Joint FAO/IAEA Programme
Nuclear Techniques in Food and Agriculture

Animal Production & Health Newsletter

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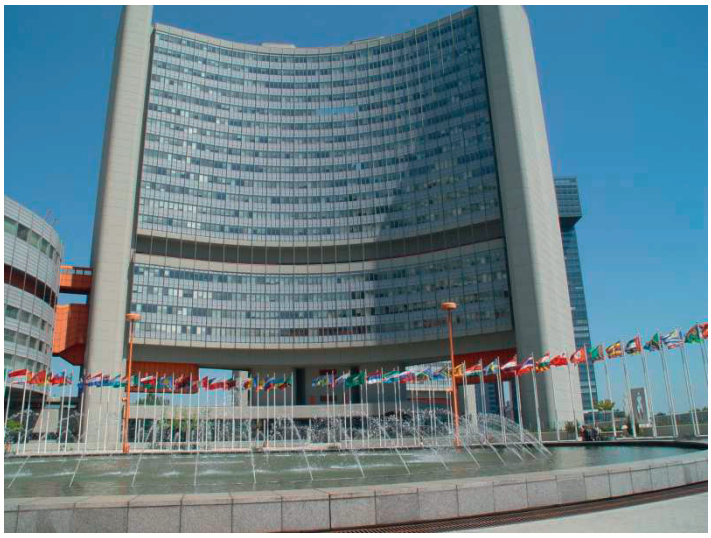
To Our Readers

This year, the Animal Production and Health Section is 50 years old. The Joint FAO/IAEA Division with its respective Sections was established in 1964 as part of an agreement between the DGs of FAO and IAEA to promote food and agriculture through atomic, nuclear and nuclear related technological means. To complete the work of the Animal Production and Health Section, the Animal Production and Health Laboratory was established in 1984. Since its inception in 1964, the Animal Production and Health Section had many achievements. Two of the best known achievements were the Section's development and establishment of the radioimmunoassay (RIA) platform that measures and monitors progesterone to improve quality and quantity of livestock, and the Section's unique contribution towards the eradication of Rinderpest. The Animal Production and Health Section has evolved over the years and is dynamically changing to offer maximum assistance to the Member States to overcome constraints and to achieve the sustainable intensification of animal production in an environmentally safe, clean and ethical way. Atomic, nuclear and nuclear related technologies play an important role towards achieving these goals. The Animal Production and Health Section identifies new areas of interest based on the Member States' needs to improve efficiencies and to control threats to animal production and health. To this effect, several platforms, assays, diagnostic kits and technical procedures have been developed, adapted and transferred to Member States, supported by R&D, expert technical backstopping and guidance from our Animal Production and Health Laboratory. In addition, several nuclear based technologies (such as reproduction and disease related radioimmunoassay have been adapted to other types of chemistries (e.g. chemiluminescence instead of isotopes) to be used at the farm level. Stable isotopes and radio- isotopes, however, still play an important and niche role to achieve the levels of sensitivity and specificity needed by the livestock



Vienna International Centre, IAEA Headquarters.

community in ensuring secure and safe food, to follow and measure feed and nutritional conversion into usable energy in the animal, to improve animal breeding traits towards more and of better quality animals, to monitor migratory animals and their associated pathogens, to generate safe and protective animal vaccines through the irradiation of pathogens and to develop and transfer early and rapid diagnostic platforms.

The Section furthermore ensures the deployment and widespread use of applicable technologies in countries most at risk from climatically influenced livestock and zoonotic diseases. This technical support and guidance to countries (which test to use, when and for what purpose, equipment needs, staff training and proficiency, and quality management) played a vital role in building developing

countries' capacities during recent outbreaks of avian influenza, foot and mouth disease, peste des petits ruminants, African swine fever and Rift Valley fever. We hope to continue this approach for the next 50 years.

Member States of IAEA have called for an initiative to renovate and modernize the Nuclear Sciences and Applications Laboratories in Seibersdorf, called the ReNuAL project. In the 52 years since the IAEA's Nuclear Applications laboratories in Seibersdorf (five of which are in the field of agriculture under the Joint FAO/IAEA Division) were established, there has been no comprehensive renovation or significant upgrading of equipment to ensure the continuing ability of the laboratories to respond to Member States' growing and evolving needs. The ReNuAL project, includes in its first phase those elements to be achieved from 2014–2017 within the €31 million target budget established by the Director General. The ground-breaking is planned for 29 September 2014, with completion - by December 2017.

Looking back at the activities of the past six months, we had several workshops, training courses, research co-ordination meetings (RCMs) and consultants meetings. Activities scheduled for the next half-year include project review meetings, RCMs, inter-regional training courses and regional workshops. Both past and future activities are discussed in further detail in this newsletter and are also accessible at our website. Let us know if you have any ideas, comments, concerns or questions. We thank all those who have responded to our request to update their contact and mailing address details and urge those who haven't to please do so by replying to R.Reiter@iaea.org or S.Piedra-Cordero@iaea.org. This will ensure that the next copy of our newsletter will be received. By also sending us the addresses of unsubscribed colleagues we will be able to widen our network. As discussed in previous newsletters, the Animal Production and Health Section will continue to move progressively forward and in pace with developments within the livestock field so as to optimally serve our Member States. We will therefore continue to encourage project teams to keep abreast of current technological developments and to promote their implementation where feasible (please see the Expert Opinion section in this newsletter by Prof Peter H. Robinson).

It is hoped that this would allow for a better positioning of our Member States with respect to international trade and other livestock-related issues. In turn, it is hoped that this would promote improved quality assurance of animal husbandry and health practices, and lead to a greater autonomy for Member States.

Please see other sections of our newsletter and website for more information.

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The Animal Production and Health Laboratory, Seibersdorf, is a collaborating Centre for ELISA and molecular technologies in animal disease diagnosis for the OIE

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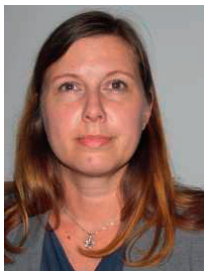
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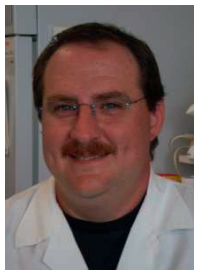
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Joint FAO/IAEA Division
of Nuclear Techniques in Food and Agriculture
50 years, 1964–2014

50TH ANNIVERSARY: 1964-2014 & Beyond

Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture

Established on 1 October 1964, the FAO and IAEA created the Joint FAO/IAEA Division as a strategic partnership in order to mobilize the talents and resources of both organizations and hence to broaden cooperation between their Member States in the peaceful application of nuclear science and technology in a safe and effective manner to provide their communities with more, better and safer food and agricultural produce while sustaining natural resources.

Fifty years later, this FAO/IAEA partnership still remains unique, with its key strengths based on interagency cooperation within the United Nations family. It is a tangible joint organizational entity with a fusion of complementary mandates, common targets, a joint programme, co-funding and coordinated management. It entails close cooperation, greater efficiency and shared approaches, and geared to demand-driven and results-based services to its Members and to the international community at large.

Nuclear applications provide added value to conventional approaches in addressing a range of agricultural problems and issues, including food safety, animal production and health, crop improvement, insect pest control and sustainable use of finite natural resources. Over the past 50 years, this partnership has brought countless successes with distinct socio-economic impact at country, regional and global levels in Member States.

During the past 50 years the mission of the Joint Division has proactively evolved to embrace the adaptation to and mitigation of climate change and the adverse effects of globalisation, to increase biodiversity and to further contribute to agricultural development and global food security. Today, both FAO and IAEA strive to mobilize commitment and concerted action towards meeting the Millennium Development Goals and the Sustainable Development Goals through appropriate use of nuclear and related technologies for sustainable agriculture and food security.

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Expert Opinion

Livestock Production – Future Directions and Priority Research Areas

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Dr Peter Robinson is a native Canadian with a PhD from Cornell University in Ithaca (NY, USA) in dairy cattle nutrition. He started his career with an MSc in ruminant nutrition from the University of Guelph (ON, Canada) before working in the Western Canadian feed industry for 3 years. After his subsequent PhD studies, he did a 2 year post-doc in Lelystad (Netherlands) before working for Eastman Chemicals Ag Division in Rochester (NY, USA) for 1 year followed by a 30 month research associateship at the University of Alberta (Edmonton, AB, Canada). He then was asked to join Agriculture Canada Research Branch in Fredericton (NB, Canada) for 8 years as a research scientist. During all of this time Dr Robinson's focus was on nutrition and management of lactating dairy cows, with particular emphasis on rumen function utilizing small groups of ruminally and intestinally cannulated dairy cows. In 1997 Dr Robinson joined UC Davis in California (USA) as an Extension Specialist with statewide responsibility for nutritional issues and management impacting lactating ruminants in the California dairy industry. In his 17 years at UC Davis, Dr Robinson has developed a near market research program which focuses on taking the lab to the farm, and he and his graduate students have completed several research projects on large commercial dairy farms which have been published in peer review journals. During his career, Dr Robinson has also been active internationally working with colleagues in South America, Europe, South Africa and India on local issues impacting lactating ruminants.

1. Background

Increased production of animal based foods has been due to increases in animal numbers, with the inevitable increase in concentration of animals, as well as increases in production per animal, with the associated increase in waste output per animal. Neither of these changes has been readily accepted by most urban populaces, which have benefited from the lower prices of the food produced, while paying the price of the increased collateral negative impacts of that food production on the environment. It is likely that the success of the animal industries in increasing food production led directly to a lack of concern by the consuming populace about the security of food availability, and an increasing regulatory concern to mitigate its negative effects on the environment. However, in countries where food security remains a concern, the regulatory (and research) focus remains on increasing food supplies. This differentiates animal production concerns of most developed countries from those of most developing countries, as well as what drives the focus of the research community which supports animal industries in different parts of the world.

2. Attitudes to Livestock: The Developed vs. the Developing World

In most of the developed world, food concerns revolve around ways to control food production in order to prevent accumulation of unnecessary supplies, suppress food energy intake of the populace to reduce obesity, change the nutritional profiles of foods to make them more 'healthful' to those humans who consume them, and mitigate environmental impacts of the animals which produce the food products. Developed countries' focus on animal research has been directed not only to increasing animal productivity to protect against a potential food shortage but also to mitigate greenhouse gas emission and protect environment.

In many European countries, traditional farm animals, such as sheep and cattle, are increasingly seen as being appropriate in rural areas only if they can be used to manage, or direct, the environment in a way, or to a state, which is consistent with the desires of the politicians and the people they represent. Food production from such animals essentially becomes the by-product of their existence and a supplement to foods obtained from someplace else which, in most cases, means that it will be imported from another country with the associated 'export' of the environmental production impacts. Regional or even

national, food self-sufficiency is no longer considered to be a necessity in much of the developed world. These factors direct production animal research away from its traditional focus of increasing animal productivity to new research areas which aim to mitigate the environmental impacts of production animals, use production animals as ways to shape the environment and to create animal products which are more 'healthful' to the humans who consume them.

However, in much of the developing world, confidence in the adequacy of food supplies relative to demand does not exist, much less a confidence in an ability to increase supply, or replace local supplies, in the face of an event which interferes with the existing food supply chain. Here, national and regional food self-sufficiency is generally considered to be a rational legislative and research goal. Thus the traditional focus of animal research, to increase food supplies by increasing animal productivity, remains a focus, albeit while attempting to use new research tools, such as genetic engineering, to achieve it. However in many cases the primary focus of animal scientists is not the animal, since export/import of live animals, semen and embryos has created a more homogeneous international production animal population than ever before, but rather a focus on feeds which are available locally or regionally and provide the bulk of the animals' feed intake. While scientific expertise in plant physiology and biochemistry is transferable, the plants themselves generally are not transferable due to local agronomic conditions and so local challenges to understanding the nutrient profiles of plants and/or nutritional upgrading of plant biomass by-products remains important.

In short, people have always been firstly concerned with assuring their food supplies and only become concerned with peripheral issues, such as the environmental impact of food production, the healthfulness of foods and the welfare of food animals when the possibility of a food shortage is fully and completely eliminated from the public conscience.

3. Livestock Research Priorities: The Developed World

Priorities for food animal research in the developed world can be divided into the general areas of changing the nutritional profiles of foods to make them more 'healthful' to the people who consume them, mitigating the environmental impacts of the animals which produce the food products, and increasing animal productivity. The latter represents the traditional role of animal scientists and appears to be the least favored in terms of research funding.

More healthful livestock food products

As most animal food products contain some animal fat, and animal fat has been associated with obesity and increased disease risk in humans, it has long been considered desirable to reduce its intake by humans. This has partially been achieved by manual fat removal from cuts of meat prior to public sale. Clearly this is a wasteful way to produce 'lean' cuts of meat, as feed and water resources must be expended (and animal wastes created) to produce the animal fat, which can be a disposal problem. In contrast, fat removal to create fat reduced (or 'fat-free') dairy products has not encountered the same problems, as 'removed' dairy fats are readily used for other dairy products. Research into the metabolic processes which direct nutrient precursors into fat versus protein synthesis by ruminant animals has received some attention although, to date, practical results/outputs/products suitable for commercial application have been limited. It seems clear that more research is required to understand the metabolic processes which govern the ways in which absorbed nutrients are utilized, thereby creating an ability to substantively impact carcass composition and deliver cuts of meat with higher lean to fat ratios.

Perhaps the most active research area on healthfulness of animal foods has been the increase in understanding of the different impacts of the individual fatty acids within fats on human metabolism. Negative effects of saturated fats with trans-bonds are now understood, and many food processors have moved to remove 'trans fats' from food products. The different impact of saturated versus unsaturated fatty acids on human health has been understood for some time, and much of this research focused on mitigating negative impacts of saturated fatty acids by replacing them with more 'healthful' unsaturated fatty acids. However recent research has focused on beneficial impacts to human health of consumption of specific fatty acids, notably conjugated linoleic acid (CLA). That fats could be less detrimental has been understood for some time, but that they have health benefits represents a sharp change in attitude towards the role of animal fats in human diets. In spite of the large amount of research on CLA in recent years, more is required to understand the metabolic processes which govern its synthesis in ruminants, so that fatty acid profiles of fats can be impacted to a greater (and practically applicable) extent than has occurred to date.

Mitigating environmental impacts of livestock

Low numbers of cattle per unit area can have positive impacts on the environment by, for example, maintaining open space, eating invasive plants or consuming by-products of other agricultural enterprises which would otherwise be a disposal problem. Low numbers of animals per unit area can also be perceived, by their human neighbors, to be a positive addition to the environment by, for example, preventing urban development and providing pastoral scenes. However as the numbers of cattle per unit area and their productivity levels increase, localized environmental impacts increase, and public perceptions of those local impacts are generally negative. While it seems

self-evident that the productivity and environmental impact of two similar cows is double that of one cow, it seems less evident to the public that the environmental impact of one cow producing double the product of two other similarly sized cows is lower. There has been confusion in this context, as many groups and persons have not differentiated waste outputs per cow from waste output per unit product, such that higher producing food animals are vilified for their high waste output per animal while, in fact, producing less waste per unit product. It is important that the huge positive impacts of increased animal productivity on reducing environmental impacts are more generally understood by urban populaces so that regulatory action is consistent with the way that animal wastes are produced. Unfortunately, in this context, perceived effects may be at least as important as real impacts (perhaps because perceptions are easier to agree upon) to the setting of regulations which impact farmers.

It is clear that animal farming has environmental impacts on water and air quality. As the size of animal operations, animal densities and animal productivity increase and the potential for local and regional impacts increase due, for example, to local releases of waste water to surface or sub-surface waters, or release of volatile compounds to the atmosphere. However it is poorly recognized that even as the potential local impacts of larger, generally denser, animal operations with higher producing animals' increases, their global impacts decrease due to a better ability to confine, and manage, those wastes and the lower net production of waste per unit product produced due to higher (generally) animal productivity. In contrast, large production facilities have no higher ability than smaller facilities to confine gaseous emissions to the atmosphere, although efforts have been made in some European countries to limit aerosol releases by rapidly moving animal wastes to fermenters in order to capture fermentation gases to create electrical power. While this does little to impact net carbon release to the atmosphere, it does change it from methane, and perhaps other volatile organic compounds (VOC), to carbon dioxide, which is a less potent greenhouse gas.

An important compound released to the atmosphere from animal operations is ammonia. In contrast to carbon based compounds, where larger more dense operations with higher producing cows will reduce net aerosol emissions to the atmosphere, and make them easier to control, these operations generally result in higher ammonia emissions due to the inability to easily separate urine (containing urea) from faeces (containing urease) and so limit production of volatile ammonia from non-volatile urea. Indeed ruminants on pasture, or other extensive operations, tend to defecate and urinate on separate spots, thereby limiting ammonia creation. Ammonia release from animal operations to the atmosphere is important, as ammonia is involved in chemical reactions with NOX and SOX compounds to create small aerosol particulates which can penetrate lung tissue and are associated with respiratory problems in affected persons. Ammonia can also be removed from the atmosphere in rain, thereby fertilizing naturally vegetated areas to stimulate their growth and/or allow infiltration of invasive species.

Ruminally bioactive compounds have been used as feed additives both knowingly and accidentally as components of plants, for many years. However, the criteria for their commercial use were based on their impacts on animal productivity, with little or no consideration of other impacts. Recent research with ruminally bioactive compounds (e.g., plant extracts, plant essential oils, yeasts), primarily using rumen in vitro systems, suggests that several of them impact the ruminal carbon balance, particularly of ruminally created gases, suggesting that there is potential to reduce release of eructated ruminal gases through use of some of these compounds as feed additives. There is also research in the area of aerosol emissions from production animal systems, although much more research is needed to understand the animal, and post-animal, metabolic processes which create ammonia and VOC. Without a clear understanding of how VOC, in particular, are metabolically synthesized in production animals, it will be difficult to mitigate their production.

Increasing productivity of cattle

There is still a substantive amount of research in this area in the developed world, although it is increasingly limited to the USA, but it is decreasing worldwide. Nevertheless, currently active areas of research include:

Impacts of fats and fatty acids on ruminal fermentation remains poorly understood even as they become more important due to higher feeding levels of fats in dairy cattle rations. There is a need for more research on impacts of specific fatty acids on rumen bacterial growth and collateral impacts on carbohydrate digestion. In addition, impacts of specific fatty acids on milk fat synthesis are very active research areas and have led to an improved understanding of the unpredictable phenomenon of 'milk fat depression'. However, to fully capture the ability to manipulate milk fat output, more research will be required, and it will need linkage to impacts on the fatty acid profile of milk fat and its impacts on human health.

