



## D8.4 Joint Innovation Report



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and zoonoses

**D8.4**  
**Joint Innovation Report**

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Partnership



Food and Agriculture Organization of the United Nations

Food and Agriculture Organization of the United Nations



Animal Production and Health Section

Joint FAO/IAEA Programme for Nuclear Techniques in Food and Agriculture



Europa Media Non-profit Ltd.



Royal Veterinary College



Centre de Coopération Internationale en Recherche Agronomique pour le Développement.



National Veterinary Institute



Shanghai Veterinary Research Institute



Harbin Veterinary Research Institute



China Animal Health and Epidemiology Center



China Animal Disease Control Center



Sociedade Portuguesa de Inovação



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## Executive Summary

Within the Dissemination and Sustainability work package, under Task 8.4 of the LinkTADs project, partners were responsible for detecting synergies and propose joint actions. One part of the task was trend analysis and comparison, the other part focused on identification of joint innovation actions and innovation actors. The scope of the Joint Innovation Report is to introduce the findings and conclusions drawn from the work done.

In close coordination with WP5 and building on WP2/WP3/WP4 results, LinkTADs partners monitored bilateral and multilateral cooperation and EU policies and programmes with China and analyzed them against the background of global tendencies for this Joint Innovation Report (hereinafter: JIR). Linking up with other projects, this task focused on the production of a comparing overview over worldwide trends in animal health research cooperation between EU and China. Possible synergies were detected and respective recommendations developed. Secondly, joint patenting and other similar joint actions of R&D actors in China and Europe were analysed as indicating innovation potential and private-sector cooperation. Results of analyses of research output were contrasted with (geographic and thematic) patterns visible in patenting activity. It served to identify the best research and innovation actors in order to approach them with targeted information, thus further increasing cooperation levels.

The first section of the Joint Innovation report focuses on introducing shortly the worldwide trends and EU-China cooperation in the field of animal health. The second section describes the conducted research for identifying innovators in the field and shares the list of best organisations in academic research and patenting activities in Europe and China. The third section provides recommendations on future EU-China cooperation and how innovators should be involved into such cooperation.

The findings will support the sustainability measures to be developed in the project focusing on the actions to be taken after the end of the project to sustain the informal focal point network, the web collaboration, the policy dialogue and the overall close coordination of EU-China research in the field of animal health and food security.



# 01

## Worldwide trends in Animal Health Research Cooperation



# Worldwide trends in Animal Health Research Cooperation

## Global Tendencies

The tendencies in animal health and food security are driven by the human population's ever growing need for animal protein and are shaped by many actors across the globe.

**FAO's strategy for international animal health<sup>1</sup>** provides an internationally accepted framework, detailing long-term global goals and methodology:

"Livestock production is constrained by a multitude of factors including disease, malnutrition, poor management and ineffective utilization of the best-suited genetic material. The major objectives of animal health activities are to secure food supply for a growing human population, to safeguard human health by combating zoonoses and to facilitate domestic and international trade in animals and animal products. The necessary interventions need to be both technically sound and cost-effective.

The control of epidemic diseases of livestock has, by definition, a geographical emphasis (country, region, continent), while health and productivity improvement schemes are usually designed for the farmer and/or local community. In the former case, veterinary interventions are most successful if uniformly applied over a prescribed area. In the latter, interventions can vary from farm to farm, depending on clinical conditions and farming practices.

There is a growing desire among veterinary services to assess current disease control programmes and, if possible, move from the control phase to an eradication phase. In order to facilitate this, the International Office of Epizootics (OIE) is defining new guidelines based on a three-stage pathway that a country will need to follow before it can obtain international recognition as being free from an epizootic disease.

For Stage 1 - Provisional freedom from disease - the director of veterinary services will declare this free state to the OIE following the absence of disease in the country and the cessation of vaccination.

Stage 2 - Freedom from disease - requires that the country has ceased vaccination for a prescribed minimum period, has had no outbreaks of the disease after declaring provisional freedom and demonstrates results of prescribed surveillance before being internationally recognized.

To attain Stage 3 status - Freedom from infection - the country must have extended surveillance after achieving freedom from disease status, have demonstrated evidence of the absence of the causative agent within the livestock population and have in place adequate measures to prevent the reintroduction of infection.

National, subregional and regional eradication will, of course, have beneficial effects for the areas involved. Yet it may not be cost-effective to achieve this, since emergency preparedness to assure the state of freedom is expensive and needs to be maintained continuously at a high level. It can be concluded, therefore, that total eradication gives the best economic return in the long term."

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<sup>1</sup> <http://www.fao.org/docrep/v8180t/v8180T0d.htm>

**Trends shaping the field**

Currently, the “Animal Health Strategy Playbook for an Evolving Industry<sup>2</sup>” by PWC and the “Global Animal Health Market Professional Survey Report 2016<sup>3</sup>” are the most comprehensive reports on latest trends and drivers in the Animal Health field. In the light of these two reports, the following trends can be highlighted.

Value-Driver Category	Key Value-Drivers	Key Trends
<b>1. Innovation</b>	<ul style="list-style-type: none"> <li>R&amp;D for new chemical entities (NCE)</li> <li>Lifecycle strategies</li> </ul>	<ul style="list-style-type: none"> <li>Declining R&amp;D productivity has led to highly mature product portfolios</li> </ul>
<b>2. Portfolio Advantage &amp; Commercial Excellence</b>	<ul style="list-style-type: none"> <li>Growing demand</li> <li>Relative power in AH value chain</li> <li>Economies of scale in commercial (direct sales)</li> <li>Branding</li> <li>Customer loyalty</li> <li>Product-portfolio-led economies of scope (share of wallet)</li> <li>Effective channel management</li> </ul>	<ul style="list-style-type: none"> <li>There are limited opportunities for leading players to grow through further industry consolidation</li> <li>Increased downstream consolidation in the Production Animal value chain has weakened AH’s position</li> <li>Vets are less influential in purchase decisions</li> <li>Technological innovations and growth of new adjacencies may be considered in growth plans</li> </ul>
<b>3. Competitive Forces</b>	<ul style="list-style-type: none"> <li>Industry structure and competitive intensity</li> <li>New entrants</li> </ul>	<ul style="list-style-type: none"> <li>Branded sales could be threatened by growth of generics and OTC/private label products, driven by regulatory changes in the U.S. and E.U., plus channel shift in Companion Animal segment</li> </ul>
<b>4. Operational Effectiveness</b>	<ul style="list-style-type: none"> <li>Manufacturing and supply chain quality and efficiency</li> </ul>	<ul style="list-style-type: none"> <li>Profit pressure could be increasing</li> <li>Increasingly global food producers require global operating structures</li> </ul>
<b>5. Regulation</b>	<ul style="list-style-type: none"> <li>Product exclusivity regulations and regulatory process</li> </ul>	

Figure 1 – Key value-drivers and Key Trends in the animal health industry<sup>4</sup>

**1. Technology Everywhere**

Sectors that are close to animal health, such as diagnostics, genetics, big data, predictive analytics and mobile technologies, have undergone technological innovations that have high potential for improving R&D productivity in the animal health field. For example, big data may provide producers with innovative tools that facilitate machines productivity, proactive diagnostics and machine-to-machine communication. Ultimately, farmers would be in a better position to make decisions that prevent mistakes and increase efficiency. Cutting-edge software applications,

<sup>2</sup> <https://www.pwc.com/us/en/health-industries/our-perspective/assets/pwc-animal-health-strategy-playbook.pdf>

<sup>3</sup> <http://www.newsmaker.com.au/releaseFile/view/id/60283/Animal-Health-Market-Professional-Survey-Report-2016-n.pdf>, <http://www.360marketupdates.com/global-animal-health-market-professional-survey-report-2016-10258527>

<sup>4</sup> <https://www.pwc.com/us/en/health-industries/our-perspective/assets/pwc-animal-health-strategy-playbook.pdf>

analytics and wearables also improve customer loyalty and engagement, and decrease the dependence of companies on products as their unique source of revenue. It is likely that this trend will continue to progress, as food producers increasingly realise the benefits offered by real time and/or longitudinal data.

## **2. Preventive Therapies**

The proliferation of innovative technologies in the field is revamping preventive therapies, focusing both on timely interventions and on proactive prevention. This includes an increasing focus on innovative vaccines, dosing schedules and precision nutrition and supplements.

