



# Wageningen MSc Thesis

LAW GROUP 2023, May

## **Improving farm animal welfare to safeguard human health**

The regulation of antimicrobial resistance in the EU and its  
relationship with farm animal welfare

Celia López Abellán

1158953

LAW80436 | 36 ECTS

WAGENINGEN UNIVERSITY  
LAW GROUP

**Improving farm animal welfare to safeguard human health**

The regulation of antimicrobial resistance in the EU  
and its relationship with farm animal welfare

CELIA LÓPEZ ABELLÁN

Supervisor: Edwin Alblas

LAW80436 | 36 ECTS

**Wageningen MSc Thesis 2023/05**

This text may be downloaded for personal research purposes only. Any additional reproduction for other purposes, whether in hard copy or electronically, requires the consent of the author(s), editor(s). If cited or quoted, reference should be made to the full name of the author(s), editor(s), the title, the working paper or other series, the year, and the publisher.

© 2023 [Celia López Abellán]  
Published in the Netherlands  
Wageningen University  
Law Group  
P.O. Box 8130 | 6700 EW Wageningen  
Visiting address: Hollandseweg 1 Wageningen  
The Netherlands  
[www.wageningenur.nl/law](http://www.wageningenur.nl/law)

*Hygia Pecoris, Salus Populi.*

# **Improving farm animal welfare to safeguard human health**

Celia López Abellán - WUR student at the LAW group.

Student ID 1158953, celia.lopezabellan@wur.nl

## **Abstract**

Antimicrobial resistance (AMR) is considered an important threat to global health. The European Union (EU) has taken a leading position in addressing it by introducing, different policy plans and legal measures. Due to the large occurrence of AMR development in the animal husbandry sector, several legal measures are established around the reduction of antimicrobial use in veterinary medicine. The most relevant measures in this area can be found within the recently implemented Regulation 2019/6 on Veterinary Medicinal Products and Regulation 2019/4 on Medicated Feed. Interestingly, a factor that has been linked with the reduction of antimicrobial use is animal welfare. This thesis contributed to the knowledge of the relationship between EU AMR governance and EU farm animal welfare governance. The legal measures within the mentioned Regulations were reviewed together with EU and international AMR policy measures. Concerning animal welfare, the thesis focused on the EU legal measures related to stocking density for pigs and broilers and the weaning of piglets. Based on this research, this thesis concludes that the successful implementation of EU AMR legal measures on farms, calls for the alignment of the EU animal welfare legal framework with the current scientific evidence.

### ***Main Key words:***

Farm animal welfare, Antimicrobial resistance, European Union, Policy & Regulations.

## List of Abbreviations

AMR	Antimicrobial resistance
CAP	Common Agriculture Policy
EMA	European Medicines Agency
EU	European Union
EARSS	European Antimicrobial Surveillance System
F2F	Farm to Fork
FAO	Food and Agriculture Organization of the United Nations
GAP	Global Action Plan on Antimicrobial Resistance
MF regulation	Regulation 2019/4 on Medicated Feed
NH3	Ammonia
OIE	World Animal Health Organization
UNEP	United Nations Environment Programme
VMP regulation	Regulation 2019/6 on Veterinary Medicinal Products
WHA	World Health Assembly
WHO	World Health Organization

# Table of contents

Abstract .....	2
List of Abbreviations .....	3
<b>1. Introduction</b> .....	6
1.1 Background.....	6
1.2 Research Questions.....	10
1.3 Methodology & Methods .....	11
1.4 Research Limitations & Justifications .....	12
1.5 Structure of this Master thesis.....	13
<b>2. Animal welfare</b> .....	15
2.1 Farm animal welfare, health and disease.....	15
2.2 Antimicrobial use and its relationship with farm.....	19
animal welfare.....	19
2.3 Stocking density and international welfare.....	22
standards.....	22
2.4 Weaning and international welfare standards.....	25
2.5 Interim conclusion .....	26
<b>3. EU regulation of farm animal welfare</b> .....	28
3.1 History of animal welfare legislation and policies in the EU.....	28
3.2 Legislation on Stocking Density.....	33
3.2.1 Introduction.....	33
3.2.2 Legislation on poultry stocking density .....	35
3.2.3 Legislation on pig stocking density .....	40
3.3 Legislation on early weaning in piglets.....	42
3.4 Interim Conclusion.....	44
<b>4. International AMR Governance</b> .....	46
4.1 Binding governance mechanisms regulating AMR.....	46
4.2 Non-binding governance mechanisms regulating AMR.....	47
4.2.1 World Health Organization on AMR.....	49
4.2.2 Food and Agriculture Organization of the United Nations on AMR.....	54
4.2.3 The World Animal Health Organization on AMR.....	57
4.3 Interim conclusion .....	61
<b>5. EU law and policy related to farm antimicrobial use</b> .....	63
5.1 Introduction.....	63
5.2 European One Health Action Plan against antimicrobial resistance.....	65

5.3 Regulation 2019/6 of 11 December 2018 on Veterinary Medicinal Products .....	67
5.4 Regulation 2019/4 of 11 December 2018 on Medicated Feed .....	72
<b>6. Discussion</b> .....	<b>77</b>
<b>7. Conclusion and recommendations</b> .....	<b>87</b>
<b>8. Bibliography</b> .....	<b>89</b>



# 1. Introduction

## 1.1 Background

Animal welfare policies and standards in the European Union (EU) have been shaped over the recent years by different influencing factors and drivers of change.<sup>1</sup> In their study of 2014, Villa and others identified ethics as the overarching driver that underpins the human interrelation with animals, increases the recognition of animal's sentience and contributes to the development of animal welfare policies.<sup>2</sup> In this same study, the authors described that ethics, in the notion of animal welfare driver, is supported by actions from driving areas such as market and trade, science or knowledge which also motivate the rise in awareness around animal welfare.<sup>3</sup>

Notably, within EU livestock production systems, this awareness around animal welfare has also grown recently significantly, from a farmer and consumer perspective, but also from the regulatory governance perspective.<sup>4</sup> Governments, veterinarians and consumers have been the main actors that have contributed shaping directly or indirectly farm animal welfare.<sup>5</sup> However, despite the contributions of these mentioned actors, it is important to be aware that the figure of the farmer plays a particularly important role in the integration of animal welfare. Farmers decide in practice, and within the context of existing legal and policy frameworks, which efforts are to be implemented around welfare in-farm. Consequently, they greatly condition the living environment in which animals in livestock production systems are reared.<sup>6</sup> According to Balzani and Hanlon, the motivation of farmers to integrate improvements in animal welfare is influenced by the costs such implementation induces and by potential (dis)trust in the economic

---

<sup>1</sup> Paolo Dalla Villa and others "Drivers for animal welfare policies in Europe" (2014) 33, *Revue Scientifique et Technique* (International Office of Epizootics) 39.

<sup>2</sup> *ibid.*

<sup>3</sup> *ibid.*

<sup>4</sup> Reinhard Uehleke and Silke Hüttel "The free rider deficit in the demand for farm animal welfare-labelled meat" (2019) 46 *European Review of Agricultural Economics*, 291.

<sup>5</sup> *ibid.*

<sup>6</sup> Tiina Kauppinen and others "Improving animal welfare: qualitative and quantitative methodology in the study of farmers attitudes" (2010) 19 *Animal Welfare*, 523.

advantages that those improvements could bring along.<sup>7</sup> In fact, there are several factors that improve animal welfare, such as husbandry conditions and livestock management. These practices when implemented with a focus on levelling up animal welfare within a farm, result in a decrease in productivity and an increase in economic costs.<sup>8</sup>

Improving the balance between animal welfare, health and productivity in farms has become one of the objectives within the EU in order to develop better welfare-friendly production systems.<sup>9</sup> Different pieces of legislation, such as directives and regulations, and accompanying policies have already been implemented to support these changes on farm animal welfare.<sup>10</sup> Presently, animal welfare is considered within the EU in all areas of the production system, from farming itself to transport and slaughtering.<sup>11</sup>

Interestingly, animal welfare is currently gaining more attention in the literature due to its potential to be a driver in contributing to addressing antimicrobial resistance (AMR).<sup>12</sup> AMR has been defined as a natural phenomenon that occurs when pathogens are exposed to antimicrobial medicines.<sup>13</sup> When this happens, pathogens undergo selective pressure, which results in the inhibition or death of the pathogens, or in the survival and multiplication of those with naturally (or intrinsically) resistant characteristics.<sup>14</sup> The excessive and improper use of antimicrobials in human medicine, in the raising of food animals, and in the production of crops, are the major contributors to the increase of this significant global threat to

---

<sup>7</sup> Agnese Balzani and Alison Hanlon "Factors that Influence Farmers" Views on Farm Animal Welfare: A Semi-Systematic Review and Thematic Analysis" (2010) 10 *Animals*; Harald Grethe "The Economics of Farm Animal Welfare"(2017) 9 *Annual Review of Resource Economics*, 75.

<sup>8</sup> John McInerney "Animal welfare, economics and policy" (2004) 165.

<sup>9</sup> Yongzhen Li and others "Space allowance determination by considering its coeffect with toy provision on production performance, behavior and physiology for grouped growing pigs" (2021) *Livestock Science*.

<sup>10</sup> *ibid.*

<sup>11</sup> Denis Simonin and Andrea Gavinelli "The European Union legislation on animal welfare: state of play, enforcement and future activities" (2019) in S Hild and L Schweitzer (eds) *Animal Welfare: From Science to Law*, 59.

<sup>12</sup> Maria Rodrigues da Costa and Alessia Diana "A Systematic Review on the Link between Animal Welfare and Antimicrobial Use in Captive Animals" (2022) 12 *Animals*.

<sup>13</sup> Francesca Prestinaci and others "Antimicrobial resistance: a global multifaceted Phenomenon" (2015) 109 *Pathogens and global health* 309; WA Adedeji "The treasure called antibiotics" (2016) 14 *Annals of Ibadan postgraduate medicine* 56-57.

<sup>14</sup> *ibid.*

human and animal health.<sup>15</sup> An increase in resistant pathogens results in loss of effectiveness of antimicrobial medicines, which will turn them ineffective in the prevention and treatment of infectious diseases, caused mainly by bacteria, but also by viruses, fungi and parasites.<sup>16</sup>

One of the major threats that make the AMR so relevant is that antimicrobial-resistant organisms can spread between human beings, and between human beings and animals, including through transmission from food of animal origin.<sup>17</sup> It is worth mentioning that, although AMR has severe repercussions for human beings, animals and plants, the primary concerns around AMR, in light of the findings of this study, appeared to be majorly framed around the impacts on human health and the global economy. The direct consequences of developing an infection with resistant microorganisms are severe and can entail longer illness or higher mortality rates in humans, animals and plants.<sup>18</sup> According to the World Health Organization (WHO), 700.000 people die every year due to drug-resistant diseases, with the estimation that this number could rise to 10 million yearly by 2050.<sup>19</sup> The estimates of global economic impact, should the rise in resistant pathogens continue, have been studied to cause losses of up to 100 trillion USD by 2050.<sup>20</sup>

In relation to the development of AMR among farm animals specifically, more and more attention is paid now to resistant pathogen transmission

---

<sup>15</sup> FAO "Why should policy makers act on antimicrobial resistance in agrifood systems?" (2003) FAO.

<sup>16</sup> Francesca Prestinaci and others "Antimicrobial resistance: a global multifaceted Phenomenon" (2015) 109 Pathogens and global health 309; WA Adedeji "The treasure called antibiotics" (2016) 14 Annals of Ibadan postgraduate medicine 56-57; Porooshat Dadgostar "Antimicrobial Resistance: Implications and Costs" (2019) 12 Infection and drug resistance, 390.

<sup>17</sup> WHO "Antimicrobial Resistance" (2021) <<https://www.who.int/newsroom/fact-sheets/detail/antimicrobialresistance#:~:text=AMR%20occurs%20naturally%20over%20time,from%20food%20of%20animal%20origin>> accessed 23 March 2023.

<sup>18</sup> FAO "Antimicrobial Resistance, what is it?" <<https://www.fao.org/antimicrobial-resistance/back-ground/what-is-it/en/>> accessed 20 November 2022.

<sup>19</sup> WHO "New report calls for urgent action to avert anti-microbial resistance crisis" <<https://www.who.int/news/item/29-04-2019-new-report-calls-for-urgent-action-to-avert-antimicrobial-resistance-crisis>> accessed 11 November 2022.

<sup>20</sup> Bethany Cooper and Walter O Okello "An economic lens to understanding antimicrobial resistance: disruptive cases to livestock and wastewater management in Australia" (2021) 65 Australian Journal of Agricultural and Resource Economics, 900.

between animals and humans.<sup>21</sup> Scientific evidence shows that the increased development of resistant pathogens affecting human beings and animals is influenced by the large application of antimicrobials in animal production. The reason is mainly because, in this sector, antimicrobials are applied not only for therapeutic purposes but also for non-therapeutic purposes, namely, metaphylaxis, prophylaxis or growth-promotion, being the latter purpose, the major therapeutic practice in livestock production to contribute to the development of AMR.<sup>22</sup> Ultimately, the rise of AMR in animals does not only have an impact on human health and animal health but also results in reduced food security, reduced food production, greater food safety concerns, higher economic losses to farm households, and contamination of the environment.<sup>23</sup>

Due to the complexity of AMR as a public health threat which has different root causes and impacts on different areas, it has become critical to restrain it from further escalation by integrating multisectoral involvement that addresses animal health, human health and the environment.<sup>24</sup> Consequently, effective and coordinated governance has emerged as a core necessity to mitigate AMR.<sup>25</sup> The important role that animal welfare plays in supporting animal health, avoid the occurrence of disease and ultimately mitigate the rise of AMR has been explored. Yet, thus far, there has been very little engagement with this relevant question and the role of good animal welfare policy and legislation integration for the successful implementation of AMR policies and legislation. This thesis aims to contribute filling this gap.

---

<sup>21</sup> FAO "Antimicrobial resistance" <<https://www.fao.org/fao-who-codexalimentarius/thematic-areas/antimicrobial-resistance/en/>> accessed 9 May 2023.

<sup>22</sup> FAO "Status Report on Antimicrobial Resistance" (2015) C 2015/28 Rev.1; Jim O'Neill "Tackling drug-resistant infections globally: final report and recommendations-Review On Antimicrobial Resistance" (2016) Wellcome trust.

<sup>23</sup> OECD "Antimicrobial resistance and agriculture" <<https://www.oecd.org/agriculture/topics/antimicrobial-resistance-and-agriculture/#:~:text=The%20potential%20consequences%20of%20antimicrobial,and%20contamination%20of%20the%20environment>> accessed 9 May 2023.

<sup>24</sup> WHO "Tackling Antimicrobial Resistance (AMR) together Working Paper 1.0: Multisectoral coordination" (2018) WHO/HWSI/AMR/2018.2.

<sup>25</sup> Birgand Gabriel and others "Comparison of governance approaches for the control of antimicrobial resistance: Analysis of three European countries" (2018) 7(28) Antimicrobial Resistance & Infection Control.

## 1.2 Research Questions

This master thesis serves to answer the following main research question:

- What is the relation between AMR governance and farm animal welfare governance in the EU?

To support the answer to this main question, the research will be guided by the following sub-research questions:

- Sub-question 1: What is the relation between farm animal welfare and the use of antimicrobials?
- Sub-question 2: What are the main international standards addressing animal welfare in animal husbandry, especially for stocking density in pigs and poultry and early weaning in piglets?
- Sub-question 3: How does the EU regulate animal welfare in animal husbandry, especially for stocking density in pigs and poultry and early weaning in piglets?
- Sub-question 4: What are the main international actors and actions regulating AMR at the farm level?
- Sub-question 5: What are the main EU policies and legal measures that currently address AMR at the farm level?

### 1.3 Methodology & Methods

This thesis is characterised by being desk-based and by drawing mainly on doctrinal legal research and policy research.<sup>26</sup> Secondary legal sources such as EU regulations, directives were used in the analysis of the governance of AMR and farm animal welfare at the international level and the EU level. In addition, selected primary legal sources such as EU Treaties were used to further study the governance of farm animal welfare in the EU. Other sources were also used, such as legal journal articles, policy documents such as EU resolutions and EU Commission guidance documents, documents of international organizations, and grey literature.<sup>27</sup> In addition, scientific journal articles, scientific opinions and reports and scientific grey literature were included in the review and the study, to support or analyse in context the legal matters under examination. The answer to the first sub-question drew uniquely on a scientific literature review and online research. The answer to sub-questions 2 and 3 was performed by integrating scientific literature review and legal literature review in the analysis. Lastly, the answer to sub-questions 4 and 5 relied mainly on using legal sources.

---

<sup>26</sup> Doctrinal research, also known as pure theoretical research, is a type of legal research performed on a legal proposition or propositions by means of analysing the existing statutory provisions and cases by implementing the power of reasoning. Doctrinal research differs from other types of legal research since it is characterised by studying the law within itself; therefore, this type of legal approach does not intend to look at the effect of the law or how it is applied but instead analyses law as a written body of principles which can be described and study using only legal sources. See EduCheer "Doctrinal and non-doctrinal research" <<https://educheer.com/research-papers/doctrinal-and-non-doctrinal-research/>> accessed 16 April 2023; ASC LLM Support – UWE "Research Methods: Doctrinal Methodology" <<https://uweascllmsupport.wordpress.com/2017/01/18/research-methods-doctrinal-methodology/>> accessed 16 April 2023.

<sup>27</sup> Grey literature is characterised by being a type of literature where the information is produced outside of traditional publishing and distribution channels. This type of literature can comprise, for example, reports, policy literature, working papers, newsletters, government documents, speeches or white papers. Grey literature is usually developed by intergovernmental or governmental organisations, inter-governmental agencies or industry, with the aim to keep information and report on their activities. See SFU Library "Grey literature: What it is & how to find it" <<https://www.lib.sfu.ca/help/research-assistance/format-type/grey-literature>> accessed 16 April 2023.

## 1.4 Research Limitations & Justifications

This Master's thesis was developed between September 2022 and May 2023. The scope of the research is limited to the areas of farm animal welfare and measures on AMR at the farm level, due to the prominent and influencing link between these two areas, as was mentioned in the introduction.

The first area that is analysed is farm animal welfare. With the aim to ensure sufficient focus for answering the research question, the scope is limited to the farm animal welfare concept, the scientific link between farm animal welfare, disease and use of antimicrobials, the international animal welfare standards from the World Organisation for Animal Health (commonly known as "OIE")<sup>28</sup> and the EU legal framework for farm animal welfare. Concerning the international OIE standards and the EU legal framework on farm animal welfare, two particular husbandry and management practices within farms were selected as case studies. These were, stocking density in pigs and broilers, and weaning in piglets. The reason to select these two practices as case studies together with these two species is firstly due to the prominence of these two practices in affecting animal welfare and increasing AMR. Secondly, pigs and broilers were selected due to their importance within the EU livestock industry. Other welfare standards on different factors and management practices, or other farm species, were not considered due to their less prominent capability to influence animal welfare and AMR, as highlighted above, their less prominent importance within the EU livestock sector, and the constraints of time to perform this Master thesis. Factors influencing the implementation of these animal welfare standards, such as international trade or economic costs, are not included in the research due to being areas that fall outside the scope of the research.

The second area that is analysed in this research comprises policies and legal measures on AMR at the farm level. At the international level, the research is limited to the WHO, the FAO and the OIE intergovernmental organizations as main actors playing a role in establishing guidelines on AMR

---

<sup>28</sup> The initials OIE stand for Office International des Epizooties. This was the original name coined in the foundation of the organization in 1927. In 2003 the organization decided to adopt the name of World Organisation for Animal health (WOAH). However, the initials OIE prevailed as its sign of identity. OIE "Who we are" <<https://www.woah.org/en/who-we-are/>> accessed 4th November 2022.

in animal husbandry. The guidelines and measures analysed are limited to antimicrobial stewardship actions and husbandry and management measures on farms. At the EU level, the scope of the policy research is limited to policy measures on farm antimicrobial stewardship within the "European One Health Action Plan against AMR". Concerning specific legal measures, the research is limited to the analysis of antimicrobial stewardship measures within Regulation 2019/6 on veterinary medicinal products and Regulation 2019/4 on medicated feed since they are the key legal instruments currently in force nowadays.

## 1.5 Structure of this Master thesis

This thesis is divided into a total of seven chapters, which could in turn be figuratively divided into four parts. The first part consists of the introduction, the second part concerns the area of farm animal welfare, the third part concerns the area of AMR and the fourth and last part encompasses the discussion and conclusion.

The first chapter called "Introduction" provided an overview of the main aims and objectives of the research. This chapter also introduced the necessary background to understand the research. In addition, the research questions and the overall methodology were illustrated.

The second and third chapters introduce the content around guidelines and legal measures around farm animal welfare. The second chapter called "Animal welfare", introduces the content related to animal welfare, what entails farm animal welfare together with its link with disease and the use of antimicrobials, and the OIE international standards on animal welfare. The third chapter, called "The EU regulating farm animal welfare", introduces the content related to the EU legislating on animal welfare over the years, the analysis of the current EU legal measures concerning stocking density in pigs and broilers and the weaning in piglets, and the scientific evidence around these elements.

The fourth and fifth chapters introduce the content around the AMR guidelines and legal measures in animal husbandry. Chapter four called "International AMR Governance" starts firstly with the illustration of the different possibilities of legal instruments for the governance of AMR.



Secondly, the different intergovernmental actors and their non-binding legal mechanisms and measures governing AMR are analysed. Chapter five called "EU law and policy related to farm antimicrobial use" starts with the role of the EU in contributing to the fight against AMR. The most relevant and recent policies are analysed together with the two recently established Regulations on veterinary medicinal products and medicated feed.

Finally, chapters six and seven will be the ending chapters of this master thesis. In chapter six on "Discussion", the considerations derived from the overall analysis, in the context of the thesis questions and the literature review, will be explained and interpreted and the possible implications will be discussed. The final argumentation will support the conclusion in chapter seven.

## 2. Animal welfare

Good animal welfare that reduces stress and brings along positive physical and psychological states has been linked to reducing animals' susceptibility to disease.<sup>29</sup> As a consequence, it has become an important subject of study over the last years in preventative medicine, due to its potential to preserve animals' health and reduce the use of antimicrobials.<sup>30</sup> The present chapter will answer to sub-question 1 by analysing, firstly, the link between farm animal welfare, disease and the use of antimicrobials on farms. Secondly, it will analyse the current international standards from the OIE on stocking density rules in poultry and pigs and the weaning in piglets.

### 2.1 Farm animal welfare, health and disease

In the study of farm animal welfare and its relationship with factors such as health and disease, it is first important to first characterise what exactly constitutes animal welfare. As a first observation, it is important to note the concept of animal welfare is not static. Instead, animal welfare is influenced by different dimensions such as science, ethics, economy, culture, society, religion or politics that make the subject of animal welfare complex and multi-faceted.<sup>31</sup> For this reason, the definition of animal welfare can present different interpretations within different cultures and people, and it evolves over the years.<sup>32</sup> The OIE, the inter-governmental organisation in charge of

---

<sup>29</sup> Karin Hoelzer and others "Antimicrobial drug use in food-producing animals and associated human health risks: what, and how strong, is the evidence?" (2017) 13 BMC Veterinary Research, 211; Karen L Tang and others "Restricting the use of antibiotics in food-producing animals and its associations with antibiotic resistance in food-producing animals and human beings: a systematic review and meta-analysis" (2017) 1 Lancet Planetary Health; Anna Mae Scott "Is antimicrobial administration to food animals a direct threat to human health? A rapid systematic review" (2018) 52 International Journal of Antimicrobial Agents, 316.

<sup>30</sup> Sandra Döpjan and Marian Stamp Dawkins "Animal Welfare and Resistance to Disease: Interaction of Affective States and the Immune System" (2022) 9 Frontiers in Veterinary Science.

<sup>31</sup> OIE "Animal Welfare" <<https://www.woah.org/en/what-we-do/animal-health-and-welfare/animal-welfare/>> accessed 24 March 2023.

<sup>32</sup> Caroline J Hewson "What is animal welfare? Common definitions and their practical consequences" (2003) 44 Canadian Veterinary Journal, 496.

improving animal health worldwide,<sup>33</sup> describes animal welfare as “the physical and mental state of an animal in relation to the conditions in which it lives and dies”.<sup>34</sup> Similarly, the American Veterinary Medical Association refers to animal welfare as “how an animal is coping with the conditions in which it lives”.<sup>35</sup> At a broader level, achieving a good state of animal welfare is generally understood to imply fulfilling the so-called “Five Freedoms”, which are internationally accepted standards developed in 1965 by the UK Farm Animal Welfare Council.<sup>36</sup> These widely recognised standards entail: (1) freedom from hunger and thirst; (2) freedom from discomfort; (3) freedom from pain, injury and disease; (4) freedom to express normal behaviour and (5) freedom from fear and distress.<sup>37</sup> In order to commit to these welfare standards, animals should be provided with disease prevention and veterinary treatment, management, shelter, nutrition and humane handling.<sup>38</sup> Yet, these standards tend to be applied differently depending on the utilitarian category in which animals are placed.<sup>39</sup> Taking as an example a rat, it can be perceived, for example, as a pest, as a pet or as a laboratory animal, depending on the utility value conferred to the animal.<sup>40</sup> The animal

---

<sup>33</sup> OECD “World Organisation for Animal Health (OIE), in International Regulatory Co-operation: The Role of International Organisations in Fostering Better Rules of Globalisation” (OECD publishing 2016) <[https://www.oecd-ilibrary.org/governance/international-regulatory-co-operation/world-organisation-for-animal-health-oie\\_9789264244047-41-en](https://www.oecd-ilibrary.org/governance/international-regulatory-co-operation/world-organisation-for-animal-health-oie_9789264244047-41-en)> accessed 29 December 2022.

<sup>34</sup> OIE “Terrestrial Animal Health Code” (2022) (OIE Terrestrial Code).

<sup>35</sup> American Veterinary Medical Association “Animal welfare: What is it?” <<https://www.avma.org/resources/animal-health-welfare/animal-welfare-what-it>> accessed 10 January 2023.

<sup>36</sup> Animal Human Society “The Five Freedoms for animals” <<https://www.animalhumanesociety.org/health/five-freedomsanimals#:~:text=The%20Five%20Freedoms%20are%20internationally,for%20companion%20animals%20in%20shelters>> accessed 10 January 2023; OIE “Animal Welfare” <<https://www.woah.org/en/what-we-do/animal-health-and-welfare/animal-welfare>> accessed 13 January 2023.

<sup>37</sup> A J F Webster “Farm animal welfare: The five freedoms and the free market” (2001) 161 *The Veterinary Journal*, 229.

<sup>38</sup> American Veterinary Medical Association “Animal welfare: What is it?” <<https://www.avma.org/resources/animal-health-welfare/animal-welfare-what-it>> accessed 10 January 2023.

<sup>39</sup> Sara Wolfensohn and P Honess “Laboratory animal, pet animal, farm animal, wild animal: Which gets the best deal?” (2007) 16 *Animal Welfare* 117; Utilitarian category refers to those first used in law and can be, for example, laboratory animals, pet animals, farm animals or wild animals. See Auffret van der Kemp T “To which animals does animal welfare apply in law and why?” in S Hild and L Schweitzer (eds) *Animal Welfare: From Science to Law*, (2019) pp.47-56.

<sup>40</sup> Michelle Sinclair and others “International perceptions of animals and the importance of their welfare” (2022) *Frontiers Animal Science*.

will be consequently exposed to different considerations and levels of legislative protection.<sup>41</sup> Regarding farm animals, where husbandry conditions and management practices generally shape their animal welfare, their primary value is however, dominated by their capability to bring forth economic revenue.<sup>42</sup> As a result, improving husbandry conditions and management practices to implement higher welfare standards translates beyond a point, into a decrease in productivity and an increase in economic costs. Farm animal welfare is therefore contingent upon productivity.<sup>43</sup>

As has been explained before, the perception of animal welfare has varied over the years. A relevant example of this happened during the second half of the 20<sup>th</sup> century, when global livestock production levels increased considerably.<sup>44</sup> The increase in production was achieved in developed countries, by moving from extensive systems to more intensive or “confinement” systems, especially in the sectors of pigs, eggs and poultry.<sup>45</sup> The shift was further accomplished by reducing the number of farms and concentrating the production on fewer farms.<sup>46</sup> Together with these changes in animal production, western nations also experienced cultural changes which led ultimately, to a rise of concern in the society over the welfare of farm animals under confinement production systems.<sup>47</sup> Over the years, the global leader in the development of animal welfare policies and the implementation of the highest standards has been the EU (in the next chapter its legislation and policies on animal welfare will be analysed).<sup>48</sup>

---

<sup>41</sup> *ibid.*

<sup>42</sup> John McInerney “Animal welfare, economics and policy” (2004) 165.

