Strategic Research and Innovation Agenda

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EXECUTIVE SUMMARY OF THE STRATEGIC RESEARCH AND INNOVATION AGENDA (SRIA) OF THE ONE HEALTH EJP

This strategic document aims at attaining sustainability of the main outcomes and impacts of the One Health EJP and leads the way to create and consolidate an aligned, dynamic and coordinated One Health collaboration among actors responsible for public health, animal health and the environment in Europe.

This SRIA builds on the legacy of the One Health EJP, which is a unique European network of public institutions with reference activities in the domains of foodborne zoonoses, antimicrobial resistance and emerging threats, and encompassing animal health, public health and food safety. The One Health EJP recognises that an interdisciplinary, integrative and international approach to One Health is essential to prevent, detect and control disease across Europe. The One Health EJP put mechanisms in place to make the project outcomes available to the scientific community, the authorities and policy makers to encourage these and other stakeholders to take up the outputs, to use and implement them in their work as researchers, risk assessors and risk managers. Impact of the One Health EJP is expected at least in the fields of society, science and technology, and policy.

In the **introduction** a description of **the past**, background and context of the One Health EJP is given. This is followed by an overview of **the present** challenges and opportunities in the One Health arenas, addressing policy, the need of international collaboration, the environmental pillar of One Health and policy, the COVID-19 pandemic, One Health approach and preparedness against possible pandemics, food safety, state-of-the-art in One Health science and technology, society and, lastly, One Health EJP progress and challenges. An assessment of the actual needs of stakeholders in **the future** is presented, addressing citizens' priorities, policy needs, globalisation and international cooperation, environment, ecosystem health and wildlife, climate change, AMR in the environment, with focus on water, One Health approach to tackle AMR, One Health approach to tackle pandemics, sustainable food systems, emerging trends: edible insects, synthetic meat, synthetic biology, harmonisation of methods and data between sectors, animal welfare and new human animal interrelationships, sharing of information, communication with the public, and science to policy translation and other emerging issues.

Vision and mission of the SRIA. The SRIA aims at broadening the One Health scope, and at reinforcing and consolidating the single European One Health consortium, which will guide partners towards a collaborative and coordinated, multi-disciplinary network where surveillance, laboratory procedures,

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risk assessment methodologies and intervention approaches are aligned across sectors and across borders, thus maximising the health of animals, humans and the environment, in Europe and beyond. In addition, the SRIA will provide input into future research agendas, programmes and/or calls. An objective of this SRIA is to give guidance to candidate future European One Health consortia that will build on the outcomes of the One Health EJP.

The **objectives** of the SRIA include an update of the specific One Health EJP objectives, previously presented in the Strategic Research Agenda in 2019, to meet the present and future challenges, opportunities and needs. Next, additional objectives identified during the course of the One Health EJP are presented. The UN Sustainable Development Goals addressed by the One Health EJP and to be continued in future activities consist of *Goal 17* Partnerships for the goals, *Goal 3* Good health and well-being, *Goal 2* Zero hunger and *Goal 9* Industry, innovation and infrastructure.

Expected impacts. It is expected that the uptake and application of One Health EJP tools and solutions will have important scientific and policy impact that will continue in the future. Elements that facilitate the use of the tools and solutions at the national, European and international national level as well as dissemination activities aimed at stakeholders and users are described. A selection of outcomes from the One Health EJP projects intended to be utilised by key stakeholders were aligned according to the integrative strategy matrix, i.e. by the theme (design and implementation of surveillance activities, laboratory methods, reference material and data, interpretation of surveillance data, cross-sector communication of data and action (prevention and response), and per domain (foodborne zoonoses, AMR, emerging threat).

An overview on the procedures that were followed in the One Health EJP to select **priority research and integrative topics**, which were thereafter the focus of projects is given. Two main priority topics are developed in length in the SRIA, **antimicrobial resistance** and **One Health**.

Sustainability plan 2021-2030

Based on the background information and analyses provided, a sustainability plan for 2021-2030, which intends to guide and recommend actions that will result in maintaining major outcomes of the One Health EJP so that the benefits will persist in the future, after the end of the project in 2023, is developed. The key instruments for the sustainability of the One Health EJP are identified. The **Med-Vet-Net Association** will have a key role in sustaining many of the activities and outcomes. Other instruments include European Partnerships, in particular, EUP Animal Health & Welfare, EUP Sustainable Food Systems, EUP Pandemic Preparedness, EUP One Health AMR and EUP Biodiversa.

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One Health Initiatives and initiatives dealing with zoonotic infections at the national, European and international level are also important channels for the continuation of One Health EJP activities in the future. Links have already been established with 60 One Health EU projects and initiatives and outcomes of these collaborations are presented. European funding of One Health research, development, innovation, networking and training and dissemination instruments are listed.

Priority outcomes, activities and actions of the One Health EJP to be sustained and further developed in the future are identified. Finally, a sustainability plan of the One Health EJP is presented. The instruments and opportunities that can be applied to achieve sustainability of each of the priority outcomes are shown, as well as a proposed timeline.











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1 INTRODUCTION

1.1 The past: background and context of the One Health EJP

The main objective at the start of One Health EJP was to enhance the prevention, detection and control of zoonoses and antimicrobial resistance

One Health has been defined as 'an integrated, unifying approach that aims to sustainably balance and optimise the health of people, animals and ecosystems' and it recognises that 'the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent' (OHHLEP, 2022). The Quadripartite - Food and Agriculture Organisation of the United Nations (FAO), the World Organisation for Animal Health (WOAW), the World Health Organisation (WHO) and the United Nations Environment Programme (UNEP) - have expressed support to this definition and emphasised One Health as a key focus in their strategies (OHHLEP, 2022, WOAH, 2021).

Threat of zoonoses and antimicrobial resistance

Pathogens that are transmitted directly or indirectly between animals and humans (zoonoses) and antimicrobial resistance (AMR), pose major risks for public health. Zoonoses and AMR have a significant social and economic impact, and especially when transmitted via food, they need to be addressed by all actors in the farm-to-fork continuum. Societal and environmental changes, including changes in land use, operation of large terrestrial and aquaculture food production units, and microbial pollution of land and water sources, have created new threats to public health. Among these threats, illness and even death from consumption of unsafe food pose a considerable burden. Food imports and exports in Europe have doubled since 2005, and the consequences of increasing global food chains have tremendous consequences for food safety. The emergence of major zoonotic diseases and AMR in Europe and globally has led to continuous adjustments to the way authorities address these threats. The European agricultural sector and the European authorities have been at the forefront in the control of many zoonotic pathogens as close to the source as possible, sometimes even stamping out the disease in the full production system (e.g. *Brucella* in cattle in some countries). It is highly likely that a number of other zoonotic pathogens can be addressed in this way, but the pre-condition is typically good scientific cross-sectoral work and preparedness in line with the 'Prevent-Detect-Respond' concept.

A holistic approach to prevention, detection and control

A transdisciplinary approach is needed to better understand the processes behind the emergence and spread of foodborne zoonoses and AMR, including their routing in the animal-human-environment









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triangle. This is possible with a One Health approach involving synergies amongst human, animal and environmental health. Indeed, the One Health concept recognises that human health is tightly connected to the health of animals and the environment, i.e. that animal feed, human food, animal and human health, and environmental contamination are closely linked. Therefore, the study of infectious agents that may cross species and environmental barriers to move between these compartments is key within the One Health concept. Action is needed at the European level to identify and characterise existing and emerging risks, particularly in the field of food safety, by building capacity to collect and analyse information, and supporting application of state-of-the-art reference and surveillance tools, considering the harmonisation of existing and new diagnostic tests. Clearly, national research agendas need to be integrated and aligned. There is also a need for research-based recommendations to various stakeholders (e.g. policy-makers, industry, citizens) to identify priorities, to set up public-public and public-private collaborations and to avoid duplication of work. In addition, extending the response to the European needs, such as standardisation and novel food chain thinking, to the rest of the world links to both better and more sustainable food production, benefiting world and European consumers alike.

The role of the Med-Vet-Net Association at the initial stages of the One Health EJP

In September 2004, the Med-Vet-Net Network of Excellence was launched under Work Programme 6 of the European Commission (EC). It aimed at studying zoonotic infectious diseases in Europe through collaborative research projects across the food chain. This successful network consisted of seven public health and seven animal health/food safety partners and rose awareness of foodborne zoonotic diseases among policymakers, the general public and other stakeholders, and enhanced the skills and knowledge base of researchers on zoonoses. After the project ended in October 2009, the network was demonstrated to be a solid basis to create the Med-Vet-Net Association, a legal entity under French law. Public organisations active in public and animal health and in food safety take part in the Association, thus enabling the continuity of the cross-sector collaboration, including the partners of the former Network of Excellence, albeit without EC funding. Building further on these initiatives, the One Health European Joint Programme (One Health EJP) under Horizon 2020 was launched in January 2018.

The One Health EJP recognises that an interdisciplinary, integrative and international approach to One Health is essential to address the existing and emerging threats of zoonotic disease and antimicrobial resistance. In many countries, institutes across the sectors of animal health, public health and food safety joined the Consortium, and all have reference responsibilities, representing a sustainable framework for an integrated research community and encouraging the cross-sector collaboration within those countries and among them.



Pursuing common goals

The One Health EJP has set up a common strategic research agenda SRA among the partners, taking into account the needs of key European Union (EU) stakeholders, especially the European Food Safety Authority (EFSA) and the European Centre for Disease Prevention and Control (ECDC), and strategic links with other EU initiatives and international stakeholders, such as WHO, WOAH and FAO. Moreover, through the existing links with the Programme Owners (national authorities and policy makers), national priorities are also taken into account of in the One Health EJP strategy. The main focus of One Health EJP consortium has therefore always been to reinforce collaboration between institutes by enhancing transdisciplinary cooperation, integration of activities, and training in the fields of foodborne zoonoses (FBZ), antimicrobial resistance (AMR) and emerging threats (ET). The collaborative efforts among partners offered opportunities for harmonisation of approaches, methodologies, databases and procedures for the prevention, detection and control of FBZ, AMR and ET across Europe, which improves the quality and compatibility of information for decision making. The joint research projects (JRPs) and joint integrative projects (JIPs) have been key instruments to facilitate partner organisations working together. To complement these research and integrative activities, PhD and other training opportunities have been provided to develop the next generation of One Health scientists.

Besides delivering on the objectives presented above, the One Health EJP put mechanisms in place to make the project outcomes available to the scientific community, the authorities and policy makers in order to encourage these and other stakeholders to take up the outputs, to use and implement them in their work as researchers, risk assessors and risk managers. Impact of the One Health EJP is expected at least in the fields of society, science and technology, and policy.

The vision of One Health EJP

Towards a shared landscape

Medical, veterinary, food and environmental sciences are separate fields of expertise at the institutional level in many countries, being often located in different institutes and funded or mandated by different ministries, probably resulting in inefficient exploitation of new techniques, redundant or overlapping research activities, even within countries, and suboptimal systems for risk assessment and management of emerging threats, possibly missing important opportunities for solutions. Similarly, within the EU research funding on the topics of the various sectors can be found in different programmes and directorates. This fragmented landscape, in a timeframe of evolving scientific developments and reduced research budgets has benefited from the implementation of a One Health approach of the One Health EJP where multidisciplinary, cross-sector and cross-border cooperation were enhanced.



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The overarching ambition

Following a One Health approach, the One Health EJP is creating a sustainable European framework through integration and alignment of medical, veterinary, and food institutes with reference laboratory functions. These organisations united forces through joint prioritisation and conduction of research and integrative activities, as well as training and education exercises in the domains of FBZ, AMR, and ET, thus matching the needs of European and national policy makers and stakeholders. Such a Consortium is unique in Europe and therefore a good basis to build future One Health networks on.

Specific objectives of One Health EJP

The specific objectives of One Health EJP have been presented and elaborated in the Strategic Research Agenda (Ref to SRA) and summarised below.

Objective 1. To bring together the major representatives of the European scientific community in the fields of FBZ, AMR and ET. The target scientists are mainly those dealing with national mandates of reference and performing official research programmes in these three domains.

Objective 2. To implement scientific projects related to the prevention and control of foodborne zoonoses, antimicrobial resistance, and emerging threats. The joint programme encompasses research activities proposed by partners in the different member states. In addition, integrative activities will be strengthened by creating synergies between the five thematic areas of expertise: detection and analytical methods, host-microbe interaction, epidemiology, risk assessment and intervention in synergy with the three domains: FBZ, AMR and ET.

Objective 3. To stimulate scientific excellence by co-funding dedicated joint research projects. These projects will have the potential to enhance the scientific evidence base useful in the preparation of tools for surveillance and reference activities at the national and European levels in the fields of FBZ, AMR and ET.

Objective 4. To foster the harmonisation and standardisation of the reference methods and tests by bringing together scientific and technical expertise in the fields of FBZ, AMR and ET. This will deliver standards and materials of reference such as biological archives including collections of strains and DNA libraries.

Objective 5. To exchange and communicate with all national and international stakeholders. Strong interaction with the European Centre for Disease Prevention and Control (ECDC) and the European Food Safety Authority (EFSA) is crucial, as well as with other European and global organisations that take responsibility in the domains of FBZ, AMR and ET, i.e. European Environment Agency (EEA), European Medicines Agency (EMA), Food and Agriculture Organisation of the United Nations (FAO), World





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Organisation for Animal Health (WOAH) and World Health Organisation (WHO). Stakeholder liaison actions consist of *i*) developing privileged contacts to ensure that the objectives of the Consortium are in accordance with the overarching policies and mandates of the respective agencies, *ii*) maintaining current links and developing new ones with related networks in the EU and beyond.

Objective 6. To promote and develop food safety research in the EU by training, education and communication. The research findings and identified new research topics are presented to the scientific community by designed scientific meetings and workshops. The agreed sphere of integrated scientific activities represents the themes of the joint training courses. By short term missions, staff exchanges and target training, the scientific community has the opportunity to improve its skills in new techniques. The activities of the Consortium are promoted through a series of public engagement activities involving both national and international policy makers and the general public.

Outputs and outcomes of the One Health EJP

An objective of the One Health EJP was to ensure that the EJP main scientific outputs will be sustainable beyond the lifetime of the project. Numerous outcomes were achieved and made public to facilitate their use by the wide scientific community, these are given in The One Health EJP Outcome Inventory (OHOI), a public database of scientific and integrative outcomes of the One Health EJP Joint Research Projects and Joint Integrative Projects. The Outcome section of the inventory lists more than 120 databases, strain collections, tools and other scientific output (computational model, excel plugin, workflow, software, hardware, novel detection method, etc).

Focussing on sustainability, acknowledging that the outcomes are numerous, and having the needs of principal stakeholders in focus, namely, ECDC, EFSA, DGHEALTH and DGAGRI, a list of selected outcomes of the One Health EJP JIPs and JRPs was made. This list of outcomes describes protocols, databases and other tools and solutions expected to contribute to the work of not only the four named stakeholders, but also others. The outcomes are arranged following the integrative strategy matrix, i.e. addressing analytical methods, host-microbe interaction, epidemiology, risk assessment and intervention in relation to the three main domains of the One Health EJP, namely FBZ, AMR and ET. This list provides specific examples of outcomes, illustrates the breadth of topics investigated and constitutes an important component of the legacy of the One Health EJP. The list of outcomes is presented in the table in Annex 1.



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The One Health EJP network

The One Health EJP boasts a landmark partnership of 43 acclaimed food, veterinary and medical laboratories and institutes across 22 member states (MSs) in Europe, and the Med-Vet-Net Association. An important result of the One Health EJP is the creation of an outstanding interdisciplinary, integrative and international network of One Health scientist across Europe. Research and integrative activities are complemented by PhD and other training opportunities to develop the next generation of One Health scientists.

Dissemination of the One Health EJP outcomes

Further dissemination of the One Health EJP results consists of, amongst others, an updated list of publications available in the <u>publications section</u> of the One Health EJP website. The four Annual Scientific Meetings (ASM) were international multidisciplinary scientific events for those interested in One Health. Each meeting gathered hundreds of scientists from all over Europe and beyond to share and discuss science, offering an ideal platform for presenting research, initiating collaborations and reinforcing building of networks.

1.2 The present: current challenges and opportunities Policy

After the acceptance of the SRA of the One Health EJP, a number of major European and international One Health initiatives were launched, including policy initiatives. By aligning to them, current and future One Health programmes, partnerships, networks and projects have the possibility to adjust their goals to these international initiatives, thus maximising impact.



A European flagship initiative is the **European Green Deal**: a set of policy initiatives launched by the European Commission in late 2019, aiming primarily to curb climate change and environmental degradation. It is an overarching policy, as 'all EU actions and policies will have to contribute to the European Green Deal objectives' (The European Green Deal, 2019). It aimed at improving animal welfare and benefiting the health of the environment and of EU citizens. Such an ambitious goal requires



Figure 1. Countries participating in the One Health EJP

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multisectoral action, and a number of policies were, and are being, approved to tackle the issue from different perspectives, such as those related to energy, economy, biodiversity and others. Among these, the **EU Farm-to-Fork Strategy** is not just a pillar of the European Green Deal, but it is also of particular relevance for the One Health community. While the overall goal is to make food production more sustainable protecting biodiversity and the environment (notably tackling climate change), one important aim is to reduce by 50% the sale of antimicrobials for animal use, including aquaculture, by 2030. This aim is in synergy with the pre-existent European One Health action plan against antimicrobial resistance and is supported by relevant regulations, for example, by the Regulations on Veterinary Medicinal Products and on Medicated Feed.

When the One Health EJP was fully operational, in its third year, the COVID-19 pandemic shifted the priorities of the EU. On the one hand the zoonotic aspects of COVID-19 highlighted once again the relevance of the One Health paradigm, on the other hand EU interests prioritised preparedness to cross-border health threats. Important policies were swiftly proposed, negotiated and approved. Of central importance were the ones dealing with the foundation of the European Health Union (EHU).

The EC proposed the EHU with the vision of facing future health crises as a Union, and not as single states. "we must be sure that all European countries are equally prepared and responsive", said EC President Ursula von der Leyen (Speech by President von der Leyen at the S&D event 'A strong and inclusive Health Union'). The legal package concerning the foundation of the EHU includes *i*) a communication part: Building a European Health Union, a Proposal for a Regulation on serious cross-border threats to health, and *ii*) a proposal to extend the mandate of ECDC and EMA. It also establishes the funding of a new authority that should work in synergy with ECDC and EMA in the prevention and response to health threats, i.e. the Health Emergency Preparedness and Response Authority (HERA).

It is important to note that the EHU considers also threats resulting from AMR, pressure on biodiversity and climate change, making it a full-fledged One Health policy. Referring to the proposal for a new regulation on cross-border health threats, Commissioner Kyriakides underlined the 'vital importance of the One Health approach' in order to improve the prevention, surveillance, and response to cross-border threats (opening of the November 2021 European Public Health Conference).

Funding tools to support European One Health policies include the Horizon Europe Programme, concerning research and innovation, and EU4Health. The budget of the latter received an unprecedented boost following the COVID-19 pandemic, surpassing €5bl, more than 10 times the budget of the Third Health Programme.



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European public health and food safety agencies are aligned in underscoring the increasingly important role of multisectoral – One Health – approach, as seen for example by the ECDC Strategy 2021–2027 and the EFSA Strategy 2027.

Also at national level forces should be joined to support the One Health approach, to tackle the challenges in an aligned manner, across public health, animal health, food safety and the environment. In many European countries the responsibilities for public health, animal health and the environment are separated and hardly harmonised. For instance, the National Reference Laboratories (NRL) for animal health and the national reference centres (NRC) for public health often are affiliated to different ministries, which is not optimal for a true One Health approach.

The need of international collaboration

The strategies addressed above also point out the need of international collaboration. The EU, in fact, acknowledges that to tackle efficiently One Health issues, in particular zoonoses and AMR, international collaboration is crucial. This is reflected, for example, in the EU Green Deal and also in high policy events like the G20 Rome Declaration.

A number of notable recent international initiatives were launched by EU or by its Member States (MS), highlighting the will of the EU to take leadership in global health. Such examples include the international treaty to prevent pandemics, that is a legally binding agreement launched by the Council of the EU within the framework of the WHO, the regional One Health Coordination Mechanisms, and PREZODE (Preventing Zoonotic Disease Emergence), an explicitly One Health initiative started by France and Germany in line with the Tripartite's One Health High Level Expert Panel.

