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Food and Agriculture
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Продовольственная и
сельскохозяйственная организация
Объединенных Наций

Organización de las
Naciones Unidas para la
Alimentación y la Agricultura

منظمة
الاغذية والزراعة
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FAO REGIONAL CONFERENCE FOR AFRICA

Twenty-ninth Session

Abidjan, Côte d'Ivoire, 4-8 April 2016

Success in Nuclear Applications: African VetLab Network and Sterile Insect Technique

Executive Summary

- 1) Major global trends that will frame agricultural development over the medium term include rising food demand, lingering food insecurity, an increase in the occurrence of emerging and re-emerging transboundary animal and plant diseases (including those of zoonotic importance) and insects, unknown genetic potentials of animals for the production intensification, poor optimization of local feed resources and feeding technologies and the detrimental impacts of climate change. In the fifty years of the FAO-IAEA partnership cooperation has expanded and focuses on the main areas of work in which nuclear techniques have contributed to implementing and achieving the FAO Strategic Objectives.
- 2) Nuclear applications serve a multitude of purposes as they address specific issues of agricultural importance, filling gaps and adding value. To optimize on-site implementation, the Joint FAO/IAEA Division strives to connect scientists and researchers, testing laboratories and regulatory entities directly with farmers, their fields, crops, animals and production processes. Hence, the work of the Joint Division is more than just science – it is the application of science from the laboratory to the field.
- 3) The side event for which this information note is prepared will highlight recent successes in the application of nuclear techniques in Africa, with special reference to the African VetLab Network and to the use of the Sterile Insect Technique (SIT).
- 4) A summary of key messages relating to nuclear applications in these sub-sectors are:

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The FAO-IAEA partnership supports:

- the use of peaceful nuclear applications in national and regional food security programmes
- Strengthening animal health networks, such as the African VetLab Network, through harmonization and common response strategies are crucial to the effective control of emerging and re-emerging transboundary animal diseases
- national efforts to control major native and invasive insect pests through an integrated pest management systems approach incorporating the Sterile Insect Technique (SIT) in the region.

Key messages

1) The FAO-IAEA partnership, supports national and regional efforts to improve animal health and production and hence food security

- Increasing resilience of livestock production systems by optimizing indigenous resource utilization to fit into sustainable growth increase and production environment
- Developing and transferring technologies for early detection and rapid response (action) to control transboundary animal diseases, including those with zoonotic potential

2) The FAO-IAEA partnership supports the strengthening of animal health networks, such as the African VetLab network, through harmonization and common response strategies

- Strengthening laboratory networks for early detection, containment and control of animal disease outbreaks, including those of zoonotic importance, and other multi-hazard risks and threats to food and agriculture
- Improving capacities at institutional, national and regional level for sustainable intensification of livestock production
- Transferring and adapting techniques to end users to increase overall livestock productivity

3) The FAO-IAEA partnership supports national efforts to control major insect pests using the Sterile Insect Technique (SIT)

- Tsetse fly-transmitted diseases cause billions of dollars in losses in Africa – technical assistance can be provided using SIT to suppress and eradicate this pest
- Assisting several West and East African countries in introducing this integrated approach to tsetse fly eradication
- Success in using SIT to eradicate tsetse in parts of Senegal, with early reduction of prevalence of trypanosomosis in cattle from 40-50% to less than 10% and on track for eradication of tsetse in the target area.
- Assisting sub-Saharan countries in controlling invasive fruit flies, reducing insecticide use, overcoming trade barriers and improving the quality and quantity of fruit and vegetable production.

I. Introduction of the FAO-IAEA partnership and its benefits

1. Peaceful use of atomic energy for development is one of the major mandates of the International Atomic Energy Agency (IAEA). Since 1964, the FAO and IAEA have been cooperating through the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture to support and promote the safe and appropriate use by member countries of nuclear and related technologies in food and agriculture, with the aim to contribute to global food security and sustainable agricultural development. An integral part of the FAO-IAEA partnership is the FAO/IAEA Agriculture & Biotechnology Laboratories that spearhead the use of ‘atoms for peace’, with particular emphasis on research for development. Applying cutting-edge isotope and radiation technologies these laboratories add critical value to global agricultural research in the areas of animal production and health, food and environmental protection, insect pest control, plant breeding and genetics, and soil and water management & crop nutrition. Their extraordinary expertise is often at the forefront of worldwide efforts to fight global hunger and malnutrition, improve environmental sustainability, protect plants and livestock, improve farmers’ incomes and ensure safe food for consumers. This collaborative model, unique in the United Nations system, plays a pivotal support role in the success of nuclear applications in food and agriculture.

2. Major global trends that will frame agricultural development over the medium-term include rising food demand, lingering food insecurity, an increase in the occurrence of emerging and re-emerging transboundary plant and animal diseases (including those of zoonotic importance) and insects, unknown genetic potentials of animals for the production intensification, poor optimization of local feed resources and feeding technologies and the detrimental impacts of climate change. In the fifty years of the FAO-IAEA partnership, cooperation has focused on the main areas of work in which nuclear techniques can most effectively contribute to implementing and achieving the FAO Strategic Objectives.

3. Nuclear applications serve a multitude of purposes as they address specific issues of agricultural importance, filling gaps and adding value. To optimize on-site implementation, the FAO-IAEA partnership strives to connect scientists and researchers, testing laboratories and regulatory entities directly with farmers, their fields, crops, animals and production processes. Hence, the work of the Joint Division is more than just science – it is the application of science from the laboratory to the field.

