Nuclear Energy and Agriculture - an unlikely pairing?

by Karen Sliter, DVM

I recently had the opportunity to visit the APHIS office in Vienna, Austria and review our collaboration with international organizations, including the International Atomic Energy Agency (IAEA), the Food and Agriculture Organization (FAO), particularly in the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. Once again I was impressed with the scope of work within the APHIS mandate and the ways our work has a global impact through our collaboration with International Organizations such as the IAEA and FAO. I realize it might not be immediately obvious why the same organization which is the world's "nuclear watchdog" is a key partner for APHIS. Read on, though, and you might be surprised at the number of ways our APHIS mission and the IAEA mission intersect.

APHIS collaboration with the IAEA dates back over 50 years. The IAEA was established in 1957 as the global organization which promotes the peaceful use of nuclear energy while preventing its use for any military purpose, including nuclear weapons. A world without atomic energy would be very different - no use of radiation for treating cancer, no airport x-ray scans, no use of isotopes to measure and manage drinking water. The face of U.S. agriculture would also be very different. APHIS programs use atomic energy in three main ways: the Sterile Insect Technique (SIT) is used to suppress or eradicate pests such as Mediterranean fruit fly (medfly) and screwworm, the irradiation of fruits as a quarantine treatment (where PPQ is recognized as a global leader in the field), and the diagnosis of foreign animal diseases using laboratory tests which have been developed using nuclear techniques to achieve the high levels of sensitivity and specificity needed to detect that one pathogen in a million. The IAEA continues to explore future uses of atomic energy; for example, the use of irradiated vaccines for the control of diseases such as Peste des Petit Ruminants (PPR). APHIS' main counterparts at IAEA work in the Joint Division. FAO.

Sterile Insect Technology as an alternative pest control

SIT was first developed in the U.S. and has been used in the suppression, eradication, containment and prevention of major insect pests for over 50 years. Through the results of joint research efforts with APHIS, Agricultural Research Service (ARS) and support of the FAO/IAEA joint division, preventative SIT programs were set up in California and Florida, while containment, suppression or eradication programs were set up in Texas, Mexico, Central and South America. These programs safeguard American agriculture, facilitate trade and reduce the need for insecticides.

SIT is not only applied in the Americas but on all six continents. For example, SIT has been used in Zanzibar in a successful pilot project to demonstrate that SIT can be used to eradicate tsetse fly populations, helping control two significant diseases – trypanosomiasis in cattle and "sleeping sickness" in humans. Under FAO/IAEA leadership, SIT has also successfully overcome political challenges; the FAO/IAEA joint division established a successful collaborative project between Israel, Palestine and Jordan to control the movement of insect pests in the area.

A recent highlight of the collaboration between APHIS and the IAEA is the ongoing efforts towards the eradication of the medfly in the Dominican Republic.

For further information on IAEA and its work on SIT, this is a good place to look: http://www-naweb.iaea.org/nafa/ipc/sterile-insect-technique.html

Irradiation as a Quarantine Treatment

In order to meet U.S. entry requirements, certain fresh fruits and vegetables must be quarantined to eliminate pests and pathogens that may pose a phytosanitary risk to U.S. agriculture and natural resources. Irradiation can be used as an option in some instances.

Irradiation is one of the few viable alternatives to methyl bromide fumigations. As methyl bromide is phased out due to concerns about its environmental impact, replacements have to be found. Many of the technical and political challenges have been addressed, such as the "paradigm shift" of accepting that a commodity presented for import could possibly have live (irradiated) larvae and/or pathogens present. In addition, because radiation dosage standards are needed for each commodity, the IAEA continues to develop these and has doubled the number of standard treatments in the past year. The biggest remaining challenge is the relatively high cost, and it is a commercial decision of whether or not to pursue this option. Companies who use it have found that irradiation treatment is effective against a wide range of pests/pathogens and can be a substitute for complicated and costly combinations of treatments, systems approaches, and other mitigations.

The Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, initiated a coordinated research project on Irradiation as a Phytosanitary Treatment of Food and Agricultural Commodities in 1998. This groundbreaking research has provided direction to the National Plant Protection Organizations worldwide. The Joint Division also initiated and coordinated a five year international research on development of generic irradiation doses for quarantine treatments that ended in 2014. For further information please see: http://www-pub.iaea.org/MTCD/Publications/PDF/te_1427_web.pdf

Diagnosis of Foreign Animal Diseases

Approximately 70 percent of the activities of the Animal Production and Health (APH) section of the FAO/IAEA Joint division are animal disease related. A major part of this work focuses on the diagnosis of foreign animal and zoonotic diseases which entails the development of diagnostic tools and the dissemination of these techniques and related materials to member states both as a preventative measure and in cases of emergency. Most of the diagnostic tools focus on the early detection of animal diseases and the subsequent development of vaccines.

