlighted the important role of nuclear science and technology in supporting sustainable development in his discussions with State Counsellor and Union Minister for Foreign Affairs Daw Aung San Suu Kyi, during his visit to Myanmar last week.

https://www.iaea.org/newscenter/news/iaea-director-general-highlights-iaea-support-for-development-during-myanmar-visit

Differentiating Transboundary Animal Diseases in a Single Test

March 2017. The IAEA, in partnership with the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, has developed a multi-pathogen assay at its Animal Production and Health Laboratory in Seibersdorf, Austria, that was validated in collaboration with veterinary laboratories from the VETLAB Network. The assay simultaneously detects the PPR virus and other pathogens causing similar signs of disease. Thanks to this innovative method, Member State scientists are now able to diagnose diseases more efficiently, both in terms of time and costs.

https://www.iaea.org/newscenter/news/differentiating-transboundary-animal-diseases-in-a-single-test

IAEA Helps Bulgaria Tackle Cattle Disease with Nuclear-Derived Technique (video)

July 2017. Traditionally common to Africa and Asia, lumpy skin disease emerged in Turkey in 2013 and has since rapidly spread through south-eastern Europe. The International Atomic Energy Agency (IAEA) is providing laboratory support and expertise to help countries battle the cattle disease that can cause significant economic losses to farmers.

https://www.iaea.org/newscenter/multimedia/videos/iaea-helps-bulgaria-tackle-cattle-disease-with-nuclear-derived-technique

Myanmar's Dairy Farmers Benefit from Cattle Breeding Programme Using Nuclear-based Techniques

January 2017. Genetic improvement of native cattle breeds through radio-immune assay and artificial insemination applications to increase milk production while retaining their adaptability to the local environment and tolerance to diseases, resulting in sustainable improvement of farmers livelihood in Myanmar. The IAEA and the Food and Agriculture Organization of the United Nations (FAO) have jointly supported Myanmar's Livestock Breeding and Veterinary Department in perfecting and rolling out appropriate technologies across the country.

https://www.iaea.org/newscenter/news/myanmars-dairy-farmers-benefit-from-cattle-breeding-programme-using-nuclear-based-techniques

Vets in Africa Help Prevent Spread of Zoonotic Diseases (video)

May 2017. Scientists are joining forces through the IAEA to prevent the spread of diseases that can be transmitted from animals to humans, known as zoonotic diseases.

https://www.iaea.org/newscenter/multimedia/videos/vets-in-africa-help-prevent-spread-of-zoonotic-diseases

Vets in Africa Help Prevent Spread of Ebola and Other Zoonotic Diseases

May 2017. During the Ebola epidemic of 2014, the IAEA reacted quickly to provide specialized diagnostic equipment to help combat the Ebola virus. With the immediate crisis over, the focus is now on longer term prevention. The IAEA, in partnership with the Food and Agriculture Organization of the United Nations (FAO), is providing expertise and equipment to help countries use nuclear-derived techniques to detect zoonotic diseases and respond to them.

https://www.iaea.org/newscenter/news/vets-in-africa-help-prevent-spread-of-ebola-and-other-zoonotic-diseases

IAEA Brings Together Experts from Africa to Increase Preparedness for Ebola and Other Zoonotic Diseases

August 2017. The International Atomic Energy Agency (IAEA) is bringing together African human health, veterinary and wildlife experts this week to strengthen early warning systems for managing animal-to-human, or zoonotic, disease outbreaks.

https://www.iaea.org/newscenter/pressreleases/iaea-brings-together-experts-from-africa-to-increase-preparedness-for-ebola-and-other-zoonotic-diseases

Strengthening Africa's Regional Capacity for Diagnosis of Emerging and Re-emerging Zoonotic Diseases (two videos)

April 2017. A key issue in dealing with highly contagious infectious zoonotic diseases is the personal safety of medical and veterinary staff during processes where they may be exposed to dangerous pathogens. To facilitate dissemination of safety knowledge in this area, the Joint FAO/IAEA Division has generated two videos: the first is a general introduction to the topic itself; the second a step-by-step instruction guide to the correct use of personal protective equipment during field sampling.

Diagnosing Zoonotic Diseases

http://www-naweb.iaea.org/nafa/aph/aph-multimedia.html#

Diagnosing Zoonotic Diseases - Training Video

http://www-naweb.iaea.org/nafa/aph/aph-multimedia.html#

These stories as well as other articles are also available under 'Highlights' on our Homepage http://www-naweb.iaea.org/nafa/aph/index.html

Coordinated Research Projects

Project Number	Ongoing CRPs	Project Officers
D31028	Application of Nuclear and Genomic Tools to Enable for the Selection of Animals with Enhanced Productivity Traits	M. Shamsuddin, K. Periasamy
D31029	Quantification of intake and diet selection of ruminants grazing heterogeneous pasture using compound specific stable isotopes	M. Shamsuddin M. Garcia Podesta
D32031	Early and rapid diagnosis and control of TADs – second phase- African swine fever	H. Unger G.J. 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.E. Lamien
D32033	Irradiation of Transboundary animal disease (TAD) pathogens as vaccines and immune inducers	H. Unger G.J. Viljoen
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.J. Viljoen

Application of Nuclear And Genomic Tools to Enable for the Selection of Animals With Enhanced Productivity Traits (D31028)

Technical Officers: Mohammed Shamsuddin and Mario Garcia Podesta

The CRP aims at enabling Member States in the application of genetic evaluation and selection involving genomic tools in artificial insemination (AI) programmes for rapid but sustainable improvement of livestock productivity. Ten research contracts (RC) and three research agreements (RA) have already been awarded.

Two major lines of research work are planned, one for those who target crossbreeding and the other for those who keep purebred taurine populations. The crossbreeding group will aim at admixture analysis to assess the distribution of genetic groups of crossbreds, evaluate their performance and identify suitable genotypes for the prevailing production systems. The group with purebred taurine populations will work to estimate PTAs (Predicted Transmitting Ability) of sires under local conditions, which will be correlated with genomic PTAs of sires at their origin. Two technical contracts were awarded, one on whole genome sequencing of the radiation hybrid clones of camel cells with that of hamster and the other on the use of isotope labelled amino acids for the detection of proteins synthesizes and released into maternal blood by embryos (day 16 pregnancy) as a marker for early pregnancy diagnosis tests. The second RCM will be held in late 2018 aiming at a midterm evaluation of the CRP and finalizing work plans for the rest of the CRP period.

