

MONITORING AND CONTROL OF INFECTIOUS DISEASES - A ONE HEALTH APPROACH

Initiative towards a strategic research agenda on **Monitoring and control of infectious diseases in food-producing animals - a One Health approach**

Contact:

E Sven.Arnouts@UGent.be

T +32 9 264 73 33

M +32 495 707 334

Towards

Sustainable production of safe food from healthy animals

by improved

Monitoring and control of infectious diseases in food producing animals

This document is an invitation to contribute to a strategic research agenda towards competitive and sustainable livestock production by improved monitoring and control of infectious diseases in food producing animals.

Better monitoring and control of infectious diseases in food producing animals is essential for more sustainable production of safe food from healthy animals.

Support of this strategic research will contribute to the realization of the sustainable development goals (SDG): building public-private-partnerships (SDG17) to boost innovation (SDG9) supply of nutritious, safe and healthy food (SDG 2), reducing environmental impact, making better use of resources (SDG 12), respecting animal welfare and safeguarding human and animal (SDG 3) and environment (SDG 13 & 15) health thus responding to the requirements of the consumer/citizen.

These goals can best be achieved through a concerted action between academia, industry and the primary sector and through a research agenda that is aligned with priorities set by STAR-IDAZ IRC and with broader initiatives supporting sustainable livestock production (eg ATF) in Europe.

Said strategic research agenda can result from intensive and coordinated interaction and discussion between academia and industry both at regional/national and at international/European level.

The increasing need for healthy and safe animal protein

The need for sustainable production of sufficient and safe animal protein to feed the growing world population is increasing fast. It is estimated that the world population will increase from 7 to more than 9 billion by 2050. Food supply must therefore increase with 70% by 2050. The growth of the middle class, mainly in developing and BRIC-countries, will increase the demand for high-quality animal protein and lead to a greater demand for livestock production. An increase in meat production from 218 million ton in 2000 to 376 million ton in 2030 is expected. To take part to this evolution, livestock production in Europe should be sustainable and competitive at a global level.

For both aspects, optimal animal health is essential as it contributes to efficient growth and minimal output of waste and (antibiotic) residues in the environment.

Zoonoses deserve special attention. About 60% of all pathogens that threaten humans originate from animals. It is therefore important for public health that we limit the spread of these zoonoses.

Related to food safety we want to pay special attention to enteric pathogens. The last decade, a group of gastro-intestinal diseases have emerged in animals and are still increasing in prevalence. Strikingly, such trends are occurring simultaneously in human and animal health (one health). Said

diseases include chronic inflammatory diseases and undefined enteritis syndromes, and diseases caused by pathogenic micro-organisms. Specific attention should go to Salmonella and Campylobacter. They colonize the gut of production animals, contaminate animal products and are thus transmitted to humans.

Challenges and possible solutions for better control of infectious diseases

Optimizing health of food producing animals will only be possible through a better and more intelligent control of infectious diseases, mainly through prevention, in order to avoid huge losses due to outbreaks of infectious diseases or to more chronic subclinical disease complexes.

There are however some complicating factors.

At global level the intensity of livestock production increases leading to larger units/farms, increased transport of animals and the pathogens they carry and increased mixing of different strains of (related) pathogens within a population of animals. To keep such intensive production sustainable, it is important to minimize major outbreaks of infectious diseases and the associated losses.

Climate change is speeding up the spread of infectious diseases, often through their vectors. This will create new variants of known pathogens with new virulence characteristics. Rapid diagnosis and control will thus be essential to control disease spread and to prevent large losses.

Increasing antibiotic and antiparasitic resistance is another growing problem worldwide. More and more pathogens escape the control via these antibiotics/anthelmintics and alternative (preventive) measures should be developed. Vaccines are seen as one of the main alternatives to antibiotics, but also other solutions that allow the host to defend itself more effectively against the infection (eg immunostimulation, passive immunization / immunotherapy) gain more and more attention. Management systems on farm will combine data from monitoring of (subclinical) infectious diseases with data on production and behavior of the animals. Based on the combination of these data thresholds can be defined for more accurate and targeted use of drugs on the herd or on individual animals (precision livestock farming).

