Antibiotic resistance: mitigation opportunities in livestock sector development

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Opinion paper: Antibiotic resistance: mitigation opportunities in livestock sector development

T. P. Robinson[1†], D. P. Bu[2], J. Carrique-Mas[3], E. M. Fèvre[4], M. Gilbert[5], D. Grace[6], S. I. Hay[7,8], J. Jiwakanon[9], M. Kakkar[10], S. Kariuki[11], R. Laxminarayan[12], J. Lubroth[13], U. Magnusson[14], P. Thi Ngoc[15], T. P. Van Boeckel[16] and M. E. J. Woolhouse[17]

[1]Livestock Systems and Environment (LSE), International Livestock Research Institute (ILRI), P.O. Box 30709, 00100 Nairobi, Kenya; [2]Institute of Animal Science, Chinese Academy of Agricultural Sciences (CAAS), Beijing, China; [3]Oxford University Clinical Research Unit (UCRU), Wellcome Trust Major Overseas Programme, Ho Chi Minh City, Vietnam; [4]Institute of Infection and Global Health, University of Liverpool, Liverpool, UK; [5]Spatial Epidemiology Laboratory (SpeLL), Université Libre de Bruxelles (ULB), Brussels, Belgium; [6]Food Safety and Zoonoses (FSZ), International Livestock Research Institute (ILRI), Nairobi, Kenya; [7]Institute for Health Metrics and Evaluation (IHME), University of Washington, Seattle, WA, USA; [8]Li Ka Shing Centre for Health Information and Discovery, Oxford Big Data Institute, Oxford, UK; [9]Research Group for Preventive Technology in Livestock, Faculty of Veterinary Medicine, Khon Kaen University, Khon Kaen, Thailand; [10]Public Health Foundation of India (PHFI), Delhi, India; [11]Kenya Medical Research Institute (KEMRI), Nairobi, Kenya; [12]Center for Disease Dynamics, Economics and Policy (CDDEP), Washington, DC, USA; [13]Food and Agriculture Organization (FAO) of the United Nations, Rome, Italy; [14]Department of Clinical Sciences, Swedish University of Agricultural Sciences (SLU), Uppsala, Sweden; [15]National Institute of Veterinary Research, Hanoi, Vietnam; [16]Center for Adaptation to a Changing Environment, Institute of Integrative Biology, Swiss Federal Institute of Technology (ETH), Zurich, Switzerland; [17]Centre for Immunity, Infection & Evolution, University of Edinburgh (UoE), Edinburgh, UK

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Our diets and food production systems have changed dramatically in recent decades, and the way we use antibiotics is closely linked to these changes. Population growth and changing dietary preferences, brought about largely through economic growth and urbanization, have driven up demand for animal source foods (ASF), particularly in low-and middle-income countries (LMICs) (Alexandratos and Bruinsma, 2012). The resulting production gains, particularly in pig, poultry and dairy systems, have been achieved largely through intensification: increasingly large, specialized units, disconnected geographically from the land producing their feed, containing high densities of genetically homogenous animals, highly bred for productivity traits. Intensive livestock farms have been far more dependent on antibiotics for growth promotion, disease prevention and disease treatment, so these structural changes bring about considerable increases in antibiotic use and this is predicted to double in the rapidly growing economies of Brazil, Russia, India, China and South Africa from 2010 to 2030 (Van Boeckel *et al*., 2015).

Livestock production sits at the nexus of three global public goods: (i) health and nutrition; (ii) climate and natural resource use; and (iii) equity and growth. Each of these domains includes both positive and negative consequences of livestock sector growth (Food and Agriculture Organization, 2009). Antibiotic resistance epitomizes the issues around this nexus; with dramatic impacts on health, equity and the environment. There is growing consensus that antibiotic use in livestock production is linked to antibiotic-resistant human infections; based on evidence available from either whole-genome sequencing and phylogenetics or natural experiments involving the introduction or withdrawal of antibiotics from livestock production systems (Robinson *et al*., 2016). However, we lack a quantitative understanding of the relative importance of people, livestock and the environment in the emergence and persistence of antibiotic-resistant genes, and of the routes and mechanisms of their transmission between livestock and people and the role of the environment in those processes.

It is an inevitable and natural phenomenon for bacteria to develop resistance against antibiotics, but this is exacerbated by their inappropriate use. This, in turn, leads to treatment failure in both livestock and people, with detrimental effects on the health of people and livestock, and on farmers' livelihoods. Although the global burden of antibiotic resistance in livestock has not been estimated, 700 000 human deaths in 2010 have been linked to antimicrobial resistance (AMR) more generally, and this is projected to increase dramatically if no action is taken (O'Neill, 2016). The proportion attributable to bacterial infections is not distinguished but it is certainly considerable, and is growing rapidly. The poor will shoulder the larger part of the burden and will be most affected by reduced access to and increasing costs of effective antimicrobials to treat diseases in both themselves and their livestock. Access for farmers in LMICs to effective antimicrobials is already compromised by poor service provision and low-quality drugs. Environmental issues stem from contamination of soil and water resources both with antibiotic residues and with antibiotic-resistant bacteria and genes. Considerable quantities of antibiotic residues enter

† E-mail: t.robinson@cgiar.org

the environment due to waste and spillage from the pharmaceutical industry and, because of the incomplete absorption and breakdown of antibiotics fed to people and animals, also in effluent from farms and hospitals. Farm animals, communities and hospitals are sources not only of residues but also of antibiotic-resistant bacteria and genetic determinants. Disrupting the natural balance of the environmental microbiome may have dire consequences for ecosystem function.