<sup>43</sup> *ibid.*

<sup>44</sup> David Fraser “Toward a global perspective on farm animal welfare” (2008) 113, *Applied Animal Behaviour Science*, 330.

<sup>45</sup> David Fraser, Joy Mench and Suzanne Millman “Farm animals and their welfare in 2000” in Deborah J Salem and Andrew N Rowan (eds) *The state of the animals*, 87 (Humane Society Press, 2001).

<sup>46</sup> David Fraser “Toward a global perspective on farm animal welfare” (2008) 113, *Applied Animal Behaviour Science*, 330.

<sup>47</sup> David Fraser “Animal Welfare and the Intensification of Animal Production: An Alternative Interpretation” (2005) Food and Agriculture Organization of the United Nations (FAO).

<sup>48</sup> Paolo Dalla Villa and others “Drivers for animal welfare policies in Europe” (2014) 33, *Revue Scientifique et Technique* (International Office of Epizootics) 39; European Court of Auditors “Animal welfare in the EU: closing the gap between ambitious goals and practical implementation” (2018) Special report No 31, Publications office of the European Union.

The importance given to animal welfare has also moved to be progressively perceived as an integral element of food safety.<sup>49</sup> This is due to the important close relationship of animal welfare with animal health and food-borne diseases.<sup>50</sup> This relation can be viewed as complementary. Animals that present a disease will see their welfare being decremented because of the appearance of physical symptoms, e.g., fever or inflammation, that will cause them pain, and the occurrence of psychological effects, e.g., phobia or anxiety, that will cause them distress.<sup>51</sup> Likewise, psychological stress situations caused by impaired welfare, have the potential to produce an immune system depression, undermining the physical health of the animal and hence, producing the appearance of disease.<sup>52</sup> Ultimately, the occurrence of illness due to deficient welfare, can lead to a rise of transmissible diseases among herds, and has the potential to increase the risk of foodborne infection in the final consumer.<sup>53</sup> Consequently, the need for preserving food safety and food quality could motivate the implementation of higher animal welfare standards.<sup>54</sup>

The likelihood that the welfare of livestock animals becomes affected depends on different factors. Animal husbandry practices such as stocking density, biosecurity measures or farm hygiene can contribute to increased stress when these are not implemented correctly.<sup>55</sup> Management practices

---

<sup>49</sup> Rex Horgan and Andrea Gavinelli "The expanding role of animal welfare within EU legislation and beyond" (2006) 103, *Livestock Science*, 303; EFSA "Animal Welfare" <<https://www.efsa.europa.eu/en/topics/topic/animal-welfare>> accessed 10 January 2023.

<sup>50</sup> *ibid.*

<sup>51</sup> Farm Animal Welfare Committee "Farm animal welfare: health and disease" (2012) <[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/324616/FAWC\\_report\\_on\\_farm\\_animal\\_welfare\\_-\\_health\\_and\\_disease.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/324616/FAWC_report_on_farm_animal_welfare_-_health_and_disease.pdf)> accessed 10 January 2023.

<sup>52</sup> Donald M Broom "Behaviour and welfare in relation to pathology" (2006) 97, *Applied Animal Behaviour Science*, 73; Donald M Broom and Andrew F Fraser "Domestic animal behaviour and welfare" (2015) in Donald M Broom and Andrew F Fraser (eds) *Welfare and behaviour in relation to disease*, 237.

<sup>53</sup> European Food Safety Authority (EFSA) "Animal Welfare" <<https://www.efsa.europa.eu/en/topics/topic/animal-welfare>> accessed 10 January 2023 (EFSA)

<sup>54</sup> Rex Horgan and Andrea Gavinelli "The expanding role of animal welfare within EU legislation and beyond" (2006) 103, *Livestock Science*, 303

<sup>55</sup> European Medicines Agency (EMA) and European Food Safety Authority (EFSA) "EMA and EFSA Joint Scientific Opinion on measures to reduce the need to use

such as weaning, castration or dehorning are also stress factors that promote immunosuppression.<sup>56</sup> As mentioned above, these types of situations can turn into a disease outbreak among a group of animals, compromising animal health and ultimately, public health. Important to note is that, when clinical signs related to a microbiological infection are presented on a farm, the most common approach to prevent a further impact on the general health and welfare of the farm is to apply a curative antimicrobial treatment.<sup>57</sup> This is because curative treatments based on antimicrobials are an easy-to-use disease control tool, tend to present relatively low cost, and under standardized conditions, they can guarantee effectiveness.<sup>58</sup>

## 2.2 Antimicrobial use and its relationship with farm animal welfare

In the livestock industry, antimicrobials are widely used. To address illnesses, they are applied following three main purposes.<sup>59</sup> According to Hughes, Hermans and Morgan, antimicrobials may be administered for therapeutic purposes, which entails treating clinically diseased animals. They may be administered with metaphylactic purposes, which implies their application to healthy animals within the same flock in which ill animals have been identified. Lastly, they may be administered for prevention purposes (“prophylaxis”) which implies the application of antimicrobials to completely healthy animals when the risk of becoming ill is pondered to be high.<sup>60</sup> In addition to these strategies, antimicrobials, and in particular antibiotics, may be applied for non-therapeutic purposes with the aim to enhance animal’s growth promotion. This practice has been performed for already six decades

---

antimicrobial agents in animal husbandry in the European Union, and the resulting impacts on food safety (RONAFA)” (2017) 15 EFSA Journal 2017 (EMA and EFSA).

<sup>56</sup> *ibid.*

<sup>57</sup> *ibid.*

<sup>58</sup> Guillaume Lhermie, Yrjö T Gröhn and Didier Raboisson “Addressing Antimicrobial Resistance: An Overview of Priority Actions to Prevent Suboptimal Antimicrobial Use in Food-Animal Production” (2017) 7 *Frontiers in Microbiology*.

<sup>59</sup> Laura Hughes, Patrick Hermans and Kenton Morgan “Risk factors for the use of prescription antibiotics on UK broiler farms” (2008) 61 *Journal of Antimicrobial Chemotherapy*, 947.

<sup>60</sup> *ibid.*

and entails the incorporation of antimicrobials as feed additives with the aim to improve feed efficiency.<sup>61</sup> However, this non-therapeutic use has been studied to contribute highly to the emergence of AMR, threatening food safety and public health.<sup>62</sup> For this reason, in 2006, the EU established a wide ban on the use of antibiotics as growth promoters in animal feed.<sup>63</sup> Despite this ban, between 2006 and 2007 the number of antimicrobial sales kept the upward trend of that moment, signalling that EU farmers were increasing instead the administration of antimicrobials under veterinary prescription for prevention purposes.<sup>64</sup> Moreover, outside the EU, antimicrobials are still currently used as growth promoters.<sup>65</sup> The 2022 OIE'S "Annual Report on Antimicrobials Agents Intended for Use in Animals" showed that, in 2020, 40 countries out of 157 surveyed were still using antimicrobials as growth promoters.<sup>66</sup> In addition, 6 countries reported using Colistine, an antibiotic classified as "Highest Priority Critically Important" for use in humans, as a growth promoter.<sup>67</sup>

The demand for antimicrobial use in livestock production is expected to rise largely worldwide in the upcoming years, also motivated by the rise in global demand of protein for human consumption.<sup>68</sup> Although AMR occurs naturally, the overuse and misuse of antimicrobials over the years in intensive farms, for both therapeutic and non-therapeutic purposes, have contributed

---

<sup>61</sup> Renqiao Wen and others "Withdrawal of antibiotic growth promoters in China and its impact on the foodborne pathogen *Campylobacter coli* of swine origin" (2022) 13 *Frontiers in Microbiology*.

<sup>62</sup> *ibid.*

<sup>63</sup> Commission "Ban on antibiotics as growth promoters in animal feed enters into effect" IP/05/1687 <[https://ec.europa.eu/commission/presscorner/detail/en/IP\\_05\\_1687](https://ec.europa.eu/commission/presscorner/detail/en/IP_05_1687)> accessed 10 January 2023.

<sup>64</sup> Dik Mevius and Dick Heederik "Reduction of antibiotic use in animals 'let's go Dutch'" (2013) 9 *Journal of Consumer Protection and Food Safety*, 117.

<sup>65</sup> Cólín Nunan "Achieving responsible farm antibiotic use through improving animal health and welfare in pig and poultry production. Ending routine farm antibiotic use in Europe" (2022) <<https://epha.org/wp-content/uploads/2022/02/report-ending-routine-farm-antibiotic-use-in-europe-final-2022.pdf>> accessed 10 January 2023.

<sup>66</sup> OIE "Annual Report on Antimicrobial Agents Intended for Use in Animals, 6<sup>th</sup> edition" (2022).

<sup>67</sup> *ibid.*

<sup>68</sup> Thomas P Van Boeckel and others "Global trends in antimicrobial use in food animals" (2015) 112, *Proceedings of the National Academy of Sciences*, 5649.

to the development of antimicrobial resistance.<sup>69</sup> Despite the estimated prospective trends, there is a need to change production practices to reduce antimicrobial use,<sup>70</sup> since a relationship between a reduction in antimicrobial use in farm animals and a decrease in AMR does exist.<sup>71</sup> One of the approaches to address the problem of AMR that has received particular attention is the so-called “antimicrobial stewardship”. This implies striving for judicious use of antimicrobials where they are employed only when necessary and appropriate.<sup>72</sup> According to a joint scientific opinion from the European Medicines Agency (EMA) and the EFSA, on measures to reduce the need to use antimicrobial agents in animal husbandry in the EU, some of the stewardship strategies aimed at reducing antimicrobials usage on-farm could entail: stopping the routine use of antimicrobials for disease prevention, except for justified cases that will require a veterinary prescription; reducing and refining the use of antimicrobials for metaphylactic practices; reserving antimicrobials categorised as “highest priority critically important” for human medicine to be used in livestock only as a last resort and when dully justified; and administering antimicrobials to farm animals only when they are prescribed by a veterinarian.<sup>73</sup>

---

<sup>69</sup> A E van den Bogaard and E E Stobberingh “Antibiotic usage in animals: impact on bacterial resistance and public health” (1999) 58 *Drugs*, 589; Vanmathy Kasimanickam, Maadhanki Kasimanickam and Ramanathan Kasimanickam “Antibiotics Use in Food Animal Production: Escalation of Antimicrobial Resistance: Where Are We Now in Combating AMR?” (2021) 9 *Medical Sciences*, 14.

<sup>70</sup> FAO “Antimicrobial resistance, what is it?” <<https://www.fao.org/antimicrobial-resistance/background/what-is-it/en/>> accessed 12 January 2023.

<sup>71</sup> Karin Hoelzer and others “Antimicrobial drug use in food-producing animals and associated human health risks: what, and how strong, is the evidence?” (2017) 13 *BMC Veterinary Research*, 211; Karen L Tang and others “Restricting the use of antibiotics in food-producing animals and its associations with antibiotic resistance in food-producing animals and human beings: a systematic review and meta-analysis” (2017) 1 *Lancet Planetary Health*; Anna Mae Scott “Is antimicrobial administration to food animals a direct threat to human health? A rapid systematic review” (2018) 52 *International Journal of Antimicrobial Agents*, 316.

<sup>72</sup> Sameer J Patel and others “Antibiotic stewardship in food-producing animals: challenges, progress, and opportunities” (2020) 42 *Clinical Therapeutics*, 1649.

<sup>73</sup> EMA and EFSA “EMA and EFSA Joint Scientific Opinion on measures to reduce the need to use antimicrobial agents in animal husbandry in the European Union, and the resulting impacts on food safety (RONAFA)” (2017) 15 *EFSA Journal* 2017.



Given the complexity and multifactorial nature of AMR, an integrative approach is needed.<sup>74</sup> The presented initiatives and measures on the prudent use of antimicrobials must be implemented together with improved husbandry and management procedures that contribute to preventing diseases in farms and consequently, avoid at first instance, the application of antimicrobials.<sup>75</sup> As was explained above, animal welfare plays a role in the occurrence of disease in a herd. Animals whose welfare is decremented, because of the husbandry and management conditions provided, have the potential to develop a disease due to stress-triggered immune suppression. Such animals will eventually require curative and preventive treatment with antimicrobials to address or avoid the infection.

### 2.3 Stocking density and international welfare standards

Poultry and swine production are two live-stock sectors that are predominantly characterised by intensive rearing conditions, especially in high-income countries.<sup>76</sup> Stocking density has been studied to be one of the key factors in these two sectors that affect animal welfare and health, due to the association between poor hygiene, increased levels of stress and facilitation of disease transmission among animals.<sup>77</sup> In addition, high stocking density levels enable the rise of harmful gases, such as ammonia which increases the possibility to develop intestinal and respiratory infections.<sup>78</sup> Consequently, antimicrobials will be applied to maintain the

---

<sup>74</sup> WHO "Global Action Plan on Antimicrobial Resistance" (2015) World Health Organization.

<sup>75</sup> *ibid.*

<sup>76</sup> Marius Gilbert and others "Income Disparities and the Global Distribution of Intensively Farmed Chicken and Pigs" (2015) 10 Plos One.

<sup>77</sup> C oil n Nunan "Achieving responsible farm antibiotic use through improving animal health and welfare in pig and poultry production. Ending routine farm antibiotic use in Europe" (2022) <<https://epha.org/wp-content/uploads/2022/02/report-ending-routine-farm-antibiotic-use-in-europe-final-2022.pdf>> accessed 10 January 2023.

<sup>78</sup> Tahseen Aziz and John Barnes "Harmful effects of ammonia on birds, Poultry World" (2010) <<http://www.poultryworld.net/Breeders/Health/2010/10/Harmful-effectsof-ammonia-on-birds-WP008071W/>> accessed 21 January 2023; EMA and EFSA "EMA and EFSA Joint Scientific Opinion on measures to reduce the need to use antimicrobial agents in animal husbandry in the European Union, and the resulting impacts on food safety (RONAFA)" (2017) 15 EFSA Journal 2017; Xue Li and others "Effects of stocking density on growth performance, blood parameters and immunity of growing pigs" (2020) 6 Animal Nutrition, 529.

animal's health within the farm.<sup>79</sup> In fact, a report by EMA and EFSA issued in 2017 describes the association between higher stocking densities and higher preventive use of antimicrobials due to the expectation of presenting an increase in disease occurrence.<sup>80</sup>

Stocking density for animal farms can be defined as "the number of animals that are kept on a given unit of area".<sup>81</sup> It can be expressed in terms of kilograms of body weight per meter square and varies greatly between regions, countries, and management conditions.<sup>82</sup> As previously mentioned, stocking density has a strong link with animal health and welfare. In fact, stocking density is perceived by consumers as one of the major factors undermining animal welfare.<sup>83</sup> Moreover, stocking density is also interlinked with production performance, efficiency, and producer's profit.<sup>84</sup>

Improving the balance between animal welfare, health and productivity in farms has become one of the objectives for some countries and regions in order to develop better welfare-friendly production systems. Different legislations and policies on animal welfare have been implemented at the commercial farming level to support these changes.<sup>85</sup> At the international level, there exists the OIE's intergovernmental standards which address the field of animal welfare. These OIE standards are science-based and adopted by consensus by all 108 OIE member countries.<sup>86</sup> They are collected within

---

<sup>79</sup> Jacopo Tarakdjian and others "Antimicrobial Use in Broilers Reared at Different Stocking Densities: A Retrospective Study" (2020) 10 *Animals*.

<sup>80</sup> European Medicines Agency (EMA) and European Food Safety Authority (EFSA) "EMA and EFSA "Joint Scientific Opinion on measures to reduce the need to use antimicrobial agents in animal husbandry in the European Union, and the resulting impacts on food safety (RONAFA)" (2017) 15 *EFSA Journal* 2017.

<sup>81</sup> Annette C Longland "Pastures and pasture management" (2013) *Equine Applied and Clinical Nutrition*, 332.

<sup>82</sup> Sandro Cerrate "Stocking Density and Farm Profitability in Broiler Chickens" (2021) <<https://en.engormix.com/poultry-industry/articles/stocking-density-farm-profitability-t48377.htm>> accessed 27 February 2023.

<sup>83</sup> V Tsiouris and others "High stocking density as a predisposing factor for necrotic enteritis in broiler chicks" (2015) 44 *Avian Pathology*, 59.

<sup>84</sup> Yongzhen Li and others "Space allowance determination by considering its coeffect with toy provision on production performance, behavior and physiology for grouped growing pigs" (2021) *Livestock Science*.

<sup>85</sup> *ibid.*

<sup>86</sup> OIE "Fact sheet - Animal Welfare" (2015) <[https://www.woah.org/fileadmin/Home/eng/Media\\_Center/docs/pdf/Fact\\_sheets/AW\\_EN.pdf](https://www.woah.org/fileadmin/Home/eng/Media_Center/docs/pdf/Fact_sheets/AW_EN.pdf)> accessed 37 February 2023.

the Terrestrial and Aquatic Codes, and they can entail general principles or specific issues in areas such as animal welfare.<sup>87</sup>

Within chapter 7 of the Terrestrial Code, different animal welfare standards can be found. Stocking density standards for poultry are enclosed in section 10 called "Animal welfare and broiler chicken production systems", of the same chapter. In it, the standards provided around stocking density are within article 7.10.4. called "Recommendations", it is stated that "broilers should be housed at a stocking density that allows them to access feed and water and to move and adjust their posture normally".<sup>88</sup> Different factors such as management capabilities, the housing system or the production system are stated to be considered when determining stocking density. In addition, different outcome-based measurables are included to help determining inadequate stocking density ratio and in which the incidence of diseases is one of the parameters to be considered.<sup>89</sup> No reference to a recommended value of maximum stocking density is stated.

Concerning stocking density standards for pigs, these can be found in section 13 on "Animal welfare and pig production systems" of chapter 7. These standards are also in the "Recommendations" section and are under article 7.13.13, where stocking density is paraphrased as "space allowance". In it, it is stated that "Stocking density should not adversely affect normal behaviour of pigs and duration of time spent lying".<sup>90</sup> It is further stated that "Insufficient and inadequate space allowance may increase stress, the occurrence of injuries and have an adverse effect on the growth rate, feed efficiency, reproduction and behaviour such as locomotion, resting, feeding and drinking, agonistic and abnormal behaviour".<sup>91</sup> Injuries, morbidity rates or mortality are some of the factors considered within groups of animals as animal-based criteria to determine insufficient space allowance. As with poultry standards, no reference is made in relation to maximum stocking density/space allowance value.

---

<sup>87</sup> *ibid.*

<sup>88</sup> OIE Terrestrial Code, art 7. 13.13.

<sup>89</sup> *ibid.*

<sup>90</sup> *ibid.*

<sup>91</sup> *ibid.*

## 2.4 Weaning and international welfare standards

Weaning is a management practice regularly performed in mammal farm animals, which particularly presents high consumption rates of antibiotics in swine production.<sup>92</sup> This stage is where piglets are separated from their sow, are mixed with other piglets, and are switched from sow's milk to a plant-based diet.<sup>93</sup> When this practice is performed at early stages, which is the most common approach to increase productivity, it results in the occurrence of diarrhoea in these animals due to stress and dietary change.<sup>94</sup> The prospect of regular occurrence of diarrhoea, every time this activity is performed, leads farms, in most cases, to apply antimicrobials systematically as a preventive measure.<sup>95</sup> Contrary, farming systems that have in place late weaning management have shown lower levels of antibiotic use during this phase.<sup>96</sup>

Weaning of piglets is also included within the animal welfare standards of the Terrestrial Code. As with stocking density, it can be found in the section of recommendations. Under Article 7.13.20 it is recognised that "Weaning is a stressful time for sows and piglets and good management is required".<sup>97</sup> Moreover, it is stated that piglets should "be weaned at three weeks or older, unless otherwise recommended by a veterinarian for disease control purposes".<sup>98</sup> In addition, it is added that "Delaying weaning to the age of four

---

<sup>92</sup> C il n Nunan "Achieving responsible farm antibiotic use through improving animal health and welfare in pig and poultry production. Ending routine farm antibiotic use in Europe" (2022) <<https://epha.org/wp-content/uploads/2022/02/report-ending-routine-farm-antibiotic-use-in-europe-final-2022.pdf>> accessed 10 January 2023; EMA and EFSA "EMA and EFSA Joint Scientific Opinion on measures to reduce the need to use antimicrobial agents in animal husbandry in the European Union, and the resulting impacts on food safety (RONAFA)" (2017) 15 EFSA Journal 2017.

<sup>93</sup> Devin B. Holman and others "Weaning age and its effect on the development of the swine gut microbiome and resistome" (2021) 6 Applied and Industrial Microbiology.

<sup>94</sup> C il n Nunan "Achieving responsible farm antibiotic use through improving animal health and welfare in pig and poultry production. Ending routine farm antibiotic use in Europe" (2022) <<https://epha.org/wp-content/uploads/2022/02/report-ending-routine-farm-antibiotic-use-in-europe-final-2022.pdf>> accessed 10 January 2023.

<sup>95</sup> EMA and EFSA "EMA and EFSA Joint Scientific Opinion on measures to reduce the need to use antimicrobial agents in animal husbandry in the European Union, and the resulting impacts on food safety (RONAFA)" (2017) 15 EFSA Journal 2017.

<sup>96</sup> AMCRA "Antimicrobial Consumption and Resistance in Animals (Belgium), L'importance de l' ge du sevrage Un jour de plus,  a compte?" <<https://www.amcra.be/fr/nouvelles/het-belang-van-speenleeftijd-mag-het-eeen-dagje-meer-zijn/lid=14308>> accessed 20 February 2023.

<sup>97</sup> OIE Terrestrial Code, art 7. 13.20

<sup>98</sup> *ibid.*

weeks or more may produce benefits such as improved gut immunity, less diarrhoea and less use of antimicrobial agents”.<sup>99</sup>

As stated by the EMA and the EFSA, in order to reduce the need for antibiotics in livestock farming, “husbandry factors should be aimed at minimising stress levels”.<sup>100</sup> Many farms are believed to apply antimicrobials to counteract for poor husbandry farm conditions.<sup>101</sup> For this reason, the successful implementation of measures aimed at a prudent use of antimicrobials calls for proper welfare, achieved by good husbandry and management conditions which do not contribute making animals sick.

## 2.5 Interim conclusion

As discussed in this chapter, although the improvement of farm animal welfare is contingent upon productivity and economic costs, much attention has been given over the last few years to improve it. This will for improvement is due to a raise in awareness from society and the concerns over the close relation of animal welfare with animal health and food-borne diseases. Impaired animal welfare can result in the occurrence of disease among a herd that will often be managed by applying broad antimicrobial treatments. However, the global rise in AMR calls for a change in production practices that reduces antimicrobial use. Antimicrobial stewardship strategies together with improved husbandry and management procedures have been studied to be some of the best approaches to address AMR on farms. At the international level, the OIE has established intergovernmental standards around different animal welfare areas such as stocking density or the weaning of piglets, to provide guidance and a common application for its member countries. Concerning the recommendation on stocking density for broilers and pigs, no recommended ratio values are given. In relation to the weaning of piglets, the OIE recommends weaning at 28 days or older.

---

<sup>99</sup> *ibid.*

<sup>100</sup> EMA and EFSA “EMA and EFSA Joint Scientific Opinion on measures to reduce the need to use antimicrobial agents in animal husbandry in the European Union, and the resulting impacts on food safety (RONAFA)” (2017) 15 EFSA Journal 2017.

<sup>101</sup> Cólín Nunan “Achieving responsible farm antibiotic use through improving animal health and welfare in pig and poultry production. Ending routine farm antibiotic use in Europe” (2022) <<https://epha.org/wp-content/uploads/2022/02/report-ending-routine-farm-antibiotic-use-in-europe-final-2022.pdf>> accessed 10 January 2023

To complement the examination of farm animal welfare governance, the next chapter will zoom in on the regulation of animal welfare within the EU, with a focus in animal husbandry. It will start with a general review of the EU's animal welfare legislation and policies, to then analyse the legislation of stocking density of pigs and poultry and the legislation of weaning in piglets.

### 3. EU regulation of farm animal welfare

One of the key goals of the EU has been to improve the balance between animal welfare, health and productivity in farms in order to develop better welfare-friendly production systems.<sup>102</sup> For the last forty years, the EU has gradually developed different pieces of legislation, such as directives and regulations, and accompanying policies to support these changes on farm animal welfare.<sup>103</sup>

This chapter will focus on the analysis of the regulation of animal welfare within the EU, with a focus on animal husbandry. Firstly, an introduction and historical review of the most relevant EU actions over the last years on farm animal welfare will be exposed. The second part of this chapter will study the rules on stocking density in the EU for broilers and pigs. Within this second part, firstly it will be illustrated generally the relevance of these two agricultural sectors for the EU and the relation between stocking density and the use of antimicrobials. Secondly, the specific rules for stocking density for broilers and pigs will be analysed and the current scientific evidence on these matters will be exposed. The third and last part of the chapter will be the analysis of the EU rules on the weaning of piglets. As with the previous part, firstly an analysis of the specific rules will be provided to then compare it with the current scientific evidence on this subject.

#### 3.1 History of animal welfare legislation and policies in the EU

Over the last years, awareness of the general public about animal welfare has been of the main drivers that has motivated the EU to advocate on animal welfare legislation, as highlighted in the existing scholarly literature.<sup>104</sup> The first time that the need for reducing animal suffering was recognized in a legal instrument was in 1974 with Directive 74/577/EEC on the stunning of

---

<sup>102</sup> Yongzhen Li and others "Space allowance determination by considering its coeffect with toy provision on production performance, behavior and physiology for grouped growing pigs" (2021) *Livestock Science*.

<sup>103</sup> *ibid*; Denis Simonin and Andrea Gavinelli "The European Union legislation on animal welfare: state of play, enforcement and future activities" (2019) in S Hild and L Schweitzer (eds), *Animal Welfare: From Science to Law*, 59.

<sup>104</sup> Paul T M Ingenbleek "EU animal welfare policy: Developing a comprehensive policy framework" (2012) 37 *Food Policy*, 690.

animals before slaughter.<sup>105</sup> Since then, societal attention on the welfare of animals has continued to increase over the years. This has been influenced by factors such as the activism of animal interest groups and by the concerns on food safety and human health posed by the emergence of agriculture crises such as the Bovine Spongiform Encephalopathy disease during the second half of the 1980s.<sup>106</sup> These different calls and events constituted drivers that pushed European policymakers to respond with different initiatives.<sup>107</sup>

A landmark in the EU's animal welfare policy came in 1997 with the Treaty of Amsterdam,<sup>108</sup> which included by means of an annex, the "Protocol on Protection and Welfare of Animals".<sup>109</sup> This established the obligation for the EU and the Member States to recognise animals as sentient beings, and to consider their welfare requirements when formulating and implementing policies on agriculture, transport, internal market, and research.<sup>110</sup> In 2009, the Treaty of Lisbon, which amended the Treaty on European Union and the Treaty establishing the European Community (nowadays renamed "Treaty on the Functioning of the European Union"), reconfirmed the legal recognition of

---

<sup>105</sup> Council Directive 74/577/EEC of 18 November 1974 on stunning of animals before slaughter (1974) OJ L 316; Yari Vecchio, Gregorio Pauselli, and Felice Adinolfi "Exploring Attitudes toward Animal Welfare through the Lens of Subjectivity—An Application of Q-Methodology" (2020) 10 *Animals*, 1364.

<sup>106</sup> Paul T M Ingenbleek "EU animal welfare policy: Developing a comprehensive policy framework" (2012) 37 *Food Policy*, 690; Felice Adinolfi, Jorgelina Di Pasquale, and Fabian Capitanio "Economic Issues on Food Safety" (2016) 5 *Italian Journal of Food Science*.

<sup>107</sup> Rex Horgan and Andrea Gavinelli "The expanding role of animal welfare within EU legislation and beyond" (2013) 103, *Livestock Science*, 303.

