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Animal production, animal health and food safety: Gaps and challenges in the chilean industry

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ABSTRACT

This paper summarizes the gaps and challenges related to animal production, health, and food safety as discussed by a panel at the 1st International Symposium of Food Safety (ISFS) in Santiago, Chile, in December 2016. Participating representatives of academia, industry, and government and statements from the audience confirmed that food safety is essential for increasing food security. First, panelists identified the need for a science-based regulatory framework to implement effective regulations. Second, they highlighted the importance of a risk analysis framework to quantify the risk of the potential for antimicrobial resistance associated with the use of antimicrobials, and the need of studies to evaluate foodborne prevention/control strategies. Third, the challenges of filling the gaps between industry and academia were addressed, including examples of successful collaboration, opportunities, and weakness identified by industry. Finally, challenges in animal food production included issues related to changing consumer preferences, animal welfare, the use of antimicrobials, and sustainable animal production. The symposium provided a regional platform to share experiences from the implementation of methods and approaches for food safety. The roundtable successfully explored the future science and technology challenges that are of strategic importance for Chile and the region in animal health and food safety.
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1. Introduction

A panel discussion was held at the 1st International Symposium of Food Safety (ISFS) conference in Santiago (Chile) in December 2016. The main topic of the ISFS was the identification of new tools to prevent and detect foodborne pathogens from farm to fork. This short communication describes the key messages resulting from this discussion panel, specifically gaps and challenges for: 1) the role of animal health and food safety regulations in animal production, 2) the use of antimicrobials in animal food production, 3) enhancing collaboration between the animal food industry and academia, and 4) challenges in animal food production in the 21st century. All these aspects reflected the gaps and challenges from a Chilean context, but there was agreement that much of this discussion would be relevant for other developing countries in the region. The authors of this manuscript were members of the panel or facilitators thereof.

2. Animal production in Chile

Chile has a unique geography occupying a narrow strip along the Pacific coast of South America whose width at maximum reaches

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only 420 km (km) and extends from the Atacama Desert in the north to Patagonian rangeland in the south (4300 km). Most of the agricultural activity occurs in the depression between the Andes and lower Coastal range running parallel the Pacific Ocean, including Mediterranean and template climates (FAO, 2006a). Such a landscape creates natural barriers to disease transmission, although coastal wetlands with migratory birds present a risk for disease introduction (Altizer et al., 2011). Livestock farming is concentrated in the South plains and Patagonia, the regions rich in grasslands and pasture (Oenema et al., 2014). The husbandry is largely pastoral, with low livestock densities and dispersed herds, which also reduces the risks of disease spread. Confined poultry, pig meat and dairy intensive systems exist in the central zone and intensive dairying is also present in the southern regions (OECD, 2017). The livestock sector generates 37% of Chilean agricultural output (OECD, 2016) and total livestock production more than doubled between 1990 and 2013 and rose by almost 60% in *per capita* terms (FAOSTAT, 2017). The sector's exposure to trade over this period increased considerably, both on export and import sides. Chile became a net overall exporter of livestock products in the 2000s, but returned to net imports in the 2010s with a broadening negative balance (ODEPA, 2017). Chile has traditionally been an exporter of sheep meat and wool and has also considerably increased net exports of pig meat and poultry meat since the early 2000s. These exports are destined to markets with different consumption characteristics and sanitary requirements – from large emerging markets such as China and Russia, to North America and the European Union. Chile is a net importer of beef and in 2015-16 it was also net importing dairy products. A good sanitary status is thus important for Chile to both minimize domestic market risks and to ensure stable access to export markets. Around two-thirds of agricultural establishments in Chile undertake some livestock activity (OECD, 2017). The cattle and sheep sub-sectors have a distinctly dualistic farm structure with most of the herds concentrated in a small number of large operations, and numerous small establishments existing alongside. For example, almost 70% of the total sheep number is concentrated in units with 500 ha and more, but which represent only 2% of all holdings that keep sheep, while units below 50 ha constitute around 80% of such holdings. The presence of many small livestock holders in these industries makes them important as a constituency to be targeted by animal disease policy. The dualistic farm structure is also observed in poultry and pig production. However, the ownership and organization of these industries differ significantly from the bovine and sheep sectors: the numerous pig and poultry establishments are typically parts of integrated businesses that are owned and managed by the same operators (OECD, 2017). Today, Chile enjoys a favorable animal health situation, thanks to geographic conditions impeding disease transmission and decades of successful work on disease eradication (OECD, 2017).

