



Strategic Research Agenda Emerging and Major Infectious Diseases of Livestock

10 – 15 year Outlook

EMIDA – Foresight & Programming Unit

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This document presents the outcome of the work dedicated to the EMIDA ERA-NET deliverables D 4.4, D 4.5 and D 4.6, focussing on the common strategic research agenda.

D 4.5: A common strategic animal health research agenda based on shared priorities submitted to the Project Consortium.

D 4.4: An Action Plan for maintenance of the strategic research agenda.

D 4.6: An Action Plan for joint trans-national programmes submitted to the Project Consortium.



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Executive Summary

The need for a co-operative funding environment to further collaborative research in animal health is well recognised. The nature of the threats posed (all funders are not able to address all problems in isolation) and the need to make efficient use of resources to reduce duplication of effort, provide further credence that collaborative research is the way forward. A Strategic Research Agenda (SRA) has been developed that takes a 10-15 year forward look and describes the future landscape in respect of animal health across the EU. The SRA sets out the context of the issue, attempting to identify factors that may influence future disease occurrence/incidence, provides a list of priority issues for consideration and describes a framework against which funding decisions may be considered in support of furthering collaborative research initiatives.

The identification of research topics concerning infectious animal diseases based on a future outlook is a complicated process, it requires an appreciation of trends that will influence animal health, many of which will not be obvious or have a direct association. When other spatial and temporal factors are brought into the mix such as the time-frame of the study, the trans-boundary nature of disease and the occurrence of new and emerging disease, it will give rise to additional levels of uncertainty that must be taken into account. However the ability to pull this data together and describe the nature of these threats is key to development of the SRA.

In developing the SRA as a tool to support and drive further international collaboration in the field of animal health research, a number of objectives were addressed; to take account of existing 'future's' data and publications and engage with stakeholders and experts on research priorities. Whilst the output of this initiative has provided a set of research priorities for consideration, perhaps equally importantly the SRA has developed proposals on how it may be utilised in a collaborative manner and how it may be maintained for future use.

The SRA reflects the 'One World, One Health' concept, which establishes an interdisciplinary and cross-sectional approach to preventing epidemic or epizootic disease and for maintaining ecosystem integrity. For example zoonoses research efforts should concentrate on vigilant and efficient surveillance, diagnosis and the impact of infection on animal production and health. Such studies need a multidisciplinary approach bringing together public and animal health professionals, agriculture, environment and other sciences at the national and international level.

The importance of maintaining an oversight of future animal health issues and providing a framework for how the research community may address them in a co-operative and co-ordinated manner cannot be overstated. Individual funding organisations do not have the resources to address and to tackle these threats in isolation and must act appropriately. The development of a cross EU SRA sets the tone to support further international research co-ordination and starts to address the problems of tomorrow, today.



Introduction

The EMIDA ERA-NET on "Coordination of European Research on Emerging and Major Infectious Diseases of Livestock" is a Seventh Framework Programme-funded project of the European Union involving 27 partners in 19 countries. The aim of the Animal Health ERA-NET is to build on and accelerate the work of the Collaborative Working Group on Animal Health and Welfare of the EU Standing Committee on Agricultural Research (SCAR CWG) in developing a durable focused network of national research funders in Member and Associated States of the EU for the purpose of sharing information, coordinating activities and working towards a common research agenda and mutual research funding activities in the field of animal health. The scope of the project includes emerging and major infectious diseases of production animals, including fish and bees and including those conditions that pose a threat to human health, but excluding foodborne zoonoses. The project is concerned with the coordination of research activities of Member and Associated states of the EU at the level of the research funding organisations through sharing of information, organising joint research calls and working towards a common research agenda. The joint research calls are organised and funded by the EMIDA partners themselves, and are intended to support research initiatives within the contributing Member states. Moreover, the research is additional to the research procurement within the EU framework programmes. Regarding the common research agenda, it was agreed that the ERA-NET should address research topics at a strategic level for the benefit of both the EU and the individual Member states.

In support of this activity, a Strategic Research Agenda (SRA) has been developed with a timeframe of 10-15 years, common objectives are set out although a regional focus is included when considered appropriate. It is expected that the SRA will be useful as a reference work for governmental research funders in EU Member states to manage and to coordinate research priorities and joint calls in the long term. Additionally, the SRA could support development of research programmes within the individual EU Member states, and could influence EC-DG Research procurement activities as well.

Rationale

To develop a SRA a vision is needed, preferably a shared vision, on future changing conditions that may influence the emergence of infectious diseases in the EU and its regions. When the work in the EMIDA ERA-NET commenced, one of the first issues was to describe the envisaged evolution of emerging and major infectious diseases of livestock. This enables the setting of strategic goals and to prepare for this future.

The vision on the future has been addressed in subsequent activities, including the review of relevant 'futures' publications and documents (Annex 5), the Delphi study (Annex 6), and the consensus workshop (Annex 7), each of which generated inputs to draft the SRA. Of these activities the outcome of the consensus workshop was probably the more appropriate foundation to build on, because the results of both the foresights review and the Delphi study have been used as input for the discussion sessions during this workshop.

The overall results are on quite a high abstraction level. This is not surprising, given the longer the timespan of the future outlook the harder it is to be very precise.

Objectives

In order to support, enable and sustain research to prevent, control or mitigate emerging infectious livestock diseases, the following objectives are defined:

1. To undertake a multidisciplinary 10 to 15 year forward-look exercise, which provides basic knowledge of current views on the envisaged future;
2. To identify Europe's regional and trans-national medium to long-term scientific and technological needs through qualitative assessment by stakeholders of their research priorities on infectious animal diseases including research capacity and capability;
3. To develop a common strategic research agenda (SRA) based on shared priorities to enable coordination of research to be taken forward eventually by a sustainable coordina-



- tion network of research funding bodies (e.g. Collaborative Working Group of the EU Standing Committee on Agricultural Research (SCAR CWG));
4. To develop a proposal on how to utilise the SRA;
 5. To develop a maintenance plan for the SRA.

Approach

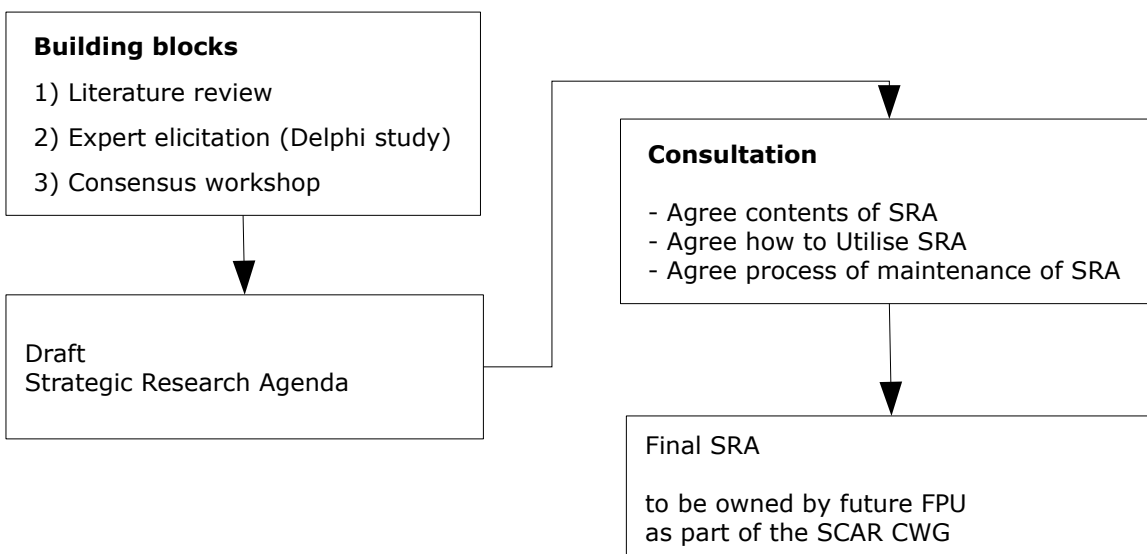
The first objective has been achieved by identification of research issues, varying from broad areas to detailed topics, based on the most important priorities in terms of (future) threats to livestock health (including associated human health issues), national and EU animal health policies, and the current research gaps. A review and analysis of existing foresight studies on (re-)emerging animal health risks was carried out. This literature review was followed by a Delphi study (see Box 1) to collect and collate additional points of view regarding Emerging and Major Infectious Diseases of Livestock which have general support from a wide range of experts.