## **3. Globalisation of operating structures**

Traditional business models of animal health product manufacturers are becoming obsolete; there are two predominant drivers for this: R&D productivity in the field is declining, and food production is becoming increasingly globalised, due to the growing protein consumption in emerging markets – including China. Industry players are responding to this trend by creating operating structures that are increasingly globalised.

## **4. Wider partnerships**

In order to improve R&D productivity, many players are progressively launching multi-actor collaborations, for example between large (“Tier 1”) companies and smaller companies, as well as with research centres or clinical research organisations. In particular, ongoing collaborations on TADs, including global networking, data sharing and other coordinated actions, are proving their merits. For example, the One Health initiative is pushing for the expansion of interdisciplinary collaborations and communications to all aspects of health care for humans, animals and the environment.

“The One Health concept is a worldwide strategy for expanding interdisciplinary collaborations and communications in all aspects of health care for humans, animals and the environment. The synergism achieved will advance health care for the 21st century and beyond by accelerating biomedical research discoveries, enhancing public health efficacy, expeditiously expanding the scientific knowledge base, and improving medical education and clinical care. When properly implemented, it will help protect and save untold millions of lives in our present and future generations.”

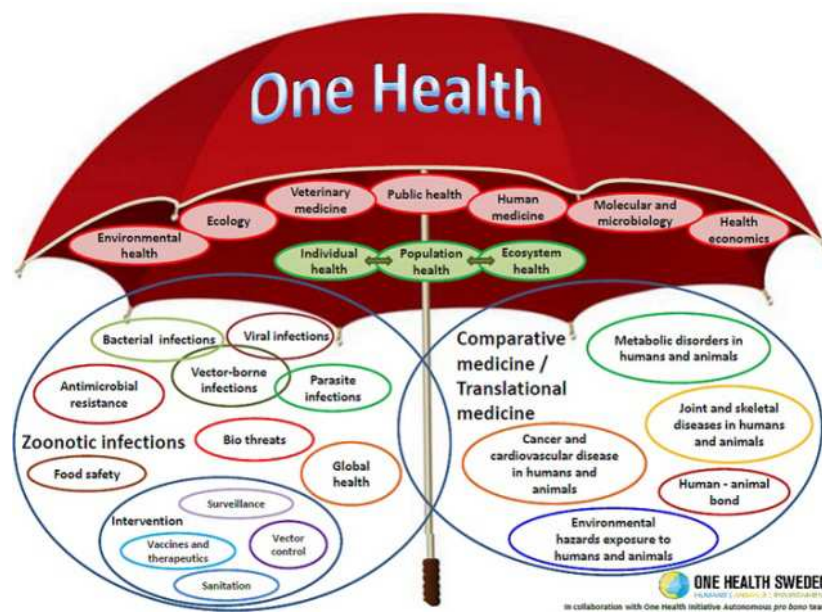


Figure 2 – One Health

## EU policies and programmes with China

This section of the report aims at introducing the main drivers and background information on policies and programmes for EU-China collaboration in animal health research. First we share our main findings on EU-China collaboration and then we introduce the existing EU-China Strategic Partnership and policy dialogues to be followed.

### Best practices report

The best practices report, D8.10<sup>5</sup> result of LinkTADs project introduces in more details the findings on EU-China collaboration in the field of animal health, thus we do not repeat all the information in this report.

The main findings on EU-China collaboration were the following:

- EU-China cooperation in any research field should be focusing on the commonly defined strategic priorities in order to gain funding more easily on both the European and Chinese sides.
- One issue was a concern for both regions – the lack of awareness of and difficulties in access to postgraduate epidemiology courses.
- EU research is more likely to involve collaborations with other countries than China, while papers published in China are more likely to involve European collaborators than *vice versa*.
- Filling the gaps in resources is a common interest shared between both regions, as is the need to address a lack of existing collaborations.
- There is a need for both the EU and China to be compliant with OIE standards.

<sup>5</sup> [http://linktads.com/eu\\_china\\_cooperation/document/107](http://linktads.com/eu_china_cooperation/document/107)

The following best practices have been identified to be the most relevant ones for LinkTADs. Please see for more information the report itself.

Best practices collected	
Best practice	Activity
EU-China Trade Project I-II	Supporting CFETPV training courses – animal health
Bilateral Netherlands-China cooperation	Supporting the development of veterinary epidemiology in China – animal health
LinkTADs initiated collaboration between SHVRI, CIRAD and SVA	Common project application to MoST funding for « Eco-epidemiology and risk analysis of genotype shift of Japanese encephalitis virus in pigs and mosquitos » - the project was funded and started in 2015 – animal health
LinkTADs initiated collaboration between HVRI and SVA	Collaboration for establishment of a joint laboratory of Veterinary microbiology – animal health
ESA-MOST Dragon 2 Programme	A programme supporting long term scientific collaboration between the EU and China – training, products useful for animal health research
China Field Epidemiology Training programme for Veterinarians	European epidemiologists supporting a training programme for Chinese veterinarians – training, collaboration in animal health
ICONZ project	Integrated control of neglected zoonoses – Africa focus - animal health
STAR-IDAZ project	Global Strategic Alliances for the coordination of research on the major infectious diseases of animals and zoonoses – global collaboration - animal health
ChinaAccess4EU project	EU-China research collaboration support – any scientific field
Dragon STAR project	EU-China research collaboration support – any scientific field
CHOICE project	EU-China research collaboration support – ICT field

### EU-China Strategic Partnership<sup>6</sup>

Originated from the 1985<sup>7</sup> EU-China trade and cooperation agreement, nowadays the EU-China Strategic Partnership covers many more areas where joint strategic priorities have been identified. The partnership is already extended to foreign affairs, security matters and international challenges such as climate change and global economy governance. The latest document signed by the two parties is the EU-China Strategic 2020 Agenda for Cooperation, agreed at the EU-China Summit in 2013. The Agenda states that within the field of Agriculture, two of the main priorities are:

- “Design concrete projects in ensuring food security and safety, coordinating urban and rural development, building environmentally-friendly agricultural systems while ensuring quality and safety of agricultural products. With regard to food safety, intensify cooperation with the objective to protect consumer health, recognising the importance of food safety as a key element for consumer health, sound food markets, economic development and social welfare, highlighting the

<sup>6</sup> [http://eeas.europa.eu/china/index\\_en.htm](http://eeas.europa.eu/china/index_en.htm)

<sup>7</sup> Diplomatic ties were established in 1975

continuous and already fruitful cooperation between the EU and China on food safety, and underlining that risk analysis should form the foundation of any food safety policy, laws and regulations.

- With the view to enhance win-win research and innovation cooperation in the field of food, agriculture and biotechnology, the EU and China will collaborate closely using their respective research and innovation programmes to develop joint initiatives of common interest, including potential joint calls for proposals, twinning activities, joint labs, researchers' exchanges and seminars.”

The objectives and priorities of the Strategic Agenda are reviewed annually at the EU-China summits. The 17th summit organised in 2015<sup>8</sup> resulted in a joint statement with the following main conclusions – *relevant for our topic*:

- “Both sides confirmed their strong interest in each other's flagship initiatives, namely the Investment Plan for Europe, and the “Silk Road Economic Belt” and “21st Century Maritime Silk Road” (The Belt and Road Initiative).
- The EU and China agreed to improve their infrastructure links. They decided to establish a new Connectivity Platform.
- They welcomed the signing of a Memorandum of Understanding on reinforcing the EU-China IP Dialogue Mechanism.
- They agreed to work together to harness each other's comparative advantages in such areas as innovation policy, mobility and training of researchers, commercialisation of R&D results, technology dissemination and sharing of research facilities and framework conditions for innovation. It was agreed to set up a mechanism for jointly financing research and innovation projects in areas of mutual interest, as well as to promote and monitor reciprocity of access to the EU and China's respective research and innovation funding programmes.
- The EU and China acknowledged that people-to-people exchanges, including cooperation in the areas of culture, higher education, youth, multilingualism and gender equality are vital to deepen mutual understanding, foster innovation and creativity, and enhance contacts between the peoples of both sides. They agreed to hold the 3rd round of the EU-China High Level People-to-People Dialogue in September 2015 in Brussels.
- The EU and China committed to enhance exchanges on best practice regarding issues such as climate change, environment/biodiversity, global health and infrastructure in their respective development assistance policies.
- The parties signed the Implementing Arrangement between the European Research Council and the National Natural Science Foundation of China.”