3. Role of animal health and food safety regulations in animal production

Often initiated by the industry and discussed by academia, animal health and food safety policies are ultimately established by governments to put into place a system of controls that cooperatively aim to assure that food safety standards are met (Breckenridge et al., 2011). In this context, regulations and standards are a fundamental part of the food control system, *i.e.*, the integration of a mandatory regulatory approach with preventive and educational strategies that ensures food safety from farm to table (WHO and FAO, 2003). The modern idea of food control places direct responsibility for ensuring food safety on all operators in the food chain (WHO, 2012). The main challenge identified by the panelists is to develop and implement policies that effectively ensure a safe and secure food supply alongside competitive livestock, poultry, swine, and aquaculture sectors in a developing country such as Chile. These pressures are particularly acute for smallholder producers given the increasing concentration and intensification of agriculture, livestock, and aquaculture (FAO, 2005, 2009; Oenema et al., 2014). Moreover, for countries that export, such as Chile, this is further complicated by differing regulations among importing countries.

An important gap identified in the roundtable was the lack of an established science-based regulatory framework for regulatory science, which refers broadly to the scientific and technical foundations upon which regulations are based in various industries - particularly those involving health or food safety (FDA, 2010). Specifically, the discipline of regulatory science is defined as the development of new tools, standards and approaches to assess the safety, efficacy, quality and performance of regulated products (FDA, 2010). Recent breakthroughs in science and technology, ranging from genomics to nanotechnology, have the potential to transform the ability to prevent, diagnose, and treat animal diseases (including zoonotic and foodborne diseases) (Wang et al., 2016). For these advances to be fully realized, regulators must play a growing part in facilitating the integration of scientific, public health, and legal frameworks (Breckenridge et al., 2011). In Chile, an important aspect associated with the current legislation is the lack of scientific knowledge by politicians and the nonexistence of scientific advisory boards (or commissions), often resulting in rules that are not scientifically sound for some husbandry practices and/or animal health management. Panelists emphasized that when certain foreign policies or norms are implemented to the national industry, they establish sample sizes, sampling intervals or diagnostic techniques for monitoring a hazard in which no technical consideration is given *e.g.*, the expected prevalence or other important demographic determinants.

One panelist referred to the Code of Federal Regulation (CFR[1]) of the United States. The CFR is the codification of the general and permanent rules and regulations (sometimes called administrative law) published in the Federal Register by the executive departments and agencies of the federal government of the United States. In brief, authorities publish rules that establish or modify the way they regulate items such as food, drugs, and biologics. The establishment of a "bullet-proof" regulation relies primarily on a qualitative risk analysis (FDA, 2006). This is followed by a period of public input and carefully considers these comments when it draws up a final rule. The authority gathers public comments mainly through two channels: proposed rules and petitions (FDA, 2014).

The panel agreed that a regulation in animal health and food safety should be constructed in norms or guidelines that are driven or actualized by science and with demonstrated capabilities to protect public and animal health. The establishment of effective food safety systems is pivotal in ensuring the safety of national food supplies, and food products for regional and international trade. Decisions on animal disease interventions should be made in the context of the general state of the economy and at all levels, from farms to the government. Therefore, socio-economic analysis needs to be part of animal health policy development. The implementation of animal health policies requires strong incentives or controls in the field, and if veterinary interventions are provided at a cost that is proportionate to the risk and the economic impact of disease, there are no conflicts with the economic (or social) interests of producers or farmers. However, interventions can become 'uneconomical' for official veterinary services as well as for individual

[1] http://www.ecfr.gov/.

farmers or companies.