Quantification of Intake and Diet Selection of Ruminants Grazing Heterogeneous Pasture Using Compound Specific Stable Isotopes (D31029)

Technical Officers: Mohammed Shamsuddin and Mario Garcia Podesta

The CRP aims at developing a practical method to predict pasture intake of ruminants grazing heterogeneous pastures and rangeland using stable isotopes to provide tools for better grassland management that enhance animal productivity and reduces impact on environment due to overgrazing, and to allow the design of effective feed supplementation strategies at farm level to optimize animal production. The first research coordination meeting (RCM) was held from 23 to 27 January 2017 at the Vienna International Centre, Vienna, Austria.

During the first phase of the CRP, a minimum of eight mature cattle/yaks will be penned and fed with a known set of five pasture/browse fresh grasses. Half of the animals will receive 10% extra of maintenance levels and the other half will be fed *ad libitum*. During the enclosure, feed composition and feed intake will be recorded, n-alkane will be orally administered, and feeds and faecal samples will

be collected. This procedure will be conducted in two major seasons within 18 months. Two technical contracts (TCs) were awarded, one on the analysis of n-alkane and stable carbon-13 isotope and the other on NIRS analysis of forages, diets and faeces. Results from the two TCs will be used in computing formulas for the estimation of dry matter and diet composition of ruminants grazing on heterogeneous pasture or ranch land. RC and TC holders will report progress done based on these work plans in the 2nd RCM by the first quarter of 2019. Based on the results obtained, additional research activities will be developed.

The Early and Rapid Diagnosis and Control of Tads – Second Phase – African Swine Fever (ASF) (D32031)

Technical Officers: Herman Unger and Charles Lamien

This CRP started in 2014 and focuses on evaluating technologies which could help to control ASF worldwide.

African swine fever is a contagious viral disease of pigs transmitted by ticks or through contact. In domesticated pigs, it leads to acute disease with high mortality and survivors are chronically infected serving as the reservoir for further transmission. Wild boars are the natural reservoir in Africa. Endemic in wide parts of sub-Saharan Africa it has spread in the last 10 years to the Northern Caucasus and keeps expanding primarily to the West and North. The disease creates severe economic hardship for pig farmers and due to the lack of a vaccine, culling and quarantine measures are the only tools available to control the disease. As pig production is in many cases a small-scale business, farmers often lack the means and education on how to fend off disease. Even with the availability of diagnostic tools, some issues regarding ASF epidemiology or virology are not understood.

Under the CRP, a validation trial for the serological diagnostic ASF tests (ELISA based) has been completed and the contract holders will now begin testing molecular diagnostic tools to define the fitness for purpose for each available test. In parallel, samples from infected pigs, wild or domestic, will be collected for virus isolation. These isolates should be further characterized by sequencing to gain a better understanding of the genetic diversity on a spatial scale. This knowledge together with information regarding the pathology of each strain should allow some insight into the underlying pathogenic mechanisms and might help identify epitopes of interest for a candidate vaccine. Finally, control measures will be initiated to see how efficient they are in the context of small scale commercial production. The first research coordination meeting took place from 7 to 11 July 2014 in Vienna, Austria. The second RCM took place from 20 to 24 June 2016 in Vienna, Austria.

Early Detection of Transboundary Animal Diseases (Tads) to Facilitate Prevention and Control Through a Veterinary Diagnostic Laboratory Network (VETLAB Network) (D32032)

Technical officers: Ivancho Naletoski and Charles Lamien

The Veterinary Laboratory Network (VETLAB Network) currently integrates 44 African and 19 Asian Member States which are dedicated to the sharing of knowledge and experience and to supporting each other during the implementation of international standards, routine diagnostic procedures, diagnostic approaches for specific disease outbreaks, thus facilitating emergency preparedness and response to animal health emergencies. The concept of networking proved very successful during the rinderpest eradication campaign. Nowadays, this concept has resulted in great successes in some of the Member States where diagnostic laboratories have received the ISO 17025 accreditation. Additionally, several other laboratories in this network are in advanced phases of implementation of the ISO 17025 standard and expect accreditation soon.

The VETLAB Network aims to establish a unique regional/interregional communication and activity structure which enables the sustainable functioning and upgrading of the member laboratories under internationally recognized principles.

A critical step for harmonization of diagnostic techniques is the establishment of primary and/or secondary standards (as appropriate) which can be used as references during the calibration and maintenance of the diagnostic tests. The present CRP will target the establishment of such standards for use in serological and molecular diagnostic techniques and produce the following outputs:

1. A set of internationally acceptable standards for the serological diagnostic techniques for priority diseases among the partners of the VETLAB Network;

2. A set of internationally acceptable standards for the molecular diagnostic techniques for priority diseases among the partners of the VETLAB Network;

3. Procedures for simultaneous detection of multiple pathogens (multi-pathogen detection panels);

4. Procedure for easy access, free-of-charge genetic sequencing services for pathogens of the priority diseases among the partners of the VETLAB Network;

5. Establish an information platform for integrated information collection, geo-visualization, analysis and decision making.

The project team is comprised of eight research partners (Argentina, Cameroon, Croatia, Ethiopia, Ivory Coast, The FYR of Macedonia, Morocco and Sudan), two technical partners (France and United Kingdom) and three agreement holders (two from France and one from Australia). The first RCM took place from 15 to 19 August 2016 in Vienna, Austria. The second RCM took place from 7 to 11 August 2017 in Vienna, Austria.

Irradiation of Transboundary Animal Disease (TAD) Pathogens as Vaccines and Immune Inducers (D32033)

Technical officers: Hermann Unger and Gerrit Viljoen

A recent CRP on the 'Evaluation of irradiation for vaccine production' clearly showed, that protection delivered through irradiated pathogen preparations is possible. Specifically, good results obtained with irradiated intestinal and haemo-parasites allow us to speculate that one can really induce protection against these parasites. This would be a big relief for farmers as the use of anti-parasitic drugs is expensive, reduces innate immunity and can lead to resistant strains. As man and animals are both affected by many parasites, this research addresses human health as well.

