STAR-IDAZ
International Research
Consortium on Animal Health

Map Existing Initiatives in Working Group Fields

Secretariat of the STAR-IDAZ International Research Consortium on Animal Health, September 2022

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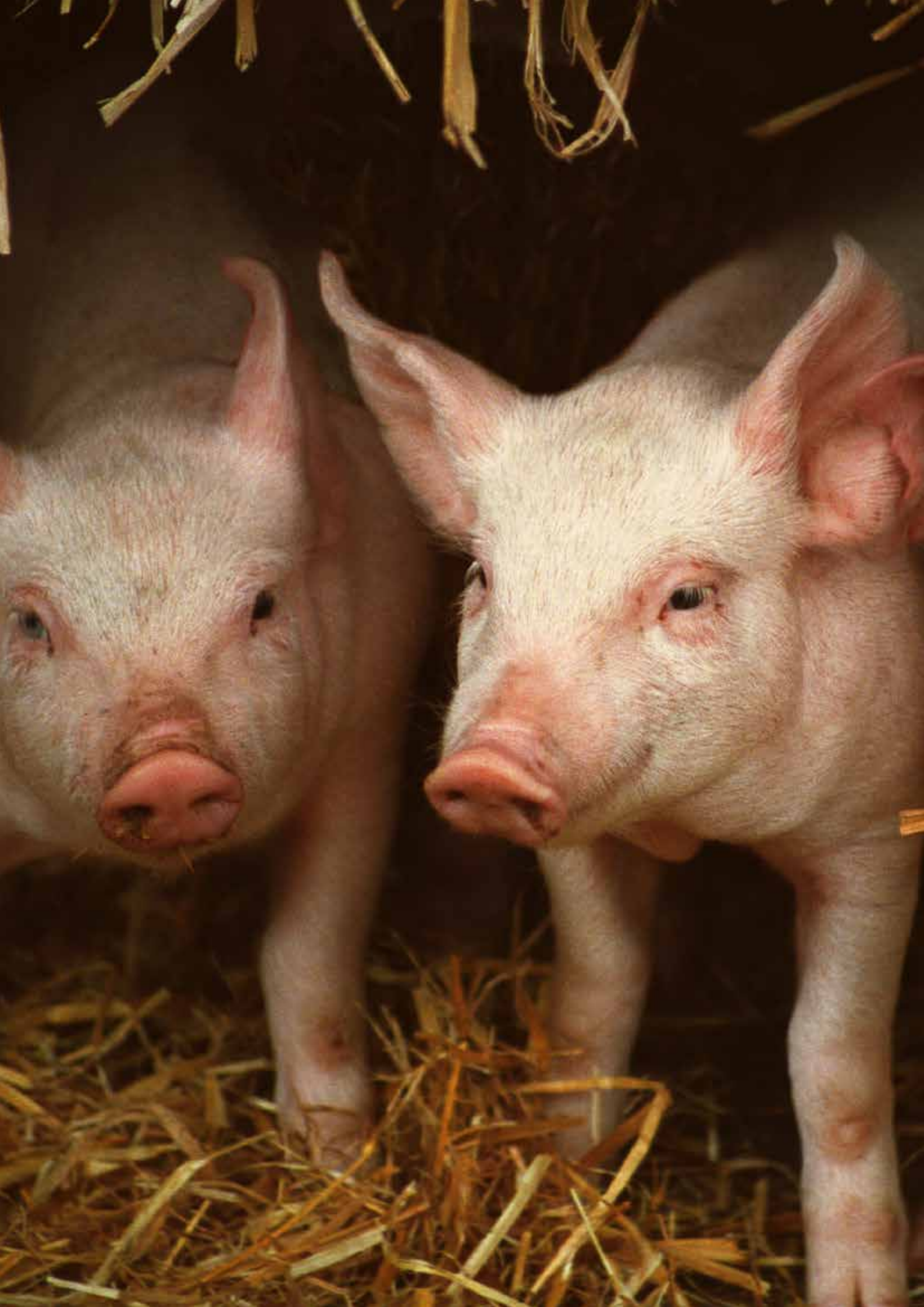

Contents

This document is produced by the Secretariat of the STAR-IDAZ International Research Consortium on Animal Health (SIRCAH) for the task: T3.3.2 – Map existing initiatives in Working Group (WG) fields with input from IRC members and stakeholders. The aim is to gather and compile the documents produced by IRC members, research consortia, learned societies and other relevant stakeholders relating to existing initiatives in the fields of the WGs. The lists will be fed into the working groups and disseminated publicly via the STAR-IDAZ databases.

This task relates to three milestones: MS19: Existing initiatives in WG fields mapped (I, ii and iii) (BBSRC, September 2017, 2018 and 2019).

Definition

Initiatives in this case refer to existing research networks/alliances which enables research teams to successfully work together and facilitate communication/collaboration/sharing reagents and resources. It provides a platform to identify common approaches and areas of collective interest.

Background

SIRCAH is supported, since 2016, by a European H2020 contract – Secretariat for the International Research Consortium on Animal Health (SIRCAH). The overall objective is to facilitate the STAR-IDAZ International Research Consortium on Animal Health (STAR-IDAZ IRC) achieving its objectives by establishing a secretariat to provide organisational and communication support to the STAR-IDAZ IRC and its various members and assisting with the development of focused research roadmaps. This will contribute to accelerating research on animal health and at reinforcing international research cooperation.

The agreed aim of the STAR-IDAZ IRC is to coordinate research at international level to contribute to new and improved animal health strategies for at least 30 priority diseases/infections/issues. The deliverables will include candidate vaccines, diagnostics, therapeutic, procedures and key scientific information/tools to support risk analysis and disease control.

Several diseases and issues, listed below, have initially been identified for action where it is hoped coordination of research will help better achieve the overall objectives of STAR-IDAZ IRC.

- African Swine Fever
- Bovine Tuberculosis
- Brucellosis
- Corona viruses
- Diagnostics
- Emerging issues
- Epidemiology
- Foot and Mouth Disease
- Foresight
- Genetics and genomics for animal health
- Helminths (including anthelmintic resistance)
- Influenza
- Integrated pathogen control for the reduction of resistance
- Mastitis
- Mycoplasmas
- Porcine Reproductive and Respiratory Syndrome
- Porcine respiratory disease
- Pox virus infections
- Rift Valley Fever
- One Health (including food-borne pathogens)
- Vaccinology
- Vector-borne diseases

The following pages describe existing networks and included are additional networks which are either species specific, and related to infrastructure and technologies.

African Swine Fever

Global African Fever Research Alliance (GARA)[1]

GARA's mission is to establish and sustain global research partnerships that will generate scientific knowledge and tools to contribute to the successful prevention, control and where feasible eradication of African Swine Fever (ASF).

Strategic Goals of GARA

Goal 1. Identify research opportunities and facilitate collaborations within the Alliance

Goal 2. Conduct strategic and multi-disciplinary research to better understand ASF

Goal 3. Determine social and economic drivers and impact of ASF

Goal 4. Develop novel and improved tools to support the prevention and control of ASF

Goal 5. Determine the impact of ASF prevention and control tools

Goal 6. Serve as a communication and technology sharing gateway for the global ASF research community and stakeholders

Addressing the dual emerging threats of African swine fever and lumpy skin disease in Europe (Defend)[2]

The DEFEND consortium will target two viral diseases of livestock which are emerging into Europe – African swine fever (ASF) and lumpy skin disease (LSD).
African swine fever virus (ASFV) is the causative agent of ASF, a highly contagious disease of domestic pigs which causes a haemorrhagic syndrome with up to 100% mortality. ASF is endemic in sub-Saharan Africa and on the Italian island of Sardinia. In 2007 the disease was reported in Georgia. Since then it has spread to Russia, Ukraine, Poland and neighbouring countries. In 2017 outbreaks were reported in the Czech Republic and Romania. Wild boar are susceptible to ASFV and facilitate the continuing spread of the disease in Europe with regular spill-over into in-contact domestic pigs.

VACDIVA: A Safe DIVA vaccine for African Swine Fever Control and Eradication[3]

October 2019 – September 2023

African swine fever (ASF) is a devastating infectious disease in pigs – usually deadly. No vaccine exists to combat this virus. The European Union has laid down prevention and control measures to be applied where African swine fever is suspected or confirmed, either in holdings or in wild boars. The EU-funded VACDIVA project will provide three safe and effective pilot vaccines for wild boar and domestic pigs that is ready for registration. It will also validate tests and develop cost-benefit and -effective surveillance and control-vaccination strategies. Field trials will be conducted in Kenya and Lithuania. Epidemiological modelling of worldwide scenarios will be offered in a portfolio of services to help animal health authorities control and eradicate the disease.

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1 https://www.ars.usda.gov/GARA/
2 https://defend2020.eu/about-us/
3 https://cordis.europa.eu/project/id/862874

USDA – Swine Hemorrhagic Fevers: African and Classical Swine Fever Integrated Surveillance Plan[4]

The U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS) and Veterinary Services (VS) proposes an integrated active surveillance plan for ASF and CSF targeting higher-risk populations, sick pigs, and mortality events with the purpose of enhancing the vigilance for both diseases and the country's preparedness for emergency response.

The Biosecurity Research Institute[5,6]

African swine fever (ASF) research entails developing novel vaccines and a diagnostic assay that can differentiate pigs infected with wild type virus from those vaccinated with experimental vaccine. In addition, antiviral reagents that can be used to inactivate ASF virus are also being evaluated. Classical swine fever (CSF) research includes developing and validating a unique method of differentiating between vaccinated and infected pigs. A novel vaccine platform that will induce high level anti-CSFV immunity in pigs is under development. Lastly, the team is developing and testing novel vaccines for high pathogenic porcine reproductive and respiratory syndrome (PRRS).

The Pirbright Institute: African Swine Fever Research Programme[7]

Scientists at The Pirbright Institute have been working on understanding the virus since 1963, prior to its spread to Europe and Asia from Africa, and is one of the few institutes that continues to have an ASF research programme. Pirbright researchers are currently developing different types of ASF vaccines with the aim of producing one that will protect pigs from this deadly disease. They are also working with ViroVet to produce ASF antivirals that could lower virus replication in pigs and limit clinical signs, which would form an important part of any feed-based strategy to control the virus.

4 https://www.aphis.usda.gov/animal_health/downloads/animal_diseases/swine/hemorrhagic-fevers-integrated-surveillance-plan.pdf

5 The Biosecurity Research Institute at Pat Roberts Hall on the Kansas State University Manhattan campus is a unique biocontainment research and education facility that has helped Kansas State University become a national leader in biodefense research.

6 https://www.bri.k-state.edu/

7 https://www.pirbright.ac.uk/asfv

International Livestock Research Institute: African Swine Fever[8]

In early 2000, ILRI commenced research on ASF with a focus on epidemiology and surveillance, diagnostics and assessing the socio-economic impacts of the disease. Over time, with national and international collaborations, the scope of research has expanded to undertake ASF vaccine development and further expand activities on diagnostic development. A group of ILRI scientists are currently working on developing vaccines for ASF using CRISPR-cas system to develop mutants as well as develop attenuated strains. The scientists are also working on establishing reverse genetic system as well as conducting studies to identify the role of ASFV genes in host immune response pathways.

Epidemiological research has improved our understanding of disease dynamics by using mathematical modelling and ex-ante socio-economic impact assessments which have contributed to the identifying measures for improving biosecurity. The disease impact assessments have also been carried out in Vietnam by ILRI for FAO. Other studies are now underway to evaluate the effectiveness of applying biosecurity measures using a value chain approach in Uganda. More recent work involves understanding the genome evolutionary process of the circulating viruses in Africa as well as different pig breeds from China and Africa and detecting genes related to African swine fever.

ASF-RASH – African Swine Fever pathogenesis and immune responses in Resistant And Susceptible Hosts[9]

March 2021 – February 2024

This project brings together teams from Germany, Denmark, Switzerland, the Netherlands and Belgium to address gaps in understanding ASF disease. The consortium aims to identify factors at the level of the pathogen, the host species and their immune cells that will define host/cellular susceptibility and protection. They aim to explain phenomena such as the observation of higher seroprevalence rates or resistance in the field by co-ordinately evaluate correlates of protection and basic host-virus interactions in multiple hosts including susceptible domestic pigs (SPF and conventional farm-raised) and European wild boar and resistant red river hogs. Responses of relevant ASFV strains with moderate and high virulence will be compared in these hosts. For part of this work, they will employ a systems immunology approach that will use computational biology tools to process all collected data from the consortium including virological, clinical and immunological readouts and immune cell transcriptomics. This will identify immunological processes and mechanism of both the innate and adaptive arms that are relevant in controlling ASFV or on the contrary that relate to disease severity. Among the studies addressing the long-term fate of animals and drivers of disease dynamics, they will experimentally address the impact of maternal immunity on disease outcome using a sowsuckling piglet model. Moreover, they will address the possibility of ASFV reactivation following survival from ASFV infection. The presence of the virus in semen and possibility of vertical transmission will be formally investigated. Evolutionary pressure on the viral genome by host immune responses will be examined for the different isolates using deep sequencing. Aspects of cellular susceptibility will be investigated in macrophage subpopulations by combining complementary approaches in vivo and in vitro. The project will combine knowledge, expertise, and reagents of six teams with high international reputations in ASFV research and porcine immunology to improve basic knowledge on ASFV host interactions and mechanisms of protective immunity. The multipronged and combinatorial approach of this consortium will reveal virus-host interactions at the animal and cellular level, which will reveal mechanisms of higher resistance, immunity and alternative transmission pathways.

8 https://www.ilri.org/research/programs/animal-and-human-health/african-swine-fever

9 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/african-swine-fever-pathogenesis-and-immune-responses-in-resistant-and-susceptible-hosts

ASFInt – Decoding a virus Achilles heel: the African swine fever virus interactome[10]

March 2021 – March 2024

This project brings together teams from France, Germany, the UK, Spain and Estonia. They aim to work on developing knowledge of the functions of viral proteins and their interactions with host proteins for the rational development of new antiviral strategies or vaccines. Functional characterization of virus-host protein-protein interactions will be critical to understand how viral proteins target cellular functions to allow viral replication and spread. They will use high-throughput systems biology approaches to map interactions between viral and cellular proteins in a systematic way. After confirmation of the physical interactions by biochemical analysis, their biological significance will be independently tested in the context of infection by deleting genes of interacting viral proteins and silencing interactors from the host. The African swine fever virus Interactome project (ASFVInt) is designed to identify cellular signalling pathways, functional modules, and machineries that are manipulated by the virus to its own benefit or even are essential for ASFV replication. Knowledge of such pathways would represent a valuable resource for the development of antiviral strategies. Collectively, deciphering virus-host molecular interactions opens new perspectives to predict/simulate future emergencies and develop effective countermeasures for disease control, such as novel spectrum anti-infectious compounds and rationally designed ASFV vaccines.

IFNASF – Characterization of virus- and host-specific modulation of type I IFN in African Swine Fever Virus virulence or attenuation[11]

March 2021 – March 2024

Knowledge about the effective immune response against ASF remains incomplete, and the precise host mechanisms that can be harnessed to defend against this virus, and therefore the basis for rational vaccine design, are still uncertain. The scientific and technical advances that constitute the ambition of this project are focused on the generation of knowledge to unravel the complexity of the virus-host interaction. They will use state-of-the art scRNA-seq protocols. The Consortium as a whole IFNASF is a four-actor (CSIC, LMU, PIWET, SVA) driven ICRAD Action to improve the European research on the molecular and immunological knowledge on ASFV/ host interaction. Project partners include Spain, Germany, Poland and Sweden.

10 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/decoding-a-virus-achilles-heel-the-african-swine-fever-virus-interactome

11 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/characterization-of-virus-and-host-specific-modulation-of-type-i-ifn-in-african-swine-fever-virus-virulence-or-attenuation

Bovine Tb

Global Research alliance for Bovine TB (GRAbTb)[12]

It is a coordinated global research alliance enabling improved understanding and control of bovine TB. The strategic goals include:

Goal 1. Identify research opportunities and facilitate collaborations within the Alliance

Goal 2. Conduct strategic and multi-disciplinary research to better understand TB

Goal 3. Develop and share novel and improved tools to control TB

Goal 4. Serve as a communication and technology sharing gateway for the global bovine TB research community and stakeholders

Goal 5. Promote collaboration with the human TB research community

The Roadmap for Zoonotic TB[13]

The four partners in health, WOAH, WHO, FAO and International Union against Tuberculosis and Lund disease have joined forces to develop the roadmap and address the major health and economic impact of disease.

ANSES (French Agency for Food, Environmental and Occupational Health & Safety)[14]

ANSES's laboratories, in particular the Nancy Laboratory for Rabies and Wildlife[15] and the Maisons-Alfort Laboratory for Animal Health[16] (home to the National Reference Laboratory (NRL) for tuberculosis) are undertaking extensive research work on bovine tuberculosis. Among other things, the NRL is responsible for developing analytical methods dedicated to the surveillance of this disease and transferring these methods to the network of accredited laboratories that it coordinates across the country.

The main research work undertaken by the Agency aims to improve knowledge of *M. bovis* infection in domestic populations and in wildlife, in order to understand the networks of transmission between these two types of populations:

- role of various wildlife species in the maintenance of infection and its transmission, whether direct between animals or indirect through environmental contamination,
- modelling of interactions between various infected compartments, to improve disease control in animals,
- characterisation of *Mycobacterium bovis* strains and of possible differential virulence traits in affected regions.

ANSES is also involved in research work to develop an oral vaccine. Early trials for preventive vaccination, as a possible way of controlling infection in wildlife under certain conditions, are being set up in collaboration with foreign teams in the United Kingdom and Spain.

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12 Global Research Alliance for Bovine Tuberculosis (GRAbTB) – STAR-IDAZ

13 http://www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/Tuberculosis/Roadmap_zoonotic_TB.pdf

14 https://www.anses.fr/en/content/bovine-tuberculosis

15 Nancy Laboratory for Rabies and Wildlife | Anses - Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail

16 Laboratory for Animal Health (Maisons-Alfort and Dozulé sites) | Anses - Agence nationale de sécurité sanitaire de l'alimentation, de l'environnement et du travail

VISAVET Health Surveillance Centre, Universidad Complutense Madrid[17]

It is Bovine Tuberculosis European Union Reference Laboratory.

Tbhub – The Home of UK TB Information[18]

The TB hub is the 'go-to' place for British beef and dairy farmers to find practical advice on dealing with bovine TB on their farm, covering everything from biosecurity measures to understanding trading rules. The hub is a joint industry and government initiative, supported by the Agriculture and Horticulture Development Board (AHDB), the Animal & Plant Health Agency (APHA), the British Cattle Veterinary Association (BCVA), the Department for Environment, Food and Rural Affairs (Defra), Landex, and the National Farmers Union (NFU).

Photo: ©Panos Pictures/Zacharias Abubeker

17 https://www.visavet.es/bovinetuberculosis/bovine-tb/epidemiology.php
18 https://tbhub.co.uk/

Brucellosis

Brucella Bioinformatics Portal[19]

This BBP website is dedicated to becoming a bioinformatics resource portal for the *Brucella* research community to facilitate *Brucella* research and includes a list of programs for analysis of *Brucella* and host-*Brucella* interactions.

Brucellosis Annual Conference

Annual conference provides best networking opportunity. Every third year there is an international meeting. The other two years meeting is in December in Chicago as part of the Conference of Research Workers in Animal Disease (CRWAD)[20]. Between 100-120 researchers from across the globe share their research and discuss current issues at the domestic meetings. Attendance at the international meetings may vary from 150 -350.

BVG1 – New vaccine for Brucellosis safe for humans[21,22]

March 2020 – February 2023

When it comes to Brucellosis, main transmitters are cows and sheep and goats, therefore animal vaccination is the best strategy to avoid human infections. The problem is that existing vaccines, have some serious limitations including residual virulence for animals and humans. This EU-funded BGV1 project aims to solve those drawbacks, allowing mass vaccination of any animal at any time, which is crucial in case of an outbreak or in case of an intended attack to human health; and by solving the DIVA problem, which will allow millions of healthy animals stay away from unfair quarantines and culling, allowing huge savings of money and suffering to governments and farmers not only in the developing world, but also in developed areas like the Mediterranean region.

This project was preceded by a Horizon 2020 funded project – BVG1 - New vaccine for a paradigm shift in Brucellosis[23].

Bruce-GenoProt – A comprehensive proteogenomic analysis of Brucella to understand the epidemiology, biology, virulence mechanisms, and host-pathogen interaction[24]

March 2021 – March 2024

To explain its epidemiology, virulence mechanisms and host specificity, a better understanding of Omics (genomics, transcriptomics, proteomics and metabolomics) of brucellae will be needed. To date, few multicenter projects have been conducted on genomics and proteomics of Brucella and this kind of

19 http://www.phidias.us/bbp/
20 https://crwad.org/
21 https://cordis.europa.eu/project/id/946275
22 https://www.greenvac.es/
23 https://cordis.europa.eu/project/id/836308/es
24 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/a-comprehensive-proteogenomic-analysis-of-brucella-to-understand-the-epidemiology-biology-virulence-mechanisms-and-host-pathogen-interaction

approach is paramount to tackle this dangerous disease. Thus, the main objectives of the current project are to assess the role of environment and wildlife in transmission and dissemination of brucellosis, development of a cgMLST scheme for epidemiological investigation, as well as to unravel several enigmatic aspects of Brucella utilizing various proteogenomics and transcriptomics approaches. They expect to develop a cgMLST scheme useful for epidemiological investigations and for tracing back the sources of brucellosis at least in domestic ruminants (sheep, goats, cattle, water buffaloes and camels) living in the participating countries (Germany, Turkey and Greece). The data obtained from the WGS and proteomics analysis will help to explore the secret behind host specificity and host/pathogen interaction phenomena, as well as to explore the undiscovered virulence mechanisms. This will help to unravel the unknown mechanisms of infection and develop strategies to hinder the spillover of the diseases.