<sup>108</sup> Treaty of Amsterdam amending the Treaty on European Union, the Treaties establishing the European Communities and certain related acts, (1997) *OJ C 340*.

<sup>109</sup> Paul T M Ingenbleek "EU animal welfare policy: Developing a comprehensive policy framework" (2012) 37 *Food Policy*, 690; Yari Vecchio, Gregorio Pauselli, and Felice Adinolfi "Exploring Attitudes toward Animal Welfare through the Lens of Subjectivity—An Application of Q-Methodology" (2020) 10 *Animals*, 1364.

<sup>110</sup> As stated in the Treaty of Amsterdam "Desiring to ensure improved protection and respect for the welfare of animals as sentient beings" and "In formulating and implementing the Community's agriculture, transport, internal market and research policies, the Community and the Member States shall pay full regard to the welfare requirements of animals, while respecting the legislative or administrative provisions and customs of the Member States relating in particular to religious rites, cultural traditions and regional heritage", see Treaty of Amsterdam amending the Treaty on European Union, the Treaties establishing the European Communities and certain related acts, (1997) *OJ C 340*.



animals as sentient beings.<sup>111</sup> It is worth mentioning that, as a result of this strengthening of animal welfare, we have seen animal welfare being integrated into different EU legal texts of the Common Agriculture Policy (CAP).<sup>112</sup>

Some other notable initiatives aimed at improving the minimum standards for the protection of farmed animals via legislative acts came also between the second half of the 1990s and the second half of the 2000s. During this time, different EU directives and regulations were introduced to legislate on the protection of farm animals, in all areas of the production system, from farming itself to transport and slaughtering.<sup>113</sup> Regulation 1/2005 and Regulation 1099/2009, for instance, govern the transport of animals and the slaughtering of all farmed species, respectively.<sup>114</sup> In addition, five directives lay down minimum standards for certain species. One of them is Directive 98/58 concerning the protection of animals kept for farming purposes, which functions as a horizontal directive containing general provisions for all vertebrated farmed species.<sup>115</sup> The other four directives cover separately and, in more detail, calves, pigs, laying hens and broilers. Directive 2008/119/EC lays down minimum standards for the protection of

---

<sup>111</sup> Article 13 of the Treaty of Lisbon states "In formulating and implementing the Union's agriculture, fisheries, transport, internal market, research and technological development and space policies, the Union and the Member States shall, since animals are sentient beings, pay full regard to the welfare requirements of animals, while respecting the legislative or administrative provisions and customs of the Member States relating in particular to religious rites, cultural traditions and regional heritage". See Consolidated version of the Treaty on the Functioning of the European Union (2008) OJ C 326; Paul T M Ingenbleek "EU animal welfare policy: Developing a comprehensive policy framework" (2012) 37 Food Policy, 690; European parliament "Fact Sheets on the European Union-The Treaty of Lisbon" <<https://www.europarl.europa.eu/factsheets/en/sheet/5/the-treaty-of-lisbon>> accessed 6 March 2023.

<sup>112</sup> Denis Simonin and Andrea Gavinelli "The European Union legislation on animal welfare: state of play, enforcement and future activities" (2019) in S. Hild and L. Schweitzer (eds), *Animal Welfare: From Science to Law*, 59.

<sup>113</sup> *ibid.*

<sup>114</sup> Council Regulation (EC) No 1/2005 of 22 December 2004 on the protection of animals during transport and related operations and amending Directives 64/432/EEC and 93/119/EC and Regulation (EC) No 1255/97 (2005) OJ L 3; Council Regulation (EC) No 1099/2009 of 24 September 2009 on the protection of animals at the time of killing (2009) OJ L 303.

<sup>115</sup> The annex of this Directive does not apply to fish, reptiles and amphibians. Council Directive 98/58/EC of 20 July 1998 concerning the protection of animals kept for farming purposes (1998) OJ L 221.

calves,<sup>116</sup> Directive 2008/120/EC lays down minimum standards for the protection of pigs,<sup>117</sup> Directive 1999/74/EC lays down minimum standards for the protection of laying hens,<sup>118</sup> and Directive 2007/43/EC lays down minimum rules for the protection of chickens kept for meat production.<sup>119</sup> Currently, these five directives and two regulations mentioned are in force.

According to an evaluation of the EU policy on animal welfare, commissioned in 2010 by the Directorate General for Health and Consumers, the adoption of these legislative acts already brought improvements in the welfare conditions of those groups of animals addressed by targeted legislation.<sup>120</sup> However, the evaluation revealed that implementation varied throughout the EU, hindering development towards uniform high standards.<sup>121</sup> Clear and specific requirements that could reach all aspects of welfare were pointed out to be necessary.<sup>122</sup> Ultimately, the evaluation showed that there was a call from different animal welfare NGOs and sector bodies, to include specific legislation for those groups that lacked them (such as rabbits, sheep, dairy cows or ducks).<sup>123</sup> Consequently, in 2012, the Commission launched an EU animal welfare strategy which comprehended

---

<sup>116</sup> Council Directive 2008/119/EC of 18 December 2008 laying down minimum standards for the protection of calves (2009) OJ L 10.

<sup>117</sup> Council Directive 2008/120/EC of 18 December 2008 laying down minimum standards for the protection of pigs, (2009) OJ L 47 (Council Directive 2008/120/EC).

<sup>118</sup> Council Directive 1999/74/EC of 19 July 1999 laying down minimum standards for the protection of laying hens (2019) OJ L 203.

<sup>119</sup> Council Directive 2007/43/EC of 28 June 2007 laying down minimum rules for the protection of chickens kept for meat production (2007) OJ L182 (Council Directive 2007/43/EC).

<sup>120</sup> GHK and ADAS UK (Food Policy Evaluation Consortium) "Evaluation of the EU Policy on Animal Welfare and Possible Policy Options for the Future" (2010) <<http://www.vuzv.sk/DBWelfare/vseob/2013/3%20Final%20Report%20%20EUPAW%20Evaluation.pdf>> accessed 9 May 2023; European Parliamentary Research Service "EU animal welfare strategy, 2012-2015: State of play and possible next steps" (2016) PE 589.831.

<sup>121</sup> European Parliamentary Research Service "EU animal welfare strategy, 2012-2015: State of play and possible next steps" (2016) PE 589.831.

<sup>122</sup> *ibid.*

<sup>123</sup> GHK and ADAS UK (Food Policy Evaluation Consortium) "Evaluation of the EU Policy on Animal Welfare and Possible Policy Options for the Future" (2010) <<http://www.vuzv.sk/DBWelfare/vseob/2013/3%20Final%20Report%20%20EUPAW%20Evaluation.pdf>> accessed 9 May 2023; Commission "Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee on the European Union Strategy for the Protection and Welfare of Animals 2012-2015"(2012) COM(2012) 6 final/2.

the period from 2012 to 2015.<sup>124</sup> The goal of this strategy was to build the base for an improvement of welfare standards while guaranteeing their application and enforcement in all Member States. The “Strategy for the Protection and Welfare of Animals” consisted of two parts with different objectives and actions aimed at addressing the existing gaps.<sup>125</sup> One part was aimed at reinforcing actions already in place, and the other was aimed at simplifying the EU animal welfare legal framework.<sup>126</sup> However, in 2019 the Commission launched an evaluation of this strategy which evidenced that most problems and gaps identified before the release of the Strategy, still persisted.<sup>127</sup> Some of the problems that had not yet been resolved were, for example, the introduction of a simplified EU legislative framework on animal welfare, or the uneven level of protection across different animal species.<sup>128</sup>

A year later, in 2020, the Commission adopted the Farm to Fork Strategy (F2F Strategy) in which animal welfare was highlighted as having an important role in the sustainability of food systems.<sup>129</sup> This role coined in contributing to sustainable food systems, comes from the acknowledgement that animal welfare is central to minimising the dependence on the overuse of veterinary medicines, improving animal health and food quality, and contributing to the preservation of biodiversity.<sup>130</sup> In addition, the F2F Strategy points out the role the EU trade policy could take in contributing to

---

<sup>124</sup> European Parliamentary Research Service “EU animal welfare strategy, 2012-2015: State of play and possible next steps” (2016) PE 589.831.

<sup>125</sup> European Parliamentary Research Service “On-farm animal welfare: Implementation of EU law 2022” (2022) PE 698.834.

<sup>126</sup> European Parliamentary Research Service “EU animal welfare strategy, 2012-2015: State of play and possible next steps” (2016) PE 589.831.

<sup>127</sup> International Organization for Animal Protection (OIPA) “The European Commission publishes the evaluation of EU’s strategy for the protection and welfare of animals” (2021) <<https://www.oipa.org/international/evaluation-eu-animal-welfare-strategy/>> accessed 7 March 2023.

<sup>128</sup> Consilium Europa “Evaluation of the EU Animal Welfare Strategy 2012-2015 Information from the European Commission” <<https://www.consilium.europa.eu/media/49315/background-note-evaluation-of-the-eu-animal-welfare-strategy-2012-2015.pdf>> accessed 7 March 2023.

<sup>129</sup> *ibid*; Commission “A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system” (2020) COM/2020/381 final.

<sup>130</sup> Commission “A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system”(2020) COM/2020/381 final; Intergroup on the welfare and conservation of animals “Discussion about the EU Farm to Fork Strategy and the EU Biodiversity Strategy for 2030” <<https://www.animalwelfareintergroup.eu/news/discussion-about-eu-farm-fork-strategy-and-eu-biodiversity-strategy-2030>> accessed 7 March 2023.

animal welfare by enhancing cooperation and obtaining commitments from third countries.<sup>131</sup> In addition, it is recognised in the Strategy the need to improve animal welfare via legislative revision. To commit to this purpose, the Commission intends to revise by the conclusion of 2023, and via a “Fitness check”, several animal welfare legislations. The review intends to align the legislation with the latest scientific evidence, broaden their scope, make them easier to enforce and ultimately, ensure a higher level of animal welfare.<sup>132</sup> The pieces of legislation intended to be revised are the Directive on the protection of animals kept for farming purposes, the four Directives laying down minimum standards for the protection of broilers, laying hens, pigs and calves, and the Regulations on the protection of animals during transport and slaughtering.<sup>133</sup> Lastly, the Commission requested scientific opinions by EFSA on the welfare of several animal species, to be available during 2022 and 2023.<sup>134</sup> The results and recommendations are expected to feed into the revision of the EU animal welfare legislation.<sup>135</sup>

## 3.2 Legislation on Stocking Density

### 3.2.1 Introduction

As was illustrated in the previous chapter on animal welfare, high levels of stocking density are one of the key factors in the poultry and pig sectors that affect animal welfare and health due to its association with poor hygiene,

---

<sup>131</sup> Commission “A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system” (2020) COM/2020/381 final; Alexandra Molitorisová and Ciarán Burke “Farm to fork strategy: Animal welfare, EU trade policy, and public participation” (2022) Applied Economic Perspectives and Policy.

<sup>132</sup> Commission “A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system” (2020) COM/2020/381 final; Christian Juliusson “Animal welfare activities under the Farm to Fork Strategy” (2020) DG SANTE/G5 Animal Health Advisory Committee <[https://food.ec.europa.eu/system/files/2020-11/comm\\_ahac\\_20201029\\_pres-05a.pdf](https://food.ec.europa.eu/system/files/2020-11/comm_ahac_20201029_pres-05a.pdf)> accessed 10 March 2023.

<sup>133</sup> Commission website “Revision of the animal welfare legislation” <[https://food.ec.europa.eu/animals/animal-welfare/evaluations-and-impact-assessment/revision-animal-welfare-legislation\\_en](https://food.ec.europa.eu/animals/animal-welfare/evaluations-and-impact-assessment/revision-animal-welfare-legislation_en)> accessed 7 March 2023.

<sup>134</sup> *ibid*; Food Navigator “EU Farm to Fork Strategy: How far does it go for animal welfare” (2022) <[https://www.foodnavigator.com/Article/2022/03/23/eu-farm-to-fork-strategy-how-far-does-it-go-for-animal-welfareutm\\_source=copyright&utm\\_medium=OnSite&utm\\_campaign=copyright](https://www.foodnavigator.com/Article/2022/03/23/eu-farm-to-fork-strategy-how-far-does-it-go-for-animal-welfareutm_source=copyright&utm_medium=OnSite&utm_campaign=copyright)> accessed 10 March 2023.

<sup>135</sup> Compassion in World Farming “EFSA publishes new report on broiler chicken welfare” (2023) <<https://www.compassioninfoodbusiness.com/our-news/2023/03/efsa-publishes-new-report-on-broiler-chicken-welfare>> accessed 9 March 2023.

increased levels of stress and facilitation of disease transmission between animals.<sup>136</sup> In addition, there is also scientific evidence of a link between higher stocking densities and higher preventive use of antimicrobials.<sup>137</sup>

The poultry and pig sector are very important agricultural sectors within the EU. In 2017, 47 million tonnes of meat were produced in the EU, of which 50% of-total was pig meat and 31% poultry meat.<sup>138</sup> At a global level, these quantities have positioned the EU poultry sector as the world's third-largest meat producer and the EU pig sector as the world second-largest producer of pig meat.<sup>139</sup> In the EU, the farming systems of these two sectors are characterised by the intensive indoor conditions under which animals are raised.<sup>140</sup> In the poultry meat sector, while around 90% accounts for intensive indoor systems, only 5% of broilers are raised in less intensive indoor conditions, up to 5% accounts for free-range production, and about 1% is under organic production.<sup>141</sup> Concerning the pig sector, there exist different rearing methods across Member States, ranging from extensive organic to intensive confinement. While 75 % of pigs are raised in large commercial holdings, only 3 % are reared in backyard farms<sup>142</sup> and less than 1% account for organic pig farming.<sup>143</sup>

---

<sup>136</sup> C oil n Nunan "Achieving responsible farm antibiotic use through improving animal health and welfare in pig and poultry production. Ending routine farm antibiotic use in Europe" (2022) <<https://epha.org/wp-content/uploads/2022/02/report-ending-routine-farm-antibiotic-use-in-europe-final-2022.pdf>> accessed 10 January 2023.

<sup>137</sup> European Medicines Agency (EMA) and European Food Safety Authority (EFSA) "EMA and EFSA Joint Scientific Opinion on measures to reduce the need to use antimicrobial agents in animal husbandry in the European Union, and the resulting impacts on food safety (RONAFA)" (2017) 15 EFSA Journal 2017 (EMA and EFSA).

<sup>138</sup> Directorate-General for Agriculture and Rural Development (Commission), Jean-Louis Peyraud, and Michael MacLeod "Future of EU livestock : How to contribute to a sustainable agricultural sector ? Final report" (2020) Publications Office.

<sup>139</sup> Silvia Bellini "The pig sector in the European Union" in Laura Iacolina and others (eds), *Understanding and combatting African Swine Fever* (Wageningen Academic Publishers 2021); AVEC secretariat "This is European Poultry, High-quality poultry with European guarantee" accessed 10 March 2023.

<sup>140</sup> European Parliamentary Research Service "The EU poultry meat and egg sector Main features, challenges and prospects" (2019) PE 644.195; European Parliamentary Research Service "The EU pig meat sector" (2020) PE 652.044.

<sup>141</sup> European Parliamentary Research Service "The EU poultry meat and egg sector Main features, challenges and prospects" (2019) PE 644.195.

<sup>142</sup> Backyard farm production method entails that pigs are reared outside in a fenced area. See: The Pig Site "Characterising outdoor pig production in Europe" <<https://www.thepigsite.com/articles/characterising-outdoor-pig-production-in-europe>> accessed 12 March 2023.

<sup>143</sup> European Parliamentary Research Service "The EU pig meat sector" (2020) PE 652.044.

Research has shown that intensive indoor confinement results in high biological and economic productivity but also results in disadvantageous conditions for the animals, such as a high-stocking density.<sup>144</sup> Several EU legislative acts govern the poultry meat and pig sectors, covering different and relevant aspects of animal welfare and animal health but also food safety, environmental protection or organic production.<sup>145</sup> Notably, the current EU rules on maximum stocking densities result from the acknowledgments that poor conditions negatively impact animal welfare, increase animal stress, and consequently increase the dissemination of infectious diseases.<sup>146</sup>

In the following section of this chapter, the current EU rules concerning stocking density for broilers and pigs will be analysed, and the recent scientific evidence between animal welfare, high levels of stocking density and the use of antimicrobials will be illustrated

### 3.2.2 Legislation on poultry stocking density

The protection of chickens kept for meat production is covered by Council Directive 2007/43/EC in which rules on animal welfare improvements in holdings, for this group, are included.<sup>147</sup> The scope of this Directive encompasses chickens kept for meat production (broilers) solely reared, or reared together in the same holding with breeding stocks.<sup>148</sup> The scope does not include holdings with less than 500 chickens, holdings with only breeding stocks of chickens, extensive indoor and free-range chickens, and organically

---

<sup>144</sup> Dominiek G D Maes and others "A critical reflection on intensive pork production with an emphasis on animal health and welfare" (2020) 98 Journal Animal Science.

<sup>145</sup> European Parliamentary Research Service "The EU poultry meat and egg sector Main features, challenges and prospects" (2019) PE 644.195; European Parliamentary Research Service "The EU pig meat sector" (2020) PE 652.044.

<sup>146</sup> C il n Nunan "Achieving responsible farm antibiotic use through improving animal health and welfare in pig and poultry production. Ending routine farm antibiotic use in Europe" (2022) <<https://epha.org/wp-content/uploads/2022/02/report-ending-routine-farm-antibiotic-use-in-europe-final-2022.pdf>> accessed 10 January 2023.

<sup>147</sup> Council Directive 2007/43/EC of 28 June 2007 laying down minimum rules for the protection of chickens kept for meat production (2007) OJ L182 (Council Directive 2007/43/EC).

<sup>148</sup> Chicken kept for meat production is often called broiler to differentiate it from the chicken used for egg production. In Council Directive 2007/43/EC of 28 June 2007 laying down minimum rules for the protection of chickens kept for meat production, the term of broiler is used.

reared chickens.<sup>149</sup> Stocking density rules for broilers can be found in this Directive. Stocking density is defined in the Directive as “the total live weight of chickens which are present in a house at the same time per square meter of useable area”.<sup>150</sup> Directive 2007/43/EC sets a baseline maximum stocking density for broilers of 33 kg of chicken per square meter. As specified in article 3 of the Directive, “Member States shall ensure that the maximum stocking density in a holding or a house of a holding does not at any time exceed 33 kg/m<sup>2</sup>”.<sup>151</sup> However, Member States have the possibility to apply for a derogation that allows them to increase the stocking density up to 39 kg/m<sup>2</sup>, “Member States shall ensure that, when a derogation is granted under paragraph 3, the maximum stocking density in a holding or a house of a holding does not at any time exceed 39 kg/m<sup>2</sup>”.<sup>152</sup> This derogation is granted when fulfilling the requirements set out in Annex 1 and a series of additional requirements set out in Annex II.<sup>153</sup> These additional requirements entail documented details and determined environmental parameters for holdings. One of the main particulars, entails maintaining levels of ammonia (NH<sub>3</sub>) below 20 parts per million (ppm).<sup>154</sup> Notably, in 2012, the “Scientific report updating the EFSA opinions on the welfare of broilers and broiler breeders”, stated that ammonia levels of 10 ppm or higher, at broiler houses could already harm chickens’ lung surface and increase their predisposition for respiratory diseases.<sup>155</sup> The occurrence of these respiratory diseases could involve processes such as pneumonia, airsacculitis or sepsis which have been

---

<sup>149</sup> Council Directive 2007/43/EC, art 1; Rules for free range meat production are included in different piece legislation which establishes marketing standards. The competence belongs to Directorate-General for Agriculture and Rural Development. Organically-reared poultry presents separate requirements and legislation. See ADAS ADAS UK Ltd and University of Arkansas “Comparison of the Regulatory Framework and Key Practices in the Poultry Meat Supply Chain in the EU and USA” (2016) <<https://britishpoultry.org.uk/identity-cms/wp-content/uploads/2018/05/2016-ADAS-EU-US-comparison.pdf>> accessed 10 March 2023.

<sup>150</sup> Council Directive 2007/43/EC, art 2.

<sup>151</sup> Council Directive 2007/43/EC, art 3.

<sup>152</sup> Council Directive 2007/43/EC, art 3, para 4.

<sup>153</sup> Council Directive 2007/43/EC, art 3, para 3.

<sup>154</sup> Council Directive 2007/43/EC, annex II.

<sup>155</sup> Ingrid de Jong and others “Scientific report updating the EFSA opinions on the welfare of broilers and broiler breeders” (2012) 9 Supporting Publications 2012.

studied to be among the circumstances in which antimicrobials are used the most in poultry<sup>156</sup>

The decision to exceed stocking densities above 33 kg/m<sup>2</sup> corresponds to each Member State and it must be controlled by the competent authority of that country. In addition to this derogation, Member States can grant to increase further the maximum limit for stocking density up to 42 kg/m<sup>2</sup>. Paragraph 5 of article 3 states "When the criteria set out in Annex V are fulfilled, Member States may allow that the maximum stocking density referred to in paragraph 4 be increased by a maximum of 3 kg/m<sup>2</sup>".<sup>157</sup> The particular criteria set up in Annex V for increasing stocking density from 39 kg/m<sup>2</sup> to 42 kg/m<sup>2</sup> entails, firstly, to meet the conditions mentioned for the first derogation, and secondly, to present records of low mortality rates and good management practises confirmed and monitored by the authorities.<sup>158</sup> However, in exceptional circumstances, Member States can concede an increase in stocking density up to 42 kg/m<sup>2</sup> even when the records of mortality are excessive, as stated in Annex V, "the competent authority may decide to increase the stocking density when the owner or keeper has provided sufficient explanation for the exceptional nature of a higher daily cumulative mortality rate or has shown that the causes lie beyond his sphere of control".<sup>159</sup> It is noteworthy to mention, with the aim to better illustrate what a stocking density of 42 kg/m<sup>2</sup> is, that this maximum legal translates approximately into 21 birds (of 2 kg each) per square meter.<sup>160</sup>

According to a study performed in 2017, when transposing the Directive into national legislation, countries like Austria, Denmark, Germany, and Sweden chose to not make use of some or all of the stocking density

---

<sup>156</sup> Ingrid de Jong and others "Scientific report updating the EFSA opinions on the welfare of broilers and broiler breeders" (2012) 9 Supporting Publications 2012; EMA (European Medicines Agency) and EFSA (European Food Safety Authority) "EMA and EFSA Joint Scientific Opinion on measures to reduce the need to use antimicrobial agents in animal husbandry in the European Union, and the resulting impacts on food safety (RONAFA)" (2017) 15 EFSA Journal 2017.

<sup>157</sup> Council Directive 2007/43/EC, art 3, para 5.

<sup>158</sup> Council Directive 2007/43/EC, annex V; Commission "Report from the Commission to the European Parliament and the Council on the application of Directive 2007/43/EC and its influence on the welfare of chickens kept for meat production, as well as the development of welfare indicators" (2018) COM/2018/0181.

<sup>159</sup> Council Directive 2007/43/EC, Annex V.

<sup>160</sup> Scientific Committee on Animal Health and Animal Welfare (SCAHAW) "The welfare of chickens kept for meat production (Broilers)" (2000) SANCO.B.3/AH/R15/2000.



derogations.<sup>161</sup> In fact, since the Directive gives Member States the discretion to apply stricter limits, Austria opted for establishing a maximum legal stocking density of 30 kg/m<sup>2</sup>.<sup>162</sup> Sweden had the maximum permitted stocking density set at 36 kg/m<sup>2</sup> and Denmark at 40 kg/m<sup>2</sup>. Germany opted for not taking up the derogation that allows to establish maximum stocking densities of 42 kg/m<sup>2</sup> and in addition, it established that the requirements set in Annex II, had to be followed by all producers, irrespective of the stocking density applied.<sup>163</sup> Germany based this decision on the scientific evidence that animal welfare could be jeopardized at higher stocking densities.<sup>164</sup> The same research study shows that only 34% of broilers in the EU kept the maximum stocking density at 33 kg/m<sup>2</sup>, while 26% of EU broilers were kept at the maximum stocking density of 42 kg/m<sup>2</sup>.<sup>165</sup> Belgium, Finland, France, the Netherlands, Poland and Spain were the countries, at the time data was retrieved, using the highest stocking densities permitted.<sup>166</sup>

In regard to scientific evidence, a now somewhat dated report of 2000 from the Scientific Committee on Animal Health and Animal Welfare, a former EU body,<sup>167</sup> stated that, "the stocking density must be 25 kg/m<sup>2</sup> or lower for major welfare problems to be largely avoided and that above 30 kg/m<sup>2</sup>, even with very good environmental control systems, there is a steep rise in the frequency of serious problems".<sup>168</sup> Such serious problems could entail

---

<sup>161</sup> Commission, Directorate-General for Health and Food Safety "Study on the application of the broiler directive DIR 2007/43/EC and development of welfare indicators – Final report" (2017) Publications Office; Commission "Report from the Commission to the European Parliament and the Council on the application of Directive 2007/43/EC and its influence on the welfare of chickens kept for meat production, as well as the development of welfare indicators" (2018) COM/2018/0181.

<sup>162</sup> European Commission, Directorate-General for Health and Food Safety "Study on the application of the broiler directive DIR 2007/43/EC and development of welfare indicators : final report" (2017) Publications Office.

<sup>163</sup> *ibid.*

<sup>164</sup> *ibid.*

<sup>165</sup> *ibid.*

<sup>166</sup> *ibid.*

<sup>167</sup> The Scientific Committee on Animal Health and Animal Welfare was an EU body known also as SCAHAW, was established in 1997. Its function was to advise the Commission on questions relating to animal health and welfare. The operation of this EU body came to an end with the establishment of EFSA. See Commission "Review of the operation of the Scientific Committee on Animal Health and Animal Welfare" (2003).

<sup>168</sup> Scientific Committee on Animal Health and Animal Welfare (SCAHAW) "Scientific Committee on Animal Health and Animal Welfare. The welfare of chickens kept for meat production (Broilers)" (2000).

pathologies related to breast blisters, chronic dermatitis and leg disorders. More recently, in 2020, the Norwegian Scientific Committee for Food Safety released a scientific review that analysed different subjects on poultry species and animal welfare. In the review is stated that some health and behavioural indicators showed a decrease in broiler welfare when space allowance was higher than 25 kg/m<sup>2</sup>.<sup>169</sup>

As was mentioned before, in line with the F2F Strategy, the Commission requested scientific opinions from EFSA on the welfare of several animal species. Concerning broilers, in February 2023 a scientific opinion on the welfare of broilers on farms was released.<sup>170</sup> The scope of this scientific opinion covers day-old chicks, broiler breeders and broiler chickens within different husbandry systems.<sup>171</sup> To improve broiler chickens' welfare, the opinion highlights different recommendations for different factors, considered urgent to apply. Stocking density, it is a factor evaluated in the opinion and which is identified among the major hazards that lead to reduce animal welfare. The assessment identifies that a high ratio of stocking density can derive principally in, an inability to achieve comfort behaviour and perform exploratory and foraging behaviour, restricts movement, and produces soft tissue and integument damage.<sup>172</sup> It concludes that, in order to prevent these welfare consequences, which are identified as highly relevant, a maximum stocking density of 11 kg/m<sup>2</sup> should be established.<sup>173</sup>

Ultimately, the opinion also includes ammonia within the analysis, as part of the specific gases in the air that might be harmful to chickens. It is highlighted in the opinion that ammonia levels above 15 ppm impair the welfare of broiler chickens and therefore, corrective measures should be

---

<sup>169</sup> Norwegian Scientific Committee for Food and Environment and others "The use of light, restrictive feeding, fibrous feed and stocking density and the consequences for animal welfare for poultry species kept in Norway. Scientific Opinion of the Panel on Animal Health and Welfare of the Norwegian Scientific Committee for Food and Environment" (2022) Norwegian Scientific Committee for Food and Environment (VKM).

<sup>170</sup> EFSA AHAW Panel (EFSA Panel on Animal Health and Animal Welfare) and others "Scientific Opinion on the welfare of broilers on farm" (2023) 21 EFSA Journal 2023 (EFSA AHAW Panel).

<sup>171</sup> *ibid.*

<sup>172</sup> EFSA AHAW Panel "Scientific Opinion on the welfare of broilers on farm" (2023) 21 EFSA Journal 2023, page 161.