Structural carbohydrates are generally the slowest digesting fraction of ruminant diets and, as such, drive voluntary intake potential and the net energy density of diets. There has been an important recent shift in the commercial sector to utilize rumen in vitro fermentation systems to determine the potential digestibility of structural carbohydrates (mostly within feedstuffs) to assess potential intake and energy value of those feedstuffs. Similar systems have been utilized by feed analysis services in many European countries for over 25 years. However, the reliance on a biological (i.e., in vitro) 'test', regardless of its specific nature, suggests a fundamental lack of understanding of the differences

among structural carbohydrates which impact their resistance to bacterial degradation in the rumen (i.e., rate and extent of ruminal degradation). In order to escape the use of inherently variable in vitro systems, research is required to understand the basic chemistry of structural carbohydrates, both within and among feedstuffs.

There are some dietary nutrients, such as urea (as a ruminally available N source) and some carbohydrates (as ruminally available energy sources) which could benefit from controlled (i.e., slowed) release in the rumen in order to increase the efficiency of their use by the rumen microbial population. In addition, there are several potential nutrients (e.g., essential amino acids, B complex vitamins) which may not be delivered to the small intestine at levels sufficient to optimize the metabolic use of all absorbed nutrients, especially in high producing ruminants. Encapsulated nutrients, designed either to slow release in the rumen or avoid it altogether, have made their way onto the market in the past decade. Unfortunately a great deal of the research in this area is focused on supporting marketing of nutrients which corporate groups want to sell, rather than being used as a means to evaluate nutrient needs of animals. Much more research is required in this area if the efficiency of nutrient utilization by cattle is to be meaningfully increased with this technology.

Reproductive performance of dairy cattle in high production systems is very low. Historically, ruminant nutritionists have tended to judge nutritional strategies, compounds and approaches in a rather simple fashion - do the cows produce more milk? In many cases, the experiments had very short time frames and in virtually no cases was the reproductive performance of the cows considered. Nevertheless, results from such studies have been widely used, for at least 80 years, as the basis for nutrient (and animal management) recommendations of commercial lactating dairy cows. In this context, it is no wonder that productivity has been steadily increasing while reproductive performance has been steadily decreasing. The linkage of nutritional strategies to productive and reproductive performance has begun, and the science has started to see more publications which utilize cows for full lactations in order to evaluate the impacts of the experimental (often dietary) treatment(s) on productive, as well as reproductive, performance. More such studies are required to understand the linkage of nutrition and reproduction, and to start to reverse the decline in reproductive performance in commercial dairy herds. However such studies tend to be very expensive in terms of facilities, animals and personnel, and it is unrealistic to expect a large number of them to be completed.

Overall

There is a general sense that improving the productivity of cattle primarily benefits the farmers with no, or a negative, environmental impact. While this is not true, it is a difficult argument to sustain outside of the animal science community. Indeed the fastest way to reduce the environmental impact of cattle populations is to have fewer animals, and the fastest way to do that is to increase their productivity. Although it is unlikely to happen, a much higher proportion of public funding which is currently devoted to reducing the environmental impacts of dairy cows should be devoted to increasing their productivity.

4. Food Animal Research Priorities: The Developing World

Priorities for food animal research in many parts of the developing world remain focused on increasing production of animal derived foods primarily, where fiscal resources of the food consuming populace allow it, by increasing animal numbers. In general, increasing animal numbers has a much faster impact on increasing food supplies than increases in animal productivity. However, high numbers of low producing animals (versus low numbers of high producing animals) leads to the same negative environmental impacts as occur in developed countries, although they can be locally worse if the regulatory environment is weak. Increasing output of animal products by increasing animal productivity is often constrained by availability of feedstuffs with a high enough nutrient density to support high animal productivity. Reasons for this are myriad, but generally revolve around competition from humans and non-ruminant food animals for nutrient rich feeds. Thus a great deal of research has focused on increasing the nutrient density of biomass by-products, such as straws and bagasses, for ruminant feeding. This represents both a traditional and a current strategy to increase ruminant productivity.

Direct increases in productivity of cattle

Export/import of live animals, semen and embryos has created a more homogeneous international production animal population than ever before. Thus research findings on animal metabolism which occur in one part of the world are generally transferable to other parts of the world with a minimal need for local adaptation. In many developing countries (and in many developed countries) the major limit to increased animal performance, by optimizing animal metabolism, is a lack of application of what is known, rather than global ignorance of the solution to the problem. Often this is caused by poor systems to transfer known technologies and information to potential users, in spite of the information often having been transferred to the country, although it has not moved past its research community. In most developing countries, large improvements in animal productivity are possible by allocating funding to facilitate application of what is known, rather than by allocating funds to new research initiatives. However many developing countries have poor extension systems and have reacted to cuts in such systems

in developing countries by concluding that extension is not important.

It too often occurs that animal production research in developing countries focuses on relatively small issues related to local adaptation, or understanding, of well understood animal metabolic knowledge. While success rates of such research efforts tend to be very high, impacts of the findings on animal productivity are generally marginal. Thus, while there remains a need for animal metabolism research in developing countries, it needs to be better focused on specific issues of local, or national, importance while fully exploiting the current state of animal metabolic knowledge which is available in other parts of the world.

Increasing the productivity of cattle by better understanding their feeds

Increased ruminant productivity is often constrained by availability of feedstuffs with a high enough nutrient density to support high animal productivity. As human populations grow, particularly in the developing world, ruminants will increasingly be returned to their traditional role as consumers of feeds which are not suitable for direct consumption by humans and non-ruminant food producing animals and poultry. These feeds will encompass a wide variety of plant biomass wastes from the grain, nut, citrus, tree fruit, vegetable, brewing, food processing, distilling, wine, sugar, cotton and olive industries, to name a few. However, the most important of these plant biomasses, at least quantitatively, will be straws from rice, wheat, maize and barley grain production. In addition, non-traditional feeds, such as tree leaves, will increasingly find their way into ruminant diets as sources of nutrients. There are two major areas of research which require increased research attention if animal productivity is to be increased concomitant with an increased reliance on low quality feeds high in structural carbohydrates.

A common characteristic of most by-product straws and bagasses is the low rate and extent of degradation of their structural carbohydrates (SC) in the rumen. Defined as cellulose, hemicellulose, lignin and cutin, SC vary dramatically in rate and extent of ruminal degradation among feeds and, to a lesser extent, within feeds. As many by-product straws and bagasses contain 70%, or more, of their organic matter as SC, and in vivo digestion of SC ranges from 15 and 50%, this represents a major constraint to animal productivity. Past efforts to increase digestion of SC in feeds with high SC levels have focused on treatments with bases, acids or ammonia. While successful in increasing digestion of SC, these processes are little used in practice due to the high costs of chemicals and equipment, health risks to workers and collateral impacts of excreted compounds (e.g., Na excretion from cattle fed NaOH treated straws impacts soil salinity). More recent efforts have focused on use of enzymes added, generally, to the diet to degrade some SC prior to ingestion by cattle or to augment rumen microbial enzymes. While showing positive impacts in some studies, these impacts have tended to be modest and largely unpredictable. The common feature of both approaches is that they attempt to degrade SC with chemicals or enzymes without an understanding of differences among SC from different plants which cause them to have differences in their inherent rates and extents of digestion. Another traditional approach to increasing SC digestion has been to use the variation in digestion of SC among cultivars within crops to select cultivars which have higher SC digestion, while maintaining desirable agronomic characteristics and grain quality. However like the chemical and enzymatic approaches, this approach selects for that which is desirable (relative to rate and extent of ruminal SC degradation) without understanding what it is about the cultivars which make their SC desirable. Thus the most important limitation to enhanced ruminant animal production, and productivity, is the low rate and extent of digestion of the SC in feeds which are fed in many developing countries. Indeed, as ruminant animal production relies more on these feeds in the future, this limitation will become more important. This suggests an urgent need for research directed at understanding carbohydrate chemistry of plants, particularly the chemistry of SC, to be able to breed plant varieties with higher digestion by eliminating the chemical features which impede degradation of SC in the rumen.

Traditional animal science research, particularly in the generally temperate developed countries, focused on the 'positive' nutrients of plants, such as proteins, fats, starches and SC, while largely ignoring impacts of plant secondary compounds. Often referred to as 'anti-nutrients', compounds such as tannins, alkaloids, saponins and essential oils have traditionally been considered to be negative in diets (hence the term 'anti-nutrient'), but recent research suggests that many secondary compounds have positive impacts on ruminal fermentation and gut health at low dietary levels. Nevertheless, as ruminant feeds come under increasing pressure in developing countries, plants which have not traditionally been used as feeds are likely to move into the ruminant feeding industry. Many of these, including salt-tolerant crops (which also tend to concentrate trace minerals), tree leaves and plants from arid areas, often have high levels of secondary compounds. Research is required to identify ways to overcome their negative effects when they are at high levels in plants, as well as understand their positive effects at low levels, at least if they are to be successfully incorporated into ruminant rations.

Overall

There remains a significant focus on enhancing production and productivity of ruminants in developing countries to assure increasing supplies of ruminant meat and milk products for their increasingly, and increasingly affluent, urban populations. However a focus on raising production by increasing animal numbers will increase both local and global environmental impacts of that production, while ultimately being constrained by insufficient feeds with high digestibility and this is likely to increasingly be the case in the future. To alleviate this limitation, much more research is required to understand the chemistry of SC within plant biomass by-products in order to select, or breed, plants which create feeds and feed by-products with higher digestibility.

5. Conclusions

While specific issues facing ruminant production differ in detail between developed and developing countries, the general constraints and challenges suggest that common research interests will continue to exist. The need to increase outputs of ruminant meat and milk products differ sharply between the developed and developing world, although a need to increase animal productivity is evident in both, albeit primarily to increase product output in the developing world but to decrease environmental impacts of food producing ruminants in the developed world.

The largest single limitation to increasing productivity of ruminants is the low digestibility of the structural carbohydrates which comprise a large proportion of their diets. Research on actions of secondary compounds in ruminal metabolism is required to avoid their negative effects and harvest the benefits of their positive effects. Domesticated ruminants have historically provided a substantial portion of the world's food supplies. However if that is to continue, ways must be found to increase digestibility of their primary feedstocks, increase the 'healthfulness' of their products to humans, and decrease the environmental impact of their production systems.

Forthcoming Events

Research coordination meeting on the Use of Diagnostic and Control Technologies to Control African Swine Fever

Technical Officer: Hermann Unger

The first research coordination meeting of the new coordinated research project in support of the early and rapid diagnosis and control of African swine fever (ASF) is planned to be held from 7 to 11 July 2014 in Vienna, Austria.

The purpose of the meeting is to present different approaches of the selected research contract holders and discuss the technical inputs with the research agreement holders for an optimal performance. The main topics will address improved diagnostics and their development and validation; collection of field isolates and the whole genome sequencing of important strains; implementation of sanitary measures to control ASF in outbreak situations. The work plan for the first two years of this CRP will be finalized with the participants.

Regional training course on Genetic Characterization of Indigenous Livestock Breeds Using DNA Markers (RAS/5/063)

Technical Officers: M. Garcia Podesta, K. Periasamy

The training course is planned to take place from 11 to 22 August at Seibersdorf Laboratories, Austria.

The regional training course (RTC) aims at enhancing knowledge and capacity building of participants on breed survey and monitoring, animal identification, DNA marker techniques and genomic tools for characterization and improvement of indigenous livestock breeds.

This training course is open to 15 participants from IAEA Member States in the Arab-Asia Region.

The participants will be trained in using different platforms/techniques that upon implementation will result in:

- improved efficiency in identification of animals for breed survey and monitoring;
- improved design of sampling animals under field conditions for characterization of indigenous livestock breeds;
- improved ability in applying DNA marker tools to perform genotyping of domestic animal breeds;
- increased capacity to manage and analyze phenotypic and genetic data on livestock;
- improved ability to use livestock DNA data for the selection and breeding of superior quality animals;
- improved capacity in managing and utilizing livestock genetic resources to ensure sustainable food security.

Training course on the Diagnosis of Transboundary Animal Disease: Pathogen Typing Using Molecular Techniques

Technical Officers: Adama Diallo, Charles Lamien

This training is planned to take place from 25 August to 5 September 2014 at the National Veterinary Institute, Debre Zeit, Ethiopia.

The aim of this training is to promote the application of gene-based identification and classification of pathogens in sub-Saharan African veterinary diagnostic and research laboratories in support of the respective national and regional transboundary animal disease control strategies.

The training will consist of lectures on the principles of the different techniques used for virus typing and sub-typing as well as general knowledge on the epidemiology and control strategies for peste des petits ruminants, capripox disease, Newcastle disease and highly pathogenic avian influenza. Additionally, practical hands-on training on laboratory techniques and bioinformatics will be provided.

The course is open to veterinary diagnostic laboratory scientists from sub-Saharan African countries, member of the veterinary laboratory network supported by the IAEA Peaceful Uses Initiative (PUI) and African Renaissance Fund (ARF) projects. Good background knowledge on molecular biology is required.

Regional (AFRA) training course on Livestock Data Collection and Analysis for Breeding Improvement (RAF/5/068)

Technical Officer: Hermann Unger

The training course is scheduled to take place from 1 to 5 September in Sidi Thabet, Tunisia.

In the context of the work package 'support for commercial small scale farmers', the training course on livestock breeding management and performance recording will focus on establishing reliable breeding services in Member states. Particular breeding strategies and stakeholder involvement, organization of breeding centers and breeding services and collection of farm and animal data for evaluating the productive and reproductive performance of livestock are on the agenda. The aim is to expand artificial insemination services to establish or improve livestock productivity.

The training course aims to transfer knowledge in livestock breeding management and performance recording and should help in the development of reliable breeding services. The course will cover:

•Breeding strategies and stakeholder involvement;
•Organization of breeding centers and breeding services;
•Training of inseminators and their duties;
•Importance of animal identification and tracing;
•The retrieving of farm and animal data for evaluating the productive and reproductive performance of livestock;
•The selection and monitoring of phenotypically superior males for breeding purposes.

This course is intended for participants with Veterinary or Animal Science background and with a good knowledge on livestock production and basic concepts of reproduction and performance recording. Preference will be given to participants having working experience on animal trials, measuring the response in biological and production parameters to treatment involving feeding , breeding, reproductive intervention or veterinary care. Participants must be actively involved in activities related to artificial insemination in livestock, flock management, evaluation of animal performance or in livestock data analysis. The training course will be conducted in English; participants should be capable of freely expressing themselves and following lectures.

Training course on the Diagnosis of Transboundary Animal Diseases: Practical Approaches for Introducing New Assays for Routine Use in Veterinary Diagnostics Laboratories

Technical Officer: Charles Lamien

The meeting will be held from 15 to 26 September 2014 at Seibersdorf Laboratories, Austria.

The purpose of this training is to promote veterinary laboratories the application of gene-based technology for the accurate identification of pathogens in Members States.

This training will reinforce the participants' knowledge on the set up and routine use of molecular assays for the early detection of transboundary animal diseases. More specifically, this training will demonstrate the practical steps in introducing new assays for routine use in a laboratory. The introduction of a new test is usually based on the customer, end user's need or demand for improving existing assays or addressing new needs. Additionally, this can be done as part of a contingency preparation plan within a country under the threat of specific transboundary animal diseases.

The main steps involved in the introduction of new assays will be taught.

To routinely use these protocols in a quality ensured manner, scientists must undertake several steps including the validation and use of quality controls and maintain a consistent performance of the assay. During this training the participants will be familiarized with some of the many steps involved in the process.

The course is open to veterinary diagnostic laboratory scientists from sub-Saharan African countries, member of the veterinary laboratory network supported by the IAEA Peaceful Uses Initiative (PUI) and African Renaissance Fund (ARF) projects. Good background knowledge and laboratory skills in molecular biology are required.

Past Events

National training course on Techniques and Organization of Artificial Insemination Field Services in Cattle in Myanmar (MYA/5/022)

Technical Officer: Mohammed Shamsuddin

The meeting took place from 13 to 24 January 2014 in Yangon, Myanmar.

The aim of the course was to improve the skills of veterinarians on delivering quality artificial insemination (AI) services, involving practice and organization of AI field services and management of frozen semen and liquid nitrogen, AI recording and the management of fertility in cattle in Myanmar.

The training course was organized by Myanmar's Animal Health and Development Division of the Livestock Breeding and Veterinary Department (LBVD) of Ministry of Livestock, Fisheries and Rural Development as part of activities of IAEA Technical Cooperation MYA/5/022 project.

The International Atomic Energy Agency appointed two external lecturers, Dr Basil Alexander, Department of Farm Animal Production and Health, Faculty of Veterinary Medicine and Animal Science, University of Peradeniya, Sri Lanka and Professor Mohammad Musharraf Uddin Bhuiyan, Department of Surgery and Obstetrics, Faculty of Veterinary Science, Bangladesh Agricultural University, Mymensingh, Bangladesh. The local organizer was Dr Okkar Soe from the Animal Health and Development Division of the LBVD, Yangon.

The course was attended by 25 veterinarians from the LBVD. Theoretical lectures, practical demonstration and hands-on practices were conducted at Training Centre of LBVD and AI Laboratory in Yangon.

Participants palpates cows genital tract at practical exercises on farm.

The following topics on AI and reproductive health management were taught to the participants: anatomy and physiology of the reproductive system of cows, rearing and management of AI bulls and, collection, evaluation and processing of bull semen, storage, transportation and handling of frozen semen, preservation of liquid semen and its use in AI in cows, technique of AI in cows and goats, evaluation of the AI service quality, including pregnancy diagnosis.

The practical demonstration and hands-on practices were done on palpation of abattoir derived genital tract of cows, per rectal palpation of the genital tracts in live cows, pregnancy diagnosis in cows, passing of AI gun through the cervix of abattoir derived genital tract of cows, intrauterine infusion of drugs in abattoir derived genital tract of cows, bulls semen collection, evaluation, processing and storage of frozen semen, semen thawing and preparation of AI gun for insemination, hygienic and safe passage of AI gun through the cervix in live cows, AI techniques in goats.

Additionally, videos on per rectal palpation of genital tract, pregnancy diagnosis and correction of dystocia in cows were shown to the participants.