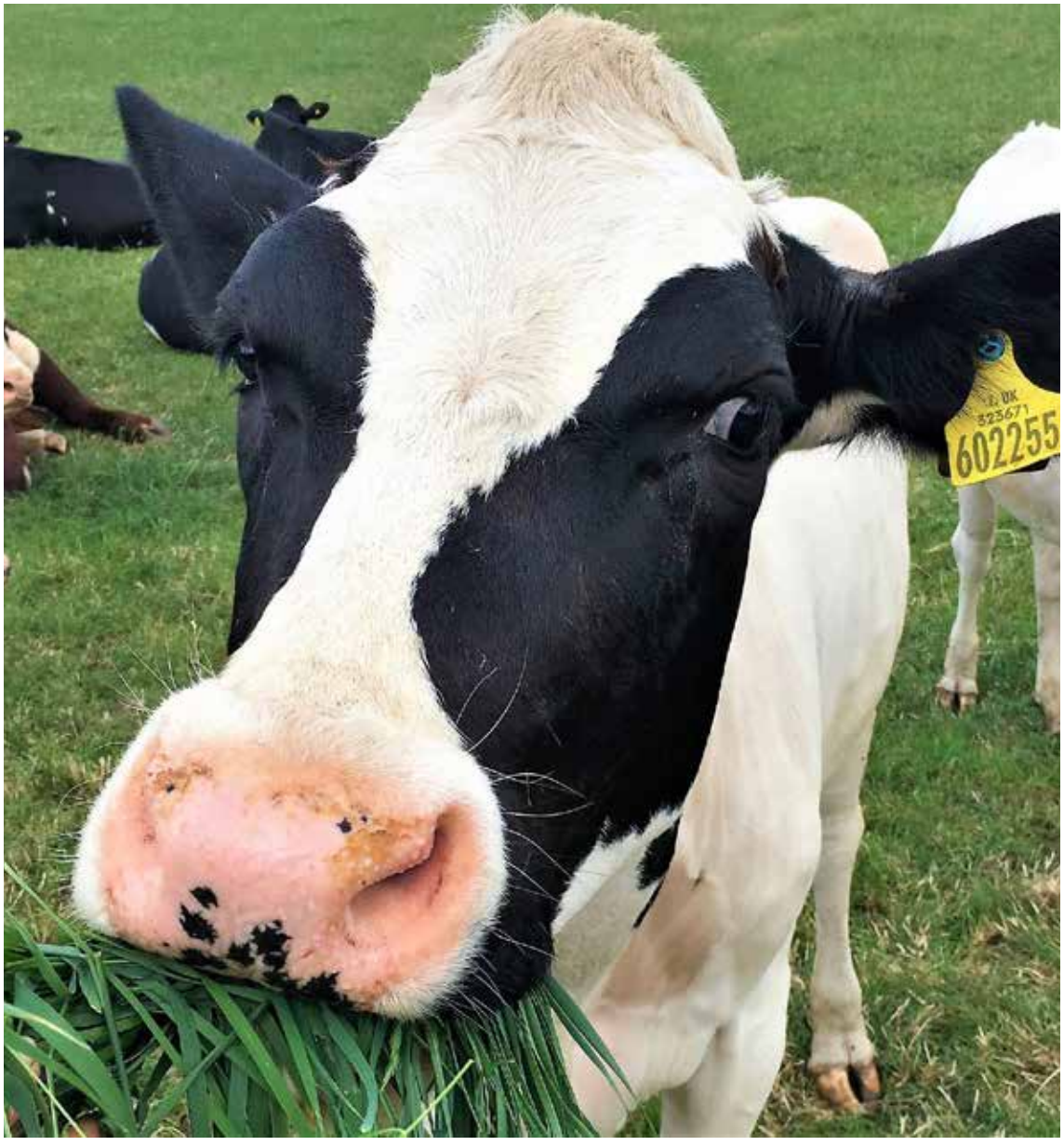

Photo credit: Jesslyn Thay

Coronavirus

UK International Coronavirus Network (UK-ICN)[25]

The UK International Coronavirus Network (UK-ICN) is a four-year project (Oct 2021 – Oct 2025), funded by the Biotechnology and Biological Research Council (BBSRC) and the Department of Environment, Food and Rural Affairs (DEFRA).

The aims of UK-ICN are as follows:

- To provide a community gateway, including a network of networks with the inclusion of UK and international bodies (FAO/WOAH/WHO)
- To facilitate and co-ordinate interactions between members, especially at the animal-human-environment interface
- To foster cross-fertilisation of ideas, providing expert perspectives to identify knowledge gaps
- Create research opportunities and build an evidence-based road map for one-health
- Ensure the longevity of coronavirus research after the impetus of SARS-CoV2 has reduced
- Disseminate and preserve knowledge to better combat future emerging coronaviruses

WOAH Working Group on Wildlife[26]

Founded in 1994, this Working Group informs and advises the WOAH on all health problems relating to wild animals, whether in the wild or in captivity. It has prepared recommendations and oversees numerous scientific publications on the surveillance and control of the most important specific wildlife diseases. The Working Group comprises world-leading scientific experts in their subject areas.

Under the leadership of the Wildlife Working Group, WOAH mobilised an expert group to provide scientific advice and to develop guidelines on a range of topics linked to human-animal-ecosystems interface aspects of COVID-19[27]. These include identifying research priorities, communicating results of on-going research in animals, developing scientific opinions on the implications of COVID-19 for animal health and veterinary public health, and providing practical guidance for Veterinary Services. Subsequently an expert group was established to assess the risks and implications of COVID-19 for safe trade in animals and animal products.

G2P-UK – A National Virology Consortium to address phenotypic consequences of SARSCoV-2 genomic variation[28]

G2P-UK is a National Virology Consortium which study how mutations in the SARSCoV-2 virus affect how transmissible it is, the severity of COVID-19 it causes, and the effectiveness of vaccines and treatments. This brings together leading virologists from 10 research institutions in the UK. They are working to determine the effects of the recent virus variants identified in the UK and South Africa and what that means for the transmission of SARS-CoV-2 and vaccine effectiveness.

25 https://www.liverpool.ac.uk/health-and-life-sciences/research/uk-international-coronavirus-network/

26 Working Group on Wildlife %working group wildlife – WOAH - World Organisation for Animal Health %OIE Working Group on Wildlife

27 https://www.woah.org/en/what-we-offer/emergency-and-resilience/covid-19/#ui-id-4

28 https://www.imperial.ac.uk/news/212533/imperial-leads-consortium-study-threats-from/

UK-CIC – UK Coronavirus Immunology Consortium[29]

UK-CIC is a nationally targeted effort to understand the immunology of SARS-CoV-2 and COVID-19 and deliver real benefits to patients and public health at pace. The consortium is bringing together the expertise and specialist resources of 20 centres around the UK.

The project will focus on five key research themes:

- 1. Primary immunity: Characterising the primary immune response to COVID-19 and how this relates to clinical outcome of individual patients
- 2. Protective immunity: Identifying how effective immunity is established and maintained to prevent re-infection
- 3. Immunopathology: Understanding how the immune system can damage tissue while fighting COVID-19 and how this can be stopped
- 4. Cross-reactive coronavirus immunity: Examining if immunity to other mild 'seasonal' coronaviruses (that cause common colds) can alter the outcome of SARS-CoV-2 infection
- 5. Immune evasion: Revealing how SARS-CoV-2 can 'evade' the immune system

COG- UK – COVID-19 Genomics UK Consortium[30]

The COG-UK consortium has over 500 members with a range of scientific and business expertise in genomics, bioinformatics, operations, clinical science and public health. An early goal was to look ahead and envisage a sustainable public health sequencing network across the UK. Having provided the knowledge, expertise, and facilities to provide UK-wide SARS-CoV-2 genome sequencing and analysis over the first 18 months of the pandemic, they have passed on these efforts for further developments by Public Health Agencies to create a long-term national pathogen genomics service.

They are now refocused on three areas: research, data linkage and analysis, and training. They aim to create new value from existing data by linking SARS-CoV-2 genomes to extensive and diverse datasets, including human genome data. This will be explored to seek new information about the disease process and prediction of patient outcomes. They invest in the development of new molecular and genomic methods to detect and elucidate circulating and emerging pathogens, in support of this pandemic and the next.

ConVErgence – Assessing swine as potential hosts for emerging Coronaviruses [31,32]

ConVergence is a collaboration between Italy, the Netherlands and the United Kingdom and has been funded within the framework of ICRAD[33]. The project will investigate the process of emergence of coronaviruses in the swine industry, focusing on bats and humans as the most likely sources of infection.

The objective of CoVErgence is:

1. to investigate the relationship between swine and bats and humans in different farming systems,
2. to determine how much pigs are exposed to known bat and human CoVs by measuring their antibody response,
3. to detect the circulation of bat/human CoVs in pig populations from North Eastern Italy.

29 https://www.uk-cic.org/news/media-office
30 https://www.cogconsortium.uk/
31 https://www.izsvenezie.com/convergence-project-swine-cornaviruses/
32 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/assessing-swine-as-potential-hosts-for-emerging-coronaviruses
33 https://www.icrad.eu/

In addition, they will consider the fact that shedding of coronaviruses is highly seasonal in both bats and humans to build a mathematical model aiming to spot situations that are at higher risks for spillover.

ConVErgence will use cutting-edge technologies from different fields including veterinary medicine, ecology, virology, epidemiology and mathematical modelling exploiting the expertise of partners included in the consortium with the Istituto Zooprofilattico Sperimentale delle Venezie, namely the University of Sussex (UK) and the Erasmus Medical Centre in Rotterdam (NL).

MUSECoV – Multi-scale Eco-evolution of Coronaviruses: from surveillance toward emergence prediction[34]

March 2021 – February 2024

MUSECoV is an EU wide ICRAD funded project29 and brings together collaborators from France, Poland, Spain and Italy. The first aim of the project will be to evaluate the circulation of SARS-CoV-2 in companion and domestic animals and to perform in-vitro studies that analyse its potential to replicate in cells derived from different animals. They will address the cross-species potential of other coronaviruses from wildlife and domestic animals. The second aim of the project is to better understand the global circulation of animal CoVs and their genetic evolution dynamics under different constraints and ecological context. Samples collected from bats, domestic carnivorous, ruminants, poultry and wildlife over time in different European locations, will allow the analysis of their evolution rates at a multi-scale level (temporal and geographic), under natural conditions. These studies will be complemented by in vitro assays that will evaluate the frequency of recombination between different virus strains of the same species (avian or pig) when inoculated simultaneously onto cell cultures. The data generated by MUSECoV will be invaluable for a better comprehension of how coronaviruses evolve and circulate in European domestic and wild animals. These findings will help improve countermeasures and better prevent future coronavirus emergence in animals and humans.

34 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/multi-scale-eco-evolution-of-coronaviruses-from-surveillance-toward-emergence-prediction

Diagnostics

VHFMoDRAD – Viral haemorrhagic fever: modern approaches for developing bedside rapid diagnostics[35,36]

January 2019 – December 2022

Better, faster diagnosis of viral haemorrhagic fevers like Ebola is the ultimate goal of the VHFMoDRAD project. The aim of VHFMoDRAD is to develop rapid point-of-care (POC) diagnostic tools capable of identifying a number of viral haemorrhagic fevers. The project builds on the work of IMI's EbolaMoDRAD project, which advanced the development of rapid diagnostics for Ebola. The new tools and methods developed by VHFMoDRAD will be validated in the field. In addition, the project plans to run training courses for professionals in the west African region. It will also transfer the production capacity for the diagnostic tools to a project partner in the region so that the tests can be produced locally. Ultimately, VHFMoDRAD will contribute to better preparedness for outbreaks of viral haemorrhagic fevers, and to capacity building in Africa.

SWINOSTICS: Swine diseases field diagnostics toolbox[37]

November 2017 – October 2021

The increased population density in modern animal production systems has made them vulnerable to various transboundary infectious agents & diseases. During the last decades in the developed world, a reduction in the direct burden of livestock diseases has been observed, because of more effective drugs & vaccines. However, the total impact may actually be increasing, because in a highly interconnected world, the effects of diseases extend far beyond animal sickness and mortality. Therefore, early diagnosis and establishment of reliable countermeasures to infectious disease outbreaks is essential to limit severe biophysical and socio-economic consequences.

To date, the time between initial disease outbreak and laboratory confirmation of the etiologic infectious agent can be up to several weeks. Reliable & simple diagnostic testing directly on site would enable rapid local decision making, which is crucial to prevent further spreading of the disease.

Silicon-based Photonic Integrated Circuits (PIC) have been demonstrated as a powerful platform for biosensing systems. In combination with integrated monoclonal antibodies, they can provide portable multiplex detection of proteins with sensitivity & specificity previously not realized. SWINOSTICS addresses the sector needs, by developing a novel field diagnostic device, based on advanced, proven, bio-sensing technologies to tackle viruses causing epidemics in swine farms and leading to relevant economic damages, complying to the objectives of the STAR-IDAZ. The diagnostic device will allow threat assessment at the farm level, with the analytical quality of commercial laboratories. The device will be developed for a panel of 6 important swine diseases. The device will be portable & will provide results in 10 minutes for 5 samples simultaneously, making it highly suitable for field use. It is based on 3 lab-verified concepts: a) PIC technology, b) Label-free optical detection, c) patented nano-deposition technology.

35 https://www.imi.europa.eu/projects-results/project-factsheets/vhfmodrad
36 https://vhfmodrad.eu/
37 https://cordis.europa.eu/project/rcn/212392_en.html

Veterinary Validation of Point-of-Care Detection Instrument (VIVALDI)[38]

January 2018-April 2022

In the VIVALDI project the consortium will validate new equipment (the VETPOD platform) for rapid on-site detection of zoonotic pathogens in industrial food and animal production chains.

The coordinator Technical University of Denmark (DTU) has developed the VETPOD platform based on Loop mediated isothermal amplification (LAMP) technology and optical read-out to a user interface, with disposable plastic cartridges (Lab-on-Chip, LOC) that can be adapted to an infinite number of assays for almost all pathogens.

The Foundation for Innovative New Diagnostics – FIND[39]

FIND is an international non-profit organisation that enables the development and delivery of much needed diagnostic tests for poverty-related diseases, including tuberculosis. FIND acts as a bridge between experts in technology development, policy and clinical care, reducing barriers to innovation and effective implementation of diagnostic solutions in low- and middle-income countries. It has active collaborations with more than 200 partners including research institutes, academia, health ministries and disease control programmes, commercial partners, the World Health Organisation, bilateral and multilateral organisations and clinical trial sites. It is a WHO Collaborating Centre for Laboratory Strengthening and Diagnostics Technology Evaluation. There are regional hubs in India, Kenya, South Africa and VietNam.

Institute of Virology Diagnostics – Friedrich-Loeffler-Institut[40]

The Institute of Diagnostic Virology focuses on the diagnosis and differential diagnosis of virus diseases of farm animals which are of importance in veterinary medicine. Special emphasis is laid on notifiable animal diseases. Thus, the institute houses reference laboratories for classical swine fever, fowl plague, Newcastle disease, infections with bovine herpesvirus 1, equine infectious anemia, foot- and mouth-disease, swine vesicular disease, vesicular stomatitis and African swine fever, bovine viral diarrhoea/mucosal disease as well as exotic animal diseases such as orbivirus infections or rinderpest. The laboratories for fowl plague, Newcastle disease, BHV-1 adf ovine Viral Diarrhea are designated WOAH reference laboratories.

Biosens4PrecisionMastitis – Channel-based biosensors to support a precision agriculture approach for improved bovine mastitis management[41]

April 2021 – March 2024

The project aims to improve farm profitability by developing cutting-edge technology for early diagnosis of cows infected with mastitis. Diagnosis of bovine mastitis is of utmost importance due to its economic, social and environmental impact. Antibiotic overuse induced by the current limitations

38 https://cordis.europa.eu/project/rcn/212396_en.html
39 https://www.finddx.org/
40 https://www.fli.de/en/institutes/institute-of-diagnostic-virology-ivd/
41 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/channel-based-biosensors-to-support-a-precision-agriculture-approach-for-improved-bovine-mastitis-management

in mastitis diagnosis is thus key in the emergence of antibiotic resistance. Apart from directly affecting animals' immune response, antibiotic residues can be present in milk intended for human consumption and be released into water and soil. Therefore, animal mastitis significantly contributes to maintaining antimicrobial resistance at the forefront of the most pressing global one health issues. Diagnosis of mastitis suffers from several complications, e.g. the lack of symptoms in subclinical mastitis or Mycoplasma bovis-caused mastitis. The project builds upon new knowledge acquired on host response-derived biomarkers key during incubation, such as pro-inflammatory cytokines and host nucleic acids, identified as prospective mastitis biomarkers to report disease status and etiology. This paradigm-shifting concept differs significantly from existing approaches focused on detecting pathogen-derived markers that can only indicate exposure, but not necessarily confirm infection. Leveraging the presence of these biomarkers in milk, a "liquid biopsy" approach will be pursued to ensure non-invasive, stress-free and prompt diagnosis of bovine mastitis. Such approach, facilitated via sensing technology, will be a breakthrough in mastitis diagnosis and prognosis enabling action before pathogen replication and manifestation of symptoms. Advances in materials science will be key in the design of layered channel-based biosensors for the analysis of milk on site, possibly in line and thus in near-to-real time, at a low cost and with a readily available instrument, supporting the use of these tools for constant animal surveillance. The integration of these tools in a precision agriculture approach to disease management will lead to a step change in infection prevention and appropriate antimicrobial stewardship. Project partners are Spain, Hungary, Poland and Latvia.

CAE-RAPID – Development of a rapid screening test for on-site serological diagnostics of caprine arthritis-encephalitis using individual milk samples[42]

The objective of CAE-RAPID is to develop the rapid immunochromatographic diagnostic test (point-of-care test) for caprine arthritisencephalitis (CAE) – a viral, lifelong and incurable disease of goats caused by small ruminant lentiviruses (SRLV), members of Retroviridae family. The major challenge of CAE diagnostics results from the long-time which elapses between the infection and the emergence of first apparent signs. During this time the disease insidiously spreads between goats and when the farmer realizes that something is wrong usually a substantial proportion of goats in the herd is already infected. Currently, the mainstay of CAE diagnostics are serological tests. Even though they are highly accurate, their price including the veterinary service necessary for blood sample collection and its transportation to the laboratory, and the time which it takes to obtain results from laboratory hinder their routine use when a single animal needs to be tested. CAE-RAPID aims to improve individual diagnostics of CAE by providing an easily available and convinient tool for reliable exclusion and early detection of the disease. The rapid test for detection of antibodies to SRLV in a drop of milk, serum or whole blood will be intended for use in two basic situations. First, for on-site quick screening of asymptomatic goats which are intended to be purchased or introduced into the herd. Second, for on-site quick screening of goats in which first clinical signs have emerged. The test will be a screening diagnostic method so it will be expected to maximize diagnostic sensitivity and the negative predictive value, so that a goat that tests negative can be safely introduced into or retained in the herd. The largest part of the project will be dedicated to the CAE-RAPID test validation in laboratory and field conditions.

42 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/development-of-a-rapid-screening-test-for-on-site-serological-diagnostics-of-caprine-arthritis-encephalitis-using-individual-milk-samples

Emerging diseases

Global Early Warning System (GLEWS+)[43]

The ultimate goal of GLEWS+ is to inform prevention and control measures, through the rapid detection and risk assessment of health threats and events of potential concern at the human-animal-ecosystems interface. This goal is critical to attaining the vision of FAO, WOAH and WHO of *'a world capable of preventing, detecting, containing, eliminating, and responding to animal and public health risks attributable to zoonoses and animal diseases with an impact on food security through multi-sectoral cooperation and strong partnerships'*.

GLEWS[44] was established in 2006 and has since evolved into GLEWS+ .

In addition to the activities of the existing GLEWS, the proposed system – GLEWS+ – will provide a unique cross-sectoral mechanism for conducting robust and timely joint risk assessments, aimed at formulating risk management options for health events at the human-animal-ecosystems interface. These options will then be communicated in a timely, coordinated and relevant way within the three international organizations, hereby contributing to risk communications of the three organizations to relevant stakeholders, the public and the international community. GLEWS+ will:

- systematically link to areas such as wildlife health, food and biological threats;
- drive more advanced and cross-sectoral risk assessment when a need is identified; and
- provide more opportunities for participation by a broader range of stakeholders via specific working groups established on priority areas.

GLEWS+ contributes to the tripartite continued work to advance from reactive to proactive preparedness and prevention, through joint risk assessment for targeted and timely action.

Emergency Preventions System for Animal Health (EMPRES)[45,46]

The mission of the programme is to promote the effective containment and control of the most serious epidemic livestock diseases/Transboundary Animal Diseases (TAD) as well as newly emerging diseases by progressive elimination on a regional and global basis through international cooperation involving early warning, early reaction, enabling research and coordination.