Even if animal health has not been mentioned specifically on the 17<sup>th</sup> summit, but highlighting the people-to-people exchanges, the support to mobility and generally to research and innovation cooperation, and the sharing of research facilities show that both the EU and China will strongly support the future collaborative projects of the researchers and innovation actors.

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<sup>8</sup> <http://www.consilium.europa.eu/hu/press/press-releases/2015/06/29-eu-china-statement/>

In June 2016 the European Commission has published a communication<sup>9</sup> on “Elements for a new EU strategy on China”. In this communication the EU proposes to pursue dialogues with China on standards, regulation and conformity assessment procedures in key sectors such as health and safety, food and consumer product safety, etc. as well as encourages China to play a more engaged and active role in developing policies to fight the spread of antimicrobial resistance (AMR) and to support a global strategy to tackle this serious health threat. For LinkTADs and its partners these two highlighted actions are important because they underline the importance of one of the main identified sustainability routes for the project, a new common project focusing on AMR.

## Bilateral and Multilateral Cooperation

### EU-China Research & Innovation Cooperation<sup>10</sup>

In both regions clear strategies are guiding the researchers in planning international cooperation, such as the ‘European Partnership for International Scientific and Technological Cooperation’ from 2008 and the new strategy from 2012 ‘Enhancing and Focusing EU International Cooperation in Research and Innovation: a Strategic Approach’ in the EU and the ‘Guidelines on the National Plan for Medium and Long-Term Program for Science and Technology Development (2006-2020)’ and ‘Science and Technology in China: A Roadmap to 2050’ in China as well as the ‘EU-China Strategic 2020 Agenda for Cooperation’ guiding on the specific EU-China collaboration.

There are best practices on EU-China research cooperation available from FP7, the 7<sup>th</sup> Framework Programme on Research and Development. You may look at the description of 16 selected projects on [eeas.europa.eu](http://eeas.europa.eu)<sup>11</sup> China delegation’s website.

As stated also in the Best practices report, regarding previous collaborations in the animal health field, the report on the ‘Review of emerging animal health and food security issues’ (submitted as deliverable D2.1 in LinkTADs) has found that there is a small number of papers that currently involve collaborations between researchers in the EU and China. EU research is more likely to involve collaborations with other countries than Chinese research, while papers published in China are more likely to involve European collaborators than vice versa. While collaborations are currently fairly few, both partners already have experience in collaboration that can be built upon in forming networks between the EU and China and increasing opportunities for collaboration as per the aims of LinkTADs. That is why this Joint Innovation Report focuses on analysing the details of the joint EU-China activities in terms of publications and patenting.

<sup>9</sup> Joint Communication to the European Parliament and the Council: [http://eeas.europa.eu/china/docs/joint\\_communication\\_to\\_the\\_european\\_parliament\\_and\\_the\\_council\\_-\\_elements\\_for\\_a\\_new\\_eu\\_strategy\\_on\\_china.pdf](http://eeas.europa.eu/china/docs/joint_communication_to_the_european_parliament_and_the_council_-_elements_for_a_new_eu_strategy_on_china.pdf)

<sup>10</sup> [http://eeas.europa.eu/delegations/china/eu\\_china/research\\_innovation/index\\_en.htm](http://eeas.europa.eu/delegations/china/eu_china/research_innovation/index_en.htm)

<sup>11</sup> [http://eeas.europa.eu/delegations/china/documents/eu\\_china/research\\_innovation/1\\_st\\_relations/success\\_stories\\_fp7\\_with\\_chinese\\_participants.pdf](http://eeas.europa.eu/delegations/china/documents/eu_china/research_innovation/1_st_relations/success_stories_fp7_with_chinese_participants.pdf)

## Horizon 2020

Horizon 2020 is the biggest EU Research and Innovation programme with nearly €80 billion of funding available over 7 years (2014 to 2020) – in addition to the private investment this money will attract. It promises more breakthroughs, discoveries and world-firsts by taking great ideas from the lab to the market. Horizon 2020 is based on 3 pillars: Excellent Science, Industrial Leadership and Societal Challenges.<sup>12</sup>

Within Horizon 2020 it is too early to analyse the joint collaboration between EU and China. However, based on the flagship calls launched by the European Commission supporting EU-China collaboration, significant increase in EU-China collaboration can be expected in the field of animal health, regardless the need of continuous mirroring funding from China for the Chinese institutions participating in H2020 projects.

In terms of animal health research, the main funding programme open to China is Horizon 2020. All parts of the programme are also open to Chinese researchers and organisations. “Whilst China-based researchers are eligible to apply for all Horizon 2020 calls, there are several topics which have been specifically targeted for cooperation with China”<sup>13</sup>. These are described in the document “People's Republic of China - Country Page”<sup>14</sup>. The hyperlinks in the document will take you directly to the call descriptors.

The second most important funding source for EU-China collaboration is based on bilateral and multilateral agreements between governments from Europe and China.

## Agreements

The EU-China scientific, research and innovation cooperation is governed by the following agreements:

- The EU-China **Science & Technology Agreement** was signed in December 1998. An annual joint steering committee is held between the Chinese Ministry of Science and Technology (MoST) and European Commission's DG Research and Innovation (DG RTD). The S&T Agreement was renewed in 2004, 2009 and 2014.
- EURATOM-China **Agreement for R&D Cooperation in the Peaceful Uses of Nuclear Energy** (R&D-PUNE Agreement) was signed in April 2008. It is implemented by a joint steering committee co-chaired by the DG Research and Innovation representing EURATOM and MoST.
- MoST and DG Research and Innovation signed the **Agreement on Implementing the Science & Technology Partnership Scheme** (CESTYS) in May 2009. This agreement provides for joint co-decided, co-selected and co-funded research projects in common priority areas.
- **A Joint Statement** between MoST and DG Research and Innovation on **Energy Research and Innovation** was signed in December 2010. It aims to support the twinning of projects, joint programmes or joint calls based on mutual interest and equal partnership.
- The National Natural Sciences Foundation of China (NSFC) and DG Research and Innovation signed an **Administrative Arrangement** in March 2010. It provides a framework for coordinated research projects in areas of common interest.

<sup>12</sup> [http://grantsportal.europamedia.org/funding\\_programme/59](http://grantsportal.europamedia.org/funding_programme/59)

<sup>13</sup> <http://www.dragon-star.eu/european-programs/>

<sup>14</sup> [http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020\\_localsupp\\_china\\_en.pdf](http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020_localsupp_china_en.pdf)



- The EU-China **Joint Declaration on Innovation Cooperation Dialogue** (ICD) was signed in September 2012 to create an official platform for exchanges and cooperation on innovation between both sides.
- A **Letter of Intent** on Research and Innovation Cooperation in **Food, Agriculture and Biotechnologies** (FAB) between the European Commission and the Chinese Academy of Agricultural Sciences (CAAS) was signed in November 2013 launching the first EU-China flagship initiative for research and innovation in the areas of food, agriculture and biotechnologies.
- An **Implementing Arrangement** between the DG Research and Innovation/**European Research Council (ERC) and the National Natural Science Foundation of China (NSFC)** was signed in June 2015. The arrangement will facilitate short- and medium-term research visits of Chinese researchers holding a NSFC grant in the teams of ERC funded principal investigators in Europe.

DRAGON-Star plus project tries to map bilateral agreements between EU Member States and China at <http://www.dragon-star.eu/bilateral-agreements-between-eu-member-states-china/>.