Like the EU, also international organisations acknowledge the importance of a multisectoral approach to tackle health threats, to the point that the WHO has defined a coordinated multi-disciplinary approach as 'imperative' for the response and prevention of outbreaks (A coordinated global research road map, 2020). FAO, WOAH and WHO join forces in the Tripartite, which was later, in March 2022, officially joined also by United Nations Environment Programme (UNEP).

These international organisations have launched a number of initiatives, in synergy with European ones, to foster the One Health approach, as well as cross-border collaboration. FAO, WOAH, UNEP and WHO have jointly established the One Health High Level Expert Panel, that will advise the Tripartite agencies on the development of long term plans to prevent outbreaks. FAO, WOAH and WHO also launched





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Regional One Health Coordination Mechanisms, fostering cross-sectoral and cross-border cooperation by coordinating One Health actions, thus avoiding duplication of efforts.

The environmental pillar of One Health and policy

The environment is an essential pillar of One Health, included in the 'Manhattan Principles' since the formalisation of the One Health paradigm, however it is often overlooked in One Health initiatives. The reason for that is that probably most attention is being paid to public health and that extended European legislation is available regarding prevention and management of animal infectious diseases and zoonoses, and less regarding environmental issues. Research on the environment has not been a priority focus of the One Health EJP, even though many projects have addressed various environmental factors in their studies (ref to Thematic report environment). This SRIA emphasises the importance of the environment in One Health and acknowledges that the interest on the role of the environment in One Health has increased during the lifetime of the One Health EJP. This is reflected by the launch of major European and international initiatives during that period (2018-2022), and named below.

For the sake of this SRIA, the following definitions from the Glossary of the European Environment Agency are used:

Environment - includes the built environment, the natural environment and all natural resources, including air, land and water, waterways (both natural and man-made, including wastewater), and wildlife; *Ecology* - The study of the interrelationships between living organisms and their environment; *Ecosystem* - A community of organisms and their physical environment interacting as an ecological unit.

The Biodiversity Strategy for 2030 for example, core of the European Green Deal, aims at building 'societies' resilience to future threats' by reversing the degradation of the ecosystems. The Biodiversity Strategy aims to tackle not only climate change but also disease outbreaks, by protecting wildlife and fighting illegal wildlife trade.

Protection of the environment and of ecosystems is embedded in the European Farm-to-Fork Strategy and in the Biodiversity Strategy. It highlights the essential need for future European One Health initiatives to include all three pillars of One Health – animal health, public health, and environmental/ecosystem health.

In addition, the COVID-19 crisis, and in particular the zoonotic origin of SARS-CoV-2, forcefully underscored even more the link between degradation of ecosystems and the emergence of infectious diseases.



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Protection of the environment and of ecosystems, was, for example, central for the 2021 One Planet Summit, a global event which focused on the importance of protecting biodiversity, also in order to prevent future pandemics.

Indicative also that United Nations Environment Programme (UNEP) formally joined the FAO, WOAH and WHO in the Tripartite, to 'strengthen the environment dimensions of a One Health approach' (UNEP joins three international organisations in expert panel to improve One Health, 2020).

The COVID-19 pandemic

The COVID-19 pandemic has led to a devastating loss of human life globally and enormous economic and social disruption. The pandemic has presented unprecedented challenge to public health and food systems, including animal production and health. Another consequence of the COVID-19 pandemic, in relation to the not yet fully understood origin and transmission of the SARS-CoV-2 virus from wildlife to humans, is the increased interest of the general public in biodiversity loss and in climate change issues, which raised the awareness among citizens that infections across sectors (animal-humanenvironment) and across borders are part of our lives, and even more in the future. Consequently, policy makers and international authorities should take action (see policy) so that risk managers may prevent emergence of these pathogens and install preparedness measures against infections that can originate from animals, including wild animals, and that may become pandemics. For these reasons, and based on the international interest for One Health, there is a need to translate the One Health principle into practical guidance.

While huge investments to protect human health have been made; less focus has been put on animal health, and in particular wildlife.

One Health approach and preparedness against possible pandemics

International cooperation and high-level coordination are profitable approaches to handle large outbreaks, threats and pandemics, see Tripartite plus (AMR), HERA (EC), One Health High-Level Expert Panel (WHO), Regional One Health Coordination Mechanism (WHO, FAO, OIE, UNEP).

The Consortium, as established and consolidated in the One Health EJP, is an excellent basis to communicate, disseminate and build efficient cross-sector and cross-border collaborations in Europe.

Food safety and food security

Society is expecting safe food, meaning that no microbiological nor chemical risk should be involved in



consuming foodstuffs that are commercially available, be it in regular supermarkets or through the short chain supply. Efficient mechanisms of prevent-detect-respond across sectors ensure that such threats are reduced to a minimum, or in case they emerge, are managed adequately. Working on the health of production animals also contributes to food security. The One Health approach therefore complies with a societal demand, and cross-sector collaboration among surveillance programme owners, laboratories, risk assessors and risk managers importantly improve health and thus has a serious impact on society.

New food safety challenges arise in parallel with changing consumption of food and eating habits, such as The Planetary Health Diet and the food crisis due to the war in Ukraine.

State-of-the-art in One Health science and technology

We live in an age where science and technology evolve rapidly and it is important that new research results are promptly and effectively applied to create up-to-date and/or innovative solutions to the continuously rising health challenges.

One Health EIP has contributed to the development of state-of-the-art tools and technologies that are already applied in diagnostics, surveillance, risk assessments, modelling and other fields. They are also applied to characterise new infectious agents, to provide better understanding of the epidemiology of zoonoses, to monitor AMR and more. A selection of such outcomes is provided in Annex 1.

Society

Societal current challenges and opportunities include the awareness of pandemics (e.g. coronavirus, influenza, antimicrobial resistance) and the societal demand to be better prepared against pandemics that may originate from animals, including wild animals. Global societal challenges related to climate change and emergence of infectious diseases that may spill over to humans are becoming more evident.

One Health EJP progress and challenges

- The particularities of this European consortium are:
- The One Health EJP is a unique One Health network in Europe consisting of many paired Med-Vet organisations with reference tasks in FBZ, AMR and emerging threats, facilitating cross-sector and cross-border collaboration:
- Expanding and consolidation of the network through research and integrative activities, and education and training;
- The management has a privileged contact and cooperation with large European and global organisations, i.e. ECDC, EFSA, FAO, WOAH, WHO and EEA and EMA;





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- Due to targeting existing surveillance programmes and related reference laboratories (FBZ and AMR), focus on animal health, public health and food safety, less on the environment;
- Due to its concept (strengthening the collaboration among partners of the One Health EJP), the scientific excellence and critical mass of the Consortium is focused on its partners only, although some projects collaborate with external partners;
- Dissemination of project outputs and uptake of outcomes started at the end of 2021 and will be expanded towards the end of the One Health EJP (September 2023); impact is challenging to measure but expected impact is high;
- Data sharing, despite challenges, such as unequal distribution of sectors and language barriers;
- Unfortunately, and despite multiple efforts to reach out to them, there is a lower involvement of Eastern European countries, no accession countries nor countries outside Europe are partner.

1.3 The future: actual needs of stakeholders in the future

Citizens' priorities

Eurobarometer surveys provide insights into public perception of certain issues, and, together with other tools (e.g. scanning of newspapers, social media), give an overview of trends of public interests and of the social milieu of the moment.

The media resonance of certain events (e.g. The Intergovernmental Panel on Climate Change (IPCC) reports, COVID-19 pandemic, outbreaks of bird flu, journalistic investigations on animal welfare) shapes public perceptions and interests. At the same time, media reports are influenced by public concerns.

Health is seen as a crucial issue by European citizens, second only to the economic situation and unemployment, and followed by cost of living, and environment and climate change¹.

European citizens place great importance on the protection of the environment and acknowledge that European legislation is necessary to protect it². In line with this, climate change is seen as a top challenge for the EU³.

During the lifetime of the One Health EJP, One Health issues received increasing attention from the media, the COVID-19 pandemic shifted public awareness to the issue of zoonoses. Climate change is under the spotlights, thanks, for example, to the publication of the IPCC reports. Climate change is dissected by the media from different perspectives, including scientific (consequences for health), social (population movements), economic (revenue loss) and political (lobbying, political discourse).

¹ Flash Eurobarometer on public opinion in EU regions, Ref: 2552 / 500, 2021 ²Attitudes of Europeans towards the Environment, Ref: 2257 / 501, 2020 ³Special Eurobarometer on the Future of Europe 2021, Ref: 2554/517, 2022



Another issue often taken over by the media is animal welfare and the environmental impact of food production.

Policy needs

One Health is going beyond the relatively narrow circle of researchers and public health specialists: the concept (or the term) is present in the media and political debate, reflecting the awareness about the importance of One Health implementation.

Such awareness makes it necessary and urgent to institutionalise a sustainable EU-wide structure able to provide scientific evidence, data sets and tools to implement One Health-based approaches to protect the health of humans, animals and the ecosystems.

Needs of the stakeholders are constantly evolving. The needs listed below have been identified in the years 2019 to 2021, therefore represent the likely future needs that could help guiding the agenda of future One Health initiatives.

When setting up a One Health initiative with EU funds, the importance of cross sectoral work should be kept in mind, as well as focusing on green, sustainable future (Seizing the opportunities for a healthy recovery - Multiannual Financial Framework 2021-2027 and Next Generation EU).

In general, One Health is increasingly considered in future plans of European agencies dealing with food safety (EFSA Strategy 2027 – Science, safe food, sustainability, 2021) and public health (Single Programming Document. 2022–2024, ECDC, 2022). It is encouraging that the EU agencies have committed to a cross-agency One Health task force (Bronzwaer *et al.*, 2022).

Globalisation and international cooperation

Many events, such as Covid pandemics and climate change alerts from imported food commodities, have highlighted that the EU is integrated in a wider global context that includes the Mediterranean (where three continents meet) and the Eastern Neighbouring Countries from Balkans to



Figure 2. Google trends of the words 'zoonosis meaning' and 'one health' searched worldwide from January 2014 to February 2022.



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the Caucasus. For instance, one of the foremost One Health EJP stakeholders - the EFSA - is developing a programme of co-operation with Eastern Neighbouring Countries, pivoting around the One Health concept. More in general, EU does consume more food than it can produce, hence, EU food security unavoidably depends on global exchanges.

The EU has developed high levels of protection of food and environment, with production of scientific evidence, models and tools to achieve these goals. In a globalised world, in order to maintain such high level of protection, the EU should implement consistent and effective collaboration with other world areas: this should include, among others, the transfer of models, methods, technologies and best practices as well as capacity building. As most issues, from food safety to emerging global threats, call for a One Health approach, a proactive global role of EU needs to be supported by a sustainable scientific network of One Health.

Europe aims at leading global health actions in synergy and collaboration with Tripartite's organisations, and instruments to support Member States in cross border-One Health cooperation are available (e.g. EU4Health, see EU public health policy, European Parliament Think Tank, 2020).

Although focused on European needs⁴, outcomes developed in the frame of European initiatives, notably the European Research and Innovation Framework Horizon Europe, can be used globally, in particular by low- and middle-income countries.

Environment, ecosystem health and wildlife

Policy engagement surrounding environmental issues has been recently highlighted by a UN resolution that recognised access to a healthy and sustainable environment as a universal right (The right to a clean and healthy environment: 6 things you need to know, UN, 2021).

Environment and ecosystem health are already predominant in the European One Health agenda, for example in policy documents of the EU Green Deal and in the Strategic Approach to Pharmaceuticals in the Environment (see above). Sustainability of initiatives has to be taken into account when using EU funding mechanisms (Seizing the opportunities for a healthy recovery - Multiannual Financial Framework 2021-2027 and Next Generation EU and EuroHealthNet, 2021), in fact, one of the strategic aims of Horizon Europe is to restore Europe's ecosystems and biodiversity (Horizon Europe's first strategic plan 2021-2024: Commission sets research and innovation priorities for a sustainable future, EC, 2021).







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EEA is also joining efforts with ECDC and EFSA, noting the increasing emphasis on interactions between environment and health and aware that the knowledge base relating to the 'ecosystem health' dimension of One Health needs to be significantly expanded. Whereas several initiatives are already in place, notably the European Climate and Health Observatory, the EEA will further step up its engagement with One Health as part of a new line of work on food systems and health. This line of work may also involve the engagement of MS representatives, in order to gather examples of best practices at the national level.

It is acknowledged that European food safety will also benefit from including to a greater extent the environmental sector in the One Health approach (EFSA's expertise supports One Health policy needs, EFSA, 2021). This includes focusing more on ecosystems, as wildlife poses a risk for the introduction of transboundary diseases, both in Europe (Food Safety Regulatory Research Needs 2030, EFSA, 2019), and globally (Animal health and climate change, FAO, 2020). Moreover, emerging zoonoses from wildlife are a risk constantly identified by EFSA (EFSA's activities on emerging risks in 2018, EFSA's activities on emerging risks in 2019).

WHO called for a more inclusive One Health approach to prevent pandemics, that should consider activities strictly related to the environment, such as pollution, large-scale deforestation and food production (Strengthen 'One Health approach' to prevent future pandemics – WHO chief, WHO, 2021). In fact, nature degradation and loss of biodiversity are issues well acknowledged to affect human health (Nature, biodiversity and health: an overview of interconnections (2021), WHO-Euro, 2021), and effective prevention of future pandemics cannot ignore the environmental dimension (Preventing the next pandemic - Zoonotic diseases and how to break the chain of transmission, UNEP, 2020).

Scientific uncertainties surround also the risk of introduction in the environment of synthetic biology organisms (Synthetic biology and the environment, EEA, 2020), including insects (Adequacy and sufficiency evaluation of existing EFSA guidelines for the molecular characterisation, environmental risk assessment and post-market environmental monitoring of genetically modified insects containing engineered gene drives, EFSA, 2020), and microorganisms (Evaluation of existing guidelines for their adequacy for the microbial characterisation and environmental risk assessment of microorganisms obtained through synthetic biology, EFSA, 2020), although widespread use of both is not expected in the near future.

Loss of biodiversity, nature degradation, land use, are yet other important examples of issues requiring the expertise of the environmental side of One Health (e.g. ecologists, water pollution experts, conservationists).



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Besides global warming, climate change brings modifications of ecosystems and increased occurrence of extreme events. Public awareness increases about such risks as infections driven by vectors or alien species or extreme events (floods, fires) disrupt farming and health systems. Climate change is a well-acknowledged driver of (re)emerging threats, also influencing the burden of AMR and having a major effect on food safety. Societal attention and alarm toward the direct and indirect adverse health consequences of climate change will most likely increase. Indeed, the impact of events and trends related to climate change will involve humans, animals and the ecosystems, calling for One Health-based structures supporting prevention, control and response.

Climate change is expected to have an increasingly strong impact on public health (The 2020 report of The Lancet Countdown on health and climate change: responding to converging crises, Watts *et al.*, The Lancet 2020).

As a global issue, the impact of climate change will be felt also in Europe on a plethora of issues directly or indirectly linked with public health like food safety (Climate change as a driver of emerging risks for food and feed safety, plant, animal health and nutritional quality, EFSA, 2020) including AMR (Role played by the environment in the emergence and spread of antimicrobial resistance (AMR) through the food chain, EFSA, 2021) and supply of agricultural commodities (Global climate change impacts and the supply of agricultural commodities to Europe, EEA, 2021). In Europe climate change could also have an influence on the spread of vector-borne diseases (see for example the peak in West Nile virus cases reported in The European Union One Health 2018 Zoonoses Report, ECDC or the locally acquired cases of dengue in Rapid risk assessment: Autochthonous cases of dengue in Spain and France, ECDC, 2019.

In parallel, global organisations are also preparing to face the impact that climate change will have on animal health, zoonoses (Animal health and climate change, FAO, 2020), microbiological food risks, and AMR (Climate change: Unpacking the burden on food safety, FAO, 2020).

AMR in the environment, with focus on water

There is still no consensus on what proportion of AMR comes from the human, animal, plant, and environmental sector (Technical brief on water, sanitation, hygiene (WASH) and wastewater management to prevent infections and reduce the spread of antimicrobial resistance (AMR), Tripartite, 2020). This is in part due to the lack of data from the environment, which is lagging behind also in Europe (Addressing antimicrobial resistance: progress in the animal sector, but this health threat remains a challenge for the EU, ECA, 2019; 5th Progress report on the EU's AMR Action Plan, EC, 2020).





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Environment can be a source of AMR for the food chain, and a number of knowledge gaps exist leaving space for research and improved risk assessment. For example, it is not clear what is the relative contribution of the food producing environment compared to AMR already existent in the animals, and more could be done in assessing the effectiveness of current disease and hygiene control measures (Role played by the environment in the emergence and spread of antimicrobial resistance (AMR) through the food chain, EFSA, 2021). The environment can as well be a source of residues of AM, biocides or heavy metals that, even at low doses, may select for resistant organisms.

Globally, increased AMR pollution in water is predicted to have serious impacts on human health and the economy (The costs and risks of AMR water pollution, World Economic Forum, 2021).

There is a need to improve AMR surveillance of wastewaters in the community, hospital, animal and plant production sector (Technical brief on water, sanitation, hygiene (WASH) and wastewater management to prevent infections and reduce the spread of antimicrobial resistance (AMR), Tripartite, 2020), and to gather more scientific evidence on the use of such wastewaters for irrigation, as well as when using faecal material of human or animal origin (Joint FAO/WHO Expert Meeting in collaboration with OIE on Foodborne Antimicrobial Resistance: Role of the Environment, Crops and Biocides, Tripartite, 2019). It has also to be kept in mind that risk assessment, risk management, and policy/global level actions have to go hand in hand also when dealing with AMR in the environment (Briefing note: Antimicrobial resistance: An emerging water, sanitation and hygiene issue, WHO, 2021).

One Health approach to tackle AMR

The One Health approach is acknowledged to be central to tackle AMR (EU Action on Antimicrobial Resistance) and in Europe its success is particularly evident in the animal sector (Addressing antimicrobial resistance: progress in the animal sector, but this health threat remains a challenge for the EU, ECA, 2019).

Globally, although it is recognised that multisectoral work and the One Health approach are needed to tackle AMR (Monitoring global progress on addressing antimicrobial resistance: analysis report of the second round of results of AMR country self-assessment survey 2018, WHO, 2019), international organisations call for more effort to be put in legislative commitments, addressing problems of health and subsidising (One Health as a pillar for a transformative pandemic treaty, Global Health Centre Policy Brief 2021; Antimicrobial resistance. Report by the Director-General, WHO, 2021; Challenges to tackling antimicrobial resistance: economic and policy responses, WHO-Euro, 2020). Efforts should also be made in collecting details on the sales and use of Antimicrobials.



One Health approach to tackle pandemics

The COVID-19 pandemic highlighted to the world policy makers the strict connection between animals (both domestic and wild), humans, and the environment they share (G7 Health Ministers' Declaration, Oxford, 4 June 2021). As corollary, coordinated multi-disciplinary approach is seen as 'imperative' for the prevention and response to future crisis (A Coordinated Global Research Roadmap, WHO, 2020). Such collaborative approach should be active during an outbreak and also, importantly, before a crisis (Make science evolve into a One Health approach to improve health and security: a white paper, Osterhaus *et al.*, 2020). Legislation promotes the implementation of the One Health approach to prevent pandemics (Preventing the next zoonotic pandemic. Strengthening and extending the One Health approach to avert pandemics of animal origin in the region. FAO 2020) by creating the appropriate mechanisms (One Health legislation: Contributing to pandemic prevention through law, FAO, 2021). Nevertheless, One Health global governance has to be improved (Build back better in a post-COVID-19 world – Reducing future wildlife-borne spill-over of disease to humans, FAO, 2020) in the light of limitations of current treaties, and should include emerging issues like wildlife trafficking and live animal markets (One Health as a pillar for a transformative pandemic treaty, Global Health Centre Policy Brief 2021).

Sustainable food systems

Ensuring food security for next generations is a major strategic issue in the EU. Searching for sustainability must not jeopardise the policy goal of ensuring a high level of food safety. The EU conceptual framework intends food safety to be promoted from farm-to-fork, thus it calls for a One Health-based approach encompassing the health of humans and of food-producing organisms. EFSA will have the task to assess risks and benefits of changes intended to increase sustainability (e.g., circular economy practices); this task will need the support by a sustainable EU-wide structure with robust capacity on One Health.