Some high-income countries (HICs), exemplified by Sweden, the Netherlands and Denmark, have responded to public pressure and reduced dependence on antibiotics while maintaining highly productive, intensive systems. However, even in the European Union, with a common ban on use of antibiotics as growth promoters since 2006, there are considerable differences in antibiotic use between the highest and lowest consumers. However, interventions that have succeeded in HICs may neither be implementable nor sustainable in LMICs in the immediate term. The majority of LMICs are in the tropics, where people and livestock live in high densities and in close proximity, pathogen biodiversity is high and environmental conditions favour pathogen growth and year-round survival. Biosecurity measures are generally poor and the policy and institutional frameworks weak, resulting in less enforcement and implementation of regulations that do exist. Consumer decisions are driven more by cost than considerations of societal consequences and the consumer base is generally less informed and empowered to put pressure on the livestock industry to conform to health, welfare and environmental standards. This means that policy, legislation and consumer influence are much less effective tools to bring about changes in the livestock sector.

In the rapidly emerging intensive units of LMICs, the blanket use of antibiotics for growth promotion or disease prevention acts as a smoke screen to conceal all sorts of husbandry shortcomings and animal health issues. Moreover, it is not only large intensive facilities that contribute to excessive and inappropriate use of antibiotics; intensifying smallholders are also potentially non-rational users of antibiotics – where administration of drugs is often based on poor information, weak animal health services and using substandard, counterfeit drugs.

Although recognizing that dramatic reductions in the use of antibiotics for growth promotion and disease prevention must be a long-term objective in LMICs, we stress the need to work on more pragmatic interventions in the immediate term that will reduce antibiotic consumption and disrupt the transmission of antibiotic resistance, whilst being acceptable to LMIC livestock producers. Interventions need to be based on biological and economic evidence, tailored to suit the epidemiological environment, the cultural and socio-economic context and the political economy; accounting for competing priorities and different perceptions of risk.

Potential solutions are many and integrated approaches that could significantly reduce dependence on antibiotics can draw from a suite of interventions at different stages of the food system, and the context in which it operates. Some examples at the farm-level include (i) management and biosecurity innovations such as 'all-in-all-out' systems; (ii) non-antibiotic growth promoters such as enzymes, competitive exclusion products, probiotics and prebiotics; (iii) better use of other animal health technologies, such as vaccines to control infectious disease (including matching vaccines to circulating strains), vector control, bacteriophages and disinfectants; (iv) improved diagnostics to improve appropriate drug selection, dosing and length of treatment, and to identify prevalent resistance traits among pathogens to avoid the use of ineffective drugs; (v) reduced dependence on antibiotics for semen preservation; (vi) reduced stocking densities and increased genetic diversity of livestock; (vii) increased use of genetic traits for disease resistance; and (vii) better waste management.

Other interventions can create an enabling environment, such as (i) building the capacity of farmers to carry out good husbandry practices; (ii) developing animal health systems that focus on the productivity expectations of the farmer with mitigation of antibiotic resistance in mind; (iii) interventions to reduce access to counterfeit drugs; (iv) compensation schemes for expired antibiotics; and (v) strengthening laboratory capacity to diagnose bacterial pathogens and their antibiotic resistance profiles.

Other interventions still, can contribute to raising awareness; fostering a culture of concern over antibiotic resistance. Such interventions include (i) consumer and farmer engagement campaigns; (ii) labelling of food regarding antibiotic use in its production; (iii) implementing surveillance systems for antibiotic resistance; and (iv) improving access to affordability of testing services for antibiotic residues in ASF and in the environment.

The issue of AMR has finally arrived on the global agenda. In 2015, the World Health Organisation (WHO), the Food and Agriculture Organization and the World Organisation for Animal Health each had resolutions passed before their governing bodies – an unprecedented event. WHO launched the Global Action Plan (WHO, 2015), which called upon the food and agriculture sector as a partner in tackling the growing threat of AMR. In September 2016, AMR will be on the agenda at the 71st Session of the United Nations General Assembly, another important step forward. With this increasing recognition of the problem national governments will be expected to take action to reduce the use of antibiotics in livestock production not only from international bodies but also from their own public and animal health sectors.

We propose an interdisciplinary community of practice that will generate and advocate the evidence needed to reduce livestock's contribution to the global burden of antibiotic resistance in LMICs, in ways that promote animal welfare and are environmentally and socially sustainable. Given the many diverse ways that livestock contribute to economic growth and poverty reduction, to food and nutritional security and to sustainable food production, it is vital that we avoid AMR casting a shadow over the livestock sector. Instead, we must exploit the opportunities presented by livestock sector development to mitigate antibiotic resistance and so conserve the effectiveness of these drugs that are so essential to the health and well-being of people and their livestock.

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