A recent consultant meeting on immunology agreed that vaccines against parasites will be a breakthrough in livestock production as many of these parasites, in addition to the symptoms and performance reduction they cause, can have immune compromising effect which can lead to other infectious diseases. So far, the irradiation of *Theileria*, *Haemonchus* and *Fasciola* has been addressed successfully and will now be followed up in this new CRP. *Theileria annulata* trials were successful and the same principle will now be tested with *T. parva* which causes East Coast Fever (ECF). A vaccine exists for ECF, but in ~20% of cases the vaccine can be a source of ECF or it does not induce adequate resistance. For *Haemonchus contortus* the expansion of production of the stage III larvae will be the major challenge. These irradiated larvae given orally lead to >99% protection. But the larvae have to be harvested from infected animals, which may be infected with other infectious organisms (*Fasciola hepatica* and *F. gigantica* are zoonotic parasites, i.e. they infect man as well). Preliminary experiments with irradiated larvae showed protection in terms of disease/ symptoms and prevent challenge infections. Here the production of metacercariae is the major problem and should be addressed. An additional topic in this CRP is the evaluation of irradiated pathogens as adjuvants. Gamma-irradiated influenza A viruses have shown their great capacity to induce a cellular immune response. So additional pathogens will be irradiated and their immune response in livestock tested. The first RCM took place from 3 to 7 April 2017 in Vienna, Austria.

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)

Technical Officers: Ivancho Naletoski and Gerrit Viljoen

The objective of this 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 labelled bird with specific characteristics (disease carrier) using conventional methods is negligible. Knowledge and experience obtained through the previous project (D32030) 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 etc. has attracted the attention of the scientific community; however, this can be used in epidemiological studies which target long-range transmissions 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 isotope ratios in the environment (especially open waters).

During the first phase of the IAEA CRP (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) several important fragments in the linking of SI ratios of feather samples (bird migrations) with the epidemiology of AI were established, including:

i) Development of a database of most common wild bird carriers of AI, including their migration patterns obtained from conventional studies (ringing, radio- and GPS locators). This database is to be used as reference information for the SI studies;

ii) Development of protocols for sampling, transport and testing of samples obtained from wild migratory birds;

iii) Evaluation of "PrimeStore" as a solution to inactivate pathogen infectivity by simultaneous preservation of the viral RNA. The component was important to facilitate

international transport and decrease the price of international shipment of samples;

iv) Adaptation of validated SOPs for detection of the AI virus and the NDV virus in wild birds;

v) Development of a validated SOP for DNA barcoding of feather samples, used for determination of the species from feathers (or parts of feathers) collected from the environment. The SOP can be also used for phylogeny of genotypes within a single species;

vi) Development of an algorithm for SI assignment of birds based on the feather and environmental (GNIP) SI ratios;

vii) Development of geo-visualization indicating the probability of origin of the birds, calibrated using established algorithms for SI assignment of birds.

Achievements of the CRP D32030 have shown not only that the isotope assignment works, but have delivered a full package of techniques that will compact 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: to detect birds that carry avian influenza viruses and eventually other dangerous pathogens and to evaluate the stable isotope ratios in feathers of these birds (only the pathogen carriers) to understand their origins and migration pathways.

Submission of Proposals

Research contract proposal forms can be obtained from the IAEA, the National Atomic Energy Commissions, UNDP offices or by contacting the Technical Officer. The form can also be downloaded from the URL:

http://cra.iaea.org/cra/index.html

Activities of the Animal Production and Health Laboratory

Animal Genetics

Application of Nuclear and Genomic Tools to Enable for the Selection of Animals with Enhanced Productivity Traits (CRP D31028)

Radiation hybrid mapping for dromedary camel

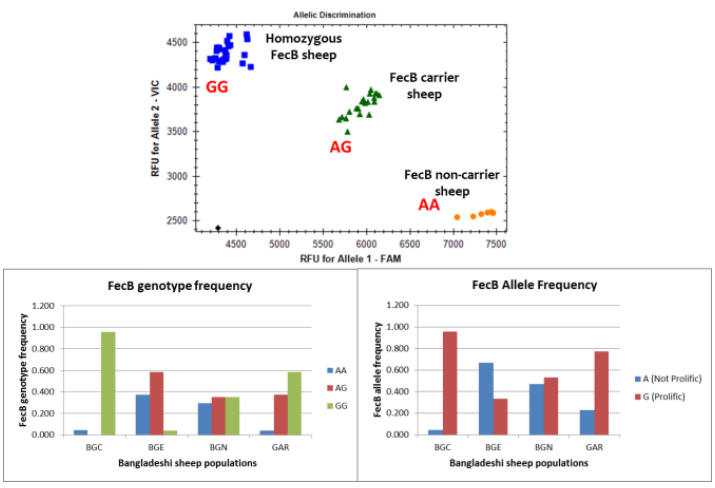
Radiation hybrid (RH) mapping has proven to be a reliable technique for producing chromosome level maps, an important prerequisite to develop genomic tools for improving livestock productivity. The Animal Production and Health Laboratory (APHL) recently completed the construction of two camel RH panels (5000_{RAD} and 15000_{RAD}), with an average retention frequency of 47.7% and 39% respectively. During 2017, APHL initiated the development of the first generation RH map for dromedary camels. About 200 oligos were designed from genomic scaffolds that are putatively located in chromosome 16. More than 100 oligos were optimized for PCR based typing of RH clones. Standardization of PCR conditions for remaining markers is currently in progress and the RH genotype data will be utilized to order and assemble the genomic scaffolds to camel chromosome 16.

Development and validation of a rapid, cost-effective genotyping tool for the detection of FecB (marker for twinning) in sheep

Mutations in a closely linked group of genes under the transforming growth factor-β (TGFβ) super family have been established to affect ovulation rate and litter size in sheep. Of these, bone morphogenetic protein receptor 1B (BMP15RIB; FecB) has been the first major gene widely attempted by researchers for marker assisted introgression to improve litter size in sheep. The mutation in BMP15RIB induces maturation of ovarian follicles by increasing the sensitivity of the follicles to follicle-stimulating hormone (FSH), thus resulting in higher ovulation rate and litter size. The weighted mean advantage of ewes carrying one copy of the FecB mutation was estimated to be +1.3 (range +0.8 to +2.0) for ovulation rate and +0.7 (range +0.4 to +1.3) for litter size across different production systems and varying recipient genetic background. Thus, with crossbreeding in sheep, it is possible to achieve significant increases in fecundity in a single generation. However, the advantage of the FecB mutation on ovulation rate, litter size and ewe productivity essentially depended on three major factors: donor and recipient genetic background, production system type, and potential maternal effect of recipient ewes. In general, FecB introgression has been found to be advantageous in small holder sheep production system, particularly for meat production.