One project currently being run by the APH section aims at developing a one-step multiplex RT qPCR assay for the simultaneous detection of capripox virus (lumpy skin/sheep-pox/goat-pox), Peste des Petit Ruminants, *Pasteurella multocids* and *mycoplasma ssp.* in small ruminants. This diagnostic tool helps present a more complete picture of the landscape of animal diseases in countries where small ruminants such and goats and sheep are the source of many residents' livelihood.

In addition to helping diagnose animal diseases, the diagnostic systems and equipment were also particularly helpful during the most recent Ebola outbreak. During the peak of the crisis, the IAEA was approached by member states for help. The IAEA collaborated with the World Health Organization (WHO) and CDC, and worked to move veterinary lab equipment and veterinary laboratory technicians to human health laboratories in Sierra Leone to help diagnose human Ebola cases. This was done strategically due to biosecurity concerns so that potentially risky samples were sent only to one laboratory.

Looking to the Future – Irradiated Vaccines

With the issue of drug resistance becoming a growing concern, alternatives for protecting both people and animals are being sought. One potential solution is the use of irradiated vaccines. The FAO/IAEA joint division is currently developing methods which involve the use of irradiation to make vaccines more effective for use in the field. One current project which is being developed is the use of irradiation to rendering an antigenically active but biologically inactive trypanosome vaccine for protection against Trypanosomosis. Trypanosomosis is a livestock disease caused by the most widely distributed disease-causing parasite in Asia, South America and Africa. The current project aims to determine the exact dose of ionizing radiation, measure in gray (Gy), which will elicit the highest possible protective immune response while limiting the disease causing capabilities of the parasite. This technique could leave these parasites still able to cause disease, and therefore it must be used in conjunction with genetic manipulation. The hope is to use these two techniques to produce a metabolically active vaccine to ultimately prevent this disease from developing in cattle around the world.

Additional information on animal health activities can be found here:
https://www.iaea.org/topics/livestock

Capacity Building and Training

The development and implementation of the techniques named above is only possible through extensive and comprehensive training programs held both at the FAO/IAEA laboratory facilities in Seibersdorf, Austria and on site at laboratories across the globe. FAO/IAEA capacity building is three fold. The first line of defense is the on-the-job training of fellows, trainees and interns at the Seibersdorf lab facilities. These trainings can last from one month to one year with the aim to exchange knowledge between the FAO/IAEA joint division and the scholars of labs in member states. A current example of

APHIS-Joint FAO/IAEA Division cooperation is the two week training course in August on lumpy skin disease diagnosis in European and Balkan countries

Secondly, specific training programs aim at capacity building of lab personnel. These training programs, which run over a course of one to four weeks, are held in Seibersdorf laboratories or abroad and accommodate 20-30 participants. The financial support of USDA APHIS helps make some of these courses possible. These training programs often take the "train the trainer" approach meaning that each attendee is meant to return to their respective labs and train their colleagues in the newly learned techniques. The participants are often provided with kits that they can then take back to their respective countries for use in the field.

Finally, training programs can also be held on site in member states. Onsite training combined with facility evaluations help to ensure that lab personnel are able to carry out diagnostic testing and apply techniques in the most effective manner.

An overview of training activities and opportunities can be found here:
https://www.iaea.org/publications/training/iaea-training-resources

Below are some photos from my visit. I hope the information above and these photos help convey a sense of the multiple ways the APHIS mission intersects with that of the IAEA, and the strength of our more than 50 years of technical collaboration. Nearly 63 years ago, on December 8, 1953, President Dwight D. Eisenhower addressed the General Assembly of the United Nations on Peaceful Uses of Atomic Energy. It was a speech which led the way to the creation of the IAEA four years later. Even at that time, President Eisenhower envisioned a world where peaceful uses of nuclear energy could be used to benefit agriculture.

"The more important responsibility of this Atomic Energy Agency would be to devise methods whereby this fissionable material would be allocated to serve the peaceful pursuits of mankind. Experts would be mobilized to apply atomic energy to the needs of agriculture, medicine, and other peaceful activities. A special purpose would be to provide abundant electrical energy in the power-starved areas of the world. Thus the contributing powers would be dedicating some of their strength to serve the needs rather than the fears of mankind."

So yes, Nuclear Energy and Agriculture are unlikely partners at first glance, but this partnership- this positive bonding- is stronger than ever.

The APHIS team reviews pupae of different fruit fly species and strains and learns about the development of new genetic strains. From left: Rui Cardoso Pereira, Konstantin Bourtzis, Diana Chapman, Karen Sliter, Marc Gilkey, Jere Dick, Cheryle Blakely, Hala Toubia

Jorge Hendrichs showing different fruit fly species being reared in the Seibersdorf laboratories, thereby allowing unique comparative studies that because of quarantine barriers are not possible elsewhere in the world. .