## Trade Cooperation

The Business Europe EU-China Relations: 2015 and beyond found that trade and investment have increased in the past years. “China and the European Union remain major trading partners and their economies are strongly interlinked, with the EU respectively being China’s top trading partner (€429 bn / 13.4% of total share), closely followed by the United States (€396 bn / 12.4%). For the European Union, the United States are the top trading partner (€484bn / 14.2%), and China being second (€428 bn / 12.5%). China’s tariff levels have not changed substantially during the past three years.<sup>15</sup>”

The 2014 Business Confidence Survey<sup>16</sup>, reported that “two thirds of large companies stated that business in China has become more difficult and half of European companies believe that the ‘golden age’ for multinational companies in China has ended. Naturally, this is also linked to the slowdown of the Chinese economy.<sup>17</sup>”

BUSINESSEUROPE calls for a comprehensive application of the New York Convention on the recognition how to revitalise the relationship with China – recommendations:

- Make a thorough assessment of the state of play and redraft the EU’s China strategy where appropriate,
- Prevent China to exert pressure on domestic affairs and speak up with a common voice on China matters,
- Continue the negotiations for an ambitious Bilateral Investment Agreement as a matter of priority,
- Use better the High Level Economic Dialogue to tackle barriers,
- Use the Political Summits and other highest level meetings to advance key bilateral and multilateral negotiations, such as China’s accession to the GPA,
- Closely coordinate with major partners how to tackle common challenges in China,
- Extend visa limits as a way to facilitate trade and investments.

<sup>15</sup> Business Europe EU-China Relations: 2015 and beyond

<sup>16</sup> <http://www.eurochamber.com.cn/en/publications-business-confidence-survey>

<sup>17</sup> Business Europe EU-China Relations: 2015 and beyond



# 02.

## Identifying innovators and innovative actions

## Identifying innovators and innovative actions

In this section, we are identifying key innovators and innovative collaborations from China and the European Union. During the analysis we have taken into consideration the work done in WP2, where in order to prioritize the emerging animal health, food safety and food security issues in the EU and in China, two literature reviews of published information were carried out, one each in the EU and China. These findings were then discussed at separate meetings involving key local stakeholders and experts. The findings have been shared in D2.1 Review of emerging animal health and food security issues.

### Methodology

The above mentioned deliverable defined the actual key priorities in animal health, food safety and food security for the EU and for China.

According to D2.1<sup>18</sup>, the diseases that are considered the highest priority in both China and the EU are:

- animal influenza
- African swine fever
- rabies
- brucellosis
- foot-and-mouth disease

In addition, **antimicrobial resistance** was also added as a significant concern in both China and the EU. These topics served as focus points for the identification of innovators and innovative actions of the JIR.

After the focus was identified, desk research was conducted concerning trends in patenting and publications related to the focus topics. A great number of publications and patents were selected for further analysis.

For collecting publications, The National Center for Biotechnology Information's<sup>19</sup> PubMed database and ScienceDirect<sup>20</sup> were used.

Multiple searches were conducted using the focus topics as keywords; 2015 and 2016 (until May, when the search was conducted) were chosen as the years for publication to seek out the most up-to-date references. The search was conducted in English and the results were collected in a Microsoft Excel 2007 database.

### Search terms:

- 'animal influenza'
- 'H1n\*[TITLE/ABSTRACT] OR H2N\*[TITLE/ABSTRACT] OR h3n\*[TITLE/ABSTRACT] OR h4n\*[TITLE/ABSTRACT] OR h5n\*[TITLE/ABSTRACT] OR h6n\*[TITLE/ABSTRACT] OR h7n\*[TITLE/ABSTRACT] OR H8N\*[TITLE/ABSTRACT] OR H9N\*[TITLE/ABSTRACT] OR H10N\*[TITLE/ABSTRACT] OR H11N\*[TITLE/ABSTRACT] OR H12N\*[TITLE/ABSTRACT] OR H13N\*[TITLE/ABSTRACT] OR H14N\*[TITLE/ABSTRACT] OR H15N\*[TITLE/ABSTRACT] OR H16N\*[TITLE/ABSTRACT] OR swine flu[TITLE/ABSTRACT] OR avian influenza\*[TITLE/ABSTRACT] OR avian flu[TITLE/ABSTRACT] OR bird

<sup>18</sup> See more at: <http://linktads.com/about/deliverables>

<sup>19</sup> <http://www.ncbi.nlm.nih.gov/pubmed>

<sup>20</sup> <http://www.sciencedirect.com/science/search>

flu[TITLE/ABSTRACT] OR fowl plague\*[TITLE/ABSTRACT] OR influenza A\*[TITLE/ABSTRACT] OR swine influenza\*[TITLE/ABSTRACT]'

- 'rabies'
- 'African swine fever'
- 'Brucellosis OR (brucella AND abortus) OR (undulant fever) OR (brucella AND melitensis) OR (malta fever) OR (brucella AND suis)'
- 'foot-and-mouth disease (fmd, fmdv)'
- 'animal antimicrobial resistance'
- 'broiler/bovine/porcine antimicrobial resistance'

And as countries, China on one side, and the following terms for the EU:

- Austria
- Belgium
- Bulgaria
- Croatia
- Cyprus
- Czech Republic
- Denmark
- United Kingdom
- Estonia
- Finland
- France
- Germany
- Greece
- Holland, The Netherlands
- Hungary
- Italy
- Ireland
- Latvia
- Lithuania
- Luxembourg
- Malta
- Poland
- Portugal
- Romania
- Slovakia
- Slovenia
- Spain
- Sweden

After the collection of publications, the focus of the research turned to patenting trends. Using the same search conditions, two online databases were searched for patents related to animal health; World Intellectual Property Organization<sup>21</sup>s and European Patent Office<sup>22</sup>s.

- antimicrobial resistance
- animal influenza
- African swine fever
- brucellosis
- foot and mouth disease
- rabies
- other related to animal health

This data gathering process resulted in the collection of:

<sup>21</sup><https://patentscope.wipo.int/search/en/search.jsf>

<sup>22</sup><https://worldwide.espacenet.com/>

- 1,534 publications
- 665 patents

**Publications**

The publication database contains the following data:

- title
- abstract
- author affiliation info (all related institutes)
- institute(s)
- country/countries of origin
- publication date
- focus/key word.

**Patents**

The patent database contains the following data:

- title
- abstract
- inventor(s)
- applicant(s) - institutes
- country/countries of origin
- publication date
- focus/key word(s).

**Results**

**Publications by topic**

Animal influenza is the most researched disease in 2015-2016, followed by AMR. The distribution among the other diseases is fairly similar, with African swine fever being the last.

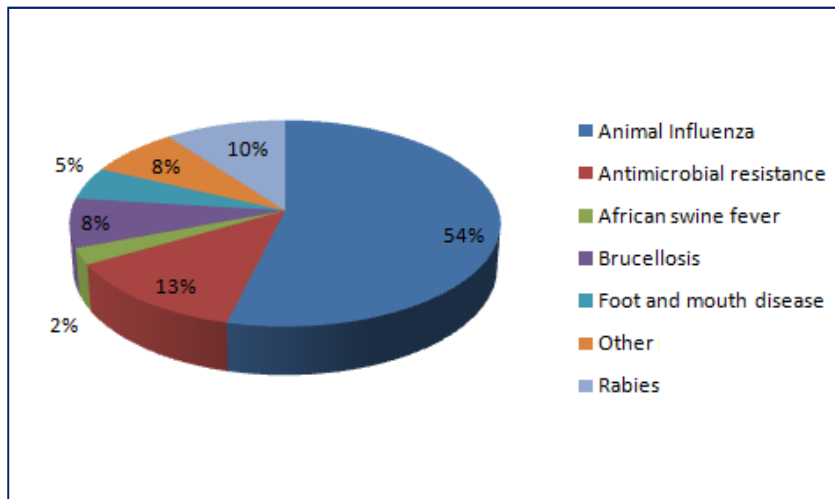


Figure 3 – Publications by topic

The WP2 literature reviews done in the EU and China, particularly within the framework of D2.2 - Report on the mapping of synergies and gaps, showed that “... laboratory research and epidemiology are of major importance in

both China and EU. Almost three quarters of animal health research in China involves laboratory research, and there is comparatively considerably more research activity in epidemiology in the EU than in China. Research involving risk analysis and mathematical modelling also makes up a small proportion of all research in both the EU and China, so it may be necessary to explore any constraints to this type of research and seek opportunities to increase research activity in this area, given its importance in surveillance, contingency planning and response to epidemics of zoonoses and transboundary animal diseases. Linking LinkTADs with the EU FP7 projects RISKSUR and ASFORCE and the NIH Avian Influenza project will facilitate opportunities for increasing skills and research activity in risk analysis and mathematical modelling in the future. It was considered that reviewers in China and the EU may have differed in their interpretation of what constitutes laboratory research, and that this category may have been over-represented in the Chinese review. This does in itself illustrate what may be a strong propensity to focus on laboratory research in China over other types of research”