Emerging trends: edible insects, synthetic meat, synthetic biology

Novel food applications will require expertise from different sectors to assess the risks. Such novel foods include insects (e.g. Edible insects: the science of novel food evaluations, EFSA, 2021) and lab-grown meat (EFSA's activities on emerging risks in 2019, EFSA, 2020), which are being approved for consumption in Europe (EFSA Strategy 2027 – Science, safe food, sustainability, EFSA, 2021). Limited data, however, complicate the assessment of environmental risks (Artificial meat and the environment, EEA, 2020).

Scientific uncertainties surround also the risk of introduction in the environment of synthetic biology organisms (Synthetic biology and the environment, EEA, 2020), including insects (Adequacy and sufficiency evaluation of existing EFSA guidelines for the molecular characterisation, environmental risk assessment and post-market environmental monitoring of genetically modified insects containing engineered gene







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drives, EFSA, 2020), and microorganisms (Evaluation of existing guidelines for their adequacy for the microbial characterisation and environmental risk assessment of microorganisms obtained through synthetic biology, EFSA, 2020), although widespread use of both is not expected in the near future.

Harmonisation of methods and data between sectors

Member States shall collect relevant and comparable data in order to identify and characterise hazards, to assess exposures and to characterise risks related to zoonoses and zoonotic agents⁵.

A major step in the direction of data accessibility and interoperability across sectors is the European Health Data Space, which aims at facilitating the sharing of high-quality data to support public health actions, research, and policy making.

Gaps in the harmonisation of One Health cross-sectoral methods exist too for surveillance of AMR in foodborne pathogens (EU Laboratory Capability Monitoring System (EULabCap), 2018, ECDC, 2020).

The trend of data interoperability is evident also at the global level, as international organisations highlight the need of protocols and procedures to be standardised across sectors. This would help, for example, the veterinary sector to contribute to tackling outbreaks relevant to public health (Veterinary Laboratory Support to the Public Health Response for COVID-19, OIE, 2020).

To tackle AMR data interoperability, further steps are being taken as data from WOAH will be comparable with that from FAO and WHO. WHO will be responsible for AMR and antimicrobial use (AMU) in humans, the standardised approach provided in the Global Antimicrobial Resistance and Use Surveillance System, GLASS, FAO for AMU in plants and AMR in animals, and WOAH for AMU in animals. The Tripartite Integrated System for Surveillance on AMR and Antimicrobial Use (TISSA) platform will visualise the AMR and AMU data of the various organisations.

The production of such high-quality data should be supported by adequate legislation (Antimicrobial resistance. Report by the Director-General, WHO, 2021).

Animal welfare and new human animal interrelationships

Animal welfare should be included in the efforts to improve animal health, and be coherent along the whole production-distribution chain, including in sectors like fisheries, trade, environmental and transport policies, in line with the goals of the Farm-to-Fork strategy (Revision of the animal welfare legislation (europa.eu). Risks to animal health will be increasingly important in EFSA assessments (EFSA Strategy 2027 - Science, safe food, sustainability, EFSA, 2021).

⁵ Consolidated TEXT: 32003L0099 — EN — 01.07.2013 (europa.eu)







A number of factors are changing the traditional human-animal interrelationships in the EU, including increasing role of pets as family components living with close contact with humans, extended range of companion animal species, including exotic animals that may escape and colonise environments. Additionally, an increased number of wild (i.e. non-domesticated) vertebrate species with synanthropic habits and/or expanding into urban habitats and the illegal trade or movements of exotic species, which may establish as alien species in new territories enhance the extent and diversity of human-animal contacts. This results also in an increased attention toward the maintenance and development of natural parks, reserves and other protected areas, along with many favourable aspects, it cannot be ignored that these areas may increase the shelters for vectors and reservoirs of zoonoses. Overall, the new societal trends on human-animal interrelationships will change, sometimes dramatically and the evolving epidemiological scenarios of many zoonoses should be carefully considered regarding emerging threats.

Sharing of information, communication with the public, and science to policy translation

Sharing of information and open communication between sectors and disciplines are crucial in outbreak settings (OIE ad hoc Group on COVID-19 and the human-animal interface, series, OIE, 2020) as well as in 'peace time' (Make science evolve into a One Health approach to improve health and security: a white paper, Osterhaus *et al.*, 2020) and should include intelligence from surveillance, research, preventive interventions, and therapeutics R&D.

Effective communication between experts and policy makers supports evidence-based decision making (The use of evidence in decision-making during public health emergencies, ECDC, 2021). Such evidence should be meticulously controlled by experts (Science Advice to European Policy in a Complex World, EC, 2019) and uncertainties and risk perception issues will have to be clearly communicated (EFSA's activities on emerging risks in 2018, EFSA, 2019). Communication with the public should be trustworthy and inclusive (Future directions for risk communications at EFSA, EFSA, 2021) and the engagement between scientists, policy makers and the public should initiate at the early stages (Science Advice to European Policy in a Complex World, EC, 2019). Accordingly, in the future, European authorities will engage even more with civil society (Food Safety Regulatory Research Needs 2030, EFSA 2019; EFSA Strategy 2027 – Science, safe food, sustainability, EFSA, 2021.

Other emerging issues

- Cost analysis of new technologies and interventions.
- Tools for real time monitoring (Food Safety Regulatory Research Needs 2030, EFSA 2019).
- Development of new antibiotics (2021 antibacterial agents in clinical and preclinical development: an overview and analysis, WHO, 2021).























Alternatives to antimicrobials in aquaculture (Joint FAO/WHO Expert Meeting in collaboration with OIE on Foodborne Antimicrobial Resistance: Role of the Environment, Crops and Biocides).

- Evaluation of EU policies (EU public health policy, European Parliament Think Tank, 2020).
 - Inclusion of microbiome into risk assessment (Exploring the need to include microbiomes into EFSA's scientific assessments; EFSA's expertise supports One Health policy needs).
 - Evaluation and implementation of digital technologies (Digital technologies for the surveillance, prevention and control of infectious diseases - A scoping review of the research literature, ECDC, 2021).
 - Whole genome sequencing (WGS): a technology increasingly used in outbreak investigation and risk assessment in the food sector (Whole genome sequencing and metagenomics for outbreak investigation, source attribution and risk assessment of foodborne microorganisms, EFSA, 2019).





2 VISION AND MISSION OF THE SRIA

This SRIA builds on the legacy of the One Health EJP, which is a unique European network of public institutions with reference activities in the domains of foodborne zoonoses, antimicrobial resistance and emerging threats, and encompassing animal health, public health and food safety.

The SRIA described in this document aims at broadening the One Health scope, and at reinforcing and consolidating the single European One Health consortium, which will guide partners towards a collaborative and coordinated, multi-disciplinary network where surveillance, laboratory procedures, risk assessment methodologies and intervention approaches are aligned across sectors and across borders, thus maximising the health of animals, humans and the environment, in Europe and beyond. An objective of this SRIA is to give guidance to candidate future European One Health consortia that will build on the outcomes of the One Health EJP.

Short-term vision: the SRIA of One Health EJP is useful for ongoing and starting One Health initiatives that look for practical ways to enhance cross-sector and cross-border cooperation on infectious diseases between public organisations responsible for animal health, public health and food safety, and with a mandate from their authorities.

Long-term vision: the SRIA of One Health EJP contributes to and promotes successful, sustainable, practical and fruitful One Health collaborations on common threats (i.e. microbial and chemical threats) between organisations responsible for animal health, public health and the environment, in Europe and beyond.

Mission: to create and consolidate aligned, dynamic and coordinated One Health collaboration among all actors responsible for public health, animal health and the environment in Europe. The One Health consortium will lead to aligned and harmonised surveillance systems that cover all threats of epidemiological importance, appropriate and validated laboratory methods for diagnosis, detection and characterisation, performant risk assessment methodologies, and that support effective risk management measures to optimally prevent outbreaks and aid the recovery from them.



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3 OBJECTIVES

3.1 Updated specific One Health EJP objectives

Following the One Health approach, the One Health EJP aims to create a sustainable European framework for multidisciplinary collaboration through the integration and alignment of activities among medical, veterinary, and food safety institutes with national reference laboratory functions. These organisations unite forces through joint prioritisation and conduction of research and integrative activities, as well as training and education exercises in the domains of foodborne zoonoses (FBZ), antimicrobial resistance (AMR), and emerging threats (ET), thereby matching the needs of both European and national policy makers and stakeholders.

The landscape of national and European reference laboratories has hardly changed during the last years, but the interest of One Health partners in the environment has grown, as well as their activities in this domain. European policies like the Green Deal and the Farm-to-Fork strategy, and wider interest in biodiversity, pandemic preparedness and climate change, leverage the need to structurally encompass environmental issues into the One Health approach.

Based on these evolving conditions (drivers), the following modifications to the original One Health EJP specific objectives are proposed for the continued and sustained work to be done by future upcoming One Health initiatives.

Objective 1. To bring together the major representatives of the European scientific community in the domains of FBZ, AMR and ET. The target scientists of the original One Health EJP (2018-2023) were mainly those dealing with official national mandates of reference and conducting research in those three domains. The continuous endeavour to integrate knowledge from different disciplines, while giving the necessary importance to all relevant viewpoints in the collective One Health approach, is crucial to improve our ability to prevent and respond to the threats posed by zoonoses and AMR. In recent years, One Health-oriented research within the One Health EJP and beyond has experienced an unprecedented growth and has developed rapidly in different directions. This was possible also thanks to the invaluable contribution of universities, research institutes, non-governmental organisations, local authorities, etc. without national mandates, but with substantial expertise in the three domains addressed by the One Health EJP. It is, therefore, preferable that a larger involvement of the One Health community beyond the One Health EJP is to be foreseen, as to synergise with each other and build upon existing knowledge. Moreover, collaborations with global (i.e. extra-EU) initiatives on One Health and partners outside the EU, shall be sought after or continued (e.g. UK) if possible. Ideally, in order to have major impact,





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the partners should cover most countries in Europe (i.e. EU and beyond), should include most of the organisations with a mandate from their authorities, and cover all or most of the sectors (animals, humans, feed, food, the environment) in their country.

Objective 2. To implement scientific projects related to the prevention and control of FBZ, AMR, and ET. The One Health EJP conducted joint research projects as proposed by national experts in the different countries participating in the One Health EJP, with additional input provided by key EU stakeholders, on FBZ, AMR and ET as related to five thematic areas: analytical methods, host-microbe interaction, epidemiology, risk assessment, and intervention. While all five thematic areas received consideration in the One Health EJP, some were relatively more often considered as a priority than others. Moreover, the One Health EIP consortium was enlarged to include new partners along the way and trends in One Health research have evolved as well. As a result, certain themes (and specific topics therein) that did not score very high in terms of priority for joint activities within the One Health EJP, have grown in importance over the years within the Consortium. This was the case of the theme's intervention and host-microbe interaction for FBZ, particularly for microbiome research in terms of microbiome modulation, and disinfection and treatment practices in the food production chain. For AMR, the strengthening surveillance systems, particularly those targeting the environment, as well as waste management and AMR in plant production, have emerged as subject areas needing more attention. The same can be said for pandemic preparedness, vector-borne diseases, and climate change for the ET domain. The importance of topics that have been the focus of most projects funded within the One Health EJP, such as the use of molecular typing methods, including WGS, and the development of analytical methods and tools for early warning, has also grown. Moreover, it is expected that these topics shall continue to be priorities for the One Health EJP partners as well as for other scientists in the future. Additionally, implementing future projects across all sectors will strengthen the collaborative and coordinated One Health consortia.

Objective 3. To stimulate scientific excellence by co-funding dedicated joint research projects. These projects were meant to enhance the scientific evidence base for the purposes of surveillance and other reference activities at the national and European levels in the domains of FBZ, AMR and ET. For FBZ, the research scope includes bacterial, viral, prionic, fungal and parasitic pathogens, as well as toxins produced by foodborne pathogens. AMR concerns both pathogenic and commensal bacteria. Research on ET is primarily focused on improvement of early warning, preparedness and response for threats emerging from 2017 onwards with a suspected zoonotic potential and has therefore included SARS-CoV-2 when the pandemic started. The growth of One Health research initiatives, within and outside the One Health EJP, has led to a progressive erosion of the traditional monodisciplinary 'silos



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of knowledge', with an increase in multidisciplinary collaborations to improve human, animal, and environmental health. Tackling FBZ, AMR and ET at the animal-human-environment interface are global priorities; thus, the expertise of the One Health EJP and the outcomes of the scientific activities performed by the Consortium have the potential to provide benefits for Europe and the world alike, and vice versa (i.e. the One Health EJP can benefit from similar initiatives globally). While the One Health concept aims at achieving human and animal health, and developing resilient and sustainable ecosystems using a holistic approach, the three branches of knowledge (i.e. medical science, veterinary science, and environmental science) and the individual disciplines therein (e.g. microbiology, epidemiology, bioinformatics, etc.) are still very much needed. Moreover, their relative importance to the overall goal is expected to vary depending on the domain in question (e.g. FBZ, AMR, ET), the importance that is ascribed to their objectives, and the specific (geographical and temporal) context they find themselves in. Both within and outside the One Health EJP, most hotspots in One Health research about FBZ pertain to the microbiological and epidemiological investigations of foodborne outbreaks. Indeed, studies tend to focus on the transmission, source tracing, surveillance and prevention of pathogens causing these outbreaks, using molecular epidemiological methods, and it is expected that these topics will continue to be a priority in One Health research. Moreover, because most research projects in the One Health EJP focus on humans and animals, and less on the environment, this latter component is expected to need more attention in the future. Similarly, the animals involved in the research activities funded by the One Health EIP are mainly farm animals, whereas companion and wild animals are less represented and shall then receive more attention as well.

Objective 4. To foster the harmonisation and standardisation of the reference methods and tests by bringing together scientific and technical expertise in the domains of FBZ, AMR and ET. These activities deliver standards and materials of reference, such as biological archives (biobanks) including collections of strains and DNA libraries, providing a One Health glossary, and envisage activities regarding training and capacity building, experimental facilities/models, detection and typing methods/protocols, digital infrastructure, data sharing protocols and bioinformatics, surveillance strategies, reporting and signalling, and legal/policy aspects. Most 'unique selling points' of the One Health EJP identified by the partners themselves referred to these activities, particularly the harmonisation of biosecurity protocols, best practices, analytical methods and sampling procedures, as well as One Health surveillance infrastructure, knowledge-integration/exchange platforms, and creation of national and international expert networks inter-sectorial collaborations. To train and improve the joint capability, capacity, and interoperability of authorities in public health, animal health and food safety the One Health EJP beneficiaries were offered to take part in the exercise SimEx. Recommendations were produced for any country aiming to improve their One Health strategy enabling a rapid, effective response to future zoonotic foodborne outbreaks.

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Joint Integrative Projects focusing on harmonisation and reference materials pave the way for comparable data from different countries and across sectors. Joint Research Projects also include integrative activities.

These points are of paramount importance for the field and summarise the main outcomes of several One Health EJP projects that may be beneficial for future partnerships.

Objective 5. *To exchange and communicate with all national and international stakeholders*. At the foundation of the One Health EJP, formal contacts were established with the EU stakeholders ECDC and EFSA, with representatives of such organisations joining the One Health EJP Stakeholders Committee. Strong interaction with ECDC and EFSA has been crucial. Stakeholder liaison actions consist of *i*) developing liaisons with EFSA and ECDC to ensure that the objectives of the consortium are in accordance with the overarching policies and mandates of the respective agencies, *ii*) maintaining current links and developing new ones with related networks in the EU. During the lifetime of the Consortium, the Stakeholders Committee expanded, welcoming the EU Agencies EEA and EMA, as well as the international organisations WOAH, FAO and WHO-Euro. While ECDC and EFSA still represented the Key EU Stakeholders, the inclusion of lead EU and global organisations highlighted the relevance of the One Health EJP for all the sectors of One Health, and its potential to benefit countries outside the borders of Europe, thanks to the support of the Tripartite organisations. Interaction with EEA, EMA, FAO, WOAH and WHO-Euro, in addition to ECDC and EFSA, allowed the identification of needs of a broader group of stakeholders' agencies and facilitated the wide dissemination of the outcomes of the One Health EJP across sectors and borders.

In parallel, focusing on the national stakeholders, an enlargement campaign was ran which aimed at the inclusion of all EU countries in the Consortium, ideally represented by one animal health and one human health organisation. The enlargement campaign resulted in six new partners from four previously unrepresented EU countries joining the One Health EJP consortium. In order to facilitate the uptake of projects outcome and to gain impact, communication and dissemination, and if possible, exploitation of outputs, is essential.

Objective 6. To promote and develop food safety research in the EU by training, education and communication. The research findings and identified new research topics were presented to the scientific community by designed scientific meetings and workshops. The agreed sphere of integrated scientific activities represented the themes of the joint training courses. By short-term missions, staff exchanges and target training, the scientific community had the opportunity to improve its skills in new techniques. The activities of the Consortium were promoted through a series of public engagement activities involving both national and international policymakers and the general public. PhD research



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and other training activities effectively complemented the research and integrative activities and were developed around the three research domains. PhD projects provided excellent added value, including improved integration (both geographical and interdisciplinary), and an opportunity to develop the next generation of scientists in One Health. Training and Education are essential to train the future One Health experts and add to the impact of the One Health consortium.

3.2 Additional objectives addressed in this SRIA

Besides the specific objectives presented above, additional objectives have been identified during the course of the One Health EJP based on results of projects, inputs from institutional stakeholders, new perspectives brought forward by global scenarios such as the COVID pandemics and climate change, and most importantly the new EU strategies Green Deal and Farm-to-Fork. These have had important implications for the activities and goals of the One Health EJP.

Noticeably, most additional objectives are particularly relevant to the environmental pillar of One Health. As outlined also in the One Health EJP Summer School Environmental issues in One Health (July-August 2021) the environment is a key component of the One Health EJP conceptual framework, as well as of One Health EJP goals and activities. While important, the multi-faceted roles of environment in the One Health framework are still emerging and are foreseen to gain even more momentum in the future. This is highlighted by the new Green Deal and Farm-to-Fork strategy, emphasising food chain sustainability, as well as by the UN Sustainable Development Goals (SDG).

Additional objectives identified in this SRIA are:

A conceptual and operational framework for the role of the environment in the One Health EJP SRIA There is a need to identify the priority areas for One Health EJP goals and activities such as: the role of water bodies and their ecosystems in the ecology and epidemiology of zoonotic agents, a conceptual and operational characterisation of different wildlife species as vector of zoonoses based on their biology and ecology.

The role of global warming in the epidemiology of biological hazards

For activities that take place at the interface of public health, animal health and the environment it is necessary to assess the pathways by which global warming may increase the exposure of humans, animals and the ecosystems to biological hazards such as the increase of alien species bringing infectious agents into vulnerable ecosystems, the spread of arthropod vectors bearing viruses and other infectious agents from tropical areas to temperate regions, including the EU release of infectious agents from permafrost.

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Preparedness to future pandemics

The Covid-19 pandemic has provided several important lessons. One lesson is that preparedness is needed since other pandemics are expected in a changing globalised world; in the last decades most emerging threats were of zoonotic origin, thus preparedness to future pandemics needs to adopt a One Health approach. This requires facing such challenges as surveillance programmes for wildlife, integrated platforms for multi-source data analysis and analysis of obstacles and boundaries toward One Health-preparedness, all to be prepared in 'peace time'.

Food safety, food security and sustainable food systems

The new EU Farm-to-Fork strategy foresees the integration of food safety goals - which remain a high-rank priority for the EU - with food security and sustainability. This clearly calls for integrated strategies to protect and promote the health of humans, food-producing animals and the ecosystems. This requires facing challenges such as One Health approaches to assess the hazards inherent to circular economy, assessment of the impact by strategies intended to enhance food chain sustainability (in terms e.g., of greenhouse emissions) on foodborne zoonoses and other foodborne hazards, including emerging or re-emerging threats and strategies to improve the security of foods of animal origin while ensuring a high level of food safety.

The role of changing techniques in animal production

The evolving animal farming techniques must be assessed from the standpoint of risk assessment for zoonoses, both foodborne and non-foodborne. This includes: i) new epidemiological scenarios due to the changing attitude toward animal welfare; *ii*) reduced use of antimicrobials in animal production with emphasis on good practice and biosecurity; iii) the foreseen increase of organic farming, bringing a decreased stress, hence a potential higher resistance to infections, as well as an increased exposure to the environment and wild animals.