<sup>173</sup> EFSA AHAW Panel "Scientific Opinion on the welfare of broilers on farm" (2023) 21 EFSA Journal 2023.

taken when reached or surpassed that level.<sup>174</sup> Notably and as was pointed out, the present maximum in EU legislation is 20 ppm.

### 3.2.3 Legislation on pig stocking density

Piglets and rearing pigs are usually housed in a fixed enclosed area for an interval of time. As pigs grow, this space remains invariable in size, meaning that the area available per animal will be progressively reduced. As a consequence, around the end of these fattening periods, there is a high increase in stocking density that results in the emergence of several welfare issues, such as group stress or restriction of movement.<sup>175</sup> These welfare issues often lead to tail biting which is one of the main causes that result in an increase in antimicrobial treatments.<sup>176</sup>

Stocking density rules for pigs together with other welfare standards can be found in Council Directive 2008/120/EC laying down minimum standards for the protection of pigs.<sup>177</sup> The scope of this Directive encompasses pigs confined for rearing and fattening purposes.<sup>178</sup> Stocking density is paraphrased as “unobstructed floor area available”, which can also be understood as the minimum floor space per pig. Depending on the weight of the pig, different minimum floor space requirements are set. For pigs reaching 110 kg or more, the minimum legal floor space is 1 m<sup>2</sup>. However, if the pigs weigh less than 110 kg, but more than 85 kg, the minimum legal floor space falls to 0,65 m<sup>2</sup>. However, these current space allowances permitted in the EU have been studied to be insufficient, causing adverse effects on the performance of pigs.<sup>179</sup>

---

<sup>174</sup> EFSA AHAW Panel and others “Scientific Opinion on the welfare of broilers on farm” (2023) 21 EFSA Journal 2023, page 118.

<sup>175</sup> EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare) and others “Scientific Opinion on the welfare of pigs on farm” (2022) 20 EFSA Journal 2022 (EFSA AHAW Panel).

<sup>176</sup> Anna H Stygar and others “High biosecurity and welfare standards in fattening pig farms are associated with reduced antimicrobial use” (2020) 14 Animal, 2178.

<sup>177</sup> Council Directive 2008/120/EC of 18 December 2008 laying down minimum standards for the protection of pigs (2009) OJ L 47 (Council Directive 2008/120/EC).

<sup>178</sup> Council Directive 2008/120/EC, art 1.

<sup>179</sup> Compassion in World Farming and Heather Pickett “Welfare of pigs in the European Union; The urgent need for reform of existing legislation and effective enforcement” (2009).

In a study performed in 2016, four EU countries (Belgium, Germany, Sweden, and France) were analysed based on their antimicrobial usage on herd level and the influence by several determined factors.<sup>180</sup> The lowest average overall antimicrobial consumption was found in the country of the study with the lowest pig density at the regional level.<sup>181</sup> Thus, the authors suggested the possible influence of the relation between disease transmission in herds and density.<sup>182</sup> Moreover, in a study of 2021, lower farm pig density was identified as one of the factors influencing lower antimicrobial use.<sup>183</sup> Lastly, another study from 2021 which studied antibiotic usage in Danish conventional and organic herds showed that lower stocking densities of pigs, which were applied in organic systems, were among the factors that contributed to lower antibiotic usage.<sup>184</sup>

Commission Regulation 889/2008 establishes standards for minimum surface area in organic production schemes, being these standards higher than the standards applied to conventional production methods.<sup>185</sup> For fattening pigs up to 110 kg, a minimum floor space of 1,3 m<sup>2</sup> for the indoor area is established and for the outdoor area, a minimum floor space of 1 m<sup>2</sup> is set, making a total of 2,3 m<sup>2</sup> per pig.<sup>186</sup> For fattening pigs up to 85 kg, the Regulation sets the minimum floor space for the indoor area at 1,1 m<sup>2</sup> and for the outdoor area at 0,8 m<sup>2</sup> (1,9 m<sup>2</sup> in total).<sup>187</sup>

In line with the F2F Strategy, EFSA published in 2022 an opinion on the welfare of pigs on farms.<sup>188</sup> The opinion provides detailed recommendations to improve the welfare of EU farmed pigs by analysing

---

<sup>180</sup> Marie Sjölund "Quantitative and qualitative antimicrobial usage patterns in farrow-to-finish pig herds in Belgium, France, Germany and Sweden" (2016) 130 Preventive Veterinary Medicine.

<sup>181</sup> *ibid.*

<sup>182</sup> *ibid.*

<sup>183</sup> Rita Albernaz-Gonçalves, Gabriela Olmos G and Maria José Hötzel "My pigs are ok, why change? - animal welfare accounts of pig farmers" (2021) 15 Animal.

<sup>184</sup> Cecilie Liv Nielsen and others "Antibiotic and medical zinc oxide usage in Danish conventional and welfare-label pig herds in 2016–2018" (2021) 189 Preventive Veterinary Medicine.

<sup>185</sup> Commission Regulation (EC) No 889/2008 of 5 September 2008 laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labelling of organic products with regard to organic production, labelling and control (2008) OJ L 250 (Regulation (EC) No 889/2008).

<sup>186</sup> Regulation (EC) No 889/2008, annex III.

<sup>187</sup> *ibid.*

<sup>188</sup> EFSA AHAW Panel "Scientific Opinion on the welfare of pigs on farm" (2022) 20 EFSA Journal 2022.

sixteen relevant animal welfare consequences for different husbandry systems. Stocking density is among the factors studied that jeopardizes animal welfare. The opinion's recommendation on space allowance determined that "the minimum space allowance should be increased relative to the current legal requirement to reduce many welfare consequences (e.g. restriction of movement, resting problems, inability to express comfort behaviour, inability to express exploratory/foraging behaviour, group stress, soft tissue lesions and integument damage), thus reducing tail biting behaviour and increasing growth rate".<sup>189</sup> Although a minimum surface area is not specified, it is exemplified that, by increasing space allowance in pigs weighing up to 110 kg, from 0,65 m<sup>2</sup> to 0.84 m<sup>2</sup>, tail biting could be reduced by 52%. If increased to 1,10 m<sup>2</sup>, tail biting could be reduced by 83%.<sup>190</sup>

### 3.3 Legislation on early weaning in piglets

As was illustrated in chapter 2 on animal welfare, weaning in piglets is a management practice that is particularly linked with high consumption rates of antibiotics.<sup>191</sup> This is because farmers, in light of the prospective occurrence of diarrhoea in piglets, apply antimicrobials routinely and preventatively. The stress induced by this practice and the dietary changes are two factors that, when performed in piglets at early stages, cause the mentioned symptomatology. Noteworthy, in the EU, around 20% of these preventive treatments use critically important antibiotics for humans, such as the last-resort antibiotic colistin, to treat the diarrhoea of piglets.<sup>192</sup>

---

<sup>189</sup> *ibid.*

<sup>190</sup> EFSA AHAW Panel "Scientific Opinion on the welfare of pigs on farm" (2022) 20 EFSA Journal 2022; Compassion in World Farming "EFSA Publishes comprehensive opinion on pig welfare" (2022) <<https://www.compassioninfoodbusiness.com/our-news/2022/08/efsa-publishes-comprehensive-opinion-on-pig-welfare>> accessed 11 March 2023.

<sup>191</sup> EMA (European Medicines Agency) and EFSA (European Food Safety Authority) "EMA and EFSA Joint Scientific Opinion on measures to reduce the need to use antimicrobial agents in animal husbandry in the European Union, and the resulting impacts on food safety (RONAFA)" (2017) 15 EFSA Journal 2017; C oil n Nunan "Achieving responsible farm antibiotic use through improving animal health and welfare in pig and poultry production. Ending routine farm antibiotic use in Europe" (2022) <<https://epha.org/wp-content/uploads/2022/02/report-ending-routine-farm-antibiotic-use-in-europe-final-2022.pdf>> accessed 10 January 2023.

<sup>192</sup> Colistin, although classified as critically important antibiotic, is not banned by EU law for use in animal's treatment. See: Federation of Veterinarians Europe "Ban on

As with stocking density rules, weaning rules in piglets, can be found in Council Directive 2008/120/EC laying down minimum standards for the protection of pigs. The minimum weaning age set by the Directive is at 28 days of age. However, a reduction to 21 days of age is allowed provided that “they are moved into specialised housings which are emptied and thoroughly cleaned and disinfected before the introduction of a new group and which are separated from housings where sows are kept, in order to minimise the transmission of diseases to the piglets”.<sup>193</sup> In practice, several countries within the EU use weaning ages lower than 28 days to increase productivity.<sup>194</sup>

The age at which the piglet is weaned plays an important role in its resilience and growth.<sup>195</sup> While early weaning affects negatively piglet's health,<sup>196</sup> a late weaning age facilitates piglets to develop more mature intestines which translates into a reduction in the occurrence of diarrhoea and results in less use of antimicrobial therapy.<sup>197</sup> The previously mentioned study of 2016 where antimicrobial use on herd level was compared between Belgium, Germany, Sweden and France, showed that farms applying early

---

veterinary use of colistin would impact animal welfare” (2022) <<https://fve.org/ban-on-veterinary-use-of-colistin-would-impact-animal-welfare/>> accessed 9 May 2023; De Briyne and others “Antibiotics most commonly used to treat animals in Europe” (2014) 175 *The Veterinary Record*.

<sup>193</sup> Council Directive 2008/120/EC of 18 December 2008 laying down minimum standards for the protection of pigs (2009) OJ L 47 (Council Directive 2008/120/EC).

<sup>194</sup> The trend over the years has been focused on producing the most piglets per sow possible to achieve more income. The simplest way to accomplish it is to wean the piglets at sooner ages rather than at later ages. See Pig Progress “Delayed weaning better for piglet welfare” (2020) <<https://www.pigprogress.net/specials/delayed-weaning-better-for-piglet-welfare/>> accessed 25 March 2023; Cólín Nunan “Achieving responsible farm antibiotic use through improving animal health and welfare in pig and poultry production. Ending routine farm antibiotic use in Europe” (2022) <<https://epha.org/wp-content/uploads/2022/02/report-ending-routine-farm-antibiotic-use-in-europe-final-2022.pdf>> accessed 10 January 2023.

<sup>195</sup> AMCRA “Antimicrobial Consumption and Resistance in Animals (Belgium), L’importance de l’âge du sevrage Un jour de plus, ça compte?” <<https://www.amcra.be/fr/nouvelles/het-belang-van-speenleeftijd-mag-het-eeen-dagje-meer-zijn/lid=14308>> accessed 20 February 2023.

<sup>196</sup> Joy M Campbell, Joe D Crenshaw and Javier Polo “The biological stress of early weaned piglets” (2013) 4 *Journal of Animal Science and Biotechnology*; Adam J Moeser and other “Gastrointestinal dysfunction induced by early weaning is attenuated by delayed weaning and mast cell blockade in pigs” (2007) 293 *American Journal of Physiology-Gastrointestinal and Liver Physiology*.

<sup>197</sup> *ibid*; AMCRA “Antimicrobial Consumption and Resistance in Animals (Belgium), L’importance de l’âge du sevrage Un jour de plus, ça compte?” <<https://www.amcra.be/fr/nouvelles/het-belang-van-speenleeftijd-mag-het-eeen-dagje-meer-zijn/lid=14308>> accessed 20 February 2023.

weaning also had higher antimicrobial consumption.<sup>198</sup> Sweden, the country with the highest average weaning age (35 days), presented 7 times lower antibiotic use in weaned piglets compared to Belgium, Germany and France which were using average weaning ages of 23.5 days, 24.4 days, and 24 days respectively.<sup>199</sup> This research thus illustrates, that current EU regulations on the weaning of piglets are presently not in line with current animal welfare scientific evidence.

In this context, it is important to note that the EFSA opinion on the welfare of pigs on farms of 2022, includes weaning among the factors to review in relation to animal welfare. The opinion acknowledges that a higher weaning age than the current legal of 21 and 28 days brings meaningful positive results due to an increase, during this period, in the maturity of the behavioural, digestive, and immunological systems.<sup>200</sup> Although it recommends, under animal welfare reasons, to maintain the current legal minimum weaning age of 28 days, it states that the exception allowing earlier weaning should be reconsidered. Ultimately, it concludes that there is a need for further research on the welfare benefits of weaning ages higher than 28 days.<sup>201</sup>

### 3.4 Interim Conclusion

In this chapter, it was first reviewed how the EU legislation on farm animal welfare has evolved over the years. The inclusion of the recognition of animals as sentient beings in the Treaty of Lisbon is one of the most relevant milestones in the legislation of animal welfare within the EU. In addition, farm animal welfare in the EU is integrated into five Directives and two Regulations that protect the welfare of animals in different areas of the production system and for different species. The most relevant and recent actions from the Commission aim at reviewing the mentioned pieces of legislation to ultimately improve animal welfare. Secondly, in this chapter it was analysed the rules

---

<sup>198</sup> Marie Sjölund "Quantitative and qualitative antimicrobial usage patterns in farrow-to-finish pig herds in Belgium, France, Germany and Sweden" (2016) 130 Preventive Veterinary Medicine.

<sup>199</sup> *ibid.*

<sup>200</sup> EFSA AHAW Panel "Scientific Opinion on the welfare of pigs on farm" (2022) 20 EFSA Journal 2022.

<sup>201</sup> *ibid.*

for stocking density for broilers within Council Directive 2007/43/EC and the rules for stocking density and weaning for pigs within Council Directive 2008/120/EC. Together with the analysis of the legal measures, the current scientific evidence on the relation between stocking density, weaning and animal welfare and antimicrobial use was also reviewed. The results of the analysis show that current EU rules are not aligned with current scientific evidence. It was found that a reduction in the maximum legal for stocking density in broiler and pig productions, and an increase in the minimum legal age of weaning in piglets, could potentially improve animal welfare and reduce antimicrobial use.

The following two chapters will move to the analysis of the governance of AMR at the international level and the EU. The focus will be on the different measures within plans, strategies and legislation aimed at improving antimicrobial stewardship, husbandry conditions and management practices.



## 4. International AMR Governance

This chapter will focus on the governance of AMR at the international level. The first two parts of chapter will serve to analyse whether AMR presents binding governance mechanisms and to illustrate the characteristics that differentiate binding and non-binding instruments. The third part of the chapter will consist of three sub-sections, in which the most important AMR actions, measures, plans and strategies proposed over the last years, by 3 relevant intergovernmental organizations (WHO, FAO and OIE) will be analysed.

### 4.1 Binding governance mechanisms regulating AMR

International governance is characterized by its great variety in the degrees and forms of legalization.<sup>202</sup> Binding governance mechanisms pertain to what is known as a “Hard law” form of legalization, which refers to “legally binding obligations that are precise (or can be made precise through adjudication or the issuance of detailed regulations) and that delegate authority for interpreting and implementing the law”.<sup>203</sup> Within binding governance mechanisms, treaties are considered the gold standard because of their transformative potential in accomplishing social goals.<sup>204</sup> They further have the potential to be used as tools to hold countries responsible for the commitments they have agreed upon (irrespective of government changes), they can deal with transnational problems that cannot be addressed unitarily by a country or organization, and they can facilitate international cooperation and coordination.<sup>205</sup>

It has been researched that a treaty on managing antimicrobials and addressing AMR could bring along benefits such as coordinated efforts, better implementation mechanisms and regulatory functions, reductions in market

---

<sup>202</sup> Kenneth W Abbott and Duncan Snidal “Hard and Soft Law in International Governance” (2000) 54 *Legalization and World Politics*, 421.

<sup>203</sup> *ibid.*

<sup>204</sup> Steven J Hoffman and others “Strategies for achieving global collective action on antimicrobial resistance” (2015) 93 *Bulletin of the World Health Organization*, 867.

<sup>205</sup> Allyn L Taylor “Global governance, international health law and WHO: looking towards the future” (2002) 80 *Bull World Health Organization*, 975; Steven J Hoffman and others “An international legal framework to address antimicrobial resistance” (2015) 93 *Bull World Health Organization*, 66.

disadvantages for determined industries, transparency and accountability improvements or data surveillance sharing.<sup>206</sup> However, presently, such agreement concerning AMR does not exist. In international law, binding governance mechanisms are scarce, mainly due to a lack of centralized institutions or the existence of considerable challenges. Such challenges can entail difficulties in conciliating the different stakeholder's interests or the incapability of most countries to deliver meaningful information due to a lack of proper infrastructure and reporting mechanisms.<sup>207</sup> Consequently, in international law, "soft law", which some authors describe it as "purely political arrangements in which legalization is largely absent",<sup>208</sup> has become, despite its prominent disadvantages, easier to achieve.

## 4.2 Non-binding governance mechanisms regulating AMR

The global governance of AMR is based on non-binding governance mechanisms. This type of governance mechanism is characterized by being more flexible in its implementation, permits a more dynamic discourse, and often includes the engagement of civil society organizations and nonstate actors.<sup>209</sup> Non-binding mechanisms bring forth political and legal significance without the legal consequences of binding mechanisms if the commitments made by a state are not achieved.<sup>210</sup> Moreover, they facilitate the political participation of low- and middle-income countries since these voluntary contributions allow them to attend, at the same time, other important needs, such as economic development or food security.<sup>211</sup> However, it is important to remark that they do present also prominent disadvantages. They lack the strength, credibility and financial and logistical support for implementation

---

<sup>206</sup> *ibid*; Steven Hoffman and Asha Behdinan "Towards an international treaty on antimicrobial resistance" (2016) 47 *Ottawa Law Review*, 507.

<sup>207</sup> Susan Rogers Van Katwyk and others "Developing an approach to assessing the political feasibility of global collective action and an international agreement on antimicrobial resistance" (2016) 1 *Global Health Research and Policy*, 20.

<sup>208</sup> Kenneth W Abbott and Duncan Snidal "Hard and Soft Law in International Governance" (2000) 54 *Legalization and World Politics*, 421.

<sup>209</sup> Ponnu Padiyara, Hajime Inoue, Marc Sprenger "Global Governance Mechanisms to Address Antimicrobial Resistance" (2018) 11 *Infectious diseases*.

<sup>210</sup> *ibid*.

<sup>211</sup> Arne Ruckert and others "Governing antimicrobial resistance: a narrative review of global governance mechanisms" (2020) 41 *Journal of public health policy*, 515.

that the binding mechanisms present.<sup>212</sup> Nevertheless, despite these disadvantages, non-binding governance mechanisms are the only instruments implemented in the international governance of AMR. They are still legal instruments that facilitate global cooperation and come in the form of political declarations, resolutions, or guidelines.<sup>213</sup>

The main key actors that have been launching resolutions and policy instruments at the international level concerning AMR are the WHO, OIE and the FAO. These international organisations have also been collaborating with each other to bring joint and cross-sectoral actions that address properly AMR emergence.<sup>214</sup> The policies issued are oriented to the human, animal, and environmental health areas, and their measures are diverse, ranging from pharmaceutical innovation to prevention and control of infections or surveillance.<sup>215</sup> As was previously mentioned, in the area of animal health, the overuse and misuse of antimicrobials in animal agriculture is one of the main contributors to the development of antimicrobial-resistant pathogens. For this reason, most of the actions implemented within global and national policies are actions aimed at reducing and optimizing the use of antimicrobials in the animal health sector.<sup>216</sup>

The importance of the international AMR policy measures, issued by the mentioned actors, in influencing European AMR policy, makes it relevant to also conduct an analysis of said international measures. This analysis will be illustrated in the following sections where the focus will be also directed at the international measures related to animal health and antimicrobial use.

---

<sup>212</sup> Ponnu Padiyara, Hajime Inoue and Marc Sprenger "Global Governance Mechanisms to Address Antimicrobial Resistance" (2018) 11 *Infectious diseases*.

<sup>213</sup> *ibid.*

<sup>214</sup> Didier Wernli and others "Mapping global policy discourse on antimicrobial resistance" (2017) 2 *BMJ Global Health*.

<sup>215</sup> Michael Anderson and others "A governance framework for development and assessment of national action plans on antimicrobial resistance" (2019) 19 *The Lancet Infectious Diseases*.

<sup>216</sup> Kasimanickam Vanmathy, Maadhanki Kasimanickam and Ramanathan Kasimanickam "Antibiotics Use in Food Animal Production: Escalation of Antimicrobial Resistance: Where Are We Now in Combating AMR?" (2021) 9 *Medical Sciences* 9.

### 4.2.1 World Health Organization on AMR

The WHO is the international body from the United Nations responsible for international public health and which.<sup>217</sup> Within the World Health Assembly (WHA) health objectives, targets and strategies are discussed and studied to determine WHO's priorities and policies.<sup>218</sup> The Assembly's agenda can comprise a variety of different global health matters, with antimicrobial resistance being one of them. Although WHA decisions may not always become legally binding, they have political weight.<sup>219</sup> They are considered agreed policy statements and therefore they can end up being used by governments, political parties, the industry or as a source in international relations.<sup>220</sup> Moreover, the accumulation and relevance of certain decisions can mark precedents and have an impact on the framing of international law.<sup>221</sup>

The first time that antibiotic resistance was drawn to the global political agenda was at the WHO's Eight World Health Assembly of 1955.<sup>222</sup> In this World Health Assembly, the potential danger that could pose the development of Malaria's resistance to insecticides was recognised. WHO's member countries were urged to intensify their control plans in order to achieve the eradication of the disease.<sup>223</sup> Over the following years, warnings and mentions of different scenarios involving the development of AMR kept forming part of the World Health Assembly's Agenda. Particularly significant

---

<sup>217</sup> The WHO was established in 1948 and since then it has played a major role in public health by acting on matters such as eradicating diseases like smallpox, reducing the threat of Malaria, coordinating international responses to disease outbreaks or promoting healthy lifestyles. See Michael Marshall "The World Health Organization" (New Scientist) <<https://www.newscientist.com/definition/world-health-organization/>> accessed 20 December 2022.

<sup>218</sup> WHO "World Health Assembly" <<https://www.who.int/about/governance/world-health-assembly>> accessed 14th November 2022.

<sup>219</sup> Global Health Now "The World Health Assembly: What It Does, Why It Matters" <<https://globalhealthnow.org/2022-05/world-health-assembly-what-it-does-why-it-matters>> accessed 14 November 2022.

<sup>220</sup> *ibid.*

<sup>221</sup> *ibid.*

<sup>222</sup> WHO "Handbook of resolutions and decisions of the World Health Assembly and the Executive Board" (1973) 1 Official records of the World Health Organization series.

<sup>223</sup> WHO "Handbook of resolutions and decisions of the World Health Assembly and the Executive Board" (1973) 1 Official records of the World Health Organization series.

was the Resolution of the Fifty-first WHA of 1998, where it was called for more urgent actions to address the AMR.<sup>224</sup> During this period, drug resistance continued to rise worldwide. The use of antimicrobials in agricultural practices and the environment started to be an increased concern, especially for international organizations and developed countries such as the U.S. and the European countries.<sup>225</sup> For this reason, the WHO published in 2001 the “WHO global strategy for containment of antimicrobial resistance”.<sup>226</sup> This strategy marked the beginning of what has been described by some authors as the stage of rapid development in AMR governance.<sup>227</sup> The strategy renovated efforts at increasing the presence of AMR on the international political agenda and facilitated the addressing of AMR from a more integrated perspective. It was drafted with the intention to work as a tool that could identify the key elements related to the emergence of AMR associated with human disease while establishing an interventional framework to reduce AMR development.<sup>228</sup>

Despite the efforts made with the launch of the 2001 WHO Global Strategy, several barriers such as underdeveloped health infrastructures or scarcity of valid data, were impeding the strategy’s implementation.<sup>229</sup> The call for international coordinated action remained imperative and necessary.<sup>230</sup> Antimicrobial resistance continued rising and there was an

---

<sup>224</sup> Institute of Medicine (US) Forum on Emerging Infections and others “Resistance Phenomenon in Microbes and Infectious Disease Vectors: Implications for Human Health and Strategies for Containment: Workshop Summary” (2003) National Academies Press.

<sup>225</sup> Jia Yin and others “The progress of global antimicrobial resistance governance and its implications to China: A Review” (2021) 10 *Antibiotics*, 1356.

<sup>226</sup> European Medicines Agency (EMA) “Information session on antimicrobial resistance Initiatives presented to EMA Working Parties with Patients, Consumers and Healthcare Professionals on 19 September 2017” (2017) EMA/648538/2017.

<sup>227</sup> Jia Yin and others “The Progress of Global Antimicrobial Resistance Governance and its Implication to China: A Review” (2021) 10 *Antibiotics*, 1356.

<sup>228</sup> WHO “WHO global principles for the containment of antimicrobial resistance in animals intended for food. Report of a WHO Consultation with the participation of the Food and Agriculture Organization of the United Nations and the Office International des Epizooties” (2000) WHO/CDS/CSR/APH/2000.4.

<sup>229</sup> Institute of Medicine (US) Forum on Emerging Infections and others “Resistance Phenomenon in Microbes and Infectious Disease Vectors: Implications for Human Health and Strategies for Containment: Workshop Summary” (2003) National Academies Press.

<sup>230</sup> Otto Cars and Per Nordberg “Antibiotic resistance—the faceless threat” (2005) 17 *International Journal of Risk & Safety in Medicine*, 103.

urgency to speed-up and achieve progress. The threat of antimicrobial resistance moved from being mainly framed as a present issue around the burden of illness, to a major future problem affecting also social and economic development, should no proper actions were taken in the present.<sup>231</sup> AMR was even framed as a threat that should be regarded as important as climate change.<sup>232</sup> The WHO, noting that the efforts made to date, through the different resolutions and the previous strategy, had had limited impact on the necessary change to contain in time AMR, launched in 2015 the Global Action Plan on Antimicrobial Resistance (GAP).<sup>233</sup>

As will be detailed further below, this strategy has been categorised by some authors as one of the strongest non-binding global governance mechanisms currently in place.<sup>234</sup> It is also the most recent one developed by the WHO.<sup>235</sup> It was launched in conjunction with the FAO and OIE, which, in addition, adopted their own supporting action plans.<sup>236</sup> This tripartite collaboration derives from the acknowledgement that the containment of AMR calls for a multisectoral, transdisciplinary, integrative approach.<sup>237</sup> This type of approach is known as the “One Health” approach and aims at not only sustainably improving the health of human beings but also the health of animals and ecosystems.<sup>238</sup> For this reason, the Global Action Plan on AMR brings into cooperation diversified sectors such as agriculture, husbandry, health, environment or finances.<sup>239</sup>

---

<sup>231</sup> Scott H Podolsky “The evolving response to antibiotic resistance (1945–2018)” (2018) 124 Palgrave Communications.

<sup>232</sup> Dame Sally C Davies “Annual Report of the Chief Medical Officer, Volume Two, 2011, Infections and the rise of antimicrobial resistance” (2013) Department of Health.

<sup>233</sup> WHO “Global Action Plan on Antimicrobial Resistance” (2015) World Health Organization.

<sup>234</sup> Arne Ruckert and others “Governing antimicrobial resistance: a narrative review of global governance mechanism” (2020) 41 Journal Public Health Policy 515.

<sup>235</sup> WHO “Global Action Plan on Antimicrobial Resistance” (2015) World Health Organization.

<sup>236</sup> OIE “The OIE Strategy on Antimicrobial Resistance and the Prudent Use of Antimicrobials” (2016); FAO “The FAO Action Plan on Antimicrobial Resistance 2021–2025” (2021).

<sup>237</sup> *ibid.*

<sup>238</sup> WHO “One Health overview” <[https://www.who.int/health-topics/one-health#tab=tab\\_1](https://www.who.int/health-topics/one-health#tab=tab_1)> accessed 29 November 2022.

<sup>239</sup> Jia Yin and others “The Progress of Global Antimicrobial Resistance Governance and its Implication to China: A Review” (2021) 10 Antibiotics, 1356.