**Publications by countries**

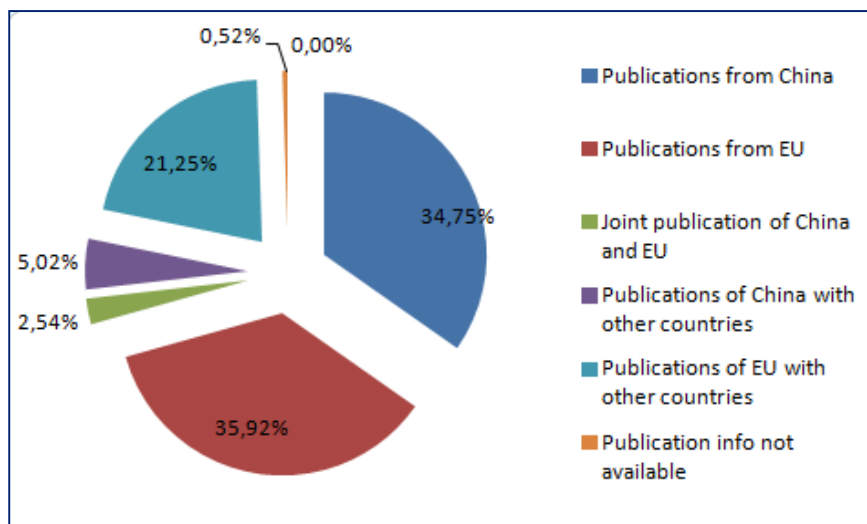


Figure 4 – Publications by countries

As the Figure above shows, the number of publications on the searched animal health issues from China (number) is very close to that of publications from the EU (number). However, EU countries tend to be more active in terms of joint publications with third countries, mostly with the USA and Israel. Following a historical trend, joint publication activities between EU and China in 2015-2016 still remain at a very low level.

**Patenting by countries**

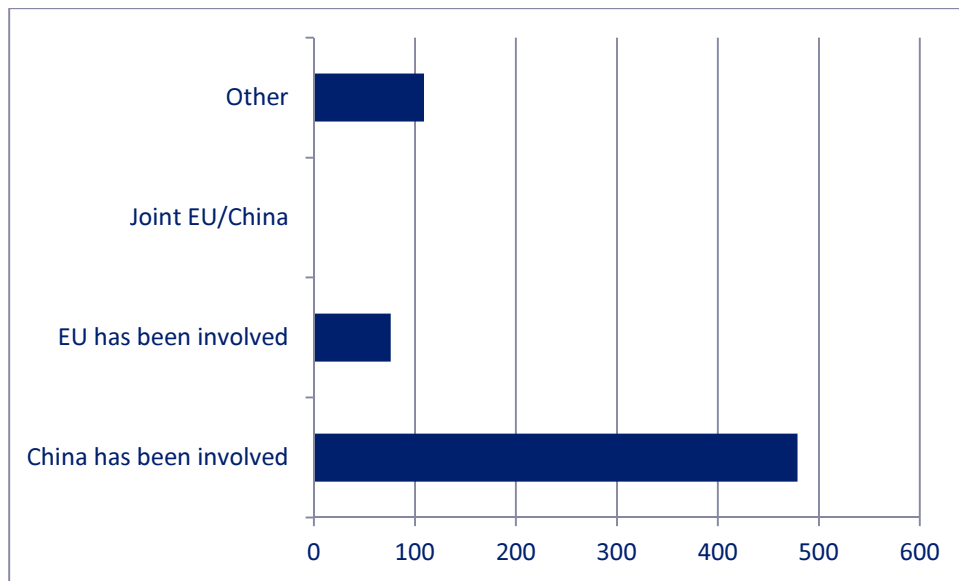


Figure 5 – Patenting by countries

Based on our research, the patenting activity is most substantial in China, but co-operations in this field are rare (1 results for joint EU-China patent and 3 results for China-other country cooperation in patenting).

**Patenting topics**

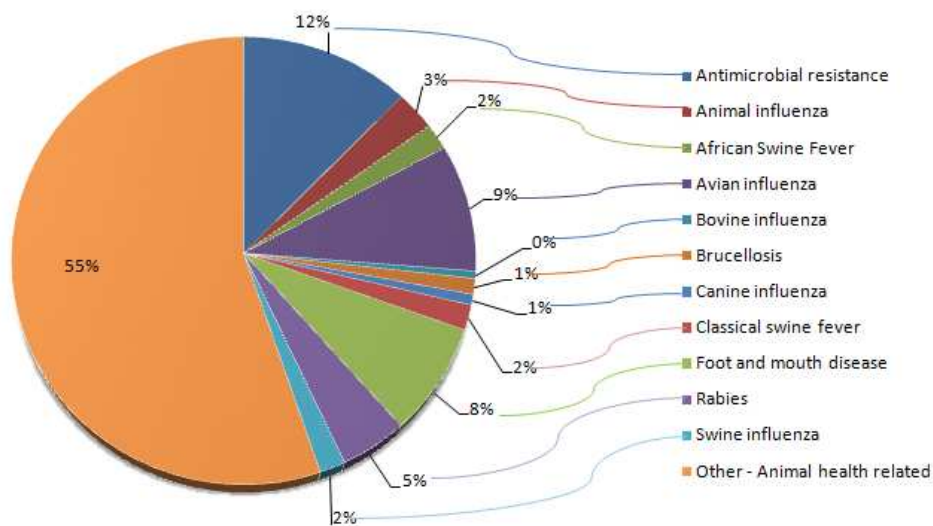


Figure 6 – Patenting topics

Patents' disease of focus shows a similar distribution of topics (as for the peer-reviewed scientific publications), animal influenza being the most patented disease.

### Top patenting keywords

The keyword analysis shows the following keywords to be the most important:

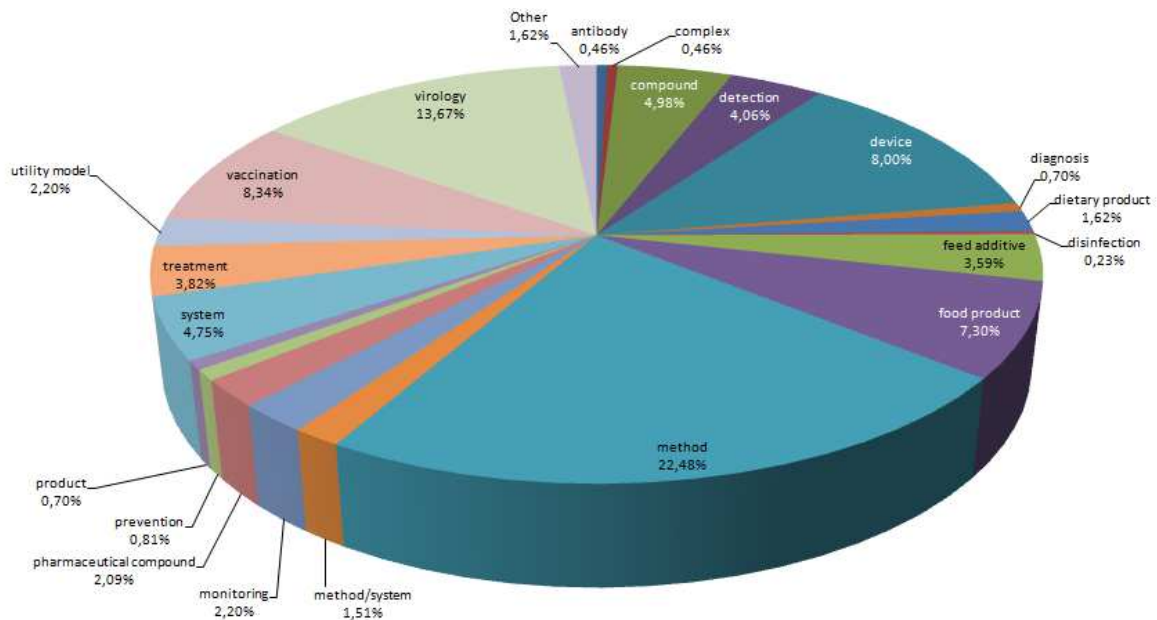


Figure 7 – Top patenting keywords

We can conclude from the keyword distribution that the key areas are:

- Vaccination/virology – more than 20%
- Dietary/Food products – more than 8%
- Detection – more than 4%
- Husbandry (devices and methods) – more than 30%

Among the results we can find patents composed of hardware and software elements as well. The wearable systems can be found for pets and food producing animals as well.