The DNA marker based genotyping tool helps to improve the efficiency of back crossing and intercrossing in a marker assisted introgression program. During 2017, APHL initiated the development of a rapid, cost-effective genotyping tool for the detection of FecB in sheep. A simple and accurate competitive allele specific PCR based genotyping method was developed and optimized. The method has been validated and works well on at least three real time PCR platforms. Utilizing the new method, more than 1500 sheep belonging to various breeds and located across Asia, Africa, Europe and Latin America were screened. FecB was found in Indian and Indonesian sheep as expected. Interestingly, all the local sheep populations from Bangladesh were found to possess FecB with a frequency ranging from 33.3% to 95.5% (next graphic).

Sheep populations from eastern and northern Bangladesh showed good genetic potential for improved prolificacy and meat production.



(top) Competitive allele specific PCR based FecB genotyping; (bottom left) Frequency of FecB genotypes among Bangladeshi sheep populations; (bottom right) Frequency of FecB alleles among Bangladeshi sheep populations

Implementing Global Plan of Action for Animal Genetic Resources (AnGR)

Genetic characterization of indigenous guinea fowl populations in Burkina Faso (BKF5017)

In continuation of Joint FAO/IAEA efforts towards implementing the Global Plan of Action on animal genetic resources (AnGR), APHL supported genetic characterization of native guinea fowl populations in Burkina Faso through the IAEA technical cooperation project, BKF5017. Two fellows, Ms Fabiola Traore and Mr Amadou Traore, were trained on molecular genetic characterization using nuclear and extra-nuclear DNA markers. Guinea fowl is an important backyard poultry species in Africa providing livelihood and nutritional security in rural areas. Local guinea fowl populations in Burkina Faso remain largely under-utilized due to a lack of sufficient information on their genetic and production characteristics. During 2017, APHL designed and developed five sets of DNA marker panels for molecular characterization of guinea fowls. All the five sets involving 18 different markers were optimized for automated genotyping. A total of 192 Guinea fowl located in six regions (Tenado, Dori, Gaoua, Tenkodogo, Fada and Ouagadougou) were genotyped and analysis of data is currently in progress. The results of molecular characterization will help to classify native Burkina Guinea fowl populations into different groups based on their genetic characteristics. Different genetic groups of Burkina Guinea fowl will be tested subsequently for their fertility and growth performance under field conditions to identify the most suitable ecotype under prevailing guinea fowl production systems.

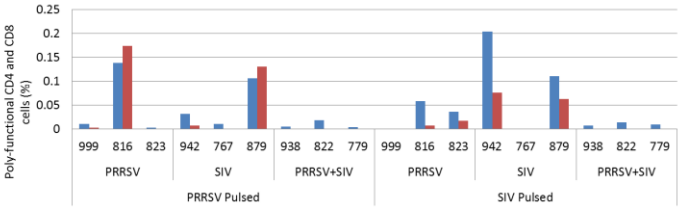
Animal Health

Defining Cell Mediated Immune (CMI) Responses in Hosts Vaccinated with Irradiated Vaccines

Long term immunity induced against vaccines is a key outcome in successful vaccines which is mediated by both humoral and cell mediated immune (CMI) responses. Measuring specific antibodies raised against vaccine antigens is the standard method of assaying humoral immunity and is frequently used in human and animal vaccines. However, in certain vaccines, especially with viral diseases, this does not always correlate with the protection produced by vaccines.

The APHL in collaboration with institutions in several Member States is conducting a research programme to develop novel irradiated prototype vaccines against important livestock pathogens, including Brucella, avian influenza, trypanosoma and gastro-intestinal parasites. The APHL and AGES are also working together on the evaluation of irradiated porcine reproductive and respiratory syndrome (PRRS) virus and swine influenza virus as candidates for novel vaccines.

In addition to producing irradiated organisms, one of the key supports in these experiments by APHL is to monitor CMI responses in vaccinated animals. In order to define CMI responses, we assayed CD4 and CD8 lymphocytes which are two effector cell subsets that are very important in confirming immunity against viruses. Once an effector immune cell is activated against a pathogen, it starts proliferating and starts producing cytokines. Among these cytokines, IFN-gamma, TNF-alpha and Interleukin (IL)-2 are strong indicators of Th1 type of immunity that yields robust responses. We measured the percentage of CD4 and CD8 lymphocytes (poly-functional lymphocytes; graphic below) that would produce all these three cytokines at single cell level by employing Boolean gating. The value of this was shown in preliminary experiments in which some of the vaccinated animals showed CMI but none showed humoral responses.



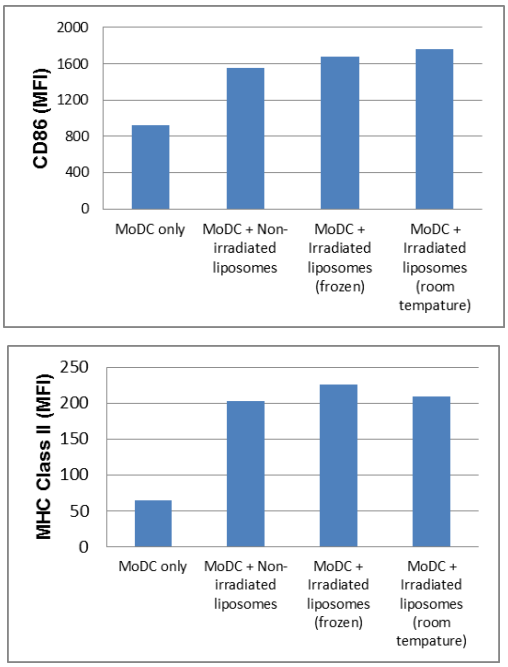
Percentage of poly-functional CD4 (blue) and CD8 (red) cells in peripheral blood from swine vaccinated with irradiated (30 kGy) PRRS virus (PRRS) or irradiated (30 kGy) swine influenza virus or combination of both of above (PRRS+SIV). Purified peripheral blood lymphocytes were pulsed with PRRS or SIV and intra cellular cytokine production and cell surface markers were analysed by a flow cytometer following staining with fluorescent conjugated monoclonal antibodies against these markers.

Effect of Irradiation on Vaccine Adjuvant Liposomes Containing Monophosphoryl lipid A (MPLA)

Vaccines induce long term immunity against infectious diseases through the activation of the host adaptive immune system. However, it is the innate immune system that recognizes the vaccine antigens at the site of inoculation through antigen presenting cells such as dendritic cells (DC) which eventually activate the adaptive immune system. Many vaccines, especially the subunit, lack the ability to activate the innate immune system - hence they need the extra boost through vaccine adjuvants. Liposomes are nanoscale molecules with at least one lipid bilayer and are used as carriers to deliver vaccine antigens. Monophosphoryl lipid A (MPLA) is a compound that is derived from lipopolysaccharides of the walls of gram negative bacteria which is safe and extremely potent in activating the cells of the innate immune system. Therefore, liposomes containing MPLA are excellent vaccine adjuvants and have been used along with many vaccine formulations to increase their potency.