The Global Action Plan on AMR is conceived to be implemented at global, regional and national levels.<sup>240</sup> The goal of the plan was to ensure perpetual continuity in the prevention and treatment of infectious diseases by means of accessibility to effective antimicrobials and responsible use of safe and quality-assured antimicrobials<sup>241</sup> Five strategic objectives were set to achieve this goal:

- Objective 1: improve awareness and understanding of antimicrobial resistance through effective communication, education and training;
- Objective 2: to strengthen the knowledge and evidence base through surveillance and research;
- Objective 3: to reduce the incidence of infection through effective sanitation, hygiene and infection prevention measures;
- Objective 4: to optimize the use of antimicrobial medicines in human and animal health and;
- Objective 5: to develop the economic case for sustainable investment that takes account of the needs of all countries and to increase investment in new medicines, diagnostic tools, vaccines and other interventions.<sup>242</sup>

These strategic objectives structure different actions that, as a result, provide a general guidance framework for the member countries to take and draft their own national action plans. Within these actions, there are several objectives that are appointed at reducing AMR within the animal health sector. In the description of objective 3 named "Reduce the incidence of infection through effective sanitation, hygiene and infection prevention measures", for instance, it is stated that most antibiotic use is related to animal production. It is affirmed that, in addition to being applied to prevent infections and contain their spread, they are also used as growth promoters. Some of the actions to address this matter within this objective 3 involve, for example, the strengthening of animal health and agricultural practices through the implementation of the standards published in the OIE's

---

<sup>240</sup> WHO "Global Action Plan on Antimicrobial Resistance" (2015) World Health Organization.

<sup>241</sup> WHO "Global Action Plan on Antimicrobial Resistance" (2015) World Health Organization.

<sup>242</sup> *ibid.*

Terrestrial and Aquatic Code and the FAO/WHO Codex. In addition, within this objective, the FAO is designated to provide support to producers and stakeholders in the food and agriculture sectors, for the adoption of good practices in animal husbandry and health with the aim to reduce the use of antibiotics and the risk of the development and spread of AMR.<sup>243</sup>

Furthermore, objective 4 of the plan underlines the potential benefit that reducing antimicrobial use in food production practices brings forth. The measures within the objective to address animal health and antimicrobial use, entail the development, by WHO'S member countries, of action plans that incorporate elements such as effective and enforceable regulation and governance for the use of antimicrobial medicines.<sup>244</sup> Additionally, the development and implementation of policies on the use of antimicrobials in animals and agriculture (that include the implementation of Codex Alimentarius and OIE international standards) that phase out the use of antibiotics for animal growth promotion and reduce non-therapeutic antimicrobial use in animal health.<sup>245</sup>

After the release of the GAP, activity around AMR has continued within the WHO. The last resolution on AMR adopted by the World Health Assembly was Resolution WHA72.5 in 2019.<sup>246</sup> Among the different calls directed at member countries, the Resolution urged them to increase efforts concerning the Global action on AMR, in order to implement the actions and achieve the strategic objectives within it. It also added in the Resolution the need for further increase of the prudent use of all antimicrobials, and to consider developing and implementing clinical guidelines and criteria for critically important antimicrobials. In addition, it requested member countries to strengthen infection prevention and control measures and to ensure prudent use of quality-assured antimicrobials.<sup>247</sup> Lastly, the Resolution also requested

---

<sup>243</sup> *ibid.*

<sup>244</sup> *ibid.*

<sup>245</sup> *ibid.*

<sup>246</sup> World Health Assembly "Seventy-second World Health Assembly; Antimicrobial resistance" (2019) WHA72.5.

<sup>247</sup> Pan American Health Organization (PAHO) "World Health Assembly Adopts Resolution on Antimicrobial Resistance" (2019) <[https://www3.paho.org/hq/index.php?option=com\\_content&view=article&id=15202:asamblea-mundial-de-la-salud-adopta-decision-sobre-resistencia-antimicrobiana&Itemid=0&lang=en#gsc.tab=0](https://www3.paho.org/hq/index.php?option=com_content&view=article&id=15202:asamblea-mundial-de-la-salud-adopta-decision-sobre-resistencia-antimicrobiana&Itemid=0&lang=en#gsc.tab=0)> accessed 16 March 2023.



the WHO Director-General to accelerate the implementation of the actions of the Global Action Plan on AMR through all levels of WHO.<sup>248</sup>

## 4.2.2 Food and Agriculture Organization of the United Nations on AMR

The FAO, founded in 1945, is one of the specialized agencies of the United Nations.<sup>249</sup> It leads international actions aimed at ending hunger worldwide.<sup>250</sup> Its core efforts are pointed at ensuring food security for all and guaranteeing that people have regular access to sufficient high-quality food in order to have active and healthy lives.<sup>251</sup> The FAO intervenes in different key areas to accomplish the demands posed by relevant global trends in agricultural development and the challenges that member countries deal with regularly.<sup>252</sup> Some of these activities include for example, to help eliminate hunger, food insecurity and malnutrition, to make agriculture more productive and sustainable or to ensure inclusive and efficient agricultural and food systems.<sup>253</sup> Within the agricultural field, the organization presents wide expertise in different disciplines such as terrestrial animal health or animal welfare and production.<sup>254</sup>

The threat that AMR poses to global food security due to the development of untreatable livestock diseases, the increasing cost of treating drug-resistant diseases or the livestock losses, have led the FAO to centre AMR as one of the major global issues to intervene.<sup>255</sup> The international organization aims at taking a role in supporting governments, producers, traders and other stakeholders to progress towards the responsible use of

---

<sup>248</sup> World Health Assembly "Seventy-second World Health Assembly; Antimicrobial resistance" (2019) WHA72.5.

<sup>249</sup> Medecins sans frontieres "Food and Agriculture Organization of the United Nations (FAO)" <<https://guide-humanitarian-law.org/content/article/3/food-and-agriculture-organization-of-the-united-nations-fao/>> accessed 16 March 2023.

<sup>250</sup> FAO "About FAO" <<https://www.fao.org/about/en/>> accessed 16 March 2023.

<sup>251</sup> *ibid.*

<sup>252</sup> United Nations "FAO: Food and Agriculture Organization of the United Nations" <<https://www.un.org/youthenvoy/2013/09/fao-food-and-agriculture-organization-of-the-united-nations/#:~:text=Our%20mandate%20is%20to%20improve,contribute%20to%20global%20economic%20growth>> accessed 16 March 2023.

<sup>253</sup> *ibid.*

<sup>254</sup> FAO "The FAO Action Plan on Antimicrobial Resistance 2021–2025" (2021).

<sup>255</sup> FAO "Why should policymakers act on antimicrobial resistance in agrifood systems?" (2003) FAO.

antimicrobials in agriculture, in order to reduce AMR in agricultural systems.<sup>256</sup> In 2005, the Codex Committee on Residues of Veterinary Drugs in Foods launched as part of the Codex Alimentarius, the “Code of Practice to Minimize and Contain Foodborne Antimicrobial Resistance”.<sup>257</sup> The objectives set in this document were pointed at reducing the potential negative impacts on public health resulting from the use of antimicrobials in food-producing animals.<sup>258</sup> The document includes principles on different areas such as preventing infections and reducing the need for antimicrobials, the responsible and prudent use of antimicrobials and the use of antimicrobials in specific circumstances. In this last principle, it is included different guidelines on the use of medically important antimicrobials such as the no use of medically important antimicrobial agents for growth promotion.<sup>259</sup>

In 2015, the FAO adopted Resolution 4/2015 on AMR which recognized the increasingly serious threat that AMR constituted to public health and sustainable food production.<sup>260</sup> It also stated the need for an effective response involving all sectors of government and society.<sup>261</sup> An action plan called “FAO Action Plan on antimicrobial resistance 2016-2020” was released a year later to support the implementation of the resolution. The plan was released in line with the WHO’s “Global Action Plan” on AMR and highlighted the necessity to embrace and integrate the “One Health” approach. This plan was later continued by the current action plan, which is the “FAO Action Plan on Antimicrobial Resistance 2021-2025”. The current action plan presents five objectives that guide the programming of FAO activities on AMR.<sup>262</sup> These

---

<sup>256</sup> FAO “Global Forum on Food Security and Nutrition (FSN Forum)- The FAO Action Plan on Antimicrobial Resistance 2016-2020” <<https://www.fao.org/fsnforum/resources/reports-and-briefs/faoaction-plan-antimicrobial-resistance-2016-2020>> accessed 16 March 2023.

<sup>257</sup> FAO Task Force on Antimicrobial Resistance “Code of practice to minimize and contain foodborne antimicrobial resistance” (2005) FAO, CXC 61-2005.

<sup>258</sup> Gracia Brisco “Work of the Codex Alimentarius on Foodborne AMR” Codex Secretariat <[https://cdn.who.int/media/docs/defaultsource/searo/foodsafety/webinarsep21/work-of-the-codex-alimentarius-on-foodborneamr.pdf?sfvrsn=735f5547\\_5Z](https://cdn.who.int/media/docs/defaultsource/searo/foodsafety/webinarsep21/work-of-the-codex-alimentarius-on-foodborneamr.pdf?sfvrsn=735f5547_5Z)> accessed 15 March 2023.

<sup>259</sup> FAO Task Force on Antimicrobial Resistance “Code of practice to minimize and contain foodborne antimicrobial resistance” (2005) FAO, CXC 61-2005.

<sup>260</sup> FAO “Resolution 4/2015 Antimicrobial Resistance” (2015) Report of the conference of FAO Thirty-Ninth Session, C 2015/REP.

<sup>261</sup> *ibid.*

<sup>262</sup> Commission “The FAO Action Plan on Antimicrobial Resistance 2021-2025” (2021) <[https://knowledge4policy.ec.europa.eu/publication/fao-action-plan-antimicrobial-resistance-2021%E2%80%932025\\_en](https://knowledge4policy.ec.europa.eu/publication/fao-action-plan-antimicrobial-resistance-2021%E2%80%932025_en)> accessed 16 March 2023.

are increasing stakeholder awareness and engagement; strengthening surveillance and research; enabling good practices; promoting responsible use of antimicrobials; and strengthening governance and allocating resources sustainably.<sup>263</sup> The objectives that are more related to antimicrobial stewardship and management practices in livestock production are the objectives of enabling good practices, promoting responsible use of antimicrobials and strengthening governance and allocating resources sustainably.

Within the objective of enabling good practices, the plan intends to make accessible guidance for the implementation of good practices for reducing and containing AMR. It also aims at developing and implementing interventions that effectively promote good practices for reducing and containing AMR. Some of the initiatives related to livestock production, within these two lines of work, include: developing guidance for improved management of animal diseases in key food production sectors and establishing training on the application of specific good practices for minimizing and containing AMR, including better diagnosis of diseases in terrestrial animal health at farm level.<sup>264</sup>

The objective set to promote the responsible use of antimicrobials establishes also two lines of work, the first one is aimed at developing and sharing guidance and resources for responsible antimicrobial use, and the second one is aimed at developing and implementing initiatives for enabling responsible antimicrobial use.<sup>265</sup> One of the initiatives related to livestock animals within these two lines of work entails to contribute to the development, revision and update of international standards for prudent antimicrobial use in food and agriculture, in which the OIE guidance for responsible use of antimicrobials in animals is considered to be reviewed.<sup>266</sup>

Lastly, the objective that aims at strengthening governance and allocating resources sustainably, presents two relevant activities for livestock production. One is aimed at supporting FAO members and regional/subregional organizations to review and update relevant legislation

---

<sup>263</sup> FAO "The FAO Action Plan on Antimicrobial Resistance 2021–2025" (2021).

<sup>264</sup> *ibid.*

<sup>265</sup> *ibid.*

<sup>266</sup> *ibid.*

on AMR and AMU in the food and agriculture sectors. The other one is aimed at supporting FAO members and regional/subregional organizations, if requested, in phasing out the use of antimicrobials as growth promoters.<sup>267</sup>

In 2022, the Tripartite became formally a Quadripartite as it welcomed UNEP (United Nations Environment Programme) with the objective to better promote a "One Health" response to AMR that could enhance a coordinated strategy for human, animal and ecosystem health.<sup>268</sup> The goal of this Quadripartite alliance is to safeguard antimicrobial efficacy and guarantee sustainable and equitable access to antimicrobials for responsible and prudent use in human, animal and plant health, while contributing to further implement the Global Action Plan on AMR.<sup>269</sup>

#### 4.2.3 The World Animal Health Organization on AMR

As was previously introduced, the OIE is the intergovernmental organization responsible for improving animal health worldwide.<sup>270</sup> It was founded in response to the dire consequences that a rinderpest outbreak in Belgium in 1920 brought to Europe's food security and animal health.<sup>271</sup> This event served to acknowledge the need for international cooperation in the control of animal diseases.<sup>272</sup> Since then, the organization has been establishing international sanitary policies and has become the reference organization that provides intergovernmental standards not only in animal welfare but also in animal health and veterinary public health.<sup>273</sup> Some of the responsibilities of the OIE include: to analyze and spread veterinary scientific information,

---

<sup>267</sup> *ibid.*

<sup>268</sup> FAO "Antimicrobial Resistance - who we are" <<https://www.fao.org/antimicrobial-resistance/Quadripartite/who-we-are/en/>> accessed 16 March 2023.

<sup>269</sup> *ibid.*

<sup>270</sup> OIE "Who we are" <<https://www.woah.org/en/who-we-are/>> accessed 4 November 2022.

<sup>271</sup> Rinderpest is a highly viral contagious disease that affects mainly cloven-hoofed animals. It caused huge animal population losses and economic disruption. As of 2001, Rinderpest has been eradicated globally. See OIE "Rinderpest" <<https://www.woah.org/en/disease/rinderpest>> accessed 4 November 2022.

<sup>272</sup> OIE "100-year anniversary of the origin of the OIE at the 1921 Paris International Conference" (2021) <<https://bulletin.woah.org/?p=17863>> accessed 30 November 2022.

<sup>273</sup> Elisabeth Erlacher-Vindel, Jacques Acar and Margot Raicek "The OIE commitment to overcoming antimicrobial resistance and why it is important" (2017) <<http://resistancecontrol.info/2017/the-oie-commitment-to-overcomingantimicrobial-resistance-and-why-it-is-important/>> accessed 30 November 2022.

ameliorate the legal framework and the resources of national veterinary services, secure global trade by releasing health standards for international trade in animals and animal products or to foster animal welfare by means of scientific-based approach.<sup>274</sup>

The first time that the OIE recognized the need for AMR containment was in 1997 and since 2010 the organization has grown increasingly focused on this matter.<sup>275</sup> Following the release of the Global Action Plan on AMR in 2016, the OIE's 84th General Assembly adopted the "OIE Strategy on Antimicrobial Resistance". It is the current OIE's policy on AMR, it is in line with the WHO's plan, and as was previously mentioned, it acknowledges the importance of implementing the aforementioned "ONE Health" approach.<sup>276</sup> The strategy has very similar core goals as the Global Action Plan on AMR and serves as a support tool for the 182 OIE's member countries to assess and manage AMR.<sup>277</sup> The mandate of the strategy is reflected through four objectives: awareness and understanding improvement; knowledge strengthening through surveillance and research; good governance and capacity building support, and implementation encouragement of international standards.<sup>278</sup>

The policy is mostly centred on the prudent use of antimicrobials. Some of the measures related to this subject are aimed at, for instance, encouraging member countries to reduce the use of antimicrobials; boosting a professional culture that supports their ethical and responsible use or providing support to member countries in the development, implementation and/or updating of their National Action Plans, policies and regulations related with the use of veterinary products. In addition, in the strategy, the prevention of diseases and the limitation of the use of antimicrobials is also

---

<sup>274</sup> OECD "World Organisation for Animal Health (OIE), in International Regulatory Co-operation: The Role of International Organisations in Fostering Better Rules of Globalisation" (2016) OECD publishing <[https://www.oecd-ilibrary.org/governance/international-regulatory-co-operation/world-organisation-for-animal-health-oie\\_9789264244047-41-en](https://www.oecd-ilibrary.org/governance/international-regulatory-co-operation/world-organisation-for-animal-health-oie_9789264244047-41-en)> accessed 29 December 2022.

<sup>275</sup> Peter Lees and others "A history of antimicrobial drugs in animals: Evolution and revolution" (2021) 44 *Journal of Veterinary Pharmacology and Therapeutics*, 137.

<sup>276</sup> OIE "The OIE Strategy on Antimicrobial Resistance and the Prudent Use of Antimicrobials" (2016).

<sup>277</sup> *ibid.*

<sup>278</sup> *ibid.*

considered an important matter.<sup>279</sup> For this reason, the strategy intends to achieve this by promoting good husbandry practices by means of improving its scientific and guidance materials.<sup>280</sup> Moreover, throughout the strategy, there is an intention of improving animal health and welfare by ensuring the positioning of well-trained veterinarians at the forefront of national and regional actions. Ultimately, the role of the OIE's standards is also acknowledged in the strategy, concretely the OIE standards related to the prudent use of antimicrobials. The organization aims at supporting individual member countries in the implementation of such standards and to encourage the adoption of the OIE List of Antimicrobials of Veterinary Importance.<sup>281</sup>

The OIE international standards can provide harmonization on the implementation of AMR National Plans by setting a common procedure<sup>282</sup> or a point of reference for more consistent development and management.<sup>283</sup> The OIE international standards concerning AMR are enclosed within chapters 6.7 to 6.11 of the Terrestrial Code and chapters 6.1 to 6.5 of the Aquatic Code. These AMR standards provide a variety of methodologies that OIE members can incorporate to appropriately approach the emergence and spread of AMR resulting from the use of antimicrobial agents in animals.<sup>284</sup> Guidelines for AMR in livestock production belong to the Terrestrial Code. In the introduction of these chapters, the OIE recognizes that antimicrobials are essential medicines for animal health and welfare.<sup>285</sup> In chapter 6.10 on the responsible and prudent use of antimicrobial agents in veterinary medicine, the code establishes that the activities on this matter involve all relevant stakeholders (e.g., veterinarians, the veterinary pharmaceutical industry, distributors or food animal producers).<sup>286</sup> Moreover, the objectives on

---

<sup>279</sup> OIE "The OIE Strategy on Antimicrobial Resistance and the Prudent Use of Antimicrobials" (2016).

<sup>280</sup> *ibid.*

<sup>281</sup> *ibid.*

<sup>282</sup> Jorge Pinto Ferreira "Why antibiotic use data in animals needs to be collected and how this can be facilitated" (2017) 4 *Frontiers in Veterinary Science*, 213; Pim Sanders and others "Monitoring of farm-level antimicrobial use to guide stewardship: overview of existing systems and analysis of key components and processes" (2020) 7 *Frontiers in Veterinary Science*, 540.

<sup>283</sup> Jorge Pinto Ferreira "Why antibiotic use data in animals needs to be collected and how this can be facilitated" (2017) 4 *Frontiers in Veterinary Science*, 213.

<sup>284</sup> *ibid.*

<sup>285</sup> See Chapter 6.7 "Introduction to the recommendations for controlling antimicrobial resistance" OIE's Terrestrial Code.

<sup>286</sup> OIE Terrestrial Code, ch 6.10.

responsible and prudent use set that practical measures and recommendations that consider animal health and animal welfare must be considered. Some of the measures to accomplish this objective should entail “ensuring the rational use of antimicrobial agents in animals” or “complying with the ethical obligation and economic need to keep animals in good health”.<sup>287</sup> Veterinarians are responsible for promoting public health, animal health and animal welfare and in order to do so, good animal husbandry methods are recognized in the chapter as one of the elements that reduce the need for antimicrobials use in food-producing animals.<sup>288</sup> In addition, it is established in the same chapter that antimicrobials should only be administered or prescribed by veterinarians, when necessary, and taking into consideration the “OIE List of Antimicrobial Agents of Veterinary Importance”.<sup>289</sup>

This “OIE List of Antimicrobial Agents of Veterinary Importance” was introduced with the aim of safeguarding the efficacy and availability of veterinary antimicrobial agents.<sup>290</sup> It was first adopted in 2007 and it was updated over the years. The version of 2018 is the current one. In this list, antimicrobials are classified into three categories: (1) veterinary critically important antimicrobial agents, (2) veterinary highly important antimicrobial agents and (3) veterinary important antimicrobial agents.<sup>291</sup> In order to fulfil the objective related to the responsible and prudent use of antimicrobials, in the absence of risk analysis, the use of antimicrobial agents as growth promoters should not be contemplated, for those antimicrobials included in this list.<sup>292</sup> However, some of the antimicrobials belonging to the first category (veterinary critically important antimicrobial agents) are requested to be completely banned as growth promoters.<sup>293</sup>

Since 2016, the OIE has been releasing annual reports on the use of antimicrobials intended for use in animals. In the last report of 2022, the data collected among the 157 countries surveyed showed that, in 2020, 40

---

<sup>287</sup> *ibid.*

<sup>288</sup> OIE Terrestrial Code, art 6.10.6.

<sup>289</sup> *ibid*; OIE “OIE list of antimicrobial agents of veterinary importance” (2018).

<sup>290</sup> OIE “OIE list of antimicrobial agents of veterinary importance” (2018).

<sup>291</sup> OIE “OIE list of antimicrobial agents of veterinary importance” (2018).

<sup>292</sup> *ibid.*

<sup>293</sup> *ibid.*

countries were still using antimicrobials as growth promoters.<sup>294</sup> In addition, 15 countries reported using Tylosin, an antibiotic classified as “Critically Important Antimicrobial” for use in humans, as a growth promoter.<sup>295</sup> Moreover, another 6 countries reported using Colistine as a growth promoter, an antibiotic which is classified as “Highest Priority Critically Important” for use in humans.<sup>296</sup> The report concludes making a call to OIE members to carry on with the efforts on the implementation of policies on the use of antimicrobials by following the guidelines of the WHO’s Global Action Plan and respecting the OIE intergovernmental standards. Ultimately, it requests them to include recommendations for the phasing out antimicrobials as growth promoters in the absence of risk analysis.<sup>297</sup>

### 4.3 Interim conclusion

To summarize this chapter, the first part of the analysis showed firstly that the international governance of AMR is based on non-binding governance mechanisms. The policy measures and plans on AMR have been released over the years but there has been increased attention and action given to AMR since the 2000s onwards. This was mainly due to the concerns aroused by the threat that posed the transmission of AMR between animals and humans, and the eventual effects on human health and food safety. This motivated an increase in the implementation of different actions from intergovernmental organizations such as the WHO, the FAO and the OIE. Common measures and actions on animal health were released by these actors, mainly in the area of animal husbandry, and aimed generally at making a responsible use of antimicrobials but also at improving the husbandry and management conditions.

In the next chapter, the governance of AMR within the EU will be illustrated by analysing the implemented law and policies related to farm antimicrobial use. A brief introduction around the first EU actions concerning AMR will be given that will lead out to the current EU plan on AMR and the

---

<sup>294</sup>OIE “Annual Report on Antimicrobial Agents Intended for Use in Animals, 6th edition” 2022.

<sup>295</sup> *ibid.*

<sup>296</sup> *ibid.*

<sup>297</sup> *ibid.*



F2F strategy's objective on AMR. The chapter will conclude with the analysis of the AMR provisions of two recently implemented regulations on veterinary medicinal products and medicated feed.

## 5. EU law and policy related to farm antimicrobial use

### 5.1 Introduction

The last two decades have seen a steady rise in international and national actions aimed at addressing AMR. From the beginning, the European Union has been a key player in contributing to these actions and has shown an ambition to lead and become the best practice region when addressing AMR.<sup>298</sup> Already in 1998, the European Commission set up the EARSS (European Antimicrobial Surveillance System), a European network for AMR surveillance in the human sector.<sup>299</sup> That same year, Council Regulation (EC) No 2821/98 was adopted introducing, on the basis of the precautionary principle, a ban on the use of four antibiotics as additives in animal feedingstuffs, due to the risk of AMR development.<sup>300</sup> Three years later, in 2001, it released the Community Strategy against AMR. This Commission Communication was developed with a focus on human medicine, and it established the foundations for EU actions in the areas of surveillance, research, prevention and international cooperation.<sup>301</sup> Concerning veterinary medicine, the first measures on AMR were included in Directive 2003/99/EC on the monitoring of zoonoses and zoonotic agents, in which specific

---

<sup>298</sup> Michael Anderson and others "Averting the AMR crisis: What are the avenues for policy action for countries in Europe?" (2019) European Observatory on Health Systems and Policies.

<sup>299</sup> Rodolphe Mader and others "Building the European Antimicrobial Resistance Surveillance network in veterinary medicine (EARS-Vet)" (2021) 26 Eurosurveillance; Health Protection Surveillance Center "European Antimicrobial Resistance Surveillance Network (EARS-Net)" <<https://www.hpsc.ie/a-z/microbiologyantimicrobialresistance/europeanantimicrobialresistancesurveillancesystemearss/>> accessed 24 January 2023.

<sup>300</sup> These European bans were attempted to be overturned by two major pharmaceutical companies, ultimately giving rise to two CJEU cases (Case T70/99, Alpharma, Inc. v. Council and Case T-13/99, Pfizer Animal Health SA v. Council). The Court dismissed the cases on the grounds that the European Commission had proper authorization to apply such restrictions on feed additives pursuant the protection of human health. See Meghan F Davis and Lainie Rutkow, "Regulatory Strategies to Combat Antimicrobial Resistance of Animal Origin: Recommendations for a Science-Based U.S. Approach" (2012) 25 Tulane Environmental Law Journal 327; Case T-70/99, Alpharma Inc. v. Council, 2002 E.C.R. II-3495 (Ct. of 1st Instance); T-13/99, Pfizer Animal Health SA v. Council, 2002 E.C.R. II-3305 (2002) (Ct. of 1st Instance).

<sup>301</sup> Elta Smith and others "Evaluation of the EC Action Plan against the rising threats from antimicrobial resistance: final report" (2016) Publications Office of the European Union.

measures were set to monitor antimicrobial resistance in zoonotic agents.<sup>302</sup> The importance of the prudent use of antimicrobials in animal health was recognised in 2006 when an EU-wide ban on the use of antibiotics as growth promoters in animal feed was introduced.<sup>303</sup> As was explained in chapter 2 on animal welfare, this ban derives from the fact that the use of antibiotics as growth promoters contributes highly to the emergence of AMR, ultimately threatening food safety and public health. In 2011, the first AMR plan was issued, called "Action Plan against the rising threats from AMR".<sup>304</sup> The plan served to reinforce the "Community strategy against AMR" of 2001 and to address AMR in the human and animal health areas by integrating the "One Health" approach.<sup>305</sup> However, the Council conclusions of 2016, on the next steps to combat antimicrobial resistance, manifested the need for the development of a renovated EU action plan on AMR.<sup>306</sup> Consequently, and following also the launch of the WHO's Global Action Plan, the Commission adopted in 2017 the "European One Health Action Plan against antimicrobial resistance (AMR)".<sup>307</sup>

---

<sup>302</sup> Infectious diseases are characterised for being transmissible between non-human animals and humans. See "Zoonotic Diseases" from Centers for Disease Control and Prevention <<https://www.cdc.gov/onehealth/basics/zoonotic-diseases.html>> accessed 24 January 2023; Directive 2003/99/EC of the European Parliament and of the Council of 17 November 2003 on the monitoring of zoonoses and zoonotic agents, amending Council Decision 90/424/EEC and repealing Council Directive 92/117/EEC (2003) OJ L 325.

<sup>303</sup> Michael Anderson and others "Averting the AMR crisis: What are the avenues for policy action for countries in Europe?" (2019) European Observatory on Health Systems and Policies.

<sup>304</sup> Commission "Communication from the Commission to the European Parliament and the Council Action plan against the rising threats from Antimicrobial Resistance" (2011) COM (2011) 748.

<sup>305</sup> Commission "The new EU one health action plan against antimicrobial resistance" (2017) <[https://www.resistenciaantibioticos.es/sites/default/files/biblioteca\\_universidades/04a\\_eu-amr-action-plan-summary\\_2017\\_en.pdf](https://www.resistenciaantibioticos.es/sites/default/files/biblioteca_universidades/04a_eu-amr-action-plan-summary_2017_en.pdf)> accessed 23 January 2023; Snjezana Zrncic "European Union's Action Plan on Antimicrobial Resistance and Implications for Trading Partners with Example of National Action Plan for Croatia" (2021) 33 Asian Fisheries Science, 75.

<sup>306</sup> Council "Council conclusions on the next steps under a One Health approach to combat antimicrobial resistance" (2016) OJ C 269.

<sup>307</sup> European Court of Auditors "Addressing antimicrobial resistance: progress in the animal sector, but this health threat remains a challenge for the EU- Special report No 21/2019, 2019)" (2019) <[https://www.eca.europa.eu/Lists/ECADocuments/SR19\\_21/SR\\_Antimicrobial\\_resistance\\_EN.pdf](https://www.eca.europa.eu/Lists/ECADocuments/SR19_21/SR_Antimicrobial_resistance_EN.pdf)> accessed 23 January 2023.