Developing countries increasingly participate in the global trade of food products, a surge that has repercussions on the design and implementation of their national food policies (Pinstrup-Andersen and Watson II, 2011). Despite significant advancements in the development of domestic food policies, developing countries often experience difficulties in conforming to the regulatory standards set by developed countries. When products intended for the markets of so-called high-regulating countries - most importantly the United States, EU, and Japan - violate regulations, these products can face import refusals, bans, or be destroyed. Moreover, China has become a relevant actor in the global food supply chain and is currently developing, strengthening and implementing institutions to cope with international standards in quality and sustainability challenges. However, little is known about the aspects and nature of the Chinese norms related to food safety and new requirements to food suppliers and exporting countries such as Chile.

4. The use of antimicrobials in animal food production

Another concern for the panelists was linked to the use of antimicrobials in food-producing animals and the potential for the development of resistance in human pathogens that are transmitted to humans via animal-derived food (Landers et al., 2012). Antimicrobial resistance happens when microorganisms (such as bacteria, fungi, viruses, and parasites) change when they are exposed to antimicrobial drugs (such as antibiotics, antifungals, antivirals, antimalarials, and anthelmintics) (WHO, 2012). New resistance mechanisms are emerging and spreading globally, threatening our ability to treat common infectious diseases, resulting in prolonged illness, disability, and death (WHO, 2012). Evidence of potential public harm from antimicrobial resistance is growing (Collignon et al., 2016). However, the risks to public health are different in developed and developing countries and between actors of the supply chain (producers, processors, retailers and consumers) and are influenced by regulation, monitoring, and compliance (behaviors) (Rich et al., 2018).

Panelists agreed that the issues of antimicrobial use in food animals are of global concern. However, while antibiotic use in food animals may represent a risk to human health, their degree and relative impact have not been well characterized. Given divergent stakeholder interests and inadequate research to date about this topic, public policy discussions of this issue are often contentious and highly polarized (Wernli et al., 2017).

Panelists identified that risk analysis - risk assessment, risk management, and risk communication - is a critical tool to integrate science and risk perceptions at all levels. In risk assessment, scientific data are used to identify, characterize, and measure hazards; assess exposure; and characterize risks (WHO and FAO, 2009). In fact, the World Organization for Animal Health (OIE) at the Terrestrial and Aquatic Animal Health Codes (Chapters 6) provides guidelines for risk assessment of antimicrobial resistance arising from the use of antimicrobials in animals (OIE, 2017a, b). The principal aim of risk analysis in the context of antimicrobial resistance in micro-organisms from animals is to provide OIE members with a transparent, objective, and scientifically defensible method to assess and manage the human and animal health risks associated with the development of resistance arising from the use of antimicrobials in animals.

Today, several disease control strategies are used to manage diseases in farmed animals and fish including the use of screening tests, vaccines, antibiotics, dietary supplements and restrictions, early removal before harvest, etc. (Christensen, 2001). Each disease control strategy acts at a different stage of prevention (primary, secondary, and tertiary) and has a range of actions by different stakeholders such as the type of diagnostic tests and sampling intervals, type of vaccine/antibiotic used, etc., that ultimately complicate disease-controlling decisions. Panelists agreed that more studies are needed to evaluate the effectiveness of each preventive and/or control strategies that ultimately will identify the combination of those that are more effective under field conditions. Such approach is crucial and should define a more sustainable yet cost-effective plan to control diseases.

5. Enhancing collaboration between the animal food industry and academia

Consensus was achieved by the panelists in stating that food safety is a shared responsibility. Industry is responsible and held accountable for sourcing and producing safe food products while the government sets policies and enforces regulations pertaining to food safety standards in production. Academic institutions conduct research, teaching, and extension to promote food safety, while consumers practice proper selection, handling, preparation, and serving techniques. Joint efforts between research universities and public agencies have improved understanding on control and eradication of many animal diseases through advances in veterinary medicine, basic and applied research, educational programs, and animal housing (National Research Council, 2005; Breman et al., 2011). However, without effective surveillance systems, even eradicated diseases can return. Universities and industry have collaborated for over a century, but the rise of a global knowledge economy has intensified the need for strategic partnerships that go beyond the traditional funding of discrete, one-time research projects (Perkmann and Walsh, 2007).