Filtration is the method used to sterilize liposomes during production. However, some liposomes containing MPLA that consist of saturated phospholipids are too large to be filtered and gamma irradiation could be used for sterilization. In the past, several groups have tried using irradiation on different types of liposomes with variable success rates. At the APHL, we have developed a bovine DC biology programme and the biological effects of irradiation on MPLA liposomes were evaluated through DCs. This was a collaborative effort with another organization based in Vienna, Austria: Polymun Scientific Immunbiologische Forschung GmbH. The results obtained thus suggest that irradiation of MPLA liposomes at a dose of 25 kGy at room temperature does not change their adjuvant effect, rather it increases its potential in certain ways. This was confirmed by a slight decrease in antigen uptake ability and unaffected maturation (expression of MHC class II and CD86; graphic below) of bovine monocyte derived (MO)DC with irradiated liposomes. Furthermore, the chemical and physical properties of the liposomes were also unaffected by irradiation at room temperature with 25 kGy dose. Irradiation with the same dose under frozen conditions increased adjuvant activities of the liposomes further by increasing the antigen uptake. However, the physical and chemical properties were changed.

These results suggest that irradiation can potentially be used to sterilize MPLA liposomes and in future it will also be possible to use such adjuvants to increase the immunogenicity of the vaccines, including the irradiated ones.



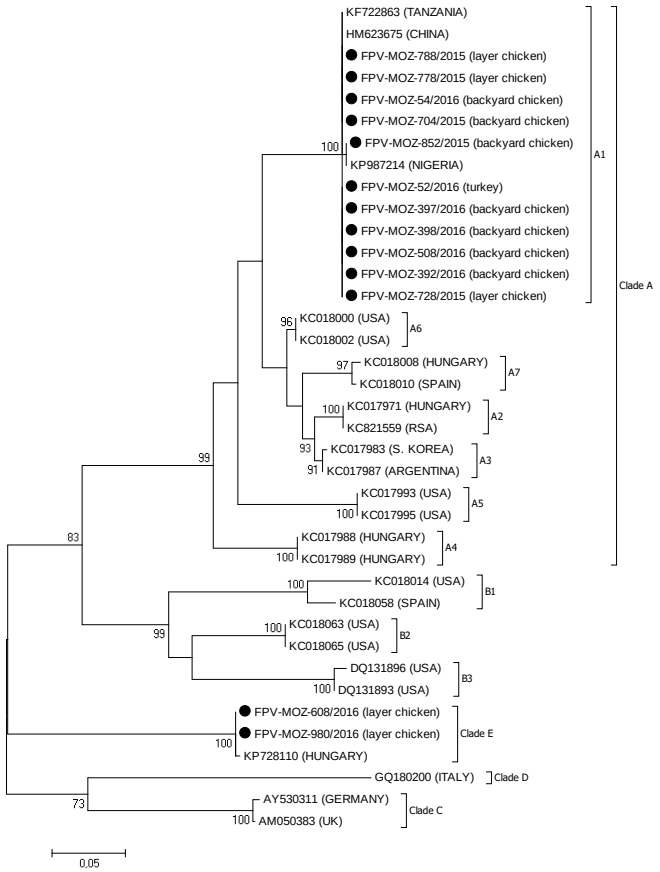
Expression of maturation markers of bovine MoDC when incubated without or with liposomes treated with without irradition. Mean fluoresnce intensity (MFI) of CD86 and MHC Class II is shown.

Fighting Poultry Infectious Diseases in Africa: the First Identification of Clade E Avipoxvirus in the Continent

Fowl pox (FP), caused by avipoxviruses, is endemic and commonly reported in Mozambique. The disease causes significant economic losses in domestic poultry as a result of a drop in the egg production, reduced growth, blindness and increased mortality which can reach 50%.

Samples from sixteen separate FP outbreaks were collected from four provinces by the Agrarian Research Institute of Mozambique between August 2015 and November 2016. The outbreaks primarily affected backyard chickens and commercial laying hens although a flock of broilers and another of turkeys were also investigated. The ante-mortem clinical signs and lesions reported included reduction of appetite, listlessness, nodules and/or scabs of different sizes on less feathered areas and pronounced ulcerations on the interdigital space. Different colour tones and irregular wrinkled shells were also observed on eggs.

Sixteen samples were positive following amplification with FP–specific primers. Amplicons were purified and sequenced. A phylogenetic analysis using the 4b protein gene sequences revealed that the majority of the samples collected contained virus that clustered in subclade A1 which has already been identified in Africa. However, two samples taken from chickens vaccinated against FP from two separate outbreaks three months apart were of particular interest because they clustered in clade E with a recently described avipoxvirus isolated in Hungary in 2011.



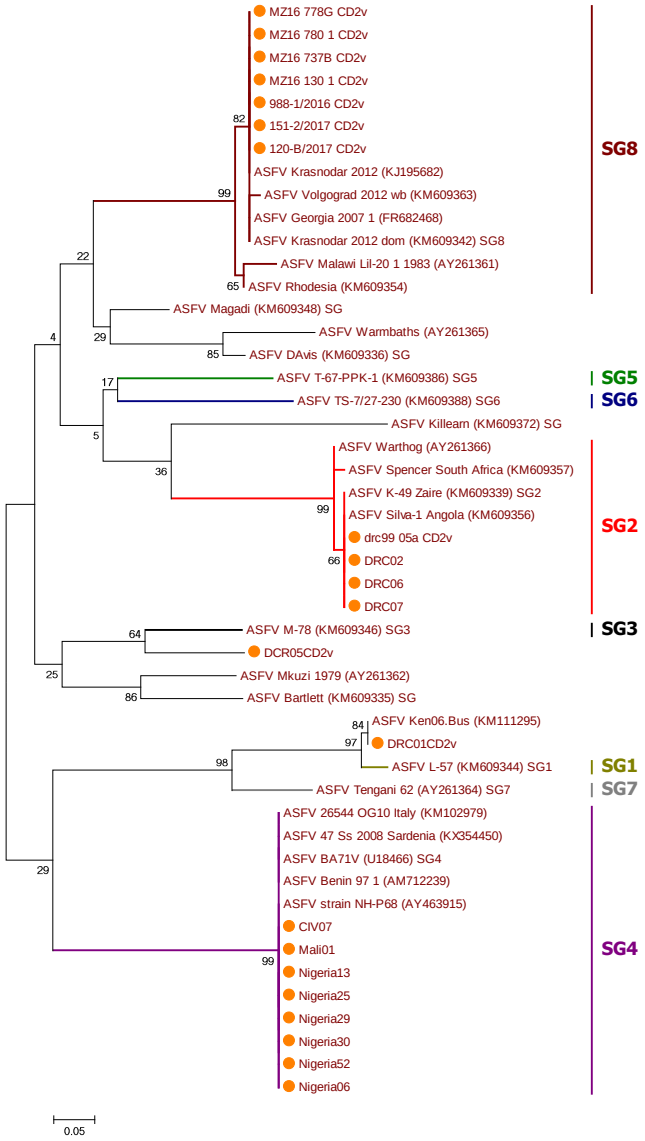
Phylogenetic analysis of avipoxviruses from Mozambique in 2015-2016 using a 4b protein gene fragment. Samples sequenced in this study are shown with black filled circles.

