



### Improving Animal Production and Health How Nuclear Techniques Help



**Crossbred cows in a dairy farm in Angola.** (Photo: M.Garcia Podesta/IAEA)

#### What should I know?

Animal diseases have increasingly become a global problem and pose a serious challenge to food security. These diseases have the potential to spread across borders (transboundary diseases) or from animals to humans (zoonotic diseases) or are considered a biothreat that not only kill animals and impact their productivity but also have serious public health consequences.

Poor animal genetics and scarcity of feed in the tropics are major causes that limit animal productivity (quality and quantity of milk or meat). Global climate change and the increased movement of animals and people are creating conditions for the emergence and re-emergence of transboundary animal diseases, especially those with zoonotic potential that pose a threat to humans.

Additionally, challenges to disease resistance or weather variations, have further aggravated the problem.

Nuclear and nuclear-derived immunological and molecular techniques are essential tools in the early, rapid and accurate diagnosis and control of diseases and are used for genetic characterization, improving reproductive performance and for optimizing locally available feed resources to enhance animal productivity.

#### Building capacity

The IAEA, in partnership with the Food and Agriculture Organization of the United Nations (FAO) through the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture (Joint Division), supports the use of nuclear and related technologies, in conjunction with conventional approaches, that contribute substantially to improving livestock production and health.

Capacity building includes:

1. R&D support, technology transfer and capacity building in the use of nuclear and nuclear-



derived techniques for accurate diagnosis of animal and zoonotic diseases and enhancing animal productivity;

2. Improving immunological and molecular diagnostic techniques using isotopic labelling to trace, monitor and characterize transboundary animal and zoonotic diseases;
3. Using irradiation to weaken or inactivate pathogens for developing vaccines against animal and zoonotic diseases;
4. Using isotopic techniques to investigate migratory routes of birds to help understand the potential risks of spreading transboundary animal and zoonotic diseases;
5. Developing radioimmunoassays to measure and trace hormones that control the reproductive cycle and thus enhance artificial insemination, embryo transfer and breeding strategies;
6. Using isotopic techniques to estimate intake and diet selection by grazing animals, which enable appropriate management of pasture, grasslands and ranch lands to help reduce environmental degradation;
7. Delivering individual and group capacity building through training courses and workshops;
8. Transferring technologies and knowledge through scientific visits, expert services and the provision of diagnostic emergency toolkits and equipment to Member States, with a direct impact on farmers' lives and their livelihoods.

Other support includes publications, harmonization of protocols and standard operating procedures in this field.

## Laboratory support

The Animal Production and Health Laboratory run by the Joint FAO/IAEA Division at Seibersdorf, Austria, helps countries to develop and transfer molecular and immunoassay methods for diagnosis and control of transboundary animal and zoonotic diseases. It assists Member States in the use of radioisotopes and related technologies to map

genes related to higher production yields (meat, milk, wool, fibre) and identify genetic markers for increasing productivity, adaptability and resistance to diseases.

## The VETLAB Network

The Joint Division's Veterinary Diagnostic Laboratory Network (VETLAB Network) is a platform for the sustainable transfer of technologies to strengthen national and regional laboratory capacities and staff proficiency for early and rapid animal and zoonotic disease diagnosis and to support alignment with internationally recognized standards such as the ISO 17025 standard, to share knowledge and experience, and to improve Member States' emergency response capabilities to control outbreaks of animal and zoonotic diseases