Panelists agreed that to attract industry involvement, university programs in animal health and food safety must be strongly oriented to the needs of the industry. From the view of the panelists, most local universities in Chile are somewhat passive and not persistent enough in developing research partnerships with the sector. There is a perception (and fear) that investigators carrying out research with a company or sector may be stigmatized and somewhat biased in results or reporting. Additionally, the time-consuming nature of most research activities limits obtaining results and/or generating innovation in the short term, and consequently it is not an alternative to provide “real-time” answers and in reporting results relevant to producers. Finally, most academic institutions are rigid from an administrative viewpoint, showing difficulties when promulgating contracts or agreements. Panelists agreed that work is needed to build on and strengthen mutual agreements entered into by two or more entities across academia and private sectors in which each entity provides part of the knowledge, funds, and/or labor toward a shared interest and by which each sector benefits in the outcome.

On the other side, companies must have a real commitment to make these kinds of projects work, so that proposals should reflect win-win situation for both parties and commitment to a long-term partnership. According to the panel, the food industry is willing to promote research. In fact, one panelist mentioned some examples of applied research carried out through private institutes, consultancies, or experts. However, the industry appears uncertain about sharing research data and/or research results, hindered in part, by practical difficulties or legal barriers. In principle, the sharing of data and research materials in the sciences is generally accepted as a desirable practice by much of the scientific community (Evans, 2010). Moreover, publishing research in scientific journals is an issue because while academics are judged by publications, competition shapes the means of communication and sharing in the private sector, but in a different way and for different reason. In business, the nature of ideas conspires against their marketing

because to advertise an idea is to give it away. As a result, companies compete primarily over the sale of products and services, where discoveries represent only one step in development. Companies frequently conceal discoveries to develop innovative products while minimizing competition. However, as shown previously in a study in Chile and Colombia, collaboration with universities substantially increased the propensity of firms to introduce new products and to patent (Marotta et al., 2007). Although there are important issues regarding sharing data and information with the private sector, working with universities or research centers can improve returns as demonstrated by world-class research universities which are at the forefront of pioneering such partnerships (*e.g.*, Microsoft -Cisco-Intel-University of Melbourne[2]; BP's Energy Biosciences Institute, University of California, Berkeley[3]; GE Global Research Munich[4]). They are designed to run longer, invest more, look farther ahead and hone the competitiveness of companies, universities and regions. In short, they transform the role of the research university for the 21st century, anchoring it as a vital center of competence to help tackle social challenges and drive economic growth.

Finally, the panel identified two major goals needed to foster an industry-academia collaborative plan: (a) to identify and fund rigorous, innovative, and multi-disciplinary research that addresses the safety of animal food products and (b) to share research findings as widely and quickly as possible to support the development of advanced safeguards within the food animal industry. In any case, collaboration may be formal or informal, from formal equity partnerships, contracts, research projects, patent licensing, and so on, to human capital mobility, publications, and interactions in conferences and expert groups, among others (Hagedoorn et al., 2000).

6. Challenges in the animal food production in the 21st century

Specialists in animal health not only allow farmers to meet the growing demand for animal products such as meat, milk, eggs, and fish but also to protect consumers from harmful food-borne pathogens or diseases transmissible between animals and people (zoonoses). At the same time, consumers are increasingly drawing connections between their own health and the conditions in which animals are raised (Verbeke, 2009). Panelists agreed that consumer preferences have changed and producers need to adapt to new requirements particularly in the following four issues: listening to consumers, using antimicrobials, animal welfare, and environmental impact and sustainability.

Listening to (and understanding) the consumers is a key challenge identified by the panelists. There is growing evidence that agriculture is a big factor in overall ecosystem health, ensuring a stable climate, abundant biodiversity and clean water (Koneswaran and Nierenberg, 2008). Consumers want to know that their food is safe, that producers care about the environment, and are willing to use less inputs (*e.g.*, water, fuel, soil, etc.). Consumers certainly want to know that producers care for animals, the land, and the environment, which has revealed itself in growing preferences.