The second objective was achieved by building on these first two results and explored in detail any consensus, disagreement and priorities regarding necessary future research, with a select group of experts from various disciplines, and from various geographical regions in Europe. This involved a multidisciplinary consensus workshop, called Strategic Research Agenda Workshop (STRAW), which was organised to allow face-to-face discussions between those experts to achieve the goals of this third step (see Box 2).

To finalise the process of SRA development and to achieve the third objective, the results of the workshop together with the results of the Delphi study and the literature review were evaluated with additional information from on-going work in the same field. This led to a list of research priorities on emerging and major infectious animal diseases for Europe, including a regional focus when appropriate, for the next 10-15 years.

In order to facilitate coordination and collaboration in research procurement at an EU level, several suggestions are made on how to take forward the utilisation of the SRA (fourth objective). To support, if possible ensure, the long-term relevance and sustainable use of the SRA (fifth objective) a foresight exercise is described that would fit this purpose.

Flow diagram of steps taken to develop and maintain the Strategic Research Agenda:





Box 1. The Delphi methodology

In EMIDA a web-based Delphi methodology was used with on-line questionnaires, which is particularly useful for expert consultations of this type. Delphi methodology (Linstone and Turoff, 1975) possesses the practicability of a survey, with its benefits in terms of cost and potential access to wider expertise. The Delphi method has several advantages as a form of expert consultation. It guarantees anonymity, removes the influences of dominant participants and group dynamics, but the approach maintains a degree of interactivity and dialogue associated with group meetings or workshops. Furthermore, it allows feedback and opportunities for adjustment of opinions through several rounds of responses as well as a level of statistical analysis. Geographical and language barriers are reduced as participants are not required to attend several meetings at a significant monetary cost, and many stakeholders can be approached in varied geographical locations simultaneously (Wentholt et al., 2009). Empirical research has shown that the method (in its various forms) leads to better (e.g. more accurate) judgements and forecasts than interacting groups (Rowe and Wright, 1999, 2001). Although, survey methodology, which solicits answers to key questions of interest, is ideally suited to identifying consensus and disagreement, it does not allow for any possibility of interaction between participants, or resolution of disparate opinions. To overcome this problem, a consensus workshop was organised.

Scope and Delineation

The SRA is structured to provide a framework against which funders of animal health research may be able to co-ordinate their future activities to best mitigate against likely future threats in a co-operative manner. It does not aim to dictate or specify future research requirements or calls, rather with an intelligent customer (audience) in mind, to direct and distil relevant advice that may be considered and acted upon in line with their own priorities and those of EMIDA. Further studies relevant to the work undertaken, that are currently ongoing or have recently been published have also been taken into account (Annex 4).

The scope of EMIDA warrants the inclusion of zoonotic diseases, but excludes foodborne zoonoses. As production animals are a primary source of food safety issues it would be almost unethical not to discuss foodborne zoonotic impacts on human health. Nevertheless, it has not been a main objective and, therefore, not systematically included in the discussions and in the SRA.

Research Priorities

Identification of future research areas and topics

Several studies focused on identification of (re-)emerging risks have been conducted in recent years (EMRISK – EFSA, 2006). Together with the 44 foresight studies concerning future animal health issues that have been reviewed and analysed within EMIDA's first step of SRA-development (see Annex 5), these studies indicate that a holistic approach is needed in order to obtain useful information about the driving forces and future threats. This implies that multidisciplinary and interdisciplinary knowledge is required and should be applied to identify the relevant issues pertinent to developing the SRA in the context of future European animal health research.

The output of the literature review is organised as drivers and threats to animal health, and research priorities are identified based on the individual studies and the analysis thereof. Given the wide source of material used for the literature review, it is inevitable that the scope of subjects collated as drivers, threats and research priorities are broad. And due to the fact that different sources used different definitions for drivers and threats it is impossible to generate an unambiguous and unquestionable list of prioritised research issues (Table 1).



Table 1. Future research issues ranked according the number of times found in reviewed literature (abridged version, full version in Annex 5).

Research issue
1. Medication (preventive and therapeutic measures; avoidance of drug resistance)
2. Prevention: novel vaccine; host selection or modification for genetic resistance to disease
3. Fundamental knowledge development on diseases, such as Rift Valley fever, West Nile fever, visceral leishmaniosis, leptospiroses, bluetongue, African horse sickness, fish diseases
4. New technologies (novel and easy-to-use delivery systems; generic immune enhancement systems, nano delivery of drugs, genomics)
5. Early detection of disease/pathogen, like: <ul style="list-style-type: none"> - remotely read biosensors (nanotechnology) - diagnostics / analysis (including rapid field diagnostics through use of genomics, proteomics) - rapid real-time information flow and analysis with links to a global knowledge web
6. Vectors and vectorborne diseases (vector control, host range, competence)
7. Surveillance system (epidemiological data; animals/vectors/reservoirs)
8. Remote sensing (e.g. environmental measurements), information access, and rapid transmission
9. Climate (e.g. methods to slow down the change, including education activities)
10. Convergence of animal health and public health strategies, interests and priorities
11. Early warning system development (e.g. arbovirus)
12. Relationships in complex ecosystems, long range effects on ecosystems; biodiversity
13. Tracking animal movement
14. Surveillance of wildlife animal reservoirs
15. Societal changes (How to reduce public anxiety?)
16. New paradigm for animal health: proactive risk management; sharing of decision-making responsibility & accountability among all stakeholders
17. Environmental impacts/drivers on animal health
18. International collaboration (including data sharing)
19. Data collection (real time, biotic and abiotic), Data mining, Data sharing, Modelling
20. Bio-informatics
21. Immune modulation and enhancement

The drivers and threats identified in the Delphi study are more coherent, although there is no consensus regarding the direction of impact of some of the driving forces on the incidence of infectious animal diseases (e.g. increase or decrease). Nevertheless, it results in a long list of potential research topics and domains of which the condensed list, without any ranking, can be found in Table 2. No significant differences are found for any of the issues, regarding whether they were short or medium term priorities. Some participants listed research disciplines rather than research priorities. These disciplines are included in Table 2. It is suggested that both disciplines and research priorities should be included in research programmes for further investigation.

Table 2. Research priority areas from the Delphi study, split over research priorities (*topical*) and research disciplines.

