One Health, Food-Borne Zoonoses and EU Green Policies

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Contributor: Alessandra Mazzeo, Patrizio Tremonte, Silvia Jane Lombardi, Costantino Caturano, Arianna Correra, Elena Sorrentino

Zoonotic agents are pathogens with an unrestricted host spectrum. In nature, their survival occurs in reservoir animal species, which generally do not present clinical symptoms and, therefore, are difficult to identify. Promiscuity between farmed animals and wildlife increases the risk of transmission of pathogens and their consequent adaptation to new host species, including human beings. Therefore, promiscuity increases the risk of emergence of new zoonoses. According to the World Organisation for Animal Health (OIE), zoonoses represent 60% of human infectious diseases and 75% of the emerging ones; 80% of pathogens of animal origin have strong potential as bioterrorism agents. Deforestation and destruction of natural areas produce promiscuity, pushing wild species to invade new areas and to arrive in anthropic environments. In high-income countries, domesticated animals are as much a potential reservoir of high-risk zoonoses as the wildlife animals in equatorial rainforests or wet markets.

Keywords: One Health ; food-borne zoonoses ; EU Green Deal ; Farm to Fork ; food safety

1. Introduction

Companion and zoo animals—with limited syndromic monitoring in place—remain an underestimated but potentially high-risk disease reservoir for emerging zoonoses [1]. Through the global commercialisation of food, food-borne zoonoses (FZs) can also reach individuals who have never been in contact with infected animals or their environment.

FZs are transmitted to human beings indirectly, both through food obtained from infected animals—which are contaminated at their origin—and through food previously contaminated in the various steps of production, sale, and domestic use. Once infected, consumers generally become a source of infection for animals and humans, as well as a source of contamination for food and the environment.

Human beings, animals, and the environment constitute a cohesive and inextricable system, in which human and animal health are interdependent and linked to the health of the ecosystem in which they live. Therefore, they must be considered under the framework of One Health (OH) [2].

Since organic farming contributes to environmental and climate protection, long-term soil fertility, high levels of biodiversity, a safe environment, and high animal welfare standards [3], the European Commission (EC) has set a target of at least 25% of the European Union's (EU's) agricultural land being under organic farming by 2030 [4]. To achieve this goal and help organic agriculture reach its maximum potential, the EC proposes an action plan for organic production in the EU [3]. Then, improvement of human health can be achieved through better environmental conditions and healthier food. The EU's organic logo gives a coherent visual identity to organic products produced in the EU. This makes it easier for consumers to identify EU organic products, and helps farmers to market them [5]. Thus, OH overlaps the European Green Deal plan and its relaunched Farm to Fork Strategy.

Nevertheless, zoonoses and animal infectious diseases cause decreased breeding yields and reduced income. Consequently, the cost and market price of farm products become uncompetitive with respect to the price of industrial food. In other words, zoonoses cause lower revenues, hindering the growth of organic farming expected in the framework of the EU Green Deal. In such scenarios, zoonosis control becomes a key element to align EU policies aimed at achieving the goal of "ZERO environmental impact" by 2050.

2. Food-Borne Zoonoses and EU Animal Health Laws

Zoonosis control in the EU is regulated by Directive 2003/99/EC [6], which lists in LIST A the zoonoses to be subjected to mandatory control, including the main FZs, such as brucellosis and tuberculosis in cattle and buffaloes, salmonellosis in poultry and turkeys, and trichinellosis. The individual Member States (MSs) activate National Control Plans (NCPs) in primary production. NCPs are mandatory and possibly co-financed by the European Commission [7]. They are harmonised in order to make the results comparable, thanks to methods of analysis developed, validated, and disseminated by the European Union Reference Laboratories (EURLs) [8], which transfer them to individual National Reference Laboratories (NRLs) of each Member State (MS) which, in turn, disseminate them extensively to the laboratories of their own national territory. Other optional plans can be activated, based on the epidemiological situation of specific territories as regards the zoonoses included in LIST B of Directive 2003/99/EC.