An integrated approach

Optimal health of food-producing animals can only be obtained when a combination of tools are available to the veterinarian/farmer:

- rapid and more precise diagnostics and tools for the monitoring of health and infection
- novel methods that prevent or cure infection and/or empower the animal's general defense against infection
 - new and improved veterinary vaccines including autogenous vaccines or easily adaptable vaccine platforms
 - new delivery methods causing less stress to animals (eg oral delivery of vaccines)
 - new feed additives/drugs
 - use of biomarkers of disease resistance or immunity in breeding programs

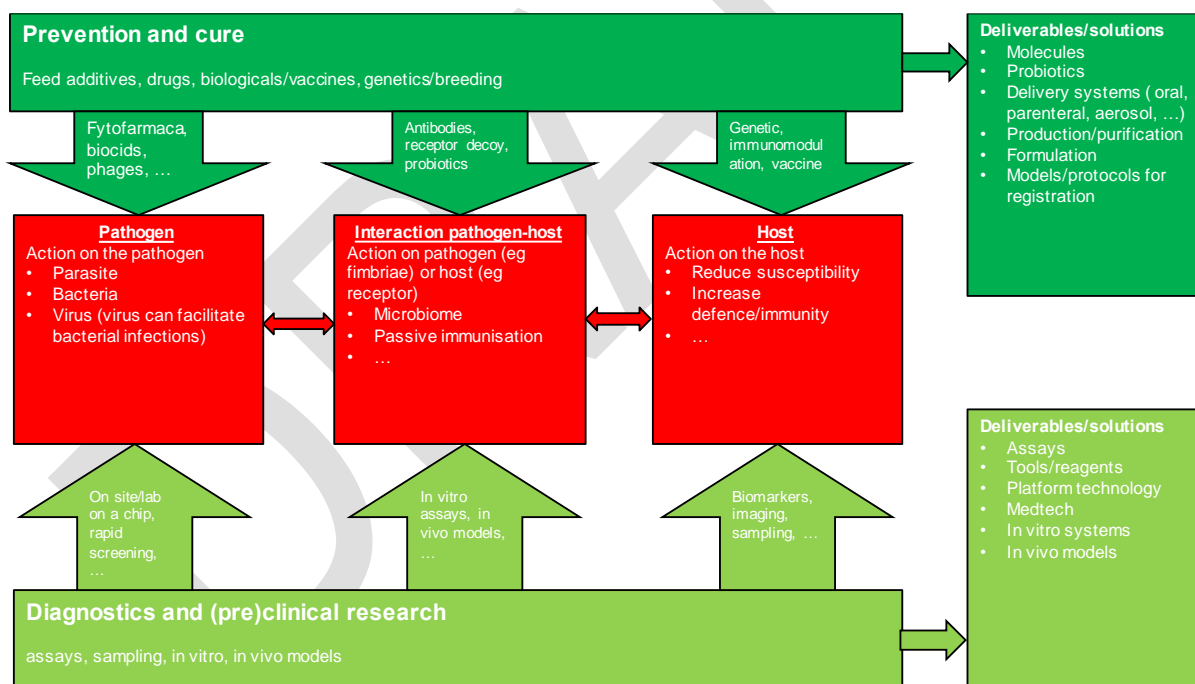
New technologies and tools are already available today or in development. The strength in veterinary science, advances in biotechnology and new technologies (such as next generation sequencing, synthetic biology and systems biology) and tools are already available today in Europe but they

should be combined in an integrated approach. This offers great opportunities for coordinated multidisciplinary research and development actions leading to concrete and applicable solutions.

Assuring optimal health of food-producing animals requires intensive monitoring and rapid diagnosis and rapid, preferably preventive, treatment in cases of increased infection pressure. For the latter new routes of vaccine administration for mass vaccination (for example oral vaccines) on farms with increasing size are explored. More general and non-specific support of the immune system of the host could provide another part of the solution.

The development of vaccines, therapeutics and diagnostics is always a multidisciplinary project and requires not only the knowledge of the target/antigen/biomarker but a lot of other complementary expertise: adjuvants, formulation, expression systems for recombinant proteins, vectors for vaccine delivery, etc. New technologies such as targeting of antigens via carrier antibodies/nanobodies are used also in vaccine development. Specialized laboratories or small biotechs/start ups have further developed these technologies and can be valuable partners.

Data from the monitoring of infectious diseases will be combined on farm with data from production and behavior of the animals, intake of feed and drinking water (digitisation of livestock production) to make optimal decisions on use of preventive or curative measures from a clinical, epidemiological, environmental and economical viewpoint (precision livestock farming).