For example, only in Europe 30 startups are operating in the area of Internet of things, specifically focusing on animal health. In particular, the areas include monitoring of health, big data, vaccines and GPS tracking. For example, Connectra<sup>23</sup>, an Amsterdam based start-up, developed a monitor that provides accurate estrus detection, health analysis and location services for dairly cattle. The overall European market of animal health startups is evaluated at 24 billion dollars.<sup>24</sup>

Example:

*Remote livestock heartbeat monitoring system based on Internet of things*<sup>25</sup>

<sup>23</sup> <http://www.connecterra.io/>

<sup>24</sup> [http://animalhealthevent.com/wp-content/uploads/2016/01/8.1\\_Animal\\_Health\\_Investment\\_-\\_Article\\_January\\_2016.pdf](http://animalhealthevent.com/wp-content/uploads/2016/01/8.1_Animal_Health_Investment_-_Article_January_2016.pdf)

<sup>25</sup> <https://worldwide.espacenet.com/publicationDetails/biblio?CC=EP&NR=0922434A1&KC=A1&FT=D>



The TOP 20 researching institutions from China and the EU based on involvement

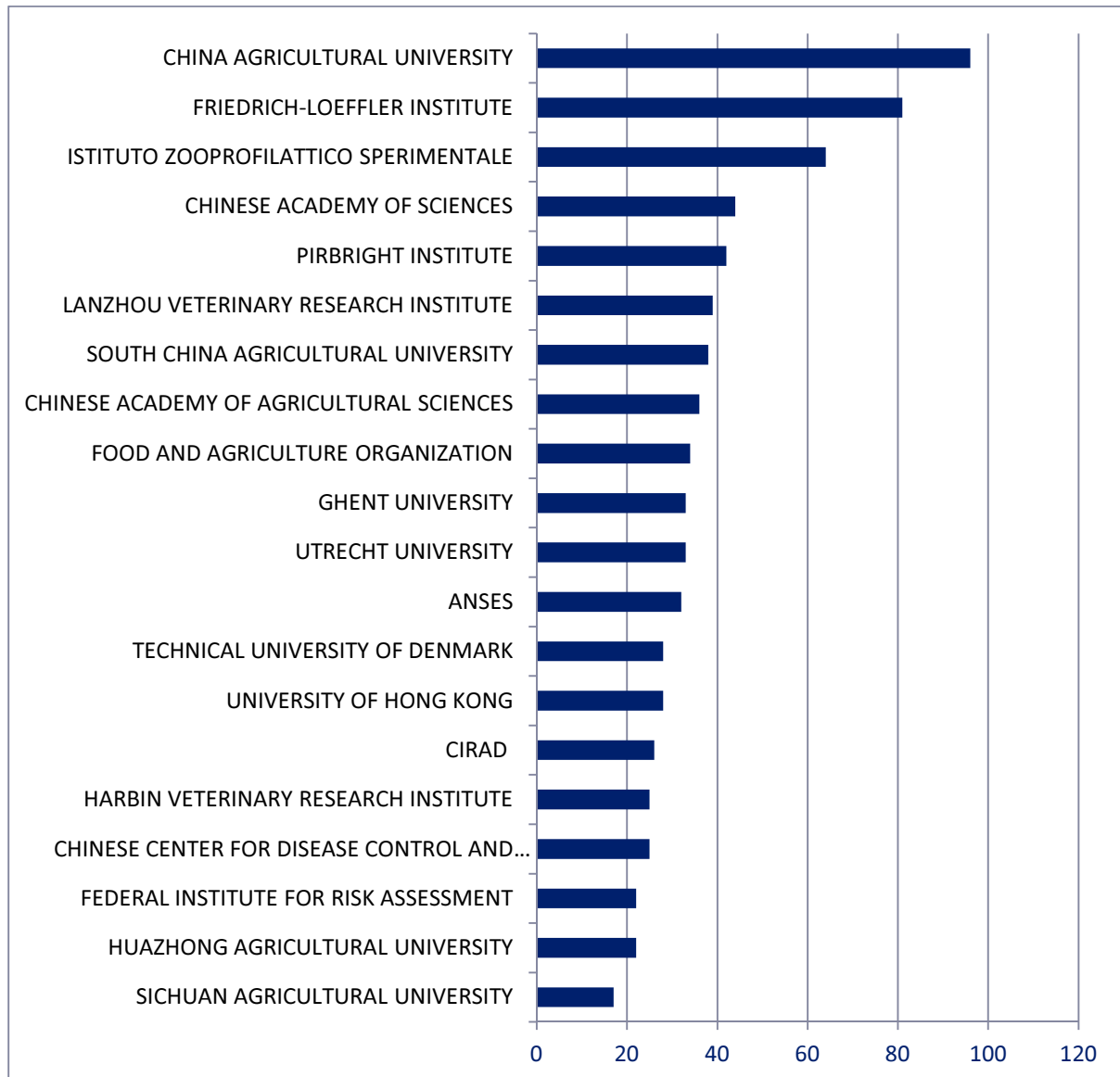


Figure 8 - TOP 20 researching institutions from China and the EU

### Top researchers of China

We have gathered the top innovators from China based on our findings.

**Top 10 Institutions active on the field of academic research – based on the (number of publications)**

- China Agricultural University (96)
- Chinese Academy of Sciences (44)
- South China Agricultural University (39)
- Lanzhou Veterinary Research Institute (38)
- Chinese Academy of Agricultural Sciences (36)
- Huazhong Agricultural University (28)

- Chinese Academy of Sciences (25)
- Chinese Center for Disease Control and Prevention (25)
- University of Hong Kong (22)
- Harbin Veterinary Research Institute (17)

## Top researchers from the European Union

We have gathered the top innovators from the EU based on our findings.

### Top 10 Institutions active on the field of academic research – based on the (number of publications)

- Friedrich-Loeffler Institute (81)
- Istituti Zooprofilattici Sperimentali (64)
- The Pirbright Institute (42)
- Utrecht University (34)
- Ghent University (33)
- ANSES (French Agency for Food, Environmental and Occupational Health & Safety) (33)
- Technical University of Denmark (32)
- CIRAD (French Agricultural Research Centre for International Development) (28)
- FAO, Food and Agriculture Organization, Rome (26)
- Federal Institute for Risk Assessment, Berlin (22)

The data underline the findings of WP2 “...universities account for the largest proportion of all research in both EU and China, with government institutions also playing a very important role. Private companies have a considerable role in research in the EU compared to their involvement in Chinese research.”

## TOP Patenting Organizations/Institutions

In Europe (No. of patents)

- BAYER ANIMAL HEALTH GMBH + BAYER CROPSCIENCE AG, Germany (14)
- DANSK MINK PAPIR AS, Denmark (5)
- DELAVAL HOLDING AB, Sweden (4)
- NEDAP NV, the Netherlands (3)
- BODYMARKERS AB, Sweden (3)
- ELANCO ANIMAL HEALTH IRELAND, Ireland (3)
- INMUNOLOGÍA Y GENÉTICA APLIC S A, Spain (2)
- SCHEBO BIOTECH AG, Germany (2)
- CRUCELL HOLLAND BV, the Netherlands (2)
- CUREVAC AG, Germany (2)

Top patenting Chinese organisations (No. of patents)

- ZHAOQING DAHUANONG BIOLOG PHARMACEUTICAL CO LTD (19)
- GUANGXI VETERINARY RES INST (16)
- LANZHOU VETERINARY RES INST CAAS (8)
- JIANGSU DADI ANIMAL HEALTH PRODUCTS CO., LTD. (8)
- HARBIN VET RES INST CAAS (7)
- CHINA ANIMAL HUSBANDRY INDUSTRY CO LTD (7)
- INSTITUTE OF ANIMAL HEALTH, GUANGDONG ACADEMY OF AGRICULTURAL SCIENCES (7)
- FUYANG MUWANG ANIMAL HUSBANDRY CO., LTD. (5)
- JIANGSU ACAD AGRICULTURAL SCI, JIANGSU LIHUA ANIMAL HUSBANDRY CO LTD ( 5)
- UNIV SOUTH CHINA AGRICULT (5)
- YEBIO BIOENG CO LTD QINGDAO (5)
- ZHEJIANG ESIGMA ANIMAL HEALTH CO., LTD. (5)
- ANIMAL & PLANT AND FOOD INSPECTION CT OF TIANJIN ENTRY EXIT INSPECTION AND QUARANTINE BUREAU (5)
- CHINA ANIMAL HEALTH AND EPIDEMIOLOGY CENTER (5)

### Joint publications

Based on the publications by topic we can see that the focus of joint research activities is animal influenza. Joint publication is defined here as one containing at least one EU institution and at least one Chinese institution.