The NCPs are based on the following aspects: diagnosis (serological diagnosis is adopted if there is no possibility of taking samples useful for direct diagnosis); identification and elimination of infected animals or of the entire herd hosting them; attribution of the sanitary qualification "Officially Free" (OF) to breeding and, progressively, to the entire province or region and to the MS in which the specific zoonosis has been eradicated; the prohibition of vaccination (generally mandatory); biosecurity measures, which must be adopted in a strict way, because the presence of the NCP causes the absence of natural or artificial immunological responses against the specific zoonotic agent, due to the pathogen-free territory and to the prohibition of vaccination, respectively. While vaccination can be authorised in the event of a serious emergency with attribution of the sanitary qualification "Free" (F), antibiotic therapy is not allowed. In case of vaccine authorisation, the OF qualification can be newly acquired when only non-vaccinated animals are present in livestock. NCPs are divided into "eradication plans", if the zoonosis is present in the animal population, and "surveillance plans", which are limited to checking whether the eradicated zoonosis is re-emerging. The surveillance, in turn, is divided into active surveillance, which involves official controls on farms aimed at identifying infected animals, and passive surveillance, which induces the activation of official controls only when suspected cases are signalled.

Data relating to the results obtained in primary production under the application of NCPs, reported human cases, test results in food control activities, test results in feed control activities, and antimicrobial resistance converge in *The European Union One Health Zoonoses Report*, published jointly by the European Food Safety Authority (EFSA) and the European Centre for Disease Prevention and Control (ECDC), in open access and on an annual basis. In the report published in 2021 [9], relating to data for the year 2020, *Salmonella* (Le Minor and Popoff, 1987) [10] remains the most frequently reported etiological agent in episodes of FZs in the EU, and the pathogens considered in relation to the foods of greatest risk were found to be *Salmonella* in eggs and their derivatives, norovirus in crustaceans and molluscs (including bivalves), and *Listeria monocytogenes* (Murray, Webb, and Swan, 1926) [10] in fish and fish products. Correlation between human brucellosis and non-OF territories persists [9].

Regarding *Salmonella* infections, on 17 February 2022, the United Kingdom (UK) reported a cluster of cases with monophasic *Salmonella* Typhimurium sequence type 34 infection. As of 18 May 2022, 324 cases had been reported in 12 EU/EEA countries and the UK, including two distinct strains. As of 3 June 2022, 392 cases of monophasic *S*. Typhimurium have been identified in the EU/EEA and the UK (n = 370 confirmed cases and n = 22 probable cases). In addition, cases have been identified in Canada (n = 4), Switzerland (n = 48), and the United States (n = 1), bringing the total number of cases to 445 globally [11][12]. Most cases were detected in persons below 10 years of age, and 41% of all cases were hospitalised. The two strains are multidrug-resistant, and some tested isolates also exhibit resistance to disinfectants based on quaternary ammonium compounds and hydrogen peroxide, but are susceptible to azithromycin, ciprofloxacin, meropenem, and third-generation cephalosporins. Epidemiological investigations have suggested some specific chocolate products, produced in a plant in Belgium, as likely vehicles of infection. Two monophasic *Salmonella* Typhimurium strains matching the outbreak strains were identified in the buttermilk line at the Belgian plant between December 2021 and January 2022. The buttermilk was provided by an Italian supplier, where *S.* Typhimurium was not detected. On 8 April 2022, on the basis of official controls, the Belgian food safety authority decided to revoke the production authorisation of the indicated plant due to lack of transparency and insufficient guarantees for safe production. All at-risk products produced at the closed plant have been recalled. National competent authorities in several countries issued public warnings. This outbreak has evolved rapidly, with children most at risk of severe infection. The plant closure and the global recall of all potentially hazardous products have reduced the risk of exposure. However, eight cases cannot be explained by consumption of chocolate products, suggesting that there may also be other sources of infection.

The ECDC has published, in open access, the data on antimicrobial resistance [13] and, jointly with EFSA, *The European Union Summary Report on Antimicrobial Resistance in Zoonotic and Indicator Bacteria from Humans, Animals and Food in 2018/2019* [14].

2.1. EU Control Programmes

EU co-funded veterinary programmes have proven to be a catalyst for achieving improvements in public and animal health, reductions in disease prevalence/incidence, safeguarding of public health (in the case of zoonoses), disease prevention/management in the context of the EU Animal Health Strategy, and economic benefits for the EU as whole by protecting the value of the sector, contributing to market stability, guaranteeing safe trade, increasing extra-EU trade, and reducing human health costs.