Important sectors of animal production outside the terms of reference of the initial One Health EJP

The current main farm animal production of cattle, pigs and poultry cannot be extended anymore due to their consumption of vital resources, such as land and water, contribution to global warming and noxious emissions. While optimisation of farming techniques may achieve substantial improvements, emphasis should be on other sources of animal origin, including: aquaculture: farmed freshwater and saltwater is steadily increasing as source of animal proteins, with favourable aspects from the standpoint of human nutrition (omega-3, iodine, etc.). Notwithstanding its value, aquaculture needs more attention from the standpoint of biological hazards, including fish-borne zoonoses, contamination of water and contamination by toxin-producing bacteria.





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Insects are novel foods that receive a growing interest in the EU: hence, identification and characterisation of biological hazards are required as well as the definition of good breeding practices for hazard prevention, control and management.

The issues posed by the additional objectives will last well beyond the One Health EJP life. However, the sustainable knowledge, methods and networks developed by the One Health EJP will represent an essential support for risk assessment, prevention and response.

3.3 One Health EJP addresses the UN Sustainable Development Goals (SDGs)

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future' (The 2030 Agenda for Sustainable Development). The Sustainable Development Goals (SDGs) provide agreed strategies on socio-economic and technical developments that improve health and education, reduce inequality, and stimulate economic growth, while tackling climate change and working to preserve healthy ecosystems. The SDGs are an urgent call for action by all countries - developed and developing - in a global partnership. The One Health EJP is part of the global partnership and has worked towards several SDGs. More specifically, the SDGs and targets shown below have been in focus throughout the course of the One Health EJP, and, importantly, will continue to be central to activities that will ensure the sustainability of the One Health EJP. For simplicity, only extracts of the targets are shown.

Goal 17: Partnerships for the goals. Strengthen the means of implementation and revitalise the Global Partnership for Sustainable Development.

Key targets relevant to One Health EJP:



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17.6 Collaborate and share knowledge about science, technology and innovations.

17.8 Strengthen the scientific, technological and innovative capacity of the least developed countries.



Figure 3. The UN Sustainable Development Goals addressed by the One Health EJP and to be continued in future activities.


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The work of the One Health EJP has been based on collaboration where knowledge about science, technology and innovation has been developed and shared. The information, coupled with the communications platform build by the One Health EJP, has informed well-founded decision-making regarding AH and PH. Close communication was established with authorities, nationally, at the EU level and internationally, such as within the Stakeholders Committee meetings and conference, and through targeted reports to key EU Stakeholders, national mirror groups meetings and a policy event as well as participation in simulation exercise and dissemination workshops. Extensive and broad research collaboration, both nationally, within EU and beyond (JRPs) has been established. JIPs have liaised national reference, EU reference laboratories and scientists (JIPs). Targeted efforts and events, for example, ASM, summer school and project meetings have facilitating dialogue and communication of research results. Knowledge has been shared through broad dissemination of scientific results through scientific publications, One Health EJP newsletter and reports, and open access offers availability to the least developed countries.

Goal 3: Good health and well-being. Ensure healthy lives and promote well-being for all at all ages.

Key targets relevant to One Health EJP:

3.d Strengthen the capacity for early warning, risk reduction and management of national and global health risks;

3.3 End epidemics.

The One Health EJP has contributed to this goal by developing tools and methodologies to enhance the prevention, detection and response to infectious diseases and reducing the risks of serious disease outbreaks. Scientific and integrative projects have worked to monitor, prevent, combat and improve diagnosis of serious animal diseases and zoonoses and AMR. A simulation exercise has reinforced the capacity for early warning, risk reduction and management of health and epidemic risks.

Goal 2: Zero hunger. End hunger, achieve food security and improved nutrition and promote sustainable agriculture.

Key targets relevant to One Health EJP:

Target *2.1* Safe and nutritious food for everyone; Target *2.4* Sustainable food production and resilient farming practices. One Health EJP has importantly contributed to this goal through its work to make food safe and food





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production sustainable. Healthy animals benefit of well-being, grow better and have less impact on the environment, which makes animal production more sustainable. Research and integrative work has contributed to counteract the spread of serious animal diseases, foodborne infectious and antibiotic resistance.

Goal 9: Industry, innovation and infrastructure. Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation.

Key targets relevant to One Health EJP:

Target 9.5 Enhance scientific research, upgrade the technological capabilities, encourage innovation and increasing the number of research and development workers; Target 9.b Support technology development, research and innovation.

One Health EJP has made important R&I contributions that enhance the scientific and technological capabilities and infrastructure of the EU to meet the challenges posed by FBZ, ET and AMR. Altogether the work has resulted in modernisation and harmonisation of diagnostic and research methods and tools. Capacity building and training of young researchers have strengthened the EU resource of R&D workers in One Health. Outcomes made publicly available benefit R&D workers at large, including in developing countries, as well as the industry.

The One Health EJP has also worked towards *i*) *Goal 12*. Responsible consumption and production, by making animal production more sustainable and with the importance of AMR in focus, *ii*) *Goal 4*. Quality education, by offering training and education in One Health, in particular to young scientists and with gender balance in mind (addressing also *Goal 5*. Gender equality), *iii*) *Goal 13*. Climate action, indirectly by providing new scientific knowledge on the ecology of pathogens, the development of tools to detect pathogens and AMR in the environment and the identification of environmental risk factors.

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4 EXPECTED IMPACTS

Scientific impact is measurable using classical investigation tools (e.g. number of publications, number of new research projects based on earlier achievements and deliverables, etc.), however, such approaches do not demonstrate that the outcomes developed are taken into use, benefitting human and animal health.

Operationalisation of One Health-developed solutions is paramount to support the process of prevention, detection and response to infectious threats. This uptake is facilitated if the underlying research follows a planning (a Strategic Research & Innovation Agenda) agreed on beforehand by the end users (i.e. relevant authorities, for instance ministries responsible for public health, agriculture, food safety, etc.) and the research performing organisations (e.g., reference laboratories), and thus by a detailed previous dialogue between the actors.

It is expected that the uptake and application of One Health EJP tools and solutions will have important scientific and policy impact that will continue in the future, after the end of the One Health EJP. Partner institutes that have already implemented One Health EJP tools and solutions can provide experiences and further developments.

The use of the tools and solutions at the national level have been facilitated by the following elements:

- Priority research and integrative activities were the result of a structured prioritisation process, and they followed a SRA agreed on by line ministries of partner institutes (e.g. ministries of health and agriculture);
- All partner institutes had national mandates of reference in the domain of AMR, FBZ and ET, facilitating the incorporation of developed solutions in their official tasks;
- Dissemination of outcomes was performed at dedicated, regular meetings of Programme Owners Committee (POC), Programme Managers Committee (PMC), and Scientific Steering Board (SSB);
- The training by cross-sectorial participation in the One Health EJP exercise SimEx.

The use of the tools and solutions at the *European and international national level* have been facilitated by the following elements:

- ECDC and EFSA played an active role in the prioritisation of research and integrative topics;
- Discussion on how the developed outcomes could efficiently be taken up and benefit European



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and international stakeholders was performed at regular meetings of the Stakeholders Committee, which included representatives of the agencies ECDC, EFSA, EEA, EMA, FAO, WOAH, WHO/Euro:

European and international stakeholders appointed dedicated contact points to follow selected One Health EJP projects, and to facilitate the uptake of the tools and solutions at the stakeholder's organisation (bilateral collaborations);

Additional tools of dissemination and support to national and international stakeholders existed in the form of workshops, reports, consultations etc.

To achieve impact, the elements named above illustrate the importance of i) good planning of the research and integrative activities involving end-users, stakeholders and ministries ii) a clear and well documented research strategy, in a SRA or SRIA, iii) a clear and transparent process to prioritise activities; iv) involvement of partner institutes with reference mandate in the domains involved, v) good understanding of the needs of national and international stakeholders enabled by regular and clear discussions and vi) dissemination of outcomes facilitated by identification of the main outcomes that can be taken up, an attractive and performant communication process and targeting the most relevant stakeholders.

The One Health impact resulted from the contribution of the developed outcomes to improving health of animal and humans, and safety of food, was depicted at POC, PMC, SSB and SC meetings, i.e. meetings of national, European and international stakeholders. Alongside dissemination of advancement in scientific knowledge, these meetings provided an occasion to highlight the impact and potential impact at the policy, societal and economic level. Benefits resulting from the application of developed outcomes were shown by programme beneficiaries, and, importantly, discussed directly with scientists.

Additional dissemination to national decision makers was performed by targeted Dissemination Workshops (Dissemination Workshop on Improving One Health Preparedness to (re) Emerging Infectious Threats, Dissemination Workshop on Metagenomics). Focus of this series of workshops was the applicability of project outcomes, and the benefit to the prevention, detection, and response to One Health threats. Given the focus on practical applications, the workshops were designed to target an audience of policy makers and risk managers in the fields of public health, animal health and food safety: those involved in coordinating practical implementation and those involved in wider strategic future plans, not necessarily with a technical background. To maximise the usefulness, topics were selected and prioritised based on stakeholders' input.

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At the European and international level, focus was put on maximising the benefit of One Health EJP results in the light of shifting priorities during the lifetime of the One Health EJP (see section 1.2. The present). One tool to keep up with stakeholders' evolving priorities were the Thematic Reports (Thematic reports). In these reports One Health EJP research and integrative outcomes were related to stakeholders' needs as identified in stakeholders' documents and during dialogue with stakeholders. Thematic Reports were a tool to present how One Health EJP addressed stakeholders' emerging knowledge gaps, and how developed solutions could be applied to specific issues.

The One Health EJP achieved impact also thanks to its direct support to policy initiatives, and to its advocating activity, employing the knowledge created by the One Health EJP consortium to shape the European and international One Health environment.

Input was given to major European One Health policy initiatives (e.g. EU4Health, HERA) by taking part in stakeholders' consultations and meetings, either following invitation or by One Health EJP's own initiative. In addition, support was provided by contributing to Preventing Zoonotic Diseases Emergence (PREZODE), as partner institutes and as a Consortium as a whole, and to international activities. Examples of impact at the international level include joining and supporting activities of the WHO-Global Outbreak Alert and Response Network (GOARN), and joining the Partner Platform of the Regional One Health Coordination Mechanism.

Contribution to stakeholders' initiatives allowed not just broader application of the One Health EJP tools and solutions compared to that foreseen in the SRA, but provided also opportunities to take advantage of the well-consolidated network of institutions (e.g. dissemination of GOARN calls for action).

Impact at the policy, economic and societal level is not a natural consequence of scientific research, but requires additional well-thought initiatives, as well as engagement of specific stakeholders. Impact and potential impact at the policy, economic and societal level was highlighted during meetings with national, European, and international stakeholders, and will also be the focus of the *ad hoc* event Stakeholders Conference, that will take place in 2023. The latter targeting also sectors not traditionally associated with One Health initiatives (e.g. industry, associations, consumers).

A different kind of long-lasting impact to the European One Health environment was achieved by the input into new research programmes and the funding and training 17 successful PhD projects, resulting in the formation of the same number of future One Health experts.



Image: Pxhere



5 PRIORITY RESEARCH AND INTEGRATIVE TOPICS

5.1 The priority research and integrative topics of the One Health EJP

The priority research topics and priority integrative topics of the SRA are the result of a structured prioritisation process and formed the basis for launching the two internal calls for proposals for joint research projects, joint integrative projects, and PhD projects within the 5-year period of the One Health EJP.

To provide a basis for the SRA, a strategy matrix was developed consisting of three domains, i.e. foodborne zoonoses (FBZ), antimicrobial resistance (AMR), and emerging threats (ET); and five themes, i.e. analytical methods, host-microbe interaction, epidemiology, risk assessment, and intervention, resulting in 15 research areas. In the preparatory phase of the One Health EJP in 2016, a provisional SRA was developed. To this end, the One Health EIP partners were invited to nominate national experts based on the strategy matrix, i.e. one expert per research area (maximum of 15 experts per country). Subsequently, these experts were asked to suggest top three research topics for each of the 15 research areas of the strategy matrix, as well as three integrative activities. Similar research topics were then grouped into broader topics, resulting in a list of maximum five research topics per research area (maximum 25 topics per domain). Furthermore, the integrative activities were categorised into seven integrative topics, reflecting a series of integrative needs along the prevent-detect-respond chain, and corresponding to work procedures and infrastructures where harmonisation and alignment serve to strengthen the joint capacity. In May 2016, an experts meeting was held at the ANSES in Paris, France, involving 60 experts selected based upon nomination by the partner organisations and based on their expertise as to cover the strategy matrix. Based on the list of research topics and the list of integrative topics, priority research and integrative topics were identified by the experts following an established protocol based on a Multi-Criteria Decision Analysis (MCDA) procedure. This procedure resulted in nine ranked priority research topics for FBZ, seven for AMR, five for ET, and seven ranked priority integrative topics. Final ranking and selection of priority topics for the first internal call for project proposals were done by the One Health EJP's Scientific Steering Board (SSB) in June 2016. The SSB selected the four highest ranked research topics in the FBZ domain, the three highest ranked research topics in the AMR domain, the first ranked topic in the ET domain, and the two highest ranked integrative topics (see Table). The first internal call for project proposals launched in June 2016 consisted of a 2-step procedure, including an expression of interest (letter of intent) followed by final project proposals. The project proposals were evaluated by external examiners. The final selection of JRPs and JIPs was done by the SSB in November 2016. This resulted in eleven research and two integrative projects granted for the first round.



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In 2018, in the first half year of the One Health EJP, the provisional SRA was further developed to prepare the second internal call (launched in October 2018). Compared to the development of the provisional SRA, in 2016, a few new partner organisations were involved. The first step of the procedure for developing the SRA was to perform a gap analysis to identify first round topics insufficiently covered by the projects granted in the first round. Topics that were sufficiently covered were not to be included in the second round of project proposals. Subsequently, in June 2018, an experts meeting was held at the RIVM in Bilthoven, the Netherlands. As the firstround research topics were rather broad and unspecific, the goals of this latter meeting were to narrow down the first round research topics (to give them more focus) and to prioritise the narrowed down research, as well as integrative, topics to identify priorities for the second internal call. Both the narrow down and prioritisation procedures were based on an established protocol that guaranteed consideration of: 1) national priorities (i.e. individual topics proposed by the One Health EJP partners in 2016 and by newly joined partners, reflecting the importance of specific topics in the whole Consortium); 2) European stakeholders' research needs (from EFSA and ECDC); 3) gaps in the current work plan (i.e. results from the gap analysis of first round topics); and 4) strategic interactions with other EU projects and initiatives. The narrow down session resulted in a total of 19 narrowed down research topics. In addition, 15 additional research topics were included by the One Health EJP's Project Management Team (PMT) based on the stakeholders' needs unaddressed in the narrowed down topics. The prioritisation procedure for the 34 research topics, as well as for the five integrative topics, consisted of a MCDA using a tool and pre-defined criteria and scoring system. After the prioritisation, in June 2018, a Stakeholders Committee meeting was organised in Brussels to present and discuss the preliminary lists of priority research and integrative topics, and particularly to clarify how the needs of EFSA and ECDC were taken into account. Furthermore, the meeting aimed at obtaining guidance for the detailed description of the topics, verifying whether any newly emerged needs were to be considered, and exchanging mechanisms for interaction to avoid duplication of work and identify strategic synergies. After this step, updated lists and descriptions of ranked priority topics were developed,

	FOODBORNE ZOONOSES	ANTIMICROBIAL RESISTANCE	EMERGING THREATS
Analytical methods	Development and harmonisation of NGS-based methods for detection and tracing of FBZ agents, emerging threats and AMR determinants(1) Better tools for detection and investigation of foodborne outbreaks, including antimicrobial resistant pathogens, as well as economic assessments of potentially increased cluster detection through whole genome sequencing (2)	Development and harmonisation of phenotypic methods (1) Development of new tools for early (real-time) detection of resistant pathogens in humans and animals, as well as new diagnostic tools, in particular on-site tests for humans and animals (2)	Development and harmonisation of non-NGS-based methods for detection of FBZ agents and emerging threats (1) Development of a toolkit to characterise emerging threats by combining genomic and phenotypic information (2) Development and harmonisation of NGS and non-NGS methods for the detection of foodborne parasites (2)
Host-microbe interaction			
Epidemiology	Improved surveillance systems and harmonised data analyses (1) Source attribution and transmission routes (1) Source attribution of bacterial foodborne zoonoses and antimicrobial resistance considering also the environment and non-livestock reservoirs (e.g. pets and wildlife) as sources (2) Source attribution and transmission routes of foodborne pathogens other than bacteria, with emphasis on <i>Toxoplasma gondii</i> (2) Determinants of the reversal of the decreasing trend in Salmonella incidence in humans and poultry in the EU (2)	Epidemiological studies into the dynamics of AMR in human and animal populations and the environment including horizontal gene transfer and selection of AMR (1) Dynamics of AMR selection, clonal spread and horizontal gene transfer in humans, animals and the environment, including epidemiology of resistant microorganisms and antimicrobials in the environment and their (environment-mediated) spread (2)	
Risk assessment		Risk Assessment AMR (1)	
Interventions	Biosecurity and other interventions (1) Benchmarking biosecurity practices for pig farming across Europe using national surveillance data and management standards for identifying best practice to prevent biological hazards, particularly Salmonella and hepatitis E virus, from entering the food supply chain (2)		
Integrative topics	Interpretation of surveillance data - Standardised data formats and ontologies, common tools and procedures for data analyses, including interpretation of sequence data (1) Common reporting and signalling procedures, joint platform for sharing surveillance data and their interpretation, incl. risk assessments (1) Joint databases of reference materials and data, incl. metadata (2) Harmonised protocols and common best practice (2) Common frameworks for design and methods to assess equivalence between surveillance and control activities (2) Mentoring (twinning) system for sharing of best intervention practice (2)		

Table 1. Selected research and integrative topics in the first (1) and second (2) internal call for project proposals

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validated by the PMT, and submitted to the SSB for final validation and selection. In October 2018, the SSB selected the research and integrative topics to be included in the second call for project proposals. In total, nine research topics (five for FBZ, two for AMR, and two for ET) and four integrative topics were selected by the SSB for the second round. An overview of these topics is presented in Table 1. Also, the second internal call for project proposals consisted of a 2-step selection procedure like in the first round. The final selection of JRPs and JIPs was done by the SSB. This resulted in nine JRPs and three JIPs granted for the second round.

As One Health oriented research and other activities are continuously evolving in different directions, even within the One Health EJP consortium itself, scientific developments in the field were monitored also after the second round of project proposals in order to understand where the One Health community mainly focuses on (i.e. the research hotspots or 'hot topics'). This was relevant also for identifying potential gaps present in the SRA, as well as the changing national priorities of the One Health EJP partners (partly determined by the COVID-19 pandemic), to identify new opportunities for innovation in One Health for whatever shall come after the end of the One Health EJP. For these reasons, a second gap analysis was performed to identify what was still left to do within the One Health EJP based on the activities that were prioritised and funded in the second round of project proposals. Moreover, an analysis of the current 'hot topics' in One Health, both within and outside the One Health EJP consortium, was performed along with a rapid consultation of the One Health EJP partners to identify new or different national priorities in the Consortium.

From these activities, it was concluded that:

Overall, the SRA largely covers the research priorities of the One Health EJP partners and does not have major gaps in terms of priority topics of interest for the One Health EJP consortium as a whole, with all selected topics being sufficiently covered (content-wise) by the funded projects.

The few minor gaps present in the SRA concern mainly a relatively limited spectrum of pathogens, antimicrobial resistance types and livestock sectors included as the focus of the research activities. Moreover, for a wider use in different EU organisations, the several tools developed by the projects need to be thoroughly assessed in terms of compatibility and applicability.

The holistic perspective of One Health in the One Health EJP could be better reflected by focusing more on the environmental component. An underrepresentation of the environmental component is also evident in the research hotspots, as these tend to focus mainly on humans and animals, and less on the environment. This is particularly evident for antimicrobial resistance, for which the strengthening



Image: Pxfuel



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of surveillance systems, particularly those systems targeting the environment, as well as waste management, is a hot topic. Furthermore, the animals involved in One Health research are most often farm animals, whereas companion and wild animals are less represented.

Most One Health research outputs seem to focus on studies dealing with microbiological and epidemiological investigations of foodborne diseases, particularly outbreaks, including their transmission routes and sources, as well as surveillance and prevention activities, using mainly molecular epidemiological methods. This reinforces the relevance (for the One Health EJP partners) of the content of the SRA, as these topics are well covered by the SRA, particularly the focus on molecular typing methods in surveillance and the development of analytical methods and tools for early warning and outbreak investigation.