Technical meeting with directors of veterinary laboratories participating in the project to strengthen animal disease diagnostic capacities in selected sub-Saharan countries

Technical Officer: Adama Diallo

The meeting was held from 4 to 6 February 2014 at IAEA's Headquarters in Vienna, Austria.

The purpose of the meeting was to discuss the results of past activities, draw on lessons learnt from past experiences, develop future plans and promote the VETLAB network of veterinary diagnostic laboratories in

Africa. The following eleven partner laboratories were represented:

- Botswana (National Veterinary Laboratory, Gabarone)
- Burkina Faso (Laboratoire National d'Elevage de Ouagadougou)
- Cameroon (LANAVET, Garoua)
- Chad (Institut de recherche en élevage pour le développement, N'Djamena)
- DRC ((Laboratoire Vétérinaire de Kinshasa)
- Ethiopia (National Animal Health Diagnostic and Investigation Centre, Sebeta)
- Ethiopia (National Veterinary Institute, Debre Zeit)
- Mali (Laboratoire Central Vétérinarie, Bamako)
- Mozambique (Animal Science Directorate Central Veterinary Laboratory, Maputo)
- Namibia (Central veterinary Laboratory, Winhoek)
- Zambia (Central Veterinary Research Institute, Lusaka).

Hands-on training of laboratory technicians.

The meeting consisted of presentations made by the project coordinators explaining background and aims of the PUI-ARF project. In addition, each partner presented their specific needs for capacity building within their own countries based on the present state of transboundary animal disease and their diagnostic capabilities. It was evident from the presentations that the main TADs of concern to the majority of the countries and, therefore, of relevance to this project, were CBPP, ASF, PPR and rabies.

Final regional coordination meeting on Strengthening Capacities for the Diagnosis and Control of Transboundary Animal Diseases in Africa (AFRA) (RAF/5/057)

Technical Officers: Hermann Unger and Adama Diallo

The final coordination meeting of the regional AFRA project RAF/5/057 was held from 24 to 28 February 2014 in Arusha, Tanzania.

The meeting was attended by the project coordinators from 22 countries and IAEA staff. During the country report sessions, each participant presented their country's progress in the implementation of project activities, the challenges and local constraints.

The key achievements of the project were the wide spread surveillance activities for TAD's, including FMD, Newcastle disease, CBPP, PPR, highly pathogenic avian influenza, rabies, ASF and Rift Valley fever.

Discussions of meeting participants and lecturer.

The training courses in molecular diagnostics, disease surveillance, serology and bioinformatics and molecular epidemiology enhanced the capability of the participating MS and helped to upgrade the diagnostic capacities. QA procedures are now established in all labs and nine laboratories are in various stage of accreditation or accredited. Finally, the isothermal amplification techniques were seen as a proper approach to expand molecular testing to the field.

A number of countries faced challenges implementing their work plans due to difficulties in clearing equipment and consumables from customs, loss and lack of skilled manpower, irregular power

National training course on Techniques and Organization of Artificial Insemination Field Services in Cattle (ERI/5/009)

Technical Officer: Mohammed Shamsuddin

The training course was held from 17 to 28 March 2014 in Asmara, Eritrea.

Objectives of the course were to provide on-site, hands-on training to inseminators on (1) the use and practice of the artificial insemination (AI) technique in cattle, (2) the use, care and handling of AI equipment and organizing effective AI field services with emphasis on efficient distribution and management of liquid nitrogen and frozen semen, (3) AI record keeping and analysis and reporting to farmers and AI service providers for making breeding decisions, (4) evaluation of the AI service quality, including pregnancy diagnosis, improving fertility and management of infertility.

Training participants.

The training course was organized by the Eritrea's Veterinary Services Division of the Animal Resources Department of the Ministry of Agriculture in Asmara as part of activities of IAEA TC project ERI/5/009.

The International Atomic Energy Agency appointed two external lecturers, Dr Paul Egesa Egang'A, Central Artificial Insemination Station, Ministry of Livestock and Fisheries Development, Nairobi, Kenya and Dr Paul Michael Mollel, National Artificial Insemination Centre, Arusha, Tanzania. The local organizer was Mr Tzeggai Tesfai Bekele, Veterinary Services Division, Ministry of Agriculture, Asmara, Eritrea.

The course was attended by 21 AI technicians from the Ministry of Agriculture, Eritrea. Theoretical lectures, practical demonstrations and hands-on practices were conducted at the Central Animal Health Laboratory.

The following topics on AI and reproductive health management were taught to the participants: anatomy and physiology of the reproductive system of bulls and cows, rearing and management of AI bulls and, collection, evaluation and processing of bull semen, semen production, handling and its use in AI in cows, storage, transportation and handling of frozen semen, care maintenance and use of AI equipment, technique of AI in cows and goats, causes of AI failure, evaluation of the AI service quality, including pregnancy diagnosis, understanding of reproductive indices, improvement of fertility and management of infertility in cows, oestrous cycle behaviour, ovarian hormones and hormonal regulation of the oestrous cycle in ruminants, heat detection and timing of insemination, body condition score and its relations to fertility, breeding health and production recording and organization of AI field services, clinical management of reproductive disorders of cows and practical application of reproductive hormones, basic genetics and breeding.

The practical demonstration and hands-on practices were done on palpation of abattoir derived genital tract of cows, per rectal palpation of the genital tracts in live cows, pregnancy diagnosis in cows, passing of AI gun through the cervix of abattoir derived genital tract of cows, intrauterine infusion of drugs in abattoir derived genital tract of cows, bulls semen collection, evaluation, processing and storage of frozen semen, semen thawing and preparation of AI gun for insemination, hygienic and safe passage of AI gun through the cervix in live cows.

A comprehensive training manual was provided to the participants on the first day of the programme, including a hard copy manual and electronic copies of all PowerPoint presentations.

Participants' knowledge and skills were evaluated before and after the training. An AI Technician was considered competent if he succeeded to conduct an AI in a cow safely and hygienically. Also the course was evaluated.

The participants' knowledge and skills substantially improved after the training. All technicians are now considered competent to perform AI in cows. All participants expressed their satisfactions with the knowledge and skills of both lecturers and materials provided for practical exercises. They considered the training course as effective and very useful in delivering quality AI field services for the development of cattle in Eritrea.

Research coordination meeting on the on Use of Stable Isotopes to Trace Bird Migrations and Molecular Nuclear Techniques to Investigate the Epidemiology and Ecology of the Highly Pathogenic Avian Influenza

Technical Officer: Ivancho Naletoski

The second research coordination meeting took place from 5 to 9 May 2014 in Izmir, Turkey.

The purpose of the meeting was to review the work carried out in the previous two years and to prepare the work plan and activities for the next phase of the project.

The second research coordination meeting (RCM) of the coordinated research project (CRP) D3.20.30: 'Use of Stable Isotopes to Trace Bird Migrations and Molecular Nuclear Techniques to Investigate the Epidemiology and Ecology of the Highly Pathogenic Avian Influenza' was held in Izmir, Turkey, from 5 to 9 May 2014. Counterparts from Bulgaria, China, Egypt, Germany Russia, Tajikistan, Turkey and the United Kingdom have participated at the meeting. The purpose of the meeting was to review the project activities and achievements, including problems observed and to discuss the work plans for the upcoming years.

From the beginning of the project until May 2014, the counterparts have collected 1397 faecal samples and 782 feather samples. The majority of the samples were collected from wetland areas in the participating Member States. The most commonly sampled bird species were the bar-headed goose (Anser indicus), the black-headed gull (Chroicocephalus ridibundus), the common myna (Acridotheres tristis), the coot (genus Fulica), the greater white-fronted goose (Anser albifrons), the little egret (Egretta garzetta), the mew gull (Larus canus), the mute swan (Cygnus olor), the northern shoveler (Anas clypeata) and the oriental (rufous) turtle dove (Streptopelia orientalis). However, many faecal and feather samples (approximately 38%) were collected directly from the ground - from undetermined bird species. These samples will be tested using DNA barcoding for species determination. The faecal samples were tested for the presence of M gene of the avian influenza virus using the modified Spackmann protocol, as recommended by the AHVLA reference laboratory in Weybridge, United Kingdom. Only three samples have tested positive (1 from Korea and 2 from Egypt). The samples will be sent to the Weybridge laboratory for further typing.

Based on the initiative of the technical counterpart from the Weybridge laboratory, selected faecal samples will be also tested for the presence of other diseases, (primarily the Newcastle disease) in order to determine the role of the wild migratory birds in transmission of these diseases.

The collected feather samples will be submitted to the laboratory of the technical counterpart in Canada, for quantitative evaluation of the stable isotope ratios.

The final goal of the project is to establish a non-invasive platform for determination of: 1) the bird species (DNA barcoding); 2) the disease carrier status (detection of the specific genetic sequence of disease pathogens in the feces) and 3) migration pathway (stable isotope ratios), without even capturing the bird.

Participants at the meeting in Izmir, Turkey.

Regional training course on Livestock Data Collection and Analysis for Breeding Improvement (RAS/5/063)

Technical Officer: Mario Garcia Podesta

The training course is part of the activities of TC project RAS/5/063. The training course was held from 11 to 15 May 2014 in Amman and Karak, Jordan.

The aim of the training course was to transfer knowledge and know-how on the importance of animal recording for animal selection and breeding strategies, electronic identification for cattle and small ruminants, the use of RFID (Radio-frequency identification) and FDX-B protocols for animal identification applications, international regulations/standards on animal identification, comparison of visual and electronic identification devices for livestock, the retrieving of farm and animal data for evaluating the productive and reproductive performance of livestock, the selection and monitoring of phenotypically superior males for breeding purposes, and the use of database computer applications for monitoring artificial insemination services.

The course was addressed to scientists from ARASIA Member States that are participating in the Regional TC

Project RAS/5/063 that are involved in activities related to artificial insemination in livestock, flock management, evaluation of animal performance or in livestock data analysis. The course was attended by 12 participants from Iraq, Syrian and Yemen and 5 local participants.

The course Director, Mr Nadir Al Habahbeh, from the Animal Production Department, Ministry of Agriculture, Amman, Jordan, did an excellent job in organizing the course and taking care of all the arrangements.

Consultants meeting on Early Pregnancy Diagnosis in the Bovine using Nuclear and Molecular Technique

Technical Officer: Mohammed Shamsuddin

The meeting was held from 11 to 13 June 2014 at IAEA's Headquarters in Vienna, Austria.

The consultant meeting aims at updating the current state of research information targeted to identify pregnancy-associated glycoprotein, early conception factor, interferon tau (IFN-tau) and IFN-tau stimulated genes as the best-bet candidate for early pregnancy diagnosis on farms. Interferon tau is promising for its early production by the bovine conceptus from Day 14 to 18 (Day of breeding = Day 1). Polymerase chain reaction (PCR) and radioimmunoassay have been used to detect genes and the resultant conceptus-produced molecules in the maternal blood, respectively. The techniques, especially PCR, once developed, can be modified to fit into the loop mediated isothermal amplification (LAMP) assay and be used for early pregnancy diagnosis on farms to identify non-pregnant animals by Day 17 and be bred during the next oestrus, which is likely to occur during Day 18–24. The practice will not only reduce the number of non-productive animals in a herd and increase herd level productivity but also increase the number of breeding's per year and artificial insemination service quality. The technique will contribute to climate-smart animal agriculture by improving herd-level productivity and reducing greenhouse gas emission per unit of food from animals.

Meeting participants and IAEA staff.

The project was seen as a big success, as nearly all participating countries improved their diagnostic capacities.

First coordination meeting and Workshop on Complementing Conventional Approaches with Nuclear Techniques towards Flood Risk Mitigation and Post-Flood Rehabilitation Efforts in Asia (RAS/5/069)

Technical Officers: Gerrit Viljoen, Ivancho Naletoski

The training course took place from 10 to 13 June 2014 in Vienna, Austria.

The overall objective of the coordination meeting and workshop was to improve the capacity of participating Member States (MSs) to develop strategies/guidelines for resilience/adaptation of agricultural production systems through effective on-farm water conservation and improved land, water and farm management practices and to fulfil additional needs in post-flood rehabilitation efforts.

Floods are the most frequent among all natural disasters, and the East Asia and Pacific region, along with South Asia, are particularly vulnerable. Climate change and variability are expected to bring about increased typhoon activities, rising sea levels and out-of-phase monsoon seasons in South East Asia and other regions. These can bring about devastating floods in Cambodia, Laos, Pakistan, Thailand and Vietnam, endangering the lives and health of the population and cause serious losses in people's livelihoods, including food and livestock. In the past 30 years, the number of floods in Asia amounted to about 40% of the total worldwide. More than 90% of the global population exposed to floods live in Asia, posing a serious and growing development challenge for fast growing low and middle-income countries in East Asia.

The countries in Asia with large populations are particularly prone to recurrent flooding, resulting in countless loss of lives, injuries, diseases and trauma in addition to practically wiping out decades of investments in infrastructure and personal wealth of people. Floods have tremendous socio-economic impact, reflected mainly through retarded development. A flood-stricken area must first be restored to normal before any development activity can be carried out. Restoration can take time.

In addition to the directly determinable losses, there may be indirect potential losses. These result from unproductivity in many areas such as business, trade and commerce, etc. All these losses can wipe out whatever

gains that may have been achieved in economic development. Floods cause losses both to the gross domestic product (GDP) and to capital stock, thus hampering the growth potential of the country. Moreover, these losses also have a long-term impact on macroeconomy. Capital damages induce a lower GDP in subsequent years (to the extent of investment losses) and output losses (caused during the flood-affected year), lower incomes and possibly reduced savings available for financing investments.

The project aims to develop integrated approaches and best-fit mitigation/adaptation strategies to the needs of the participating MSs in the region. The resulting guidelines/strategies should support the governments in their decision-making process concerning flood risk mitigation and post-flood rehabilitation efforts.

Research coordination meeting on the Use of Irradiated Vaccines in the Control of Infectious Transboundary Diseases of Livestock

Technical Officers: Adama Diallo and Hermann Unger

The third research coordination meeting (RCM) of the coordinated research project (CRP) on The Use of Irradiated Vaccines in the Control of Infectious Transboundary Diseases of Livestock was held in Vienna, Austria, from 23 to 26 June 2014.

The purpose of the meeting was to discuss the results achieved since the start of the CRP in 2010 and to plan future activities. Technical officers, in link with agreement holders, discussed with each contract holder to develop a work plan that would deliver the basic information required to establish the optimum conditions for attenuation and to devise methods to assess the degree of pathogen inactivation/attenuation and to validate their effectiveness as immunogens in protecting animals against infection.

Vaccines are one of the main tools for the efficient control of infectious diseases. Roughly, they can be grouped into 2 categories: (i) live vaccine which is an alternative or mutant strain of a pathogenic organism that has reduced virulence whilst maintaining immunogenicity, or (ii) inactivated vaccine, a pathogenic microorganism which has been previously killed by either chemical or physical methods before use. Live recombinant vaccines or purified proteins are part of category 1 or 2 respectively. In general, live vaccines are most efficient than killed vaccines in inducing strong immunity. An alternative to classical technologies in developing vaccines was explored in the 1970's: use of irradiation to kill the pathogen by damaging their genetic material, the DNA or RNA. This process may affect also their proteins. This approach was neglected in 1990's following the advent of DNA recombinant technologies with recombinant vaccines which were promising. But following many failures in the recombinant vaccines development, in particular for very complex pathogens as parasites, the irradiation for vaccine development is being re-explored but in the area of obtaining a non-full killed pathogen but a micros-organism not fully competent to complete its life cycle: a micro-organism no more able to replicate completely but still able to synthesize proteins for some time. Such a non-replicative but metabolic active micro-organism may induce a better immunity than does a classical killed vaccine. This approach has been explored by the IAEA through the coordinated research project (CRP) entitled 'The Use of Irradiated Vaccines in the Control of Infectious Transboundary Diseases of Livestock' project that was launched in 2010.

This RCM was attended by nine research contract holders and two research agreement holders who have extensive experience in vaccine development for helminths and protozoan parasites.

The participants at the RCM have presented the results in the development of vaccines, attenuated or inactivated using ionizing radiation (basically gamma rays). In the focus of the research groups were: *Trypanosoma evansi, Theileria annulata, Brucella abortus and B. melitensis, Fasciola hepatica, F. gigantica, Haemonchus contortus and Ichthyophthirius multifiliis* (fish parasite). Following the presentation of the results that have been obtained since 2010, a workplan for each contract holder was drafted, discussed and amended following advice of agreement holders and IAEA technical officers. This CRP will run for one more year.

The RCM was followed by an expert consultant meeting entitled 'Development of Irradiated Vaccines' that took place on 25–26 June 2014 (please see the following event).

RCM and consultant meeting participants as well as IAEA staff.

Consultants meeting on Development of Irradiated Vaccines: Current Status and Future Prospective

Technical Officer: Ivancho Naletoski

The meeting was held from 25 to 26 June 2014 in Vienna, Austria.

The purpose of the consultancy assignment was to review the current knowledge on irradiated vaccines, to determine status and draw conclusions and recommendation on their future development.

The experts invited to this meeting joined the participants of the RCM (mentioned above) and together they have discussed four areas in the development of the irradiated vaccines:
1) using gamma rays to produce metabolically active but replication inactive pathogens (such as brucellosis);
2) the use of selective protein and DNA protectors in the process of development of irradiated vaccines;
3) possibilities of stimulation of the cell mediated immunity using irradiated vaccines and
4) current developments of DNA and protein preservation of biological products (including vaccines) after exiting the production line.

Stories

IAEA technical support to Botswana National Veterinary Laboratory (BNVL)

Botswana is considered as a middle-income country having one of the fastest growing economies in Africa during the last decade. Diamond export is the main factor behind the high growth rate in recent years as it accounts for more than one-third of the nation's GDP. Despite this, the agricultural sector remains a fundamental source of subsistence. Livestock production is an important socio-economic activity in the farming communities where the cattle industry is the principal sector with a major contribution to beef export to the EU market.

There are 2.2 million head of beef cattle, of which 0.6 million are dairy cattle, 1.6 million goats and 0.3 million sheep among other livestock species. In this scenario, transboundary animal diseases such as foot and mouth disease (FMD) and contagious bovine pleuro-pneumonia (CBPP) can have significant economic impact on trade, demand and supply, and food security. The two diseases continue to be a threat for livestock productivity in the country since they are present in the neighboring countries, and moreover, FMD is present in Northwest region of Botswana. Other infectious diseases like tuberculosis, rabies and brucellosis also pose significant threat to the public health.