43 http://www.fao.org/3/a-i3579e.pdf
44 http://www.glews.net/
45 https://empres-i.apps.fao.org/
46 http://www.fao.org/ag/againfo/programmes/en/empres/home.asp

World Animal Health Information Database (WAHIS) Interface[47]

The WAHIS Interface provides access to all data held within WOAH's new World Animal Health Information System. Information included in the database: immediate notification and follow-up reports submitted by Country/Territory Members notifying exceptional epidemiological events current in their territory; six monthly reports stating the health status of WOAH-listed diseases in each country/territory; annual reports providing health information and information on the veterinary staff, laboratories and vaccines etc.

FAO Global Information and Early Warning System (GIEWS)[48]

The Global Information and Early Warning System on Food and Agriculture (GIEWS) continuously monitors food supply and demand and other key indicators for assessing the overall food security situation in all countries of the world. It issues regular analytical and objective reports on prevailing conditions and provides early warnings of impending food crises at country or regional level. At the request of national authorities, GIEWS supports countries in gathering evidence for policy decisions, or planning by development partners, through its Crop and Food Security Assessment Missions (CFSAMs), fielded jointly with WFP. In country-level application of tools for earth observation and price monitoring, GIEWS also strengthens national capacities in managing food security related information.

National Animal Health Laboratory Network (NAHLN)[49]

The NAHLN supports U.S. animal agriculture by developing and increasing the capabilities and capacities of a national veterinary diagnostic laboratory network to support early detection, rapid response, and appropriate recovery from high-consequence animal diseases. It is a nationally coordinated network and partnership of Federal, State, and university-associated animal health laboratories. NAHLN veterinary diagnostic laboratories provide animal health diagnostic testing to detect biological threats to the nation's food animals, thus protecting animal health, public health, and the nation's food supply. They provide the capability to diagnose both endemic and high-consequence livestock pathogens in animals, food, and environmental samples and are likely to be the first-line laboratories for recognition of an intentionally or accidentally introduced agent in animals.

Caribbean Animal Health Network (CaribVET)[50]

CaribVET works in close collaboration with national surveillance networks to promote international standards and regional harmonisation with respect to animal health and veterinary public health issues. CaribVET aims to improve animal and veterinary public health in all the countries and/or the territories of the Caribbean.

CaribVET is a collaborative network involving veterinary services from 34 Caribbean countries/ territories as well as veterinary services laboratories, research institutes, veterinary faculties, CARICOM Secretariat and regional and international organizations.

47 https://wahis.woah.org/#/home
48 http://www.fao.org/giews/en/
49 https://www.nahln.org/index.html
50 https://www.caribvet.net/

The Laboratories Emergency Animal Disease Diagnosis and Response (LEADDR) Network[51]

The network aims to standardise, or otherwise harmonise, routine frontline testing platforms (such as serology and rapid molecular testing) for a number of targeted terrestrial and aquatic EADs through ANQAP or its own programs.

Animal Health and Welfare Network[52]

EFSA networks with Member States to build a mutual understanding of risk assessment principles in the area of animal health and welfare, to promote harmonisation of animal health and welfare risk assessment practices and methodologies and to reduce the duplication of activities by identifying and sharing current and upcoming priorities.

Emerging Risks Exchange Network (EREN)[53]

The role of the network is to provide a platform for the scientific cooperation between risk assessors of the EU Member States and EFSA in collaboration with the European Commission (EC), and to enhance risk assessment practices in the area of emerging risk identification methodologies.

The EWDA Wildlife Health Network[54]

The EWDA wildlife health network was initiated in October 2009 at an EWDA meeting in Brussels, Belgium, attended by representatives from 25 countries. The long-term goals of this network are to improve exchange of information among wildlife health surveillance programmes in Europe; develop standard operating procedures for diagnostic investigation; develop common criteria for diagnosis of wildlife disease; share specialist expertise; and provide training opportunities for wildlife health surveillance.

One of the first initiatives is an “EWDA wildlife health network” website that set up within Google groups. This website allows members to share information and exchange views on wildlife disease issues. EWDA members who are involved in or want to start up a wildlife disease surveillance scheme in Europe may apply for membership of this EWDA network by visiting the website: http://groups.google.com/group/ewda-network.

One of the goals of the EWDA wildlife health network is to produce “diagnosis cards” (fact sheets with emphasis on diagnosis of diseases in wildlife) and “species cards” (fact sheets with emphasis on methods for abundance and estimation of wild hosts).

51 http://www.agriculture.gov.au/animal/health/system/lab-network#the-laboratories-emergency-animal-disease-diagnosis-and-response-leaddr-network

52 https://www.efsa.europa.eu/en/animal-health-and-welfare/networks

53 https://www.efsa.europa.eu/en/cross-cutting-issues/networks

54 http://ewda.org/ewda-network/

Advancing European Research infrastructure on Highly Pathogenic Agents

January 2019 – June 2022

One of the great challenges of the 21st century is to develop the capacity to prevent and react to outbreaks caused by highly pathogenic human and animal microorganisms, which are generally characterized by a high mortality rate, unavailability of prophylactics or effective therapeutic treatment and high human-to-human transmission.

ERINHA AISBL (European Research Infrastructure on Highly Pathogenic Agents), a pan-European Research Infrastructure (RI) dedicated to the study of high-consequence pathogens of Risk Group 4 (RG4), entered into implementation phase in July 2017. It now aims to ensure its long-term sustainability to better answer societal challenges in the field of Science, Health and Security.

The overall aim of the ERINHA-Advance project is to implement actions that will contribute to the long-term sustainability of the ERINHA RI, through enlargement of its membership and partnership and strengthening the overall services offer and framework by fostering the innovation potential of the RI.

To reach these goals, the RI will focus on the following specific objectives:

1. Enlarge ERINHA's membership and research capacities (WP2)
2. Improve users services (WP3)
3. Stimulate the innovation potential of ERINHA and identify the co-innovation opportunities with industry (WP4)
4. Strengthen the overall services framework through long-term data-management and data sharing rules, clarification of IPR regimes and definition and implementation of the quality assurance system of the RI and its national nodes (WP5)
5. Reinforce ERINHA's European and International cooperation with relevant countries, initiatives and networks (WP2 and WP6).

By achieving these objectives, ERINHA-Advance will largely contribute to providing access to larger number of high containment facilities to European and international scientists and foster research and innovation in the field of highly infectious diseases.

Center of Excellence for Emerging and Zoonotic Animal Diseases (CEEZAD)[55]

CEEZAD has been active at Kansas State University since 2010 and was set up to protect agricultural and public health sectors in the USA against emerging and zoonotic disease threats. The main missions of CEEZAD are:

1. Develop novel, safe, efficacious, DIVA compatible vaccines for control and prevention of emerging and zoonotic disease that pose a high threat. These should be able to be manufactured within the US.
2. Develop and expand technology and platforms for laboratory and point-of-need pathogen detection.
3. Develop models to predict high consequence disease behaviours in the US to help prevent or control an outbreak.
4. Develop education and training programmes for those that would be needed to deal with animal diseases and animal emergencies.

55 https://ceezad.org/

All of their missions are focused around high-impact animal diseases.

Some of the centres major goals are:

5. Develop vaccines for Rift Valley Fever Virus, highly pathogenic avian influenza and African swine fever
6. Advance next-generation sequencing and multiplex detection technologies
7. Develop novel epidemiologic decision tools and create development programmes within the workforce to make these goals achievable.

International Severe Acute Respiratory and emerging Infection Consortium (ISARIC)[56]

A network of networks established to ensure a rapid research response to outbreaks of pandemic potential. To prevent illness and deaths from infectious diseases outbreaks as a global federation of clinical research networks, providing a proficient, coordinated, and agile research response to outbreak-prone infectious diseases.

They have three goals:

1. To generate the best possible clinical evidence both between and during outbreaks through clinical research conducted by ISARIC Members
2. To empower locally-led research by building clinical research capabilities and by providing urgent 'research response' support when needed
3. To make clinical evidence, expert opinion, experience and tools available to those who need it, whenever they need it

Regional Emerging and Dangerous Pathogens Laboratory Network (EDPLN)[57,58]

They work to enhance capacities of laboratories to detect and diagnose outbreaks of emerging and dangerous pathogens, including new and emerging pathogens and existing pathogens causing repeated outbreaks. The network includes both private and public, human and animal diagnostic health laboratories.

Five major objectives: 1. Improve rapid diagnosis, identification and characterization of viral, bacterial and parasitical EDP outbreaks, 2. Improve response times to outbreaks, 3. Further the regional research and development agenda including on diagnostics, vaccine and therapeutics, 4. Improve biosafety and biosecurity practices, 5. Facilitate knowledge transfer and information sharing.

56 https://isaric.org/
57 https://www.who.int/groups/edpln
58 http://www.emro.who.int/health-topics/edpln/index.html

MOOD – Monitoring Outbreak events for Disease surveillance in a data science context[59]

January 2020-December 2023

The MOOD project aims to harness the data mining and analytical techniques to the big data originating from multiple sources to improve detection, monitoring, and assessment of emerging diseases in Europe. To this end, MOOD will establish a framework and visualisation platform allowing real-time analysis and interpretation of epidemiological and genetic data in combination with environmental and socio-economic covariates in an integrated inter-sectorial, interdisciplinary, One health approach by:

1. Data mining methods for collecting and combining heterogeneous Big data,
2. A network of disease experts to define drivers of disease emergence,
3. Data analysis methods applied to the Big data to model disease emergence and spread,
4. Ready-to-use online platform destined to end users, i.e. national and international human and veterinary public health organizations, tailored to their needs, complimented with capacity building and network of disease experts to facilitate risk assessment of detected signals.

Research Capacity Network (REDe)[60]

An international network focused on building research capacity and preparedness to tackle emerging infectious disease outbreaks in Latin America and Caribbean. Specific objectives:

1. To establish a regional network of excellence for research that shares knowledge, expertise and provides local support and training when and where needed in EID preparedness and response.
2. To collaborate with regional and international networks to leverage synergies, share knowledge and identify and address regulatory bottlenecks in EID preparedness and response.
3. To leverage input and data from peer networks and research databases with the aim to speed up evidence generation and improve research efficiencies in EID preparedness and response.
4. To develop a sustainability plan that will allow the network to continue beyond the funding period.

59 https://cordis.europa.eu/project/id/874850
60 https://rede.tghn.org/

Epidemiology

Participatory Epidemiology Network for Animal and Public Health (PENAPH)[61]

Initiated in 2007, the Participatory Epidemiology Network for Animal and Public Health (PENAPH) connects groups and individuals who apply PE methods in controlling emerging and existing diseases. The concept arose as a result of applying participatory epidemiology to some of ILRI's projects which bridge human and livestock health. The main objective of PENAPH is to maintain a network for participatory epidemiology engaging diverse stake holders in identifying and solving the world's most pressing health challenges. The ten PENAPH partners are the World Organisation for Animal Health (OIE), Food and Agriculture Organisation of the United Nations (FAO), African Union Inter-African Bureau for Animal Resources (AU-IBAR), International Livestock Research Institute (ILRI), Royal Veterinary College of London University (RVC), Vétérinaires Sans Frontières-Belgium (VSF-B) and Veterinarians Without Borders-Canada (VWB-VSF-C), US Centers for Disease Control and Prevention (US-CDC), the African Field Epidemiology and Laboratory Network (AFENET) and Tufts Cummings School of Veterinary Medicine (TCSVM).

CLINF: Climate change effects on the epidemiology of infectious diseases and the impacts on Northern Societies[62]

CLINF is a Nordic Centre of Excellence that operates under the NordForsk Joint Initiative on Arctic Research: Responsible Development of the Arctic, Opportunities and Challenges-Pathways to Action. It sets out to identify and investigate the effects of climate change on the geographic distribution and epidemiology of human and animal infectious diseases throughout the Northern region, from Western Greenland to Eastern Siberia. CLINF will study such climate-change effects on northern animal husbandry households in the light of socio-economic and managerial conditions.

Developing the predictive ecology of plant-animal interactions across space and time[63]

Hosted by EIDGENOESSISCHE FORSCHUNGSANSTALT WSL, Switzerland, 1Oct 2018- 30 September 2023, €2.5M

In the face of the alarming pace of recent environmental change we lack the tools to accurately predict how biodiversity and ecosystem services will respond. One key gap in knowledge that limits our predictive ability is uncertainty concerning how the biotic interactions will change. Developing a predictive science of species interactions requires integrating evolutionary, biogeographic and ecological mechanisms acting at different spatial and temporal scales. We will use a hierarchical cross-scale approach, combining phylogeography, network ecology, statistical modelling and experiments, to disentangle the mechanisms governing species richness and mutualistic interactions in tropical hummingbirds and their food plants. Hummingbirds and their food plants are an excellent model system because they are highly diverse, highly specialized, and logistically feasible to study. Our objectives are to (1) evaluate the influence of factors, such as trait-matching, environmental conditions and relatedness, on network structure; (2) quantify how and why interaction beta-diversity (i.e., reflecting the change in both species composition, and in interacting partners) changes across elevation gradients in each of three biogeographic regions with distinct evolutionary histories (mountain regions in Costa Rica, Ecuador, Brazil); (3) evaluate the importance of

61 https://penaph.net/about/
62 https://clinf.org/
63 https://www.wsl.ch/de/projekte/ecology-of-interactions.html

multiple factors, such as trait-matching, environmental conditions, relatedness and abundance, on species interactions and network structure; and (4) develop a predictive model of species interactions and evaluate its performance using cross-validation and experimentation. Together, these tasks will provide new insight into one of the central enigmas in ecology, namely, why species diversity and its interaction architecture change across space and time. We will also be able predict how species interactions will change from present to the future, which is essential for the conservation of biodiversity and ecosystem services.

Society for Veterinary Epidemiology and Preventive Medicine (SVEPM)[64]

SVEPM was founded in 1982 and comprises approximately 250 veterinary and non-veterinary members from 24 countries. Their mission is to enable professionals to meet and share knowledge to improve the health of animals, humans and the environment.

International Society of Veterinary Epidemiology and Economics[65]

It is part of the World Veterinary Association organizing regular global symposia.

Global Burden of Animal Diseases (GBADS)[66]

A workshop, led by the University of Liverpool and the N8 Agrifood Resilience Programme, was held to initiate a programme for the Global Burden of Animal Diseases (GBADs). It was hosted by the World Organisation for Animal Health (OIE), convened by the Bill & Melinda Gates Foundation, and brought together experts in animal health and livestock production data collection and analysis, and information generation.

Six key components of a GBADs programme were identified: disease classification, data collection, disease losses, animal health expenditure, sustainability, and equitability. Disease classification involves key areas of case definition, applicability in the field and with existing data, and engagement with animal owners and health-care advisers. For data collection, there was agreement on the importance of clarity on the types of data to be collected from the public and private sectors and that ownership and commercial sensitivities are thought through and treated with transparency. Disease losses covers the need for a framework that captures what losses will be included, how they will be measured, and how they will be reported. For animal health expenditure, public and private costs need to be separated and costs for different disease issues need to be attributed. In terms of sustainability, we identified the need for a mapping exercise to determine who should be linked to a process of defining the outcomes of GBADs in a structured and timely way. To ensure equitability, impacts in low-income countries must be presented in a way that is comparable to impacts in high-income countries.

Centre for supporting evidence-based interventions in livestock (SEBI Livestock)[67]

SEBI-Livestock mobilises and improves data and evidence to help the livestock community make better investments that improve livelihoods for smallholders in low and middle-income countries. They consolidate and improve hard-to reach data and employ new techniques such as machine learning to acquire data. Their focus is on enhancing access to the best available data, strengthening the generation of high-quality data, and turning data into useful evidence.

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64 https://www.svepm.org.uk/home.html
65 https://uia.org/s/or/en/1100042319
66 https://animalhealthmetrics.org/
67 https://sebi-livestock.org/

Foot and Mouth disease

Global Foot and Mouth Disease Research Alliance[68]

GFRA aims to expand FMD research collaborations worldwide and maximize the use of resources and expertise to achieve its five strategic goals (see below).

Several research programs are currently active in Europe, North America, South America and South-East Asia. GFRA programs will continue to expand the alliance in these areas and will actively reach out to new areas of the world that have a stake in the progressive control and eradication of FMD.

Goal 1. Facilitate research collaborations and serve as a communication gateway for the global FMD research community

Goal 2. Conduct strategic research to better understand FMD

Goal 3. Development of the next generation of control measures and strategies for their application

Goal 4. Determine social and economic impacts of the new generation of improved FMD control

Goal 5. Provide evidence to inform development of policies for safe trade of animals and animal products in FMD-endemic areas

The European Commission for the control of Foot-and-mouth disease (EUFMD)[69]

EuFMD is one of FAO's oldest Commissions, came into being on the 12th June 1954, with the pledge of the sixth founding member state to the principles of a coordinated and common action against foot-and-mouth disease at a time when the disease was ravaging the continent.

The Three Pillars of the EuFMD strategy to counter the threat of the disease, have been since 2013 to work simultaneously with member countries on their preparedness, with European neighbours to put in place sustainable control programmes, and to support and promote the progressive control of FMD in all regions under the Global FMD Control Strategy of FAO and OIE.

WOAH/FAO FMD Reference Laboratory Network[70]

This Network arose from a meeting of the WOAH *ad hoc* group of Antigen and Vaccine Banks (in Paris 2004) where it was decided to generate two forums to coordinate international activities: a vaccine bank network (now the IVSRN), and this Foot-and-Mouth Disease Reference Laboratory Network. Attendance at the meeting by delegates from affiliate Foot-and-Mouth Disease laboratories is an essential component of the Network and provides an approach to ensure that the most relevant data is collected regarding FMD outbreaks and surveillance.

68 https://www.ars.usda.gov/gfra/
69 https://www.fao.org/eufmd/en/
70 https://www.foot-and-mouth.org/Ref-Lab-Network

FMD And Similar Transboundary (FAST) animal diseases (Hold-FAST)[71]

The scope of the initiative is Foot-and-mouth disease (FMD) and those transboundary animal diseases which pose similarities to FMD.

There are three main goals:

1. Improve preparedness for management of FMD and similar Transboundary animal diseases (TADS) crises by Members and across Europe as a whole,
2. Reduce risk to Members from the FAST diseases (FMD and similar TADS,
3. Sustain progress of the GF-TADS Global Strategy against FMD and the improved security of supply of effective vaccines

FMDV_PersIstOmics – From proteogenomic host response signatures of persistent foot-and-mouth disease virus (FMDV) infection to diagnostic markers and therapeutic control[72]

March 2021 – March 2024

Even after decades of research, the mechanisms underlying FMDV persistence are still largely unknown. Investigations performed so far suggest that the maintenance of persistent infection is mainly related to the host's immune responses. Filling the gap of knowledge regarding the carrier state is critical to be able to predict, prevent, detect or cure FMDV persistence and put an end to the mass culling of exposed animal populations during outbreaks of the disease in free areas. In a previous collaborative EU funded project (ERA-NET/ANIHWA "Transcriptovac"), the researchers involved established a new in vitro model of FMDV persistence in primary bovine dorsal soft palate (DSP) cells cultured as multilayers at an air-liquid interface (ALI) without any cell culture passage, to mimic in vivo conditions. The combination of proteogenomics with the DSP ALI model allowed us to analyse the transcriptional host response during acute and persistent FMDV infection. In this near-natural in vitro model, they identified time-dependent gene signatures during FMDV infection and found that a long-lasting stimulation of interferon indeed stimulated antiviral genes (ISG) along with persistence but is ultimately ineffective to clear the virus. Some highly regulated genes, which have potential use as diagnostic markers of persistence, were also identified during this study. The project proposed here is a direct follow-up to determine mechanisms and factors that may help to prevent or control persistent infection and to improve diagnostics. The project aims to (i) uncover alterations of the host response during persistent FMDV infection of cattle (ii) evaluate genes highly regulated during FMDV persistence as candidate host markers of persistent infection and (iii) identify pathways that could be targeted to prevent the establishment of FMDV persistence or terminate the infection. France, Sweden, Germany, Belgium and Turkey are consortium partners.

71 http://www.fao.org/3/ca5337en/ca5337en.pdf

72 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/from-proteogenomic-host-response-signatures-of-persistent-foot-and-mouth-disease-virus-fmdv-infection-to-diagnostic-markers-and-therapeutic-control

Genetics and Genomics

A Global Network – Functional Annotation of Animal Genomes" (FAANG) initiative[73]

A coordinated international action to accelerate genome to phenome. It aims to standardize core assays and experimental protocols, coordinate and facilitate data sharing, establish an infrastructure for analysis of these data and provide high quality functional annotation of animal genomes.

FAANG-Europe (Functional Annotation of Animal Genomes – European network)[74,75]

Research on domesticated animals has important socio-economic impacts, including underpinning improvements in the livestock sector, contributions to medical research, animal health and welfare, the evolution of domestication and the understanding of natural animal populations.

Whilst progress has been made with the identification of genome sequences, which determines the proteins encoded by farm and domesticated animal genomes, there is little information on the sequences that are transcribed but not coding, and in particular sequences that regulate gene expression. Thus, although the genomes of the major domesticated animal species have been sequenced, significant investment is now required in order to identify the functional elements within these genomes, especially the regulatory sequences.

The FAANG initiative aims to improve the functional annotation of animal genomes. FAANG was originally funded through Europe COST Action.

SMARTER – SMAll RuminanTs breeding for Efficiency and Resilience[76]

Nov 2018 – Oct 2022

SMARTER will develop and deploy innovative strategies to improve Resilience and Efficiency (R&E) related traits in sheep and goats. SMARTER will find these strategies by: i) generating and validating novel R&E related traits at a phenotypic and genetic level ii) improving and developing new genome-based solutions and tools relevant for the data structure and size of small ruminant populations, iii) establishing new breeding and selection strategies for various breeds and environments that consider R&E traits.