For FBZ, topics dealing with interventions and host-microbe interactions, particularly microbiome research in terms of microbiome modulation, and disinfection and treatment practices in the food production chain, are 'hot', albeit underrepresented in the SRA as such and shall therefore receive more attention. The same can be said for pandemic preparedness and (re-)emerging threats, according to the needs highlighted by the COVID-19 pandemic, including topics like vector-borne diseases and climate change, which are not covered by the SRA as such.

The harmonisation of biosecurity protocols, best practices, analytical methods and sampling procedures, integrated surveillance infrastructure, knowledge-integration and exchange platforms, and creation of national and international expert networks for inter-sectorial collaborations, are recognised as 'unique selling points' of the One Health EJP consortium and shall continue to be its main distinctive features.

5.2 Priority topic of the SRIA: AMR

Introduction, rationale, challenges, and opportunities

Antimicrobials are compounds that are important for treating infections in humans, animals and plants. Antimicrobial resistant organisms are found in people, animals, food, plants and the environment (in water, soil and air). They can spread from person to person or animals and people, including from food of animal origin and their environments. Antimicrobial Resistance (AMR) has a significant social and economic impact, and especially when transmitted via food and when they result in treatment failures, therefore, need to be addressed by all actors in the Farm-to-Fork continuum. The emergence and spread of drug-resistant pathogens that have acquired new resistance mechanisms, leading to antimicrobial resistance, continues to threaten our ability to treat common infections. Especially alarming is the rapid



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global spread of multi- and pan-resistant bacteria that cause infections which are not treatable with existing antimicrobial medicines such as antibiotics⁶.

The main drivers of antimicrobial resistance include: the misuse and overuse of antimicrobials; societal and environmental changes, including changes in land use, operation of large terrestrial and aquaculture food production units, and microbial pollution of land and water sources; lack of access to clean water, sanitation and hygiene for both humans and animals; poor infection and disease prevention and control in health-care facilities and farms; poor access to quality, affordable medicines, vaccines and diagnostics; lack of awareness and knowledge; and lack of enforcement of legislation. The cost of AMR to the economy is significant and if no action is taken it could reach £66 trillion by 2050.

Antimicrobial resistance is considered a silent pandemic, a global threat for human, animal and environmental health, which requires urgent multi-sectoral action. The One Health approach brings together multiple sectors and stakeholders engaged in human, terrestrial and aquatic animal and plant health, food and feed production and the environment to communicate and work together in the design and implementation of programmes, policies, legislation and research to reach better public health outcomes.

New evidence recently published by The Lancet demonstrates the significant impact AMR is causing to global health, with more than 1.2 million deaths attributable to antibiotic-resistant bacterial infections in 2019 alone. In the most comprehensive analysis to date of the burden of AMR, the Global Research on Antimicrobial Resistance (GRAM) report findings show AMR is now the leading cause of death worldwide, exceeding the death toll caused by HIV/Aids or malaria. The consequences of increasing global food chains may have tremendous consequences for food safety including the widespread dissemination of AMR. The continued use of antibiotics in some countries threatens this further.

In 2015, the World Health Organisation (WHO) announced AMR as one of the greatest threats to public health. A Global Action Plan to combat AMR was endorsed that underscores the One Health approach involving coordination among numerous sectors and actors, including human and veterinary medicine, agriculture, environment, and finance. Since then, AMR has risen to the top of the global health agenda with various institutions weighing in, including the UN Environment Assembly, the Council of the European Union, the G7 the G20, the European Union and the UN General Assembly, that lead to the setup of the UN Interagency Coordination Group on Antimicrobial Resistance (IACG).





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The overall challenge is to enhance the prevention, detection and control of AMR in pathogens and commensal bacteria. AMR is particularly problematic because the discovery and development of novel antibiotics has slowed while antimicrobial use to treat bacterial infections has increased. Antifungals, antivirals and anti-parasitics have gained much less attention but resistance is causing a problem too. The global challenge to address AMR goes beyond the production of new antimicrobials and therapies. Reducing demand for new antimicrobials through public awareness, infection prevention and control, and prudent, rational use of antimicrobials within a One Health approach, and the rapid and accurate diagnosis and surveillance of antimicrobial resistant infections and the accurate monitoring of antimicrobial sales and use, are also vital to deal with this problem globally. This highlights the need to understand the complex processes behind the emergence and spread of AMR to contribute to prevent-detect-respond properly.

Scientific challenges arise through the ongoing emergence of new resistance gene and mutations, their global spread which is closely interrelated with trade, travelling of people, climate change and changes in biodiversity, spill over to livestock, the environment, or humans.

Technological progress (detection, typing, diagnostics, alternatives) facilitate investigations into AMR across species and environmental barriers in more detail. Thus, action is needed to identify and characterise existing and emerging risks linked with AMR in a multi sectoral approach involving different fields of expertise, among them medical, veterinary, food and environmental sciences. Technological progress towards prevention needs to be exploited to address drivers of resistance in addition to protecting populations at risk.

Interdisciplinary and intersectoral networks and principles for collaboration, involving multiple institutions and considering different funding and mandating mechanisms need to overcome inefficient exploitation of new techniques, redundant or overlapping research activities, suboptimal systems for risk assessment and management, missing opportunities for solutions.

Societal challenges include improved awareness of risks linked with AMR and understanding of contributing factors which involves closely the society.

New key **policy** developments need to support implementation of a One Health approach, with consideration of challenges due to globalisation as well as to achieve the EU Farm-to-Fork strategy and the SDGs. EU and global initiatives and policies need to strengthen international cooperation and coordination to limit this silent pandemic. Efficient communication and dissemination across sectors, borders and from science to policy and society need to be addressed.



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Economy: Investments are required to tackle the silent AMR pandemic in the form of better stewardship schemes and investment into the development of new antibiotics and alternatives to antibiotics (vaccines, probiotics etc.).

There are plenty of opportunities. The Consortium established and consolidated in the One Health EJP is an excellent basis to apply a One Health approach providing transdisciplinary, cross-sectoral expertise to address the challenges to prevent, detect and respond to AMR. International collaboration established reaches far beyond the EU, providing support on European and global level. It provides the capacity to collect and analyse information, to support the application of state-of-the-art diagnostic and surveillance tools, to harmonise new diagnostic tests and approaches. New approaches can build on harmonised methodologies, databases and procedures for the prevention, detection and control of AMR.

The outcomes made publicly available are urgently needed by the scientific community for science-based risk assessments as well as risk management recommendations to stakeholders including authorities, policy makers, industry and citizens. Linking epidemiological knowledge, animal health and animal welfare issues as well as the assessment of treatment strategies (i.e. the use of pre- and probiotics, alternatives for antimicrobials, vaccination, improved biosecurity and hygiene) will give important guidance to antimicrobial stewardship (AMS) approaches. Considering consumer demands on livestock and food production and producers' interests at all stages through increased involvement of social science expertise will contribute to sustainability and AMR risk reduction.

Additional opportunities arise from enhanced transdisciplinary cooperation and integration of activities through training of the next generation of scientists, stakeholders and policy makers tackling issues in the fields of AMR.

R&I objectives

Within the One Health EJP an excellent basis for future work on topics linked to AMR and its drivers were set. This covers important topics, which should be sustained after the lifetime of One Health EJP and complemented with new aspects addressing further challenges. One main topic identified is the broadening of the One Health approach by strengthening collaboration on environmental aspects beyond the current scope. Other aspects deal with globalisation and climate change and related risks. Translation of research into policy action remains demanding and should address national, European and International needs.





The **general objective** of research and innovation should be to better **control** AMR and related threats, and to specifically reduce the drivers and supporting conditions of AMR by all actors.

The **specific objectives** of One Health EJP in the context of AMR can be updated as follows:

- To foster and broaden the interdisciplinary and inter-sectoral collaboration and cooperation of major representatives of the European scientific community in the fields of AMS, AMU and AMR;
- To promote and develop AMR research in the EU through training, education and communication;
- To boost research, stimulate scientific excellence and close knowledge gaps to enhance the scientific evidence base required to prevent, detect, and respond to AMR threats at the national, European and international level;
- To foster the harmonisation and standardisation of methods and tests for AMR and to develop new methods through collaborative working and the sharing of scientific and technical expertise in the field of AMR;
 - To strengthen exchange and communication with all national and international stakeholders and contribute to the uptake in the global strategies to tackle AMR.

The **operational objectives** have taken into consideration the operational objectives in the European Partnership for Animal Health and Welfare and are organised in line with the priority topics identified within One Health EJP, namely:

Analytical methods (diagnostics)

- To develop diagnostic procedures, methodologies and tools to support the monitoring of AMS, AMU and AMR;
- To develop and improve diagnostics to improve the pragmatic and targeted use of antimicrobials and alternatives to antimicrobials.

Host-microbe interaction

To better understand how AMU and AMR influence the host and especially the host microflora and susceptibility to infection.

Epidemiology (and surveillance)

- To develop procedures, methodologies and tools to improve and harmonise surveillance and monitoring systems for AMU and AMR;
 - To strengthen efforts to understand the drivers of AMR and thus preventing the transmission and spread of AMR.

Risk Assessment

To adapt risk assessment and policy support to address the needs in tackling AMR in a more holistic approach.



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Intervention, prevention and preparedness

- To strengthen preparedness for future needs;
- To develop guidelines and preventive tools to help mitigate against AMR and the associated drivers using a One Health approach;
- To develop new interventions and treatments, or improve existing ones, to reduce AMS, AMU and AMR;
- To increase access to vaccines, alternatives to antimicrobials, interventions and treatments;
- To encourage the development of novel alternative to antibiotics;
- To consider economic aspects of intervention measures and options.

Integrative and overarching activities

- To develop an integrated approach on AMS, AMU and AMR including socioeconomic aspects of animal health, human health, environmental and ecosystem health;
- To contribute to capacity building;
- To improve understanding and explore ways to overcome behavioural and socio-economic barriers.

Communication of science to policy and society

- To deliver scientific evidence to risk assessors and policy makers;
- To communicate scientific outcomes to society;
 - To communicate science outcome and educate the One Health leaders of the future.

Research and innovation and communication activities that will ensure sustainability in the future

In One Health EJP, **research** on AMR was organised around five themes (Analytical methods, Host-microbe interaction, Epidemiology, Risk assessment and socio-economic impact and Intervention) which are slightly modified below. From the previous research objectives given in the Strategic Research Agenda of the One Health EJP the following activities should be addressed in the future to meet the operational objectives towards sustainability:

Analytical Methods (incl. integrative themes on laboratory methods and reference materials)

- Improved and validated detection and characterisation methods, i.e.
- Detection of AMR to improve prescribing etc.;
- Development and harmonisation of phenotypic methods;
- Development of new tools for early and real-time detection of resistant pathogens in humans, animals and the environment, as well as new diagnostic tools, in particular on-site tests for humans and animals;





- Metagenomics and bioinformatics for detection and surveillance of AMR pathogens and determinants;
- Use of WGS to predict MICs;
 - Development of pen-side diagnostics and sensitivity testing;
 - Use of artificial intelligence (AI) and machine learning (ML) to improve antimicrobial susceptibility testing (AMT) prediction and diagnostics;
 - Harmonised protocols and common and applied best practice;
 - Development of harmonised and sustainable databases on AMR, AMU and AMS;
 - Development of NGS-based tools for surveillance of AMR in animals, humans and the environment;
 - For all hazards and methods of importance, there are well defined and relevant reference materials/data for proficiency testing and test development.

Host-pathogen interaction

• Animal models incl. vector/animals, *in vitro* models, microbiomes, selection mechanisms, biocides, transmission of AMR from animals to humans and vice versa, etc.

Epidemiology (including surveillance)

- Epidemiological studies into the dynamics of AMR in human and animal populations and the environment including horizontal gene transfer and selection of AMR;
- Dynamics of AMR selection, clonal spread and horizontal gene transfer in humans, animals and the environment, including epidemiology of resistant microorganisms and antimicrobials in the environment and their (environment-mediated) spread;
- Source attribution and spread among humans, domestic (livestock and companion animals) and wild animals and their environments, including the role of farming systems;
- For all hazards and methods of importance, hazard data (typing results including genomic data, metadata) are available for surveillance at EU level;
- Use of common frameworks for design and methods to assess equivalence between surveillance and control activities;
- Standardised data formats and ontologies, common tools and procedures for data analyses, including interpretation of sequence data;
- Common reporting and signalling procedures, joint platform for sharing surveillance data and their interpretation and exploitation, including risk assessments;
- Preparedness and identification of emerging risks.



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Risk Assessment

- Risk assessment capabilities (knowledge, expertise, methodologies, data) of AMR.
- Disease burden, socio-economic consequences and risk ranking;
 - Development of new economic models, exploring and analysing incentives to boost the development of new therapeutics, alternatives, vaccines and diagnostics for AMR;
- Risk assessment of AMR gene transmission between humans, animals, food and the environment;
- Link with antimicrobial, including antivirals, antiparasitics, antifungals and biocides use, drivers and risk factors, etc. (main focus in animals).

Intervention (including action: prevention and response)

- Use of pre- and probiotics and other novel interventions, vaccination, alternatives to antimicrobials, biosecurity and hygiene measures, guidelines for prudent use of AM/stewardship;
- Communication and AMR stewardship;
- Development of sustainable pipelines for the development of alternatives to antibiotics;
- Improving preparedness and response;
- Strengthened infection prevention and control measures, including development and assessment of interventions that prevent the development and spread of AMR;
- Evaluating the best practice for communication and stewardship of antibiotic prescribing in humans and animals;
- Development of technologies that enable efficient and rapid degradation of antimicrobials in wastewater and the environment and reduce the spread of AMR;
- Mentoring (twinning) system for sharing of best intervention practice;
- Aligned use of experimental facilities and models (of transmission, ecology, risk assessment);
 - Consideration of animal welfare and societal engagement;
 - Simulation exercise, guidelines for cleaning and disinfection, vaccination, crisis management and societal engagement;
 - Use of infection control simulators to help train farmers and health professionals.

Communication

- To promote innovation and translation of research results;
- To bridge the gap between research and policy, and research and society.

Continuation of the strengthened collaboration on the national and international scale is important to enhance the capacity to detect and respond to (re)emerging threats like AMR. A series of activities should be used to present the research findings and identified new research topics to the scientific



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community. For this, tools which proved already successful should be continued. Among these are scientific meetings and workshops, joint training courses, short term missions, staff exchanges and targeted training. This needs to be complemented with activities to support public engagement involving both national and international policy makers, stakeholders and the general public.

Another important aspect is close collaboration with activities covering different threats, e.g. linking AMR with threats due to climate change, changes in ecosystems and wildlife, animal pathogens, human pathogens and zoonotic aspects.

Communication and dissemination must also consider the recipients and the infrastructure around them. It needs to increase the understanding of the underlying principles in the ecosystem.

Synergies and external (outside One Health EJP) links with JPIAMR, and other relevant initiatives

Within One Health EJP, emphasis was laid on close collaboration with other relevant initiatives as well as with stakeholders. The One Health EJP established strategic interactions with pre-existing EU-funded projects and initiatives and relevant international stakeholders and statutory bodies to avoid redundancy, create synergies and maximize the benefits from EU resources. At the beginning of the OHEJP, contacts to EU funded research projects and actions, such as COMPARE, EFFORT, ENGAGE and NEOH were established. Objectives and research needs of the EU and international stakeholders have been discussed throughout the project in the stakeholder committee which met twice a year. This ensured close involvement of EFSA and ECDC, EMA, EEC, WHO-Europe, WOAH and FAO. Furthermore, links have been established with European initiatives such as Joint Programming Initiative on Antimicrobial Resistance (JPIAMR) and Joint Action Antimicrobial Resistance and Healthcare Associated Infections (JAMRAI). Throughout the project, these contacts were used to ensure that the objectives of the Consortium were in accordance with the overarching policies and mandates of the respective agencies and that new needs were identified and addressed if feasible.

Discussion with JPIAMR and an expert group aimed at identification of the areas of synergy between the existing One Health EJP and JPIAMR projects. These interactions also aimed at supporting the identification of the unique expertise present within the One Health EJP and how this can be developed further in the European Partnership for Animal Health and Welfare (EUP AH&W) as well as the EUP on One Health AMR. As an outcome, a document was drafted which determined the areas falling exclusively within the EUP OH-AMR or EUP AW&W remit and those that may be addressed in both partnerships. It can form a valuable basis for further considerations on joint implementations within the One Health framework. A rough overview is presented in Annex 2 (AMR Research and innovation objectives by priority topics (as categorised by JPIAMR)).



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In the One Health EJP, the encouragement of strategic interactions, with related EU projects and initiatives was actively supported. For this purpose, the team identified relevant EU-projects and initiatives and described the strategic interactions between One Health EJP projects and other EU projects and initiatives. In a series of so-called cogwheel workshops, EU projects and initiatives were approached. The aim of these workshops was to identify synergies, avoid overlaps and find new possibilities for collaborations.

To visualise the scientific scope of the relevant projects/initiatives, a One Health EJP matrix was developed. Table 2 shows identified projects and activities that address AMR. In addition, among the eight **JPIAMR calls**, several projects have been funded which tackle issues on AMR.

The synthesis of ongoing interaction between projects and activities and One Health EJP projects reflects that close collaboration was established with: AACTING (JPIAMR), AVANT, COMPARE, EFFORT, ENGAGE, ENOVAT, HECTOR, JAMRAI, K-STar (JPIAMR), OASIS, RAKIP, SOLIDNESS (JPIAMR), VetCAST. Seven Joint Research Projects funded within One Health EJP reported collaboration with other international activities and projects (Table 3). Furthermore, six JRPs in the domain of AMR participated in one or several cogwheel workshops to discuss interaction and synergies with other projects⁷.

- All these interactions between One Health EJP projects and other EU projects and initiatives have resulted in **synergetic collaborations** with an important impact in all the projects. The outcomes of these interactions can be summarised as follows:
- Sharing of data, workflows and bioinformatics pipelines;
- Sharing of products previously developed (standards, culture media);
- Collaboration to develop new methodology and protocols;
- Expertise in organising proficiency tests;
- Compatibility of platforms developed;
- Dissemination of One Health EJP results;
- Sharing of information on the use of NGS;

⁷ Extracted from the <u>One Health EJP Deliverable 2.9</u> onehealthejp.eu **9** @OneHealthEJP **in** ONE Health EJP

PROJECTS AND INITIATIVES		
Analytical methods (14)	AVANT, EFFORT, ELIXIR, ENOVAT, EQAS, European Burden of Disease Network, FLEXPOL, GNA-NOW, HealthyLivestock, ICRAD, JPIAMR, PANGAIA, SPRINGBOARD, VEO	
Host-microbe interaction (6)	AVANT, EFFORT, ENGAGE, FLEXPOL, ICRAD, JPIAMR, SPRINGBOARD	
Epidemiology (8)	AVANT, EFFORT, ICRAD, JPIAMR, MOOD, ROADMAP, SOUND control, VEO	
Risk assessment and socio-economic impact (10)	AVANT, EFFORT, European Burden of Disease Network, ICRAD, JAMRAI, JPIAMR, MOOD, ROADMAP, SOUND control, VEO	
Intervention (17)	AVANT, DISARM, EFFORT, EHDEN, ENOVAT, ESFRI, European Burden of Disease Network, FLEXPOL, GNA-NOW, HealthyLivestock, ICRAD, JAMRAI, JPIAMR, MOOD, ROADMAP, SHARP JA, SOUND control	
Platform Repository Guidelines (18)	EHDEN, ELIXIR, ELIXIR-CONVERGE, ENOVAT, EOSC, EOSC-Pillar, EQAS, ESFRI, European Burden of Disease Network, HIDALGO, IS_MIRRI21, JAMRAI, JPIAMR, MOOD, PANGAIA, SOUND control, TRANSVAC2, VEO	

Table 2. Overview on identified projects and activities that address AMR⁷

	JRPs	Collaboration with:
1st round JRPs	IMPART	ENOVAT, VetCAST
	ARDIG	AACTING (JPIAMR), AVANT, EFFORT, JAMRAI
	RaDAR	COMPARE, EFFORT, RAKIP
2nd round JRPs	FARMED	K-STar (JPIAMR)
	FULL-FORCE	EFFORT, ENGAGE, SOLIDNESS (JPIAMR)
	WORLDCOM	OASIS, HECTOR
	FED-AMR	COMPARE, EFFORT

Table 3. Joint Research Projects funded within One Health EJP and their reported collaboration with other international activities and projects

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- Submission of project proposals to JPI-AMR and JAMRAI calls;
- Collaborative publications and workshops.