The Botswana National Veterinary Laboratory (BNVL) has the mandate to carry out testing of samples for animal disease diagnosis and surveillance. The laboratory used to rely more on conventional test methods, which are not sensitive and fast enough to provide timely and reliable results. This caused delayed disease detection, delayed response to disease outbreaks and uncontrolled disease outbreaks. The diagnostic capacity needed to be strengthened by training and through the introduction of modern techniques like PCR and isotopic methods for confirmatory diagnosis thereby helping to adopt effective prevention and control measures besides helping to establish an early warning system.

The IAEA provides its support through the framework of the national projects BOT/5/005, BOT/5/008, and the new project BOT/5/011. The overall objective of these projects was to employ nuclear and molecular diagnostic techniques to improve diagnosis of TADS such as FMD, CBPP, avian influenza and Rift Valley fever.

Control of CBPP in the SADC region

CBPP is a cattle lung disease which is endemic in some countries in southern Africa. Currently it is present in Angola, Democratic Republic of Congo, Namibia, and Zambia. Botswana had an outbreak in 1995 after 56 years of freedom from the disease.

However, the disease was eradicated through slaughter policy in 1997 which resulted in more than 300 000 cattle being destroyed. The whole exercise cost Botswana US$96 million. This was followed by re-stocking in Ngamiland.

In case of CBPP re-incurson, early detection is of paramount importance for controlling the disease before it becomes pandemic. For early detection, abattoir surveillance and sero-surveillance are carried out in high risk areas of Botswana. Detection of the CBPP agent in the lung tissues and nasal swabs require use of molecular techniques such as PCR which are more sensitive and

specific than the classical methods. The surveillance carried out has demonstrated that the country is still free from CBPP.

The IAEA supported the improvement of the molecular diagnostic capacity of BNVL through provision of training of laboratory personnel, expert missions, reagents and equipment. Some of the equipment provided by IAEA includes photo documentation system, thermal cycler, Real Time PCR machine, LAMP machine, biosafety cabinets, laboratory fridges, biofreezers, Lyophiliser and ELISA reader and ELISA plate washer.

BNVL has been collaborating with national laboratories in neighbouring countries in provision of critical reagents, training and organization of ring trials for CBPP diagnostic tests, thus contributing to the control of CBPP in the region. The capacity attained with the help of IAEA and the collaboration with national and international laboratories resulted in BNVL being granted the status of an OIE reference laboratory for CBPP in May 2012.

Rift Valley fever

Rift Valley fever (RVF) is a zoonotic disease of domestic ruminants caused by mosquito-borne virus of the family *Bunyaviridae*, genus *Phlebovirus*. The disease is most severe in sheep, cattle and goats, producing high mortality in new-born animals and abortion in pregnant animals. Historically, RVF was first recognized in the Rift Valley in Kenya in 1930. Since then, the disease has been recorded in several other countries in Africa. In recent years, Botswana, Namibia and South Africa have reported outbreaks of RVF in the susceptible populations.

The 2010 outbreak o RVF in Botswana was suspected on pathology at BNVL and the confirmation was done at South Africa's Onderstepoort Veterinary Institute (OVI) using PCR and serological techniques which were not available at BNVL at that time. The disease was controlled by vaccination and the Department of Veterinary Services (DVS) carries out passive surveillance on abortion cases to ensure early detection and control of the disease.

BNVL has established PCR and ELISA systems for RVF to improve diagnostic capacity for rapid detection of the disease. The IAEA provided the necessary training and equipment. This facilitates timely decision making by the authorities and hence protection of public health.

Improving Diagnostic capacity for FMD at BNVL

BNVL supports DVS in the serological surveillance of FMD. In order to facilitate FMD surveillance in the country, the laboratory plays a pivotal role in sero-surveillance particularly on samples for National surveillance, import/export surveillance and post vaccination monitoring. The laboratory has therefore set up the testing platform that meets the above requirements. The structural protein test "liquid phase blocking – enzyme-linked immunosorbent assay (Lpb-ELISA)" as the test of choice and the non-structural protein test (NSP-ELISA) are set up at BNVL. BNVL experienced challenges in the optimization of the LpbELISA and IAEA assisted the laboratory by providing training through fellowships, a scientific visit in September 2012 and an expert mission in November 2012, with the objective of supporting the different FMD ELISA platforms (LPBE, SPBE, NSP), including quality assurance and test standardization. This assisted in the stabilization of the test. The IAEA provided reagents for testing as well. The laboratory was able to test timely 20, 000 serum samples for FMD surveillance from various districts of Botswana in 2013. Furthermore, the laboratory tested 15,000 serum samples from an area which previously had an FMD outbreak and this contributed to the recognition of this area as free of FMD without vaccination by the OIE in 2013.

Training

BNVL had an opportunity to conduct in-service training for officers from various laboratories in the African continent sponsored by IAEA or other donors. A total of 8 people from 5 countries were trained on the diagnosis of animal diseases and Quality Management System. These were from Ethiopa, Mali, Mozambique, Uganda, Malawi.

BNVL has been implementing a quality management system according to ISO 17025 Standard and accredited seven tests in 2007. Implementation of the management system is important in assurance of quality of test results as this is required to effectively control diseases in the country and also for export purposes.

Training participants.

Implementation of Quality Management System

The IAEA supported BNVL in improvement of the management system through scientific visits to accredited laboratories and expert missions. This led to the increase in the number of accredited tests to 27 by August 2013. The scope of accredited tests include Food Microbiology (x13), Histopathology (x1), Residues (x6) and Serology (x7). BNVL has earmarked 14 more tests to be accredited to SANAS in August 2014. The new tests comprise Residues (x10), Serology (x1), Molecular Biology (x1) and Microbiology (x2) and this will bring the total number of tests accredited to 41. Accreditation is an on-goining process which requires continuous improvement. This

contributes to the competetiveness of the livestock industry in accessing international markets.

Enhancing Food Security in Bosnia and Herzegovina

The economy of Bosnia and Herzegovina depends significantly on agriculture which employs approximately 20% of the country's workforce and contributes to 10% of the total GDP. The animal population is estimated to be 458 000 cattle, 1 125 000 sheep and goats and 529 000 pigs. The prevalence of the transboundary animal diseases (TADs) has increased due to the lack of consistency in the disease control strategies in the country. Zoonotic TADs are of special consideration, because they can be easily be transmitted to humans. Lack of proper control measures for brucellosis for example, had led to the sudden spread of the disease among the human population, and reached a peak of approximately 1 000 human cases in 2008.

As the primary source of brucellosis are the farm animals, especially sheep and goats, the transfer of nuclear related diagnostic platforms for early disease detection, as well as the upgrade of epidemiological strategies, became a priority for the State Veterinary Office and the entire veterinary service. The project assisted with upgrading laboratory capacities and implementation of standardized protocols. A strategically important epidemiological team, competent to design and enforce scientifically justified epidemiological models for the control of brucellosis and/or other TADs in the country, was designated and trained.

A disease control strategy, based on modern methods of the quantitative epidemiology, was developed for the purpose of disease surveillance and control. Today, samples collected under the established surveillance strategy are submitted to the regional (screening) laboratories and samples from positive flocks are further processed by two referent laboratories. The results of the surveillance are reported to the competent authorities for further action (i.e. removal of diseased animals). As a result of this new system, the capacity of the National Veterinary Service to detect, control or eradicate brucellosis and establish a model for other TADs was improved. A network of epidemiological units is now established and advanced, standardized and harmonized laboratory techniques and diagnostic protocols are being implemented.

Bosnia and Herzegovina is now in a better situation to ensure the safety of its livestock and people.

Mongolia Strengthened Capacity on Nuclear and Molecular Technologies for Improving Animal Productivity and Combating Transboundary Animal Diseases

Historically Mongolian economy used to be based on animal agriculture. Even with the recent boom in the mining sector, the contribution of livestock to national GDP equals 16% and it involves livelihood of 30% of its nomadic and semi-nomadic population. Although Mongolia is a very thinly populated country, 2.9 million people at 1 564 116 square kilometres, it has a very little arable land. Its livestock industry has been challenged by lack of forage due to long, deep winter and occasional flare-up of foot and mouth disease (FMD). For example, due to the severe 2009–2010 winter compounded by FMD outbreaks, Mongolia lost 9.7 million animals, or 22% of total livestock, which immediately affected meat prices, GDP dropped 1.6% in 2009. Despite a high growth in the mining industry, poverty reduction over the last decade remained rather slow, currently about 20% of the population live on less than US$1.25 per day. This highlights that agriculture, especially the improvement of animal health and productivity still remains as an important instrument to address rural poverty, improves the livelihood of nomadic and semi-nomadic pastoralists and enhance the availability of meat and milk for domestic consumptions.

A Mongolian nomad with his herd.

IAEA has been supporting the animal production research group at the Mongolian State University of Agriculture (MSUA) and the animal health research group at the Institute of Veterinary Medicine (IVM) and at the State Central Veterinary Laboratory (SCVL) for capacity building on animal production and health research and practices since 1987. Institutional capacities have been developed by training personnel and providing equipment and expert services.

Mongolian State University of Agriculture, assisted by IAEA, developed animal nutrition and reproduction laboratories. Capacities have been built for not only improving palatability and digestibility of poor quality

crop residue-based animal feed but also implementing various feed supplementation techniques for improving animals' body conditions and productivity, especially during the long and deep winter.

The IAEA project team (MON/5/021) developed methodologies for enzyme treatments of crop residues and tested that on-farm at the Bornuur district (sum) of the Tov province (aimag) to improve small ruminant feeding and productivity. Two enzymes, cellulase and xylanase, were used to treat wheat and barley straws, which are common crop residues in the country, and fed to sheep. The ration comprised of 60% treated straws and 40% wheat bran. At the end of the feeding trials, sheep weight increased by up to 13 % compared with controls on conventional feedings. This has resulted in farmers' income increase by up to US$23 from every sheep under intervention.

The team has developed and branded a composite feed for cattle, whose benefits were demonstrated on-farm. Cows fed with commercial concentrate mixes produced in average 2.6 L milk/day but when they are fed with the composite feed developed by the project team, per cow milk production was as high as 4.2 L/day. The intervention increased farmers income up to US$170 per month.

Herders and farmers were interviewed by an IAEA staff while visiting the project sites. The interviewees were happy about activities of the project team and indicated that they would like to have alternative feeds available to feed their animals during the prolonged, deep winter, which is common in Mongolia.

Earlier IAEA projects assisted Mongolia for the development of a National Gene Bank that involved preservation of semen from indigenous animals, and implementation of artificial insemination field services in cows and yaks.

Semen storage, National Gene Bank of Mongolia.

IAEA supports strengthened capacities in IVM and SCVL for the diagnosis of animal diseases, especially transboundary animal diseases (TAD) like FMD. Mongolia developed a Biosecurity Level 3 (BSL3) Laboratory in addition to the development of human resources, SOPs, guidelines and laboratory protocols. These research and diagnostic capacities enabled the Veterinary Service of Mongolia to successfully contain the FMD outbreaks in 2013 and 2014. A Mission from FAO involving the Crisis Management Centre (CMC) of FAO and OIE in early 2014 acknowledged Mongolian clear strength for addressing FMD outbreaks in the country. Also in 2010 and 2014, IAEA assisted Mongolia to successfully control devastating FMD outbreaks, where a clear path has been given on what to do for immediate effects and for the development of mid-term and long-term strategies. Additionally, Biocombinat, a public enterprise has been supported to develop a vaccine reconstitution technology for addressing emergency FMD outbreaks in the country. The technology will involve imports of killed highly concentrated FMD virus antigen from elsewhere, reconstitution and formulation of 500 thousand to one million doses of vaccines for urgent containment of FMD outbreaks. This will allow Mongolian veterinary authorities to procure the required quantity of the vaccines from elsewhere and control the disease. The IVM Laboratory with supports from IAEA has been developing irradiation technologies to produce vaccines against bacterial and viral diseases.

X-ray machine for the production of irradiated vaccine.

Support to Mongolian animal health and production will continue for further development of forage technologies, especially mutation breeding of forages for faster growth and capable of growing in adverse environmental conditions like cold and drought. Mongolia has a good repository of animal species and breeds that demands further modernizing of semen and embryo technologies for the preservation of animal biodiversity. Supports and advice will continue for the development of human resources, laboratory protocols, SOPs and guidelines for the eradication of FMD and prevention of other transboundary animal disease, like peste des petits ruminants (PPR).

Nuclear and Molecular Techniques Strengthen Capacities for Improving Animal Production and Health in Myanmar

Myanmar being an agriculture based country heavily relies on livestock for meat and milk production and for draught power and manure to support crop production, which are very important for improving country's rural livelihood and enhancing food security. The livestock and fisheries sector contributes to 7.6% of the country's total GDP. The livestock sector has been prioritised by the Government of Myanmar as a tool to address poverty reduction and rural livelihood development.

IAEA has been assisting Myanmar for the development of an Animal Genetic Laboratory. Most of the country's indigenous cattle are draught type, which can work long hours tilling agriculture fields and pull carts with heavy loads. Myanmar has three major breeds of cattle, viz., Pyar Zein, Shwe Ni and Shwe Ni Gyi, which are now characterized. Molecular genetic analysis identified Shwe Ni as a unique breed, which is distinct from Shwe Ni Gyi and Pyar Zein cattle. The data will enable designing a selective breeding programme for the development of Shwe Ni and Pyar Zein as dual purpose breeds (females for milk and males for draught) and Shwe Ni Gyi as dairy type breed involving animal identification, performance recording and the improvement of feeding and management.

Myanmar first introduced artificial insemination in 1975 with semen of exotic breeds such as Friesian, Jersey and Norwegian Red to improve the milk productivity of local cattle. Now facilities for collection and preservation of bull semen are built in the country. Staffs are trained, necessary equipment is procured and protocols and guidelines are developed and put in place to run the artificial insemination (AI) programme. About 32 000 AI were made with frozen semen in 2013. This figure is more than 5 time higher that the number (6000) of AI made in 2004. Also, a gene bank with a large repository of frozen semen has been developed. The use of AI, improved forage management and extension activities from the Livestock Breeding and Veterinary Department contributed to the development of several peri-urban dairy farming communities. In 2004, cattle rearing used to be a subsistence activity to crop production, only a few market-oriented dairy farms were recorded in Yangon and Mandalay. In 2013, 10 commercial scale dairy private farms (each one 80 to 520 heads of cattle) are already developed in the Yangon region that together produced more than 5000 litres of milk every day. Similarly, 11 commercial dairy farms are developed in the Mandalay region, which collectively produce about 3000 litres of milk. Other than increase in the number of commercial dairy farms and cattle, a clear trend has been recorded in milk production per farm and per cow. These have been contributing substantially to milk supplies from domestic sources to consumers.

The livestock industry has been challenged by tropical animal diseases. For example, foot and mouth disease (FMD) is endemic in Myanmar, which maintains a large population of FMD susceptible animals currently estimated to 13.6 million cattle, 3.0 million buffaloes, 9.3 million pigs and 4.0 million sheep and goats. At present, the National FMD Laboratory produces about 200 000 doses of cattle vaccine and 50 000 doses of pig vaccine. The number of doses of vaccines produced is still low but is a good start.

A new BSL2 level FMD Vaccine and Diagnostic Facility is being built in Yangon, funded by the Government of Myanmar and Japanese International Cooperation Agency (JICA) and the IAEA has been providing technical assistances to the initiative. The laboratory is expected to release FMD vaccine to be used in the field by the end of 2015. Additionally, a FMD diagnostic laboratory, with financial support from the Myanmar Government and the Korean International Cooperation Agency (KOICA), are being constructed in Nay Pyi Taw City.

IAEA supports networking among Member States and in this case, additional supports from Japan and Korea further boosted Myanmar's efforts for the improvement of animal health and productivity with the ultimate goal to enhance sustainable food security of the country.

Training researchers on DNA technology and AI.

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	Scientific Secretary
D3.10.26	Genetic variation on the control of resistance to infectious diseases in small ruminants for improving animal productivity	Mohammed Shamsuddin
D3.10.27	The use of enzymes and nuclear technologies to improve the utilization of fibrous feeds and reduce greenhouse gas emissions from livestock	Mohammed Shamsuddin
D3.20.26	The early and sensitive diagnosis and control of peste des petits ruminants (PPR)	Adama Diallo
D3.20.28	The control of foot and mouth disease (FMD)	Gerrit Viljoen
D3.20.29	The use of irradiated vaccines in the control of infectious transboundary diseases of livestock	Adama Diallo
D3.20.30	Use of stable isotopes to trace bird migrations and molecular nuclear techniques to investigate the epidemiology and ecology of the highly pathogenic avian influenza	Ivancho Naletoski
D3.20.31	Early and rapid diagnosis and control of TADs – second phase- African swine fever	Hermann Unger

Genetic variation on the control or resistance to infectious diseases in small ruminants for improving animal productivity

Technical Officer: Mohammed Shamsuddin

A coordinated research project (CRP) referred to above (D3.10.26) has been running since 2010. The CRP was designed to characterize phenotypes of sheep and goats related to resistance to gastrointestinal (GI) parasites and identify genes responsible for variations in phenotypes. The project has been implemented in 14 countries as research contract holders (RCH). Two major research trials (i.e. artificial challenge and field trial) were designed for recording phenotypic data focusing on parasite burden and sampling blood for DNA analysis during the first RCM (Vienna, 21–25 February 2011). RCHs of Argentina, Brazil, Eritrea, Ethiopia, Indonesia and the Islamic Republic of Iran have been working with sheep breeds. RCHs of Bangladesh, Burkina Faso, China, Mexico, Nigeria and Sri Lanka have been working with goat breeds and TCH of Pakistan has been studying both sheep and goat breeds.

All RCHs have completed the artificial challenge trial and presented the data during the Second RCM held in Bogor, Indonesia (11–15 February 2013). Based on preliminary results, there are clear indications of genetic variations in resistance to parasites in sheep and goats, however, advanced and detailed statistical analysis involving bioinformatics data are still being processed which will lead to the submission of at least one manuscript per RCH for publication in a peer reviewed journal by the end of 2014. Besides, the research team in Argentina has already initiated a breeding programme where rams have been selected for parasite resistance. On the other hand, two RCs were terminated based on poor results. Additionally to the research trials, a Radiation Hybrid panel for goats (Capra hircus) was constructed as a resource for rapid and large-scale physical mapping of the goat genome to facilitate the resolution of the genetic and physical distances prior to designing strategies for positional candidate cloning of the gene(s) that are involved in economically important traits. Later in a second step, the whole-genome Radiation Hybrid Map (RH Map) was developed. This is used during the second phase of the CRP for the genetic characterization of goat breeds, for conducting comparative genomics that are necessary to utilize the genotype-phenotype associations, for evaluating candidate genes for the identification of genetic markers associated to infectious disease resistance and for the development of analytical tools for molecular diagnostics and assisted breeding.