SMARTER with help from stakeholders chose several key R&E traits including feed efficiency, health (resistance to disease, survival) and welfare. Experimental populations will be used to identify and dissect new predictors of these R&E traits and the trade-off between animal ability to overcome external challenges. SMARTER will estimate the underlying genetic and genomic variability governing these R&E related traits. This variability will be related to performance in different environments including genotype-by-environment interactions (conventional, agro-ecological and organic systems) in commercial populations. The outcome will be accurate genomic predictions for R&E traits in different environments across different breeds and populations. SMARTER will also create a new cooperative European and

73 https://www.animalgenome.org/community/FAANG/index
74 http://faang-europe.org/
75 http://www.cost.eu/COST_Actions/ca/CA15112
76 https://cordis.europa.eu/project/id/772787

international initiative that will use genomic selection across countries. This initiative will make selection for R&E traits faster and more efficient. SMARTER will also characterize the phenotype and genome of traditional and underutilized breeds. Finally, SMARTER will propose new breeding strategies that utilise R&E traits and trade-offs and balance economic, social and environmental challenges.

The overall impact of the multi-actor SMARTER project will be ready-to-use effective and efficient tools to make small ruminant production resilient through improved profitability and efficiency.

Centre for Tropical Livestock Genetics and Health[77]

Funded by BMGF and DFID in 2015, CTLGH supports programs that improve livestock-based livelihoods in the tropics. It is a strategic alliance of the Roslin Institute, Scotland's Rural College and the International Livestock Research Institute. Their mission is to deliver genetic gains for tropical livestock development. CTLGH launched its research portfolio supported by our strategic partner institutions and funders. These initial partnerships and programmes aim to develop and apply genomic tools to improve the productivity of tropical livestock and increase climatic resilience, adaptation, and mitigation for the benefit of smallholder farmers in the tropics. Their research programmes include dairy genomics, poultry genomics, reproductive technologies, health genetics and informatics and bioresources.

Photo credit: CDC / Emily Cramer / Todd Jordan

77 http://www.ctlgh.org/

Helminth (including anthelmintic resistance)

Livestock Helminth Research Alliance (LiHRA)[78]

The mission of the research alliance is to develop sustainable effective helminth control strategies and promote their implementation by the livestock industry. Its objectives are to generate a globally leading research alliance in the field of livestock helminth infections, simulate collaborative research by enabling exchange of ideas and mobility of young researchers and by promoting mutual research project, initiate/foster research initiatives by promoting helminth research at international and national funding authorities, facilitate knowledge exchange with the livestock industry to respond to their needs and constraints and identify areas for future research, have the ability to respond to global changes that impact on livestock farming practices and helminth infection and establish a network of standardised diagnostic parasitology labs and to standardize field trial and monitoring approaches throughout Europe.

Combating anthelmintic resistance in ruminants (COMBAR)[79]

Helminth parasitic pathogens cause severe disease and are amongst the most important production limiting diseases of grazing ruminants. Frequent anthelmintic use to control these infections has resulted in the selection of drug resistant helminth populations. Anthelmintic resistance (AR) is today found in all major helminth species across Europe and globally. COMBAR will advance research on the prevention of anthelmintic resistance in helminth parasites of ruminants in Europe and disseminate current knowledge among all relevant stakeholders. By gathering parasitologists, social scientists and agricultural economists, COMBAR will bring together a multi-disciplinary blend of scientists that do normally rarely interact. Inclusion of SMEs and industry in the consortium will facilitate the dissemination of knowledge and novel technologies to the animal health playing field. COMBAR will integrate novel developments in the field of (i) diagnostic tests; (ii) vaccines to protect animals from infection; (iii) antiparasitic forages, (iv) selective treatment strategies and (iv) decision support tools. By evaluating those novel technologies and assessing their economic trade-offs and barriers to uptake in a European coordinated approach, COMBAR will tackle AR.

COST COUNTRIES Main Proposer: BE Network of Proposers: BE, CH, CZ, DE, DK, ES, FR, IT, NL, PL, SE, SK, UK (ITC share: 23%) Participants: 32% ECI/32% Women INDUSTRIAL DIMENSION SMEs: Belgium, United Kingdom.

The final COMBAR meeting took place in Athens, Greece with a focus on: “Combatting anthelmintic resistance in ruminants: options for the future”[80]. During this conference they looked back on what the COMBAR project achieved and summarized the current knowledge. They want to look forward and investigate what are the options for the future to achieve sustainable helminth control and how thye can maintain the established network and critical mass.

78 http://www.lihra.eu/
79 https://www.cost.eu/actions/CA16230/
80 https://www.combar-ca.eu/sites/default/files/COMBAR_Finalconference%20official%20announcement.pdf

Neglected Tropical disease NGO Network[81,82]

The Neglected Tropical Disease NGO Network (NNN) was established in October 2009 to create a global forum for non-governmental organisations working to control onchocerciasis, lymphatic filariasis, schistosomiasis, soil transmitted helminths, and trachoma. Other diseases including leprosy and podoconiosis have since joined the forum. These Neglected Tropical Diseases (NTDs) share common strategies including community-based health interventions that can be integrated to strengthen health care systems TRA.

Cystinet – European Network on Taeniosis/ Cysticercosis[83,84]

Taenia solium (pork tapeworm) and *T. saginata* (beef tapeworm) cysticercosis (CC)/taeniosis are zoonoses of public health importance, with significant economic impacts on the health and meat (pork and beef) sectors within and outside the EU. Despite increased research efforts, an important number of gaps remain. For more than one third of the member states, data on occurrence of porcine/bovine/human CC and taeniosis are missing. Many questions remain on transmission dynamics, infection development/course and clinical manifestations. An improved knowledge on host-parasite interactions will create opportunities for new diagnostic targets, and vaccine candidates. The main objective of this Action is to build a strong, extensive, multi-disciplinary scientific network to induce sustainable collaborations with the aim to advance knowledge and understanding of these zoonotic disease complexes. Specific objectives include the development of innovative diagnostic and cost-efficient control tools, assessments of disease burden and economic impact, as well as the development of harmonized reporting and management procedures. Intra-European collaboration is essential to stop the development of these diseases within the EU. The Action is aimed at both European economical/societal needs and scientific/technological advances. Although the action has come to an end the project continues through Cystinet.

81 https://www.ntd-ngonetwork.org/about
82 https://www.ntd-ngonetwork.org/schistosomiasis-and-soil-transmitted-helminths
83 http://www.cystinet.org/
84 https://www.cost.eu/actions/TD1302/

Influenza

Joint WOAH-FAO scientific network on animal influenza[85]

Main objectives includes to share and offer technical advice, training and veterinary expertise to international organisations and Member Countries to assist in the prevention, diagnosis, surveillance and control of animal influenza; exchange scientific data and biological materials (including virus strains) within the network, to analyse such data, and to share such information with the wider scientific community; collaborate with the WHO on issues relating to the animal-human interface, including pandemic preparedness for early preparation of human vaccine and highlight influenza surveillance and research needs, promote their development and co-ordination.

DELTA-FLU – Dynamics of avian influenza in a changing world[86]

June 2017 – November 2022

DELTA-FLU aims to determine the key viral, host-related, and environmental factors that determine the dynamics of avian influenza (AI) in poultry and other host species, with the goal of improving prevention and control strategies against this disease. As a result of rapidly changing dynamics, AI continues to cause unexpected and devastating outbreaks in poultry in the EU, as well as world-wide. Its potential to become pandemic is also of great concern to public health. The key viral, host-related, and environmental factors that drive AI dynamics are poorly understood, which currently impedes the development of effective control and prevention strategies. As the problems caused by AI require global solutions, DELTA-FLU is a consortium with top-level experts from Europe, North America, and Asia. Through interdisciplinary research focused on key questions of AI, DELTA-FLU will determine 1) potential for some highly pathogenic avian influenza viruses (HPAIV, e.g. H5N8 clade 2.3.4.4) to be maintained in wild bird populations and spread over long-distances, 2) key viral, host, and environmental factors for incursion of HPAIV from wild birds into poultry holdings, 3) roles of viral, host, and environmental factors in the transition of low pathogenic avian influenza virus to HPAIV in poultry, 4) effect of flock immunity against AI on early detection and viral genetic drift, and 5) viral genetic factors that allow reassortants of avian and mammalian influenza viruses to transmit efficiently among pigs. Primary sectors and end-users are involved through participation in the Multi-Actor Panel, which will also play an important role in the translation of the results into effective prevention and control strategies. As such, DELTA-FLU will make significant advances in knowledge of AIV dynamics and provide the evidence base for improved diagnosis, prevention, and control strategies for AI in poultry, as well as for reducing the possible risk of AI to become potentially pandemic.

85 https://www.offlu.org/
86 https://delta-flu.fli.de/de/home/

FluNuance – Virulent Non-Notifiable Avian Influenza; Determinants of virulence of emerging viruses[87]

March 2021 – March 2024

The project consists of 5 work packages (WP): WP1. Determinants of H3N1 tissue tropism and virulence will generate the tools and reagents needed to test molecular hypotheses for the unusual and age-dependent pathogenicity of the A/chicken/Belgium/460/2019 (H3N1) virus. The project aims to create a reverse genetics system for Influenza A Virus, as well as labelled virus particles as tools. The roles of HA cleavage site, receptor specificity and virus particle shape will be studied as potential virulence determinants. WP 2. Determinants of host-virus interaction indicative for altered virulence. Four models, using tissues from chicken embryos and hatched birds, will be used to study host-virus interaction at epithelial surfaces, through virus challenge and receptor mapping experiments. WP 3. Evaluation of the in vivo pathogenicity of WT and mutant H3N1 viruses to understand the unusual pathogenicity of the virus. In addition, the behaviour of the mutant viruses generated in WP1 will be similarly assessed, to test hypotheses regarding the viral basis of pathogenicity. WP 4. The virulence of WT and mutant H3N1 viruses will be assessed first using embryonated eggs of wild bird species which are selected based on their different epidemiological impact on virus spread and susceptibility to AIV. Organ tropism, influence of age, innate responses and host receptor distribution will be determined. In vivo pathogenicity tests of H3N1 WT/rg on selected species will be conducted. WP 5. Developing diagnostic tests to assess pathogenic potential of emerging LPAI viruses. A set of LPAI ranging from avirulent through to mild and moderate virulence will be compared in the systems used in WP2, looking for commonalities in response between virulence classes. The outcome will guide the development of a more tractable assay that can be used to classify the virulence of novel LPAI strains of AIV.

FluNuance brings together leading avian infection and immunity groups from University and national veterinary institutes to focus their skills, tools and expertise on a problem of genuine concern and economic impact for the poultry industry. Partner countries are the Netherlands, the UK, Germany, Poland and Hungary.

PIGIE – Understanding the dynamics and evolution of swine influenza viruses in Europe: relevance for improved intervention and sustainable pig production[88]

March 2021 – March 2024

There is an urgent need to increase knowledge of within-herd virus dynamics and evolution in order to design intervention and prevention measures to limit swIAV persistence in intensive herds and counteract continuous production losses and emergence of new swIAVs. The objectives of the research project PIGIE are: - to define the epidemiological and economic factors that drive the prevalence and dynamics of swIAV in large pig herds, - to evaluate the impact that swIAV enzootic infections have on animal welfare, production parameters and economic productivity, - to study the genetic and antigenic diversity of swIAV in Europe, - to identify the host-pathogen factors that would foster swIAV evolution, - to provide a better understanding of long-lasting and protective immunological memory responses developed in the infected hosts, - to identify mitigation points in continuously infected herds, - to implement and evaluate control strategies that would help to counter sustained infections in closed intensive herds. Control strategies will be implemented and evaluated through further longitudinal studies. Thus, thanks to data sharing, integration and analysis, PIGIE will provide further understanding of the epidemiology and means of control of swIAVs in Europe, essential for sustainable and competitive pig production. Countries represented in the consortium include France, Germany, Denmark, Italy, Spain and the UK.

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87 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/virulent-non-notifiable-avian-influenza-determinants-of-virulence-of-emerging-viruses

88 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/understanding-the-dynamics-and-evolution-of-swine-influenza-viruses-in-europe-relevance-for-improved-intervention-and-sustainable-pig-production

PREVENTER – Deciphering the role of influenza D virus in bovine and human respiratory diseases in Europe[89]

PREVENTER's objective is to develop an integrated approach to not only assess the emergence threat associated with influenza D viruses' circulating in Europe, but also the role played by the virus in cattle respiratory disease complex and the risk it may play for human. By promoting transfer and exchange of knowledge and expertise between the partners we will pave the way towards scientific-based decision-making and development of effective strategies for cattle respiratory disease control, and risk assessment for Influenza D virus infections in Human. The first question to answer relates to the role of IDV among respiratory pathogens of cattle and humans. A first work package will therefore be to survey IDV occurrence and prevalence in the 2 species in Europe and collect field data (samples for respiratory pathogens detection, bioaerosols, cloths from farm premises, but also questionnaires on biosecurity and mitigation measures) to understand IDV's place within its pathogens counterparts. In field samples collected at a given time it will however not be possible to understand the sequence of infection (which pathogen is more likely to infect first/second), nor whether the co-circulating pathogens act in synergy or antagonism in the host. A second work package will therefore enable answering more mechanistic questions using in vitro and ex vivo culture methods to better understand the field situation. All parts of the projects will act as support for the models for risk assessment (third work package) with clear benefits for both animal (cattle) health and public health. To estimate the IDV human risk exposure through aerosols in cattle farms at risk (viral circulation), a quantitative risk assessment modelling will be performed and refined using field (WP1) and experimental (WP2) data. Based on prospective scenarios analysis, the effect of medical (vaccination) and/or sanitary (biosecurity) mitigation measures will be evaluated through the previous modelling. This project addresses the need for capacity building at EU level to improve the EU's scientific assessment capacity and international competitiveness. The output of the project will enhance European cooperation and generate a sustainable network necessary for detecting, preventing and responding to an emerging animal disease that could constitute a threat not only to animal health and welfare but also to European food production and directly or indirectly to human health. Partners involved are France, Italy, Belgium, Sweden and Turkey.

89 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/deciphering-the-role-of-influenza-d-virus-in-bovine-and-human-respiratory-diseases-in-europe

Alternatives to Antibiotics

Global AMR R&D Hub [90]

The Global AMR R&D Hub was launched in May 2018, following a call from G20 Leaders, to address challenges and improve coordination and collaboration in global AMR R&D using a One Health approach. It is a global partnership currently consisting of 17 countries, the European Commission and two philanthropic foundations. The work of the Global AMR R&D Hub is steered by a Board of Members.

The Global AMR R&D Hub collects and presents information on AMR R&D investments and market interventions. This information is intended for countries, foundations, organisations and initiatives to help set priorities and maximise the impact of resources invested in R&D to mitigate the AMR threat. To achieve its vision and objectives, as outlined in the Terms of Reference, the Global AMR R&D Hub's strategic approach is delineated into three pillars:

1. Guide and support evidence-based decision making;
2. Enhance collaboration and coordination; and;
3. Promote awareness, knowledge and visibility.

AVANT Alternative to Veterinary ANTimicrobials[91]

Jan 2020 – Dec 2024

Antimicrobials such as antibiotics are used to kill or inhibit microorganism growth in human and veterinary medicine. For instance, farmers add antibiotics to animal feed, speeding up their growth and preventing them from getting sick. However, the overuse of antibiotics in farming and agriculture is a growing threat to human health. The EU-funded AVANT project is developing alternatives to antimicrobials for the management of bacterial infections in pigs. These include a gut-stabilising intervention based on symbiotic products and faecal microbiota transplantation, and feed additive products, as well as alternative feeding strategies targeting sows and piglets. Mathematical modelling tools with be used to estimate reduction in antimicrobial use by 2030 if these alternative practices are adopted by the pig production industry.

Healthylivestock Tackling Antimicrobial Resistance through improves livestock Health and Welfare[92]

September 2018 – February 2023

HealthyLivestock aims to reduce antimicrobial (AM) use by the pig and broiler industries in China and Europe, and consequent residues in meat and the environment, by improving animal health & welfare without compromising productivity. Phase 1, combining efforts from 5 Chinese and 8 EU academic partners, will include novel scientific approaches in 4 interlinked strategies to reduce AM need. 1) Biosecurity: reducing risk of pathogen presence within a farm through zoning-based Health & Welfare plans, including animal-based indicators of success. 2) Resilience: increasing ability of animals to cope with endemic diseases, through novel stress-reducing housing systems and probiotic improvement of gut health. 3) Rapid detection: applying precision farming techniques to facilitate early detection, diagnosis and intervention of health & welfare problems. 4) Precision medication: using pharmacokinetics to target

90 https://globalamrhub.org/
91 https://cordis.europa.eu/project/id/862829
92 https://cordis.europa.eu/project/id/773436

AM to only individuals or groups in need. Phase 2 will validate the technical innovations by establishing their societal acceptability and economic viability. It will also assess the relationships between the Health & Welfare plans, the level of pathogens on the farm and AM residues in product and manure. In phase 3 the project's industrial partners dedicate their network and expertise to knowledge exchange. The Federation of Veterinarians of Europe will lead dissemination of the scientific findings through Technical Notes. China's only animal welfare standard setting organisation ICCAW, and Europe's leading organisation GLOBALG.A.P., will strengthen their Quality Assurance schemes. Zoetis, the world's largest veterinary pharmaceutical company, will develop and disseminate their pig and poultry advisory apps for global use. Finally, HealthyLivestock will support Chinese and EU policy making through CAAS and its links with International Veterinary Collaboration for China, and through the forthcoming EU Animal Welfare Platform and Network of Welfare Reference Centres.

Interagency Coordination Group on Antimicrobial Resistance[93]

In UN General Assembly Resolution A/RES/71/3, Member States requested "the Secretary-General to establish, in consultation with WHO, FAO and WOAH, an ad hoc interagency coordination group, cochaired by the Executive Office of the Secretary-General and WHO, drawing, where necessary, on expertise from relevant stakeholders, to provide practical guidance for approaches needed to ensure sustained effective global action to address AMR".

In response to this request, the Secretary-General convened a group of 28 organizations (note that UNITAID was added by the Secretary-General after the first meeting) and experts to carry out this work on his behalf. This Ad Hoc Interagency Coordination Group on Antimicrobial Resistance (the IACG) is co-chaired by the Deputy Secretary-General and the WHO Director-General. At the request of the Secretary-General, the tripartite Secretariat of FAO, WOAH and WHO is hosted in Geneva. The IACG's work is directed by three conveners: Professor Junshi Chen, Professor Dame Sally Davies, and Ms Martha Gyansa-Lutterodt. The objective of the Group will be to provide practical guidance for approaches needed to ensure sustained effective global action to address antimicrobial resistance, including options to improve coordination, taking into account the Global Action Plan on Antimicrobial Resistance.

Global database on antimicrobial agents intended for use in animals[94]

In the framework of the Global Action Plan on Antimicrobial Resistance (AMR), the WOAH, supported by FAO and WHO within the tripartite collaboration, has taken the lead to build a global database on antimicrobial agents intended for use in animals. The WOAH's partners acknowledge this accomplishment as a major milestone in the global effort to contain antimicrobial resistance.

European Network for Optimization of Veterinary Antimicrobial Treatment[95]

November 2019 – November 2023

The global antimicrobial resistance crisis has been the driver of several international strategies on antimicrobial stewardship. Despite their good intentions, such broad strategies are only slowly being implemented into "real life". This is particularly unfortunate for veterinary medicine, which is challenged by (i) a shortage of experts in key disciplines related to antimicrobial stewardship, (ii) few

93 https://bulletin.woah.org/?officiel=2019-1-iacg-amr-en
94 https://www.woah.org/en/what-we-do/global-initiatives/antimicrobial-resistance/#ui-id-3
95 https://www.cost.eu/actions/CA18217/#tabs|Name:overview

antimicrobial treatment guidelines, and (iii) inferior diagnostic tests compared to human microbiology. The aim of this Action is to optimize veterinary antimicrobial use with special emphasis on the development of antimicrobial treatment guidelines and refinement of microbiological diagnostic procedures. For this purpose, the Action will first survey the state-of-the-art in terms of microbiological diagnostic practices and veterinary treatment guidelines across Europe. Secondly, tools in the form of an extensive European strain database and a standard for making antimicrobial treatment guidelines will be created. Third, Action Participants will exploit these tools for the development and refinement of microbiological methods and European treatment guidelines. Finally, the surveys, tools, diagnostic methods, and treatment guidelines will be disseminated to national and international stakeholders. Furthermore, the Action will recommend priority research areas for future optimization of antimicrobial treatment in animals, and develop a roadmap outlining how European countries can advance towards a common high level of veterinary antimicrobial stewardship. The planned investigations and the educational activities will raise the critical mass of expertise in veterinary antimicrobial stewardship in Europe, especially in less resourceful countries and among Early Career Investigators.

WOAH Working Group on Antimicrobial Resistance[96]

The Working Group will maintain a global perspective and foresight on antimicrobial resistance regarding animal health and the interface with human health, food production and the environment.

The WOAH's work is this area is supported by a Reference Laboratory and several Collaborating Centres, as well as by an Ad hoc Group of international experts, including experts from WHO and FAO. The WOAH World Assembly of Delegates strengthened its commitment to the Tripartite at the 87th General Session by passing Resolution No. 14 to a Joint Tripartite Secretariat and AMR Multi-Partner Trust Fund for rapid implementation of recommendations.