4. During the 2014-15 biennium, the FAO-IAEA partnership contributed to food security and sustainable agriculture development in the Africa Region through 127 national and five regional Technical Cooperation Projects (TCPs), financially supported by the IAEA Technical Cooperation Programme with US €10.6 million, as well as 24 Coordinated Research Projects (CRP). Equipment, expert advice and capacity building was provided through the TCPs, including the training of 395 scientific and technical personnel on the application of nuclear technologies in food and agriculture. The CRPs provided applied research support and enabled participants from the region to also link to the network of almost 500 national and international research institutions and experimental stations working worldwide to solve local, regional and global issues related to sustainable food security.

5. The following provides a very selected overview of some successful applications of nuclear and related techniques in the Africa region in the areas of animal health, animal production and insect pest control.

II. Selected applications of nuclear techniques in food and agriculture

a) The African veterinary diagnostic laboratory network for control of transboundary animal disease

6. An African veterinary diagnostic laboratory network (“VETLAB”) has been established and promoted on a regional basis to create preparedness to prevent and effectively react to animal and zoonotic disease challenges. The network comprises of 51 laboratories in 32 African Countries with focus on the early and rapid diagnosis and control of emerging and re-emerging transboundary animal diseases, and is an extension of the successful rinderpest veterinary diagnostic network. Several member countries, such as Botswana, Cameroon, Côte d’Ivoire, Democratic Republic of Congo, Ethiopia and Mali, have already benefitted from this network to better control foot-and-mouth disease, African swine fever, avian influenza, peste des petits ruminants, and other animal and zoonotic diseases, and have already been accredited under the international ISO 17025 standard. This network is now being expanded also to the Asia region.

b) Nuclear applications for animal production and health programmes

7. Molecular and biotechnology options for the production of food from animals used to be confined mostly in developed sophisticated laboratories. These modern technologies were not only beyond access to African scientist and researchers but also highly expensive, often making it impossible for a resource-poor producers to buy the product of such modern laboratories. The joint FAO/IAEA Division through adaptive research and field trials using nuclear and nuclear-derived techniques has developed kits, guidelines and standard operating procedures (SOPs) to enable the application of these modern techniques in the field under the prevailing African environment. Cases in point are the recent actions by the Joint FAO/IAEA Division, in response to requests for assistance by Côte d’Ivoire and Ghana, to combat the recent HPAI-H5N1 outbreaks. The assistance comprised of expert assistance and a toolbox of critical reagents and equipment.

c) Nuclear techniques for livestock improvement in the context of climate change in Africa

8. Animal productivity can be enhanced by the optimization of indigenous resources (animals, feeds, human capacities) and thus reduce impacts of food production on climate change. Genetic selection of animals for better feed conversion efficiencies and optimization of rumen environment will enable animals to survive on more marginal feed resources by increasing the energy utilization and reducing greenhouse gas emissions. This is not an easy task but technology options are foreseen to address the challenges of increasing food production while mitigating agriculture’s impact on climate change. Nuclear and nuclear-derived techniques permit the development of strategies that optimize the efficiency of the digestive process in rumen and thus increase energy uptake and decrease methane and CO₂ emissions.

d) Eradicating the tsetse fly – the poverty insect – with the Sterile Insect Technique in Senegal

9. A project to eradicate a tsetse fly population from the Niayes area using the Sterile Insect Technique (SIT) as a component of an area-wide integrated pest management approach is being carried out in Senegal. The tsetse fly in the Niayes was responsible for the cyclical transmission of parasites that cause the debilitating cattle disease nagana or African animal trypanosomiasis (AAT). A feasibility-, capacity-building- and preparatory phase from 2005 to 2011 was followed by an

eradication phase starting in 2012 with extra-budgetary funding from the USA. The three blocks of the target area are being treated sequentially with tsetse population suppression tactics, followed by the release of sterile male insects as the final eradication component. Excellent progress has been achieved, with the fly population already eradicated in the first block and very good suppression of the fly population obtained in block 2 (>98%). Suppression of the fly population in block 3 was started in the second half of 2015. The disease (trypanosomosis) prevalence in cattle in the target area has already been reduced from 40-50% to less than 10%. The sustainable removal of the disease nagana will allow the farmers to replace their local, unproductive cattle breeds, with more productive exotic cattle breeds. In addition, herd size can be drastically reduced, which will reduce the pressure on the already fragile ecosystem, giving significant environmental benefits. A cost-benefit analysis has estimated that the sustainable elimination of the tsetse fly and nagana from the Niayes will ultimately bring annual profits of €2.8 million to cattle farmers.

e) Managing invasive Asian and other African fruit flies

10. In addition to local Tephritid fruit fly pests, the African continent has been invaded in recent years by a series of major fruit fly pests of Asian origin. This includes *Bactrocera invadens*, detected in Kenya in 2003, which attacks most tropical fruits and has spread to all countries of sub-Saharan Africa. As a result farmers have to invest heavily in insecticides for the control of this pest to avoid the loss of most of their crops. Applying a multidisciplinary approach, a recently concluded 5-year FAO/IAEA Coordinated Research Project (CRP) was able to show that *B. invadens* is actually *B. dorsalis*, the Oriental fruit fly, thereby overcoming trade barriers that had been established by some Asian countries. The same CRP also clarified the taxonomic status of major African fruit fly pests. FAO/IAEA has also been supporting regional fruit fly TCPs to facilitate networking among fruit fly workers in the region and capacity building on integrated pest management systems to reduce insecticide applications that are hazardous to growers, fruit and vegetable consumers and the environment. In some special situations the Sterile Insect Technique (SIT), an environmental-friendly control method, is also being integrated in a systems approach together with post-harvest treatments to overcome insecticide resistance problems, improve the quantity and the quality of fruit and vegetable production and facilitate exports to retain existing export markets and qualify for entry into new markets.