Research priorities	Research disciplines
Emerging diseases	Biology
Improve surveillance (diagnostics)	Climatology
Improve/develop early warning systems	Ecology
Improvements in emergency preparedness	Economics, related to animal health
Improvements in emergency response	Entomology
Pathogen-host interaction	Epidemiology
Pathogens related to zoonoses	Immunology
Resistance of pathogens to, e.g. anti-microbials	Risk analysis
Vaccine development	Virology
Vector related research	
Zoonoses (in general)	



Therefore a debate was organised between 33 experts of government, research, industry and NGO's with a global, European and/or regional perspective, and with disciplines like epidemiology, virology, bacteriology, wildlife, economy, insurance, risk assessment and risk management. Their effort, further discussion and review during the workshop helped disentangle these outputs toward a structured frame-work in support of the SRA.

As it is generally accepted that relevant driving forces lead to animal health threats and as a consequence aid the process of identification of research priorities, the first aim of the workshop was to obtain a clear-cut overview of the drivers and threats at stake. To guide the discussion the following definitions of drivers and threats were provided.

Driver: A general political, social, demographic, economic (including agriculture) or environmental condition acting on such a scale that it may directly or indirectly influence the (re-)emergence of animal and human infectious diseases.

Threat: A consequence of political, social, demographic, economic (including agriculture) or environmental decisions or actions, but with possible adverse effects on the occurrence of animal and human infectious diseases. In addition, pathogens are included as threats.

Based upon the identified drivers and threats, the workshop participants derived research priorities at a pan-European level and at the level of different bio-geographical regions. The output of the consensus workshop (Table 3), as the final result of discussions on research priorities, provided the foundation upon which to build for this SRA. These results are on quite a high abstraction level, because of the difficulties incumbent in generating detailed and reliable information when looking 10 to 15 years ahead. In order to try and validate the consensus workshop results, and at the same time identify essential issues still lacking, the results are compared with other relevant sources like the results of the interactive session on 'Major Epidemic Threats' of the future conducted during the EPIZONE meeting 2010 in St. Malo, the Strategic Research Agenda of the European Technology Platform on Global Animal Health, and preliminary results of the EU-project DISCONTTOOLS. Additionally, this makes it possible to provide more detailed information about what may be addressed in forthcoming research programmes. Other 'futures' activities that are underway or may be planned to take place should be accounted for to maintain and update the SRA.

Priority research areas

The priority research areas as derived from the consensus workshop and depicted in Table 3 are not independent of each other. Several areas show some overlap or interaction, and further analysis allows for them to be regrouped and restructured to better distinguish the priorities from each other (Table 4).



Table 3. Priority research areas at pan-European and regional level, identified at the consensus workshop STRAW of EMIDA Workpackage 4.

Priority Research Area	Eur	A	N	C	M
Improvement of surveillance	1 ^A , 1 ^C	1		1	
(risk analysis of) Biosecurity measures on all levels, including border crossing of wildlife	2 ^A , 1 ^N , 3 ^C	2	2	2	
Better understanding of vectorborne diseases and health effects of ecosystem change	1 ^M		3	4	1
Improvement of preparedness for emerging and exotic diseases by improvement of diagnostic tools	2 ^N		1		
Development of diagnostic tools and control methods for diseases of neglected species	3 ^M				2
Improvement of preparedness for emerging and exotic diseases by an epidemiological approach of risk pathways identification	3 ^A	3			
Better understanding of host-pathogen interaction	4 ^A , 3 ^N , 4 ^C	4		4	
Development/improvement of vaccines and vaccination strategies	2 ^C , 4 ^M			3	
Antimicrobial resistance				4	
Improvement of understanding of emerging, neglected and endemic zoonoses	2 ^M				

EUR=pan-European; A=Atlantic; N=Nordic/Baltic; C=Continental; M=Mediterranean

The numbers give the priority order according the workshop discussion groups; the column Eur represents the opinion of the respective bio-geographical group on priority of the research area on pan-European level.

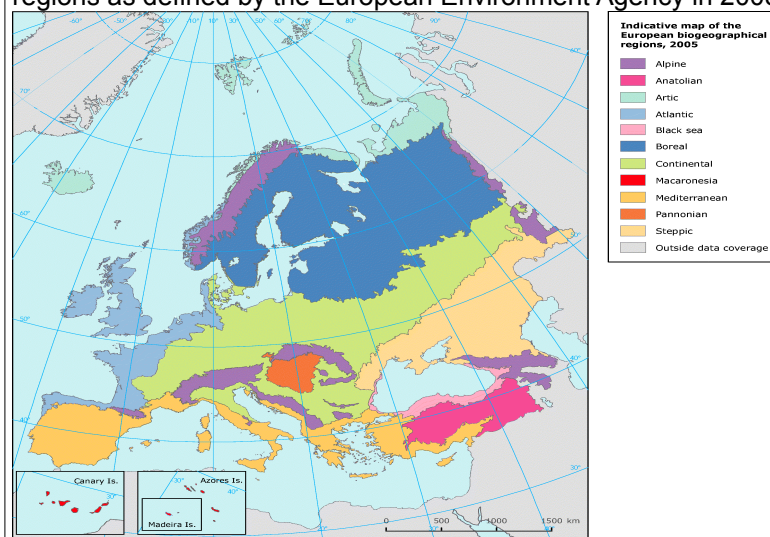
The colours indicate the priority level of the research areas and how urgently these areas should be addressed, red being a high priority and green a lower priority. The grouping of the areas is somewhat arbitrary, because the specific features of the areas are not always very distinctive.



Box 2. The Strategic Research Agenda Workshop (STRAW)

As a third step in the development of the Strategic Research Agenda a consensus workshop (STRAW) was organised. From 10 to 11 June 2010, a multidisciplinary group with expertise related to infectious animal disease threats gathered in Prague. The objective of the workshop was to list and prioritise research needs to enable EMIDA to identify, prevent/control/mitigate emerging infectious animal diseases in the next 10 to 15 years on a European level and, if appropriate, on a regional level.

Based upon the review and analysis of existing foresight studies on (re-)emerging animal health risk and the additional expert elicitation via the Delphi methodology, several discussion sessions were conducted. The participants were asked to discuss which research priorities could be identified and prioritised at a pan-European level and at the level of different bio-geographical regions. The participants were divided into four biogeographical groups. The participant's country of origin determined which group he was in. The four regions, Nordic/Baltic (i.e. Boreal region including Denmark and Norway), Atlantic, Continental and Mediterranean, were based on biogeographical regions as defined by the European Environment Agency in 2005. (see also Annex 7)



From further scrutiny and discussion of research priorities (at the consensus workshop) it is apparent that there is an element of overlap and interaction between them. For example, it is clear that biosecurity measures are included in control methods. Likewise, infectious disease surveillance is linked to diagnosis and risk assessment, and climate change may cause the emergence of new vectorborne diseases and therefore risk analysis and preparedness of the veterinary services are essential. Studies on host-pathogen interactions lead to increased knowledge that serves both diagnostic tools and vaccine development. On the other hand, research on antimicrobial resistance and on zoonoses is more or less unrelated to the other issues. Therefore a regrouping of the research areas is suggested to better distinguish the different areas. The overlap, interaction, and regrouping is shown in Table 4, where the research areas are prioritised according the original priorities. It should be noted that all topics (A-F) are identified as priorities for further research, the ranking (higher, medium, lower) does not negate the importance of these issues, but rather provides a priority order.

Higher priority:

- (A) Surveillance systems and risk analysis
- (B) Control measures and biosecurity
- (C) Ecosystem change, vectorborne diseases and preparedness (in the field, laboratories and veterinary services)



Medium priority:

(D) Host-pathogen interaction that serves the development of diagnostic tools and vaccination

Lower priority:

(E) Antimicrobial resistance

(F) Zoonoses

Table 4. Research areas overlap, interaction, and transformation of the STRAW outcome into more coherent research areas.