RCHs have already started or nearly completed the field trial that involves studying sheep and goat breeds for resistance to natural infections with GI parasites. DNA has

been extracted from blood samples and most of the RCHs have sent an aliquot to the IAEA's Animal Production and Health Laboratory (APHL) in Seibersdorf for genotyping. Single Nucleotide Polymorphism based DNA markers were discovered in different candidate genes at Seibersdorf laboratory. Part of the DNA samples collected from resistant/susceptible sheep and goat breeds by the RCHs during artificial challenge trials were genotyped. Several RCH have already published their data. The project progresses according to the work plan. The CRP will end in 2015.

The use of enzymes and nuclear technologies to improve the utilization of fibrous feeds and reduce greenhouse gas emissions from livestock

Technical Officers: Mohammed Shamsuddin, Gerrit Viljoen

The CRP referred to above has been implemented since 2010 and involved 11 RCHs. The CRP aims at improving efficiency of utilizing locally available feed resources including tree and shrub leaves, agro-industrial by-products and other lesser-known and/or new plants adapted to the harsh conditions or capable of growing in poor, marginal and degraded soils. The first RCM was held in Lethbridge, Alberta, Canada, from 7 to 11 February 2011 and work plans were finalized to conduct the research work in two phases.

Most of the RCHs published data generated during the first phase of the CRP. The first phase had three major activities. In the first activity, commercial fibrolytic enzymes were screened in vitro to identify 2 to 4 best-bet candidates and their optimal dosages for further evaluation in animal trials. All enzyme candidates were assayed locally by each RCH for enzyme activity using standardized methodology before starting the in vitro research which focused on batch culture incubations of the forage substrates in buffered rumen fluid plus enzymes to determine effects on 24 and 48 h dry matter (DM) and neutral detergent fibre (NDF) degradation. Additionally, the teams surveyed for and collected samples of fibrous feed materials available and/or used on smallholder farms for chemical compositional analysis of feed ingredients. The second activity was the evaluation of fibrolytic enzyme activity using the different fibrous feed materials available in the region, including endoglucanase, exoglucanase, cellulase and xylanase activity. The third activity was to conduct initial in vitro batch cultures to identify enzyme candidates and optimum dose rates for the forages of interest using DM and NDF degradation followed by more detailed in vitro batch cultures or continuous culture incubations to measure other variables of interest such as digestibility, kinetics of digestion, methane production, microbial protein synthesis, rate of gas production including methane, volatile fatty acid production and concentrations, microbial ecology of the rumen, etc.

The activities of the second phase were planned during the second RCM in Vienna, from 13 to 17 May 2013. The activities focus on in vivo evaluation of best-bet candidate fibrolytic enzymes to determine effects on animal productivity, the critical enzymatic activities, optimal enzyme application method and to establish possible mode of action. In vivo trials with the best-bet candidate fibrolytic enzymes are being in progress to determine effects on animal productivity including effects of enzyme on methane production. The project progresses along the work-plan. The CRP will end in 2015.

The control of foot and mouth disease (FMD)

Technical Officer: Gerrit Viljoen

The FMD CRP investigates vaccine matching procedures, vaccine potency testing methods and guidelines, and procedures by which an FMD vaccine's ability to induce production of protective antibodies in cattle without the need for animal challenge experiments can be evaluated.

The first research coordination meeting (RCM) of the coordinated research project (CRP) on The Control of Foot and Mouth Disease, FAO, Rome, Italy, from 10 to 14 January 2011, was held in collaboration with FAO and EU-FMD. It was attended by all, but one, research contract holders and agreement holders, as well as several observers from EU-FMD and FAO and foot and mouth disease (FMD) vaccine and diagnostic manufacturers and producers. Discussions were focused on: (1) the status of FMD in the participating counterpart's respective countries (e.g. FMD free vs. FMD free zone with or without vaccination vs. FMD endemic) with respect to the risks and threats, (2) what is currently being done in terms of vaccine matching, (3) what criteria are being used to choose FMD vaccines and how they are being applied, (4) how is vaccine potency being determined and utilized, (5) how are post-vaccination monitoring and surveillance being performed, (6) the status of counterpart's vaccine laboratory quality assurance and FMD laboratory analysis and diagnoses (i.e. their analysis and/or diagnostic laboratory proficiencies and capacities both for routine testing and research, laboratory infrastructure and procedures). The work plans of all the research contract holders (RCH) and the agreement holders (AH) were developed and discussed, and all the agreement holders will supervise (based on their respective expertise) identified aspects of the work plans.

Foot and mouth disease is one of the most important livestock diseases known to man due to its high infection rate (ease of spread) and its effect on the limitation of livestock movement and trade. An outbreak of FMD can have a devastating effect on a country's food security with direct impact on national and international trade. The confirmatory diagnosis of FMD and its effective control through prophylactic, quarantine or slaughter procedures are therefore of paramount importance as they have financial and trade implications. Vaccination with inactivated FMD virus is undertaken to control FMD in endemic countries or countries at risk. Vaccines, whilst widely available but which should match (i.e. should be of homologous serotype and strain isolate) with virulent FMD viruses circulating in the region of vaccine use, are of variable quality, not from the homologous outbreak serotype/strain isolate, and are often stored under inadequate temperature conditions and therefore might be not as effective in the field as determined in animal experiments. Due to insufficient knowledge on vaccine strength and antigenic match (antigenic cartography) between vaccine strain and outbreak virus, it is often not possible to pinpoint the weakness of the vaccination strategy and to take action on this weakness. Vaccine effectiveness can be determined by animal challenge, but this is both costly and difficult. In vitro systems have been developed in different countries since the 1980s, but these are not standardized for international use. Many countries now produce FMD vaccines but often without proper consideration of their effectiveness.

In many developing countries, vaccination will continue to be an essential component for the progressive control of FMD. Maximizing the effectiveness of current vaccines and supporting research to improve the effectiveness and quality of those and or new vaccines will be critical. Countries using locally produced vaccines need to assure trade partners that they are using quality assured vaccines in order to overcome the restrictive effects of endemic FMD. The provision of internationally accepted guidelines for quality assurance and alternatives to the present need for animal challenge vaccine trials would be a significant step forward. It is likely that control and eventual eradication in endemic areas with a low level resource base (much of Africa, parts of Asia and Latin America) will require the use of quality assured vaccine preparations, correct vaccine formulations (i.e. homologous strain or isolate vaccine to protect against outbreak, new generation vaccines with a broader protection base (i.e. cross protection between different strains and isolates) or alternative formulations of existing vaccines).

All the counterparts developed their work plans such that, individually and or collectively, they worked towards creating solutions set by the objectives of the FMD CRP.

It is important to:

- establish methods and develop internationally agreed protocols for measuring the potency of FMD vaccines using in vitro methods;
- establish guidelines for optimum population vaccination intervals based on in vitro measurements of potency and duration of the antibody response to structural proteins, after the vaccination of cattle and small ruminants with commercially available FMD vaccines, and including the evaluation of reduced dose options such as intradermal administration of FMD vaccine;
- establish protocols and guidelines for application and interpretation of vaccine matching methods (antigenic cartography) to identify the extent of expected cross-protection of type A or SAT viruses;
- provide further global coordination of current research into FMD vaccines for use in endemic settings and to cooperate with other FMD institutions such as EU-FMD and PANAFTOSA;
- evaluate and standardize:
  - Virus neutralization (VN) tests
  - Early and rapid lateral flow and dip-site technologies and their application and use
  - Antigenic cartography (at IAH and OVI) in relation to virus neutralization tests (VN).

The second RCM took place from 8 to 12 April 2013 at FAO Headquarters in Rome, Italy. The final RCM will take place in 2015.

The use of irradiated vaccines in the control of infectious transboundary diseases of livestock

Technical Officer: Adama Diallo

Vaccination has been one of the greatest achievements of mankind in enabling the eradication of serious, life-threatening diseases of man and his domesticated livestock. Many of the vaccines used today rely on technologies developed over 100 years ago involving some form of attenuation, i.e. the use of an alternative or mutant strain of a pathogenic organism that has reduced virulence whilst maintaining immunogenicity, or inactivation, where chemical or physical methods are used to kill virulent pathogenic strains. In general, attenuated vaccines are more efficient than vaccines that are killed by chemical procedures that might denature the immunogenic antigens, make them less efficient in inducing good protective immune response. Irradiation of pathogens may be an alternative to chemical inactivation of the pathogen for developing efficient vaccines.

This IAEA CRP aims at developing vaccines for the control of some animal diseases through the irradiation of pathogens, irradiation in a way to obtain an organism not able to multiply anymore while maintaining the ability to

synthesize proteins that will trigger the immune system in the host to provide a good protection against an infection. The objective of the first phase of the project was to identify the most efficient dose of irradiation to obtain such a product. For that objective the effect of different doses of irradiation was evaluated on the capacity of irradiated pathogens on their capacity of biosynthesis and growth in vitro or in vivo. Those studies allowed the determination of a range of efficient doses for each of the pathogens. In most cases, the effect of the irradiation was evaluated on the growth of the pathogen in vitro and then in mice or rabbits, non–natural hosts of those pathogens. Good results have been obtained with some cases such as, Theleria annulata and Fasciola gigantica. In those cases the evaluation in the natural host remains to be carried out. This test was already carried out in the case of the fish parasite Ichthyophthirius multifilis and the ruminant gastro-intestinal parasite Haemonchus contortus. The results are very well promising.

The third and final RCM took place from 23 to 26 June 2014 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

Technical Officer: Ivancho Naletoski

Among several important issues in the epidemiology of the highly pathogenic avian influenza (HPAI) that need attention is the role the wild water fowl (WWF) populations might play in the dissemination of infection. Tracing the movements of WWF in relation to where they originated as well as their stopover points during their migration between breeding and non-breeding grounds is a particularly challenging task.

It is necessary to utilize methods that can be used on a larger scale and not biased to initial capture location if we are to fully comprehend the role of migratory birds in the spread of avian influenza. A suitable technique that has already been used to trace migrants is based on the stable isotope (SI) signatures of the tissues of birds, especially those in feathers. Of most interest are deuterium (δD) ratios in tissues that reflect those in surface (lakes, rivers, oceans) and ground waters. Since hydrogen isotope composition of environmental water varies spatially across the globe in a predictable manner, and its presence relayed to feathers, δD analyses of feathers provide a way of linking SI data on water isoscapes with those in the feathers.

Faecal samples will be used for the detection of AI viruses eventually present in the faeces and extraction and analysis of somatic DNA to detect the bird species. These two techniques will be used to link the AI carrier status and the carrier species without even capturing the birds, and may thus be used as a non-invasive platform to generate important epidemiological information on migration pathways (obtained by SIA) and the transmission of the virus to a certain geographical area. Faecal samples should be collected randomly at the same sites where feathers are collected. Samples will undergo two test procedures:

(a) DNA barcoding (species identification), adapted at the Avian Disease Laboratory, College of Veterinary Medicine, Konkuk University, South Korea. The technique is based on detection of a short gene sequence from a standardized region of the genome as a diagnostic 'biomarker' for species. The target sequence has been the 648-bp region of the mitochondrial gene, cytochrome C oxidase I (COI), already optimized as a DNA barcode for the identification of bird species. The optimization of a DNA barcoding technique for faecal samples has been performed by comparing DNA from the faecal samples with the DNA from tissue samples (muscle, feather, and blood) from already known bird species (domestic poultry and WWF), collected from live bird markets, the Conservation Genome Resource Bank for Korean Wildlife and from the Seoul Grand Park Zoo. The results of bird species identification, using COI gene sequences from tissues matched the faecal samples of the same individuals.

(b) Detection of the AIV in the faecal samples using optimized protocol in five phases: i) detection of M gene to detect the presence of influenza A viruses using PCR technique (positive samples should be inoculated in SPF eggs for virus isolation), ii) positive samples should be tested using H5 or H7 protocol on PCR, iii) H5 and H7 positive samples should undergo molecular pathotyping (cleavage site sequencing), iv) M gene positive, H5 and H7 negative, should be further typed in order to differentiate the subtype using conventional (HI-test) and/or molecular methods, v) positive samples and a portion of negatives will be tested using loop mediated isothermal amplification (LAMP) protocol.

The main pathway of AIV transmission is faecal contamination. Natural water reservoirs are the media where WWF faeces are excreted in the water, contaminating it randomly. However, the survival of the AIV in natural water reservoirs depends on numerous environmental, physical and chemical influences, as well as on the period between excretion by an infected and infection of a healthy WWF. Testing of natural water reservoirs will generate information on the level of (eventual) contamination and the risk of AIV transmission via these media at different geographical and environmental conditions. Water samples should be collected from different points of each selected area, in an amount of approximately 500 ml per sample. Each sample should be tested for the presence of AIV, using PCR with previous concentration of the virus. Using a standardized

protocol it is possible to quantitatively evaluate the level of contamination based on a comparison with a known titrated virus isolate.

Of great epidemiological interest would be the potential application of the same technology to trace short-range migration in wildlife carriers, in order to determine their role in transmission of animal and/or human pathogens.

Seven research contract holders from Bulgaria, China, Egypt, Nepal, Russian Federation, Tajikistan and Turkey, two agreement holders from Germany, and three technical contract holders from Canada, Republic of Korea and the UK are currently participating in the CRP.

The first RCM was held at the IAEA from 31 October to 2 November 2012. The second RCM was held from 5 to 9 May 2014 in Izmir, Turkey. Please see the report under Past Events.

The early and rapid diagnosis and control of TADs – second phase – African swine fever (AFS)

Technical Officers: Herman Unger, Charles Lamien

This new CRP started this year, after a successful first phase with a focus on avian influenza control, now ASF will be addressed.

ASF is a contagious viral disease of pigs transmitted directly or by ticks. It leads to acute disease with high mortality and maintains a chronic infection when survived. 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 lack of a vaccine, culling and quarantine measures are the only tools available to control disease. As pig production is in many cases on a small scale, farmers do often lack the means and education how to fend off disease. Similarly the diagnostic tools so far available have their limitations and a number of epidemiological as well as virological issues are not understood.

The CRP will focus in its first 2 years on the validation of the serological and molecular diagnostic tools to allow veterinary services to come up with quality assured results. In parallel, samples from infected pigs, wild or domestic, will be collected for virus isolation. These isolates should be characterized and some of them sequenced in order to create an understanding of the genetic diversity on a spatial scale. This knowledge together with information regarding the pathology of each strain should allow shedding light into the underlying patho-mechanisms and might help identifying epitopes of interest for a vaccine. Finally, a number of control measures will be initiated to see how efficient they are in the context of small scale commercial production.

The first research coordination meeting will take place from 7 to 11 July 2014 in Vienna, Austria.

General information applicable to all coordinated research projects

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://www-crp.iaea.org/html/forms.html.

Such proposals need to be countersigned by the Head of the Institutions and sent directly to the IAEA. They do not need to be routed through other official channels unless local regulations require otherwise.

Complementary FAO/IAEA Support

IAEA has a programme of support through national Technical Cooperation (TC) projects. Such support is available to IAEA Member States and can include additional support such as equipment, specialized training through IAEA training fellowships and the provision of technical assistance through visits by IAEA experts for periods of up to one month. Full details of the TC Programme and information on how to prepare a project proposal are available at the URL http://pcmf.iaea.org/.

Activities of the Animal Production and Health Laboratory

Animal Genetics

Genetic variation on the control of resistance to infectious diseases in small ruminants for improving animal productivity

SNP (Single Nucleotide Polymorphism) marker discovery in goats

Parasitic infections in goats cause severe economic losses to the tune of several million dollars every year across the world. Management of gastro-intestinal parasites has become complicated with increased prevalence of drug resistant parasites. In 2010, IAEA initiated a coordinated research project on DNA marker based genetic improvement of host resistance against parasites as a long term strategy for their effective control. Animal Production and Health Laboratory is involved in the process of discovering novel candidate gene markers and development of genotyping tools for testing of goats under field trial in different member states. As part of these efforts, targeted re-sequencing of 77 candidate genes (Figure 1- NCBI GenBank candidate gene symbols) involved in various innate and adaptive immune pathways was conducted to identify new single nucleotide polymorphism (SNP) markers. A total of 187 SNP markers were discovered across the goat genome and the process of developing genotyping assays for these new DNA markers is currently in progress.

Field testing of DNA markers for parasite resistance in Burkina Faso sheep

Djallonke sheep is an important transboundary breed in Africa and is known for its better tolerance/resistance against certain diseases. In order to evaluate Djallonke sheep for its resistance against gastro-intestinal parasitic infections, a field trial under natural parasite challenge was initiated in Burkina Faso. Phenotypes related to parasite resistance (faecal egg count, packed cell volume, body weight change, etc.) were generated in more than 200 animals and DNA samples were collected for genotyping. Sampled individuals were genotyped at 181 DNA marker loci and the data were extracted for association of phenotypes with genotypes.