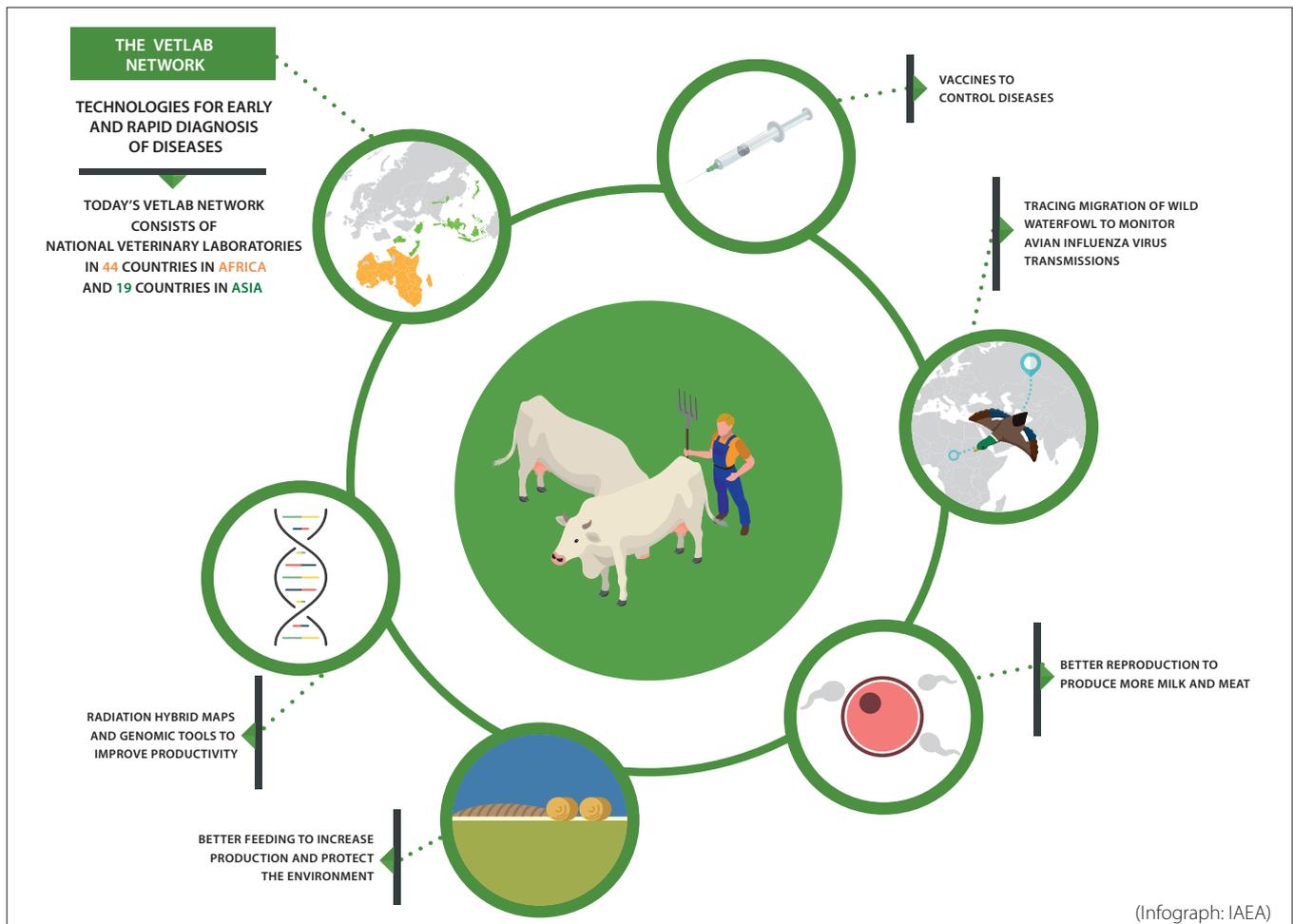
Another important support is the iVETNet information platform, that is used to facilitate data storage and sharing of information.

## How do nuclear and nuclear-derived techniques help?

Radiation hybrid mapping provides an advanced and very accurate technique in genomics. This map pinpoints the location of specific features on an animal's chromosomes, so-called DNA markers, that are important, for example, for milk, meat or egg production.

The technique enables the mapping of several DNA markers that are used to generate the whole genome map of the animal; once mapped, tens of thousands of such markers are combined on a DNA chip, which can then be used to determine the animal's breeding potential.

Enzyme-linked immunosorbent assay (ELISA) and polymerase chain reaction (PCR) are two further nuclear-derived techniques commonly used. These technologies provide high sensitivity and specificity for identifying pathogens. ELISA is also a great tool for analysing reproductive hormones and PCR for genetic studies.