		Research areas derived from STRAW									
		Surveillance	Biosecurity measures	Vectorborne diseases, ecosystem change	Preparedness based on diagnostic tools	Diagnostic tools, control methods	Preparedness based on risk identification	Host-pathogen interaction	Vaccines	Antimicrobial resistance	Zoonoses
Research areas regrouped	A. Surveillance systems and risk analysis	x			x	x	x				
	B. Control measures and biosecurity		x		x	x			x		
	C. Ecosystem change, vectorborne diseases and preparedness (in the field, laboratories and veterinary services)			x	x	x	x	x			
	D. Host-pathogen interaction that serves the development of diagnostic tools and vaccination				x	x		x	x		
	E. Antimicrobial resistance					x				x	
	F. Zoonoses					x					x

X = overlap and interaction exist between the relevant research areas

The colours indicate the priority level of the research areas and how urgently these areas should be addressed, with a decrease in priority level from red to yellow.

As these research areas are still on quite a high abstraction level and refer to a broad area containing a lot of different research opportunities, a description is provided to enable the identification of more specific research topics.



(A) Surveillance systems and risk analysis

Improvement of surveillance is identified as one of the major research areas on infectious animal diseases. Surveillance starts in the field with the farmer and his veterinarian, but also the diagnostic and reference laboratories are involved, as well as the national and international competent authorities.

Risk analysis and its components (risk assessment, risk management and risk communication) should be the basis on which any surveillance system is founded. Risks should be assessed in close relation with risk managers, but by independent scientific groups, and should be addressed in a standardised way (an example can be found in the OIE study: 'Listing and categorisation of priority animal diseases, including those transmissible to humans – Methodological Manual') so that all over Europe all competent authorities are equally well prepared when emerging infectious diseases appear. Special attention should be paid to the follow up of (re)emerging infectious diseases outwith Europe, which pose a threat to livestock and humans in Europe, e.g. in continents/regions like Africa, the Middle-East, Russia and Asia.

(B) Control measures and biosecurity

Control measures and biosecurity are part of a very broad area which includes all measures addressed to avoid the entry and -if already present- the spread of animal diseases in a herd, in a region, a country or at the European Union level.

In this sense, most common measures are: immobilisation or culling of diseased, infected or suspected animals; emergency vaccination and/or treatment to prevent spread; restriction of contacts with other animals, people, instruments, animal products... General biosecurity measures such as contact limitation of people, animals, manure, equipment and animal products, pest control, cleaning and disinfection..., are well-known and described. However, depending on the infectious agent, the type of herd, the management system, the animal density of the region, vicinity of wildlife, preparedness of the local and regional veterinary services, preparedness of the farmer, policies and legal constraints..., the specific approach to enforce efficient control measures may differ. Although many principles of disease control and biosecurity appear generic, bio-geographical differences may also need to be addressed.

Particular attention should be paid to stimulate farmers and veterinarians to take appropriate action when a new or emerging infectious disease is suspected or diagnosed on farm or on a neighbouring premise (cost benefit analysis should feature as appropriate to evidence decisions on control measures). In addition, the discussion should clarify the shared responsibilities between the livestock sector, the farmer and the veterinary practitioner with respect to the necessity of implementing biosecurity actions, and the consequences of not respecting mandatory control measures. Both classic and organic farming should be addressed.

Of course, control measures rely on adequate monitoring and surveillance systems, good clinical and laboratory diagnostic capacity and capability, alertness and response procedures, and good quality of available vaccines and vaccine strategies.

(C) Ecosystem change, vectorborne diseases and preparedness (in the field, laboratories and veterinary services)

The emergence of infectious diseases due to the current and expected ecosystem change is part of a complex interaction of factors. Ecosystem change may influence and be influenced by many factors, for instance demographic changes, socio-economic changes, increased urbanization, climate change, deforestation, changes in land-use and animal husbandry systems. Moreover, ecosystem variations can drive changes in biodiversity, exposure pathways, genetics of pathogen, the life cycle of pathogen and vectors, and more. Therefore, ecosystem change, especially climate change as its most obvious manifestation, will cause alterations in disease transmission, occurrence and spread. It is expected that vectorborne, waterborne and airborne animal diseases and zoonoses will invade new geographical regions with possibly devastating consequences if the respective governments are unprepared.



Climate change affects all of us, but the causes and solutions are driven globally. The whole structure (veterinarians, laboratories, health authorities...) should be able to react in a coordinated way to anticipate, prepare for, manage the risk and combat new emerging diseases.

According to the STRAW results, the broad topic 'ecosystem change, vector borne diseases and preparedness' includes better understanding of vector borne diseases and health effects of ecosystem change, and improvement of preparedness for emerging and exotic diseases by improvement of diagnostic tools and by an epidemiological approach of risk pathways identification.

(D) Host-pathogen interaction, leading to better diagnostics and vaccination

The general research area of host-pathogen interaction is the basis for both fundamental and applied research on infectious animal diseases. Better knowledge of the infectious agent, its (intermediate) hosts, and their interaction leads to the identification of improved or novel diagnostics and control tools. In addition, (genomic) selection of production animals with enhanced disease resistance/robustness is a promising research area. Fundamental research should also be supported, as it stimulates thematic (cross-discipline) knowledge, such as humoral and cellular immunology, molecular techniques... and acquisition of high-tech instruments and infrastructure that become available for future challenges.

Special attention should be paid to the study of vector borne diseases and more precisely to the possible adaptation of the infectious agent to new intermediate vectors, eventually driven by ecosystem change.

In particular, the topic 'vaccination' includes different aspects, like the development of novel vaccines, improvement of existing vaccines and design of new vaccination strategies, thus providing the necessary health control tools. The development of antiviral molecules to be used in epizootic outbreaks of emerging animal diseases should also be considered.

(E) Antimicrobial resistance

Both antimicrobial resistance and zoonoses were identified as areas of lower priority in Europe considering the aim to identify research issues within a time-frame of 10-15 years. Nevertheless, although considerable efforts have been made to understand the existence and emergence of antimicrobial resistance, there is still a need for more information on the correct use of antimicrobials, the reduction of resistance in animal and zoonotic pathogens, and the interaction with normal gut flora, as shown by the results of the monitoring programmes in place all over Europe. Apart from the need to monitor the evolution of antimicrobial resistance in food producing and companion animals, the timely identification of new emerging resistance profiles among target pathogens, their spread among the animal populations, the transmission from animal to human population, and a possible link with the use of antimicrobials in the animal species is needed. In other words, we need to find out how to deal with antimicrobial resistance to tackle this problem. In addition, the effectiveness of alternatives to antibiotics should be considered in the quest to reduce antibiotic usage.

(F) Zoonoses

Infectious agents that may be transmitted between vertebrate animals and humans can affect both animals (food producing/companion) and humans. As these infections may pass without any clinical consequences in the majority of healthy people, these infections are probably largely underreported, not only in the developing but also in the developed world. Therefore, the importance of zoonotic diseases and their consequences is expected to be underestimated. This does not only hold true for endemic zoonoses, but especially for emerging and neglected zoonoses new to a region. Research efforts should therefore concentrate on vigilant and efficient surveillance, on diagnosis, and on the possible impact of these infections on animal production and public health. These studies need a multidisciplinary approach, bringing together public and animal health professionals, agriculture, environment and other sciences at the national and international level. This reflects the 'One World, One Health' concept, which



establishes a more interdisciplinary and cross-sectoral approach to preventing epidemic or epizootic disease and for maintaining ecosystem integrity.