Significant differences in MSs' veterinary systems and livestock facilities lead to variability in the implementation of programmes, risking jeopardising the results achieved at the EU level—particularly when dealing with transboundary diseases [15].

Regulation (EU) No 652/2014 laying down provisions for the management of expenditure relating to the food chain, animal health, and animal welfare concerns diseases with impacts on human health, diseases with impacts on animal health (taking into consideration their potential spread and the morbidity and mortality rates in animal populations), diseases and zoonoses that risk being introduced and/or re-introduced into the EU territory from third-party countries, diseases with the potential to generate a crisis situation with serious economic consequences, and diseases with impacts on trade with third-party countries and on intra-EU trade. It also concerns the main FZs, including bovine tuberculosis, bovine brucellosis, echinococcosis, campylobacteriosis, listeriosis, salmonellosis, trichinellosis, and verotoxigenic *Escherichia coli* (Castellani and Chalmers, 1919) infections [10][16].

Regulation (EU) 2016/429 on transmissible animal diseases and amending and repealing certain acts in the area of animal health ("Animal Health Law") [17] concerns the main FZs, including infection with *Brucella* (Meyer and Shaw, 1920)—specifically, *B. abortus*, *B. melitensis*, and *B. suis*; infection with *Mycobacterium bovis* (Karlson and Lessel, 1970), *M. caprae*, and *M. tuberculosis*, included in the *Mycobacterium tuberculosis* complex; and infestation with *Echinococcus multilocularis* (Leuckart, 1863) [10][18]. It was amended and corrected in 2017, 2018, and 2020 [19].

In 2020, in Northern Europe, 20 MSs were officially brucellosis-free in cattle, and 17 MSs were officially tuberculosis-free in cattle, while these zoonoses persisted in the Mediterranean area. Italy, Portugal, and Spain activated co-funded eradication programmes for bovine brucellosis as well as for bovine tuberculosis (also activated in Ireland and Malta) [17], while in Greece only the eradication programme concerning ovine and caprine brucellosis (*B. melitensis*) was co-funded [11][20]. Greece reported the highest prevalence of *Brucella*-positive ruminant herds, and Spain reported the highest prevalence of tuberculosis in cattle.

2.2. Control of Non-Regulated Diseases in Cattle and Buffalo (Cattle Diseases Listed under Category C, D, or E in the EU Animal Health Law)

NCPs are in force both for the most important zoonoses and for the most important animal infectious diseases that lack zoonotic potential.

For diseases not included in the European Union Animal Health Law Categories A or B under Commission Implementing Regulation (EU) 2020/2002 [19], approximately one-third of control plans (CPs) are voluntary and can be limited to a well-defined territory of the MS; their funding structure is divided between government and private resources [20].

Countries that have already eradicated diseases such as enzootic bovine leukosis, bluetongue, infectious bovine rhinotracheitis, and bovine viral diarrhoea have also implemented CPs for other diseases in order to further improve the health status of cattle in their country [21], increasing the commercial value of animals and animal products. Consequently, the gap in the health status of farmed animals could progressively increase among the EU MSs.

3. The EU Green Policies concerning the Food System

In the European Union, OH overlaps the European Green Deal plan launched by the European Commission (EC Green Deal plan) to achieve the goal of "ZERO environmental impact" by 2050. In this scenario, the devastating impact of war must be considered (**Figure 1**). The Green Deal relaunches the Farm to Fork Strategy for a healthy and environmentally sustainable food system, providing specific measures to make the economy circular, while concomitantly reducing the use of pesticides, fertilisers, and antibiotics, so as to limit the alarming antimicrobial resistance that is spreading worldwide [3][4][22].

Figure 1. One Health improvements deriving from EU green policies in comparison with peacetime and wartime threats.

3.1. Public Engagement

Public engagement can be stimulated through the improvement of food labelling, which should include information concerning the production environment, aimed at facilitating consumers' choices in the direction of healthy and, at the same time, sustainable diets. A reward mechanism is triggered for farms that adopt the circular economy and that produce in compliance with the objectives of the EU Green Deal. On the other hand, consumers receive beneficial effects on their health, in terms of both food safety and the improvement of environmental conditions [23].