International Symposium on Alternatives to Antibiotics (ATA)[97]

In view of the emerging global concerns with antibiotic resistance, there is a pressing need to have a scientific forum to discuss alternatives to antibiotics in food-animal production. The focus of international symposium jointly funded by WOAH/USDA is not intended to be a forum to eliminate the use of antibiotics in food animal production as there is a specific need for antibiotics to treat diseases that impact the health and welfare of animals. Rather, new strategies for preventing and treating diseases that do not result in the creation of selection pressure favouring the development of antimicrobial resistance. They ran a third ATA conference in 2019 in Bangkok focussing on Alternatives to Antibiotics, Challenges and Solutions in Animal Health and Production

Agricultural Research Service AgAR Network[98]

Develop practical tools and protocols to measure antibiotic drugs, resistant bacteria and resistance genes in agriculturally-impacted soil, water, air, and food; design and evaluate agricultural best management practices to limit the persistence and spread of antibiotic resistance from agroecosystems; facilitate sharing of ideas and resources among ARS scientists by establishing an agency-wide network of researchers with the common goal of conducting science based research on AgAR topics.

Connect ARS researchers at multiple locations in order to develop, assess and share methods for measuring resistance that are robust and that are validated across production systems and geographical area.

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96 https://www.woah.org/en/what-we-do/standards/standards-setting-process/working-groups/working-group-on-antimicrobial-resistance/

97 https://www.ars.usda.gov/alternativestoantibiotics/

98 https://www.ars.usda.gov/alternativestoantibiotics/ResearchCenter/AgAR%20Network.pdf

European Antimicrobial Resistance Surveillance Network (EARS-Net)[99]

EARS-Net is based on routine clinical antimicrobial susceptibility data from local and clinical laboratories reported to ECDC by appointed representatives from the Member States.

Joint Programming Initiative on Antimicrobial Resistance (JPIAMR)[100]

The Joint Programming Initiative on Antimicrobial Resistance (JPIAMR) was formed 2011 by 15 European Countries with the support of the European Commission and now comprise 26 countries globally. It is funding 65 M Euros of basic and exploratory research on new antibiotics, stewardship of existing antibiotics, and studies and control of the spread of antibiotic resistance between humans, animals, and the environment in a One Health perspective. It also supports research through several activities such as the establishment of a Virtual Research Institute. JPIAMR coordinate national research programmes on AMR through its Strategic Research Agenda and with input from the IMI and a network of non-governmental stakeholders.

JPIAMR Virtual Research Institute[101]

The JPIAMR-VRI is a dynamic network of AMR research facilities that will change the way resources are shared and used, and will ensure a closer, more coordinated and continuous dialogue amongst researchers as well as between funders and policy makers.

The JPIAMR-VRI Key Principles:

- To provide a virtual corridor facilitating the generation of scientific evidence to develop public policy and guidelines, and translation into practice.
- To facilitate and provide a platform for AMR researchers to communicate and coordinate research and other activities.
- To reduce the duplication of efforts and leverage and synergise global efforts.
- To have a strong international outreach to the numerous AMR Research Community Stakeholders through the member states of the JPIAMR.
- To be able to mobilise new and existing resources through the JPIAMR.
- To cover all essential areas of One-Health, amalgamating different sectors, research areas, professional expertise.
- To address AMR as a global issue considering the needs and requirements of the AMR community in different geographical locations with various resources availabilities.
- To foster multinational research collaborations to add value to and to build upon the research conducted independently at national level.

The JPIAMR-VRI is not a funding instrument in itself but will be eligible for JPIAMR funding programmes. It is not to be seen as an added infrastructure to existing country specific ones.

99 https://ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/ears-net
100 https://www.jpiamr.eu/
101 https://www.jpiamr.eu/activities/jpiamr-vri/

Disseminating Innovative Solutions for Antibiotics Resistance Management[102,103]

January 2019 – June 2022

The DISARM thematic network (Disseminating Innovative Solutions for Antibiotic Resistance Management) is focused on disseminating best practices from innovative farms and research on how to reduce antibiotic resistance in livestock farming. Antibiotic resistance management is not only important to farming, it can also lead to reduced effectiveness of antibiotics in treating humans. Tackling antibiotic resistance is a major strategic challenge for European livestock farmers, an industry worth over 145billion euros. Evidence shows that rates of antibiotic use and resistance vary greatly from farm to farm and, that with the adoption of appropriate innovative on farm management practices that both the use of antibiotics and the development of resistance can be reduced. Disseminating these effective management practices is at the heart of the DISARM project, which will work with farmers, vets, advisors, industry and researchers to identify and disseminate widely the most cost effective and beneficial strategies. This will be delivered by:

1. Developing a 600 member multi-actor Community of Practice to share, debate and disseminate the most promising strategies to reduce antibiotic resistance in livestock farming;
2. Producing 10 best practice guides, supported by 100 best practice abstracts and 100 short videos to explain how farms have successfully adopted innovative practices to reduce antibiotic resistance;
3. Working with 40 farms (in 8 countries) to develop multi-actor farm health plans with at least 30 of these being used as case studies to show other farms how working with their vet, feed or equipment suppliers and advisory services can help them adopt a set of best practices suited to their farm;
4. Run 80 events to disseminate best practices, hosted by farmers or research centres, and speak at 60 further industry events;
5. Deliver 3 annual reports on the remaining challenges with antibiotic resistance which research or policy developments need to address.

InnoVet-AMR: Innovative Veterinary Solutions for Antimicrobials[104]

InnoVet-AMR is a four-year, CA$27.9 million partnership between International Development Research Centre and the UK government's Global AMR Innovation Fund (GAMRIF) which is part of the Department of Health and Social Care (DHSC).

InnoVet-AMR is aimed at reducing the emerging risk that antimicrobial resistance (AMR) in animals poses to global health and food security.

The initiative responds to a need identified by the international scientific and development communities. It is supported with high-level policy processes, including the UN political declaration on AMR (2016), G7/20, Global Health Security Agenda and Action Plan, as well as Global Action Plans of the World Health Assembly and the World Organization for Animal Health

InnoVet-AMR will fund research to develop new animal vaccines and other innovations to fight AMR in livestock and aquaculture production, particularly in LMICs.

102 https://cordis.europa.eu/project/rcn/218068/factsheet/en
103 https://disarmproject.eu/
104 https://www.idrc.ca/en/initiative/innovet-amr-innovative-veterinary-solutions-antimicrobial-resistance

UN Interagency Coordination Group on Antimicrobial Resistance (IACG)[105,106]

The September 2016 Political Declaration of the High-level Meeting on Antimicrobial Resistance (Resolution A/RES/71/3) called for the establishment of the Interagency Coordination Group on Antimicrobial Resistance (IACG), in consultation with the World Health Organization (WHO), the Food and Agriculture Organization (FAO), and the World Organisation for Animal Health (OIE). The IACG's mandate is to provide practical guidance for approaches needed to ensure sustained effective global action to address antimicrobial resistance; and to report back to the UN Secretary-General in 2019. They recently produced a Strategic Framework for collaboration on antimicrobial resistance[107]. The IACG Secretariat is hosted by WHO, with contributions from FAO and OIE.

CGIAR and Denmark Partner in the Fight against Antimicrobial Resistance – CGIAR AMR Hub[108,109]

CGIAR, the world's largest global agricultural innovation network, and the Government of Denmark have signed a Memorandum of Understanding (MoU) to cooperate on contributing interdisciplinary solutions to antimicrobial resistance (AMR). This partnership aims to provide evidence and research on AMR and support the development and implementation of context-specific solutions for AMR elimination with a particular focus on low- and middle-income countries as the prevalence of drug resistance generally is higher in these countries than in most industrialized countries.

This portfolio of global research programs includes grants focusing on antimicrobial use and on AMR emergence in risk hot spots characterized through close interactions of people, animals, and environment (One Health). LIVESTOCK and A4NH contribute to research on the complex pathways of AMR. Both programs start with the use of antimicrobials in livestock and fish production, with LIVESTOCK focusing on the livestock health impacts and A4NH on the implications for human health.

NeoGiANT – The power of grape extracts: antimicrobial and antioxidant properties to prevent the use of antibiotics in farmed animals[110]

October 2021-September 2025

NeoGiANT is an innovative action coordinated by the University of Santiago de Compostela (Spain). NeoGiANT aims at developing a new set of products (animal feed, treatment products, sperm extenders) able to decrease the use of antibiotics on farmed animals and substitute synthetic preservatives. These new products, based on natural extracts, using an advanced isolation technique, will not only avoid the growth of microorganisms but also improve the health and welfare of the animals increasing profitability.

105 https://www.un.org/sg/en/content/sg/personnel-appointments/2017-03-17/interagency-coordination-group-antimicrobial-resistance
106 https://www.woah.org/en/what-we-do/global-initiatives/antimicrobial-resistance/#ui-id-5
107 https://www.woah.org/app/uploads/2022/04/9789240045408-eng.pdf
108 https://www.cgiar.org/news-events/news/cgiar-denmark-partner-fight-antimicrobial-resistance/
109 https://amr.cgiar.org/
110 https://cordis.europa.eu/project/id/101036768

ROADMAP – Rethinking Of Antimicrobial Decision-systems in the Management of Animal Production[111,112]

June 2019-May 2023

The European project ROADMAP fosters transitions towards prudent antimicrobial use (AMU) in animal production and sets up innovative approaches within a transdisciplinary and multi-actor perspective to engage with animal health professionals, stakeholders and policymakers. It analyses the socio-economic drivers of AMU, develops tailored strategies for change and proposes transition scenarios in diverse farm animal production systems in Europe and low- and middle-income countries.

A cost-effective solution for controlling Salmonella and Escherichia coli in poultry production[113]

The Phagovet project is devised to satisfy market demand for a more secure and reliable solution to control Salmonella and E. coli infections in poultry farms. With more than 40,000 poultry farms, the European Union (EU-28) is the forth world´s top producers in poultry meat (13.1 million tons, 2014) and the second largest egg producer (>11 million tons, 2014). The European poultry industry employs 302,000 staff across Europe and has an annual turnover of €30 B, being then of significant economic importance. To date, avian colibacillosis and salmonellosis are considered the main bacterial infections in the poultry sector having an important economic impact worldwide. Furthermore, EFSA estimated overall economic burden of human salmonellosis at €3B/year. Finally, the overuse of antibiotic in farming has caused a rise in antimicrobial resistance 700,000 people die annually from drug resistant infections and it is estimated that this number will rise to 10 million by 2050. In response to the unmet need, Phagovet proposes a cost-effective alternative to antibiotics against Salmonella and E. coli. Phagovet consists of a biocide and two technological food additive products based on selected bacteriophages able to kill the target bacteria. Phagovet will be the first phage-based solution to naturally and effectively control both bacteria in poultry production while avoiding side effects and residues associated to antibiotic use. It will reduce Sallmonella infections by 20% and reduce the use of antibiotics on E. coli by 50%. Thus, Phagovet provides a promising effective control measure for a concerning problem for poultry farmers and for human health. The successful market launch of Phagovet will enable members of the Consortium to consolidate their position in the Animal Health, Food Safety and Environmental Control markets and commercialize the product worldwide, reaching €17.76M profit at the end of 2026.

111 https://cordis.europa.eu/project/id/817626
112 https://www.roadmap-h2020.eu/
113 https://cordis.europa.eu/project/rcn/218055/factsheet/en

Holoruminant – Understanding microbiomes of the ruminant holobiont[114,115]

October 2021-September 2026

Holoruminant is a multi-actor project aiming to elucidate the role of ruminant-associated microbiomes and their interplay with the host animal in early life and throughout fundamental life events (e.g. weaning, feed transitions and lactation) that are known to affect health, welfare and environmental efficiency in ruminant production systems. The main outputs of the project will be the creation of an expandable benchmark dataset of ruminant-associated microbes, microbiomes and methods for analysis that will be used for answering essential (who, what, where and when) scientific questions and will be the knowledge foundation for innovation.

BM-FARM – Biomarkers and Microbiome in Farms for Antimicrobial Resistance Management[116]

February 2021 – January 2024

Project BM-FARM includes extensive expertise in the area of prudent AMU and has identified two areas that need further research. The first area is the use of biomarkers (molecules to study the physiological status of the animal) and the second area is the use of new molecular technologies to manage microbial populations in farms. Altogether, BM-FARM includes expertise and ambition to not only understand disease and reduce AMU but ultimately maximize the reduction of multi-resistant bacteria.

114 https://cordis.europa.eu/project/id/101000213

115 https://holoruminant.eu/

116 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/biomarkers-and-microbiome-in-farms-for-antimicrobial-resistance-management

One Health (including food-borne pathogens)

EJP One Health[117]

Promoting One Health in Europe through joint actions on foodborne zoonoses, antimicrobial resistance and emerging microbiological hazards.

The aim of the One Health EJP is to create a sustainable European One Health framework by integration and alignment of medical, veterinary and food institutes through joint programming of research agendas matching the needs of European and national policy makers and stakeholders. In the Netherlands these organisations are already collaborating closely to counteract the threat of emerging zoonoses and antimicrobial resistance. The Dutch One Health approach can now also be deployed at EU level.

MED-VET-NET – A Network of Excellence on Foodborne Zoonoses[118,119]

MED-VET-NET is a Network of Excellence that aims to consolidate, at European level, expertise in veterinary sciences, public health and research on food, so as to strengthen the prevention and control of zoonoses, including those transmitted by food.

It is 15 member institutions, half in the veterinary field and half in public health, represent ten different countries, and are coordinated by ANSES. As a European project selected by the European Commission in 2003, Med-Vet-Net received significant funding under the 6th European Framework Programme for Research & Technological Development (FP6) for the period 2004-2009. In 2010 Med-Vet-Net became a non-profit Association under the French Act of 1901, which has established a legal framework enabling it to pursue its activities at European level.

European Food- and Waterborne Diseases and Zoonoses Network (FWD-Net)[120]

In 2007, the EU-funded dedicated surveillance network for enteric pathogens – *Salmonella*, *E. coli* and *Campylobacter* (Enter-net) was transferred to ECDC from the Health Protection Agency in the United Kingdom. Subsequently, the scope of the disease network was broadened to cover 21 food- and waterborne diseases and zoonoses, and nomination of disease experts followed the ECDC policy on Coordinating Competent Body (CCB).

FWD-Net also collaborates with partners, such as European Food Safety Authority (EFSA), World Health Organisation, relevant European Union Reference Laboratories and public health authorities of non-EU countries, e.g. US CDC. Furthermore, ECDC is actively collaborating with PulseNet International, the global network of public health laboratory networks, to ensure comparability of data and linkage to the global public health community.

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117 https://www.era-learn.eu/network-information/networks/one-health-ejp
118 https://www.anses.fr/en/content/med-vet-net
119 http://www.medvetnet.org/
120 https://ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/fwd-net

Epizone[121]

Epizone European Research Group is the international network of veterinary research institutes working on epizootic animal diseases including those which may have zoonotic potential. It plays a key role in research on prevention, detection and control of animal diseases and zoonoses in order to reduce the risks and harm to animal health and the risks to public health in the EU and beyond.

One Health Global Network (OHGN)[122]

The One Health Global Network aims at facilitating coordination and providing linkages; offering a global geographic dimension and optimal complementarity between initiatives.

One Health Regional Network (HORN)[123]

HORN, funded by UK Research and Innovation (UKRI) and the Global Challenges Research Fund, is a multidisciplinary, international partnership of the following organisations: the University of Liverpool, and Liverpool School of Tropical Medicine, United Kingdom; University of Nairobi, and International Livestock Research Institute, Kenya; University of Addis Ababa, and the International Livestock Research Institute, Ethiopia; iGAD Sheikh Technical Veterinary School, Somaliland; Hamelmalo Agricultural College, Eritrea; and other national and international organisations and NGO's.

HORN's mission is to improve the health and wealth of the people of the Horn of Africa by developing a One Health Regional Network – a network of individuals and organisations across the Horn of Africa – that can undertake high quality research into the link between people's health and wealth and that of livestock and the environment.

Global Challenges Research Fund One Health Poultry Hub[124]

Funded by the Global Challenges Research Fund1 (GCRF) of UK Research and Innovation (UKRI), this interdisciplinary Hub will address the need to meet rising demand for poultry meat and eggs in developing countries, while minimising risk to international public health. Population growth is driving continually increasing demand for poultry meat and egg production. However, rapid intensification creates conditions for diseases to emerge and spill over to people ('zoonoses'). These include bacterial food poisoning and strains of avian influenza with epidemic or pandemic potential. Increased antimicrobial resistance due to misuse of antibiotics in poultry farming is also a major global threat. The need for safe, sustainable poultry production is most urgent in South and Southeast Asia and the GCRF One Health Poultry Hub will work in Bangladesh, India, Sri Lanka and Vietnam. The Hub is led by the Royal Veterinary College (RVC), London, and comprises partners in Asia, Australia, Europe and the UK. The Hub brings teams of laboratory, clinical, veterinary and social scientists together to take a 'One Health' 4 approach to the challenge of providing safe, secure food. It will investigate how and why intensification of poultry production increases risk of infectious disease, and will identify high-risk behaviours, process and environments. It will also test and evaluate novel interventions for disease control.

121 https://www.epizone-eu.net/en/Home/About-us.htm
122 http://www.onehealthglobal.net/
123 http://onehealthhorn.net/
124 https://www.onehealthpoultry.org/

EcoHealth Alliance[125]

It is a global environmental health non-profit organization dedicate to protecting wildlife and public Health from the emergence of disease. It is an international nonprofit dedicated to a 'One Health' approach to protecting the health of people, animals and the environment from emerging infectious diseases. The organization formed with the merger of two highly respected organizations, Wildlife Trust and the Consortium for Conservation Medicine. The urgent concern for wildlife conservation and the overall health of our planet has led EcoHealth Alliance to become an environmental science and public health leader working to prevent pandemics in global hotspot regions across the globe and to promote conservation.

Global Research Collaboration for Infectious Disease Preparedness (GLOPID-R)[126]

An alliance bringing together research funding organizations on a global scale to coordinate and facilitate an effective and rapid research of a significant outbreak of a new or re-emerging infectious disease with epidemic and pandemic potential.

Objectives of GLOPID-R include: 1. Facilitate the exchange of information; 2. Address scientific, legal, ethical and financial challenges; 3. Implement a 'One Health' approach with close cooperation between human and animal health researchers; 4. Establish a strategic agenda for research response; 5. Connect infectious disease research networks; 5. involve developing countries.

One Health Research, Education and Outreach Centre for Africa (OHRECA)[127]

Their aim is to improve the health of humans, animals and ecosystems through capacity building, strengthening of local, regional and global networks and provision of evidence-based policy advice on One Health in sub-Saharan Africa. The centre has four thematic areas: control of neglected tropical zoonotic diseases, emerging infectious diseases, food safety and informal markets, and prevention and control of antimicrobial resistance.

Connecting Organisations for Regional Disease Surveillance (CORDS)[128]

This is a One-Health initiative that is built up of 28 countries in Africa, Asia, the Middle East and Europe. Their vision is to have a world that are united against infectious disease. Currently they are aiming to help build additional networks in disease hotspots e.g. West Africa and the Indian sub-continent.

The mission of CORDS is: "To catalyse collaboration amongst regional disease surveillance networks across the world in order to improve their capacity to detect and control the spread of epidemics".

Their strategic objectives are: Improving capacity, Advancing One Health, Promoting Innovation and Building Sustainable Networks.

The below initiatives are contained within CORDS.

125 https://www.ecohealthalliance.org/about
126 https://www.glopid-r.org/
127 https://www.ilri.org/research/facilities/one-health-centre
128 https://www.cordsnetwork.org/

The Southeast European Center for Surveillance and Control of Infectious Diseases (SECID)[129]

This centre was established in 2013 with the mission to develop and support projects to monitor infectious diseases in Bosnia and Herzegovina, Bulgaria, Croatia, Macedonia, Montenegro, Moldova, Serbia, Albania, Romania, Kosovo, Israel and further afield. Their aim is to provide a coordination platform for these Southern European countries to improve their ability to respond to infectious diseases.

SECID is working with the MECIDS (Middle Eastern Consortium on Infectious Disease Surveillance) to improve surveillance, detection and response to vector-borne diseases e.g. Leishmaniasis.

Other projects from the network include surveillance and response to avian and pandemic influenza, this project was supported by the WHO (World Health Organisation) and the CDC (Centres for Disease Control and Prevention).

South African Centre for Infectious Disease Surveillance (SACIDS)[130,131]

SACIDS Foundation for One Health links academic and research institutions in DR Congo, Mozambique, South Africa, Tanzania and Zambia with research centres in high income countries. Partnerships include The University of London, The Royal Veterinary College and The London School of Hygiene and Tropical Medicine.

SACIDS objectives are: To strengthen One Health driven training, Conduct pathogen and disease dynamics research, Develop societal and ecosystems impact research and Strengthen wildlife and ecosystems health research and training

SACIDS Vision targets the impact that in Africa the health and food security and livelihoods are measurably improved through mitigation of the impact of infectious diseases and antimicrobial resistance (AMR) on humans, animals and the environment.

The East African Integrated Disease Surveillance Network (EAIDSNet)[132,133]

The East African Integrated Disease Surveillance Network or EAIDSNet is a collaborative, intergovernmental initiative between the National Ministries for human and animal health and the National health research and academic institutions of Burundi, Kenya, Rwanda, South Sudan, Tanzania and Uganda.