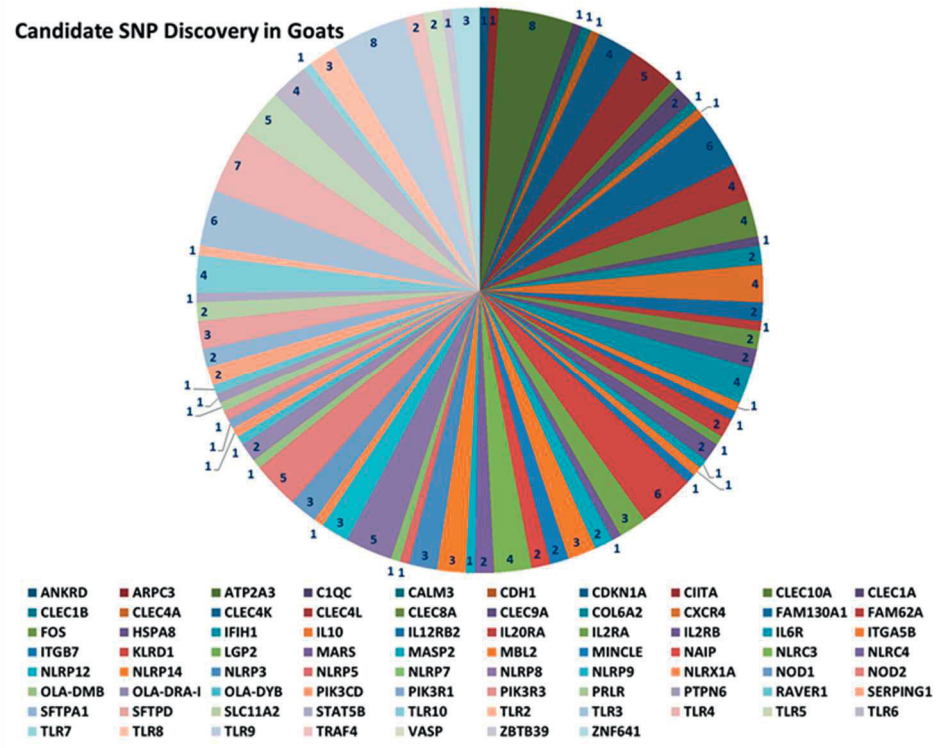

Fig 1. Distribution of newly discovered goat SNPs across various candidate genes

Genetic characterization of indigenous livestock breeds

The Joint FAO/IAEA Division is supporting Member States in implementing global plan of action on animal genetic resources (AnGR) through capacity building and training. APHL supported Madagascar and Angola on molecular genetic characterization of indigenous breeds using nuclear and extra-nuclear DNA markers.

Genetic diversity analysis of Madagascar cattle

Cattle in Madagascar are reared primarily for meat, milk and draught purposes. Madagascar government introduced the policy of crossbreeding local Malagasy zebu cattle to improve productivity and develop dairy type and meat type composites. However, absence of pedigree and performance records under field conditions resulted in varying exotic blood levels and poor adaptability to local management conditions. Optimal level of exotic blood in Malagasy crossbreds and composites has not been optimized and hence farmers still prefer to rear Malagasy zebu cattle. DNA marker based genetic analysis has potential applications for breed assignment and stabilize exotic inheritance in Madagascar cattle under field conditions. This requires generation of baseline genotype data on Malagasy zebu cattle and new composite breeds. Except for certain physical features and phenotypic characteristics, no information on genetic diversity and structure of local zebu cattle and composites is available. A total of 172 samples collected from three major cattle breeds of Madagascar (Malagasy Zebu, Renitelo and Manjani Boina) were analyzed by genotyping 27 microsatellite marker loci and sequencing control region (D-loop) of mitochondrial genome. Microsatellite based analysis revealed high level of within breed genetic diversity in Madagascar cattle breeds. The mean estimated level of inbreeding (FIS-heterozygosity deficit) was lowest in Renitelo and highest in Malagasy Zebu cattle breeds. High genetic differentiation was observed among Malagasy zebu and composite crossbred cattle (9.1%). Phylogeny and principal component analysis based on inter-individual allele sharing distance revealed strong population structure existing within three Madagascar cattle breeds (Fig 2). Microsatellite genotypes revealed strong potential for breed assignment in Madagascar cattle. With prior population information on allele frequency distribution in three breeds, 100% correct assignment was achieved in Malagasy Zebu and Renitelo breeds, while 93.75% correct assignment was observed in Manjani Boina. Mitochondrial DNA analysis revealed 30 unique haplotypes and one maternal haplotype lineage in Madagascar cattle. Comparative analysis with maternal haplotypes of Myanmar and Zambian cattle revealed close phylogeographic relationship of Madagascar and Zambian haplotypes.

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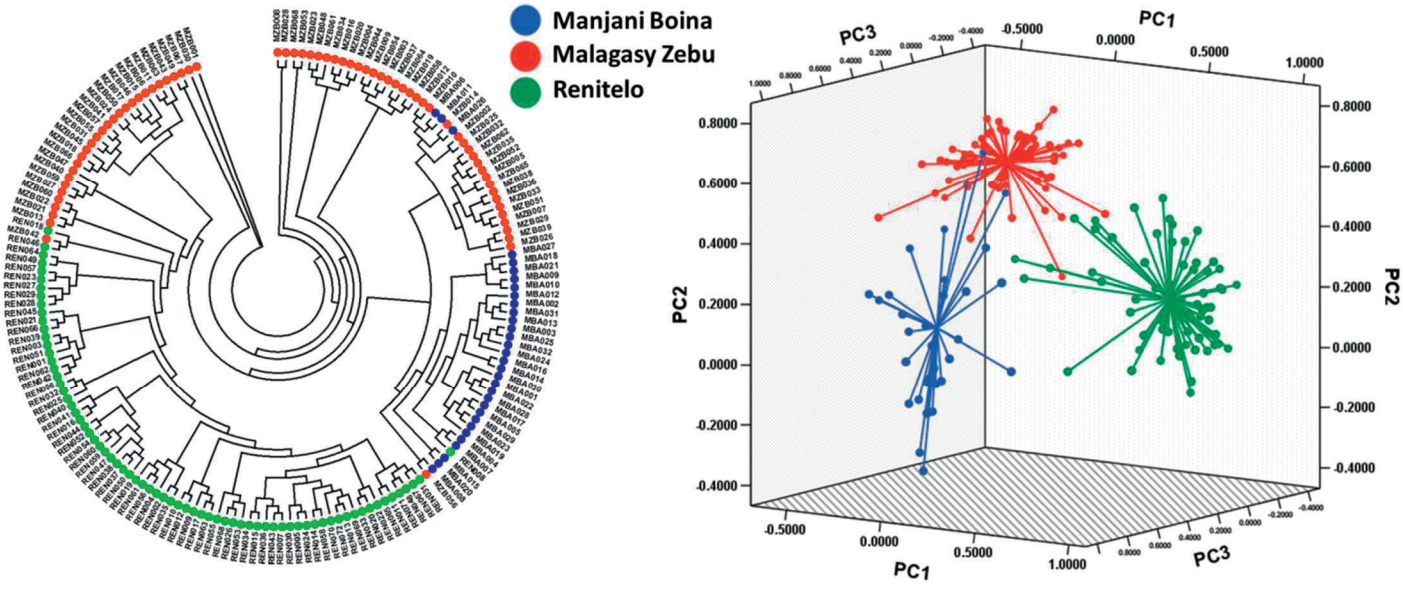

Fig 2. Phylogeny and genetic structure of Madagascar cattle breeds

Phylogeny and principal component analysis based on inter-individual allele sharing distance revealed strong population structure existing within three Madagascar cattle breeds (Fig 2). Microsatellite genotypes revealed strong potential for breed assignment in Madagascar cattle. With prior population information on allele frequency distribution in three breeds, 100% correct assignment was achieved in Malagasy Zebu and Renitelo breeds, while 93.75% correct assignment was observed in Manjani Boina. Mitochondrial DNA analysis revealed 30 unique haplotypes and one maternal haplotype lineage in Madagascar cattle. Comparative analysis with maternal haplotypes of Myanmar and Zambian cattle revealed close phylogeographic relationship of Madagascar and Zambian haplotypes.

Sequencing and genotyping wild sheep

In order to assess the genetic structure of indigenous sheep breeds across different geographical regions, the FAO and the Joint FAO/IAEA Division initiated efforts on global analysis of microsatellite genotypes and mitochondrial DNA sequences by merging data from different projects including IAEA-CRP, ECONOGENE consortium, Nordic Gene Project and national projects from different countries. As part of this effort, 44 wild sheep (Urial sheep and Asiatic mouflon) were genotyped at 19 microsatellite marker loci to assess the genetic structure. Mitochondrial DNA was also sequenced in all the samples to investigate the phylogeography of global sheep populations. Further, analysis of genotype and sequence data is in progress.

Animal Health

Testing irradiation technology for potential use in trypanosome vaccine development

African trypanosomosis is a parasitic disease in man and animals caused by protozoan parasites of the genus Trypanosoma which are mainly transmitted by the tsetse fly. This disease presents a major obstacle to development particularly in sub-Saharan Africa and is responsible for the loss of human life, depletion of livestock and underutilization of arable lands. Vaccine development presents an attractive alternative for controlling the disease in cattle although this has been frustrated by the very nature of the parasite which regularly changes its surface coat in a bid to evade the immune system thus making it difficult to identify vaccine targets. Irradiated trypanosomes have been studied as potential vaccines using mouse experiments with varying results that require further investigation.

At the APHL in the Joint FAO/IAEA Agriculture and Biotechnology Laboratory, experiments are underway that further define the characteristics of irradiated trypanosomes by measuring their metabolic processes and growth dynamics. By combining different tests (parasite counts, nucleic acid amplification test and protein analysis) to analyse the effect of irradiation on trypanosomes, a dose has been identified for producing parasites with long-term viability in vitro but non-infectious when used for inoculation in mice for in vivo studies. Preliminary results indicate that these parasites are also able to activate the immune system using cytokine expression as a marker of immune activity.

So as to help improve the efficiency of an irradiated vaccine, modified parasites that do not express pathogenic factors that influence virulence and pathology are under development using reagents from the University of KwaZulu Natal. DNA plasmids obtained from a collaborating laboratory (department of Biochemistry, University of KwaZulu Natal, Pietermaritzburg) were modified to target the deletion of virulence genes in wild type trypanosomes that will subsequently be irradiated and tested in mice using parameters obtained from the current immunization infection studies.

Strengthening animal disease diagnostic capacities in veterinary laboratories in sub-Saharan Africa

Since its launch in 2010, the IAEA Peaceful Uses Initiative (PUI) has become an important vehicle to raise extrabudgetary contributions for IAEA activities in the peaceful uses of nuclear technology. As an important funding initiative, PUI allows IAEA to implement for the benefit of its Member States additional projects in the peaceful applications of nuclear technology many of which would have otherwise remained unfunded. The Animal Production and Health Subprogramme of the Joint FAO/IAEA Division has been provided with funds from Japan, and the USA as part of the PUI project. In addition, in 2012, a donation to the IAEA from the South African Government's African Renaissance and International Cooperation Fund (ARF) was provided to APHL in order to support swift animal disease diagnosis and reduce the risk of livestock loss in sub-Saharan African countries by building/strengthening capacities in different regions and promoting close collaboration between laboratories through networks.

A technical meeting with directors of veterinary laboratories participating in the PUI and ARF projects was held at the IAEA's Headquarters in Vienna, Austria, from 4 to 6 February 2014. The purpose of the meeting was to discuss the results of past activities, draw on lessons learnt from past experiences, and develop future plans.

Please find the meeting report under Past Events.

Together with guidance from the project coordinators each partner developed a work plan for 2014 and presented a list of specific requirements. Based on these work plans, a number of expert missions to participating laboratories have been planned. In each case experts will work side by

side with laboratory technicians and diagnosticians on specific arguments (e.g. molecular diagnosis of PPR, ASF and Capripox). Following that plan, two countries were visited in April:

1) Burkina Faso. A staff of the Animal Production and Health Laboratory (APHL) travelled from 7 to 11 April 2014 Ouagadougou, Burkina Faso, to support the implementation of gene-based identification of pathogens.

The mission was undertaken in the Framework of the project to strengthen animal disease diagnostic capacities in selected sub- Saharan African countries, supported by the South African Renaissance Fund (ARF), and USA- and Japan supported- PUI project. The Laboratoire National d'Elevage (LNE), Ouagadougou, Burkina Faso has recently received equipment donated by this project to improve its diagnostic platform. On the request from the Laboratoire National d'Elevage (LNE), the APHL staff traveled to transfer real time PCR technology as an additional tool for a more accurate diagnosis of transboundary animal diseases.

During one week, the laboratory was assisted to set up their instruments and workflow, and the laboratory staff was trained on protocols selection procedures as well as different techniques used for the detection of animal diseases by real time PCR. Eleven scientists and technician from three local institutions of Burkina Faso (Laboratoire National d'Elevage du Burkina, Institut de l'Environnement et de Recherches Agricoles and the University of Koudougou, benefited from the training. The participants were able to set up and interpret the results of real time PCR assay for the detection of African swine fever, for Capripoxvirus genotyping as well as multiparametric assay to detect four pathogens responsible for respiratory diseases in small ruminants: peste des petits ruminants virus, capripoxvirus, pastereulla and contagious caprine pleuripneumonia (CCPP).

It is expected that this technology will help the laboratory to better fulfill its mandate within the national strategies for the control of transboundary animal diseases.

2) Cameroon. A technical officer from APHL carried out a field support mission to Laboratoire National Vétérinaire (LANAVET), Garoua, Cameroon, from 07th to 12th April 2014 to set up in that laboratory the work flow for animal disease diagnosis by nucleic acid amplification and DNA sequencing: sample preparation, nucleic amplification, amplified product purification and submission to sequencing service provider, DNA sequence data analysis. Total sixteen participants from LANAVET (Cameroon) and IRED (Chad) took part at the training.

The participants were guided to work with different animal pathogens- Peste des petits ruminants (PPRV), African swine fever virus (ASFV) and foot and mouth disease virus (FMDV) samples- from extraction to amplification and further appropriate samples selection for further sequencing. The generating of high quality amplicons for sequencing is very critical to achieve high quality sequencing data. These parameters were detailed and participants performed PCR product purification and quantification. Followed by sample preparation, submission to service provider, upload of sample details and download of sequence data was learnt by the participants. Bioinformatics tools for the sequence data analysis (Assembly, database, BLAST, aligning) using freely available online software were tried with the sample data. Finally, participants were able to draw the best fit phylogenetic tree and interpret the sample data.

This mission allowed the laboratories to perform the sequencing based molecular assays and analyse their data, which further allowed in determining the genotypes, generating the epidemiological information, which is crucial in proper management of the transboundary animal diseases.

Proficiency Testing for Peste des Petits Ruminants (PPR) Diagnosis by Nucleic Acid Amplification (RT-PCR)

Since 2010, the Animal Production and Health Laboratory (APHL) has been conducting annual proficiency testing (PT) in some laboratories in Africa and Asia for the evaluation of diagnosis of PPR by reverse transcription polymerase chain amplification (RT-PCR). Participants from 17 countries participated in this exercise in 2013 (see table 1). A number of well characterized samples (6 positives and 4 negatives) were sent as blind samples but labelled with random numbers to each laboratory and the participants were asked to determine the diagnostic status of these samples using the RT-PCR method of their choice. They could repeat the testing as many times as they wished but should, at the end, supply a single definitive result for each sample. The returned data were collected, analysed

and the results including a short report were sent back to each participating laboratory. Each laboratory (participant/counterpart) has received the full coded results were they could see only their own results. Three participating laboratories did not send back data. From the 14 responsive laboratories, only three counterparts had 100% correct results. Some participants didn't receive the shipment in time because of delays with customs clearance. The conditions of storing the shipment before customs clearance, such as high room temperatures, might have affected the quality of the samples and thereby the results. Apart from those cases, analysis of the results suggested that the majority of participating laboratories which failed this PT need training on the implementation of RT-PCR and/or more stringent implementation and monitoring of quality control and GLP. The next PPR proficiency test will be organized in the second semester of 2014 with the improvement of shipment conditions.

Country	Institute
Côte d'Ivoire	Laboratoire Central Vétérinaire de Bingerville
Turkey	Viral Diagnostic Laboratory, Pendik Veterinary Control and Research Institute
China	Institute of Animal Science and Veterinary Medicine, Chinese Academy of Agricultural Sciences, Beijing, China, 100081
Mali	Laboratoire central vétérinaire de Bamako
Pakistan	National Institute for Biotechnology & Genetic Engineering (NIBGE)
Bangladesh	Department of Pathology, Bangladesh Agricultural University
Burkina Faso	Laboratoire National D' Elevage
Sudan	Animal Resources Research Corporation (ARRC), Central Veterinary Research Laboratory Center
Nigeria	Federal Ministry of Agriculture and Water Resources, National Veterinary Research Institute
Cameroon	Laboratoire national vétérinaire (LANAVET), Diagnostique et santé animale
Kenya	Central Veterinary Laboratories Kabete
URT	Center for Infectious Diseases and Biotechnology, Tanzania Veterinary Laboratory Agency
Ghana	Accra Veterinary Laboratory
Benin	Laboratoire de Diagnostic Vétérinaire et de Sérosurveillance
Ethiopia	National Animal Health Diagnostic and Investigation Center (NAHDIC)
Uganda	National Animal Disease Diagnostics and Epidemiology Center
DRC	Central Veterinary Laboratory

Fellows

Mr Moumouni Sanou from Département Productions Animales, Institut de l'Environnement et de Recherches Agricoles (INERA), Ouagadougou, Burkina Faso, was trained on "Single nucleotide polymorphism (SNP) marker genotyping of candidate genes related to parasite resistance in Djallonke sheep at APHL for three months (15 November 2013 to 13 February 2014) under TC fellowship (BKF/13005).

Mr Norbertin Ralambomanana from Departement de Recherches Zootechniques et Veterinaires, Centre national de la recherché appliquee au development rural, Antanarivo, Madagascar was trained on Genetic characterization of Madagascar Zebu cattle using nuclear and extra nuclear DNA markers at APHL for three months (3 February 2014 to 30 April 2014) under TC fellowship (MAG/13018).

Mr Kiala Sebastino from Instituto de Investigacao Veterinaria (IIV), Huambo, Angola was trained on genetic diversity analysis of indigenous livestock breeds using DNA markers at APHL for three months (3 February 2014 to 1 May 2014) under TC fellowship (ANG/13002).