## 5.2 European One Health Action Plan against antimicrobial resistance

The European One Health Action Plan against AMR (2017 AMR EU Action Plan) is the current non-binding plan in place in the EU. It builds on the 2011 action plan by presenting actions in the areas of human health and animal health, and it includes environmental actions so as to expand the “One Health” scope approach.<sup>308</sup> In the plan, it is sought to address AMR more properly by improving the areas of data collection, monitoring and surveillance.<sup>309</sup> The overarching goal of this plan is to conserve the feasibility of effective treatment of human and animal infections. In order to do so, the plan constitutes a framework for sustained and more wide-ranging action, serving to minimize the emergence and spread of AMR and to increase the development and availability of new effective antimicrobials within and outside the EU.<sup>310</sup> Three main pillars cement the plan: (1) to make the EU a best practice region, (2) to boost research, development and innovation on AMR and (3) to shape the global agenda.<sup>311</sup> Within these pillars, different and concrete actions are set to modify or reinforced existing actions or to address identified gaps within the EU response against AMR.<sup>312</sup>

The plan centres the actions on areas with the highest added value for the EU Member States, being the prudent use of antimicrobials, infection prevention, and cross-sectorial collaboration, some of the areas that receive attention.<sup>313</sup> Concerning actions on AMR that have a relation with animal husbandry, the European Commission aims at improving and promoting the prudent use of antimicrobials. It states in the plan that it will “work towards EU implementing and delegated acts under the forthcoming veterinary medicinal products and medicated feed Regulations”.<sup>314</sup> These mentioned Regulations, which were adopted in 2019, are Regulation 2019/6 on

---

<sup>308</sup> Commission “A European One Health Action Plan Against Antimicrobial Resistance” (2017) COM(2017)339.

<sup>309</sup> *ibid.*

<sup>310</sup> *ibid.*

<sup>311</sup> *Ibid.*

<sup>312</sup> *ibid.*

<sup>313</sup> *ibid.*

<sup>314</sup> *ibid.*

veterinary medicinal products and Regulation 2019/4 on medicated feed, which will be analysed in the next section.<sup>315</sup> In relation to measures that seek better prevention and control of AMR, it is acknowledged in the plan that infection prevention, biosecurity measures and control practices contribute to reducing the use of antimicrobials.<sup>316</sup> For this reason, and in relation to animal husbandry, it is stated that the Commission will “continue to promote animal husbandry, including aquaculture and livestock farming systems, and feeding regimes, which support good animal health and welfare to reduce antimicrobial consumption”.<sup>317</sup> Lastly, within pillar 3 on shaping the global agenda, the Commission’s will to continue contributing to the work development performed by the WHO, the OIE and the FAO on the different international frameworks and standards, norms, guidelines and methodologies connected with AMR is stated.

After the release of the 2017 AMR EU Action Plan, a number of updates in the form of strategies, programmes and decisions followed in order to further strengthen the EU’s response against AMR. One of the most relevant actions involving AMR came in 2020, when the Commission adopted the F2F Strategy.<sup>318</sup> This Strategy, which is part of the Green Deal, strives for making food systems within the EU more sustainable across all related dimensions and aims at reducing its impact on third countries.<sup>319</sup> In the Strategy, an important objective related to AMR, aimed at making a reduction of 50% in sales of antimicrobials for farmed animals and aquaculture by 2030 is established.<sup>320</sup> In order to support the objective’s achievement, the Strategy relies on the two Regulations above mentioned and which are, Regulation 2019/6 on veterinary medicinal products and Regulation 2019/4 on medicated feed.<sup>321</sup>

---

<sup>315</sup> Commission “Veterinary medicines and medicated feed” <[https://food.ec.europa.eu/animals/animal-health/vet-meds-med-feed\\_en](https://food.ec.europa.eu/animals/animal-health/vet-meds-med-feed_en)> accessed 25 January 2023.

<sup>316</sup> Commission “A European One Health Action Plan Against Antimicrobial Resistance” (2017) COM(2017)339.

<sup>317</sup> *ibid.*

<sup>318</sup> Commission “A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system” (2020) COM/2020/381 final.

<sup>319</sup> *ibid.*

<sup>320</sup> *ibid.*

<sup>321</sup> Commission “Veterinary medicines: New rules to promote animal health and fight antimicrobial resistance now apply” (Press Release) (2022) IP/22/663.

Lastly, it is relevant to add that in the year of the application of these Regulations, a ban on the use of Zinc Oxide for therapeutic purposes started to be applicable. Zinc oxide is an inorganic compound with antimicrobial activity that used to be incorporated into veterinary medicines and regularly administered orally for the prevention and control of post-weaning diarrhoea in piglets.<sup>322</sup> The introduction of the Commission's ban consisted of the withdrawal of all marketing authorisations for veterinary medicines containing zinc oxide. The consideration for the withdrawal was due to concerns associated with environmental risk due to its toxicity to plants and aquatic organisms, and the contribution to the incidence of AMR, which outweighed the benefits of zinc oxide in the prevention of piglet diarrhoea.<sup>323</sup> Consequently, it was put in evidence that the introduction of the Zinc Oxide ban together with the ban on preventative group treatments with antibiotics, called for different management approaches to avoid post-weaning diarrhoea, such as increasing the piglet's weaning age.<sup>324</sup>

### 5.3 Regulation 2019/6 of 11 December 2018 on Veterinary Medicinal Products

Commission proposals for a new regulation on veterinary medicinal products started in 2014 and were approved by the European Council and Parliament four years later, in 2018. A year later, in January 2019, the Regulation entered into force.<sup>325</sup> Before the entrance of Regulation 2019/6 on Veterinary Medicinal Products (VMP Regulation), Directive 2001/82/EC and Regulation (EC) 726/2004 constituted the legal frameworks that governed the market placement, manufacturing, export, import, supply, distribution,

---

<sup>322</sup> European Medicines Agency (EMA) "Zinc Oxide" <<https://www.ema.europa.eu/en/medicines/veterinary/referrals/zinc-oxide>> accessed 12 March 2023.

<sup>323</sup> *ibid*; PAN Germany and HCWH Europe "Veterinary medicine in European food production: Perspectives on the environment, public health, and animal welfare" 2021.

<sup>324</sup> Alliance to Save Our Antibiotics "New European Union rules on farm antibiotic use" (2020) <<https://www.saveourantibiotics.org/media/1842/2022-changes-to-european-law-farm-antibiotics.pdf>> accessed 12 March 2023.

<sup>325</sup> Gregory Bacon and Janna Lawrence "New EU Regulation for Veterinary Medicinal Products" <<https://www.lexology.com/library/detail.aspx?g=82a5f686-7358-4d2c-a285-5e8440fc9a12>> accessed 24 January 2023.

pharmacovigilance, control and the use of veterinary medicinal products.<sup>326</sup> On January 2022, the VMP Regulation entered into force, replacing part of Regulation (EC) 726/2004 and repealing Directive 2001/82/EC.<sup>327</sup> The transition from directive to regulation would mean therefore, that no longer measures within the new legislative act needed to be transposed into national legislation and therefore, not leading to different interpretations and implementation discrepancies between Member States since the Regulation would be enforced uniformly throughout the EU.<sup>328</sup> The implication of this uniform enforcement would strengthen the EU fight against AMR since, as was stated previously, AMR requires to be approached with common and coordinated actions.

The overall purpose of the Regulation's introduction was to accomplish EU's "Better Regulation", this is, to base policymaking on evidence; improve, simplify, and avoid unnecessary burdens in law; and to involve in decision-making processes citizenship, business, and stakeholders.<sup>329</sup> This new Regulation provided a modern, innovative and fit-for-purpose legal framework that could respond to the needs of the veterinary sector.<sup>330</sup> One of the important steps forward of the VMP Regulation was implemented in conjunction with Regulation 2019/5, which amended the EU pharmaceutical legal framework and developed a legal framework specific for veterinary medicinal products.<sup>331</sup> It allowed that veterinary medicinal products to no longer be subject to the authorisation system for human medicines, setting

---

<sup>326</sup> Regulation (EU) 2019/6 of the European Parliament and of the Council of 11 December 2018 on veterinary medicinal products and repealing Directive 2001/82/EC (2019) OJ L 4 (Regulation (EU) 2019/6).

<sup>327</sup> *ibid.*

<sup>328</sup> Ferry van Bergen-Henegouw "Understanding the difference between EU Directives and EU Regulations" <<https://certification-experts.com/understanding-the-difference-between-eu-directives-and-eu-regulations/>> accessed 1 March 2023.

<sup>329</sup> Commission "Better Regulation: Why and How" <[https://commission.europa.eu/law/law-making-process/planning-and-proposing-law/better-regulation\\_en](https://commission.europa.eu/law/law-making-process/planning-and-proposing-law/better-regulation_en)> accessed 10 May 2023.

<sup>330</sup> European Medicines Agency (EMA) "Veterinary Medicinal Products Regulation (VMP-Reg, Regulation (EU) 2019/6)" <[https://aacting.org/swfiles/files/AACTING\\_Advent-Talk\\_2020\\_Freischem.pdf](https://aacting.org/swfiles/files/AACTING_Advent-Talk_2020_Freischem.pdf)> accessed 23 January 2023.

<sup>331</sup> Regulation (EU) 2019/5 of the European Parliament and of the Council of 11 December 2018 amending Regulation (EC) No 726/2004 laying down Community procedures for the authorisation and supervision of medicinal products for human and veterinary use and establishing a European Medicines Agency, Regulation (EC) No 1901/2006 on medicinal products for paediatric use and Directive 2001/83/EC on the Community code relating to medicinal products for human use (2019) OJ L4.

consequently, a prominent divergence between human and veterinary medicinal products regulation at EU level.<sup>332</sup>

The scope of the VMP Regulation covers the authorisation, use and monitoring of veterinary medicinal products in the EU.<sup>333</sup> To improve the safety and availability of veterinary medicinal products and strengthen its legal framework, different key objectives are included in the new legislation. One objective that is particularly relevant for the analysis of this thesis, is the objective that is set to enhance EU measures against AMR.<sup>334</sup> The other objectives, although not related to AMR, are set to reduce the administrative burden on companies and regulatory authorities, improve the internal EU market for veterinary medicinal products, and stimulate innovation of new and existing medicines.<sup>335</sup>

Regarding specifically the actions directed at addressing AMR and promoting a more prudent and responsible use of antibiotics in animals, they are illustrated in seven elements hereunder:

- 1- Measures on careful and responsible use of antimicrobials; article 107(1) states that “Antimicrobial medicinal products shall not be applied routinely nor used to compensate for poor hygiene, inadequate animal husbandry or lack of care or to compensate for poor farm management”.<sup>336</sup>

---

<sup>332</sup> Regulation (EU) 2019/6.

<sup>333</sup> Shabbir Simjee and Gabriella Ippolito “European regulations on prevention use of antimicrobials from January 2022” (2022) 44 Brazilian Journal of Veterinary Medicine.

<sup>334</sup> Van Bael & Bellis “Veterinary Medicines – Publication of Regulation (EU) 2019/6 of December 2018 Modernising EU Regulatory Framework”(2019) <[https://www.vbb.com/media/Newsletters/Memorandum\\_Regulation\\_on\\_Veterinary\\_Medicinal\\_Products.pdf](https://www.vbb.com/media/Newsletters/Memorandum_Regulation_on_Veterinary_Medicinal_Products.pdf)> accessed 25 January 2023.

<sup>335</sup> European Medicines Agency (EMA) “Veterinary Medicinal Products Regulation (VMP-Reg, Regulation (EU) 2019/6)” <[https://aacting.org/swfiles/files/AACTING\\_Advent-Talk\\_2020\\_Freischem.pdf](https://aacting.org/swfiles/files/AACTING_Advent-Talk_2020_Freischem.pdf)> accessed 23 January 2023; ANSES “What does the new European regulation on veterinary medicinal products change?” (2022) <<https://www.anses.fr/en/content/what-does-new-european-regulation-veterinary-medicinal-productschange#:~:text=Its%20main%20objectives%20include%20improving,and%20reducing%20the%20administrative%20burden>> accessed 28 January 2023; Van Bael & Bellis “Veterinary Medicines – Publication of Regulation (EU) 2019/6 of December 2018 Modernising EU Regulatory Framework” (2019)<[https://www.vbb.com/media/Newsletters/Memorandum\\_Regulation\\_on\\_Veterinary\\_Medicinal\\_Products.pdf](https://www.vbb.com/media/Newsletters/Memorandum_Regulation_on_Veterinary_Medicinal_Products.pdf)> accessed 25 January 2023.

<sup>336</sup> Regulation (EU) 2019/6, art 107 (1).



- 2- Ban on the use of antimicrobials on groups for prophylaxis purposes; under article 107(3) "Antimicrobial medicinal products shall not be used for prophylaxis other than in exceptional cases, for the administration to an individual animal or a restricted number of animals when the risk of an infection or of an infectious disease is very high and the consequences are likely to be severe". In such cases, and following article 105, the veterinarian must provide justification for the prescription.<sup>337</sup> Moreover, in the same article it is stated that "the quantity of the medicinal products prescribed shall be limited to the amount required for the treatment or therapy concerned. As regards antimicrobial medicinal products for metaphylaxis or prophylaxis, they shall be prescribed only for a limited duration to cover the period of risk".<sup>338</sup>
- 3- Restriction measures on the use of antimicrobials for metaphylactic purposes. Article 105 (1) states that "A veterinary prescription for an antimicrobial medicinal product for metaphylaxis shall only be issued after a diagnosis of the infectious disease by a veterinarian". As with prophylaxis applications, paragraph 6 of the mentioned article applies, limiting the quantity of antimicrobials prescribed for treatment to the amount required for the concerned disease. Also, to issue antimicrobials, these can only be prescribed to cover the duration of the risk period. In addition, article 107(4) specifies also, regarding metaphylactic purposes, that "Antimicrobial medicinal products shall be used for metaphylaxis only when the risk of spread of an infection or of an infectious disease in the group of animals is high and where no other appropriate alternatives are available".<sup>339</sup>
- 4- EU Member States obligation to collect data on the sale and use of antimicrobials; Collection of antimicrobial sales data and its annual

---

<sup>337</sup> Regulation (EU) 2019/6, art 105 (2).

<sup>338</sup> Regulation (EU) 2019/6, art 105 (6).

<sup>339</sup> Regulation (EU) 2019/6, art 107 (4).

publication by Member States has shown to be a prominent contributor to major reductions in farm antimicrobial usage in Europe.<sup>340</sup> The VMP Regulation states under article 57 (1) that “Member States shall collect relevant and comparable data on the volume of sales and on the use of antimicrobial medicinal products used in animals”. While the data on sales was already gathered by EU countries and submitted to the EMA annually before the entrance of the Regulation, this article introduces the requirement of gathering also data on the use of antimicrobials per animal species.<sup>341</sup> Delegated Regulation (EU) 2021/578 establishes the agenda in which this requirement will be introduced gradually for the different species.<sup>342</sup>

- 5- Reinforced ban on the use of antimicrobials for growth promotion and yield increase as stated in article 107(2) “Antimicrobial medicinal products shall not be used in animals for the purpose of promoting growth nor to increase yield”.<sup>343</sup>
- 6- List of antimicrobials reserved to be utilized in humans only; Under Article 37(5) it is stated that “The Commission shall, by means of implementing acts, designate antimicrobials or groups of antimicrobials reserved for treatment of certain infections in humans”. The result of this article is the development of a list of antimicrobials to be reserved for human medicine use and that are not to be applied in veterinary medicine under any circumstance.
- 7- Two prohibitions incorporated to imports of animals and products of animal origin from third countries. Under article 118 it is stated “Article

---

<sup>340</sup> Cólín Nunan “Achieving responsible farm antibiotic use through improving animal health and welfare in pig and poultry production. Ending routine farm antibiotic use in Europe” (2022) <<https://epha.org/wp-content/uploads/2022/02/report-ending-routine-farm-antibiotic-use-in-europe-final-2022.pdf>> accessed 10 January 2023.

<sup>341</sup> *ibid.*

<sup>342</sup> Commission delegated regulation (EU) 2021/578 of 29 January 2021 supplementing Regulation (EU) 2019/6 of the European Parliament and of the Council with regard to requirements for the collection of data on the volume of sales and on the use of antimicrobial medicinal products in animals [2021] OJ L 123.

<sup>343</sup> Regulation (EU) 2019/6, art 107 (2).

107(2) shall apply, *mutatis mutandis*, to operators in third countries and those operators shall not use the designated antimicrobials referred to in Article 37(5), insofar as relevant in respect of animals or products of animal origin exported from such third countries to the Union".<sup>344</sup> The implications of this article are that the ban on using antimicrobials as growth promoters and the list of antimicrobials reserved to be administered in humans only, apply also to animals and products of animal origin imported from non-EU countries.

To put it concisely, the application of VMP Regulation brought in the non-need for legislation transposition and the implementation of uniform enforcement throughout the EU of the measures introduced. The measures related to AMR entailed: the non-routinary application of antimicrobials; the non-use of antimicrobials to compensate for poor hygiene and husbandry; a ban on prophylactic use of antimicrobials on groups of animals; different restrictions on metaphylactic use of antimicrobials; an obligation to collect data on the sale and use of antimicrobials; a reinforce ban on the use of antimicrobials for growth promotion; the introduction of a list of antimicrobials reserved for human treatment only; and the incorporation of prohibitions on imports of animals and products of animal origin from third countries regarding two of the mentioned measures.

## 5.4 Regulation 2019/4 of 11 December 2018 on Medicated Feed

Medicated feed refers to a special type of feed that incorporates veterinary medicinal products, forming a homogeneous mixture that does not require further processing.<sup>345</sup> It is given orally to animals and is mainly applied to treat an animal disease within large groups, such as pigs and poultry, in which

---

<sup>344</sup> Regulation (EU) 2019/6, art 118.

<sup>345</sup> Commission "Medicated feed - safe and controlled oral treatment" <[https://food.ec.europa.eu/animals/animal-health/vet-meds-med-feed/medicated-feed-safe-and-controlled-oral-treatment\\_en](https://food.ec.europa.eu/animals/animal-health/vet-meds-med-feed/medicated-feed-safe-and-controlled-oral-treatment_en)> accessed 24 January 2023; Shabbir Simjee and Gabriella Ippolito "European regulations on prevention use of antimicrobials from january 2022" (2022) 44 Brazilian Journal of Veterinary Medicine

individual treatments tend to be logistically not feasible to perform.<sup>346</sup> Medicated feed represents one of the three forms by which antimicrobials can be provided orally to a herd, being the other two the administration of antimicrobials in the water supply and the administration by manual mixing into feed. While all three methods are covered by the VMP Regulation, medicated feed, due to its consideration as a type of feed, has a specific legal framework for its manufacture, placement on the market and use, which is currently Regulation 2019/4 (MF Regulation).<sup>347</sup> In addition, and due to its consideration as feed, the general principles of Regulation 178/2002 (General Food Law Regulation) apply to the placing on the market and use of medicated feed.<sup>348</sup> Ultimately, medicated feed and its intermediate products, fall also under Regulations 183/2005,<sup>349</sup> 767/2009,<sup>350</sup> 1831/2003,<sup>351</sup> and Directive 2002/32/EC.<sup>352</sup>

Before the adoption of Regulation 2019/4, the manufacture, placement on the market and use of medicated feed within the EU was regulated by Directive 90/167/EEC.<sup>353</sup> However, the national transposition of this legal

---

<sup>346</sup> *ibid.*

<sup>347</sup> Regulation (EU) 2019/4 of the European Parliament and of the Council of 11 December 2018 on the manufacture, placing on the market and use of medicated feed, amending Regulation (EC) No 183/2005 of the European Parliament and of the Council and repealing Council Directive 90/167/EEC (2019) OJ L 4 (Regulation (EU) 2019/4); C  il  n Nunan "Achieving responsible farm antibiotic use through improving animal health and welfare in pig and poultry production. Ending routine farm antibiotic use in Europe" (2022) <<https://epha.org/wp-content/uploads/2022/02/report-ending-routine-farm-antibiotic-use-in-europe-final-2022.pdf>> accessed 10 January 2023.

<sup>348</sup> Regulation (EU) 2019/4.

<sup>349</sup> Regulation (EC) No 183/2005 of the European Parliament and of the Council of 12 January 2005 laying down requirements for feed hygiene (2005) OJ L 35.

<sup>350</sup> Regulation (EC) No 767/2009 of the European Parliament and of the Council of 13 July 2009 on the placing on the market and use of feed, amending European Parliament and Council Regulation (EC) No 1831/2003 and repealing Council Directive 79/373/EEC, Commission Directive 80/511/EEC, Council Directives 82/471/EEC, 83/228/EEC, 93/74/EEC, 93/113/EC and 96/25/EC and Commission Decision 2004/217/EC (2009) OJ L 229.

<sup>351</sup> Regulation (EC) No 1831/2003 of the European Parliament and of the Council of 22 September 2003 on additives for use in animal nutrition (2003) OJ L 268.

<sup>352</sup> Directive 2002/32/EC of the European Parliament and of the Council of 7 May 2002 on undesirable substances in animal feed (2002) OJ L 140; Regulation (EU) 2019/4, rec 8.

<sup>353</sup> Commission "Proposal for a Regulation of the European Parliament and of the Council on the manufacture, placing on the market and use of medicated feed and repealing Council Directive 90/167/EEC" (2014) COM (2014) 556 final.

instrument together with the fact that it was established before the creation of the internal market and was never adjusted accordingly, called for the implementation of a harmonised framework that could reduce financial and administrative burdens and that could also support innovation on veterinary medicine applications.<sup>354</sup> As with Regulation 2019/6, the Commission submitted a proposal in 2014 which was later adopted by the Parliament and the Council of the EU in 2018. The MF Regulation entered into force also in 2019, thus repealing Directive 90/167/EEC.<sup>355</sup>

The new Regulation on medicated feed entered into force in the beginning of 2022. Its main aims are to guarantee a proper level of public health protection, high safety and quality standards for product manufacturing and to raise the availability of medicated feed, including medicated food for companion animals.<sup>356</sup> Moreover, the MF Regulation seeks to foster a proper, prudent, and responsible use of antimicrobials with the purpose of addressing AMR among animals and preventing the dissemination of antibiotic-resistant bacteria through the food chain.<sup>357</sup> The Regulation incorporates different key points. It sets a series of rules at every stage of the chain, from production to distribution, such as hygiene facilities aspects or manufacturing and quality control aspects. It also sets rules on the use of medicated feed, such as the prescription of medicated feed to be applied exclusively to the animals for which the veterinary prescription has been granted. Moreover, it incorporates different measures aimed at contributing to the EU's action against AMR. Lastly, this Regulation also created the legal framework for manufacturing, placing on the market and use of medicated pet food.<sup>358</sup>

Regarding specifically the measures directed at contributing to the EU's actions against AMR with a particular focus on prescription and disease control and disease prevention, the MF Regulation has incorporated the following measures that we detail in four elements, as follows:

---

<sup>354</sup> *ibid.*

<sup>355</sup> Regulation (EU) 2019/4.

<sup>356</sup> *ibid.*

<sup>357</sup> Publications Office of the European Union "Medicated animal feed-manufacture, marketing and use" (2019) <<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM:4384446>> accessed 25 January 2023.

<sup>358</sup> *ibid.*

- 1- Restriction on the validity and duration of veterinary prescriptions; under article 16(7) it is stated that, with the exception of non-food-producing animals, “medicated feed shall not be used for more than one treatment under the same veterinary prescription for medicated feed”. In addition, it is stated that “The duration of a treatment shall comply with the summary of product characteristics of the veterinary medicinal product incorporated in the feed and, where not specified, shall not exceed one month, or two weeks in case of a medicated feed containing antibiotic veterinary medicinal products”.<sup>359</sup>
  
- 2- Prescription of medicated feed by the veterinarian to be limited, according to article 16(9), to one veterinary medicinal product containing antimicrobials, “the veterinarian shall not prescribe medicated feed with more than one veterinary medicinal product containing antimicrobials”.<sup>360</sup>
  
- 3- Ban on prophylactic use. Article 17(3) states “Medicated feed containing antimicrobial veterinary medicinal products shall be used in accordance with Article 107 of Regulation (EU) 2019/6, except as regards paragraph 3 thereof, and shall not be used for prophylaxis”.<sup>361</sup> This article from the VMP Regulation, referred to routine use of antimicrobials, compensation for poor husbandry and management conditions, prohibition on use as growth and yield promoters and restrictions on prophylactic and metaphylactic purposes. As it can be seen, Article 17 (3) from the MF Regulation, introduces a complete ban on prophylaxis for medicated feed. However, within the same article, it is included as an exception, medicated feed containing antiparasitic and immunological veterinary medicines.
  
- 4- Restrictions on metaphylactic use; Recital 27 alludes to the VMP Regulation stating that medicated feed presenting antimicrobials and

---

<sup>359</sup> Regulation (EU) 2019/4, art 16(7).

<sup>360</sup> Regulation (EU) 2019/4, art 16(9).

<sup>361</sup> Regulation (EU) 2019/4, art 17(3).

that will be used for metaphylactic purposes, should only be allowed when the risk of spread of an infection or of an infectious disease is considered high.<sup>362</sup>

In summary, the application of MF Regulation introduced measures on AMR aimed at restricting the validity and duration of medicated feed prescriptions, limiting the prescription of medicated feed to one veterinary medicinal product containing antimicrobials, banning prophylactic uses (except for antiparasitics and immunologics) and restricting metaphylactic uses.

---

<sup>362</sup> Regulation (EU) 2019/4, para 27.

## 6. Discussion

This thesis examined six research questions (one main research question and five research sub-questions). The answers to these different questions are formulated based on the analysis performed previously through the different chapters and can be found hereunder:

**Sub-question 1:** What is the relation between farm animal welfare and the use of antimicrobials?

Farm animal welfare and the use of antimicrobials present a relationship where the improvement of animal welfare influences the reduction of antimicrobial use. Improvement of animal welfare in farms by means of the improvement of husbandry conditions or/and management practices, reduces the stress of animals, contributing to not triggering the occurrence of disease due to, for example, a decrease in their immunological system. As a result, the amount of disease cases needing antimicrobial treatment could see a reduction, as was illustrated in chapter 2 section 2.

**Sub-question 2:** What are the main international standards addressing animal welfare in animal husbandry, especially for stocking density in pigs and poultry and early weaning in piglets?

The international main standards addressing animal welfare are provided by the OIE, the so-call OIE international standards. For the case studies analysed (stocking density in broilers and pigs and weaning of piglets), some recommendations within the "Terrestrial Animal Health Code" were found. The standards on stocking density for broilers, recommend taking into consideration the incidence of disease, among a group of animals, when defining the ratio of stocking density. However, no mention of a maximum stocking density value is stated. With regards to the stocking density of pigs, the OIE includes within its standards, the recognition that high stocking densities may increase stress or the occurrence of injuries. It recommends taking morbidity rates and mortality as criteria to determine whether there exists an inadequate ratio of stocking density. As with poultry standards, a



reference value in relation to maximum stocking density/space allowance is not provided. Lastly, concerning the case study of weaning in piglets, the OIE does include in the standards a reference value of 21 days but it does recommend delaying weaning to the age of 28 days or more since it can bring meaningful health benefits and less use of antimicrobials. However, as it was explained in chapter 4, since the international standards are of non-binding nature, it is left up to the OIE's member countries to implement or not, such standards and recommendations.

**Sub-question 3:** How does the EU regulate animal welfare in animal husbandry, especially for stocking density in pigs and poultry and early weaning in piglets?