The main objectives of the initiative are to:

1. Enhance and strengthen cross-country and cross-institutional collaboration through regional coordination of activities for the prevention and control of both human and animal (zoonotic) diseases under the “One Health” Initiative.
2. Promote exchange and dissemination of appropriate information on Integrated Disease Surveillance and other disease control activities.
3. Harmonise integrated disease surveillance systems in the region.
4. Strenghen capacity for implementing integrated disease surveillance and control activities.
5. Ensure continuous exchange of expertise and best practices for integrated disease surveillance and control.

129 https://www.cordsnetwork.org/networks/secid/
130 https://www.cordsnetwork.org/networks/sacids/
131 http://www.sacids.org/
132 https://www.cordsnetwork.org/networks/eaidsnet/
133 https://www.eac.int/health/disease-prevention/east-african-integrated-disease-surveillance-network

UN Interagency Coordination Group on One health

The four international agencies, the Food and Agriculture Organization of the United Nations (FAO), the World Organisation for Animal Health (WOAH), the UN Environment Programme (UNEP) and the World Health Organization (WHO), have signed a groundbreaking agreement to strengthen cooperation to sustainably balance and optimize the health of humans, animals, plants and the environment.

On 17 March 2022, the heads of the four organizations – QU Dongyu, the Director-General of FAO, Monique Eloit, the Director-General of WOAH, Inger Anderson, the Executive Director of UNEP, and Tedros Adhanom Ghebreyesus, the Director-General of WHO -signed a Memorandum of Understanding (MoU)[134] for joint One Health works, by which UNEP joined the former Tripartite (FAO, WOAH and WHO) as an equal partner to form a new Quadripartite Collaboration for One Health.

The new Quadripartite MoU provides a legal and formal framework for the four organizations to tackle the challenges at the human, animal, plant and ecosystem interface using a more integrated and coordinated approach. This framework will also contribute to reinforce national and regional health systems and services.

134 https://www.woah.org/app/uploads/2022/05/mou-fao-oie-who-unep-signed-final.pdf

Pox Virus

Addressing the dual emerging threats of African swine fever and lumpy skin disease in Europe (Defend)[135]

The DEFEND consortium will target two viral diseases of livestock which are emerging into Europe – African swine fever (ASF) and lumpy skin disease (LSD).
African swine fever virus (ASFV) is the causative agent of ASF, a highly contagious disease of domestic pigs which causes a haemorrhagic syndrome with up to 100% mortality. ASF is endemic in sub-Saharan Africa and on the Italian island of Sardinia. In 2007 the disease was reported in Georgia. Since then, it has spread to Russia, Ukraine, Poland and neighbouring countries. In 2017 outbreaks were reported in the Czech Republic and Romania. Wild boar are susceptible to ASFV and facilitate the continuing spread of the disease in Europe with regular spill-over into in-contact domestic pigs.

The capripoxvirus Lumpy Skin Disease virus (LSDV) causes a classic systemic poxvirus disease in cattle and spreads rapidly in warm humid conditions, most likely due to insect-borne transmission. LSDV entered Europe, the Balkans and Caucasus for the first time in 2015. The ongoing epidemic has caused the deaths of thousands of cattle through mortality and eradication campaigns.

ASFV and LSDV represent an immediate and serious threat to the pig and cattle industries in Europe and eastern and central Asia. The aim of the consortium is to control the growing LSD and ASF epidemics in Europe and neighbouring countries by understanding the drivers of LSDV and ASFV emergence and generating research outputs which underpin novel diagnostic tools and vaccines and authenticate appropriate and rapid responses by decision-makers. A multi-actor approach will be incorporated as a central tenant of the project, with collaborations between experts from academia, industry, and government bodies including EU and non-EU partners from countries affected or threatened by ASF and LSD.

R&D Blueprint: Monkeypox[136]

The R&D Blueprint is a global strategy and preparedness plan that allows the rapid activation of research and development activities during epidemics. Its aim is to fast-track the availability of effective tests, vaccines and medicines that can be used to save lives and avert large scale crises.

In 2022 R&D Target Product Profile (TPP) for monkeypox[137] was developed through a consultation process with key stakeholders in human and animal health, scientific, funding and manufacturing communities. It is intended to guide and prioritize the evaluation of repurposed therapeutic agents for Monkeypox or the development of new therapeutic agents.

135 https://defend2020.eu/about-us/

136 https://www.who.int/teams/blueprint/monkeypox

137 https://cdn.who.int/media/docs/default-source/blue-print/who_rd-blueprint_tpp_monkeypox-therapeutics_final-draft.pdf?sfvrsn=6652f120_3&download=true

Rift Valley Fever

Coinfection with Rift Valley Fever virus, Brucella spp. and Coxiella burnetii in humans and animals in Kenya: Disease burden and ecological factors – International Livestock Research Institute[138]

Sept 2019- Aug 2022

The project will analyse existing samples and carry out active surveillance to determine the burden of Rift Valley fever, brucellosis and Q fever and their co-infections in humans, livestock and wildlife in Kenya. It will be implemented in the pastoral counties of Garissa, Isiolo, Mandera, Marsabit and Wajir.

138 https://www.ilri.org/research/projects/co-infection-rift-valley-fever-virus-brucella-spp-and-coxiella-burnetii-humans-and

Vaccinology

International Veterinary Vaccinology Network (IVVN)[139]

To establish a network of UK and LMIC-based researchers that could form collaborations to address the challenges that are impeding vaccine development for major livestock and zoonotic diseases affecting agriculture in LMICs. This includes all species that are of agricultural significance in LMICs including (but not limited to) poultry, aquaculture, ruminants and swine with an emphasis on molecular and cellular biology work relevant to vaccine development. Key aims of the Network are to bring together partners from academia, industry and other sectors.

The BactiVac Network[140]

The BactiVac network was established in August 2017 following the award of £2.2m funding under the MRC's GCRF Networks in Vaccines Research and Development initiative.

This funding will support the establishment of a global bacterial vaccinology network, BactiVac, to accelerate the development of vaccines against bacterial infections relevant to low and middle-income countries (LMICs). The BactiVac network will deliver this through catalyst project and training awards to encourage cross-collaboration between academic and industrial partners in developed and developing nations.

Zoonoses Anticipation and Preparedness Initiative (ZAPI)[141]

Part of the IMI public-private partnership, aims to enable swift response to major new infectious disease threats in Europe and throughout the world by designing new manufacturing processes (up to large scale) for delivering effective control tools against (re)-emerging zoonotic diseases with pandemic potential within a few months after the occurrence of first cases. (End date: 01/03/2020).

AfvaNet

An initiative started to stimulate vaccine research in Africa with the following goals

- Bring together all stakeholders in vaccinology and related sciences in Africa;
- Identify and prioritise vaccine gaps in Africa;
- Promote vaccine research and development in Africa; and
- Promote sound ethics, biosafety and biosecurity in Africa.

139 https://www.intvetvaccnet.co.uk/
140 https://www.birmingham.ac.uk/research/activity/immunology-immunotherapy/research/bactivac/index.aspx
141 www.zapi-imi.eu

US Animal Vaccinology Research Coordination Network[142]

Vaccines remain the greatest tool for the control of current and emerging infectious disease threats to animal agriculture, and efficient development of improved vaccines will prove critical for a biotechnologically advancing, globalizing, and resource-stretched world. We propose to create the U.S. Vaccinology Research Coordination Network, comprised of academic, government, and corporate vaccine researchers, who will be brought together on a formal basis to identify current and future vaccine needs and opportunities in the US, and to collaboratively set broad goals and priorities for addressing them. We will leverage current and future research at multidisciplinary member institutions of the U.S. Vaccinology Research Coordination Network to develop next generation, safe and efficacious vaccines, and in doing so consolidating technologies and programs toward a common purpose, quickly gathering and disseminating information from within and across the network, and ultimately developing integrated strategies based on the collective data of the network partners.

European Network of Vaccine Research and Development (TRANSVAC2)[143]

TRANSVAC2 builds upon the success of TRANSVAC, the European Network of Vaccine Research and Development funded under the EC´s previous Framework Programme (FP7). TRANSVAC made significant contributions to the European vaccine development landscape, providing scientific-technical services to more than 29 vaccine projects and developing a roadmap for the establishment of a sustainable European vaccine R&D.

TRANSVAC2 will support innovation for both prophylactic and therapeutic vaccine development. High-quality technical services across four different service platforms will be offered: Technology (for process development and GMP production), Immunocorrelates & Systems Biology, Animal models, and support for Clinical Trials. Academic and non-academic research groups, including SMEs, can apply to benefit from the expertise, reagents, and facilities offered by TRANSVAC2 to accelerate the development of their vaccines. The call for applications is planned to be launched in October 2017. TRANSVAC2 will further accelerate vaccine development by applying cutting-edge technologies to address critical issues in modern vaccine development and thereby increase the quality of services provided. Additionally, TRANSVAC2 will continue the efforts to establish a sustainable vaccine development infrastructure in Europe. (May 2017 – May 2022)

Flanders Vaccine[144]

Flanders Vaccine is a non-profit, strategy-driven platform for academic, industrial and public stakeholders with relevant expertise in human and animal immunotherapeutics and vaccines. Flanders Vaccine brings together universities, public and private hospitals, research centres, SMEs, pharma, competence providers, patient organisations, and government bodies to develop novel immunological health solutions and the vaccines of the future.

Flanders Vaccine supports the development of immunotherapeutics and vaccines for both prophylactic and therapeutic targets in humans and animals by facilitating the exchange of know-how and complementary innovative technologies between academia and industry. The Flanders Vaccine platform can be seen as an integrated tool that gives rise to more and better partnerships.

142 http://cag.uconn.edu/pvs/usanimalvaccinenetwork/topics.php
143 http://www.euvaccine.eu/portfolio/project-index/transvac2
144 http://flandersvaccine.be/

US Veterinary Immune Reagent Network[145,146]

A major obstacle to advances in veterinary immunology and disease control is the lack of sufficient immunological reagents specific for ruminants, swine, poultry, equine, and aquaculture species. A broad community plan to begin to systematically address the immunological reagent gap has been initiated with a goal of 20 reagents per species group. The reagents produced will include bioactive recombinant cytokines and chemokine proteins (expressed using mammalian cells, Pichia pastoris or E. coli systems) as well as polyclonal Ab and mAb to them, their receptors, as well as mAb to Ig isotypes, T cell receptors (TCR), Toll like receptors (TLR), and other CD molecules. Our goal is to produce antibodies that function in Elisa and ELISpot assays, for intracellular staining, for blocking function and signalling, and that are useful in flow cytometric applications as well as in fixed tissue sections. Products developed in this proposal will benefit a large group of researchers, including veterinary immunologists, pathologists, and microbiologists.

The Immunological Toolbox[147]

The website that provides a platform for veterinary researchers to find resources and collaborate. The Toolbox aims to remove barriers to veterinary vaccine development by providing a central database of reagents and aiding information exchange. The website is home to the most up-to-date and comprehensive repository of antibodies and modified proteins available from commercial companies and academic institutes. It details over 1,600 immortalised cell lines that produce well-characterised antibodies against cattle, chicken, pig, sheep, goat, horse and fish molecules. Researchers are able to freely search the location, supply and application of these immune reagents, as well as submit requests for new reagents and antibody production.

Immuno Valley[148]

Immuno Valley match business and science to build, nurture and manage lasting partnership in human and animal health research focussing on diagnostics, prevention and treatment of inflammatory and infectious diseases in humans and animals.

Italian Network of Veterinary Immunology – RNIV[149]

RNIV in an Italian network of scientists working in different fields of veterinary sciences on both farm animals and pets. That want to adopt an immunological approach to diverse issues of animal health and welfare. This way, veterinary immunologists share expertise with other research workers also at international level to achieve complementation and synergism in research projects.

American Association of Veterinary Immunologists[150]

The American Association of Veterinary Immunologists (AAVI) is dedicated to the development, promotion, and dissemination of knowledge in veterinary immunology. This includes immunology of livestock and poultry, companion animals, fish and marine mammals. The AAVI was formed in 1979 by a group of veterinary immunologists assembled at the annual Conference of Research Workers in Animal Diseases (CRWAD). The AAVI is open to all veterinary immunologists internationally. The AAVI holds an annual business and scientific meeting in conjunction with CRWAD each year as well as an annual symposium in conjunction with the American Association of Immunologists (AAI).

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145 http://www.vetimm.org/
146 https://wagnerlab.vet.cornell.edu/research/us-veterinary-immune-reagent-network.html
147 https://www.immunologicaltoolbox.co.uk/
148 http://www.immunovalley.nl/
149 www.immvet.it
150 http://www.theaavi.org/about.htm

International Union of Immunological Societies (IUIS)[151]

IUIS is an umbrella organisation for many of the regional and national societies of immunology throughout the world. The objectives of IUIS are:

- To organise international co-operation in immunology and to promote communication between the various branches of immunology and allied subjects
- To encourage within each scientifically independent territory co-operation between the Societies that represent the interests of immunology
- To contribute to the advancement of immunology in all its aspects.

There are currently 73 Member Societies of IUIS, many of which belong to one of the four Regional Federations encompassing Europe, Latin America, Africa and Asia-Oceania.

International Congresses of Immunology are held every three years under the auspices of IUIS. IUIS also contributes to the staging of regular congresses and conferences by each of the four Regional Federations.

IUIS Veterinary Immunology Committee (VIC)[152,153]

VIC promotes and coordinates the interests of the international immunology community. It is composed of 14 veterinary immunologists, co-opted with the aim of achieving equitable representation for different regions of the world. As a scientific discipline, veterinary immunology traverses topics ranging from fundamental studies on how the immune system functions to more applied areas such as production of vaccines and clinical applications of immunology.

The British Society of Immunology (BSI)[154]

The BSI's main objective is to promote and support excellence in research, scholarship and clinical practice in immunology for the benefit of human and animal health and welfare. The BSI seeks to help British immunology accomplish the highest possible goals. To meet this objective, the BSI undertakes the following:

- Running innovative events in research, public engagement and education
- Promoting and disseminating research and good practice in immunology, translational medicine and vaccination
- Working with its members to develop the benefits of membership and the relevance of the Society
- Providing bursaries and grants
- Enhancing public awareness of immunology
- Influencing policy and decision makers
- Working with other societies

151 http://www.iuisonline.org/index.php?option=com_content&view=frontpage&Itemid=1
152 http://www.iuisonline.org/index.php?option=com_content&view=article&id=74&Itemid=70
153 https://iuis.org/committees/vic/
154 https://www.immunology.org/about-us

vAMRes – Vaccines as a remedy for antimicrobial resistant bacterial infections[155]

November 2018 – October 2023

vAMRes propose to use new technologies to develop human monoclonal antibodies and vaccines against three AMR bacteria such as gonococcus, pneumococcus and E.coli. The technology defined as reverse vaccinology 2.0, already successful for viral infections, will be used for bacterial vaccines. Taking advantage of the recent possibility of high throughput cloning of human B cells from convalescent or vaccinated people we aim to find targets difficult or impossible to be discovered using conventional technologies. B cells will be cloned from people convalescent from target infections and from people vaccinated with Men B vaccine which confers some protection against gonococcus. The antibodies produced by the clones will be screened for their ability to bind, intoxicate or kill bacteria using a novel high-throughput microscopy platform that rapidly captures digital images and also with conventional, lower throughput technologies such as bactericidal, opsono-phagocytosis and FACS assays. The selected antibodies will be expressed as full length and used for passive immunization in animal models and tested for protection in vivo. Finally, those antibodies that will provide the best protection in the above assays, will be used to identify the recognized antigens. Selected antigens will be expressed and tested in vaccine formulations. Fab fragments can be used to make co-crystals with the antigen and determine the crystal structure of the new antigens, for the development of structure-based antigen design. In conclusion we expect to enable development of human monoclonal antibodies and vaccines against AMR.

Coalition for Epidemic Preparedness Innovations (CEPI)[156]

CEPI is a global alliance financing and coordinating the development of vaccines against infectious diseases. It was launched in Davos in 2017 to develop vaccines to stop future epidemics. CEPI's mission is to stimulate and accelerate the development of vaccines against emerging infectious diseases and enable equitable access to these vaccines for people during outbreaks.

Vaccine Safety Net (VSN)[157]

VSN is a global network of websites, verified by the World Health Organization, that provides reliable information on vaccine safety.

155 https://cordis.europa.eu/project/rcn/217960/factsheet/es
156 https://cepi.net/
157 https://www.vaccinesafetynet.org/vsn/vaccine-safety-net

The Global Vaccine and Immunization Research Forum (GVIRF)[158]

The GVIRF is a unique Forum in the field of vaccines & immunization. It is the central discussion platform of all research aspects related to the Global Vaccine Action Plan (GVAP), which was developed in the context of the Decade of Vaccines Collaboration and endorsed by the 2012 World Health Assembly. The GVIRF is co-hosted by WHO, the National Institute of Allergy and Infectious Diseases, and the Bill & Melinda Gates Foundation. Gathering leading experts from public health, academia, government, civil society and private sector, the forum is held every second year.

The overall objective of the GVIRF is to serve as a forum to:

- track progress and discuss obstacles related to priority vaccine research and development;
- identify gaps, opportunities and actions for the research and development (R&D) community in the areas of vaccines and immunization;
- create an opportunity for networking and collaboration among the vaccine R&D and immunization communities; and
- review progress towards GVAP research and development strategic objectives and goals.

NEOVACC – Novel strategies to enhance vaccine immunity in neonatal livestock[159]

March 2021 – March 2024

This project aims to test vaccine strategies designed to enhance immune responses in neonatal animals with maternally derived antibodies (MDA). They will focus on two major endemic viral diseases: bovine respiratory syncytial virus (BRSV) in cattle and porcine reproductive and respiratory syndrome virus (PRRSV) in pigs, for which the consortium has developed preliminary tools and knowledge of strategies to counteract different mechanisms of MDA interference. The project is structured with three complementary work-packages (WP): WP1: Designing BSRV immunogens to exploit differences in antibody repertoires between adult and neonatal cattle. WP2: A DNA vaccine-based approach against PRRSV to counteract MDA interference. WP3: Engineering immune checkpoint inhibitors (ICIs) to enhance neonatal responses to vaccination. The outputs from this project will directly benefit the development of improved vaccines against these two key diseases but also as a concept since the approaches may be exploited in the context of other pathogens, livestock species and humans. Project partners include the UK, France, Sweden, Switzerland and Norway.

NucNanoFish – Nucleic NanoVaccines for Fish[160]

NucNanoFish will design, produce and test DNA/mRNA nucleic acid vaccines loaded or not onto safe-by-design LipoNanoParticles (LNP). LNP are based on a PLA/PLGA (Poly-Lactic/Glycolic Acid) core surrounded with a lipid corona. To achieve this, NucNanoFish has assembled a consortium of six partners (from France, Belgium, the UK and Norway), with highly complementary expertise: one in nanodelivery of antigen and mRNA using LNP, four groups of fish immunovirologists / vaccinologists and a biotech company in DNA production. Three fist species have been selected: rainbow trout, common carp and Atlantic salmon, and four important and well-studied viruses: the Viral hemorrhagic septicemia virus (VHSV), a rhabdovirus; the Infectious pancreatic necrosis virus (IPNV), a birnavirus; the Salmonid alphavirus (SAV) and the Cyprinid herpesvirus3 (CyHV3). Then, we have identified 6 work packages

158 https://www.who.int/teams/immunization-vaccines-and-biologicals/product-and-delivery-research/the-global-vaccine-and-immunization-research-forum-(gvirf)

159 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/novel-strategies-to-enhance-vaccine-immunity-in-neonatal-livestock

160 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/nucleic-nanovaccines-for-fish

to address this innovative project: 1) Different batches of LNP with DNA or mRNA encoding reporter proteins, or viral antigens (Ag) will be produced, down selected and validated for their expression in vitro using fish cells. 2) The biodistribution of LNP-DNA / mRNA vaccines after administration by IM, oral or bath route will be characterized and their nanotoxicity evaluated. 3) The induction of immune responses (both systemic and mucosal) after administration of LNP-DNA and mRNA vaccines by IM injection will be characterized in 3 models: VHSV and IPNV in rainbow trout and CyHV3 in carp. Strength of adaptive B and T cell responses will be assessed, including in-depth analysis of endogenous type I IFN expression at site of injection. 4) Responses induced following oral vaccination (IPNV in rainbow trout and SAV in Atlantic salmon) or bath (CyHV3 in common carp) will also be characterized, both at systemic/mucosal level. In particular, the effects of diet-associated gut conditioning on LNP uptake by gut, and induction of adaptive immunity will be studied, in the SAV/salmon model. 5) Challenge models (already available in each project partners) to test the protection afforded by vaccination using relevant LNP formulations. and 6) Management Combining all data, we will develop a versatile vaccine platform to control fish health in aquaculture in a context of environmental change, and emergence of new and more virulent strains that spread in naïve populations due to global trade.