The identification of a clade E virus in Mozambique is intriguing and requires further investigation in order to understand how a virus which has only been reported once found its way to Mozambique.

In the meantime, the presence of FP in birds vaccinated against FP viruses requires urgent formulation of vaccination procedures and control strategies in Mozambique.

Molecular Epidemiology of African Swine Fever in Africa

The Animal Production and Health Laboratory (APHL) supports the efforts of several African Member States to tackle African swine fever (ASF) by reinforcing the local laboratory capacities to detect and perform in-depth analysis of the ASF virus (ASFV). APHL is also supporting several Member States to better characterize their local isolates in order to improve the understanding of ASFV diversity and epidemiology. Recently, APHL has taken advantage of its repository of ASFV samples to analyse the CD2v genes of isolates from various countries: Cote d'Ivoire, Mali and Nigeria in western Africa; Democratic Republic of Congo (DRC) in central Africa; and Mozambique in southern Africa. The CD2v gene has been reported to carry information enabling the determination of ASFV serotypes. The phylogenetic comparison of the partial sequence of the CD2v gene to a set of previously characterized ASFV serogroups (graphic below) revealed that eight isolates collected in western Africa (Mali, Cote d'Ivoire and Nigeria) belonging to P72 genotype I, clustered with ASFV serogroup SG4. Four isolates from DRC belonging to P72 genotype I clustered with serogroup SG2. This is in agreement with previous findings showing that most ASFV from genotype I belong to the serogroups SG1, SG2 or SG4. Nevertheless, two isolates from DRC (DRC01 and DRC05) did not fall within any of the known serogroups. DRC01 which belongs to ASFV P72 genotype IX clusters with a Kenyan isolate (ken06.bus) which is not yet assigned to any of the known serogroups. The isolate DRC05 was closer to, but clearly distinct from, M-78 isolate of Mozambique (serogroup SG3). All isolates from Mozambique (7) that we have previously characterized as belonging to ASFV P72 genotype II clustered with serogroup SG8. This is also in agreement with previous findings showing that most ASFV from genotype II belong to the serogroup SG8.



Maximum likelihood tree of ASFV CD2v protein sequences. The isolates of this study are highlighted with orange dots.

Interlaboratory Trial for Peste des Petits Ruminants (PPR) 2017

This year as in previous ones, the APHL organized an interlaboratory trial (ILT) for peste des petits ruminants (PPR) diagnosis. The ILT is an exercise to evaluate in a qualitative manner, the ability of the participating laboratories to detect the presence of antibodies against, or genome from, peste des petits ruminants virus (PPRV). The laboratories use well-established serological and molecular techniques in a panel of samples prepared and distributed by the APHL. In 2017, the test panel consisted of 20 gamma-irradiated vials in total; ten for nucleic acid and ten for antibody detection. In total, 31 laboratories in 27 countries (19 from Africa, seven from Asia and one from the EU) confirmed their participation.

Upon completion of the exercise, a final confidential report will be sent to the participating laboratories. The APHL will discuss with laboratories that have scored less than 100%, in a confidential and individual manner, issues regarding ways to improve diagnostic methods and techniques.

The APHL encourages all members of its laboratory network to participate in future proficiency tests as they are useful exercises to determine the ability of a laboratory to diagnose PPRV (VETLAB CRP D32032/ARF/PUI).

Fellows/interns/consultants

Ms Betty Kenny Uranoli from the University of Natural Resources and Environment, Papua New Guinea was trained on "DNA marker based molecular characterization of livestock" for two months (1 June 2017 to 31 July 2017) under TC fellowship (PAP/16001).

Ms María Agustina Raschia from Instituto Nacional de Tecnología Agropecuaria (INTA), Buenos Aires, Argentina was trained on "Bioinformatics analysis of genotypic data on host genetic resistance against gastro-intestinal parasites in sheep" for three months (7 August 2017 to 27 October 2017) under TC fellowship (ARG/16032).

Ms Hussaina Makun from National Animal Production Research Institute, Ahmadu Bello University Zaria, Nigeria was trained on "Real time PCR based species detection and genetic diversity analysis of Haemonchus parasites" for three months (7 August 2017 to 3 November 2017) under TC fellowship (NIR/16021).

Ms Fabiola Traore from Département Productions Animales, Institut de l'Environnement et de Recherches Agricoles (INERA), Ouagadougou, Burkina Faso was trained on "Molecular genetic characterization of Guinea Fowl populations breeds using nuclear and extra-nuclear DNA markers" for three months (11 September 2017 to 8 December 2017) under TC fellowship (BKF5017).

Mr Amadou Traore from Département Productions Animales, Institut de l'Environnement et de Recherches Agricoles (INERA), Ouagadougou, Burkina Faso was trained on 'Bioinformatics analysis of molecular genetic data on breed characterization in livestock' for two weeks (23 October 2017 to 3 November 2017) under TC fellowship (BKF5017).

Mr Sengxay Phonthasi from the National Animal Health Laboratory, Vientiane, Laos was trained on 'Transboundary animal diseases: diagnosis and characterization of pathogens' for two months (1 October to 30 November 2017) under TC fellowship (LA/17006).