The descriptions above provide information on the main research areas that should be addressed in order to be prepared for the changes we expect in the next 10 to 15 years regarding infectious livestock diseases. This high abstraction level, with low level of detail, approach needs further exploration and specification to deliver a research agenda to be used strategically by the European community at large, in other words “setting the European priorities”. To facilitate this process Table 5 gives an overview of the research issues at stake which are identified within the different levels of detail considering preparedness, prevention and control. Furthermore, indications are given where fundamental research is needed and where applied research should be conducted. This provides the opportunity for research funders to identify their goals within their remit and seek collaboration with potential partners within the broad range of research issues depicted.

Table 5. Research issues on different level of detail depicted within the context of preparedness and prevention & control

LEVEL OF DETAIL ▼	DRIVERS ▶	ECOSYSTEM CHANGE SOCIO-ECONOMIC CHANGES DEMOGRAPHIC CHANGES			RESEARCH LEVEL ▼
		PREPAREDNESS	PREVENTION	CONTROL	
LOW HIGH	INFRASTRUCTURAL ISSUES	Competent Authority (capacity & capability)			
		Veterinary Services (capacity & capability)			
		Veterinary – Human Medicine interaction (capacity & capability)			
		Monitoring & surveillance			
	TECHNOLOGICAL DEVELOPMENTS	Vaccine development			fund./appl.
		Vaccination strategies			appl.
		Diagnostic tools			fund./appl.
	KNOWLEDGE DEVELOPMENTS	Risk assessment			appl.
		Epidemiology			fund./appl.
		Host-pathogen interactions			fund./appl.
		Vectorborne diseases			fund./appl.
		Antimicrobial resistance			fund./appl.
		Zoonoses			fund./appl.
	List of specific diseases ▼ (see Annex 4)				

fund. = fundamental research; appl. = applied research

Nevertheless, a more detailed description of research topics is required to support the research funders to take forward this research agenda in a collaborative way. Therefore, a prioritised list of research topics is addressed in the next section of this paragraph.

Prioritised list of research topics

For operational purposes more detailed information on the relevant research priorities is necessary to enable research procurement. Although the outcome of the STRAW is an overview of research areas in a prioritised manner, it obviously lacks detail. To derive more specific research topics from the STRAW outcome, other sources were consulted (see sources listed under Annexes). On the one hand these other sources provide additional research issues and specific research topics, but on the other hand they validate the outcome of the STRAW.

The research topics are listed according to the priorities set in the STRAW for the pan-European level. It is recognised that the research priorities for the bio-geographical regions,



that were distinguished as being appropriate for the STRAW (see also Box 2), are very similar to the pan-European research priorities. The research priority order can differ between the regions, and the whole of Europe, but the only research requirement that clearly stands out in the overall range of research priorities is the need of research on diagnostic tools and control methods for diseases of neglected species for the Mediterranean region. Therefore only the pan-European list of research priorities is given below. As infectious diseases do not respect member state borders or even bio-geographical boundaries, many countries should be involved in research efforts that reduce the impact of those diseases. The different priority level or priority order of the research topics that are identified on pan-European or bio-geographical level could influence the contribution of member states to future joint research programmes. It will be left at each country's discretion which priority will prevail when making their funding decision. To support this process of decision making the specific lists of research priorities on bio-geographical level are attached to the SRA as Annex 4a.

List of pan-European research priorities

The following research areas are considered to be a priority relevant to the whole of Europe:

1. **Surveillance systems and risk analysis**¹
 - 1.1. Risk based improvement of surveillance
 - 1.2. Improvement of risk analysis
2. **Control measures and biosecurity**
 - 2.1. (risk analysis of) Biosecurity measures on all levels, including wildlife issues
 - 2.2. Development of diagnostic tools and control methods for diseases of neglected species
 - 2.3. Vaccination and vaccination strategies
 - 2.4. Development of (novel) control methods for endemic diseases
3. **Ecosystem change, vectorborne diseases and preparedness** (in the field, laboratories and veterinary services)
 - 3.1. Better understanding of vector borne diseases and health effects of ecosystem change
 - 3.2. Improvement of preparedness for emerging and exotic diseases by improvement of diagnostic tools and by an epidemiological approach of risk pathways identification
4. **Host-pathogen interaction that serves the development of diagnostic tools and vaccination**
 - 4.1. Vaccine development
 - 4.2. Antiviral development
 - 4.3. Improvement or development of detection tests
5. **Antimicrobial resistance**
 - 5.1. Development of alternatives for antimicrobials
 - 5.2. Molecular and cellular basis of antibiotic and anthelmintic resistance
6. **Zoonoses**
 - 6.1. Unidentified/new, emerging, neglected and endemic zoonoses

See Annex 4b for further details on research priorities in the EU on emerging and major infectious diseases of livestock, including research suggestions for the short term.

EU Animal Health Strategy (2007-2013)

Though the term of the EU Animal Health Strategy (AHS) ends in 2013 it may be expected that the life of the strategic goals of this policy paper exceeds this period. These goals focus on ensurance of a high level of public health and food safety, prevention of animal diseases, improvement of agro-economic growth and competitiveness. In addition, they support the EU sustainable development strategy based on "prevention is better than cure". It is therefore

1 Risk analysis and its components (risk assessment, risk management and risk communication)



worthwhile to see what part of the AHS is addressed by the research priorities of this SRA and how these two documents link up.

Basically, the AHS delivers a set of criteria for setting priorities, as the risk of new threats should be analysed according to the cost-benefit and cost-effectiveness of the intervention measures needed to reduce these threats. Socio-economic issues are identified within the SRA as important drivers for emerging infectious animal diseases. It is concluded that production diseases are responsible for major economic losses. Nonetheless, specific production diseases are not mentioned in the SRA, because consensus is hard to achieve due to the divergent burden of disease in different countries. Therefore, in the SRA production disease priorities will be left at each country's discretion which priority will prevail when making their funding decision, like for the list of research topics on bio-geographical level.

Considering prevention, surveillance and preparedness, improved (border) biosecurity is mentioned in the AHS as well as in the SRA, together with improvement of surveillance, diagnostic tools (rapid methods), and control measures. But while the AHS focuses more on practicalities like improvement of electronic identification and tracing of animals and document checks, the SRA provides more in depth analysis about the existing gaps in knowledge of diseases. For instance, better knowledge must be developed on reservoir hosts for animal pathogens and their role, disease modelling in a multidisciplinary approach, and the understanding what modulates the seasonality of endemic disease infection in cattle. Moreover, these knowledge gaps and research priorities of the SRA are derived from expectations how the emerging infectious disease situation in Europe will further develop over the next 10-15 years. This could provide a baseline for the next AHS to build on.

All in all the SRA reflects and is complementary to the current AHS objectives and provides information for the upcoming European wide strategies on animal health.

Maintenance

To develop the SRA it was deemed necessary to set-up a dedicated team, and to define its terms of reference. To maintain the SRA, the experience of this team, the Foresight & Programming Unit (FPU), using different methodologies to create the SRA should be fostered, as any subsequent effort to adjust and sustain the SRA over the years to come, would benefit from it.