Labelling is a key factor for food safety in agrifood chains. It is often characterised by asymmetric information. Producers and marketers tend to be better informed than consumers about the potential risks of food. The use of innovative strategies to communicate information on food risks can help reduce the divergence between assessed and perceived risks. In this respect, innovative labels—such as traffic-light labels or the use of nanotechnologies—could be valid alternatives. Furthermore, technologies such as Agri-Food 4.0, Blockchain, and the Internet of Things can be useful tools to inform consumers in real time, while also supporting the supply chain decision-making process and improving the coordination process involving farmers, industries, and consumers [24].

3.2. Fighting the Antimicrobial Resistance

The Green Deal includes—among the objectives of primary importance—the reduction in the use of antibiotics in livestock production, in order to combat antimicrobial resistance (AMR), which is a global emergency that has increased during the COVID-19 pandemic. This is referred to as the silent, second pandemic [25].

In addition to the wide use of antimicrobials in animals [26], plant agriculture frequently uses antibiotics to enhance crop yields. This means that fruits and vegetables have also become potential sources of AMR [27].

Multidrug resistance (MDR) is continuously expanding worldwide, and poses a challenge in treating infections, necessitating the use of reserve antibiotics, which can have higher cost-to-benefit ratios and a lower safety profile. Among the MDR germs, “the ESKAPE pathogens” have had the greatest impact on healthcare-associated infections—a group of six pathogens with the capacity to elude the bactericidal activity of antibiotics: *Enterococcus faecium* (Orla-Jensen, 1919), *Staphylococcus aureus* (Rosenbach, 1884), *Klebsiella pneumoniae* (Trevisan, 1887), *Acinetobacter baumannii* (Bouvet and Grimont, 1986), *Pseudomonas aeruginosa* (Migula, 1900), and *Escherichia coli* [10]. The ESKAPE group is characterised by pathogenic and transmission, resistance traits—which are represented by enzymatic inactivation, target changes, and alteration of cell permeability through loss of porins or increased expression of efflux pumps—and mechanical protection through biofilm formation [28].

In 2019, an estimated 1.27 million deaths were attributable to bacterial AMR. At the regional level, the all-age death rate attributable to resistance was highest in western sub-Saharan Africa, and lowest in Australasia.

Lower respiratory tract infections accounted for over 1.5 million resistance-associated deaths in 2019, making this the most burdensome infectious syndrome.

The six main pathogens for resistance-associated deaths—*E. coli*, followed by *S. aureus*, *K. pneumoniae*, *Streptococcus pneumoniae* (Chester, 1901), *A. baumannii*, and *Pseudomonas aeruginosa*—were responsible for more than 900,000 deaths attributable to AMR in 2019 [10].

One pathogen–drug combination—methicillin-resistant *S. aureus*—caused more than 100,000 deaths attributable to AMR in 2019, while six others each caused between 50,000 and 100,000 deaths: multidrug-resistant (excluding extensively drug-resistant) tuberculosis, *E. coli* resistant to third-generation cephalosporins and to fluoroquinolones, *A. baumannii* and *K. pneumoniae* resistant to carbapenems, and *K. pneumoniae* resistant to third-generation cephalosporins [29].

In the EU food system, the AMR monitoring and reporting cover the following food-producing animal populations and foods: broilers; laying hens; fattening turkeys; cattle less than one year old; fattening pigs; fresh meat from broilers; and fresh meat from turkeys, pigs, and cattle.

AMR surveillance concerns the monitoring and reporting of antimicrobial resistance of the following bacteria: *Salmonella* spp., *Campylobacter coli*, *C. jejuni* (Doyle, 1948; Véron and Chatelain, 1973), indicator commensal *E. coli*, *Salmonella* spp., and *E. coli* producing extended-spectrum β-lactamases, AmpC β-lactamases, and carbapenemases. In addition, it may cover indicator commensal *E. faecalis* and *E. faecium* [10][30].

In the United States of America, Congress issued the *Disarm Act of 2021* [31], in order to develop an innovative strategy to fight the increase in antimicrobial resistance [32].

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