Technical Cooperation Projects

Country TC Project	Description	Technical Officer(s)
Angola ANG5013	Applying Nuclear and Molecular Techniques for Diagnosis and Control of Transboundary Animal Diseases	G. Viljoen I. Naletoski
Burundi BDI5002	Improving Animal Production Through Enhanced Application of Nuclear and Related Techniques	H. Unger
Benin BEN5010	Using Nuclear Techniques for Better Utilization of Local Feed Resources and Improved Reproduction Practices to Enhance Productivity and Conserve Nature	M. Shamsuddin
Bangladesh BGD5030	Building Capacity to Improve Dairy Cows Using Molecular and Nuclear Techniques	M. Shamsuddin G. Viljoen
Burkina Faso BKF5017	Using Modern Animal Breeding Methods, Nuclear and Genomic Tools to Improve Dairy Production in Smallholder Production Systems	K. Periasamy M. Shamsuddin
Burkina Faso BKF5021	Improving Local Poultry Production Through Incorporation of Nutraceuticals in Feeds and Genetic Characterization	M. Shamsuddin
Botswana BOT5015	Establishing District Laboratories that use Nuclear and Molecular Techniques for Early and Rapid Diagnosis of Endemic and Transboundary Animal Diseases	G. Viljoen C. Lamien
Botswana BOT5016	Developing the Application of Immunological and Molecular nuclear and Nuclear Derived Early and Rapid Diagnosis and Control of Transboundary Animal and Zoonotic Diseases	G. Viljoen
Belize BZE5007	Supporting Sustainable Capacity Building through Distance Learning for Laboratory Personnel of the National Agricultural Health Authority	G. Viljoen
Belize BZE5009	Establishing Early and Rapid Diagnoses and Control of Transboundary Animal and Zoonotic Diseases	G. Viljoen
Central African R CAF5009	Controlling Contagious Bovine Pleuropneumonia and Peste des Petit Ruminants	H. Unger
Central African R CAF5010	Building National Capacities for the Diagnosis and Control of Animal Diseases and for Increasing Animal Production	H. Unger
Chad CHD5005	Studying the Causes of Pulmonary Diseases in Small Ruminants	H. Unger C. Lamien
Cameroon CMR5019	Using Nuclear Techniques to Improve Milk Production	M. Garcia Podesta M. Shamsuddin H. Unger K. Periasamy

Country TC Project	Description	Technical Officer(s)
Cameroon CMR5022	Controlling Transboundary Animal diseases with Special Emphasis on Peste des Petits Ruminants	H. Unger
El Salvador ELS5012	Optimizing Livestock Production Systems through Cultivation and Efficient Use of Local Feed Resources, Monitoring of Performance and Reduction of Environmental Pollution through Solid Waste and Biogas Utilization	M. Shamsuddin 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	M. Shamsuddin
Ethiopia ETH5020	Enhancing the Livelihood of Rural Communities through Addressing Major Zoonotic and Economically Important Small Ruminant Diseases	H. Unger C. Lamien
Indonesia INS5042	Improving Cattle Productivity Through Improved Feeding and Enhanced Reproduction	M. Shamsuddin
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
Côte d'Ivoire IVC5038	Studying Small Ruminant Respiratory Diseases	H. Unger G. Viljoen
Cambodia KAM5003	Supporting Sustainable Livestock Production	M. Shamsuddin M. Garcia
Kenya KEN5038	Using Nuclear Techniques to Evaluate and Improve the Impact of Mutated Forages on the Performance of Smallholder Dairy Cows	M. Shamsuddin
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
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
Madagascar MAG5024	Applying Nuclear and DNA-Based Techniques to Improve Productivity of Local Livestock germplasm through an efficient artificial insemination programme.	M. Shamsuddin K. Periasamy
Mauritius MAR5025	Improving the Productivity of Dairy Cattle through On-Farm Application of Achieved Research Information on Feeding Practices	M. Shamsuddin
Mauritania MAU5004	Supporting Genetic Improvement of Local Cattle Breeds and Strengthening the Control of Cross-Border Diseases	H. Unger M. Shamsuddin

Country TC Project	Description	Technical Officer(s)
Mauritania MAU5007	Supporting Genetic Improvement of Local Cattle Breeds and Strengthening the Control of Cross-Border Diseases - Phase II	M. Shamsuddin
Mali MLI5026	Improving the Diagnosis of Livestock Diseases	I. Naletoski C. Lamien
Mali MLI5027	Using Nuclear and Molecular Techniques for Early and Rapid Diagnosis, Epidemiological Surveillance and Control of Transboundary Animal Diseases	I. Naletoski C. Lamien
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	H. Unger
Montenegro MNE5003	Improving Diagnosis of Animal Diseases and Food Pathogens	I. Naletoski
Mongolia MON5022	Implementing Early Diagnosis and Rapid Control of Transboundary Animal Diseases, Including Foot-and-Mouth disease (FMD) and Peste des Petits Ruminants (PPR)	H. Unger G. Viljoen
Mongolia MON5023	Enhancing Livestock Production Through the Improved Diagnosis and Prevention of Transboundary Animal Diseases	H. Unger G. Viljoen
Morocco MOR5037	Enhancing Control of Chemical Food and Feed Contaminants, Animal Disease Diagnosis and Trade in Fresh Fruits	I. Naletoski
Mozambique MOZ5007	Enhancing Mutation Breeding of Sorghum and Pearl Millet to Develop High Yield, Disease Resistance and Drought Tolerance	G.Viljoen
Mozambique MOZ5008	Strengthening National Capacity for the Application of Nuclear and Related Techniques to Improve Animal Health and Production	G.Viljoen
Myanmar MYA5024	Supporting the National Foot-and-Mouth Disease Control Programme	G. Viljoen
Myanmar MYA5026	Improving the Livelihoods of Smallholder Livestock Farmers by Developing Animal Feeding Strategies for Enhanced Food Security	M. Shamsuddin
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
Nigeria NIR5040	Controlling Parasitic and Transboundary Animal Diseases to Improve Animal Productivity in Smallholder Farms Using Nuclear and Molecular Techniques	I. Naletoski,