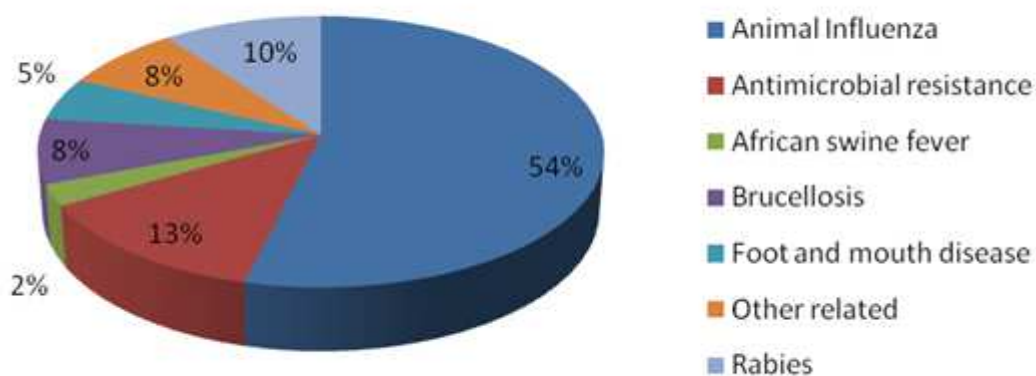


Figure 9 – Joint publications by topic

Our findings of joint publications of EU-China (39 records in total) show that within the joint research actions on animal influenza (21 records), the most active European partners (including non-EU member states) are the UK (11),

the Netherlands (5), Germany, Italy and France (3), Switzerland (2), Ireland, Norway, Sweden and Turkey, Belgium, Denmark, Hungary and Ukraine (1).

## Joint patenting

Joint patenting activities are not substantial.

## Joint actions of R&D actors in the EU and China

Based on our findings, the following institutes have already been active in joint research between the EU and China:

Joint actions of R&D actors in the EU and China	Nr of joint action	Country
China Agricultural University	5	China
University of Nottingham	5	the United Kingdom
Friedrich-Loeffler-Institut	4	Germany
The University of Hong Kong	4	China
Chinese Academy of Science	4	China
Chinese Center for Disease Control and Prevention	4	China
Institut Pasteur	3	France
The Pirbright Institute	3	the United Kingdom
Yangzhou University	3	Germany
Karolinska Institutet	2	Sweden
Lanzhou Veterinary Research Institute	2	China
Liverpool University	2	the United Kingdom
Netherlands Institute for Health Services Research (NIVEL)	2	the Netherlands
Public Health England	2	the United Kingdom
The Chinese University of Hong Kong	2	China
University of Cambridge	2	the United Kingdom
University of Munich	2	Germany
Zhejiang University	2	China

Other organisations involved in joint actions:

Imperial College London  
 Szent István University, MTA-SZIE Large Animal  
 Clinical Research Group  
 Academy of Military Medical Science  
 Animal and Plant Health Agency - Weybridge  
 Beijing Institute of Basic Medical Sciences  
 Beijing University of Agriculture  
 Changchun Veterinary Research Institute  
 China Animal Health and Epidemiology Center,  
 Qingdao

China Institute of Veterinary Drug Control, Beijing  
 Chinese Academy of Agricultural Sciences  
 Chinese Academy of Agriculture  
 Collaborative Innovation Center for Diagnosis and  
 Treatment of Infectious Diseases, Hangzhou  
 Fudan University  
 Fujian Agriculture and Forestry University  
 Ghent University  
 Harbin Veterinary Research Institute (HVRI)  
 Hungarian Academy of Sciences

Istituto Superiore Sanità	Tongling Center for Disease Control and Prevention
Jiangnan University	Umeå University
Jiangsu Provincial Centre for Disease Control and Prevention	University College Dublin
Ludwig Maximilian Universit	University of Bristol
NOVA Universidade de Lisboa	University of Catania
Shandong Binzhou Animal Science and Veterinary Medicine Academy	University of Groningen
Sichuan Agricultural University	University of Lübeck
South China Agricultural University	University of Twente
Sun Yat-sen University	University of Warwick
	WHO Collaborating Centre for Topical Diseases
	Wuhan University

### Actors most active both in the field of research and patenting

Actors most active both on the field of research and patenting	No of Publications	No of Patents
Chinese Academy of Agricultural Sciences	97	
BAYER Animal Health GMBH	5	16
Harbin Veterinary Research Institute	37	7
Lanzhou Veterinary Research Institute	45	8
Chinese Academy of Sciences	70	2
China Animal Health and Epidemiology Center	7	7
South China Agricultural University	51	
Boehringer Ingelheim GMBH	4	4
Jiangsu Academy of Agricultural Sciences	7	
National Institute of Food and Drug Control, China	5	
ZOETIS	7	2
Sanofi Pasteur	8	2
Pirbright Institute	44	1

#### Good practice

Bayer Animal Health has a long-term record of successful partnerships involving both large and small companies and academic institutions. Here are some examples of their partnerships.<sup>26</sup> We include this in the JIR, as based on our analysed data, Bayer represents an organization being very active in both research and patenting. Their network of partners shows a cross-sectoral approach on a global scale.

<sup>26</sup> <https://animalhealth.bayer.com/en/innovation-partnering/partnering/>

Industry & Trade Partners of BAYER include:

- Health for Animals<sup>27</sup>
- International Federation for Animal Health Europe<sup>28</sup>
- Asian Animal Health Association
- The Animal Health Institute<sup>29</sup>
- ANIMAL MEDICINES AUSTRALIA<sup>30</sup>

Veterinary & Scientific Partners of BAYER include:

- World Small Animal Veterinary Association (WSAVA)<sup>31</sup>
- World Association for the Advancement of Veterinary Parasitology (WAAVP)<sup>32</sup>
- LeishVet<sup>33</sup>

R&D Partner of BAYER include:

- Université de Sherbrooke<sup>34</sup>

Further Global Partner of BAYER include:

- World Farmers Organisation<sup>35</sup>

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<sup>27</sup> <http://www.health4animals.com/>

<sup>28</sup> <http://www.ifaheurope.org/about/about-ifah-europe.html>

<sup>29</sup> <http://www.ahi.org/about/>

<sup>30</sup> <http://animalmedicinesaustralia.org.au/>

<sup>31</sup> <http://www.wsava.org/>

<sup>32</sup> <http://www.waavp.org/>

<sup>33</sup> <http://www.leishvet.org/>

<sup>34</sup> <https://www.usherbrooke.ca/accueil/english/overview/>

<sup>35</sup> <http://www.wfo-oma.com/>



# 03.

## Synergies and Recommendations

## Synergies and Recommendations

While there is a good number of joint cooperation activities between EU and China, showing also in the form of joint academic research publications, scientific and innovation focused cooperation should be still supported and enhanced in both regions. The strategic priorities have been already identified, procedures for joint funding opportunities have been set up and there is a strong network of scientists and officials who can support the interested parties in successful collaboration. This final section of the report would like to give some guidance and recommendations, showing some good practices to be followed in order to motivate and support future EU-China collaboration in the field of animal health.

### Synergies with other European projects and international initiatives

Maintaining synergies with existing and building up new synergies with future European projects and international initiatives will have to become a core objective for each and every new EU-China initiative. Some key existing projects and initiatives are listed below.