Outcomes

Within One Health EJP, plenty of outputs were delivered which cover publications and reports, pilots, infrastructures, data bases, models, services, websites and others. These have been further composed to outcomes, i.e. R&I based solutions for policy makers, sectors and industry, and society. A main outcome is the strong network of actors with reference functions with increased capabilities and a common understanding on interdisciplinary collaboration following a One Health approach. In Table 4, there are some examples of outcomes associated with the integrative activities with relevance to the domain of AMR. A main activity is to disseminate these outcomes and enable impact to improve AMR preparedness and prevention and as input for future research.

Similarly, there are important outcomes from ongoing research projects on AMR.

Expected Impacts

Through the research and communication activities described above, we aimed to address identified emerging scientific, societal, political, and technological issues and trends. Exploiting this further will have an impact. By doing this, it will support national, European, and international stakeholders.

Impact is expected at least in the fields of society, science and technology, and policy:

- Advancement of science;
- Increased food safety, improved public health;
- Sustainable animal production;
- New EU guidelines, legislation;
- Improved collaboration, networking, collaboration, sharing of data.

It will contribute to meet policy objectives as described in the Farm-to-Fork strategy and in achieving the SDGs.

⁸ Extract from Table 4. Summary of the interactions between EU projects/initiatives and One Health EJP JRP, JIP and PhD projects in <u>One Health EJP Deliverable 2.9</u>

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PROJECTS	OUTCOME One Health Surveillance guidelines, including tool for the assessment of One Health Surveillance capacity.	
MATRIX:		
OH-HARMONY-CAP:	OHLabCap. Tool to collect information on capabilities, capacities and interoperability at the National Reference Laboratory (NRL) and the primary diagnostic level focusing on six high priority bacteria, ten high priority parasites and AMR for <i>Salmonella</i> and <i>Campylobacter</i> .	
CARE:	EUROpanelOH. A reference database of strains and genomes for effective quality control analysis in food safety and public health protection across sectors	
ORION:	One Health Surveillance Codex. High-level framework that supports mutual understanding and information exchange between One Health Surveillance sectors, a requisite for integrated One Health Surveillance data analyses.	
COHESIVE:	One Health Risk Analysis System for zoonoses (OHRAS). Guidelines to set up or strengthen One Health collaboration in the area of risk analysis (signaling, risk assessment, risk management, risk communication) of zoonoses including antimicrobial resistance (AMR)	

Table 4. Examples of One Health EJP outcomes associated with the integrative activities with relevance to the domain of AMR $^\circ$

IMPART:	Isolation Procedure for carbapenemase-producing Enterobacteriacea from Caeca Samples (<u>https://www.mdpi.com/2076-2607/9/5/1105</u>)		
FARMED:	A shotgun metagenomics approach to detect and characterise unauthorised genetically modified microorganisms in microbial fermentation products		
WORLDCOM:	Novel machine learning algorithms for the prediction and detection of AMR from genomic sequences		
ARDIG:	Comparability between AMU and AMR national surveillance data		
FULL-FORCE:	Toolbox for Single Molecule Real Time sequencing, aimed at the integration of mobile genetic elements typing in One Health AMR surveillance		
FED-AMR:	Probabilistic and mechanistic models of the links between antimicrobial usage in animals, AMR in the environment, and the risks for public health		
RADAR:	COMPASS. Comprehensive database compiling 12 084 complete plasmids with associated metadata from 1 571 distinct species isolated in 126 different countries over more than 100 years. Described in Douarre <i>et al.</i> , 2020		

Table 5. Examples of outcomes from ongoing One Health EJP research projects on AMR





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Scientific impact:

- Improved (standardised, validated, highly sensitive and specific) **diagnostics** that target more/all microorganisms (e.g. by metagenomics) and which are available in diagnostic labs globally and across sectors, enabling improved surveillance and preparedness for unknown/unexpected hazards and related risks in animal, environmental and human health;
- Increased capacity to generate, store, share, combine from different sources (animal, food, human, environment) and analyse (new and old) **data** with the objective to run more cost-efficient (outcome-based) surveillance and guide future policy decisions;
- Access to real-time data from monitoring systems support to measure the impact of emerging risks or new control methods;
- Improved pipelines at national and international level, e.g. for WGS analyses;
- Improved detection and characterisation methods as well as data for understanding of AMR selection, persistence and spread in animal, human and environmental microbiomes;
- Joined actions to further improve standardisation in veterinary diagnostic laboratories regarding methods for susceptibility testing of veterinary bacteria, interpretation of results and guiding treatment;
- General models and open modelling codes to support easy adaptation to similar research questions, (national) data sets, different hazards or populations;
- Harnessing new trends in data, technology and science: access to real-time data from monitoring systems in the food chain would increase EFSA's capacity to define scenarios, refine risk assessments or measure the impact of emerging risks or new control methods.

Policy impact:

- Broadened and improved capabilities and capacities of national, European and international reference laboratories and reference centers;
- Strengthened requirements for (compulsory) surveillance (data generation) and data sharing as input for risk assessment, supporting evidence-based risk management and proper intervention to lower risks;
- Improved surveillance system by evaluation of best data sources, highlighting how gaps and barriers in data access can be overcome;
- Guidance for implementation and enforcement of Regulation (EU) 2020/1279 (Monitoring antimicrobial resistance, Regulation (EU) 2019/6 (Veterinary medicinal products) and Regulation (EU) 2016/429 (Animal Health Law);
 - New tools added to Tripartite's Surveillance and Information sharing Operational Tool (SISOT).



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Societal impact:

- Reduced exposure to resistant bacteria and resistance genes through better understanding of several transmission pathways;
- Science based action to limit the emergence and spread of resistance genes towards critically important antimicrobials;
- Increased food safety (thanks to earlier detection);
- Reduced sequelae and burden of disease;
- Reduced treatment failure due to AMR.

Economic impact:

- New technologies which allow more information at lower costs, easier to perform, cost-effective surveillance, as well as new/targeted response and allow to safe resources;
- Cost-efficient surveillance strategies taking into account the assessment of performance indicators;
- Targeted restrictions (of animals and animals derived products) to true sources of AMR and drivers linked to it;
- Improved (livestock) production performance due to health of animals and better farming systems;
- Lower costs for society due to reduced failures and efficient treatment of disease;
- Strengthened consumer confidence (and consumption of European products).

5.3 Priority topic of the SRIA: One Health

Introduction, rationale, challenges and opportunities

One Health has been defined as 'an integrated, unifying approach that aims to sustainably balance and optimise the health of people, animals and ecosystems' and it recognises that 'the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and inter-dependent' (OHHLEP, 2022). The Quadripartite - Food and Agriculture Organisation of the United Nations (FAO), the World Organisation for Animal Health (WOAW), the World Health Organiation (WHO) and the United Nations Environment Programme (UNEP) - have expressed support to this definition and emphasised One Health as a key focus in their strategies (WOAH, 2021; OHHLEP, 2022).

A major challenge is that there is no dedicated initiative for One Health EJP to continue (no second EJP under Horizon Europe). However, One Health is mentioned extensively in upcoming funding opportunities and is a key part of many new initiatives, including Lancet One Health Commission, the US One Health Commission, the One Health Platform, EUP One Health-AMR, EUP Animal Health & Welfare, EUP Pandemic



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Preparedness, PREZODE, ERRAZE, EU4HEALTH Programme and UNITED4Surveillance. The One Health EJP has created a network that can contribute to interconnecting across the different initiatives.

Unique points of One Health EJP include covering food, foodborne zoonoses and AMR; the cross-sectoral network, the trust built across the Consortium, and the links of other networks including national stakeholders; and improving preparedness by not only thinking about pandemics, but also the daily work in being prepared for outbreaks, including foodborne outbreaks, and for diseases spreading to new areas. Moreover, One Health EJP has been well placed to identify further needs, e.g. those related to environment, social sciences. These fields fell outside the core scope of One Health EJP, but the Consortium has established collaborations with experts within these fields.

A unique point is also the gap-based research approach, addressing the needs of national, European and international stakeholders. This created and strengthened collaborations at science-policy interfaces and contributed to collaborations across stakeholders (Bronzwaer *et al.* 2022).

The role of Med-Vet-Net Association in the story of One Health EJP should be emphasised. The One Health EJP consortium is an established network that has demonstrable experience of working together and that is available for future needs. Future strengthening and even consolidating the network built during One Health EJP will be a challenge due to loss of EU funding after September 2023, but would bring added value to the partner institutes. The outcome of the enlargement campaign in 2020 was encouraging, indicating more public institutions see the benefit of joining the consortium. The Med-Vet-Net Association will provide a lifetime beyond that of the One Health EJP, and a solid supporting structure with many of the One Health EJP partners involved.

Within the context of the new definition of One Health formulated by OHHLEP (OHHLEP, 2022), since the start of the One Health EJP, it could be relevant to consider how well that definition fits One Health EJP and European setting. Regarding opportunities in a longer timeframe, it is important to remember that, at times, it might become more challenging to promote One Health. This should encourage a reflection on why One Health networks like One Health EJP and the One Health approach are important and beneficial for the health of people, animals and their environment.

The One Health research after One Health EJP may be less aligned, making it more challenging for key stakeholders to locate and identify useful results and outcomes. Indeed, many activities of One Health EJP adhered to the FAIR principle to ensure the findability of outcomes and new knowledge across sectors. The outputs and outcomes from One Health EJP are expected to serve and shape the future initiatives in the field of One Health. The One Health EJP network has supported many countries to build and





strengthen One Health collaborations and produced examples of joint solutions for international collaboration. Moreover, the experiences disseminating the outcomes of One Health EJP to ensure impact will be useful for future initiatives. One Health EJP consortium has shown its value, and the Consortium has expressed interest to continue the collaboration.

Short-term vision: Experiences, outcomes and outputs of One Health EJP are useful for new ongoing and starting initiatives.

Long-term vision: Sustainable One Health collaborations build on the network and trust created during One Health EJP.

Updated R&I objectives

The general objective of research and innovation should be to strengthen the collaboration among partners with an interest in One Health, which will lead to further implementing the One Health approach, reinforcing the prevent-detect-response pathway and thus the preparedness among partners.

The specific objectives of One Health EJP in the context of One Health can be updated as follows:

- 1. To bring and keep together the major representatives of the European scientific community in the field of One Health. The target scientists during One Health EJP were mainly those from institutes with national mandates of reference and performing official research programmes in three domains, but this should be widened;
- 2. To implement joint scientific projects in the field of One Health;
- 3. To stimulate scientific excellence by encouraging funding of multi-disciplinary, cross-sector (One Health) research, e.g. in consultations regarding upcoming funding calls;
- 4. To foster the harmonisation and standardisation of the reference methods and tests by bringing together scientific and technical expertise across the fields with relevance to One Health. This includes compiling and maintaining standards and materials of reference such as biological archives including collections of strains and DNA libraries;
- 5. To continuously exchange and communicate with national and international stakeholders;
- 6. To promote and develop One Health research in Europe and globally by training, education and communication;
- 7. To improve data quality and data exchange across sectors.

General aim: to support future actions that build on work done in One Health EJP. This is achieved by collaborating with new initiatives, and encouraging connections across initiatives and projects.



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6 SUSTAINABILITY PLAN 2021-2030

The aim of the sustainability plan for 2021-2030 is to guide and/or recommend actions that will result in maintaining major outcomes of the One Health EJP so that the benefits will persist in the future, after the end of the project in 2023. The research and integrative projects have advanced the state-ofthe-art outputs in the domains of foodborne zoonoses, antimicrobial resistance and emerging threats, and created novel tools and solutions, paving the way to continuing innovation. The many outcomes delivered by the One Health EJP have made and will continue to make important improvements in the animal health, public health and food safety arenas in Europe. Moreover, expanding the involvement of additional One Health fields and related initiatives will all together contribute to build a stronger and truly integrated One Health in Europe. The actual needs of the EJP's Stakeholders have been central to the prioritisation of the One Health EJP activities, efforts have been directed to address these evolving requirements and this is still the focus of the sustainability strategies outlined in this SRIA.

For any sustainability mechanism to be effective, however, it will be important to put emphasis on equity and fair representation, as One Health collaboration, being it cross-border or cross-sectoral, is based on trust. In addition, there is increasing realisation that health threats affect many aspects of society, therefore fair representation implies going a step further from simple balance among the classical One Health triad.

In times of globalisation, One Health initiatives will also have to be increasingly inclusive towards sectors not traditionally associated with One Health, like social sciences, psychology, policy, and economy. To make an example, anthropology and its contribution to understanding certain human practices (e.g. use of antimicrobials for human and veterinary use, modes of food production, treatment of patients) is crucial to make a long-standing impact. Its knowledge facilitates community engagement that is appropriate for specific socio-cultural contexts, thus supporting sustainable uptake of potentially impactful One Health solutions.



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borders of the beneficiaries, including EU pre-accession countries, and those included in the European Neighbourhood Policy.

6.1 Key instruments for the sustainability of the One Health EJP

There is a plethora of One Health initiatives, projects, organisations and networks, in Europe and worldwide. For this SRIA, a selection of those closest and/or most relevant to the One Health EJP and Europe are briefly presented below, acknowledging, however, that this selection is only a minority and may not be fully representative.

How these instruments, single or in combination, can be used to ensure a continuation of activities, maintain impacts, and/or further develop many of the principal outcomes and activities of the One Health EIP in the future is summarised in Table 6 (page 64).

The Med-Vet-Net Association

The Med-Vet-Net Association (see section 1.1.) is a legal entity set up after the FP6 Network of Excellence MED-VET-NET, which ended in October 2009, is self-funded and comprises 22 scientific research institutes.

The mission of the Med-Vet-Net Association is to promote a One Health approach to combat zoonoses and AMR and support a healthy and sustainable food supply chain across Europe (and beyond) by:

- Building a sustainably integrated European network of public institutes and academic institutions in the medical/public health (Med) and food/veterinary (Vet) domains;
- Fostering One Health research regarding zoonotic diseases and AMR at the interface of humans, animals and the environment;
- Contributing to strengthening the joint EU capacity to prevent, detect and control zoonoses and AMR in Europe and beyond.

The Med-Vet-Net Association is a beneficiary of the One Health EJP, but not all EJP beneficiaries are members of the Association. For this reason, and because both consortia are strongly aligned, these beneficiaries will be invited to become members of the Association.

In the first place, the Association will serve as forum for its members and their networks to exchange ideas and initiatives related to One Health. Indeed, the partner institutes will be scattered across several new European projects and partnerships, and the Med-Vet-Net Association will enable its members to obtain new and useful information on One Health. As resources are rather limited, activities will focus on the organisation of workshops, short term missions of scientists between the member institutes and the maintenance of web pages and tools that have been developed during the One Health EJP.



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European Partnerships

European Partnerships (EUP) are a key implementation tool of Horizon Europe and contribute significantly to achieve the EU's political priorities. European Partnerships are an important component of the new European Research Area as they allow aligning research programmes in Europe. European Partnerships bring the European Commission and private and/or public partners together to address some of Europe's most pressing challenges through concerted research and innovation initiatives. The EUPs briefly presented below address aspects of One Health highly relevant to the topics of the One Health EJP. It is expected that various outcomes and activities of the One Health EJP will be implemented and continue within the work of the EUPs. However, to date, no EUP fully incorporates all the main pillars of One Health, i.e. public health, animal health and environmental health. Therefore, collaboration among different EUPs will be essential to achieve the EU's political priorities within One Health.

EUP Animal Health & Welfare

The EUP Animal Health & Welfare aims to provide society with an efficient control of infectious animal diseases with appropriate means, where antimicrobials are prudently used, and based on the respect and improvement of the welfare of animals; thus contributing to sustainable animal farming and the protection of public health and the environment. This objective will be achieved through strengthened cooperation between public research and innovation entities, and the association of relevant partners, including relevant authorities, the animal health industry, other stakeholders, including animal welfare NGOs. The ambition of the EUP AH&W is to build a strong research and innovation framework strengthening Europe's capacity to raise healthy animals and to improve welfare standards. Although still under development, it is clear that research and reference and integrative activities supporting the One Health approach will be set up. Therefore, many One Health EJP partner institutes are likely to participate in the EUP AH&W.

EUP Sustainable Food Systems

The objective of the Partnership on Sustainable Food Systems is to collectively develop and implement an EU-wide committed research and innovation partnership that will accelerate the transition towards healthy and safe diets that are sustainably produced and consumed in resilient EU and global food systems.

Many One Health EJP partners that are actively involved in reference tasks related to food safety, will be interested to join this EUP.

EUP Pandemic Preparedness

The future European Partnership for Pandemic Preparedness European Partnership for Pandemic



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Preparedness aims to improve the EU's preparedness to predict and respond to emerging infectious health threats, by better coordinating funding for research and innovation at EU, national (and regional) level towards common objectives and an agreed Strategic Research and Innovation Agenda. Such a partnership should contribute to building a coherent European Research Area, enabling Member States, Associated Countries and the European Commission to rapidly and jointly support research and innovation in pandemic preparedness. Aligned around a multi-annual Strategic Research and Innovation Agenda with common objectives for research and innovation in pandemic preparedness, the prospective partners – in close collaboration with ECDC, EMA and other relevant actors – will define research needs in the medium- to long-term. The Partnership is expected to build on existing pandemic preparedness networks, and work in synergy with the Health Emergency Response Authority (HERA).

It is expected that partners of the One Health EJP, which focused on the networking among public Medical and Veterinary institutes, thus strengthening their capacity and alignment, will subscribe to this Partnership.

EUP One Health AMR

The common vision of the EUP OH-AMR is to improve the EU's response to fight the rise of AMR with a One Health approach by better coordinating funding for research and innovation at EU, national (and regional) level and aligning internationally towards common objectives and an agreed Strategic Research and Innovation Agenda. It also aims to contribute directly to EU priorities and the UN Sustainable Development Goals, and to deliver on the targets defined in the European One Health Action plan against AMR. AMR being one of the three domains of the One Health EJP, the EUP OH-AMR will be of interest to many One Health EJP partners.

EUP Biodiversa

The EUP Rescuing Biodiversity to Safeguard Life in Earth will provide an overarching platform connecting national/local and European R&I programs and combining in-cash and in-kind resources in support of one goal: by 2030 biodiversity in Europe is back on a path of recovery. It will co-develop multidisciplinary R&I programs with stakeholders, set up a European network of harmonised observatories for biodiversity monitoring, and implement a broad range of activities to increase relevance, impact and visibility of R&I and EU leadership in tackling the biodiversity crisis, in line with the European Green Deal and the new EU Biodiversity Strategy for 2030.

One Health Initiatives and initiatives dealing with zoonotic infections

There are many One Health initiatives and initiatives dedicated to zoonotic infections at the national,





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European and international level. Knowledge of such projects and initiatives and maintaining synergetic collaboration among them are essential to avoid duplication of efforts and to build a base to develop next One Health steps into the future.

European One Health initiatives

One Health EIP Relevant EU projects, initiatives and the procedure to identify potential strategic interactions were identified and described by the One Health EJP. Information about sixty EU projects and initiatives has been provided. (Report on strategic links established and strategic developments). Interactions to promote scientific collaborations and to identify possible synergies between the EU projects and initiatives and the One Health EIP projects have been established. A summary of these interactions is graphically presented in Figure 6.

Outcomes of these interactive collaborations can be summarised as follows:

- Sharing of data, workflows and bioinformatics pipelines;
- Sharing of products previously developed (standards, culture media);
- Collaboration to develop new methodology and protocols;
- Expertise in organising proficiency tests;
- Compatibility of platforms developed;
- Dissemination of One Health EJP results;
- Sharing of information on the use of NGS;
- Submission of project proposals to JPI-AMR and JAMRAI calls;
- Collaborative publications and workshops.

Global One Health initiatives

The increased attention to One Health in recent years has resulted in the creation of numerous networks that facilitate collaboration among the three pillars of One Health. A study identified and systematically analysed one hundred One Health networks in Africa, Asia, and Europe (The growth and strategic functioning of One Health networks: a systematic analysis), indicating the vast extent of the growing One Health activities, organisations and tools globally.