Without doubt the SRA needs adjustments in the upcoming years. After all, we are living in a dynamic environment, for instance with hard to predict changes in climate influencing disease introduction and spread, and economic developments influencing the speed of research developments. So, it will be necessary to perform regular readjustments, to reconsider current and future research needs. It is expected that one of the instruments to support these checks and balances will be a specific foresight study on emerging and major infectious livestock diseases for Europe. One of the experiences in the process of SRA development is that such a foresight study is lacking.

Another experience is that the Delphi study, as an expert elicitation process, cannot stand on itself and should be followed by a multidisciplinary workshop to distinguish and prioritise the most relevant research topics. The consensus workshop (STRAW), the way it was conducted, was well received, and provided solid information on the necessary research directions on high abstraction level. Therefore, a repetition of both the Delphi study and the multidisciplinary workshop could be an option for SRA maintenance. Though the Delphi study delivered basic material for the workshop, the workshop delivered more useful results for SRA building. The workshop method seems more suited for short term adjustments of the SRA, while the Delphi method could show a shift in opinions in the long run, as a larger group of experts can be objectively interviewed this way.

There are other methods to describe the envisaged future (scenario studies), and to prioritise research issues (see Annex 3). These could/should be taken into account while preparing updates of the SRA. Furthermore, these could be used as a validation or sustainability check of what has been achieved by the approaches used so far.



Recommendations

Recommendations for utilisation of the SRA

The SRA provides guidance for all the European countries, and suggests research priorities. This, implicitly, encourages the countries to share the same focus, but does not automatically make these countries work together. It also, implicitly, bears the risk of several countries covering the same research areas independently of each other. Therefore, it is necessary to provide the countries with an environment which facilitates collaborative activities, and prevent unnecessary duplication of efforts, and unnecessary expenditure of budgets.

Coordination and collaboration

1. Sustain the Collaborative Working Group on Animal Health and Animal Welfare (CWG) of SCAR (Standing Committee for Agricultural Research) as a body for coordination of trans-national research activities, and make coordination of these collaborative activities part of the Memorandum of Understanding of the CWG and its *modus operandi*.

The CWG is established in late 2005 as an informal group of 16 Member states and 5 Associated member states (at the time) using their own resources to interact and share information on ongoing and planned research activities. The EMIDA consortium arose from the CWG with the intention to enable and accelerate the CWG's realisation of a coordinated Animal Health European Research Area. The objective of the CWG is to develop a durable focused network of national research funders in Member and Associated States of the EU for the purpose of sharing information, coordinating activities and working towards a common research agenda and mutual research funding activities in the field of animal health and welfare, including fish health and welfare and including those conditions which also pose a threat to human health. So, the CWG can provide the long-term sustainable coordination structure for collaborative activities regarding the SRA.

2. Enable and sustain web based accessibility of the SRA and related databases.

Easy access to the available information which is relevant for CWG member's research procurement is paramount. The access to this information enables CWG members to identify potential partners for collaboration or to decide to await the results of partners already involved with specific research. This can prevent duplication of efforts or maximise return on investment. It is expected that the easiest way is to have a website available that provides access to the SRA and the information on the CWG members interested to take forward a specific research issue. The website is already in place (<http://www.scar-cwg-ahw.org/>), and it is suggested to sustain it. Therefore, the main thing is to create a database which contains the SRA research topics and to allow CWG members to express their interest in the topics, or indicate that they are planning research on topics. This could be done by having a coordinator collecting the relevant information (via e-mail for instance), or by having a system in place to allow the CWG members to upload their information on the website.

3. Establish operating procedures for joint research procurement.

The collaborative activities could be supported by a high profile call office, as is operated within the EMIDA ERA-NET, while the lowest profile will be to let the potential partners organise the procurement themselves. An 'in between' option could be that operating procedures for organising a joint call will be provided by the CWG. It is obvious that having a call office organising joint calls will be most resource-intensive.

Research priorities versus research topics

4. Support the use of the SRA priorities and the development of lists of detailed research needs on country, regional and European scale (see also recommendation 6).

The SRA provides research priorities on pan-European and bio-geographical level. It does not deliver much detail on research topics because the SRA covers a timespan of 15 years, which makes it hard



to give lots of detail, in the dynamic world we live in today. So, those partners that are interested to collaborate in a research area, need to define the research topics and make them suitable to the specific needs at the time.

Nevertheless, to facilitate the collaborative activities and speed up the process of research procurement, urgent research needs have been identified. Not only in the process of SRA development, but also (and mainly) in the DISCONTTOOLS project, that will provide (from the standpoint of the animal industry) a mechanism for focusing and prioritising research that ultimately delivers new and improved vaccines, pharmaceuticals and diagnostic tests. In EMIDA and DISCONTTOOLS people worked closely together to prevent duplication of effort, but even more importantly to share visions, knowledge, and generate coherent and consolidated outcomes.

Recommendations for maintenance of the SRA

Maintenance of a document such as the SRA requires a dedicated group of persons who take responsibility and ensure that the SRA will be updated over the years. As the SRA is built for the medium-term or longer, it contains issues on a high abstraction level which requires additional work to derive short-term research topics from it. Furthermore, it requires regular adjustment considering the dynamics it is based upon.

5. Sustain the existence of the Foresight & Programming Unit after the project's end, and make it part of a sustainable organisation with a rotating membership, as described in the terms of reference (see Annex 2).

short term

6. Organise multidisciplinary consensus workshops (e.g. based on the STRAW concept, see Annex 7), every 2-3 years, to support the development of a short-term research agenda with the necessary details to be used for trans-national research programming and procurement.

As views and opinions of individuals change over time, based on newly acquired knowledge, and changes in the SRA should proceed coherently, it is suggested to try and create a core group of participants for the next consensus workshops (STRAWs) and not change all the STRAW participants at once. On the one hand this will allow for validation of the original SRA, and on the other hand it will stimulate discussion between the 'old' core group and the new participants. In addition, it is necessary to ensure multidisciplinary within the group of participants and include not only representatives from domains like veterinary medicine, but for instance also social sciences and economics. When the STRAW in the proposed set-up will be repeated every 2-3 years, it is expected that more detailed research topics can be generated, and also (minor) adjustments to the medium-term SRA can be made. It is recognised that other 'futures' activities are underway (e.g. ENHanCE) or may be planned to take place. Accounting for such work-streams should be an integral part of maintaining and updating the SRA.

7. Create regular updates of the overview of the animal health research capacities and capabilities available in the EU as it can facilitate Member States in their decision making process for research funding.

long term

8. Commission a dedicated foresight exercise, including scenario studies and tailor made Delphi studies, within the domain of emerging and major infectious livestock diseases for the European continent with a 20 to 25 year outlook to support the necessary SRA adjustments to be made in the future.

Within the context of envisaged long-term changes and the driving forces that influence the introduction and spread of infectious diseases, it is suggested to create a 20 to 25 year outlook and broaden the scope of disciplines while doing so. This should be taken forward on short notice. A view of how the world will look like in 25 years time, for instance with its foreseen technological levels and the impact it will have on for instance transport systems, economy, human behaviour, politics,



ecosystems, can be helpful to identify emerging issues for animal health and welfare. This will require an active approach and collaboration with a wide range of experts on a global level. To involve experts from a variety of disciplines and out-of-the-box thinkers is paramount when such an outlook is to be created. The work to be considered should engage governmental bodies, industry, NGOs, consumers, researchers, and focus on technological advances and global changes. Evaluation of, still to be designed, future scenarios seems the appropriate approach for this exercise. These scenarios should be descriptive without any priority setting, and cover a wide range of domains. After building the scenarios, the relevant issues for the animal health domain may be extrapolated. The goal of scenario building is raising awareness with relevant stakeholders, especially governmental organisations, on how to create resilience and what approaches tackle the problems identified in the different scenarios.