**STAR-IDAZ International Research Consortium (IRC)** “builds up on several years of research networking on animal health supported by the European Union through its framework programmes for research (including Horizon 2020), aims to deliver measurable advancements in the control of animal diseases through the alignment of both public and privately funded animal health research programmes around the world. The Consortium includes research funders and programme owners from Europe, Asia, Australasia, the Americas, Africa and the Middle East as well as international organisations and the representation of veterinary pharmaceutical companies. Together, they have committed a total budget in the region of EUR 1 billion to invest over a five year period to 2021. These partners have agreed to coordinate their research programmes to address agreed research needs, share results and together deliver new and improved animal health strategies for at least 30 priority diseases, infections or issues, including candidate vaccines, diagnostics, therapeutics and other animal health products, procedures and/or key scientific information and tools to support risk analysis and disease control.”<sup>36</sup>

The regional network for Asia and Australasia comprises STAR-IDAZ partners from Australia (Regional Network Coordinator), China, India, Russia, New Zealand and Japan. In China, the partner organisation is CAAS, the Chinese Academy of Agricultural Sciences.

LinkTADs has cooperated with STAR-IDAZ and also after the end of the project, it cooperated with the new International Research Consortium; e.g. more information on the IRC activities will be introduced in the final newsletter of LinkTADs. The synergy possibilities between existing and future EU animal health’s projects and other projects in China, e.g. those funded by CAAS should be shared with STAR-IDAZ IRC. LinkTADs partners and other

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<sup>36</sup> <https://ec.europa.eu/programmes/horizon2020/en/news/international-partners-launch-new-international-research-consortium-work-together-animal-health>



cooperating organisations should continue raising attention on the cooperation between epidemiology and laboratory research aspects between the EU and China.

“Fighting hunger is not only about producing more food. It also means protecting livestock from diseases and preventing them from spreading across borders. That's why in 1994, FAO established the Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases, or **EMPRES**. The mission of the EMPRES-Livestock programme is to promote the effective containment and control of the most serious epidemic livestock diseases/Transboundary Animal Diseases (TAD) as well as newly emerging diseases by progressive elimination on a regional and global basis through international co-operation involving Early Warning, Early Reaction, Enabling research, Coordination.”<sup>37</sup>

LinkTADs followed closely the EMPRES programme through the information exchange between FAO colleagues and also some of the project news have been distributed through the EMPRES News and the EMPRES Bulletin. Maintaining the future cooperation and the exchange of information will have to be considered by any new project launched in the EU or in China in the field of transboundary diseases.

#### **DRAGON-STAR Plus – the new BILAT EU-China project**

“In the beginning of 2015, major European and Chinese Research & Academic organisations, Innovation intermediaries, Public Authorities, Funding agencies and SMEs have teamed up to foster EU-China cooperation in the large spectrum of S&T RDI topics.

Over 3 years, through the DRAGON STAR Plus project and building on the results of the DRAGON STAR project, they will:

- Support the European and Chinese research communities to establish collaborations under Horizon 2020 and beyond.
- Provide a cooperation platform and tools to policy makers, aiming ultimately to support and enhance the bilateral cooperation, through the concept of mutual benefit.
- Provide an ERA-NET style platform to funding agencies for exchanging best practices and planning joint activities in the field.”<sup>38</sup>

As highlighted also under global trends, all future animal health projects will have to consider the **One Health Initiative**, the One Veterinary and Medicine aspects. LinkTADs has already contributed to some of the recommendations of the FAO ECTAD China related to One Health Initiative implemented in China, such as:

- Find mechanisms to operationalize One Health activities through newly formed steering committee meetings or existing coordination mechanisms.
- Develop mechanisms for connecting One Health research and practice with policymakers.
- Support the participation of researchers and students in regional and international meetings, conferences and professional training events on One Health on an ongoing basis.

<sup>37</sup> <http://www.fao.org/ag/againfo/programmes/en/empres/about.html>

<sup>38</sup> <http://www.dragon-star.eu/dragon-star-plus/>

## Targeting best R&I actors

Based on the best practices analysed in an earlier phase of the project (see D8.10 Best practices report) and based on our own experience gained in LinkTADs collaborations here we would like to share some recommendations on how Research and Innovation collaborations can be initiated.

- Working visits/exchanges/common events: Experience shows that the best collaborations can be developed when both parties make a small investment in getting to know the other organisation better and start through a common short project. Working visits may be organized on the level of decision-makers or research departments depending on the scope of the visit. Exchanges are useful when the collaboration is based on knowledge sharing and introducing each other's procedures, research methods and equipment to see how easy it would be to set up common research collaboration. Common events might be most beneficial for both organisations if the scope and the invited participants bring added value to the running projects at these organisations. The final result of these short term collaborations will be an enhanced share of experience and knowledge; capacity building of people; networking, and most importantly both partners will have the chance to identify new areas of cooperation of mutual interest.
- Identification of new areas of cooperation of mutual interest should be generally supported also by grants provided by national authorities. These exchanges, working visits and events supported by the authorities give room for open discussions and enable the identification of opportunities not only for collaboration between countries and/or regions, but more bottom-up, on the institutional level. In addition, these events might be targeted on certain topics that will support building stronger relationships and long term partnerships with research and innovation actors on priority areas e.g. identified by the EU-China Policy Dialogue on Research and Innovation.
- As concluded in WP2: "In the EU, universities are more likely to collaborate with private companies (12% of all university research representing such collaborations) than government institutions (4% of their research)." It is clear that such collaboration is fruitful, however legal and financial concerns have to be considered. In order to support the successful collaboration with private companies, research organisations, universities and government institutions should reconsider their strategies and selection processes regarding why and how collaboration with private partners is possible within or outside projects (market basis). There should be clear objectives set for such collaborations with simpler procedures to permit the collaboration on the high decision-making level.
- Highlighting more the focus of LinkTADs - linkages between epidemiology and laboratory research and referring back to WP2 conclusions:" In China, the difference between laboratory and epidemiology research taking place in universities is much greater, with epidemiology research making up a considerably smaller proportion of their animal health research output than laboratory research." Consequently, LinkTADs has been focusing on enhancing epidemiology research in China, while encouraging joint work that links epidemiology and laboratory. This objective should be pursued by future collaborations as well.
- LinkTADs Focal Point Network (FPN) has been established and prestigious organisations are represented in the network with researchers and other officials not only open for future collaboration, but also in power of supporting other external researchers in collaborating with other institutes. LinkTADs FPN can be thus

used by future projects and researchers for getting access to important news, identifying key actors, get relevant information and support for being able to follow the right process and method to initiate collaboration in China or the EU.

## General recommendations

### Development co-operations with the private sector

We recommend that actors from the field of animal health research start building partnerships and co-operations with key actors from the private sector, particularly animal health and IT industry. It is visible from our research that key animal health industry actors play a very critical role on the field of R&I. In addition, many of these enterprises are multinational corporations, therefore they have the global sources of data and that can be beneficial to the academic field.

### Harmonization in animal health policies across the globe

It is critical to realize that the diversity of policies regulating animal health, e.g. antimicrobial usage is counter-productive for the global effort to make animal and agricultural production more efficient. We recommend that animal health policies should be further analyzed and harmonized between developed and developing countries. The existing EU-China dialogue should be continued, focusing on priority areas, but also might be extended to other countries as well.

### Establish more scientific collaborations - Carry on activities started during LinkTADs project

The activities of the LinkTADs project have already bore fruit. The Joint Laboratory for Veterinary Microbiology between SVA (Sweden), Harbin Veterinary Research Institute (China), and Centre de Recerca en Sanitat Animal (China) is a great example of transnational partnership and should be regarded as good practice. Our recommendation is that similar joint actions should be carried out with other institutions within or outside LinkTADs partnership, even from other countries.

LinkTADs methodology could be used to identify more key actors and carry out more coordinated research. Developing stronger international research networks can help to eliminate research duplication and therefore may assist the utilization of resources more harmoniously.

### IT and research, utilization of big data and mathematical models

The usage of bigdata and IT systems may be crucial in developing efficient agricultural systems. Cooperating with IT/bigdata companies expert in these fields could help to boost productivity and efficiency in animal husbandry, and for disease surveillance networks as well.