In the EU, the regulation of stocking density in broilers can be found in Directive 2007/43/EC. The Directive provides a maximum stocking density baseline for broilers of 33 kg of chicken per square metre. However, it is possible to increase, by means of a derogation, the maximum stocking density value to 39 kg/m<sup>2</sup>, provided that some requirements are met. One of the most relevant requirements entails maintaining levels of NH<sub>3</sub> within holdings below 20 ppm. In addition, it is possible to apply for a second derogation to increase the stocking density up to 42 kg/m<sup>2</sup> which would translate in practice, into 21 broilers (of 2 kg each) per square meter. The most relevant additional requirement for implementing this maximum stocking density entails presenting low levels of mortality. However, the Directive states that Member States can still concede an increase in stocking density up to 42 kg/m<sup>2</sup>, even when the records of mortality are excessive. Interestingly, in the EU 26% of broilers are kept at the maximum stocking density of 42 kg/m<sup>2</sup> and only 34% of broilers are kept at 33 kg/m<sup>2</sup>. As it was illustrated in chapter 3, section 2.2, existing research highlights the importance of keeping stocking densities below 25 kg/m<sup>2</sup> to avoid major welfare problems. Moreover, the recently released scientific opinion from EFSA on the welfare of broilers on farms, states that to prevent welfare issues, a maximum stocking density of 11kg/m<sup>2</sup> should be established. These findings evidence that EU legislation concerning stocking density in broilers, is far from being in line with current scientific evidence.

Concerning the maximum stocking density of pigs in the EU, its regulation can be found in Council Directive 2008/120/EC. For pigs reaching 110 kg or more, the minimum legal floor space is 1 m<sup>2</sup>. If pigs weigh less than 110 kg but more than 85 kg, the minimum legal floor space falls to 0,65m<sup>2</sup>. As was included in chapter 3, section 2.3, a scientific study on organic pig production systems revealed that the lower stocking density values that they were applying were one of the factors that contributed to lower antibiotic usage.<sup>363</sup> The regulation of organic production schemes for pigs establishes that it should be provided for pigs up to 110 kg, a total floor space of 2,3 m<sup>2</sup> per pig and for pigs up to 85 kg a total floor space of 1,9 m<sup>2</sup>. EFSA also recently released a scientific opinion on the welfare of EU farmed pigs. In it, although a reference value is not stated, a recommendation to increase the space allowance in pigs is included with the aim to avoid welfare issues that lead eventually to processes, such as tail biting, which often requires antimicrobial treatment.

Lastly, the weaning of pigs in the EU is regulated also by Council Directive 2008/120/EC. The minimum weaning age set by the Directive is at 28 days of age. However, a reduction to 21 days of age is allowed provided that different hygienic and biosecurity actions are performed. As was illustrated in section 3.3 of chapter 3, these hygienic and biosecurity requirements entail mainly the compartmentalization of animals and the disinfection and cleaning of the space where the animals are reared. In practice, the complexity to apply these requirements is not high, which can lead to their routinary implementation and therefore, the selection of a weaning age of 21 days instead of 28 days to increase productivity. Scientific evidence showed that farms that were applying higher weaning ages than 28, presented lower antibiotic use in weaned piglets. In addition, the scientific opinion from EFSA on the welfare of pigs on farms acknowledges that a higher weaning age than the current legal of 21 and 28 days, brings meaningful positive results to the piglet's welfare. The opinion states that the exception allowing earlier weaning at 21 days, should be reconsidered and that there is

---

<sup>363</sup> Cecillie Liv Nielsen and others "Antibiotic and medical zinc oxide usage in Danish conventional and welfare-label pig herds in 2016–2018" (2021) 189 Preventive Veterinary Medicine.

a need for further research on the welfare benefits of weaning ages higher than 28 days.

**Sub-question 4:** What are the main international actors and actions regulating AMR at the farm level?

The analysis of this section showed that binding mechanisms that could govern internationally AMR, do not exist presently. In fact, the entire international governance of AMR is based on non-binding governance mechanisms. The main intergovernmental organizations that have released over the years non-binding instruments, such as policies or strategies on AMR with a particular focus on animal health, have been the WHO, FAO and the OIE. These three actors recognise that an important volume of antimicrobial use is related to livestock production. For this reason, within their plans and strategies, they present common measures and actions in the area of animal husbandry aimed generally at making a responsible use of antimicrobials. They highlight the need to reduce non-therapeutic uses of antimicrobials and to phase out the use of antimicrobials as growth promoters. They also state the importance of strengthening infection prevention and disease control measures. Importantly, the OIE also includes within its OIE international standards the recognition that good animal husbandry methods are a significant element in the reduction of antimicrobial use. Moreover, these standards specify that measures implemented at achieving a responsible and prudent use of antimicrobials should take into consideration animal health and animal welfare. However, it is important to remember that despite the efforts made at the international to establish these policy measures and recommendations, they remain non-binding and consequently non-enforceable.

**Sub-question 5:** What are the main EU policies and legal measures that currently address AMR at the farm level?

The EU has become a key contributor to the different actions proposed by these intergovernmental organisations, and it has shown ambition to become

best practice region when addressing AMR. Its measures on animal health are also mostly addressed at improving and promoting a prudent use of antimicrobials and at the prevention of disease infection. Within its most recent policy document on AMR, the recognition that biosecurity measures and control practices contribute to reducing the use of antimicrobials is included. Moreover, the will to promote within the EU, animal husbandry systems that support good animal health and welfare to reduce antimicrobial consumption is also present. Some of the actions to become best practice region could already be seen back in 2006 when the EU introduced a wide ban on the use of antimicrobials as growth promoters in animal feed. More recently, the Commission withdrew all marketing authorisations for veterinary medicines containing zinc oxide due to concerns associated with antimicrobial resistance but also environmental contamination. In addition, the EU introduced two regulations, Regulation 2019/6 on veterinary medicinal products and Regulation 2019/4 on medicated feed. One of the goals of these two Regulations is to contribute to the F2F Strategy objective on the reduction of 50% of the use of antimicrobial sales for farmed animals and aquaculture by 2030. For doing so, the two Regulations include several measures related to AMR.

The most relevant measures on AMR, within Regulation 2019/6 on Veterinary Medicinal Products introduce a ban on the routinary application of antimicrobials; a ban on the use of antimicrobials to compensate for poor hygiene and husbandry; a ban on antimicrobial prophylaxis on groups; restrictions on antimicrobial metaphylaxis; a reinforce ban on antimicrobial use for growth promotion; the establishment of a list of antimicrobials reserved for humans only; and the incorporation of prohibitions on imports of animals and products of animal origin from third countries which use antimicrobials as growth promoters, and which use antimicrobials registered within the list of antimicrobials reserved for humans only. Likewise, the most relevant measures on AMR, within Regulation 2019/4 on medicated feed, introduce a restriction on the validity and duration of medicated feed prescriptions, a limitation of the prescription of medicated feed to one veterinary medicinal product containing antimicrobials, the prohibition of medicated feed prophylaxis (with the exception of antiparasitics and immunologics) and the introduction of restrictions on medicated feed

metaphylaxis, to be used for such purposes only when the risk of spread of an infection or of an infectious disease is considered high. The introduction of these measures, served to reinforce the ban of 2006 on the use of antimicrobials for growth promotion and also served to reduce other uses of antimicrobials within large groups of animals. However, the implementation of restrictions on metaphylactic use and the ban on prophylactic use, could require the improvement and/or change of husbandry and management practices in order to maintain the health status within a farm.

In fact, the OIE and the EU share the recognition and recommendation that good animal husbandry conditions and also good animal welfare, contribute to the successful application of the measures on prudent and responsible use of antimicrobials, which ultimately can lead to an antimicrobial use reduction. As stated above, Regulation 2019/6 on Veterinary Medicinal Products introduced as a legal measure the non-use of antimicrobials to compensate for poor husbandry. The introduction of these recognitions, recommendations and legal measures is due to the close link between animal welfare, animal health and disease. When animals are kept under conditions that enable them to present good welfare, their levels of stress are reduced. As a consequence, low levels of stress bring along positive physical and psychological states for those animals which minimizes their disease susceptibility. Ultimately, the reduction in the incidence of disease, due to the application of good animal welfare, decreases the use of antimicrobials.

Husbandry conditions and management practices are two factors that, when incorrectly applied, decrement the welfare of farm animals which potentially can lead to the occurrence of disease due to stress-triggered immune suppression. In this thesis, stocking density rules on pigs and broilers, and weaning rules on piglets were analysed as two factors within husbandry conditions and management practices that could have a relation between animal welfare and antimicrobial use in farms.

Scientific evidence has shown that high levels of stocking density in broilers and pigs are among the key factors that affect their welfare and health and in addition, a link between high stocking densities and higher preventive use of antimicrobials has been described too.

**Main research question:** What is the relation between AMR governance and farm animal welfare governance in the EU?

Having reviewed the main findings of this master research, which helped in answering the sub-questions of the research, different considerations and interpretations can be drawn to answer the main research question.

Firstly, the relevant threat that AMR poses to human health has motivated a large increase in international actions, over the last years, from different intergovernmental and governmental organisations. The complexity of the spread and increase of AMR have pushed the call for the integration of the participation of several sectors and the implementation of common and coordinated action. Notwithstanding, these proposed international actions, which are part of policy plans and strategies, are still in nature soft law. Consequently, these actions are not formally enforceable against a member country pertaining to the intergovernmental organisations, since the policy documents proposed are nonbinding. This “handicap” must be taken into consideration since a clear desired result on AMR might not happen if the international measures to address AMR are not broadly and properly implemented throughout the different member countries. A notable example is the case explained in chapter two concerning antimicrobial use for growth promotion. The non-therapeutic use of antimicrobials for animal growth promotion is scientifically known to be a major contributor to the increase of AMR. While this non-therapeutic use is banned since 2006 in the entirety of the EU, in 2020, 40 countries part of the OIE, were still using antimicrobials as growth promoters. In addition, 6 of them even used for this purpose, an antibiotic classified as “Highest Priority Critically Important” for use in humans, showing up the major difficulties that remain around this area.

Secondly, even if measures on AMR are extensively and properly implemented globally, the role of the different factors, such as animal welfare, in influencing these implemented measures in achieving the desired results, must be acknowledged. AMR measures destined to prevent disease infection by improving husbandry conditions and management practices, recognise that whichever the improvements to consider, they need to provide good animal welfare in farms to prevent the occurrence of disease. Likewise, the achievement of the measures on antimicrobial stewardship measures

which ultimately aim at a reduction of the use of antimicrobials, either in therapeutic or non-therapeutic treatments, depends on the level of animal welfare. If preventive uses of antimicrobials are banned, but the animal welfare within a farm remains poor (due to, for example, inadequate husbandry conditions or inadequate management practices), animals will eventually develop injuries or diseases that will require therapeutic treatment, instead of preventive treatment. An illustration of this is the recently implemented measures on AMR within Regulation 2019/6 and Regulation 2019/4. These Regulations introduced a ban on prophylaxis use in groups and some restrictions when applying antimicrobials with metaphylactic purposes. If conditions within a farm do not favour animal welfare, farmers that were applying antimicrobials with preventive purposes to compensate for the lack of good husbandry conditions and good management practices, will see eventually, an increase in disease incidence. Ultimately, these farmers will have to rely again on antimicrobials, this time for therapeutic purposes, to treat the illness. For this reason, AMR measures seem necessary to be established in conjunction with animal husbandry and animal welfare measures that support good animal welfare in farms.

Thirdly, in this thesis, the different rules for stocking density in broilers and pigs, and the different rules for weaning in piglets were analysed. Stocking density and weaning are respectively, elements of husbandry conditions and management practises. When these elements are applied inadequately, they have been linked, in these particular groups of animals, with poor animal welfare and high use of antimicrobials for preventive purposes.

At the international level, the standards established by the OIE on stocking density for broilers and pigs can be described as vague and generic, and do not include a reference value of recommended stocking density for these animals. Therefore, the lack of reference value within these OIE standards, does not facilitate a minimum stocking density value that favours animal welfare and ultimately reduces antimicrobial use. Concerning the weaning of piglets, the OIE standards *do* include a recommendation on the age of weaning for piglets. However, this recommendation is not in line with the current scientific evidence, which shows that weaning age around 35 days results in a reduction in antimicrobial use. Nevertheless, OIE's

recommendation on applying weaning ages above 28 days to favour animal health and reduce antimicrobial use must be considered a positive starting point.

At the EU level, it was seen that still, a prominent percentage of EU countries (26%) were using the higher stocking density levels allowed, therefore surpassing by almost 4 times the recommended ratio established by EFSA to avoid major animal welfare issues. In addition, the two derogations that allowed increasing further the stocking density required keeping levels of NH<sub>3</sub> only below 20 ppm while EFSA reports stated that levels above 10 ppm could already increase the predisposition for respiratory diseases. It is made evident therefore that current implemented rules for these two factors in the EU are far from being in line with scientific evidence.

Concerning the stocking density in pigs, organic production schemes for pigs, which have stricter rules for stocking density, have shown that a higher space allowance per pig decreases the use of antimicrobials. In addition, the most recent EFSA opinion on pigs shows that an increase in the current legal space allowance per pig would see a reduction in antimicrobial use. This shows that rules on stocking density need to be updated to current scientific evidence if there is a will to see a reduction in antimicrobial use.

With regards to EU rules on the weaning age of piglets, the fact that most piglets are weaned at 21 days of age and that scientific evidence shows that weaning at 35 days decreases largely antimicrobial use, shows once again, that there is a need for an update of the current rules. Positively, the EFSA opinion includes the aim to reconsider the suitability of weaning at 21 days and aims to continue the study of the welfare benefits of increasing the age of weaning above 28 days.

Lastly, the final consideration of this master thesis builds on all the previously stated arguments and considerations. The governance of farm animal welfare and AMR in the EU present a positive influence relationship where the improvement of the former contributes to the implementation of the later. For this reason, not improving and updating the rules on the areas analysed on animal welfare could result in the inefficacy of some of the main relevant AMR measures introduced in Regulation 2019/6 and Regulation 2019/4 which were aimed at reducing the preventive use of antimicrobials. The governance of AMR can be regarded as a pyramid, where the foundations



are the direct actions and measures implemented to address AMR. The second step in the pyramid could be the global implementation of such actions and measures by means of a common approach and involvement from several actors from different areas involved. The following step in this pyramid could be the improvement of those elements that indirectly affect the result of the proposed AMR actions, which in this case would be farm animal welfare. For this reason, it can be concluded that the will for the AMR measures to bring meaningful results which contain further the rise of AMR and safeguard human health, can and must motivate the implementation of improved farm animal welfare regulations within the EU that contribute in preventing diseases, and ultimately in reducing the use of antimicrobials.

## **7. Conclusion and recommendations**

This thesis contributed to the study of the interrelation between AMR governance and farm animal welfare governance in the EU. The different sub-questions formulated to support the main research question, in the area of AMR governance, showed the emphasis of the EU in establishing measures that are aimed at addressing antimicrobial use. The study of the intergovernmental AMR measures also allowed spotlighting the connection and alignment of the European AMR policy measures with the international measures. This connection showed the clear direction of the different actors in having a common action framework for better addressing AMR. The other different formulated sub-questions around animal welfare, which also helped in supporting the main research question, showed the need for improvement of the different international standards and the EU legal measures. The international standards reviewed around animal welfare lacked alignment with current scientific evidence and also were insufficient. Moreover, the EU animal welfare legislation also lacked alignment with current scientific evidence concerning animal welfare and AMR, which ultimately could derive in impeding the implemented AMR measures to cast successful results. For this reason, different policy and research recommendations, derived from the performed analysis, are presented hereunder:

### **OIE animal welfare standards**

To introduce recommended parameters, closely aligned with the latest scientific evidence, concerning the stocking density of broilers and pigs in order to enhance animal welfare and contribute to reducing animal disease. In addition, to include in the recommendation, that if the established recommended ratios cannot be met, stocking density should be set not only according to the incidence of disease or mortality rates (as already set in the standards) but also taking into consideration as criteria, the presence of optimal welfare within an animal flock. Concerning the weaning of piglets, the recommended parameter should be established at 28 days of age, instead of at 21 days of age. The statement recommending to delay the weaning age above 28 days of age if possible, should be kept.

### **EU stocking legal measures for broilers**

To reduce the incidence of disease and enhance animal welfare within EU broiler farms, the two derogations that allow keeping stocking densities higher than 33 kg/m<sup>2</sup> should be deleted. In addition, the feasibility of implementing lower maximum limits of broiler stocking density than 33 kg/m<sup>2</sup> and ranging between 11 kg/m<sup>2</sup> and 25 kg/m<sup>22,3</sup> should be further studied. Lastly, the maximum level of ammonia set at 20 ppm should be deleted and a further evaluation of the feasibility of establishing maximum levels of ammonia in broiler farms of 10 ppm should be performed.

### **EU stocking legal measures for pigs**

In order to avoid animal welfare issues that lead to tail biting and an increase in antimicrobial use, the current minimum floor space requirements should be reviewed with the aim to consider a further increase of such requirements, closely in line with current scientific evidence.

### **EU weaning legal measures for piglets**

In order to reduce the stress and dietary issues triggered by early weaning which results in high antimicrobial use, the EU legal minimum for the weaning age of piglets should be set at 28 days. In addition, further studies should be performed on the feasibility to increase the weaning age to 35 days in order to present lower consumption rates of antimicrobials.

To conclude, as was mentioned in the introduction chapter of this thesis, although scientific literature has already explored the subject of animal welfare's potential in contributing to addressing AMR, not significant attention has been given to the law and policy area's perspectives. The purpose of this thesis was to contribute to filling this gap, however, since the research performed was focused in the law on the books, it would be worthwhile for future research, to also complement the study of this subject with empirical research.

## 8. Bibliography

Abbott K and Snidal D "Hard and Soft Law in International Governance" (2000) 54 *Legalization and World Politics*, 421.

ADAS UK Ltd and University of Arkansas "Comparison of the Regulatory Framework and Key Practices in the Poultry Meat Supply Chain in the EU and USA" (2016) <<https://britishpoultry.org.uk/identity-cms/wpcontent/uploads/2018/05/2016-ADAS-EU-US-comparison.pdf>> accessed 10 March 2023.

Adedeji WA, "The treasure called antibiotics" (2016) 14 *Annals of Ibadan postgraduate medicine* 56-57.

Adinolfi F, Di Pasquale J and Capitanio F "Economic Issues on Food Safety" (2016) 5 *Italian Journal of Food Science*.

Albernaz-Gonçalves R, Olmos G and Hötzel MJ "My pigs are ok, why change? - animal welfare accounts of pig farmers" (2021) 15 *Animal*.

Alliance to Save Our Antibiotics "New European Union rules on farm antibiotic use" (2020) <<https://www.saveourantibiotics.org/media/1842/2022-changes-to-european-law-farm-antibiotics.pdf>> accessed 12 March 2023.

AMCRA "Antimicrobial Consumption and Resistance in Animals (Belgium), L'importance de l'âge du sevrage Un jour de plus, ça compte?" <<https://www.amcra.be/fr/nouvelles/het-belang-van-speenleeftijd-mag-het-een-dagje-meer-zijn/lid=14308>> accessed 20 February 2023.

American Veterinary Medical Association "Animal welfare: What is it?" <<https://www.avma.org/resources/animal-health-welfare/animal-welfare-what-it>> accessed 10 January 2023.

Anderson M and others "A governance framework for development and assessment of national action plans on antimicrobial resistance" (2019) 19 The Lancet Infectious Diseases.

Anderson M and others "Averting the AMR crisis: What are the avenues for policy action for countries in Europe?" (2019) European Observatory on Health Systems and Policies.

Animal Human Society "The Five Freedoms for animals" <<https://www.animalhumanesociety.org/health/fivefreedomanimals#:~:text=The%20Five%20Freedoms%20are%20internationally,for%20companion%20animals%20in%20shelters>> accessed 10 January 2023.

ANSES "What does the new European regulation on veterinary medicinal products change?" (2022) <<https://www.anses.fr/en/content/what-does-new-european-regulation-veterinarymedicinalproductschange#:~:text=Its%20main%20objectives%20include%20improving,and%20reducing%20the%20administrative%20burden>> accessed 28 January 2023.

ASC LLM Support – UWE "Research Methods: Doctrinal Methodology" <<https://uweascllmsupport.wordpress.com/2017/01/18/research-methods-doctrinal-methodology/>> accessed 16 April 2023.

AVEC secretariat "This is European Poultry, High-quality poultry with European guarantee" accessed 10 March 2023.

Aziz T and Barnes J "Harmful effects of ammonia on birds, Poultry World" (2010) <<http://www.poultryworld.net/Breeders/Health/2010/10/Harmful-effectsof-ammonia-on-birds-WP008071W/>> accessed 21 January 2023.

Bacon G and Lawrence J "New EU Regulation for Veterinary Medicinal Products" <<https://www.lexology.com/library/detail.aspx?g=82a5f686-7358-4d2c-a285-5e8440fc9a12>> accessed 24 January 2023.

Balzani A and Hanlon A "Factors that Influence Farmers" Views on Farm Animal Welfare: A Semi Systematic Review and Thematic Analysis" (2010)

Bellini S "The pig sector in the European Union" in Laura Iacolina and others (eds), *Understanding and combatting African Swine Fever* (Wageningen Academic Publishers 2021).

Brisco G "Work of the Codex Alimentarius on Foodborne AMR" Codex Secretariat <[https://cdn.who.int/media/docs/defaultsource/searo/foodsafety/webinarsep21/work-of-the-codex-alimentarius-onfoodborneamr.pdf?sfvrsn=735f5547\\_5Z](https://cdn.who.int/media/docs/defaultsource/searo/foodsafety/webinarsep21/work-of-the-codex-alimentarius-onfoodborneamr.pdf?sfvrsn=735f5547_5Z)> accessed 15 March 2023.

Broom D "Behaviour and welfare in relation to pathology" (2006) 97, *Applied Animal Behaviour Science*, 73.

Broom D and Fraser A "Domestic animal behaviour and welfare" (2015) in Donald M Broom and Andrew F Fraser (eds) *Welfare and behaviour in relation to disease*, 237.

Campbell J, Crenshaw J and Polo J "The biological stress of early weaned piglets" (2013) 4 *Journal of Animal Science and Biotechnology*.

Cars O and Nordberg P "Antibiotic resistance—the faceless threat" (2005) 17 *International Journal of Risk & Safety in Medicine*, 103.

Case T-13/99, Pfizer Animal Health SA v. Council, 2002 E.C.R. II-3305 (2002) (Ct. of 1st Instance).

Case T-70/99, Alpharma Inc. v. Council, 2002 E.C.R. II-3495 (Ct. of 1st Instance).

Centers for Disease Control and Prevention "Zoonotic Diseases" <<https://www.cdc.gov/onehealth/basics/zoonotic-diseases.html>> accessed 24 January 2023.

Cerrate S "Stocking Density and Farm Profitability in Broiler Chickens" (2021) <<https://en.engormix.com/poultry-industry/articles/stocking-density-farm-profitability-t48377.htm>> accessed 27 February 2023.

Commission "A European One Health Action Plan Against Antimicrobial Resistance" (2017) COM(2017)339.

Commission "A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system"(2020) COM/2020/381 final.

Commission "Ban on antibiotics as growth promoters in animal feed enters into effect" IP/05/1687 <[https://ec.europa.eu/commission/press-corner/detail/en/IP\\_05\\_1687](https://ec.europa.eu/commission/press-corner/detail/en/IP_05_1687)> accessed 10 January 2023.

Commission "Better Regulation: Why and How" <[https://commission.europa.eu/law/law-making-process/planning-and-proposing-law/better-regulation\\_en](https://commission.europa.eu/law/law-making-process/planning-and-proposing-law/better-regulation_en)> accessed 10 May 2023.

Commission "Communication from the Commission to the European Parliament, the Council and the European Economic and Social Committee on the European Union Strategy for the Protection and Welfare of Animals 2012-2015"(2012) COM(2012) 6 final/2.

Commission "Communication from the Commission to the European Parliament and the Council Action plan against the rising threats from Antimicrobial Resistance" (2011) COM (2011) 748.

Commission "Medicated feed - safe and controlled oral treatment" <<https://food.ec.europa.eu/animals/animal-health/vet-meds-med->

feed/medicated-feed-safe-and-controlled-oral-treatment\_en> accessed 24 January 2023.

Commission "Proposal for a Regulation of the European Parliament and of the Council on the manufacture, placing on the market and use of medicated feed and repealing Council Directive 90/167/EEC" (2014) COM (2014) 556 final.

Commission "Report from the Commission to the European Parliament and the Council on the application of Directive 2007/43/EC and its influence on the welfare of chickens kept for meat production, as well as the development of welfare indicators" (2018) COM/2018/0181.

Commission "Review of the operation of the Scientific Committee on Animal Health and Animal Welfare" (2003).

Commission "Revision of the animal welfare legislation" <[https://food.ec.europa.eu/animals/animal-welfare/evaluations-and-impact-assessment/revision-animal-welfare-legislation\\_en](https://food.ec.europa.eu/animals/animal-welfare/evaluations-and-impact-assessment/revision-animal-welfare-legislation_en)> accessed 7 March 2023.

Commission "The FAO Action Plan on Antimicrobial Resistance 2021–2025" (2021)<[https://knowledge4policy.ec.europa.eu/publication/fao-action-plan-antimicrobial-resistance-2021%E2%80%932025\\_en](https://knowledge4policy.ec.europa.eu/publication/fao-action-plan-antimicrobial-resistance-2021%E2%80%932025_en)> accessed 16 March 2023.

Commission "The new EU one health action plan against antimicrobial resistance"(2017)<[https://www.resistenciaantibioticos.es/sites/default/files/bibliotecauniversidades/04a\\_eu-amr-action-plan-summary\\_2017\\_en.pdf](https://www.resistenciaantibioticos.es/sites/default/files/bibliotecauniversidades/04a_eu-amr-action-plan-summary_2017_en.pdf)> accessed 23 January 2023.

Commission "Veterinary medicines and medicated feed" <[https://food.ec.europa.eu/animals/animal-health/vet-meds-med-feed\\_en](https://food.ec.europa.eu/animals/animal-health/vet-meds-med-feed_en)> accessed 25 January 2023.



Commission “Veterinary medicines: New rules to promote animal health and fight antimicrobial resistance now apply” (Press Release) (2022) IP/22/663.

Commission delegated regulation (EU) 2021/578 of 29 January 2021 supplementing Regulation (EU) 2019/6 of the European Parliament and of the Council with regard to requirements for the collection of data on the volume of sales and on the use of antimicrobial medicinal products in animals [2021] OJ L 123.

Commission Regulation (EC) No 889/2008 of 5 September 2008 laying down detailed rules for the implementation of Council Regulation (EC) No 834/2007 on organic production and labelling of organic products with regard to organic production, labelling and control (2008) OJ L 250 (Regulation (EC) No 889/2008).

Commission, Directorate-General for Health and Food Safety “Study on the application of the broiler Directive DIR 2007/43/EC and development of welfare indicators : final report” (2017) Publications Office.

Compassion in World Farming “EFSA Publishes comprehensive opinion on pig welfare” (2022) <<https://www.compassioninfoodbusiness.com/our-news/2022/08/efsa-publishes-comprehensive-opinion-on-pig-welfare>> accessed 11 March 2023.

Compassion in World Farming “EFSA publishes new report on broiler chicken welfare” (2023) <<https://www.compassioninfoodbusiness.com/our-news/2023/03/efsa-publishes-new-report-on-broiler-chicken-welfare>> accessed 9 March 2023.

Compassion in World Farming and Heather Pickett “Welfare of pigs in the European Union; The urgent need for reform of existing legislation and effective enforcement” (2009).

Consilium Europa "Evaluation of the EU Animal Welfare Strategy 2012-2015 Information from the European Commission" <<https://www.consilium.europa.eu/media/49315/background-note-evaluation-of-the-eu-animal-welfare-strategy-2012-2015.pdf>> accessed 7 March 2023.

Cooper B and O Okello W "An economic lens to understanding antimicrobial resistance: disruptive cases to livestock and wastewater management in Australia" (2021) 65 Australian Journal of Agricultural and Resource Economics.

Council "Council conclusions on the next steps under a One Health approach to combat antimicrobial resistance" (2016) OJ C 269.

Council Directive 1999/74/EC of 19 July 1999 laying down minimum standards for the protection of laying hens (2019) OJ L 203.

Council Directive 2007/43/EC of 28 June 2007 laying down minimum rules for the protection of chickens kept for meat production (2007) OJ L 182.

Council Directive 2008/119/EC of 18 December 2008 laying down minimum standards for the protection of calves (2009) OJ L 10.

Council Directive 2008/120/EC of 18 December 2008 laying down minimum standards for the protection of pigs (2009) OJ L 47 (Council Directive 2008/120/EC).