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List of Abbreviations

DISCONTTOOLS	Disease Control Tools
EC DG-Research	Directorate-General for Research & Innovation of the European Commission
EDEN	Emerging Diseases in a changing European eNvironment
EFSA	European Food Safety Authority
EMIDA	Emerging and Major Infectious Diseases of Livestock
ENHanCE	ERA Net Health and Climate in Europe
EPIZONE	Network of Excellence for Epizootic Disease Diagnosis and Control
ERA-NET	Networking the European Research Area
ETPGAH	European Technology Platform for Global Animal Health
FPU	Foresight and Programming Unit
ICONZ	Integrated Control of Neglected Zoonoses
NGO	Non-Governmental Organisation
OIE	World Organisation for Animal Health
SCAR	Standing Committee for Agricultural Research
SCAR-CWG	SCAR-Collaborative Working Group on Animal Health and Welfare
SRA	Strategic Research Agenda
STRAW	Strategic Research Agenda Workshop



List of Annexes

1. FPU members.
2. Foresight & Programming Unit, Terms of Reference (long term); Work Package 4, Foresight & Programming Unit – EMIDA, 16 April 2009 (<http://www.emida-era.net/upload/pdf/WP4%20deliverable%204%201%20framework%20FPU%20incl%20ToR%20final%2016042009.pdf>).
3. Report DISCONTTOOLS: approaches to the prioritisation of diseases: a worldwide review (www.discontools.eu/documents/1232_ReviewPrioFINAL20110831.doc).
- 4a. Lists of bio-geographical research priorities.
- 4b. Research Priorities in the EU on emerging and major infectious diseases of livestock, including research suggestions for the short term.

Sources used

main sources:

5. Overview of foresight studies evaluated in Work Package 4, Foresight & Programming Unit – EMIDA, 5 August 2009 (http://www.emida-era.net/upload/pdf/Report_FPU_Foresight_reviews_final_v11_050809.pdf).
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7. Strategic Research Agenda Workshop; Work Package 4 – EMIDA, 15 October 2010 (<http://www.emida-era.net/upload/pdf/Final%20STRAW%20report%20incl%20annexes.pdf>).

additional sources:

8. DISCONTTOOLS website: Disease database (http://www.discontools.eu/home/disease_home).
9. Report EPIZONE: Interactive session on 'Epidemic Threats to the European Union' conducted during st. Malo meeting 2010: (<http://www.epizone-eu.net/Lists/News/DispForm.aspx?ID=82>).
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12. European Technology Platform for Global Animal Health – Strategic Research Agenda (2006): (<http://www.etpgah.eu/strategic-research-agenda.html>).



ANNEX 1.

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Annex 4a.

Lists of bio-geographical research priorities

The following research areas are considered a priority relevant to the different bio-geographical regions:

Atlantic region

1. Surveillance systems and risk analysis
 - 1.1. Risk based improvement of surveillance
2. Control measures and biosecurity
 - 2.1. (Risk analysis of) Biosecurity measures on all levels, including border crossing of wildlife
3. Ecosystem change, vectorborne diseases and preparedness (in the field, laboratories and veterinary services)
 - 3.1. Preparedness for emerging and exotic diseases by an epidemiological approach of risk pathways identification
 - 3.1.a. Epidemiological research on risk identification of patterns of disease emergence to improve preparedness for emerging threats

Nordic/Baltic region

1. Ecosystem change, vectorborne diseases and preparedness (in the field, laboratories and veterinary services)
 - 1.1. Preparedness for emerging and exotic diseases by improvement of diagnostic tools
 - 1.1.a. Improve understanding on how to control these diseases (develop buffer zones), also with respect to wildlife issues
 - 1.1.b. Understanding of disease transmission, identification of disease risks outside Europe
 - 1.1.c. Understanding of the socio-economic (and ethical) issues
 - 1.2. Better understanding of vector borne diseases and health effects of ecosystem change
2. Control measures and biosecurity
 - 2.1. Biosecurity – identification of risk associated with organic farming

Continental region

1. Surveillance systems and risk analysis
 - 1.1. Risk based improvement of surveillance
2. Control measures and biosecurity
 - 2.1. (risk analysis of) Biosecurity measures on all levels, including border crossing of wildlife
3. Host-pathogen interaction that serves the development of diagnostic tools and vaccination
 - 3.1. Vaccination
4. Antimicrobial resistance
5. Ecosystem change, vectorborne diseases and preparedness (in the field, laboratories and veterinary services)
 - 5.1. Vector control
 - 5.2. Vector competence

Mediterranean region

1. Ecosystem change, vectorborne diseases and preparedness (in the field, laboratories and veterinary services)



- 1.1. Better understanding of vector borne diseases and health effects of ecosystem change
2. Control measures and biosecurity
 - 2.1. Development of diagnostic tools and control methods for diseases of neglected species (bees, goats, sheep, rabbits)

In this annex the Research Priorities in Europe on emerging and major infectious diseases of livestock for the long-term on a high abstraction level are given, in accordance with EMIDA's Strategic Research Agenda Workshop, and several additional sources. Moreover, more detailed information is provided on research needs, as well as research suggestions for the shorter term.

Table which shows the output of additional sources superimposed on the STRAW output

Research area (STRAW)		Topic (additional sources)	Diseases and Pathogens *
1.	Surveillance systems and risk analysis		
1.1.	<i>Risk based improvement of surveillance</i>		
1.1.a.		Harmonization of surveillance activities in animals and humans, incl molecular typing ¹	VTEC/STEC; Ruminant pox virus infection, Peste des petits ruminants, Swine Vesicular Disease, food borne viral diseases, Nipah virus ²
		Wildlife-borne and vector-borne disease surveillance ^{2,3}	
1.2.	<i>Improvement of risk analysis</i>		
1.2.a.		Knowledge development on reservoir hosts for animal pathogens and their role, incl wildlife ^{1,3}	
1.2.b.		Improvement of cost-benefit analysis ¹	
1.2.c.		Disease modelling in a multidisciplinary approach ²	
2.	Control measures and biosecurity		
2.1.	<i>(Risk analysis of) Biosecurity measures on all levels, including border crossing of wildlife</i>		Mycobacterium (bovine tuberculosis and bovine paratuberculosis), Contagious Bovine Pleuropneumonia ²
2.1.a.		Importation of live animals and animal products ^{3,4}	FMD
2.1.b.		The role of wildlife reservoirs and carriers need to be quantified ^{1,3,4}	Influenza, FMD
2.1.c.		Development of internationally accepted control tools, which allow rapid	FMD