Plants4Nemavax – Plant-based production of glyco-engineered nematode vaccines[161]

Vaccination is often put forward as the most rational and cost-effective alternative to control infections with parasitic worms. In recent years it has been shown that it is possible to protect cattle and sheep against worm infections by vaccinating them with antigens isolated directly from the worms. Unfortunately, for most parasite species, this approach is unsustainable for large-scale application as it relies on infected host animals to produce the vaccines. The production of recombinant vaccines in heterologous expression systems seems the most obvious solution. However, of all the recombinantly produced subunit vaccines that were evaluated in the past, none induced sufficient levels of protection to consider further commercial development. One of the bottlenecks explaining why many vaccination trials with nematode vaccines have been unsuccessful is the inability of the expression systems to reconstitute the antigens with their native post-translational glycan modifications. Recent research has shown that the natural glycans present on the antigens can be critical in the context of vaccination as removal of the glycans from the antigens impaired the protective immune responses elicited by the vaccines. The glycans on a given protein can shape immune responses by influencing which receptors and cells of the immune system are targeted. In addition, helminth-glycoproteins carry very diverse and sometimes unique glycan structures, which can be highly immunogenic and major targets of the host's antibody responses. Therefore, reconstructing these sugar structures on recombinant nematode proteins may be key for successful vaccine development. However, bacterial expression systems are not able to perform complex glycan modifications and the glycan decorations that occur in eukaryotic expression systems, like yeast and insect cells, show little resemblance to the glycans naturally found on nematode proteins. Project partners include Belgium, the Netherlands and the UK.

161 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/plant-based-production-of-glyco-engineered-nematode-vaccines

Vector-borne Diseases

ANTI-VeC: Application of Novel Transgenic technology & inherited symbionts to Vector Control[162]

A major goal for the scientific community working on vector borne diseases is to develop novel strategies and tools for effective vector control. The network will address the challenge of better integrating these efforts, with a specific focus on two approaches widely considered to be the most promising novel strategies: genetic modification and the use of heritable endosymbionts. Both approaches require the rearing and release of insect disease vectors with the aim of suppressing their populations or blocking the transmission of pathogens. They are highly targeted, species specific strategies, which (depending on the specific form employed) may only require one short intervention phase rather than repeated applications, thus providing major advantages over insecticides in terms of environmental impact and cost effectiveness. The Network will draw together individuals from a broad range of scientific disciplines engaged in developing and deploying these approaches to foster knowledge exchange, methodological and technological sharing, and stimulate innovative collaborative research projects that will lay the foundation for new approaches or more effective implementation

The Gnatwork: building capacity for research on neglected tropical vectors[163]

The Gnatwork brings together researchers from around the world to address technical issues that arise when working on small biting flies. Biting midges, sandflies and blackflies transmit internationally important pathogens of humans, livestock and companion animals. While highly divergent in lifecycle, ecology and the pathogens they transmit, these vector groups share the similarity of extremely small adult body size, with wing lengths of <2 mm in most species. This seemingly minor trait imposes a significant constraint on almost every aspect of research within these groups. When combined with fluctuations in funding that follows disease impact, this creates a significant challenge in retaining a critical mass of researchers on each group, particularly in countries where medical and veterinary priorities change rapidly. By creating a community of scientists around the world where research is relevant to development, we can make significant progress in translating techniques across all three vector groups, develop new ones and build a more resilient research base for these neglected vector groups.

European network for sharing data on the geographic distribution of arthropod vectors, transmitting human and animal disease agents (VectorNet)[164]

It is a joint initiative of the European Food Safety Authority (EFSA) and the European Centre for Disease Prevention and Control (ECDC). VectorNet supports the collection of data on vectors and pathogens in vectors related to both animal and human health.

162 www.anti-vec.net
163 www.gnatwork.ac.uk
164 https://ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/vector-net

VectorBite Research Coordination Network[165]

The goal of the Vector Behavior in Transmission Ecology Research Coordination Network (VectorBiTE RCN) is to increase interaction between researchers in the diverse fields studying VBDs, to encourage collection and consolidation of key data, and to encourage development of analytical tools to better understand the role of vector behavior in transmission ecology.

- The RCN will meet the overall goal by pursuing four main objectives:
- The development of theoretical models that include more details of vector behavior and heterogeneity;
- Improved data collection and statistical methods to enable such models to be confronted with data;
- Development of comprehensive and freely available parameterization and validation datasets to allow testing of methods and comparison between proposed models in a transparent fashion;
- Training young researchers to apply these new tools and models as they are developed.

Medilabsecure: One Health network for the prevention of vector-borne diseases around the Mediterranean and Black Sea regions[166]

MediLabSecure is a European project (2014-2021) aiming to: Create a framework for collaboration to improve surveillance and monitoring of emerging vector borne viral diseases (arboviruses); Provide training for public health experts in participating countries to increase the communicable disease control in the Mediterranean and Black Sea region and promote knowledge development and transfer of biosafety best laboratory practices.

PALE-Blu – Understanding Pathogen, Livestock, Environment Interactions Involving Bluetougue Virus[167]

June 2019 – November 2021

New outbreaks caused by bluetongue viruses (BTVs) have emerged in European livestock every year since 1998. These events that have been linked to climate change, resulted in massive losses due to fatalities, reduced productivity, reproductive failures, restricted animal movements/trade, and surveillance/vaccination costs. PALE-Blu brings together European institutes with expertise in BTV research and diagnosis, with partners in endemic regions (Africa, the Middle East and Turkey) that act as a 'source' for BTV strains that emerge in Europe.

Full-genome sequence-analyses will increase the accuracy of BTV-strain distribution maps, to identify pathways and mechanisms for spread into and within Europe, as well as appropriate prevention strategies. PALE-Blu will analyse the genetic connectivity of Culicoides vector populations in different regions, as well as the movements of individual BTV lineages and genes. Together with reverse genetics technologies and infection/replication studies in new Culicoides cell lines, or adults from different Culicoides species, this will elucidate the genetic basis for geographic localisation/movement of BTV strains and serotypes. We will analyse differences in saliva proteins from Culicoides species, their ability to modify the BTV surface proteins (proteases) and effects on efficiency of transmission (in both directions) between vertebrae hosts and insect-vectors. These studies will provide a better understanding of incursion risks for different BTV strains, supporting effective control strategies. PALE-BLU will explore more effective and cross-serotype subunit-vaccines that are DIVA assay compatible and generate a stronger immune response from a single innoculation. We will also explore the potential for use of antiviral agents to induce immediate protection post vaccination. More effective diagnostic systems to better detect mixed infections will also be developed by multiplexing existing or novel diagnostic assay systems.

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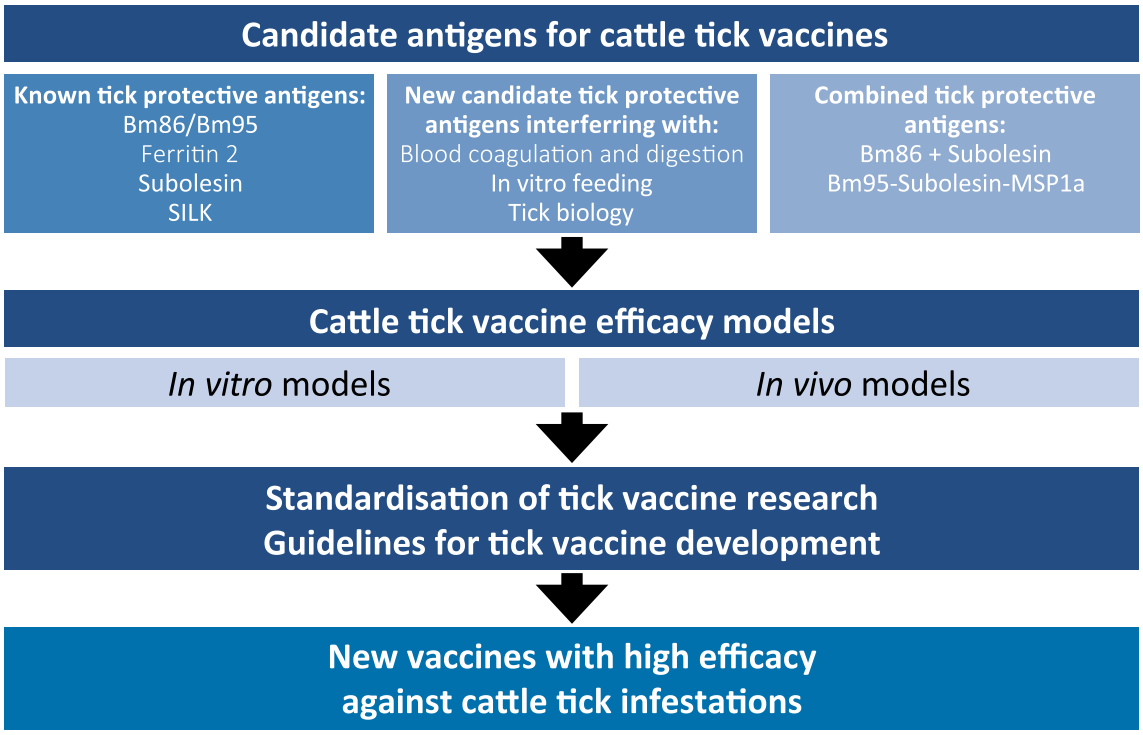
165 https://vectorbite.org/about-rcn/ourgoals/
166 http://www.medilabsecure.com/
167 https://cordis.europa.eu/project/id/727393

Cattle Tick Vaccine Consortium (CATVAC)[168]

The Cattle Tick Vaccine Consortium (CATVAC) was created at a meeting sponsored by the Bill & Melinda Gates Foundation, which was held in Morocco, 2015. The consortium is guided by a Steering Committee formed by Christine Maritz-Olivier, José de la Fuente and Theo Schetters (Chair) who will drive the project and take responsibility to realize the action points listed below:



168 https://parasitesandvectors.biomedcentral.com/articles/10.1186/s13071-016-1386-8

Infrastructure

VetBioNet – Veterinary Biocontained facility Network for excellence in animal infectious disease research and experimentation[169]

The principal aim of the VetBioNet infrastructure project is to establish and maintain a comprehensive network of pre-eminent high-containment (BSL3) research facilities, academic institutes, international organisations and industry partners that is dedicated to advance research on epizootic and zoonotic diseases and to promote technological developments

Microbial Resource Research Infrastrucutre (MIRRI)[170]

Launched in 2012, the pan-European Microbial Resource Research Infrastructure (MIRRI) is part of the BioMedical Science Research Infrastructure (BMS RI) ESFRI landscape. Currently more than 40 public biorepositories and research institutes from 19 European countries collaborate to establish MIRRI as an European Research Infrastructure Consortium (ERIC) under EU law.

The vision of MIRRI is to be a unique pan-European high-performance platform adding value to known and yet unknown microbial biodiversity and exploiting novel sources and knowledge to discover and disclose for the bioeconomy and bioscience. MIRRI will generate solutions to societal challenges by stimulating interaction between academia and bioindustry.

EVAg (European virus archive global)[171]

A unique biological resource in the field of virology. It is a non profit organisation that mobilises a global network with expertise in virology to track, collect, amplify, characterise, standardise, distribute and authenticate viruses and derived products. It is an international group of 25 laboratories including 16 EU member state institutions and 9 non-EU institutions that represent extensive range of virological disciplines.

EVA-GLOBAL – European Virus Archive GLOBAL[172]

January 2020-December 2023

This unique advanced community aims at becoming the most responsive network to improve the control of emerging or re-emerging virus outbreaks at the global level. During the past EVAg project, this infrastructure has already been able to play a key role for the control of emerging virus diseases by the supply of unique reagents for the detection of viruses under the WHO umbrella. Through this new ambitious four-year project and the new institutes joining the consortium, EVA-GLOBAL will become the largest virtual virus collection for human, animal and plant viruses will move beyond the current state-of-the-art to provide an increasingly valuable resource and service to the scientific community, including government health departments, higher education institutes, industry and to the general public as well.

169 http://www.vetbionet.eu/
170 https://www.mirri.org/
171 https://www.european-virus-archive.com/partners
172 https://cordis.europa.eu/project/id/871029

Emerging Viral Diseases- Expert Laboratory Network (EVD-LabNet)[173,174]

The EVD-LabNet (Emerging Viral Diseases-Expert Laboratory Network) is a European Network of Expert Laboratories supporting ECDC for early detection and surveillance of (re)emerging viral diseases in the EU/EEA, and for providing scientific advice.

This network is a follow-up of the Network for diagnostics of "imported" viral diseases (ENIVD) collaborative action. The EVD-LabNet provides support to EU Member States, EEA countries and EU Candidate Countries in the following areas:

- Identifying (early detection and surveillance) and assessing current and emerging threats to human health from communicable diseases, in particular (re-emerging) vector-borne and other viral infectious diseases. The network contributes to coordinated investigation and scientific expert interpretation.
- Conducting External Quality Assessment (EQA) on viral pathogens covered by the ECDC Emerging and Vector-borne Diseases programme.
- Providing short training courses and workshops to improve the diagnostic capability of EU expert laboratories.

The EVD-LabNet is coordinated by Erasmus University Medical Centre with the support of a management team and a scientific advisory board composed of experts from 11 laboratories from 9 EU countries. It works in close collaboration with other European networks involved in emerging infectious disease preparedness and response.

Infravec2 – Research Infrastructures for the control of vector-borne diseases[175,176]

February 2017 – June 2022

The overall objective of the Infravec2 project is to integrate key specialized research facilities necessary for research excellence in insect vector biology, to open the infrastructure for access by researchers, and to develop new vector control measures targeting the greatest threats to human health and animal industries. Insect vectors transmit parasitic diseases such as malaria and leishmaniasis, and viral infections such as chikungunya, dengue, Zika, Japanese encephalitis and yellow fever. The 24 consortium partners hold the major European biosecure insectaries for experimental infection and containment of insect vectors under Containment Level 2 and 3 (CL2/CL3) conditions, other key insect vector facilities, and include front-line field sites in Africa, the Pacific, and the Americas. Infravec2 will improve the exploitation of European vector infrastructures for research and public health and will develop other innovative methodologies and technologies.

173 https://www.evd-labnet.eu/
174 https://www.ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/evd-labnet
175 https://infravec2.eu/
176 https://cordis.europa.eu/project/id/731060

Collaborating Veterinary Laboratories CoVetLab[177]

CoVetLab is a partnership of national veterinary public health institutes from Denmark, France, The Netherlands, Sweden and the United Kingdom.

All the members of CoVetLab carry out research and surveillance and act as national and international reference laboratories for various animal diseases. Together they advance high quality veterinary science by the dissemination of knowledge, sharing of experience and the transfer of skills and technology to safeguard animal and public health.

EUCAST Network Laboratories[178,179]

The EUCAST Network Laboratories form two separate loosely constructed networks of microbiology laboratories with particular expertise and training in EUCAST Antimicrobial Susceptibility Testing (AST) for bacteria and EUCAST Antifungal Susceptibility Testing (AFST) methods, respectively.

EUCAST Network Laboratories are committed to help develop, validate and troubleshoot EUCAST AST/AFST methods and/or to help train and educate other laboratories in EUCAST methods. These laboratories will also play an important role in the development of improved methods and/or assist clinical breakpoint development by providing species-specific MIC datasets.

National Animal Health Laboratory Network (NAHLN)[180]

A nationally coordinated network and partnership of Federal, State, and university-associated animal health laboratories. Aims to develop and increase the capabilities and capacities of a national veterinary diagnostic laboratory network to support early detection, rapid response, and appropriate recovery from high-consequence animal diseases.

Pacific Animal Health Laboratory Network (PAHLNet)[181]

A group of animal health laboratories in the Pacific region, organised through the Pacific Regional Influenza Pandemic Preparedness Project (PRIPPP), to work together and ensure early detection of infectious animal diseases.

177 http://www.covetlab.org/

178 http://www.eucast.org/fileadmin/src/media/PDFs/EUCAST_files/Network_labs/EUCAST_Network_Laboratories_April_2016.pdf

179 https://www.eucast.org/

180 https://www.aphis.usda.gov/aphis/ourfocus/animalhealth/sa_lab_information_services/sa_nahln/ct_national_animal_health_laboratory_network

181 https://lrd.spc.int/information-and-networks/pahlnet

Technologies

AgResults – Innovation in Research and Delivery[182]

AgResults is a $122 million multi-donor, multi-lateral initiative incentivizing and rewarding high-impact agricultural innovations that promote global food security, health, and nutrition through the design and implementation of pull mechanism pilots.

AgResults originated at the June 2010 G20 Summit in Toronto, when a group of G20 leaders committed to explore innovative, results-based methods of leveraging private sector innovation to increase agricultural productivity and food security in developing countries. Two years later, at the G20 Summit in Los Cabos Mexico, the governments of Australia, Canada, the United Kingdom, and the United States, in partnership with the Bill & Melinda Gates Foundation pledged $118 million to establish AgResults through a Financial Intermediary Fund operated by the World Bank. In 2016, the Department of the Foreign Affairs and Trade (DFAT) in Australia, pledged an additional US $4 million, making the total AgResults Fund $122 million.

The objectives of AgResults are to:

1. Overcome market failures impeding agricultural innovations by offering results-based economic incentives (known as “pull” mechanisms) to competing private actors for the adoption of new agricultural technologies; and to
2. Test the effectiveness and efficiency of pull financing in comparison with traditional approaches to the promotion and adoption of innovative agricultural technologies.

Pilot Thematic Groups

- Inputs Increasing Yields
- Outputs Post-Harvest Management
- Livestock
- Nutrition

AFarCloud – Aggregate farming in the Cloud[183]

September 2018 – November 2021

Farming is facing many economic challenges in terms of productivity and cost-effectiveness, as well as an increasing labour shortage partly due to depopulation of rural areas. Furthermore, reliable detection, accurate identification and proper quantification of pathogens and other factors affecting both plant and animal health, are critical to be kept under control in order to reduce economic expenditures, trade disruptions and even human health risks.

AFarCloud will provide a distributed platform for autonomous farming that will allow the integration and cooperation of agriculture Cyber Physical Systems in real-time in order to increase efficiency, productivity, animal health, food quality and reduce farm labour costs. This platform will be integrated with farm management software and will support monitoring and decision-making solutions based on big data and real time data mining techniques.

The AFarCloud project also aims to make farming robots accessible to more users by enabling farming vehicles to work in a cooperative mesh, thus opening up new applications and ensuring re-usability, as heterogeneous standard vehicles can combine their capabilities in order to lift farmer revenue and reduce labour costs.

The achievements from AFarCloud will be demonstrated in 3 holistic demonstrators (Finland, Spain and Italy), including cropping and livestock management scenarios and 8 local demonstrators (Latvia,

182 http://agresults.org/index.php
183 https://cordis.europa.eu/project/rcn/216117/factsheet/en

Sweden, Spain and Czech Republic) in order to test specific functionalities and validate project results in relevant environments located in different European regions.

AFarCloud outcomes will strengthen partners' market position boosting their innovation capacity and addressing industrial needs both at EU and international levels. The consortium represents the whole ICT-based farming solutions' value chain, including all key actors needed for the development, demonstration and future market uptake of the precision farming framework targeted in the project.

SWINOSTICS – Swine diseases field diagnostics toolbox [184]

November 2017 – October 2021

SWINOSTICS is a European project, funded within the framework of EU's Horizon 2020 Programme. The project is coordinated by CyRIC, Cyprus Research and Innovation Center Ltd and will run for three and a half years, to allow enough time for the development and real-world validation of the technology.

The main aim is to develop a device for early, field-based, detection of important swine diseases (ASFV, PRRSV, H1N1, PPV, PCV2 and CSF). The device will use swine oral fluid samples as its main input, even though, it will be compatible with the use of other types of samples, such as faeces, blood or nasal swabs.

TechPepCon – Use of frontline technologies to screen pathogens, environment and pigs for a better disease control in swine herds[185]

March 2021 – February 2024

Very important gaps in the world-wide control of viral infections are difficulties to (1) recognize diseases at an early stage, (2) identify pathogens and pathogen complexes in a fast way and (3) convince farmers on the importance of a good biosecurity. In the past, these problems could not be solved due to technical limitations. Due to technical revolutions in recent years, these gaps can be filled. TechPepCon will use novel technologies to give an answer to these problems. (1) A fast detection of clinical signs will be performed by sensors that record environmental conditions and animal physiological conditions (commercially available, Healthy Climate Monitor) (2) A quick identification of pathogens will be performed. (3) A risk-based biosecurity scoring system will be used to determine the level of biosecurity at pig herds in an accurate and repeatable measure.

In WP1, the pathogen circulation and hidden problems will be identified in a longitudinal study on 'healthy' farms with the new sensor combined with the new diagnostic nanopore platform. Combined with a biosecurity check, the biosecurity level can be improved. In WP2, it will be examined during a clinical outbreak, which pathogens are involved using the new diagnostic nanopore platform. The clinical signs will be recorded with the new sensor. From the results, certain clinical pictures will be linked with the infection of certain pathogens or complexes. This will lead to pathogen-based treatments and preventions. In WP3, the new viral and bacterial genotypes and complexes from WP1 and WP2 will be further characterized genetically. Upon experimental infections of two new viral genotypes, the clinical outcome will be clarified. In WP4, a spatio-temporal follow-up of viral endemics and epidemics in veterinary medicine will be installed as a rapid alert and security system for swine industry.

The project will end up with fully functional service laboratories that will use the frontline technology for routine diagnostics and support of farmers. The knowledge will be spread afterwards to other interested European laboratories. The spatio-temporal follow-up of viral endemics and epidemics will be much appreciated by farmers, veterinarians, decision makers and pharmaceutical companies. Partners in the consortium are Belgium, Italy, Poland, Greece, Russia and Hungary.