Technical Cooperation Projects

TC Project	Description	Technical Officer(s)
ALG/5/027	Strengthening Animal Health and Livestock Production to Improve Diagnostic and Reproductive Capacities in Animal Breeding and Support Expertise for the Feasibility Study of a Biosafety Laboratory, Level 3 (BSL3) **Objective:** To contribute to the improvement of animal health and livestock production by using nuclear and nuclear related technologies to strengthen reproductive and diagnostic capacities in animal breeding, to support expertise for the feasibility study of a bios.	M. Shamsuddin I. Naletoski
ANG/5/010	Characterizing Indigenous Animal Breeds for Improving the Genetic Quality of Local Cattle Breeds and Small Ruminants **Objective:** To undertake phenotype and genotype characterization of indigenous animal breeds for improving the genetic quality of local and adapted cattle breeds.	M. Shamsuddin
BDI/0/001	Supporting Human Resource Development and Nuclear Technology Support including Radiation Safety **Objective**: To upgrade and strengthen the skills and capabilities of human resources and to provide general support within the broad spectrum of the application of nuclear science and technology, including radiation safety. To support unforeseen relevant needs of Member States.	I. Naletoski
BEN/5/006	Improving Animal Health and Productivity **Objective**: To strengthen, diagnose, and control African swine fever, and increase animal productivity.	H. Unger A. Diallo
BEN/5/007	Soil, Crop and Livestock Integration for Sustainable Agriculture Development Through the Establishment of a National Laboratory Network **Objective:** An interdisciplinary project that aims at a sustainable intensification of peri-urban agricultural production through the integration of cropping-livestock systems was developed.	M.Shamsuddin G. Viljoen M.L. Nguyen
BKF/5/011	Improving the Health and Productivity of Small Ruminants through Efficient Animal Feeding, Identification of Genetic Markers for Breeding Programmes and Better Health and Reproductive Management **Objective:** To improve small ruminants productivity through efficient use of local plant resources in animal feeding and health, identification of genetic markers for use in breeding programmes and better health and reproductive management.	M. Shamsuddin
BKF/5/014	Improving the Productivity of Small Ruminants through Diet, Health and Identification of Genetic Markers for Selection and Breeding Management **Objective**: To contribute to improving the productivity and profitability of small ruminant farms in Burkina Faso by applying genetic characterization and artificial insemination for breeding and utilizing local feed resources to improve nutrition and medicinal plants to control parasites	M. Garcia M. Shamsuddin K. Periasamy
BOH/5/001	Reducing the Incidence of Brucellosis in Animals and Humans by Surveillance and Control **Objective:** To reduce the incidence of brucellosis in animals and humans in Bosnia and Herzegovina	I. Naletoski
BOT/5/008	Using Nuclear and Molecular Diagnostic Techniques for Improved Diagnosis of Animal Diseases **Objective**: To employ nuclear and molecular diagnostic techniques to improve diagnosis of animal diseases.	G. Viljoen A. Diallo

TC Project	Description	Technical Officer(s)
BOT/5/011	Using Nuclear and Molecular Techniques for Early and Rapid Diagnosis and Control of Transboundary Animal Diseases **Objective**: To employ nuclear molecular diagnostic techniques to improve diagnosis of transboundary animal diseases, such as foot and mouth disease, contagious bovine pleuropneumonia, avian influenza, rift valley fever, tuberculosis, PPR (peste des petits ruminants) and rabies.	G. Viljoen C. Lamien
BZE/5/006	Establishing Early and Rapid Diagnosis of Transboundary Animal Diseases to Support Food Security **Objective:** To establish an early and rapid nuclear/nuclear related serological/molecular diagnostic and control capability for transboundary animal diseases:- Building capacity, strengthening of a national diagnosis and surveillance system for transboundary/zoonotic.	G. Viljoen
BZE/5/007	Supporting Sustainable Capacity Building through Distance Learning for Laboratory Personnel of the National Agricultural Health Authority **Objective**: To increase and sustain the level of trained qualified staff in the laboratory, and thus the sustainability of the laboratory as a whole by providing an avenue for technical laboratory staff to pursue educational advancement while retaining their services.	G. Viljoen B. Maestroni
CAF/5/005	Enhancing Livestock Productivity through the Improvement of Selection and Use of Artificial Insemination for Increased Meat and Milk Production **Objective:** Improve cattle productivity by implementing a reliable artificial insemination (AI) programme in the country.	M. Shamsuddin
CHD/5/004	Improving Cattle Productivity through Genetic Improvement, Including Artificial Insemination, to Contribute to Reducing Poverty and Combating Food Insecurity **Objective:** Improve the productivity of local cattle breeds by means of artificial insemination.	M. Shamsuddin
CMR/5/018	Improving Productivity of Indigenous Breeds and Animal Health **Objective:** Improved productivity of indigenous breeds and animal health.	H. Unger
CMR/5/019	Using Nuclear Techniques to Improve Milk Production **Objective**: To improve breeding and disease control in cattle for increased milk production in Cameroon by utilising nuclear techniques.	H. Unger K. Periasamy
ELS/5/011	Enhancing Livestock Productivity and Decreasing Environmental Pollution through Balanced Feeding and Proper Manure Management **Objective:** Enhance livestock productivity and decrease environment pollution through balanced feeding and proper manure management.	M. Shamsuddin
ERI/5/009	Enhancing Small Scale Market Oriented Dairy Production and Safety for Dairy Products through Improved Feeding and Cattle Management, Higher Conception Rates and Lower Calf Mortality **Objective:** To increase dairy production through improved feeding and cattle management and higher conception rate and lower calf mortality, and improve farmers livelihood in Eritrea.	M. Shamsuddin
ETH/5/017	Improving Livestock Productivity through Advances in Animal Health and Production **Objective:** Improvement of livestock productivity through advances in animal health and production.	A. Diallo

TC Project	Description	Technical Officer(s)
IVC/5/032	Establishing Epidemiological Surveillance of Peste des Petits Ruminants (PPR) and Studying Its Socio-Economic Impact on Rural Populations by Developing Diagnostic Tools and Providing Economic Data to Veterinary Services **Objective:** To develop diagnostic tools and provide economic data to assist veterinary services in developing a proper strategy to control peste des petits ruminants in Cote d'Ivoire.	G. Viljoen A. Diallo
IVC/5/034	Monitoring Epidemiology of Transboundary Animal Diseases **Objective**: To contribute to the fight against peste des petits ruminants (PPR). To allow for a systematic study and characterization of the viral strains present in Côte d'Ivoire. To help improve the economic situation of small-scale farmers, who have suffered in the crisis. The results from the epidemiological study planned under the project, and of the economic study to be conducted, will be key tools in this post-crisis phase.	G. Viljoen A. Diallo I. Naletoski
KAM/5/002	Using Nuclear and Molecular Techniques to Improve Animal Productivity and Control Transboundary Animal Diseases **Objective:** To improve livestock productivity for food security by integrated management of animal nutrition, reproduction and health which includes: early pregnancy diagnosis for better reproductive management, metabolic profiles in livestock for assessing nutrition.	G. Viljoen M. Garcia M. Shamsuddin
KEN/5/033	Using an Integrated Approach towards Sustainable Livestock Health and Nutrition to Improve Their Production and Productivity for Enhanced Economic Development **Objective:** To use an integrated approach to manage both livestock health and nutrition in order to improve their production and productivity for enhanced economic development.	A. Diallo M. Shamsuddin
KEN/5/034	Using Irradiated Improved Brachiaria Grass and Dolichos Lablab Species for Increasing Quantity and Quality of Milk Production and Reproduction for Smallholder Dairy Farms in Drought Prone Areas **Objective**: To investigate and determine the feasibility of using gamma irradiation to improve Bracharia and Dolochos lablab forage for improbed production and reproduction in smallholder dairy farms in Kenya.	H. Unger A. Diallo B. Forster P. Lagoda
LES/5/002	Using Nuclear and Molecular Techniques for Improving Animal Productivity and Control of Transboundary Animal Diseases to Enhance Livestock Production and Health **Objective:** To improve livestock production and health.	G.Viljoen
LES/5/003	Using Nuclear and Molecular Techniques for Improving Animal Productivity **Objective:** To improve livestock production.	G. Viljoen
MAG/5/020	Improving Stockbreeding Productivity Through the Application of Nuclear and Related Techniques for Reducing Rural Poverty **Objective:** To contribute to reducing rural poverty by improving the productivity of stockbreeding.	M. Shamsuddin
MAR/5/021	Improving Smallholder Dairy Productivity through Better Nutrition by Using Locally Available Forage and Browse Species **Objective:** To contribute to the improvement of smallholder dairy productivity through better nutrition using locally available forage and browse species.	M Shamsuddin
MAU/5/004	Supporting Genetic Improvement of Local Cattle Breeds and Strengthening the Control of Cross-Border Diseases **Objective**: To increase livestock productivity by reducing disease events and improving breeding programmes and genetic resources for food security.	H. Unger M. Shamsuddin

TC Project	Description	Technical Officer(s)
MLI/5/025	Improving National Capacities to Characterize Serotypes of Major Animal Diseases Using Molecular Biology Techniques for the Development of a National Disease Control Strategy **Objective**: The main objective is identification of the various serotypes of the foot and mouth disease virus. The project would help the elaboration of a national strategy for control of the disease by formulating vaccines which are currently imported from Botswana.	I. Naletoski
MLI/5/026	Improving the Diagnosis of Livestock Diseases **Objective:** To improve animal health by implementing a control programme to tackle the major prevalent animal diseases in Mali.	I. Naletoski C. Lamien
MLW/5/001	Strengthening the Essential Animal Health and Veterinary Infrastructure for Disease Control and Management Services in Urban and Rural Areas **Objective:** To develop capacity and strengthen infrastructure for animal disease control and management services in urban and rural areas of Malawi.	H. Unger
MON/5/020	Improving the Health Status of Livestock by Developing a Technology to Produce the Vaccine and Diagnostic Kit for Transboundary Animal Diseases **Objective:** To improve the health status of livestock by developing a technology to produce the vaccine and diagnostic kit of transboundary animal diseases.	G. Viljoen
MON/5/021	Improving the Productivity and Sustainability of Farms Using Nuclear Techniques in Combination with Molecular Marker Technology **Objective:** To improve the productivity and sustainability of livestock and crop integrated farms through utilization of high yield, disease resistant new wheat varieties and other cereal varieties developed by the combined application of nuclear and molecular marker.	M. Shamsuddin
MOR/5/034	Improving Veterinary Drug Residue Detection and Animal Disease Diagnosis with Nuclear and Molecular Techniques **Objective**: To establish technical expertise using nuclear and complimentary non-nuclear techniques for screening and confirmatory analysis of veterinary drug residues and related chemical contaminants in food for human consumption and diagnosis of animal diseases by molecular biology.	H. Unger I. Naletoski
MOZ/5/005	Strengthening the Sustainability of the Institution to Address Animal Diseases, Prevention, Food Safety and Animal Production Problems through Nuclear and Related Techniques **Objective:** To improve the productivity and sustainability of livestock and crop integrated farms through utilization of high yield, disease resistant new wheat varieties and other cereal varieties developed by the combined application of nuclear and molecular marker.	G.Viljoen
MYA/5/022	Improving Animal Productivity through the Use of DNA-Based Technology and Artificial Insemination **Objective:** To improve livestock productivity through the selection of superior breeding stock and to improve capacity in the use of molecular and related technologies for raising the genetic quality of local and adapted livestock breeds.	M. Shamsuddin
MYA/5/024	Supporting the National Foot-and-Mouth Disease Control Programme **Objective:** To increase productivity of the livestock sector by implementing sustainable strategies to control and eradicate Foot-and-Mouth Disease.	G. Viljoen
NAM/5/011	Establishing Research and Diagnostic Capacity for the Effective Control of Animal Diseases in the Northern Communal Areas and Improving Vet. Public Health Services **Objective:** To control transboundary and parasite-borne animal diseases in the Central and Northern Communal Areas (NCA) and to improve veterinary-public health.	H. Unger

TC Project	Description	Technical Officer(s)
NEP/5/002	Improving Animal Productivity and Control of Transboundary Animal Diseases Using Nuclear and Molecular Techniques **Objective:** To improve livestock productivity for food security by integrated management of animal nutrition, reproduction and health.	I. Naletoski
NER/5/016	Strengthening the Capacities of the Epidemiological Surveillance Network for Transboundary Animal Diseases of Livestock **Objective**: To contribute to ensuring food security and to reducing poverty by improving livestock productivity through mitigation of health constraints	G.Viljoen I. Naletoski
RAF/5/057	Strengthening Capacities for the Diagnosis and Control of Transboundary Animal Diseases in Africa (AFRA) **Objective**: To strengthen the diagnostic capacity of national veterinary services to monitor and control major transboundary animal diseases, particularly foot and mouth disease, peste des petits ruminants and contagious bovine pleuropneumonia.	H. Unger A. Diallo
RAF/5/068	Improving Livestock Productivity through Strengthened Transboundary Animal Disease Control using Nuclear Technologies to Promote Food Security (AFRA) **Objective**: To integrate livestock disease control in support of increased livestock productivity to enhance food security. To use an integrated approach while deploying available appropriate technologies to bring about sustainable improvement of livestock production among AFRA Member States. This will contribute to food security and poverty reduction, especially among small-holder farmers.	H. Unger A. Diallo C. Lamien
RAS/5/060	Supporting Early Warning, Response and Control of Transboundary Animal Diseases **Objective:** To establish a regional/national network of laboratories and training centres on early diagnosis, response and control of transboundary animal diseases and eradication programmes for zoonotic diseases.	H. Unger
RAS/5/063	Improving the Reproductive and Productive Performance of Local Small Ruminants by Implementing Reliable Artificial Insemination Programmes **Objective**: To improve small ruminants productivity by implementing reliable artificial insemination programmes.	M. Shamsuddin / M. Garcia
RAS/5/069	Complementing Conventional Approaches with Nuclear Techniques towards Flood Risk Mitigation and Post-Flood Rehabilitation Efforts in Asia **Objective**: To improve the capacity to develop resilience/adaptation of agricultural production systems to flooding events by (i) generating flood-tolerant crops using nuclear techniques, (ii) improving soil-water-nutrient management practices by isotopic techniques for flood adaptation-rehabilitation approach, (iii) optimizing use of local feed resources while protecting the environment, animal production and locally adapted animal breeds, and early and rapid diagnosis/control of trans-boundary animal/zoonatic diseases, (iv) flood management by use of isotope hydrology, comprehensive water resources assessment, including river basin and groundwater systems, for forecasting occurrence and potential extent of floods, and (v) developing strategies to exploit the potential of floodplains to absorb floodwater to the extent possible and to fulfil additional needs of drinking and irrigation through use of groundwater from floodplains.	G. Viljoen / M-L Nguyen / B. Kumar I. Naletoski A. Diallo
RER/5/016	Supporting Coordinated Control of Transboundary Animal Diseases with Socioeconomic Impact and that Affect Human Health **Objective**: To reduce transboundary disease incidence in livestock and livestock products in the Euro-Asian region.	I. Naletoski
RLA/5/049	Integrated Control of Fascioliasis in Latin America (in support of National Programmes **Objective**: Integrated control of fascioliasis (in support of national programmes).	G. Viljoen / I. Naletoski

TC Project	Description	Technical Officer(s)
SEY/5/008	Building Capacity for Diagnosis of Animal Diseases using Nuclear and related Techniques (Phase I) **Objective**: To enhance local production of livestock in order to improve local food and nutrition security by reducing the country`s dependence on importation of animal and animal products..	H. Unger
SIL/5/013	Establishing a Dual-Purpose Cattle Development Project for the Sustainable Contribution to Food Security, Poverty Alleviation and Improved Livelihoods of Communities Raising Cattle **Objective:** Sustainable contribution to food security, poverty alleviation and improved livelihoods of communities raising cattle.	M. Shamsuddin
SRL/5/042	Applying Molecular Diagnostics to Zoonotic Diseases **Objective**: To enhance the long term epidemic preparedness by developing competence in molecular diagnosis and surveillance of zoonotic infections.	R. Kashyap H. Unger
SRL/5/045	Establishing a National Centre for Nuclear Agriculture **Objective**: To develop and implement programmes on the use of nuclear technology applications in the field of agricultural soil, water and plant nutrient studies, crop variety improvement and associated management technologies.	H. Unger C. Lamien P. Lagoda F. Sarsu
SUD/5/036	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 **Objective**: To attain food security by improving livestock productivity.	N. Naletoski G. Viljoen
THA/5/053	Enhancing Productivity and Control of Reproductive Diseases of Dairy Cattle and Buffaloes by Application of Nuclear-Based and Molecular Techniques **Objective**: To enhance productivity of dairy cattle and buffaloes in Thailand in order to obtain food security, poverty reduction and a good quality of life for farmers according to the national development programme for food and agriculture, with a focus on animal productivity and disease control.	G. Viljoen M Shamsuddin
TUN/5/028	Supporting Watering Strategies to Help Livestock Raised in Semiarid and Arid Regions Coping with Climate Change **Objective**: To characterize, analyse and to adjust watering strategies for livestock adopted in different production systems in the main agroecological areas of Tunisia. To enhance livestock performance, secure the sustainability of livestock-based production systems and contribute to the empowerment of livelihoods of rural communities.	I. Naletoski
UGA/5/032	Improving Animal Production and Productivity through Advanced Animal Disease Control and Animal Production Measures **Objective:** To improve animal production and productivity through advanced animal disease control and animal production measures.	H. Unger
UGA/5/035	Improving Food Safety through Surveillance of Fish Diseases **Objective**: To avail credible information about trace metals and aflatoxins in fish.	H. Unger C. Lamien
URT/5/027	Improving Livestock Production and Productivity through Sustainable Application of Nuclear and Related Techniques **Objective:** The broad objective of this project is to improve livestock production and productivity in the United Republic of Tanzania through sustainable application of various nuclear and nuclear related techniques.	M. Shamsuddin M. Garcia

TC Project	Description	Technical Officer(s)
URU/5/028	Improving the Diagnosis of Bacterial, Viral and Parasitic Zoonotic Diseases that Impact the National Economy and Human Health **Objective**: Improvement of the diagnosis of important zoonotic diseases (eg Newcastle Disease, Fascioliasis, Leptospirosis, Micobacterium and others).	G. Viljoen
YEM/5/012	Improving Diagnostic and Analytical Capabilities of the Central Veterinary Laboratory Including Residue Testing of Animal Products **Objective**: To enhance livestock productivity and quality by reducing the incidence of livestock diseases.	H. Unger
ZAI/5/021	Upgrading Laboratory Services for the Diagnosis of Animal Diseases and Building Capacity in Vaccine Production to Support the Sustainability of Food Security and Poverty Alleviation **Objective:** To support the sustainability of food security and poverty alleviation through animal diseases diagnosis and immunization.	G. Viljoen I. Naletoski
ZAI/5/022	Using Nuclear and Biotechnology Techniques for Genetic Adaptation and Improvement of Staple Crops for High Temperatures and Water Stress **Objective**: To develop climate resilient varieties for major staple crops with efficient water and nitrogen use to contribute to sustainable food security and the fight against poverty. To benefit from inputs already identified under previous TC projects to build capacity for mutation induction and plant biotechnology for advanced mutants lines and infrastructures.	G. Viljoen A. Diallo I. Naletoski
ZAI/5/023	Upgrading Laboratory Services for Capacity Building in Fish and Aquaculture Diseases as a Contribution to Sustainable Poverty Alleviation and Sanitary Security of Food **Objective**: To enhance advanced skills in the diagnosis and investigation of fish and aquaculture diseases as a contribution to sustainable poverty alleviation and sanitary security of food.	A. Diallo I. Naletoski
ZAM/5/028	Improving Productivity of Dairy Animals Maintained on Smallholder Farms through Selected Breeding and Effective Disease Diagnosis and Control Using Isotopic and Nuclear Techniques **Objective:** To improve productivity of dairy animals maintained on smallholder farms in rural areas through selected breeding, effective disease diagnosis and control, improved supply of quality feeds and application of assisted animal reproduction techn.	I. Naletoski M. Shamsuddin M. Garcia
ZIM/5/016	Strengthening Food Security and Safety by Advancing Technologies for the Rapid Diagnosis of Diseases of Major Economic and Zoonotic Importance and for Residue/Pesticide Control in Animals and Animal Products **Objective:** Strengthening the existing technology and capacity to rapidly diagnose diseases of major economic and zoonotic importance and enable proper and timely response to disease outbreaks.	I. Naletoski

Publications

Prevalence of Rift Valley fever in domestic ruminants in the central and northern regions of Burkina Faso

Boussini H., Lamien, C.E., Nacoulma, O.G., Kabore, A., Poda, G. and ***G.J. Viljoen***

Rev. sci. tech. Off. int. Epiz.,In press

The seroprevalence of Rift Valley fever was determined in cattle, sheep and goats in selected areas of northern and central Burkina Faso. A total of 520 serum samples were screened for anti-Rift Valley fever virus immunoglobulin G (IgG) antibodies using an inhibition enzyme-linked immunosorbent assay (ELISA). An average seroprevalence of 7.67% (range 5% to 20%) was found in ruminants in Seno and Soum provinces, and prevalences of 20% and 22.5% in cattle in Yatenga and Oubritenga provinces, respectively. The location, species and age of the animals was found to influence the seroprevalence. All the ELISA IgG-positive samples were tested for IgM in a competitive ELISA and were found negative, thus ruling out recent infections. The IgG-positive samples, including weak positives, were further tested in a serum neutralisation test for neutralising antibodies and 54.5% of these samples tested positive. The results show that the virus is in circulation in central and northern regions of Burkina Faso, suggesting the need for improved surveillance and control systems to prevent future outbreaks and the consequent economic impact of the disease in Burkina Faso livestock.