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EU PROJECTS



Figure 6. Schematic representation of interactions between EU projects and initiatives and the One Health EIP projects

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A few examples are given below:

- The One Health Initiative, a quadripartite alliance of FAO, UNEP, WOAH, and WHO addressing health threats at the human-animal-plant-environment interface with a One Health approach. The Quadripartite utilises tools at country level to help the countries develop their capacities, all the tools are based on international standards.
- The One Health High-Level Expert Panel (OHHLEP): advisory board that provides the Quadripartite with evidence-based recommendations.
- The Regional One Health Coordination Mechanism Europe: 'consolidates cooperation between the regional offices of the FAO, the WOAH, UNEP and the WHO for the European Region (including Central Asia) to address the wide range of activities related to One Health concept, within the human-animal-environment interface'.
- The Global Burden of Animal Disease (woah.org) : Evaluates the burden linked to animal diseases to improve relationships with production animals, and to build a more sustainable world.
- National Bridging Workshop (NBW), developed originally between WHO and WOAH to link the International Health Regulation (IHR) and the Performance of Veterinary Services (PVS). NBW builds synergies between human and animal health systems (IHR-PVS National Bridging workshops (NBW) - WOAH – Europe).
- Tripartite Zoonoses Guide (Tripartite Zoonosis Guide (TZG) (who.int) and its Multisectoral Coordination Mechanisms operational tool (MCM OT).
- Join Risk Assessment operational tool (JRA OT).
- Surveillance and Information Sharing operational tool (SIS OT).
- EcoHealth Alliance: a 'global environmental health non-profit organisation dedicated to protecting wildlife and public health from the emergence of disease'.
 - One Health Commission: A 'globally focused organisation dedicated to implementing One Health and One Health actions around the world'.
 - One Health Initiative A movement of private individuals 'to forge co-equal, all-inclusive collaborations' conducting One Health promotional activities.

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A future European One Health Consortium/network

There is a need for a comprehensive and stable One Health network involving all of Europe and all the One Health pillars. At present such a network does not exist. The One Health EJP recommends launching a European One Health Consortium or Network based on the One Health EJP and including other initiatives. It should be explored if the network could be funded by a joint effort of DG HEALTH, DG-AGRI and DG-ENV, with specific support to low- and middle-income countries. Alternatively, a topic for a CSA (Coordination and Support Action) in the work programme of Horizon Europe 2025 could be incorporated, this would provide the opportunity to not only form a European One Health Consortium or Network but also at the same time facilitate the finalisation of the uptake of the One Health EJP outcomes by Programme Owners, diagnostic and reference laboratories, risk assessors and/or risk managers and other relevant actors.

European funding of One Health research, development, innovation, networking and training

Horizon Europe programme Cluster 1 and Cluster 6 COST (European Cooperation in Science and Technology) Marie Skłodowska-Curie Actions, EMBO and other grants SDG: Policy Framework and Impact Logic for Horizon Europe Erasmus+ and Erasmus Intern LIFE Programme EU4Health programme 2021-2027

Dissemination instruments

- Open access publications;
- Open science policy, a new element in Horizon Europe;
- Repositories;
- One Health EJP website;
- One Health EJP Outcome Inventory;
- Data Management Plans;
- Inclusion of One Health EJP outcomes in resources of external organisations (e.g. Tripartite Zoonoses Guide Operational Toolkits, One Health Commission toolkit);
- Med-Vet-Net Association.

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6.2 Priority outcomes, activities and actions of the One Health EJP to be sustained and further developed in the future

The vast work of the One Health EJP has resulted in numerous R&D outcomes and tools, established extensive collaboration among scientists, contributed to education, technology transfer and training and created a platform for communication and bilateral dialogue with stakeholders and policy. Sustaining some of the outcomes and activities will reinforce the impact already achieved and will maintain it in the future.

In order to identify the One Health EJP priority outcomes, activities and actions that should be built on and sustained, the following questions were posed:

What outcomes, activities and actions....

- Will address the actual needs of stakeholders involved in One Health, with main focus on Europe, in the future?
- Will lead to the fulfilment of the objectives presented in this SRIA? Will result in expected impacts or continuation of impacts of the One Health EJP?

Will address priority research and integrative topics defined in this SRIA?

Will ensure synergy and complementarity in One Health fields, with main focus in Europe?

The outcomes, activities and actions considered as being most important to be sustained in the future are shown as categories, belonging to either collaboration, communication, advocacy and policy or to scientific activities in Table 6 (*page 67 and 68*).

6.3 Sustainability plan of the One Health EJP

Having identified the main One Health EJP outcomes, activities and actions important to be sustained and/or build on in the future and the main instruments or channels that can be applied to support their continuation or the permanence of their impact, the following sustainability plan is presented in Table 6.

One Health EJP outcome or activity to be sustained How the outcome or activity can be sustained in the future, instruments and opportunities that can be applied to achieve sustainability

	COLLABORAT	ION, COMMUNICATION, ADVOCACY A	ND POLICY
	The One Heath EJP network	Med-Vet-Net Association	Ongoing and continuing until 2030 and beyond
		Advocate to launch a European One Health consortium/network, possibly with funding from Horizon Europe or a Coordination and Support Action	Initiated in 2022
	Synergies and complementarities with other One Health actors	Links with other JPI or relevant initiatives, European Partnerships PREZODE, ERRAZE, ZODIAC, Epizone, STAR-IDAZ, Collaborative Working Group on European Animal Health & Welfare Research, Med-Vet-Net Association	Ongoing and continuing until 2030 and beyond, depending on the initiative
	Promoting the environmental pillar of One Health	romoting the nvironmental pillar f One HealthAny (future) One Health initiative should stress the importance of the environment for One Health (e.g. Med-Vet-Net Association, EUP Biodiversa)C	
	Consolidating interactions with stakeholders	Continue communication with stakeholders, building on the privileged interaction of the One Health EJP with national stakeholders and international bodies like ECDC, EFSA, WOAH, FAO	Ongoing and continuing until 2030 and beyond
	International One Health aspects beyond EU	Interaction with international bodies and integration of One Health aspects in existing and future international projects (PREZODE, STAR-IDAZ, etc.)	Ongoing and continuing until 2030 and beyond
	Advocacy for One Health	Promotion and development of One Health research in Europe and globally. Communication with Programme Committees of Horizon Europe and future funding programmes	Ongoing and continuing until 2027 (Horizon Europe), beyond for future funding programmes
		National funding organisations. All actors, also non-EJP members, should be informed and encouraged to support this.	Ongoing and continuing until 2030 and beyond
ALL MA	One Health cross-sector collaboration	Promoting and facilitating the harmonisation and alignment of communication and methods used by PH/AH/FS with the addition of the environmental sector. Med-Vet-Net Association, STAR-IDAZ, and others	Ongoing and continuing until 2030 and beyond
	Translation of science-to-policy at national, European, and international levels	Relating specific policy needs with One Health EJP knowledge to inform policy initiatives, and identification of relevant expertise in the network to support stakeholders. Med-Vet-Net Association, One Health EJP network	Ongoing and continuing until 2030 and beyond

Table 6. Sustainability plan of the One Health EJP. Priority outcomes and activities important to sustain in the future, instruments and opportunities to sustain them and timeline for the future.

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6.4 Sustainability plans of individual One Health EJP projects

Several One Health EJP projects developed a specific sustainability plan for the project. As example, the sustainability plan of two projects, CARE and MATRIX is presented in Annex 3.

	One Health EJP outcome or activity to be sustained	How the outcome or activity can be sustained in the future, instruments and opportunities that can be applied to achieve sustainability	Timeline	
	COLLABORATION, COMMUNICATION, ADVOCACY AND POLICY			
Working towards SDGs		romote scientific and technological advance or the sustainable development of Europe nd the protection and improvement of the uality of the environment. /ebsite to Med-Vet-Net Association		
	Communication to target audiences	Website to Med-Vet-Net Association	From 2023 and beyond	
		SCIENTIFIC ACTIVITIES		
	R&D, R&I	Horizon Europe, EU partnerships, national funding	Ongoing and continuing	
	Scientific deliverables and outcomes developed by the One Health EJP	Presentation and promotion of publications, repositories, collection of strains, sequences, tools, etc. to interested parties (i.e. programme owners (PH, AH, FS authorities), diagnostic and reference laboratories, risk assessors and risk managers) that deal with FBZ, AMR and ET with the objective to encourage their application, for instance to expand and improve actual surveillance programmes, to use harmonised detection and characterisation protocols, etc.	Ongoing and continuing until 2030 and beyond	
	Training and education of One Health young scientists	COST, Marie Skłodowska-Curie Actions, HE, MVNA, Epizone, STAR-IDAZ, national initiatives	Achieved, ongoing and to be continued until 2030 and beyond	
	Harmonisation and standardisation of reference methods and tests	Access to materials, strain collections, databases, archives, tools, laboratory protocols, etc developed by One Health EJP. Participation in standardisation committees and input to proficiency testing by EURLs	Achieved, ongoing and to be continued until 2030 and beyond	
	Selection of outcomes of the One Health EJP intended to be utilised by stakeholders	Based on stakeholder's knowledge gaps, identification of appropriate One Health EJP integrative/scientific outcomes findable through existing resources (e.g. One Health EJP Outcome Inventory Any interested party (One Health EIP	Achieved, ongoing and to be continued until 2030 and beyond	
		resources are publicly available)		

Table 6. Sustainability plan of the One Health EJP. Priority outcomes and activities important to sustain in the future, instruments and opportunities to sustain them and timeline for the future.

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7 DISSEMINATION

The One Health EJP is an established Consortium within the scientific community and beyond. By the end of the Programme (2023), the One Health EJP will have generated numerous outputs and outcomes and hold a wealth of knowledge. One of the One Health EJP main objectives was to share insights and knowledge gained throughout the duration of the Programme to a global audience. The Consortium recognises the importance of disseminating our research findings to our extended network. Therefore, creating opportunities during the Programme, and after the Programme for others, to make significant impact in the areas of research covered by the One Health EJP at national and international level. By leading by example and sharing 'lessons learned', there is also an opportunity to change behaviours.

Dissemination of our activities is key to this. And the further we can disseminate, the larger the audience and the bigger the impact. To disseminate our outcomes effectively requires a multi-level approach and every One Health EJP consortium member plays a key role in dissemination.

Moreover, dissemination of our project outputs and outcomes, emphasising the scientific research gain, and demonstrating our contribution to the overarching One Health message, adds to the overall legacy of the One Health EJP.

The One Health EJP holds a number of annual events, and the Communications Team uses targeted promotion methods via physical, virtual, digital, and print platforms to ensure these events are accessible to content-relevant delegates.

All Work Packages are engaged in activities to generate positive outcomes towards a One Health approach to the prevention, detection and response to animal-human-environment issues. The Communications Team supports these activities with the creation of purposeful dissemination material ensuring messages are aligned and clear and engage our target audiences. By dissemination of One Health EJP key messages surrounding the overarching purpose, vision, impact, and outcomes of the consortium promotes cross-sectoral collaborations and informs and educates our scientific and non-scientific global audiences.

Our dissemination purpose utilises a Communication Strategy and Plan, which has enabled the Communications Team to establish the One Health EJP brand and generate a growing audience engaged in our news. The process has been evaluated and adapted as the One Health EJP audience reach has developed and as the needs of the Consortium changed.

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7.1 Areas for Dissemination

- Highlighting the output and outcomes of the One Health EJP Joint Research Projects and Joint Integrative Projects, and the PhD Projects;
 Demonstrating the quality and breadth of the One Health EJP
 - Education and Training programme; Showing the impact One Health EJP has made on advancement
- in science: increased food safety, sustainable animal production, improved public health;
- Addressing One Health EJP delivery towards sustainability of safety procedures, and of increased knowledge by sharing of information;
- Addressing One Health EJP delivery of strengthening of scientific networks, and creating a collaborative scientific community;
 - Driving citizen-science connectivity with social media campaigns highlighting the purpose of the One Health EJP, and highlighting the importance of the areas of our research: Foodborne Zoonoses, Antimicrobial Resistance, Emerging Threats.

7.2 Dissemination Sustainability

Dissemination material will remain on the One Health EJP website for 2 years beyond the end of the Programme until 2025 and thereafter will be taken on by the website of the Med-Vet-Net Association.

Dissemination material including all deliverables and project DMPs will be uploaded to the open access repository Zenodo.

7.3 Target Audiences

Table 7 summarises the target audiences of the One Health EJP, the type of information directed to the respective audiences, the communications function and communications objective as well as the communications channels.

	AUDIENCE	INFORMATION	COMMS FUNCTION	COMMS OBJECTIVES	COMMS CHANNEL
	One Health EJP Partners	All internal and external communications.	Maintain good relationships and lines of communication.	Foster integrative and collaborative work approaches. Demonstrate One Health EJP impact/scientific outcomes. Demonstrate use of funds.	Website, social media, newsletters, email marketing, editorial, conferences, PR.
	Stakeholders	Internal and external (relevant) communications.	Maintain good relationships and lines of communication.	Transparency of project and progress. Demonstrate use of Grant. Demonstrate One Health EJP impact/scientific outcomes.	Website, social media, newsletters, editorial, conferences, PR.
	Policy Makers	External communications.	Brand awareness. Foster relationships to grow network. Sustainability of project. To affect change.	To inform and open dialogue. Demonstrate One Health EJP impact/ scientific outcomes.	Social media, website, external newsletter, editorial, PR.
	International bodies	External communications.	Brand awareness. Foster relationships.	To inform.	Social media, website, external newsletter, editorial, PR.
	Scientists -external	External professional communications.	Brand awareness. Foster relationships.	To inform.	Social media, editorial, website, external news, email marketing, networking, conferences, PR.
	Healthcare Professionals -external	External professional communications.	Brand awareness. Foster relationships.	To inform.	Social media, editorial, website, external news, email marketing, networking, conferences, PR.
	Students, Early Career Researchers	External communications.	Brand awareness. Create the next generation of One Health EJP collaborators and One Health scientists.	To inform, educate and inspire.	Social media, website, editorial, email, marketing, networking, conferences.

Table 7. Communication strategy to target audiences



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8 ACKNOWLEDGEMENTS

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Participants of the AMR Module, in particular the JPIAMR.

9 LIST OF ANNEXES

Annex 1. Analysis of outcomes and uptake of EJPs outputs by stakeholders Annex 2. AMR research and innovation objectives by priority topics (as categorised by JPIAMR) Annex 3. Examples of sustainability plans of One Health EJP projects Annex 4. List of abbreviations

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Analysis of outcomes and uptake of One Health EJP outputs by stakeholders



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February 2023


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Strengths, Weaknesses, Opportunities and Threats key points from analysis of the One Health EJP

A key objective of the One Health EJP (OHEJP) was to identify the requirements of the stakeholders to continue the alignment and the integrative activities, and to guide the development of sustainability strategies.

To this end, a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis was carried out in 2019 via a survey involving key stakeholders, project owners and partners of the One Health EJP. Overall, 178 people were contacted with a 30% response rate. The analysis of the responses followed a reasoned, qualitative approach. A synthesis of the results is presented below, and the complete SWOT analysis is shown here.

Strengths and opportunities

- Great opportunity for One Health implementation through collaboration across sectors and members states;
- Development of solid international collaboration opportunities between researchers from public institutions in the fields of foodborne zoonoses, antimicrobial resistance and emerging threats;
- A multidisciplinary base for construction of consortia for participation in other calls/proposals;
- Excellent training opportunities, dissemination and capacity building;
- A foundation for sharing of knowledge and understanding in the domains of the One Health EJP;
- Brings together high-resource expertise centres to develop new methods and tools that are useful for increasing the preparedness of all actors involved;
- Strong commitment of public research institutions and their ministries;
- Extensive list of expected outcomes from research and integrative activities.

Weaknesses and threats

- Imbalance of partners with more focus on public institutions from animal health and food safety than on public health;
- Less prominent attention and inclusion of the environmental pillar of One Health and of overarching drivers such as climate change;
- Social sciences and economics are not considered in the conceptual framework of the One Health EJP;
- In some member countries, lack of effective involvement of national stakeholders;
- A co-fund European Joint Programme is a large administrative structure that requires many resources to run and needs profound understanding of the financial rules;
- Difficult co-ordination with lengthy official decision-making and laborious management of internal calls requiring numerous meetings;
- Need for greater involvement and participation of EU countries to cover most member states and thus gain optimal European impact;
- Predominant European outreach and therefore rather limited global approach.



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Key recommendations following the SWOT analysis:

- To further advance networking, collaboration, and inclusiveness; •
- To strive towards a major involvement of Programme owners into the process and especially the uptake of project outcomes;
- To implement clear data sharing plans;
- To assess and measure the outcomes to describe practical impact of the One Health EJP;
- To evaluate and prioritise systems, infrastructure, tools and/or processes that should be maintained post-One Health EJP.

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ANNEXE 1

ANALYSIS OF OUTCOMES OF THE ONE HEALTH EJP LIKELY TO BE UTILISED BY STAKEHOLDERS, AND ALSO BEYOND THE OHEJP

An objective of the One Health EJP was to ensure that the main scientific outputs, protocols, databases, and other strategic integration activities will be sustainable beyond the lifetime of the project. To address this objective, WP7 worked together with WP1, WP3, WP4 and WP5 in collaboration with the project leaders to produce a list of outcomes resulting from One Health EJP JIPs and JRPs that will address some of the needs of principal stakeholders, namely, ECDC, EFSA, DG-HEALTH and DG-AGRI. This list of outcomes describes protocols, databases and other tools and solutions expected to contribute to the work of not only the 4 named stakeholders, but also others. **The list is presented in the table below**.

	JOINT INTEGRATIVE PROJECTS (JIP) INTEGRATION (JIP) INTEGRATION (JIP)	INTEGRATIVE		JOINT RESEARCH PROJECTS (JRP)	
		ACTIVITIES	FOODBORNE ZOONOSES	ANTIMICROBIAL RESISTANCE (AMR)	EMERGING THREATS
	MATRIX: solutions to support and advance One Health surveillance	Design and implementation	AIR-SAMPLE: air filters to detect <i>Campylobacter</i> in broiler houses		
	COHESIVE: pathway analysis of detection of outbreaks	of surveillance activities	NOVA: code to model disease spread and explore disease surveillance options		
	OH-HARMONY-CAP: diagnostics, laboratories capabilities, capacities and interoperability collection tool		METASTAVA: Guidelines for sequence based metagenomics disease surveillance	IMPART: updated and improved detection protocols multicentre evaluation study results. New ECOFFs of veterinary antibiotics	TOX-Detect: database of protein profiles of foodborne toxogenic bacteria
			TOXOSOURCES: Hamonised Methods for detecting <i>Toxoplasma gondii</i> contamination in fresh produce	FARMED: Detection and Characterisation of unauthorised genetically modified microorganisms	MAD-Vir: Tool to detect known viruses and discover new viruses
		methods		WORLDCOM: predict/detect AMR from microbial samples and genomic sequences	TELE-Vir: portable toolbox for identification and characterisation of emerging virus threats
				MedVetKlebs: The ZKIR Assay, a Real-Time PCR method for the detection of <i>Klebsiella pneumoniae</i>	IDEMBRU: toolbox for rapid detection/identification of emerging <i>Brucella</i> species
				in environmental samples	MEmE: detection tools standardisation and data collection tools on <i>Echinococcus multilocularis/granulosus</i> in the food chain
					PARADISE: novel genotyping schemes and detection strategies for <i>Cryptosporidium</i> and <i>Giardia</i> detection

ne	JOINT INTEGRATIVE PROJECTS	INTEGRATIVE	JOINT RESEARCH PROJECTS (JRP)		
	(JIP)	ACTIVITIES	FOODBORNE ZOONOSES	ANTIMICROBIAL RESISTANCE (AMR)	EMERGING THREATS
INTRODUCTION	CARE: database of strains and genomes for quality control analysis in food safety	Reference material and data	LISTADAPT: Algorithm for selecting strains to explore the diversity of strains circulating	ARDIG: collection of large number of genomes that can be used as reference material for AMR confirmation	
VISION	ORION: framework for understanding and information exchange - One Health Surveillance Codex		ADONIS: decision making tool to determine causes and best interventions in human <i>S</i> . Enteritidis infections	ARDIG: Comparibility between antimicrobial usage and AMR data to improve AMR surveillance	
	COVRIN: models for risk assessment of SARS-CoV-2	Interpretation of surveillance data	BeONE: integrative solutions for foodborne pathogens surveillance	FULL-FORCE: data on plasmid structure and variability of drug resistant organisms	
OBJECTIVES	COHESIVE: information system that stores genomics data and metadata of pathogens from different countries (demo)		DISCoVeR: models and methods for attributing human foodborne infections to animal, food and environment sources		
IMPACTS			TOXOSOURCES: methods to eval- uate the relative contribution of different sources of <i>Toxoplasma</i> <i>gondii</i> infections		
Ŝ			MedVetKlebs: Multicentric Study of <i>Klebsiella Pneumoniae</i> in European food products		
	COHESIVE: Risk Analysis System for zoonoses; FoodChain-Lab web application to trace suspicious food items; quantitative shiny Rrisk application assessment toolbox; risk assessment Decision Support Tool	Cross-sector communication of data	BIOPIGEE: education and training activities	FULL-FORCE: tool box for Single Molecule Real Time sequencing for AMR surveillance	
			NOVA: mathematic models for data combination and analysis for One Health syndromic surveillance systems	FED-AMR: new data on the role of extracellular DNA as an AMR source and on AMR spread in agricultural environment	
	ORION: solutions for interoperability to improve data FAIRness - OHEJP Glossary, One Health Linked Data Toolbox, Health Surveillance Ontology			RaDAR: modelling methodology for AMR specific source attribution, disease burden	
	COHESIVE: review on economic analysis of foodborne zoonoses	Action (prevention and	MoMIR-PPC: Prevention & Control Measures against <i>Salmonella</i> at the poultry production level		
		response)	BIOPIGEE: biosecurity measures for the control of <i>Salmonella</i> and HEV in primary pig production and abattoir		
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AMR RESEARCH AND INNOVATION OBJECTIVES BY **PRIORITY TOPICS (AS CATEGORISED BY JPI-AMR)**

This document is the outcome of detailed discussions with the AMR expert group in the OHEJP-module AMR. The key elements of the SRIA of JPIAMR were used as a starting point (left columns) and the topics considered relevant for the PAHW were included in the right column. Please note, the order of the topics does not reflect priorities, currently it follows the systematic format of the JPIAMR.