Country TC Project	Description	Technical Officer(s)
Pakistan PAK5050	Developing a Facility for the Diagnosis of Transboundary Animal Diseases and Vaccine Production	H. Unger, V. Wijewardana
Palestine PAL5007	Upgrading Animal Feeding Laboratory in Terms of Human Capacity Building and Infrastructure	I. Naletoski, M. Shamsuddin
Papua New Guinea PAP5002	Genetically Characterizing and Improving Productivity of Cattle by Enhanced Reproduction and Better Feeding	K. Periasamy, M. Shamsuddin
Papua New Guinea PAP5003	Enhancing Genetic Characterization and Improving Productivity of Cattle by Enhanced Reproduction and Better Feeding - PHASE-II	M. Shamsuddin
Peru PER5032	Conducting Genetic Characterization of Alpacas for Resistance to Diseases	K. Periasamy, M. Shamsuddin
Congo, Rep. PRC5001	Monitoring Livestock Diseases and Certifying Animal Health	H. Unger
RAF0042	Promoting the Sustainability and Networking of National Nuclear Institutions for Development	I. Naletoski
RAF5068	Improving Livestock Productivity through Strengthened Transboundary Animal Disease Control using Nuclear Technologies to Promote Food Security (AFRA)	H. Unger 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.	H. Unger I. Naletoski
RAS5078	Enhancing Food Safety Laboratory Capabilities and Establishing a Network in Asia to Control Veterinary Drug Residues and Related Chemical Contaminants	G. Viljoen
RER5023	Enhancing National Capabilities for Early and Rapid Detection of Priority Vector Borne Diseases of Animals (Including Zoonoses) by Means of Molecular Diagnostic Tools	I. Naletoski
RER9137	Enhancing National Capabilities for Response to Nuclear and Radiological Emergencies	I. Naletoski
RLA5071	Decreasing the Parasite Infestation Rate of Sheep (ARCAL CXLIV)	M. Shamsuddin
Senegal SEN5036	Controlling *Mycoplasma mycoides* Infection — Contagious Bovine Pleuropneumonia (CBPP) and Contagious Caprine Pleuropneumonia (CCPP)	H. Unger
Seychelles SEY5008	Building Capacity for Diagnosis of Animal Diseases using Nuclear and related Techniques (Phase I)	H. Unger G. Viljoen
Sierra Leone SIL5018	Strengthening Artificial Insemination and Disease Diagnosis Services Coupled with Improved Feeding to Enhance the Productivity of Cattle	H. Unger M. Shamsuddin

Country TC Project	Description	Technical Officer(s)
Sierra Leone SIL5019	Strengthening Capacities for the Diagnosis and Control of Zoonoses to Improve Public Health Services and Livestock Production	H. Unger
Sri Lanka SRL5045	Establishing a National Centre for Nuclear Agriculture	H. Unger C. Lamien
Sri Lanka SRL5046	Improving Livelihoods Through Dairy Cattle Production: Women Farmers' Empowerment	M. Shamsuddin M. Garcia Podesta
Sudan SUD5036	Improving Livestock Production for Enhanced Food Security through Genetic Improvement of Indigenous Animal Breeds Using Artificial Insemination, Improved Nutrition and Adequate Animal Disease Control Measures	I. Naletoski M. Garcia Podesta
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. Shamsuddin
Togo TOG5001	Improving and Promoting Bovine Milk Production through Artificial Insemination	M. Shamsuddin
Tunisia TUN5028	Supporting Watering Strategies to Help Livestock Raised in Semiarid and Arid Regions Coping with Climate Change	M. Garcia Podesta I. Naletoski
Uganda UGA5035	Improving Food Safety through Surveillance of Fish Diseases	H. Unger C. Lamien
Uganda UGA5038	Supporting National Animal Production and Productivity through the Establishment of Regional Animal Health Centres and Improving Disease Control at the National Animal Disease Diagnostics and Epidemiology Centre	H. Unger
U.R. of Tanzania URT5031	Improving Indigenous Cattle Breeds through Enhanced Artificial Insemination Service Delivery in Coastal Areas	M. Shamsuddin
Vietnam VIE5019	Applying Nuclear Related Techniques for Transboundary Animal Diseases (TADs) Diagnosis	G. Viljoen V. Wijewardana
Yemen YEM5012	Improving Diagnostic and Analytical Capabilities of the Central Veterinary Laboratory Including Residue Testing of Animal Products	H. Unger
Yemen YEM5014	Improving Management of Small Ruminants	H. Unger
D.R. Congo ZAI5023	Upgrading Laboratory Services for Capacity Building in Fish and Aquaculture Diseases as a Contribution to Sustainable Poverty Alleviation and Sanitary Security of Food	H. Unger
D.R. Congo ZAI5024	Upgrading Vaccine Production to Protect Livestock from Transboundary Animal Disease	H. Unger V. Wijewardana

Country TC Project	Description	Technical Officer(s)
D.R. Congo ZAI5027	Developing Early and Rapid Diagnosis and Control of Transboundary and Zoonotic Diseases	H. Unger
Zimbabwe ZIM5022	Establishing Molecular Epidemiology Methods, Tissue Culture and Production of Biological Reagents for the Surveillance of Livestock Diseases	I. Naletoski V. Wijewardana
Zimbabwe ZIM5024	Establishing an Artificial Insemination Center to Enhance the Rebuilding of the National Herd	M. Shamsuddin

Publications

Publications in Scientific Journals

Grema M, Traoré A, Issa M, Hamani M, Abdou M, Soudré A, Sanou M, **Pichler R**, Tamboura H, Alhassane Y, **Periasamy K**. 2017. Short tandem repeat (STR) based genetic diversity and relationship of indigenous Niger cattle. Arch Anim Breeding. doi: 10.5194/aab–3–1–2017

Shatar M, Khanui B, Purevtseren D, Khishgee B, Loitsch A, **Unger H**, **Settypalli TBK**, **Cattoli G**, Damdinjav B, **Dundon WG**. 2017. First genetic characterization of peste des petits ruminants virus from Mongolia. Arch Virol 7. doi: 10.1007/s00705–017–3456–4

Diall O, Cecchi G, Wanda G, Argilés-Herrero R, Vreysen MJB, **Cattoli G**, **Viljoen GJ**, Mattioli R, Bouyer J. 2017. Developing a progressive control pathway for African animal trypanosomosis. Trends Parasitol 33: 499-509. doi: 10.1016/j.pt.2017.02.005

Ferrara F, Molesti E, Scott S, **Cattoli G**, Temperton N. 2017. The use of hyperimmune chicken reference sera is not appropriate for the validation of influenza pseudotype neutralization assays. Pathogens 6(4): E45. doi: 10.3390/pathogens6040045

Milani A, Fusaro A, Bonfante F, Zamperin G, Salviato A, Mancin M, Mastrorilli E, Hughes J, Hussein HA, Hassan M, Mundt E, Terregino C, **Cattoli G**, Monne I. 2017. Vaccine immune pressure influences viral population complexity of avian influenza virus during infection. Vet Microbiol 203: 88–94. doi: 10.1016/j.vetmic.2017.02.016

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