Permanent Mission of the Republic of Bulgaria
to the United Nations, the OSCE and other International Organizations

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Vienna,4 May 2016

NOTE VERBALE

The Permanent Mission of the Republic of Bulgaria to the UN, the OSCE and other International Organizations in Vienna presents its compliments to the Joint FAO/IAEA Division and has the honour to convey a letter by H.E. Mr. Tsvetan Dimitrov, Deputy Minister of Agriculture and Food of the Republic of Bulgaria to H.E. Mr. Qu Liang, Director, Nuclear Technology in Agriculture and Food, Joint FAO/IAEA Division with gratitude for the prompt and effective reaction to our request for assistance in connection with the outbreaks of Lumpy Skin Disease in Bulgaria.

The Permanent Mission of the Republic of Bulgaria to the UN, the OSCE and other International Organizations in Vienna avails itself of the opportunity to renew to the Office of the Secretary General of the OSCE the assurances of its highest consideration.

Enclosure:
- Letter Director GG

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REPUBLIC OF BULGARIA
Minister of Agriculture and Food

99-85
22.04.16

H. E. YUKIYA AMANO
DIRECTOR GENERAL
INTERNATIONAL ATOMIC ENERGY AGENCY

DEAR DIRECTOR GENERAL AMANO,

Herewith I would like to most cordially express my utmost gratitude to you and your entire team for the assistance and the extremely quick response from the International Atomic Energy Agency. Following the formal request for assistance sent on April 15, 2016 by the Republic of Bulgaria through its Permanent Mission in Vienna, in connection with established outbreaks of Lumpy Skin Disease in various regions of our country and thanks to your financial and expert support, professionals arrived in Bulgaria who shared their expertise with the Bulgarian veterinary authorities about ways of combating, controlling and preventing the disease.

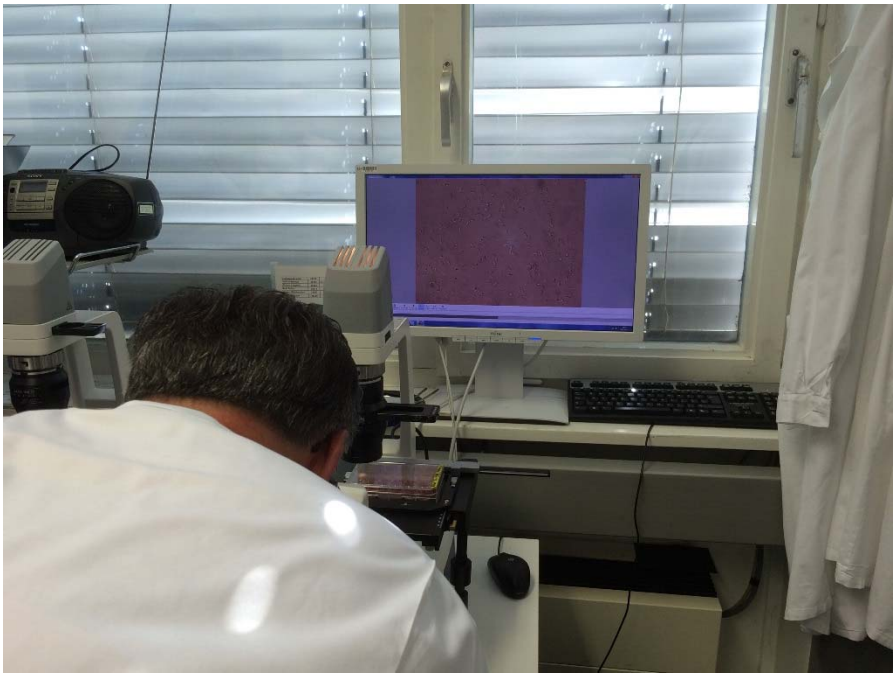
I avail myself of this opportunity to renew to Your Excellency the assurances of my highest consideration.

Sincerely yours,

DESISLAVA TASEVA
Minister

A letter of thanks from the Minister of Agriculture of Bulgaria thanking the IAEA for assistance with Lumpy Skin Disease control in Bulgaria. APHIS helped support this training course with capacity building funds.

The animal health laboratories at Seibersdorf



Looking at trypanosomiasis.

Giving a representational gift to Jorge Hendrichs, world renowned SIT expert, in recognition of his outstanding collaboration with APHIS for more than two decades as the Director of the Insect Pest Control Division.

With Dr. Aldo Malavasi, Deputy Director General, International Atomic Energy Agency

The APHIS team at the IAEA headquarters in Vienna, Austria. Marc Gilkey, Cheryle Blakely, Jere Dick, Hala Toubia, Diana Chapman, and Karen Sliter