ELISA is easy to set up and effective for identifying diseases and enhancing livestock productivity. In a diluted serum sample, an antibody, substrate and enzyme are added and, depending on the change of colour, the presence of a disease or the targeted hormone is confirmed. PCR is highly sensitive and accurate, making it well suited for identifying virus strains and bacteria and for the characterization of animal genetic resources. This technique uses an enzyme to replicate, or amplify, a specific genetic region of a pathogen's or animal's DNA by a factor of more than a billion in just half an hour.

Radioimmunoassay remains the main standard for accurate analysis of hormone profiles in a female animal to provide information on her pregnancy status, thereby helping to manipulate the reproductive cycle and apply, for example, artificial insemination and embryo transfer to increase the number of births in a herd or flock. Scientists add a sample of blood, milk, urine or other body fluids from an animal to a test tube together with specific

antibody against the hormone and iodine-125 labelled hormone to assess the hormone levels.

The stable isotope content of animal and plant tissues reflects their origins and, in the case of animals and birds, their migration patterns. Scientists detect stable isotopes using mass spectrometry methods and correlate their amounts or ratios with a database maintained by the IAEA to identify geographical locations from which the animals originated or to which they have travelled. Besides, the stable isotope content of consumed plants helps scientists to estimate the intake and diet selection of grazing animals.

## Snapshot of achievements

A number of successes in the area of animal production and health include the complete global eradication of rinderpest in 2011 — a deadly cattle disease that caused economic losses amounting to billions of dollars. The IAEA and FAO, and the



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World Organisation for Animal Health (OIE), made significant technical contributions to this achievement through the development, evaluation, validation and distribution of ELISA kits for the diagnosis and control of the disease.

A burden to over 300 million people worldwide, peste des petits ruminants (PPR) is another highly contagious, widely spread disease that kills thousands of sheep and goats per year and causes annual economic losses estimated at over US \$1.4 billion. A global effort is now underway to eradicate PPR by 2030 using nuclear techniques through a Global Control and Eradication Strategy (Global Strategy). The Global Strategy is fashioned after the successful global eradication programme for rinderpest, a closely related virus to PPR. The FAO, IAEA and their partners will work together to eradicate PPR, improving the livelihoods of people and economies in Africa, the Middle East and Asia that rely on sheep and goats, boosting food security in the process.

National animal disease diagnostic laboratories of 44 African and 19 Asian countries are currently participating in the VETLAB Network and it will soon expand to other regions. Several meetings with directors of laboratories, workshops and training courses have been held to enhance capacity building and sharing of experience. The VETLAB Network Bulletin informs the participating countries and the scientific community in general on the activities and forthcoming events of the network.

With technical support from the Joint Division, Cameroon has effectively used radioimmunoassay, immunological and molecular diagnostics and genetic screening in its livestock reproduction, breeding, artificial insemination and disease control programmes. A key outcome of this endeavour was

a three-fold increase in milk production that would potentially generate additional farmer income of \$110 million per year in the country.

The IAEA reacted rapidly by providing specialized diagnostic equipment to help Sierra Leone, Liberia and Guinea in their efforts to combat the Ebola virus in 2014. With the immediate crisis over, the focus now is on longer-term prevention.

The Joint Division has introduced a nuclear-derived molecular technique to identify specific DNA markers for resistance to gastrointestinal parasites which can be incorporated into a genetic evaluation that enables breeders and farmers to make the best possible breeding decisions. Great success has been obtained in Argentina and Uruguay and this technology is being transferred to Latin American and the Caribbean countries.

A network of artificial insemination services, a flourishing feed industry and delivery of veterinary services helped Bangladesh to achieve a fourfold increase in milk production and a sevenfold increase in meat production over the past decade. The Joint Division assisted the Bangladesh Agricultural University (BAU) in Mymensingh, and the Department of Livestock Services played an important role in this development. The work with BAU focused on increasing the success rates of artificial insemination, working through a farmers' organization with 800 members.

### More information

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

[www.iaea.org/topics/food-and-agriculture](http://www.iaea.org/topics/food-and-agriculture)

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IAEA, Vienna International Centre, PO Box 100, 1400 Vienna, Austria

Email: [info@iaea.org](mailto:info@iaea.org) • Telephone: +43 (1) 2600-0 • Facsimile +43 (1) 2600-7