Research area (STRAW)	Topic (additional sources)	Diseases and Pathogens *
	return to the status "free from FMD" based on risk quantification ¹	
2.1.d.	Epidemiological knowledge to quantify the risks of culling versus vaccination ¹	All epizootic and notifiable diseases
2.2.	<i>Development of diagnostic tools and control methods for diseases of neglected species</i>	
2.2.a.	Transmissible Spongiform Encephalopathies (ante-mortem diagnosis) ²	
2.3.	<i>Vaccination and vaccination strategies</i>	
2.3.a.	Better knowledge of vaccine performance in wild species (zoo animals) ¹	FMD, others
2.3.b.	Better knowledge of the risk of vaccinated infected animals spreading disease could lead to fewer animals culled during outbreaks ¹	FMD
2.4.	<i>Development of (novel) control methods for endemic diseases</i>	
2.4.a.	Understanding what modulates the seasonality of endemic disease infection in cattle is critical for designing control strategies ¹	VTEC/STEC
3.	Ecosystem change, vectorborne diseases and preparedness (in the field, laboratories and veterinary services)	
3.1.	<i>Better understanding of vector borne diseases and health effects of ecosystem change.</i>	
		WNF, RVF, CCHF, AHS, BT, ASF ^{2, 4, 5}
3.1.a.	Better understanding of the effect of extreme weather on disease occurrence and transmission ¹	
	Better understanding of biotic and abiotic factors, like ecosystem change, demographic and socio-economic changes, land and forest use, which influence occurrence of vectorborne diseases ⁵	
3.2.	<i>Improvement of preparedness for emerging and exotic diseases by improvement of diagnostic tools and by an epidemiological approach of risk pathways identification</i>	
3.2.a.	Epidemiology ⁴	FMD, Influenza, others
	Development of useful early warning tools using quantitative predictive modelling ⁵	
4.	Host-pathogen interaction that serves the development of diagnostic tools and vaccination	
4.1.	<i>Vaccine development</i> ^{1, 2, 3, 4}	FMD, Influenza, Campylobacter (chicken

Research area (STRAW) Topic (additional sources)		Diseases and Pathogens *
		vaccin), VTEC/STEC
4.1.a.	Develop vaccines that induce longer lasting immunity, that provide rapid protection, that provide sterile immunity, that can easily be distinguished from infection ¹	
4.1.b.	Knowledge development on molecular basis for host range and adaptation to new host species of pathogens, and mechanisms of persistence ²	
4.1.c.	Knowledge development on host-pathogen interaction on a cellular level ³	
4.2.	<i>Anti-viral development</i> ⁴	FMD, Influenza
4.3.	<i>Improvement or development of detection tests</i>	
4.3.a.	Development of inexpensive rapid / pen-side detection tests ¹	Parapoxvirus, Campylobacter, VTEC/STEC, FMD, others
5.	Antimicrobial resistance	
5.1.	<i>Development of curative and preventive therapies, excl antibiotics</i>	
5.1.a.	Increased research on phage therapy or bacteriocins usage ¹	Campylobacter (C. Jejuni, C. Coli), VTEC/STEC, others
5.2.	<i>Molecular and cellular basis of antibiotic and anthelmintic resistance</i> ²	
6.	Zoonoses	
6.1.	<i>unidentified/new, emerging, neglected and endemic zoonoses</i>	Neglected zoonoses : anthrax ⁶ , bovine tuberculosis ⁶ , brucellosis ⁶ , cysticercosis ⁶ , echinococcosis ⁶ , rabies ⁶ , trypanosomiasis ⁶ , leishmaniasis ⁶ , chlamydia and leptospirosis Other zoonoses : Q-fever ²

* The diseases and pathogens which are listed, are examples derived from the resources used to comprise the SRA. The list is not intended to be comprehensive or complete, and reflects the time frame concerned. It should be regarded as additional information that will change over time.

This list of research areas as identified in EMIDA, reflects the strategic research agenda of the European Technology Platform for Global Animal

Health (2006), although in the ETPGAH's SRA vectorborne diseases are less emphasised, while ecosystem change is not part of it. A revision of the ETPGAH's SRA is foreseen for 2012, and could take into account the topics identified in EMIDA's SRA, which need attention but are not addressed in the current ETPGAH's SRA. Additionally, the next ETPGAH's SRA could benefit from the other issues which are addressed and prioritised in this SRA.

Results of EMIDA-WP2 in relation to the SRA

When looking at this list of research needs considering the outlook of 10 to 15 years, and compared to the output of the bibliometric mapping of ongoing research by EMIDA Workpackage 2, the following conclusions could be drawn:

1. Surveillance systems and risk analysis

If we assume that disease surveillance is a part of epidemiology, this research topic is probably well addressed. On the other hand, the development and evaluation of surveillance systems based on independent risk assessment which feeds into dedicated risk management and risk communication procedures do not seem to be covered appropriately yet.

2. Control measures and biosecurity

Risk analysis of biosecurity measures on all levels is not addressed at all. The scientific output on wildlife diseases is significantly lower compared to the diseases of other species.

The scientific output on e.g. wild animals and fishery and aquaculture is significantly lower than for the "classical" domesticated species, which could be an indication to encourage research for these species.

3. Ecosystem change, vectorborne diseases and preparedness (in the field, laboratories and veterinary services)

There is no significant increase in the scientific output (1999-2008) concerning vectorborne diseases, which might indicate a research gap given the several outbreaks of vectorborne diseases in recent years. There is no significant increase in the scientific output either in respect of a better understanding of vectorborne diseases and health effects of ecosystem change in the years to come.

The improvement of preparedness for emerging and exotic diseases by an epidemiological approach of risk pathways identification has not been adequately addressed yet.

'Diagnosis of animal diseases' is one of the major topics in the scientific output based on the CABICODES analysis within EMIDA WP2.

Unfortunately, it is not specified to what extent emerging and exotic diseases are addressed.

4. Host-pathogen interaction that serves the development of diagnostic tools and vaccination

There is no significant increase in the volume of research publications between 1999 and 2008 for the theme 'cell biology', which roughly represents the host-pathogen interaction on a cellular level. This might be an indication for the need of encouraging research on this topic.

There is a significant increase in the scientific output (1999-2008) concerning the theme 'immunological mechanisms'. Furthermore there is a rather strong correlation between the themes 'vaccines' and 'virology', which is to be expected but could also be a reason to encourage research on vaccines for bacteriological and parasitic diseases.

5. Antimicrobial resistance

There is a significant increase in the scientific output (1999-2008) concerning the lexical theme 'biotherapeutics and alternatives to antibiotics'. 4.1% of the research output belongs to the CABICODE category 'pesticide and drugs resistance' (23th place). This indicates that this topic is already well addressed.

6. Zoonoses

There is a clear shift in the scientific output from 'classical veterinary science' to food safety and zoonoses during the period 1999-2008. This has led to an improvement of understanding endemic zoonoses, but lacks to provide sufficient knowledge on emerging and

neglected zoonoses.

Considering this comparison it should be kept in mind that the research on which the publications recorded in the WP2 output are based, has been programmed already several years ago. This delay in output of ongoing research programmes could mean that the identified gaps are virtual gaps, which could be filled by, still to be finalised, ongoing research efforts.

Some examples for immediate needs:

- field trials investigating effects and consequences of bacteriophages or bacteriocins are urgently needed considering risk management of *Campylobacter* (*C. jejuni* and *C. coli*);
- assays which are needed to distinguish between vaccinated and infected animals with improved sensitivity;
- development of rapid tests to identify the pathogen, its virulence and resistance pattern (to be used on farm level if possible);
- development of effective biosecurity measures on farm-, regional-, country-, and European-level based on risk analysis;
- improvement of preparedness for emerging and exotic diseases by an epidemiological approach of risk pathways identification

More research topics on specific infectious animal diseases for the shorter term can be found in the output of the DISCONTTOOL's project Disease database: http://www.discontools.eu/home/disease_home

- 1 derived from DISCONTTOOLS
- 2 derived from ETPGAH SRA
- 3 derived from EMIDA-WP2
- 4 derived from EPIZONE
- 5 derived from EDEN
- 6 derived from ICONZ