Protective efficacy of a single immunization with capripoxvirus-vectored recombinant peste des petits ruminants vaccines in presence of pre-existing immunity

Caufour P, Rufael, T., ***Lamien, C.E.,*** *Lancelot R., Kidane, M., Awel, D., Sertse, T, Kwiatek, O., Libeau, G., Sahle, M.,* ***Diallo, A.,*** *Albina, E.,*

Vaccine, In press.

Sheeppox, goatpox and peste des petits ruminants (PPR) are highly contagious ruminant diseases widely distributed in Africa, the Middle East and Asia. Capripoxvirus (CPV)-vectored recombinant PPR vaccines (rCPV-PPR vaccines), which have been developed and shown to protect against both Capripox (CP) and PPR, would be critical tools in the control of these important diseases. In most parts of the world, these disease distributions overlap each other leaving concerns about the potential impact that pre-existing immunity against either disease may have on the protective efficacy of these bivalent rCPV-PPR vaccines. Currently, this question has not been indisputably addressed. Therefore, we undertook this study, under experimental conditions designed for the context of mass vaccination campaigns of small ruminants, using the two CPV recombinants (Kenya sheep-1 (KS-1) strain-based constructs) developed previously in our laboratory. Pre-existing immunity was first induced by immunization either with an attenuated CPV vaccine strain (KS-1) or the attenuated PPRV vaccine strain (Nigeria 75/1) and animals were thereafter inoculated once subcutaneously with a mixture of CPV recombinants expressing either the hemagglutinin (H) or the fusion (F) protein gene of PPRV (103TCID50/animal of each). Finally, these animals were challenged with a virulent CPV strain followed by a virulent PPRV strain 3 weeks later. Our study demonstrated full protection against CP for vaccinated animals with prior exposure to PPRV and a partial protection against PPR for vaccinated animals with prior exposure to CPV. The latter animals exhibited a mild clinical form of PPR and did not show any post-challenge anamnestic neutralizing antibody response against PPRV. The implications of these results are discussed herein and suggestions made for future research regarding the development of CPV-vectored vaccines.

Candidate gene approach for parasite resistance in sheep – variation in immune pathway genes and association with faecal egg count

Periasamy K*,* ***Pichler R****, Poli M, Cristel S, Cetrá B, et al.*

PLoSONE
9(2): e88337. doi:10.1371/journal.pone.0088337

Sheep chromosome 3 (Oar3) has the largest number of QTLs reported to be significantly associated with resistance to gastro-intestinal nematodes. This study aimed to identify single nucleotide polymorphisms (SNPs) within candidate genes located in sheep chromosome 3 as well as genes involved in major immune pathways. A total of 41 SNPs were identified across 38 candidate genes in a panel of unrelated sheep and genotyped in 713 animals belonging to 22 breeds across Asia, Europe and South America. The variations and evolution of immune pathway genes were assessed in sheep populations across these macro-environmental regions that significantly differ in the diversity and load of pathogens. The mean minor allele frequency (MAF) did not vary between Asian and European sheep reflecting the absence of ascertainment bias. Phylogenetic analysis revealed two major clusters

with most of South Asian, South East Asian and South West Asian breeds clustering together while European and South American sheep breeds clustered together distinctly. Analysis of molecular variance revealed strong phylogeographic structure at loci located in immune pathway genes, unlike microsatellite and genome wide SNP markers. To understand the influence of natural selection processes, SNP loci located in chromosome 3 were utilized to reconstruct haplotypes, the diversity of which showed significant deviations from selective neutrality. Reduced Median network of reconstructed haplotypes showed balancing selection in force at these loci. Preliminary association of SNP genotypes with phenotypes recorded 42 days post challenge revealed significant differences ($P<0.05$) in faecal egg count, body weight change and packed cell volume at two, four and six SNP loci respectively. In conclusion, the present study reports strong phylogeographic structure and balancing selection operating at SNP loci located within immune pathway genes. Further, SNP loci identified in the study were found to have potential for future large scale association studies in naturally exposed sheep populations.

Development of an information exchange platform to facilitate the communication with counterparts in Member States

The Animal Production and Health Section (APH) is implementing numerous animal production and health projects in the counterpart institutions throughout the world, contributing to the capacity building and technology transfer in the appropriate sectors in Member States (MS). The major outcome of these projects is the improved preparedness of the MS veterinary authorities for response to the food safety challenges. However, the management of these challenges, such as global migrations and trade, climate changes (floods and draughts), nuclear emergencies etc. requires a complex response, involving multiple sectors of agricultural and public health authorities. Information exchange during the management of such challenges is of critical importance for the planning and decision making processes. Moreover, the complexity and the demand for multisectorial involvement are requiring harmonized methodologies for quantification of the events and structured data exchange. The floods in Thailand during 2011, the nuclear accident in Fukushima during the same year, as well as the recent transboundary spread of animal diseases, including those with zoonotic impact (African swine fever, Nipah fever, SARS, MERS and others) have clearly demonstrated the complexity of these events, the demands for all the sectors of the agricultural area and the regional (global) dimension of these events.

In order to facilitate the information exchange, harmonize the sources for quantification of individual parameters and potentially integrate information of different sectors, the APHS has started the development of an information exchange platform for integration of entities, parameters and tracking of field events, comprised of: 1) classified roster of entities (laboratories, authorities and educational institutions) from different sectors of agriculture, public health (where relevant) and nuclear safety (Figure 1); 2) roster of parameters (recognized standard operating procedures-SOPs) and 3) upgradeable evaluation tool for designated parameters.

The roster of entities currently includes most of the counterpart institutions of APH from 2003 onwards, with the recognized statuses of the entity (for example: testing laboratory, national or international reference laboratory, head veterinary office etc.), contact personnel for individual parameters and precise geo-referencing of the entity, enabling for direct mapping of the entities using GIS software (Figure 2). The roster is open for the authorized users to update, create or delete an entity and can be updated with additional entities from different sectors of agriculture or other relevant fields. Additionally, it is linked to a nomenclature of countries, classified according to their status in FAO, IAEA and UN, which enables for precise filtering and grouping, according to their country's eligibility to participation in the ongoing programs (Figure 3).

InstCat_Name	InstSubcat_Name
Agriculture (Multisectorial)	AGR-Competent authority (Multi sectorial)
	AGR-Education (Multisectorial)
	AGR-International organization
	AGR-Laboratory (Multi sectorial)
Animal Production and Health	APH-Competend authority
	APH-Education
	APH-International organization
	APH-Internet Resources
	APH-Laboratory
Insect Pest Control	IPC-Competent authority
	IPC-Education
	IPC-Laboratory
	IPC-Undefined
Nuclear Safety	NS-Competent authority
	NS-Education
	NS-International Organization
	NS-Laboratory
Plant Breeding	PBR-Competent authority
	PBR-Education
	PBR-Laboratory
Public (Human) Health	PHL-Competent authority
	PHL-Education
	PHL-International organization
	PHL-Laboratory
Soil and Water Management	SWM-Competenr authority
	SWM-Education
	SWM-Laboratory
Unclassified	Unclassified organization

Figure 1: Classification of responsible entities.

The roster of entities currently includes most of the counterpart institutions of APH from 2003 onwards, with the recognized statuses of the entity (for example: testing laboratory, national or international reference laboratory,

head veterinary office etc.), contact personnel for individual parameters and precise geo-referencing of the entity, enabling for direct mapping of the entities using GIS software (Figure 2). The roster is open for the authorized users to update, create or delete an entity and can be updated with additional entities from different sectors of agriculture or other relevant fields. Additionally, it is linked to a nomenclature of countries, classified according to their status in FAO, IAEA and UN, which enables for precise filtering and grouping, according to their country's eligibility to participation in the ongoing programs (Figure 3).

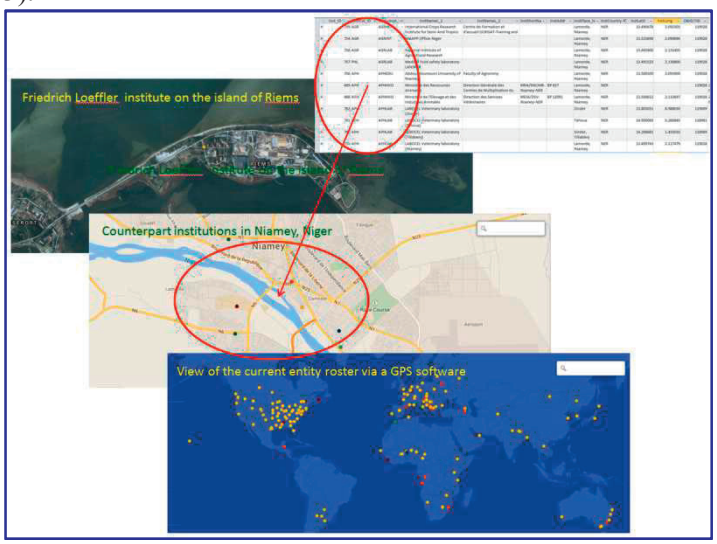

Figure 2: Mapping of the entities using GIS software (different levels of zooming, different background maps and classification of institutions based on the color of the label).

CountryName	ISO_A2	ISO_A3	FAO_Region	IAEA_Region	UN_Member	FAO_Member	IAEA_Member	TC_List
AFGHANISTAN	AF	AFG	Asia	Asia and the Pacific	Y	Y	Y	Y
ANGOLA	AO	AGO	Africa	Africa	Y	Y	Y	Y
ALBANIA	AL	ALB	Europe	Europe	Y	Y	Y	Y
ANDORRA	AD	AND	Europe	Europe		Y	N	N
UNITED ARAB EMIRATES	AE	ARE	Asia	Asia and the Pacific	Y	Y	Y	Y
ARGENTINA	AR	ARG	Americas	Latin America	Y	Y	Y	Y
ARMENIA	AM	ARM	Asia	Europe	Y	Y	Y	Y
ANTIGUA AND BARBUDA	AG	ATG	Americas		Y	Y	N	N
AUSTRALIA	AU	AUS	Oceania	Asia and the Pacific	Y	Y	Y	Y
AUSTRIA	AT	AUT	Europe	Europe	Y	Y	Y	N
AZERBAIJAN	AZ	AZE	Asia	Europe	Y	Y	Y	Y
BURUNDI	BI	BDI	Africa	Africa	Y	Y	Y	N
BELGIUM	BE	BEL	Europe	Europe	Y	Y	Y	N
BENIN	BJ	BEN	Africa	Africa	Y	Y	Y	Y

Figure 3: Nomenclature of countries with the unique identifiers and the classifying attributes for filtering of the entities in the laboratory mapping tool.

The parameters (tests) performed in each of the entities are attributed to each of the entities in a way that enables for multiple evaluations of each of the parameters. This is a useful tool for the technical officers and the experts involved in specific projects, to periodically review and evaluate the success of the implementation of the capacity building projects. The criteria for evaluation are specific for the parameter (disease in the example on Figure 4) and the test used to determine the parameter. The evaluation is performed using a 4-level description, as follows: 1) capacity exists but the parameter is not performed; 2) the parameter is performed but poorly; 3) the parameter is performed but irregularly and 4) the parameter is performed routinely (Figure 4).

The evaluation component, combined with the entity description module, enables also for filtering and mapping of entities, competent to test for required parameter, such as listing and visualization of laboratories to perform particular FMD test, to measure soil erosion after floods or to perform measurement of the eventually contaminated animal products with radionuclides.

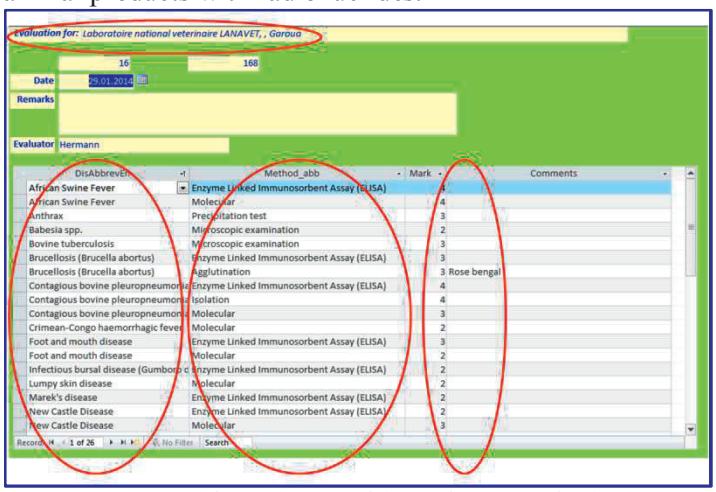

Figure 4: Panel for evaluation of the performance of individual parameters in the counterpart entities.

An integrated part of the information exchange platform is the module for basic professional information related to the parameters performed in the registered entities (Figure 5). The module is currently comprised of three information packages: 1) the list of reference laboratories for particular parameter with the contact details for laboratories and the responsible personnel; 2) relevant reading resources for the parameter and 3) recognized standard operation procedures for determination of the parameters. Figure 5 is showing the information package related to the African swine fever.

The laboratory mapping tool is designed primarily to improve the communication between the APHS and the counterpart institutions. The main idea is to develop it as a crossroad for exchange of the most important relevant information available on Internet, between competent teams in the counterpart laboratories. In the near future the tool should be uploaded on a cloud server and make it available to authorized colleagues. Each of the above mentioned components will have a 'suggestion' link where authorized counterparts can suggest eventually required changes in particular component of the tool, such as modification of existing information in the information module (update of an existing SOP or the need upload a new SOP), changing in the authorization of the personnel in the counterpart entities (new laboratory head, new CVO etc.) or changes in the status of entities (designation for testing of a new parameter, changing in the reference status of the reference laboratories etc.). Additionally, a reminder to the counterpart entities should be built-in, in order to periodically remind the counterparts for checking the records related to them. Incorporation of the 'suggestion' and 'reminder' option in the whole software is aimed to

enable continuous update (self-sustainability) of the records in the database.

Additional option should be the capacity for data exchange and querying through the external data resources, such as the existing or developing IAEA platforms (TC-PRIME, USIE or the data visualization tool for nuclear emergencies-in the process of development), FAO EMPRES, OIE-WAHIS, WHO-WHOSIS and/or existing national information systems in MS. The last communication should be establish in a way which would not require substantial changes in the existing information platforms of the linked international organizations or counterparts, but should use the predefined queries for data integration (common formats of datasets, common nomenclature keys etc.). An example of the capacity for data exchange with external information platforms is shown in Figure 6.

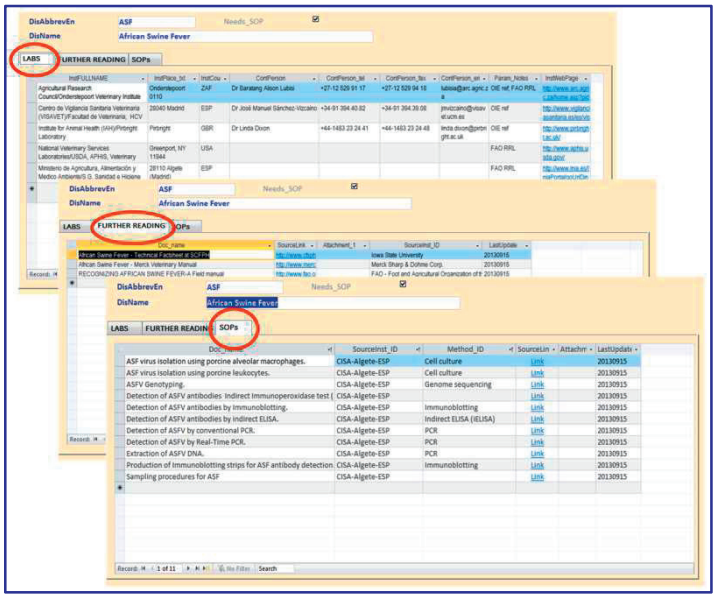

Figure 5: Information module for the parameters performed in the registered entities.

Figure 6: Testing of the capacity of the APH information platform for data exchange with external sources: Yellow spots represent the location of the currently recorded, authorized veterinary laboratories in Europe (record source APH platform), and the red spots are representing the records on the ASF outbreaks for the last two years (record source EMPRES-I, FAO).

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