Innovative solutions backed up by solid research and science

While many tools and technologies to optimize monitoring and control of infectious diseases are already available today, more research is essential to take full profit from the new opportunities they offer.

It is a prerequisite to gain more and better insights into the interactions between pathogens, including zoonoses, and their hosts. Increased understanding of the way the pathogens infect their host,

replicate and persist in the host and the virulence factors that are critical in this process leads to the identification of novel targets on the pathogen or on the host. These targets constitute the basis for the development of new vaccines, therapeutics and/or diagnostics.

Besides a good understanding of specific host-pathogen interactions an understanding of more general aspects of vaccinology, immunology and progressive insight into new technologies for the production and administration of vaccines, immunotherapeutics and health-promoting supplements is required. Better understanding of immunology at the cellular and molecular level and more attention to the non-specific immunity with higher homology between species will allow us to develop more generic technologies and technology platforms that can also be exploited more widely.

Insights into the behavior and distribution of these zoonotic diseases in humans and animals can lead to the development of new strategies and technologies that not only provide a solution for animal health, but also can be translated into new applications in humans (translational, one health).

Most gastro-intestinal diseases and syndromes are exceedingly complex because of the interaction between the host and the microbiota, which can be influenced by environmental and nutritional factors. Indeed, both communication between gastro-intestinal micro-organisms (intra- and inter-species), and between micro-organisms and the host (inter-kingdom) can influence gastro-intestinal health either in a beneficial or a negative way. These interactions can be influenced by nutrition and medication (prophylactic and curative) and the animal's immune and defense mechanisms in order to restore unbalanced host-microbiota interactions. Because of the complexity of the gastric and gut environment, studying the etiology and pathogenesis of gastro-intestinal diseases and the host's immune/defense mechanisms requires an inter-disciplinary approach in which microbiology, molecular biology, veterinary medicine and immunology, nutrition, and many other disciplines are involved. This is of crucial importance when preventive measures against disease and a decrease in gastro-intestinal function need to be developed.

Strong consortia can develop innovative solutions

The objectives described above can only be achieved by and partnerships between world class academics and industry working on a common strategic research agenda with each party playing at their strengths.

Intensive interaction with the primary sector must assure that the knowledge of the pathogen-host interactions together with the understanding of the pathogenesis and the impact of the infection on animal health and performance provides solutions that can be implemented in practice.

To bring new diagnostics, therapeutics / vaccines and feed additives to the market also requires knowledge of the regulatory framework and the market in which these new technologies have to perform.

The creation of strong consortia between academia, industry and the primary sector is thus essential for the development of new and effective strategies to control infectious diseases.

Important steps have already been set by the installation of regional/national active platforms like the Veterinary Vaccinology Network (United Kingdom), ImmunoValley (The Netherlands) and Flanders Vaccine (Belgium). In order to increase the efficiency and impact of these platforms and of their interaction with international animal health companies and to come to a strategic research agenda at European level we should link these national "hubs" into a greater international network.

These partnerships allow us to develop proprietary technology towards market-ready products and will have a leveraging effect on the impact of basic research. The partnerships will lead to multidisciplinary consortia that can deliver a major contribution to strategic research agendas at national, European and global level. This is aligned with the policy of Carlos Moedas, EU Commissioner for Research, Science and Innovation (Open Innovation, Open Science and Open to the World): bring together the best scientists in multidisciplinary teams that realize breakthrough innovations via public-private collaboration.

The economical importance of monitoring and controlling infectious diseases in livestock

The livestock sector contributes substantially to the European economy:

- €130 billion annually
- 48% of the total agricultural activity but much higher in countries like Ireland (74.2%), Denmark (66.4%), UK (60.2%) and Belgium (58.9%)

It creates employment for almost 30 million people. Reduction of livestock farming would affect the vitality of many European territories and the supply of high quality and safe European animal products while favouring imports of animal foods with lower standard quality.

The market for veterinary vaccines was estimated in 2015 at 5.5 billion USD and is expected to grow to 7.2 billion in 2020.

The market for feed additives will increase to 19.5 billion USD by 2020 with an important and growing share of the additives with a health supportive effect.

The veterinary diagnostics market will experience an expected annual growth of 7.8% leading to a total market of 3.6 billion USD in 2019.