Within the PAHW, the term livestock is understood to include both, terrestrial and aquatic animals. The term antimicrobial is used to reflect that not only bacterial, but also other agents, especially parasites might be covered in the suggested approaches. The term surveillance is used broadly and also covers monitoring approaches and surveys/studies.

Therapeutics

JPIAMR	PAHW
Discovery of new antimicrobials and therapeutic alternatives, and the improvement of current antimicrobials and treatment regimens for humans	Discovery of therapeutic alternatives, and the improvement of current antimicrobials and treatment regimens for animal diseases
Find new antimicrobials and targets	 Promote the development of novel antimicrobial compounds Repurpose existing antimicrobials (look at MPC etc.)
Develop new chemical entities and scaffolds	
 Improve pharmacokinetics and pharmacodynamics of antimicrobials, including neglected antimicrobials 	• Improve pharmacokinetics and pharmacodynamics of antimicrobials for efficient treatment of diseased animals of different livestock and companion animal species
• Use personalised medicine and artificial intelligence to improve therapies	• Use of Artificial Intelligence in mathematical modelling to improve therapies including the farming environment (e.g. SMART farming) and veterinary hospitals
• Develop alternatives for antimicrobials	 Develop alternatives to antibiotics Test alternatives to antimicrobials to treat diseased animals with a focus on final validation that new alternatives work in the field
• Develop treatment protocols based on combination therapy using new and existing antimicrobials	 Develop alternative treatment schedules for antimicrobials considering also treatment of groups of livestock for metaphylaxis and long-term efficiency of treatment schedules with the aim of prudent use Develop treatment guidelines for prudent use of AM in livestock and companion animals
• Develop policy measures and economic stimuli to minimise barriers for the development, availability and introduction of new therapies and alternatives	
Assess how regulation modifies and influences production and use of antimicrobials	



Diagnostics

JPIAMR	PAHW
Development and improvement of diagnostics to improve the use of antimicrobials and alternatives to antimicrobials	Development and improvement of diagnostics to improve the use of antimicrobials and alternatives to antimicrobials as well as availability of improved data for surveillance, prevention, epidemiology, risk assessment and risk management
 Improve the efficacy of new and existing diagnostic tools to more effectively distinguish between infections, and/or detect antimicrobial susceptibility 	 Improve availability and usage of validated methods (which include the confirmation of specific properties) for the detection of animal pathogens and resistance determinants in livestock, companion animals and wildlife considering the specifics for these populations Improve and align methods considering different approaches for resistance detection, confirmation and characterization considering phenotypic and genotypic approaches Establish clinical breakpoints for relevant antimicrobial classes to treat animal pathogens
• Create support for the implementation of innovative technologies and linkage to data platforms promoting the use of narrow spectrum antimicrobials	 Contribute to capacity building in diagnostic methods and approaches Implement links to connect expertise from different communities to profit from novel technologies
Improve the use of rapid diagnostics in appropriate One Health settings	• Develop rapid, sensitive and specific on site tests to guide treatment of diseased animals and improve usability in the field
 Improve understanding and explore ways to overcome behavioural and socio-economic barriers limiting the adoption and use of rapid diagnostics 	• Improve the understanding and explore ways to overcome behavioral and socio-economic barriers limiting the development of novel diagnostic alternatives and the use of rapid diagnostics



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Surveillance

JPIAMR	PAHW
<i>Optimisation of surveillance systems to understand the drivers and burden of antimicro- bial resistance in a One Health perspective</i>	Optimisation of surveillance systems to provide the scientific basis for risk management decisions
 Improve and standardise AMR and AMU surveillance systems, from sampling to data analysis including sampling frame, tools, methodology and reporting 	 Contribute to the establishment of an interdisciplinary network and linkage of data from different sectors through harmonizing different tools Establish and improve surveillance (monitoring) systems on AMU and AMR in animal pathogens in livestock and companion animals, taking into account specifics of the different contexts Integrate data from WGS and metagenomics in the surveillance system
• Strengthen the use of surveillance data to identify human and nonhuman reservoirs of AMR	 Provide guidance on proper sampling and analysis as well as data standardiation and sharing Consider vectors in the surveillance system which might transmit animal pathogens and their associated AMR
• Optimise the use of surveillance data to estimate burden and to assess the impact of interventions	 Develop and agree on principles and common indicators for assessment of surveillance data and guidance for decision making Optimise the use of surveillance data from livestock and companion animal populations to support treatment decisions as well as cost-benefit assessments Establish procedures to calculate disease burden estimates in livestock and companion animals
• Develop novel techniques to supplement and promote the exchange of surveillance data	 Provide a platform to share AMU and AMR information and to facilitate informed decision making Develop tools for improved and integrated analysis of AMU/AMR data, linkage between animal health, public health and environmental health Conduct research on coordination of actors and systems to maximising the usability of information collected (e.g. treatment outcomes, productivity)
• Improve and standardise the surveillance of antimicrobial use	• Establish and improve surveillance (monitoring) systems on AMU and other measures (e.g. vaccination) on farm level for the specific livestock populations, taking into account specifics of the different animal populations to support benchmarking of farms/veterinary clinics as regards AMU
Centralising registration of treatment and patient outcome	 Complement existing and newly developed systems to gather knowledge on indications and reasons for AMU in livestock animals and companion animals Link surveillance system on AMR and AMU with those related to animal health, welfare and productivity
	• Improve availability and usage of validated surveillance methods (which include the confirmation of specific properties) for animal pathogens and resistance determinants in livestock and wildlife considering the specifics for these populations
	• Assess the risk (probability of adverse health effects) related with the occurrence and spread of AMR organisms or resistance determinants

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Transmission

	JPIAMR	PAHW
	Understanding and preventing the transmission of antimicrobial resistance	Understanding the drivers and preventing the transmission and spread of animal patho- gens incl. antimicrobial resistance determinants in livestock and their environments
	• Unravel the complex dynamics of selection and transmission of antimicrobial resistance	 Improve models of AMR dynamics in closed (livestock) production systems to understand the role of different husbandry production / farming systems in Europe Develop simulation models for studying the transmission of AMR and for educating farmers and veterinary staff. Improve understanding of transmission pathways for animal diseases (bacterial, parasitic and viral diseases), i.e. spread among and between populations and their environments
• Identify factors responsible for the persistence and spread of resistant organisms and resistance elements		 Assess the impact of selection pressure through antimicrobial, antifungal, antiparasitic, biocidic use or other substances (e.g. herbicides, heavy metals) and their spread into the environment
	 Determine the impact on AMR of different systems of healthcare, animal production, global trade and environmental pollution and contamination 	• Analyse the impact of treatment of manure, changing waste management and usage of compost or other organic fertilizer

Environment

JPIAMR	PAHW
<i>The role of the environment in the persistence, selection and spread of antimicrobial resistance</i>	The role of the environment in the persistence, selection and spread of antimicrobial resistance
• Determine and model the contribution of contamination sources, environmental reservoirs and exposure routes on the emergence and spread of AMR	 Determine influencing factors (drivers, risk factors) for AMR emergence, persistence and spread within and among populations, and their interaction with wildlife, pets (companion animals) and their environments Improve procedures for treatment and use of the organic fertilizer (e.g. manure), and changing waste management
• Evaluate the relationship between AMR and the environment, climate change, and pollution	 Identify and understand the sources / reservoirs / vectors of AMR taking into account the environment in the vicinity of livestock production including aquaculture, wildlife as well as feed/crop production and imports / transports of animals
• Assess the potential impact of industrial systems on AMR in the environment	• Assess the potential impact of industrial systems on AMR in the environment and the link to animal health
• Develop innovative technological, policy, social, economic and regulatory approaches to mitigate AMR in the environment	• Develop innovative technological, policy, social, economic and regulatory approaches to mitigate AMR in the environment and the impact on animal health



Interventions

ioural change, to reduce AMR

Understand the pres

dent use of antimicrol Assess educational a

and stewardship

•ne HEALTHEIP INTRODUCTION IMPACTS









cription behaviours contributing to the responsible and pru- pials
nd training programmes to enhance antimicrobial awareness

control practices, considering different geographic and socio-economic settings

• Optimise implementation strategies, including drivers for and barriers to behav-

nterventions	
JPIAMR	PAHW
Investigation and improvement of infection prevention and control measures in One Health settings	Investigation and improvement of infection prevention and control measures in livestock production
• Develop innovative interventions aimed to detect, prevent and control the spread of AMR in a One Health perspective	 Investigate efficiency of preventive measures in livestock (for different animal species and husbandry / farming systems), considering preventing occurrence and/or spread of specific animal diseases Assess the use of pre- and probiotics, alternatives for antimicrobials, vaccination, improved biosecurity and hygiene, AM stewardship
• Investigate the effectiveness of AMR prevention and control strategies to increase uptake and acceptance in One Health settings	 Investigate the impact of consumer demands on livestock production and antimicrobial stewardship approaches
Assess the effectiveness and cost-effectiveness of specific AMR prevention and	• Improve understanding of the socio-economical (human) factors, incl. cost-benefit

analyses

practices

production systems

available technologies

behaviour) in use of alternative therapies

animal health and animal welfare issues

Improve biosecurity and hygiene

• Consider animal welfare aspects

and prudent use of antimicrobials and antiparasitics

Increase availability of vaccines to avoid animal diseases.

· Assess efficacy of guidelines for cleaning and disinfection

to help train farmers, veterinary and animal health professionals

· Develop simulation exercises applied on farms, incl. infection control simulations

Assess economic aspects of intervention measures in the specific animal sectors

Consider economic aspects of intervention measures in a specific animal sector

Identify incentives and barriers regarding data share, AM usage, and alternative

Address societal engagement, etc. (incl. understanding barriers for changing

Increase the interactions with policy makers and authorities to support implementing

· Conduct research on beliefs and attitudes and how to spread knowledge on best

• Understand the sale and prescription behaviours contributing to the responsible

• Develop AM Stewardship approaches linked with epidemiological knowledge,











Updates and sustainability plans of JIP MATRIX

Guido Benedetti Statens Serum Institut 9th Stakeholders Committee Meeting *OHEJP ASM 2022*

This presentation is part of the European Joint Programme One Health EJP. This programme has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 773830

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MATRIX: connecting

Integrative activity

One Health Surveillance. Cross-disciplinary, Multi-sectorial Foodborne **Emerging threats**

https://onehealthejp. eu/jip-matrix/









dimensions in One Health Surveillance





OHEJP MATRIX PROJECT

- ▶ 19 partners, 12 countries
- ▶ Timeline: 2020 2022

MATRIX aims to advance One Health Surveillance in practice by creating solutions for European

countries







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MATRIX solutions for OHS

https://onehealthejp.eu/jip-matrix/

<i>Expanding</i> – OHS Codex: The Knowledge Integration Platform		
One Health - EpiCap Tool	Guidelines • to develop multi-sectoral surveillance	
Roadmap to national OHS	 to operationalize collaborations in data collection, analysis, and dissemination to design implement and evaluate 	
Manual to OHS dashboards	official controls within the food sector using output-based standards	
Promoting – the Food	Safety Knowledge Exchange (FSKX) Format	

- For <u>European countries</u> (partners and non-partners) e.g. evaluating their OHS; utilizing Systems Thinking along the roadmap; developing OHS dashboards
- For OHEJP <u>stakeholders</u> e.g. to facilitate evaluation activities across countries and/or hazards
- For SIS OT (TZG) e.g. to support surveillance and information sharing



MATRIX: connecting dimensions in One Health Surveillance

Integrative activity

One Health Surveillance, Cross-disciplinary, Multi-sectorial, Foodborne pathogens, Emerging threats

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MATRIX sustainability as per its proposal



MATRIX: connecting dimensions in One Health Surveillance Integrative activity One Health Surveillance. Cross-disciplinary, Multi-sectorial Foodborne pathogens, Emerging threats

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SUSTAINARII IT

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"Sustainability refers to the maintenance of project outputs after its conclusion"

"The sustainability of the outputs from MATRIX lies primarily with each country"

https://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm#relevance-block

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MATRIX sustainability strategy in 2022 and beyond

MATRIX: connecting dimensions in One Health Surveillance

Integrative activity

One Health Surveillance. Cross-disciplinary, Multi-sectorial Foodborne pathogens, Emerging threats

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To continue the advancement and use of the OHS CODEX: KIP To support WPs' training activities

> 1. To support MATRIX partners making use of the MATRIX Solutions for OHS

2. To pilot / disseminate the MATRIX Solutions for OHS among non-partners

3. To produce and support the production of original peer-reviewed publications



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MATRIX sustainability strategy in 2022 and beyond





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1. To support MATRIX partners making use of the MATRIX Solutions for OHS

			1	
Date of last update	l		-	
Country name				
MATRIX partner institute	1			
What MATRIX output is/could	 See Annex - What solutions do 	bes MATRIX offer? at the end of this document for an		A10.0
be relevant to your institute	overview of MATRIX's outputs			+ + +
and/or country?	 Please, use a different table for 	r every MATRIX's output that you want to consider		ne ne
Is the output already in use at	1			HEALTH
you institute/in your country?	1			() as the first have
Could it be used?				
Is there any plan to use it	1			
(before/after the end of	1		MATRIX Con	ortium meeting
MATRIX)?	ļ			solution meeting
What is the problem/situation	1		March 16-18t	h. 2022
that this MATRIX output				
can/could help to solve?				
What is missing today that this	1			
What is the context of use for	l			
this MATRIX sutput including	1			
this MATRIX output, including				
relevance?		Presentations from MATRIX r	partners (10 minutes each)	
What is your desired				
outcome/situation by using this		 Statens Serum Institu 	it, Denmark	
MATRIX output?			- In a three Allander	
	l	 Norwegian veterinary 	/ Institute, Norway	
output is currently not		 Instituto Nacional de 	Investigación v Tecnología Agr	aria v Alimentaria, Spain
finalized what do you expect	1		investigación y rechología Agi	and y Annientana, Opani
from the output?		 German Federal Institute for Risk Assessment & Friedrich-Loeffler- 		edrich-Loeffler-Institut.
What is a possible way		Cormany		anon assumer modified
forward/action plan for you to		Germany		
use this MATRIX output	1			
(with/without a timeline)?	1			



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MATRIX: connecting dimensions

Integrative activity

in One Health

Surveillance

One Health Surveillance, Cross-disciplinary,

Foodborne

pathogens, Emerging threats

eu/jip-matrix/

Multi-sectorial,

https://onehealthejp.

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MATRIX sustainability strategy in 2022 and beyond

2. To pilot / disseminate the MATRIX Solutions for OHS among non-partners



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MATRIX: connecting dimensions in One Health Surveillance

Integrative activity One Health

Surveillance. Cross-disciplinary, Multi-sectorial, Foodborne pathogens, Emerging threats

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ACKNOWLEDGEMENTS

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3. To produce and support the production of original peer-reviewed publications



One Health Surveillance in Practice: Experiences of Integration among Human Health, Animal Health, Environmental Health, and Food Safety Sectors



https://www.frontiersin.org/research-topics/28964/one-healthsurveillance-in-practice-experiences-of-integration-amonghuman-health-animal-health-envi



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MATRIX: connecting dimensions

Integrative activity

Cross-disciplinary, Multi-sectorial,

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in One Health

Surveillance

One Health Surveillance.

Foodborne pathogens, Emerging threats The following topics were discussed at the OHEJP MATRIX Consortium meeting on March 17th, 2022 during a session with representatives from JIPs ORION, COHESIVE, CARE, OH-HARMONY-CAP and MATRIX

Some initiatives from JIPs of the first call are now continuing into JIPs of the second call

e.g. the work of JIP ORION about the OHS CODEX: Knowledge Integration Platform is now continuing in JIP MATRIX; the work of JIP COHESIVE about guidelines to support countries to strengthen One Health collaborations is now continuing in JIP MATRIX

Where will the initiatives of JIPs of the second call continue?

JIPs have been and are exploring opportunities outside of OHEJP to advance their achievements after 2022

To move forward, from the dissemination of JIPs' outputs towards the sustainability of the change operated by JIPs

What is the expected change of JIPs? e.g. for MATRIX, change is expected in the actual creation of the Solutions for OHS (the objective of the project), not in their use

OHEJP partner institutes and countries

Ownership

HR Turnover

Co-financing

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Would you like to help us turn MATRIX into a useful experience?









AI	artificial intelligence	JAMRIA	Join Action on Antimicrobial Resistance and Healthcare- Associated Infections
AM	antimicrobial	JIP	Joint Integrative Project
AMR	antimicrobial resistance	JPIAMR	Joint Programming Initiative on Antimicrobial Resistance
AMS	antimicrobial stewardship	JRP	Joint Research Project
AMT	antimicrobial susceptibility testing	LMIC	low and middle income countries
AMU	antimicrobial use	MCDA	Multi-Criteria Decision Analysis
ASM	Annual Scientific Meeting	MICs	Minimal inhibitory concentration
COST	European Cooperation in Science and Technology	ML	machine learning
EC	European Commission	MS	Member State of the European Union
ECDC	European Centre for Disease Prevention and Control	NGO	Non-governmental organisations
EEA	European Environment Agency	NGS	Next Generation Sequencing
EFSA	European Food Safety Authority	NRL	National Reference Laboratory
EHU	European Health Union	One Health EJP	One Health European Joint Programme
EMA	European Medicines Agency	EUP AH&W	European Partnership for Animal Health and Welfare
EP OH-AMR	European Partnership One Health AMR	PMC	Programme Managers Committee
ET	Emerging Threat	PMT	Project Management Team
EU	European Union	POC	Programme owners
EU4Health	EU for Health	SC	Stakeholders Committee
EUP	European partnership	SDGs	UN Sustainable Development Goals
FAO	Food and Agriculture Organization of the United Nations	SISOT	Tripartite's Surveillance and Information sharing Operational Tool
FBZ	Foodborne Zoonosis	SRA	Strategic Research Agenda
GOARN	WHO-Global Outbreak Alert and Response Network	SSB	Scientific Steering Board
GRAM	Global Research on Antimicrobial Resistance	UNEP	United Nations Environment Programme
HERA	EU Health Emergency and Response Authority	WGS	whole genome sequence
IACG	UN Interagency Coordination Group on Antimicrobial Resistance	WHO	World Health Organisation
IPCC	Intergovernmental Panel on Climate Change	WOAH	World Organisation for Animal Health, previously named Office International des Epizooties (OIE)











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