Consumer perceptions and knowledge of animal welfare vary among European countries and are mainly affected by their economic and educational level. Some of the aspects related to welfare include the availability of spaces and the absence of movement restrictions (chains or tethers) (Martelli, 2009). In this sense, the panel agreed that it is important to know consumer attitudes toward welfare as has been done for fish farming (Ellingsen et al., 2015) or laying hens (Pettersson et al., 2016). Consumers want greater transparency about the animal proteins they purchase today. The reasons for greater public scrutiny on the backstory of where animal proteins come from (and how they are raised) are multidimensional, relating to beliefs about diet, ethics, and the environment.

Regarding the use of antimicrobials, panelists highlighted the importance of antibiotics in improving and maintaining animal health and welfare as part of a holistic approach to minimizing diseases. In the future, and as described earlier, producers will need to identify new products and strategies to combat infectious diseases. Today, companies are being urged to act on antibiotics in food supply chains to help tackle the spread of untreatable infections from animals to humans. However, animals should be treated with antibiotics as and when is necessary - and when this reflects a diagnosis from a qualified veterinarian.

Consumer concern about how animals raised for food are treated is rising, particularly in Europe and the USA (Verbeke, 2009; Lagerkvist and Hess, 2011). Since the mid-1990s, economists have sought to quantify farm animal welfare in economic terms to provide inputs for analyzing the implications of animal production systems for resource use and food costs. Today, international standards concerning animal welfare, including transport, slaughter, emergency euthanasia, aquaculture, beef cattle, and broilers, have been produced by the OIE (OIE, 2017a, b). Unfortunately, the current OIE standards do not provide a framework for defining the welfare standards of livestock products so it is difficult for the food industry to trade products with a definable welfare status when different countries use different private certification schemes. For these reasons, panelists agreed that animal welfare is an important challenge for the future in establishing science-based metrics of animal welfare as a means of identifying best management practices and providing certified products.

A key challenge is how animal food industries will provide food to a human population of 9.6 billion by mid-2050 at the same time that they will use farming techniques that protect the environment, public health, human communities, and animal welfare. For this, the animal production system was envisioned in its broadest sense, from the individual farm, to the local ecosystem, and to communities affected by the farming system both locally and globally. Systems approaches also imply interdisciplinary efforts in research and education. This requires not only the input of researchers from various disciplines, but also farmers, farmworkers, consumers, policymakers, and others. The interconnectedness of individual, regional, and global public health; the health of the planetary environment(s); and billions of food animals and wildlife would suggest the need for a new paradigm - one that shifts away from a reactive to a more anticipatory, proactive approach to food safety (IOM, 2012). A “One Health” approach to food safety - which has been defined as “the collaborative effort of multiple disciplines - working locally, nationally, and globally - to attain optimal health for people, animals and the environment” might capture these critical needs (Page 13, AVMA, 2008; Wall, 2014).

7. Conclusions

There was significant value in a forum like ISFS to share the experiences of the successful implementation of methods and approaches for food safety as well as to show projects and initiatives from industry-academia collaboration in the food sector. The roundtable was an innovative opportunity to discuss the top-level priorities for forthcoming initiatives for the industry, academia and government. We have identified major challenges that could be

[2] http://www.socialnui.unimelb.edu.au/partners/.
[3] http://www.energybiosciencesinstitute.org/.
[4] http://www.geglobalresearch.com/.

addressed by future collaborative activities in key areas such as “regulatory science”, “frameworks for risk analysis”, “evaluation of antimicrobial resistance and use of antibiotics”, “animal welfare”, “environmental sustainability” and “One Health”. Future organizers of ISFS conferences should not only include presentations of technically complex studies, but also report on their practical applications and their effectiveness. As well as sharing ‘best practices’, failures should be communicated openly as they are likely to provide essential lessons. Sessions that illustrate how scientific findings were translated into progress in preventing food-borne pathogens and controlling disease would be welcome. New innovative research mechanisms can help transforming Chile's economy and society as a whole.

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