Council Directive 74/577/EEC of 18 November 1974 on stunning of animals before slaughter (1974) OJ L 316.

Dadgostar P "Antimicrobial Resistance: Implications and Costs" (2019) 12 Infection and drug resistance, 390.

Dalla Villa P and others "Drivers for animal welfare policies in Europe" (2014) 33, *Revue Scientifique et Technique* (International Office of Epizootics) 39.

Davis M and Rutkow L "Regulatory Strategies to Combat Antimicrobial Resistance of Animal Origin: Recommendations for a Science-Based U.S. Approach" (2012) 25 *Tulane Environmental Law Journal* 327.

De Briyne and others "Antibiotics most commonly used to treat animals in Europe" (2014) 175 *The Veterinary Record*.

de Jong I and others "Scientific report updating the EFSA opinions on the welfare of broilers and broiler breeders" (2012) 9 *Supporting Publications* 2012.

Directive 2002/32/EC of the European Parliament and of the Council of 7 May 2002 on undesirable substances in animal feed (2002) OJ L 140; Regulation (EU) 2019/4.

Directive 2003/99/EC of the European Parliament and of the Council of 17 November 2003 on the monitoring of zoonoses and zoonotic agents, amending Council Decision 90/424/EEC and repealing Council Directive 92/117/EEC (2003) OJ L 325.

Directorate-General for Agriculture and Rural Development, Jean-Louis Peyraud, and Michael MacLeod "Future of EU livestock : How to contribute to a sustainable agricultural sector ? Final report" (2020) Publications Office.

Düpján S and Stamp Dawkins M "Animal Welfare and Resistance to Disease: Interaction of Affective States and the Immune System" (2022) 9 *Frontiers in Veterinary Science*.

EduCheer "Doctrinal and non-doctrinal research" <<https://educheer.com/research-papers/doctrinal-and-non-doctrinal-research/>> accessed 16 April 2023.

EFSA AHAW Panel (EFSA Panel on Animal Health and Animal Welfare) and others "Scientific Opinion on the welfare of broilers on farm" (2023) 21 EFSA Journal 2023.

EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare) and others "Scientific Opinion on the welfare of pigs on farm" (2022) 20 EFSA Journal 2022.

EMA (European Medicines Agency) and EFSA (European Food Safety Authority) "EMA and EFSA Joint Scientific Opinion on measures to reduce the need to use antimicrobial agents in animal husbandry in the European Union, and the resulting impacts on food safety (RONAFA)" (2017) 15 EFSA Journal 2017.

Erlacher-Vindel E, Acar J and Raicek M "The OIE commitment to overcoming antimicrobial resistance and why it is important" (2017) <<http://resistancecontrol.info/2017/the-oie-commitment-to-overcoming-antimicrobial-resistance-and-why-it-is-important/>> accessed 30 November 2022.

European Court of Auditors "Addressing antimicrobial resistance: progress in the animal sector, but this health threat remains a challenge for the EU-Special report No 21/2019, 2019)" (2019) <[https://www.eca.europa.eu/Lists/ECADocuments/SR\\_19\\_21/SR\\_Antimicrobial\\_resistance\\_EN.pdf](https://www.eca.europa.eu/Lists/ECADocuments/SR_19_21/SR_Antimicrobial_resistance_EN.pdf)> accessed 23 January 2023.

European Court of Auditors "Animal welfare in the EU: closing the gap between ambitious goals and practical implementation" (2018) Special report No 31, Publications office of the European Union.

European Food Safety Authority (EFSA) "Animal Welfare" <[https://www.efsa.europa.eu/en/topics/topic /animal-welfare](https://www.efsa.europa.eu/en/topics/topic/animal-welfare)> accessed 10 January 2023.

European Medicines Agency (EMA) "Information session on antimicrobial resistance Initiatives presented to EMA Working Parties with Patients, Consumers and Healthcare Professionals on 19 September 2017" (2017) EMA/648538/2017.

European Medicines Agency (EMA) "Veterinary Medicinal Products Regulation (VMP-Reg, Regulation (EU) 2019/6)" <[https://aacting.org/swfiles/files/AACTING\\_Advent-Talk\\_2020\\_Freischem.pdf](https://aacting.org/swfiles/files/AACTING_Advent-Talk_2020_Freischem.pdf)> accessed 23 January 2023.

European Medicines Agency (EMA) "Zinc Oxide" <<https://www.ema.europa.eu/en /medicines/veterinary/referrals/zinc-oxide>> accessed 12 March 2023.

European Parliamentary Research Service "EU animal welfare strategy, 2012-2015: State of play and possible next steps" (2016) PE 589.831.

European Parliamentary Research Service "On-farm animal welfare: Implementation of EU law 2022" (2022) PE 698.834.

European Parliamentary Research Service "The EU pig meat sector" (2020) PE 652.044.

European Parliamentary Research Service "The EU poultry meat and egg sector Main features, challenges and prospects" (2019) PE 644.195.

FAO "About FAO" <<https://www.fao.org/about/en/>> accessed 16 March 2023.

FAO "Antimicrobial Resistance - who we are" <<https://www.fao.org/antimicrobial-resistance/Quadripar-tite/who-we-are/en/>> accessed 16 March 2023.

FAO "Antimicrobial resistance, what is it?" <<https://www.fao.org/antimicrobial-resistance/background/what-is-it/en/>> accessed 12 January 2023.

FAO "Antimicrobial resistance" <<https://www.fao.org/fao-who-codexalimentary/thematic-areas/antimicrobial-resistance/en/>> accessed 9 May 2023.

FAO "Global Forum on Food Security and Nutrition (FSN Forum)- The FAO Action Plan on Antimicrobial Resistance 2016-2020" <<https://www.fao.org/fsnforum/resources/reports-and-briefs/faoaction-plan-antimicrobial-resistance-2016-2020>> accessed 16 March 2023.

FAO "Resolution 4/2015 Antimicrobial Resistance" (2015) Report of the conference of FAO Thirty-Ninth Session, C 2015/REP.

FAO "Status Report on Antimicrobial Resistance" (2015) C 2015/28 Rev.1.

FAO "The FAO Action Plan on Antimicrobial Resistance 2021–2025" (2021).

FAO "Why should policymakers act on antimicrobial resistance in agrifood systems?" (2003) FAO.

FAO Task Force on Antimicrobial Resistance "Code of practice to minimize and contain foodborne antimicrobial resistance" (2005) FAO, CXC 61-2005.

Farm Animal Welfare Committee "Farm animal welfare: health and disease"(2012)<[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/324616/FAWC\\_report\\_on\\_farm\\_animal\\_welfare\\_-\\_health\\_and\\_disease.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/324616/FAWC_report_on_farm_animal_welfare_-_health_and_disease.pdf)> accessed 10 January 2023.

Federation of Veterinarians Europe "Ban on veterinary use of colistin would impact animal welfare" (2022) <<https://fve.org/ban-on-veterinary-use-of-colistin-would-impact-animal-welfare/>> accessed 9 May 2023.

Food Navigator "EU Farm to Fork Strategy: How far does it go for animal welfare" (2022) <[https://www.foodnavigator.com/Article/2022/03/23/eu-farm-to-fork-strategy-how-far-does-it-go-for-animalwelfareutm\\_source=copyright&utm\\_medium=OnSite&utm\\_campaign=copyright](https://www.foodnavigator.com/Article/2022/03/23/eu-farm-to-fork-strategy-how-far-does-it-go-for-animalwelfareutm_source=copyright&utm_medium=OnSite&utm_campaign=copyright)> accessed 10 March 2023.

Fraser D "Animal Welfare and the Intensification of Animal Production: An Alternative Interpretation" (2005) Food and Agriculture Organization of the United Nations (FAO).

Fraser D "Toward a global perspective on farm animal welfare" (2008) 113, *Applied Animal Behaviour Science*, 330.

Fraser D, Mench J and Millman S "Farm animals and their welfare in 2000" in Deborah J Salem and Andrew N Rowan (eds) *The state of the animals*, 87 (Humane Society Press, 2001).

Gabriel B and others "Comparison of governance approaches for the control of antimicrobial resistance: Analysis of three European countries" (2018) 7 (28) *Antimicrobial Resistance & Infection Control*.

GHK and ADAS UK (Food Policy Evaluation Consortium) "Evaluation of the EU Policy on Animal Welfare and Possible Policy Options for the Future" (2010) <<http://www.vuzv.sk/DBWelfare/vseob/2013/3%20Final%20Report%20%20EUPAW%20Evaluation.pdf>> accessed 9 May 2023.

Gilbert M and others "Income Disparities and the Global Distribution of Intensively Farmed Chicken and Pigs" (2015) 10 *Plos One*.

Global Health Now "The World Health Assembly: What It Does, Why It Matters" <<https://globalhealthnow.org/2022-05/world-health-assembly-what-it-does-why-it-matters>> accessed 14 November 2022.

Grethe H "The Economics of Farm Animal Welfare"(2017) 9 Annual Review of Resource Economics, 75.

Health Protection Surveillance Center "European Antimicrobial Resistance Surveillance Network (EARS-Net)" <<https://www.hpsc.ie/a-z/microbiologyantimicrobialresistance/europeanantimicrobialresistancesurveillancsystemearss/>> accessed 24 January 2023.

Hewson C "What is animal welfare? Common definitions and their practical consequences" (2003) 44 Canadian Veterinary Journal, 496.

Hoelzer K and others "Antimicrobial drug use in food-producing animals and associated human health risks: what, and how strong, is the evidence?" (2017) 13 BMC Veterinary Research, 211.

Hoffman S and Behdinan A "Towards an international treaty on antimicrobial resistance" (2016) 47 Ottawa Law Review, 507.

Hoffman S and others "An international legal framework to address antimicrobial resistance" (2015) 93 Bull World Health Organization, 66.

Hoffman S and others "Strategies for achieving global collective action on antimicrobial resistance" (2015) 93 Bulletin of the World Health Organization, 867.

Holman D and others "Weaning age and its effect on the development of the swine gut microbiome and resistome" (2021) 6 Applied and Industrial Microbiology.



Horgan R and Gavinelli A "The expanding role of animal welfare within EU legislation and beyond" (2006) 103, *Livestock Science*, 303.

Hughes L, Hermans P and Morgan K "Risk factors for the use of prescription antibiotics on UK broiler farms" (2008) 61 *Journal of Antimicrobial Chemotherapy*, 947.

Ingenbleek P "EU animal welfare policy: Developing a comprehensive policy framework" (2012) 37 *Food Policy*, 690.

Institute of Medicine (US) Forum on Emerging Infections and others "Resistance Phenomenon in Microbes and Infectious Disease Vectors: Implications for Human Health and Strategies for Containment: Workshop Summary" (2003) National Academies Press.

Intergroup on the welfare and conservation of animals "Discussion about the EU Farm to Fork Strategy and the EU Biodiversity Strategy for 2030" <<https://www.animalwelfareintergroup.eu/news/discussion-about-eu-farm-fork-strategy-and-eu-biodiversity-strategy-2030>> accessed 7 March 2023.

International Organization for Animal Protection (OIPA) "The European Commission publishes the evaluation of EU's strategy for the protection and welfare of animals" (2021) <<https://www.oipa.org/international/evaluation-eu-animal-welfare-strategy/>> accessed 7 March 2023.

Juliusson C "Animal welfare activities under the Farm to Fork Strategy" (2020) DG SANTE/G5 Animal Health Advisory Committee <[https://food.ec.europa.eu/system/files/2020-11/comm\\_ahac\\_20201029\\_pres-05a.pdf](https://food.ec.europa.eu/system/files/2020-11/comm_ahac_20201029_pres-05a.pdf)> accessed 10 March 2023.

Kasimanickam V, Kasimanickam M and Kasimanickam R "Antibiotics Use in Food Animal Production: Escalation of Antimicrobial Resistance: Where Are We Now in Combating AMR?" (2021) 9 *Medical Sciences*, 14.

- Kauppinen T and others "Improving animal welfare: qualitative and quantitative methodology in the study of farmers attitudes" (2010) 19 *Animal Welfare*, 523.
- Lees P and others "A history of antimicrobial drugs in animals: Evolution and revolution" (2021) 44 *Journal of Veterinary Pharmacology and Therapeutics*, 137.
- Lhermie G, Gröhn Y and Raboisson D "Addressing Antimicrobial Resistance: An Overview of Priority Actions to Prevent Suboptimal Antimicrobial Use in Food-Animal Production" (2017) 7 *Frontiers in Microbiology*.
- Li X and others "Effects of stocking density on growth performance, blood parameters and immunity of growing pigs" (2020) 6 *Animal Nutrition*, 529.
- Li Y and others "Space allowance determination by considering its coeffect with toy provision on production performance, behavior and physiology for grouped growing pigs" (2021) *Livestock Science*.
- Liv Nielsen C and others "Antibiotic and medical zinc oxide usage in Danish conventional and welfare-label pig herds in 2016–2018" (2021) 189 *Preventive Veterinary Medicine*.
- Longland A "Pastures and pasture management" (2013) *Equine Applied and Clinical Nutrition*, 332.
- Mader R and others "Building the European Antimicrobial Resistance Surveillance network in veterinary medicine (EARS-Vet)" (2021) 26 *Eurosurveillance*.
- Maes D and others "A critical reflection on intensive pork production with an emphasis on animal health and welfare" (2020) 98 *Journal Animal Science*.

Marshall M "The World Health Organization" (New Scientist) <<https://www.newscientist.com/definition/world-health-organization/>> accessed 20 December 2022.

McInerney J "Animal welfare, economics and policy" (2004) 165.

Medecins sans frontiers "Food and Agriculture Organization of the United Nations (FAO)" <<https://guide-humanitarian-law.org/content/article/3/food-and-agriculture-organization-of-the-united-nations-fao/>> accessed 16 March 2023.

Mevius D and Heederik D "Reduction of antibiotic use in animals 'let's go Dutch'" (2013) 9 Journal of Consumer Protection and Food Safety, 117.

Moeser A and others "Gastrointestinal dysfunction induced by early weaning is attenuated by delayed weaning and mast cell blockade in pigs" (2007) 293 American Journal of Physiology-Gastrointestinal and Liver Physiology.

Molitorisová A and Burke C "Farm to fork strategy: Animal welfare, EU trade policy, and public participation" (2022) Applied Economic Perspectives and Policy.

Norwegian Scientific Committee for Food and Environment and others "The use of light, restrictive feeding, fibrous feed and stocking density and the consequences for animal welfare for poultry species kept in Norway. Scientific Opinion of the Panel on Animal Health and Welfare of the Norwegian Scientific Committee for Food and Environment" (2022) Norwegian Scientific Committee for Food and Environment (VKM).

Nunan C "Achieving responsible farm antibiotic use through improving animal health and welfare in pig and poultry production. Ending routine farm antibiotic use in Europe" (2022) <<https://epha.org/wp->

content/uploads/2022/02/report-ending-routine-farm-antibiotic-use-in-europe-final-2022.pdf> accessed 10 January 2023.

O'Neill J "Tackling drug-resistant infections globally: final report and Recommendations - Review On Antimicrobial Resistance" (2016) Wellcome trust.

OECD "Antimicrobial resistance and agriculture" <<https://www.oecd.org/agriculture/topics/antimicrobial-resistance-andagriculture/#:~:text=The%20potential%20consequences%20of%20antimicrobial,and%20contamination%20of%20the%20environment>> accessed 9 May 2023.

OECD "World Organisation for Animal Health (OIE), in International Regulatory Co-operation: The Role of International Organisations in Fostering Better Rules of Globalisation" (OECD publishing 2016) <[https://www.oecd-ilibrary.org/governance/international-regulatory-co-operation/world-organisation-for-animal-healthoie\\_9789264244047-41-en](https://www.oecd-ilibrary.org/governance/international-regulatory-co-operation/world-organisation-for-animal-healthoie_9789264244047-41-en)> accessed 29 December 2022.

OIE "The OIE Strategy on Antimicrobial Resistance and the Prudent Use of Antimicrobials" (2016).

OIE "Animal Welfare" <<https://www.woah.org/en/what-we-do/animal-health-and-welfare/animal-welfare/>> accessed 24 March 2023.

OIE "Annual Report on Antimicrobial Agents Intended for Use in Animals, 6<sup>th</sup> edition" (2022).

OIE "Fact sheet - Animal Welfare" (2015) <[https://www.woah.org/fileadmin/Home/eng/Media\\_Center/docs/pdf/Fact\\_sheets/AW\\_EN.pdf](https://www.woah.org/fileadmin/Home/eng/Media_Center/docs/pdf/Fact_sheets/AW_EN.pdf)> accessed 37 February 2023.

OIE "OIE list of antimicrobial agents of veterinary importance" (2018).

- OIE "Rinderpest" <<https://www.woah.org/en/disease/rinderpest>> accessed 4 November 2022.
- OIE "Terrestrial Animal Health Code" (2022).
- OIE "The OIE Strategy on Antimicrobial Resistance and the Prudent Use of Antimicrobials" (2016).
- OIE "Who we are" <<https://www.woah.org/en/who-we-are/>> accessed 4th November 2022.
- OIE "100-year anniversary of the origin of the OIE at the 1921 Paris International Conference" (2021) <<https://bulletin.woah.org/?p=17863>> accessed 30 November 2022.
- Padiyara P, Inoue H and Sprenger M "Global Governance Mechanisms to Address Antimicrobial Resistance" (2018) 11 Infectious diseases.
- Pan American Health Organization (PAHO) "World Health Assembly Adopts Resolution on Antimicrobial Resistance" (2019) <[https://www3.paho.org/hq/index.php?option=com\\_content&view=article&id=15202:asamblea-mundial-de-la-salud-adopta-decision-sobre-resistencia-antimicrobiana&Itemid=0&lang=en#gsc.tab=0](https://www3.paho.org/hq/index.php?option=com_content&view=article&id=15202:asamblea-mundial-de-la-salud-adopta-decision-sobre-resistencia-antimicrobiana&Itemid=0&lang=en#gsc.tab=0)> accessed 16 March 2023.
- PAN Germany and HCWH Europe "Veterinary medicine in European food production: Perspectives on the environment, public health, and animal welfare" 2021.
- Patel S and others "Antibiotic stewardship in food-producing animals: challenges, progress, and opportunities" (2020) 42 Clinical Therapeutics, 1649.

Pig Progress "Delayed weaning better for piglet welfare" (2020) <<https://www.pigprogress.net/specials/delayed-weaning-better-for-piglet-welfare/>> accessed 25 March 2023.

Pinto Ferreira J "Why antibiotic use data in animals needs to be collected and how this can be facilitated" (2017) 4 *Frontiers in Veterinary Science*, 213.

Podolsky S "The evolving response to antibiotic resistance (1945–2018)" (2018) 124 *Palgrave Communications*.

Prestinaci F and others "Antimicrobial resistance: a global multifaceted Phenomenon" (2015) 109 *Pathogens and global health* 309.

Publications Office of the European Union "Medicated animal feed-manufacture, marketing and use" (2019) <<https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM:4384446>> accessed 25 January 2023.

Regulation (EC) No 1831/2003 of the European Parliament and of the Council of 22 September 2003 on additives for use in animal nutrition (2003) OJ L 268.

Regulation (EC) No 1831/2003 of the European Parliament and of the Council of 22 September 2003 on additives for use in animal nutrition (2003) OJ L 268.

Regulation (EC) No 767/2009 of the European Parliament and of the Council of 13 July 2009 on the placing on the market and use of feed, amending European Parliament and Council Regulation (EC) No 1831/2003 and repealing Council Directive 79/373/EEC, Commission Directive 80/511/EEC, Council Directives 82/471/EEC, 83/228/EEC, 93/74/EEC, 93/113/EC and 96/25/EC and Commission Decision 2004/217/EC (2009) OJ L 229.

Regulation (EU) 2019/4 of the European Parliament and of the Council of 11 December 2018 on the manufacture, placing on the market and use of medicated feed, amending Regulation (EC) No 183/2005 of the European Parliament and of the Council and repealing Council Directive 90/167/EEC (2019) OJ L 4 (Regulation (EU) 2019/4).

Regulation (EU) 2019/5 of the European Parliament and of the Council of 11 December 2018 amending Regulation (EC) No 726/2004 laying down Community procedures for the authorisation and supervision of medicinal products for human and veterinary use and establishing a European Medicines Agency, Regulation (EC) No 1901/2006 on medicinal products for paediatric use and Directive 2001/83/EC on the Community code relating to medicinal products for human use (2019) OJ L4.

Regulation (EU) 2019/6 of the European Parliament and of the Council of 11 December 2018 on veterinary medicinal products and repealing Directive 2001/82/EC (2019) OJ L 4 (Regulation (EU) 2019/6).

Rodrigues da Costa M and Diana A "A Systematic Review on the Link between Animal Welfare and Antimicrobial Use in Captive Animals" (2022) 12 Animals.

Ruckert A and others "Governing antimicrobial resistance: a narrative review of global governance mechanisms" (2020) 41 Journal of public health policy, 515.

Sally D "Annual Report of the Chief Medical Officer, Volume Two, 2011, Infections and the rise of antimicrobial resistance" (2013) Department of Health.

Sanders P and others "Monitoring of farm-level antimicrobial use to guide stewardship: overview of existing systems and analysis of key components and processes" (2020) 7 Frontiers in Veterinary Science, 540.

Scientific Committee on Animal Health and Animal Welfare (SCAHAW) "The welfare of chickens kept for meat production (Broilers)" (2000) SANCO.B.3/AH/R15/2000.

Scott A M "Is antimicrobial administration to food animals a direct threat to human health? A rapid systematic review" (2018) 52 International Journal of Antimicrobial Agents, 316.

SFU Library "Grey literature: What it is & how to find it" <<https://www.lib.sfu.ca/help/research-assistance/format-type/grey-literature>> accessed 16 April 2023.

Simjee S and Ippolito G "European regulations on prevention use of antimicrobials from January 2022" (2022) 44 Brazilian Journal of Veterinary Medicine.

Simonin D and Gavinelli D "The European Union legislation on animal welfare: state of play, enforcement and future activities" (2019) in S Hild and L Schweitzer (eds), *Animal Welfare: From Science to Law*, 59.

Sinclair M and others "International perceptions of animals and the importance of their welfare" (2022) *Frontiers Animal Science*.

Sjölund M "Quantitative and qualitative antimicrobial usage patterns in farrow-to-finish pig herds in Belgium, France, Germany and Sweden" (2016) 130 *Preventive Veterinary Medicine*.

Smith E and others "Evaluation of the EC Action Plan against the rising threats from antimicrobial resistance: final report" (2016) Publications Office of the European Union.



Stygar A and others "High biosecurity and welfare standards in fattening pig farms are associated with reduced antimicrobial use" (2020) 14 *Animal*, 2178.

Tang K and others "Restricting the use of antibiotics in food-producing animals and its associations with antibiotic resistance in food-producing animals and human beings: a systematic review and meta-analysis" (2017) 1 *Lancet Planetary Health*.

Tarakdjian J and others "Antimicrobial Use in Broilers Reared at Different Stocking Densities: A Retrospective Study" (2020) 10 *Animals*.

Taylor A "Global governance, international health law and WHO: looking towards the future" (2002) 80 *Bull World Health Organization*, 975.

The Pig Site "Characterising outdoor pig production in Europe" <<https://www.thepigsite.com/articles/characterising-outdoor-pig-production-in-europe>> accessed 12 March 2023.

Treaty of Amsterdam amending the Treaty on European Union, the Treaties establishing the European Communities and certain related acts, (1997) *OJ C 340*.

Tsiouris V and others "High stocking density as a predisposing factor for necrotic enteritis in broiler chicks" (2015) 44 *Avian Pathology*, 59.

Uehleke R and Hüttel S "The free rider deficit in the demand for farm Animal welfare-labelled meat" (2019) 46 *European Review of Agricultural Economics*, 291.

United Nations "FAO: Food and Agriculture Organization of the United Nations" <<https://www.un.org/youthenvoy/2013/09/fao-food-and-agriculture-organizationoftheunitednations/#:~:text=Our%20mandate%20is%20to%20improve,contribute%20to%20global%20economic%20growth>> accessed 16 March 2023.

- Van Bael & Bellis "Veterinary Medicines – Publication of Regulation (EU) 2019/6 of December 2018 Modernising EU Regulatory Framework" (2019) <[https://www.vbb.com/media/Newsletters/Memorandum\\_Regulation\\_on\\_Veterinary\\_Medicinal\\_Products.pdf](https://www.vbb.com/media/Newsletters/Memorandum_Regulation_on_Veterinary_Medicinal_Products.pdf)> accessed 25 January 2023.
- van Bergen-Henegouw F "Understanding the difference between EU Directives and EU Regulations" <<https://certification-experts.com/understanding-the-difference-between-eu-directives-and-eu-regulations/>> accessed 1 March 2023.
- Van Boeckel T and others "Global trends in antimicrobial use in food animals" (2015) 112, *Proceedings of the National Academy of Sciences*, 5649.
- van den Bogaard A E and Stobberingh E E "Antibiotic usage in animals: impact on bacterial resistance and public health" (1999) 58 *Drugs*, 589.
- van der Kemp A "To which animals does animal welfare apply in law and why?" in S Hild and L Schweitzer (eds) *Animal Welfare: From Science to Law*, (2019) pp.47-56.
- Van Katwyk R and others "Developing an approach to assessing the political feasibility of global collective action and an international agreement on antimicrobial resistance" (2016) 1 *Global Health Research and Policy*, 20.
- Vanmathy K, Kasimanickam M and Kasimanickam R "Antibiotics Use in Food Animal Production: Escalation of Antimicrobial Resistance: Where Are We Now in Combating AMR?" (2021) 9 *Medical Sciences* 9.
- Vecchio Y, Pauselli G, and Adinolfi F "Exploring Attitudes toward Animal Welfare through the Lens of Subjectivity—An Application of Q-Methodology" (2020) 10 *Animals*, 1364.

- Webster A "Farm animal welfare: The five freedoms and the free market" (2001) 161 *The Veterinary Journal*, 229.
- Wen R and others "Withdrawal of antibiotic growth promoters in China and its impact on the foodborne pathogen *Campylobacter coli* of swine origin" (2022) 13 *Frontiers in Microbiology*.
- Wernli D and others "Mapping global policy discourse on antimicrobial resistance" (2017) 2 *BMJ Global Health*.
- WHO "Antimicrobial Resistance" (2021) <<https://www.who.int/newsroom/factsheets/detail/antimicrobialresistance#:~:text=AMR%20occurs%20naturally%20over%20time,from%20food%20of%20animal%20origin>> accessed 23 March 2023.
- WHO "Global Action Plan on Antimicrobial Resistance" (2015) World Health Organization.
- WHO "Handbook of resolutions and decisions of the World Health Assembly and the Executive Board" (1973) 1 Official records of the World Health Organization series.
- WHO "New report calls for urgent action to avert antimicrobial resistance crisis" <<https://www.who.int/news/item/29-04-2019-new-report-calls-for-urgent-action-to-avert-antimicrobial-resistance-crisis>> accessed 11 November 2022.
- WHO "Tackling Antimicrobial Resistance (AMR) together Working Paper 1.0: Multisectoral coordination" (2018) WHO/HWSI/AMR/2018.2.
- WHO "WHO global principles for the containment of antimicrobial resistance in animals intended for food. Report of a WHO Consultation with the participation of the Food and Agriculture Organization of the United Nations and the Office International des Epizooties" (2000) WHO/CDS/CSR/APH/2000.4.

WHO "World Health Assembly" <<https://www.who.int/about/governance/world-health-assembly>> accessed 14th November 2022.

WHO "One Health overview" <[https://www.who.int/health-topics/one-health#tab=tab\\_1](https://www.who.int/health-topics/one-health#tab=tab_1)> accessed 29 November 2022.

Wolfensohn S and Honess P "Laboratory animal, pet animal, farm animal, wild animal: Which gets the best deal?" (2007) 16 *Animal Welfare* 117.

World Health Assembly "Seventy-second World Health Assembly; Antimicrobial resistance" (2019) WHA72.5.

Yin J and others "The Progress of Global Antimicrobial Resistance Governance and its Implication to China: A Review" (2021) 10 *Antibiotics*, 1356.

Zrncic S "European Union's Action Plan on Antimicrobial Resistance and Implications for Trading Partners with Example of National Action Plan for Croatia" (2021) 33 *Asian Fisheries Science*, 75.