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184 http://swinostics.eu/

185 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/use-of-frontline-technologies-to-screen-pathogens-environment-and-pigs-for-a-better-disease-control-in-swine-herds

Other Networks

SCAR Collaborative Working Group – Animal Health and Welfare[186]

The Collaborative Working Group on European Animal Health & Welfare Research (CWG) was formed in response to an initiative of the EU Standing Committee on Agricultural Research (SCAR). It includes 28 partners from 20 countries. The goal is to establish a durable and focused network of research funders from Member and Associated States of the EU – providing a forum leading to improved collaboration on research prioritisation and procurement, creating the necessary critical mass and focus to deliver the animal health and welfare research needs of our policy makers and the European livestock industry.

CWG Objectives:

- Share information on research projects
- Coordinate research activities
- Work towards a common research agenda
- Work towards mutual research funding activities, in the field of animal health, fish health and those conditions which pose a threat to human health

Other activities include mapping the landscape in relation to provisions of research facilities, including expertise and micro-organism collection.

Animal Health and GHG Emissions Intensity Network[187]

The Animal Health & GHG Emissions Intensity Network is a UK led initiative of the Livestock Research Group of the Global Research Alliance on Agricultural Greenhouse Gases. The aim of the Network is to bring together researchers, governments, non-governmental organisations and private sector from multiple backgrounds to:

- discuss and find inter-disciplinary approaches to understand and tackle the impacts of climate change on animal health and the impacts of animal health on the environment.
- advance the process of integrating animal health interventions to policy settings such as linking animal health data and disease surveillance systems to Tier 2 GHG inventories and the updates of Nationally Determined Contributions (NDCs).

GALVmed[188]

GALVmed makes livestock vaccines, medicines and diagnostics accessible and affordable to the millions in developing countries for whom livestock is a lifeline. They harness the best available expertise and capabilities to develop vaccines, medicines and diagnostics for the major livestock diseases impacting smallholders.

186 https://www.scar-cwg-ahw.org/
187 https://globalresearchalliance.org/research/livestock/networks/animal-health-network/
188 https://www.galvmed.org/

ENETWILD[189]

A European network of wildlife professionals capable of providing reliable data on species distribution and abundance of selected host species and their pathogens. Through ENETWILD, the European Food Safety Authority (EFSA) funds this project to collect comparable data at European level in order to analyse risks of diseases shared between wildlife, livestock and humans; data that are also essential in conservation and wildlife management. This project attempts to improve the European capacities for monitoring of wildlife population, developing standards for data collection, validation and, finally, create and promote a data repository. The objectives that ENETWILD will develop during next years are specifically focused on wild boar.

REMESA – Mediterranean Animal Health Network[190]

REMESA was formed in 2009 by the chief veterinary officers of 10 Western Mediterranean Countries (Algeria, Egypt, France, Italy, Libya, Morocco, Mauritania, Portugal, Spain and Tunisia). It's aims is to create common framework for work and cooperation, having the necessary capabilities to assist and coordinate the development and implementation of animal health regional projects and programs: the Mediterranean Animal Health Network (*REseau MEditerranéen de Santé Animale – REMESA*).

In 2013, the chief veterinary officers of Malte, Chypre and Greece joined the Network. Jordan and Lebanon joined the Network in 2014.The specific objective of REMESA is the improvement of prevention and control against the major transboundary animal diseases and zoonoses through the strengthening of the national and regional resources and capacities, the harmonization and coordination of surveillance and control activities. Four thematic sub-networks have been set up: laboratories (RELABSA), epidemiology (REPIVET), communication (RECOMSA) and socioeconomics (RESEPSA).

Infectious Diseases of East African Livestock[191]

This study involves intensive monitoring of a cohort of 500 calves for the first year of life. Any signs of infection will be noted, and provisional diagnoses will be made. Samples of blood and other tissues will be taken and used to apply state-of-the-art diagnostic techniques for indenting infections. The study will generate data on thousands of cases of infection, records of the clinical signs shown by the animals and of any impact on their health and growth, together with information on genetics, immunity and nutritional status. These data will be analysed statistically to rank different infections in order of their importance and to identify factors which predispose some cattle to a high burden of infectious diseases. The data will also be used to develop simple practical tools to help diagnose infections in the field where most animal health workers do not access to sophisticated laboratory facilities.

Programme for preventions of Streptococcus suis[192]

Streptococcus suis is an endemic porcine disease causing significant economic losses to the pork meat production industry in all countries where pigs are reared on a large scale. In some countries S. suis is the primary cause of mortality and morbidity in young pigs and the most frequent reason to prescribe antibiotics of the amino-penicillin group as a preventative measure. S. suis is also a zoonotic pathogen of humans and infections reported worldwide has increased significantly in the past years.

Within S. suis many different types (serotypes, genotypes, pathotypes) exist causing problems in the development of control strategies targeting all types. Asymptomatic carriage in adult pigs is common and combined with a lack of knowledge on the host-pathogen-environment interactions, are the

189 https://enetwild.com/
190 http://www.fao.org/remesanetwork/remesa/en/
191 https://www.ilri.org/research/projects/infectious-diseases-east-african-livestock-ideal
192 https://www.pigss-horizon2020.eu/

main reasons for failure to control the endemic nature of this pathogen. The project outputs will impact on understanding host-pathogen-environment interactions of S. suis infections through the genome sequencing of 1200-1500 S. suis isolates from representative geographic areas of the major pork producing countries and performing genome-wide-association studies with invasive disease and asymptomatic carriage. New diagnostic methods will be developed for global monitoring of infection risk and tested on case-farms. Epidemiology studies will determine risk factors for invasive S. suis disease, including the role of co-infections, and for the first time properly assess the dynamics of the disease on a representative farm. We will increase our understanding of the virulence mechanisms involved in pathogenesis including interactions of S. suis with the innate immune system. The project outputs will strengthen the evidence base for prevention and control strategies through testing of novel conserved vaccine antigens in pigs and prevention strategies based on manipulation of the microbiota and stimulation and maturation of the innate immune system.

PROCINORTE[193]

The Cooperative Program in Research and Technology for the Northern Region –PROCINORTE is a network of national agricultural research bodies in the three countries of North America: Canada, USA and Mexico. It supports agricultural trade through sound science and knowledge-sharing in areas of trilateral relevance.

National Animal Health Laboratory Network[194]

The U.S. livestock and food sectors, which account for more than $150 billion in annual cash receipts, are under continual threat from outbreaks of foreign and emerging animal diseases. Since 2002, these agricultural assets have been protected in part by the National Animal Health Laboratory Network (NAHLN), created through the cooperation of the USDA-APHIS Veterinary Service, NIFA, and State and University animal disease diagnostic laboratories. The NAHLN provides a framework for the coordination of federal and state animal disease diagnostic laboratory infrastructure, capabilities, and capacities.

Preventing Zoonotic Disease Emergence (PREZODE)[195]

PREZODE are not yet an active initiative but are set to go live in 2022. They are an international initiative whose ambition is to understand the risks of emergence of zoonotic infectious diseases.

Three research institutions are in control of setting up PREZODE and they are:

1. Cirad: The French Agricultural Research Centre for International Development
2. INRAE: French National Research Institute for Agriculture, Food and Environment
3. IRD: French National Research Institute for Sustainable Development

According to their website: *"PREZODE will help coordinate a large portfolio of regional, national and international projects and programs concerning the emergence of zoonotic infectious diseases and implement innovative methods to improve prevention and mitigate emergence risks"*.

PREZODE aim to develop:

1. A framework for the international coordination of research and innovation projects and programs, of One Health monitoring networks, and of participatory projects with stakeholders.
2. A platform for sharing knowledge brought by past, current and future projects and capitalizing on experimentations across world regions.
3. An online resource center for decision-makers to enable public policies supporting emergence risk reduction strategies for zoonotic infectious diseases.

193 https://www.procinorte.net/
194 https://www.nifa.usda.gov/grants/programs/agricultural-biosecurity/detection-diagnostic-networks#NAHLN
195 https://prezode.org/

Zoonotic Disease Integrated Action (ZODIAC)[196]

ZODIAC an initiative within the IAEA (International Atomic Energy Agency) and was established in June 2020 to help countries prevent pandemics caused by bacteria, parasites, fungi or viruses that originate in animals and can be transmitted to humans. ZODIAC aims to strengthen the preparedness and capabilities of Member States to rapidly detect and timely respond to outbreaks of such diseases. Research, development and innovation are core areas of interest for ZODIAC. There are links to ZODIAC through joint laboratories of the IAEA and the Food and Agriculture Organization of the United Nations (FAO). Links also exist between ZODIAC and World Health Organization (WHO) and the World Organisation for Animal Health (WOAH). ZODIAC aims to work using a One Health approach. Zoonotic diseases of interest include coronaviruses, the Zika virus, avian influenza viruses as well as other emerging pathogens.

Early Recognition and Rapid Action in Zoonotic Emergencies (ERRAZE@WUR)[197,198]

WUR brings together expertise in human, animal, plant and environmental health, the global agri-food system, economics, social sciences, food safety and security, ethics, and policy. The partnership aims towards an integrated global multi-stakeholder approach to the prevention and management of diseases of pandemic potential, working across the four phases of crisis management: prevention, preparedness, response and recovery and learning.

Global Outbreak Alert and Response Network (GOARN)[199]

A multidisciplinary network of technical and operational resources, which harnesses international resources at the request of affected WHO Member States to augment their response to ongoing or potential public health emergencies and assist with characterising and controlling disease outbreaks and respond to natural disasters and humanitarian emergencies.

The main objective is to provide technical support to WHO Member States experiencing a human health emergency due to various threats including disease outbreaks, food safety, chemical toxins, zoonosis, natural and manmade disasters etc. This support could include: 1. Deploying technical experts to the affected countries, 2. providing technical advice through expert committees established during the emergency, 3. provide resources for the response efforts, such as laboratory and operational logistics, tools and equipment to reinforce field teams.

196 https://www.iaea.org/services/zodiac

197 https://www.wur.nl/en/Research-Results/Research-programmes/Cross-WUR-programmes/ERRAZE-at-WUR.htm

198 https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjt_PG-94f6AhW2RkEAHRssD5IQFnoECA0QAQ&url=https%3A%2F%2Fwww.wur.nl%2Fnl%2Fshow%2FEarly-Recognition-and-Rapid-Action-in-Zoonotic-Emergencies.htm&usg=AOvVaw0N4uVoe6v5X-eYn7lNkV4r&cshid=1662734221965668

199 https://extranet.who.int/goarn/

African Coalition for Epidemic Research, Response and Training (ALERRT)[200]

A multi-disciplinary consortium building a patient-centred clinical research network to respond to epidemics across sub-Saharan Africa, with the aim to reduce the public health and socio-economic impact of disease outbreaks in sub-Saharan Africa by building a sustainable clinical and laboratory research preparedness and response network.

The aims of the network are:

1. To establish a clinical research network that can design and rapidly implement ICH-compliant, high quality, large-scale, multi-site clinical studies in preparation for and response to outbreaks;
2. To establish a laboratory network with the capabilities to provide integrated support to clinical research in preparation for and response to outbreaks;
3. To develop and implement a scalable, GCP-compliant, robust data management/ICT infrastructure suitable for resource-poor settings;
4. To establish a 'response framework' that alleviates administrative, regulatory and ethical bottlenecks and ensures ALERRT can act swiftly to initiate research;
5. To enhance and maintain the operational research capacity of the ALERRT network by developing and implementing a training and capacity development programme;
6. To ensure that the actions of the network are relevant to, accepted and supported by local communities and that the results of the networks' efforts have a sustainable impact on health through improved clinical practice and public health policy;
7. To establish ALERRT as a sustainable sub-Saharan Africa network that is linked to international networks and that synergises with, and contributes to, global health-security efforts

Pan-African Network for Rapid Research, Response and Preparedness for Infectious Diseases Epidemics (PANDORA)[201]

Multidisciplinary 'One Health' initiative that supports broad themes addressing response to emerging infections in Africa, with the aim of developing and strengthening effective outbreak response capacities across all geographical regions in sub-Saharan Africa, in partnership with national governments and other international stakeholders.

Further goals are to:

1. support the development of robust 'ready to go within 48-72 hours' PANDORA-ID-NET trained outbreak rapid response teams that can appraise, evaluate and conduct public health research in each of the four African regions.
2. develop our capacity to conduct research, evaluate and appraise scientific tools in both the emergency outbreak or epidemic situation and during the inter-epidemic period.
3. develop the younger generations of African scientists, healthcare workers, laboratory personnel, clinical trialists, ethicists, and social scientists to take leadership of public health research.
4. engage and fully involve politicians, policy makers and global public health agencies at the highest level during all stages of our programme.

200 https://www.alerrt.global/
201 https://www.pandora-id.net/

Emergency Centre for Transboundary Animal Diseases (ECTAD)

Plans and delivers veterinary assistance to FAO member countries responding to the threat of transboundary animal health crises, and builds animal health capacity to prevent, detect and respond to zoonotic and non-zoonotic disease outbreaks at source. By helping to avoid national, regional and global spread.

DECIDE – Data-driven control and prioritisation of non-EU-regulated contagious animal diseases[202]

July 2021-June 2026

The DECIDE project will develop data-driven decision support tools, which present (i) robust and early signals of disease emergence and options for diagnostic confirmation; and (ii) options for controlling the disease along with their implications in terms of disease spread, economic burden and animal welfare.

DECIDE will focus on respiratory and gastro-intestinal syndromes in the three most important terrestrial livestock species (pigs, poultry, cattle) and on growth reduction and mortality in salmonids, the most important aquaculture species. For each of these, we will (i) identify the stakeholder needs; (ii) determine the burden of disease and costs of control measures; (iii) develop data sharing frameworks based on federated data access and federated learning; (iv) build multivariate and multi-level models for creating an early warning system. Together, all of this will form the decision support tools to be integrated in existing farm management systems wherever possible and to be evaluated in several pilot implementations in farms across Europe.

ALIVEAfrica – Animals, Livelihoods and Well-being in Africa[203]

April 2021-September 2026

With a particular focus on Sierra Leone and Kenya, the ERC-funded ALIVEAfrica project will assess the role of animals for contemporary livelihoods and the implications of human-animal relations for the well-being of multispecies communities. It will also explore the mechanisms of governance that seek to manage human-animal relations. A deeper understanding of human-animal relationships will benefit sustainability across species.

3D-Omics – Three-dimensional holo'omic landscapes to unveil host-microbiota interactions shaping animal production[204]

September 2021-August 2025

The EU-funded 3D-omics project aims to develop, optimise and implement knowledge of biomolecular interactions in application to animal production. The goal is to generate 3D omics landscapes, achieving reconstructions of intestinal host microbiota ecosystems. Using poultry and swine production systems, the project will analyse the effects of different factors, including animal development, diet, exposure to pathogens, and management practices on the 3D omics landscapes. The innovative research will pave the way to improved animal breeding practices, development of microbiota- and host-tailored feeds and animal health treatments, increasing production efficiency and animal welfare.

202 https://cordis.europa.eu/project/id/101000494
203 https://cordis.europa.eu/project/id/950592
204 https://cordis.europa.eu/project/id/101000309

ICRAD – International Coordination of research on infectious animal diseases[205,206]

October 2019-September 2024

ICRAD aims to:

- support cross-cutting research to improve public health, and animal health and welfare, with associated benefits towards the environment and the economy
- connect research partners with different but complementary scientific and technological expertise to maximise resources and share risks, costs and skills.

Research and innovation co-funded through ICRAD would seek concerted approach towards the development of novel and improved instruments to address and control infectious diseases, particularly regarding novel detection, intervention and prevention strategies to:

- increase preparedness and ability to respond to emerging and endemic livestock threats
- contribute to the reduction of antimicrobial and antiparasitic use in livestock and to minimising the development of resistance for the benefit of animal and public health
- contribute to animal welfare by better prevention of diseases and renewed animal management and farming systems
- on a larger scale, contribute to food security and competitive and sustainable livestock systems, by reducing the burden of disease and reducing impact on international animal trade

Australian partnership for preparedness research on infectious disease emergencies (APPRAISE)[207]

An Australia-wide network of experts involved in medical, scientific, public health and ethics research. The research priorities, activities and projects to improve Australia's preparedness for infectious disease emergencies, response to infectious disease emergencies and recovery and evaluation of infectious disease emergencies.

Global Virome Project (GVP)[208]

An innovative network partnership among public, private, philanthropic and civil organizations to detect the majority of our planet's unknown viral threats to human health and food security within 10-years to prepare for and stop future epidemics. Aims to expand the viral discovery to reduce the risk of harm for new viral large-scale outbreak, cantered on the massive collection and sequencing of the majority of the planet's unknown viruses.

205 https://www.icrad.eu/
206 https://cordis.europa.eu/project/id/862605
207 https://www.apprise.org.au/
208 https://www.globalviromeproject.org/

EBO-SURSY (Capacity building and surveillance for viral haemorrhagic fevers)[209]

EBO-SURSY is a European Union funded project and is implemented by the WHO, Institut Pasteur, IRD and Cirad. The main aim of the project is to build upon early detection systems for wildlife in West and Central Africa to prevent outbreaks of Ebola Virus Disease (EVD), Marburg virus, Rift Valley fever, Crimean-Congo haemorrhagic fever and Lassa fever.

The three main objectives are:

1. Increase surveillance capacity for viral haemorrhagic fevers
2. Raise community awareness of viral haemorrhagic fevers
3. Strengthen surveillance protocols for viral haemorrhagic fevers

WOAH Reference Laboratories[210]

WOAH Reference Laboratories are designated to pursue all the scientific and technical problems relating to a named disease. The Expert, responsible to WOAH and its Member Countries with regard to the disease, should be a leading and active researcher helping the Reference Laboratory to provide scientific and technical assistance and expert advice on topics linked to diagnosis and control of the disease for which the Reference Laboratory is responsible. Reference Laboratories should also provide scientific and technical training for personnel from Member Countries and coordinate scientific and technical studies in collaboration with other laboratories or organisations, including through the Laboratory Twinning programme.

WOAH Collaborating Centres[211]

WOAH maintains a network of Collaborating Centres for the purposes of providing scientific expertise and support to the WOAH and its Members, and for promoting international collaboration on animal health and welfare. Collaborating Centres are designated for a specific specialty within a focus area relating to the management of general questions on animal health issues. They must provide expertise internationally.

RODENTGATE – Future rodent management for pig and poultry health[212]

March 2021 – March 2024

This project RODENTGATE will investigate the rodent-related risks for animal health in the pig and poultry industry and how this might change with altered rodent control. Ecologically based rodent management is a strategy that combines an Integrated Pest Management approach with a thorough knowledge of the rodent ecology, enabling interventions to be precisely targeted in time and space, whilst being ecologically and economically sustainable. This requires a very good understanding of the rodent demography, life history, space use, dispersal capacities as well appropriate documentation of pathogen presence and transmission patterns in the rodent population. Proper understanding of transmission mechanisms is crucial since killing hosts may have unexpected effects on the spreading of an infection.

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209 https://rr-africa.woah.org/en/projects/ebo-sursy-en/

210 https://www.woah.org/en/what-we-offer/expertise-network/reference-laboratories/#ui-id-3

211 https://www.woah.org/en/what-we-offer/expertise-network/collaborating-centres/#ui-id-3

212 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/future-rodent-management-for-pig-and-poultry-health

RODENTGATE's specific objectives are 1) to document changes in disease risk for pigs and poultry when classical rodent management around farms is prevented and rodent populations around farms change in abundance or composition and 2) to propose appropriate evidence-based and economically sustainable strategies for the ecologically-based management of rodents and rodent-borne infections around farms. This will be carried out by a multidisciplinary consortium of scientists from Belgium, UK, Germany, The Netherlands, and Poland, using a combination of analysis of existing data, sampling rodents, environment and livestock on farms, molecular diagnosis of pathogens, field work on rodent population biology and movements, ecological modelling, control strategy development and communication with the pig and poultry industry and pest control industry.

TCWDE – Tackling chronic wasting disease in Europe[213]

March 2021 – March 2024

This project will integrate research on the epidemiology and population dynamics of the disease in affected countries, with experimental approaches to study host/pathogen interactions relevant to disease transmission in wildlife, livestock and people. Using mathematical and statistical models, information on CWD cases in Norway and Sweden and population data will be used to evaluate surveillance strategies, to predict if and how CWD may spread in affected populations and indicate potential for transmission through contacts with semidomesticated reindeer and other livestock. Analysis of genetic susceptibility to CWD in the most numerous, widespread, and economically important species of wild and farmed cervids in Europe will be assessed by PRNP gene sequencing and testing the effect of novel variants on prion replication using in vitro assays.

The outcomes of this analysis will have an impact on the modelling of CWD spread and may also identify PRNP alleles associated with disease resistance that could be used in selective breeding programmes for disease control. The risks of transmission of European CWD isolates to sheep, cattle, pigs and humans will be assessed using the in vitro protein misfolding amplification assay (PMCA) and in vivo models (transgenic mice expressing PrP from the target species). Understanding which CWD strains are most likely to cross species barriers, and which species are most at risk, will allow better targeting of surveillance and control measures.

The consortium brings together expertise, resources, models and data from leading European research groups working on animal prion diseases. Building on existing collaborations, this proposal will provide increased research capacity and coordination of activities, while avoiding unnecessary duplication of effort. The outcomes of the project will provide vital evidence to support detailed risk assessments of the potential impacts of CWD on animal/human health in Europe, and lead to improved and cost-effective surveillance and control strategies.

213 https://www.era-learn.eu/network-information/networks/icrad/1st-icrad-call-2019/tackling-chronic-wasting-disease-in-europe

STAR-IDAZ
International Research
Consortium on Animal Health