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Climate change affecting animal health and production : A review

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ABSTRACT

The threat perception of climate change is well known and its provoking impact is being noted at many levels. Various scientific reports of the Intergovernmental Panel on Climate Change (IPCC) indicate that climate change will impact the globe severely, and these impacts will vary depending on the region and on ecosystems. Animal production systems, climate change and animal health are inter-related via complex mechanisms. Direct exposure to climate change comprises changing weather patterns (increasing temperatures, more precipitation, rising sea-level and more frequent extreme events). Indirect exposure comprises changes in water, air and food quality, vector ecology and changes in ecosystems, agriculture, industry and settlements. Animal production influences climate change by emitting greenhouse gases such as methane and nitrous oxide. According to the IPCC, agricultural activities, including animal production, account for 10–12% of global emissions. This means that animal production offers major opportunities for reducing emissions, as well as for increasing the sequestration of greenhouse gases. But climate change in turn affects production (affecting nutrition, access to water and animal health). Animal health could be affected both by extreme events (for example high or low temperatures) and by the emergence and re-emergence of infectious diseases, some of them transmitted by vectors that are highly dependent on climatic conditions. In the case of the veterinary services of the countries, it will be necessary to build their capacity to handle the greater risks associated with climate change.

Key words: *climate change, livestock, animal production, animal health*

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INTRODUCTION

The scientific evidences point to climate change having an increasing impact on life on the planet. Average temperatures will rise, rainfall patterns will change, and extreme weather events such as storms, flooding, drought and heat waves will become more frequent and more intense. These processes are not something that will occur in the future however they are already happening. We are encountered to these phenomena on daily basis. Intergovernmental Panel on Climate Change (IPCC) for 2007 comprises an update on the state of knowledge of the associations between weather/climatic factors and public health outcomes for human populations concerned (Patz *et al.,* 2005). Within this framework, animal health as well as animal production will be particularly affected by climate change because it is so dependent on climate. The Intergovernmental Panel on Climate Change (IPCC) is sending out a clear message that human activities are contributing massively to global warming and to climate change. Economies, especially those of the most economically-developed countries, use large quantities of fossil fuels (oil, coal, natural gas), which generate very large quantities of greenhouse gases, in particular carbon dioxide, that contribute to climate change. In addition to carbon dioxide, human activities add methane and nitrous oxide to the atmosphere. These gases are generated in city landfills, livestock farms, rice fields and through the use of nitrogenous fertilizers. Some greenhouse gases are manufactured artificially, such as the fluorinated gases used in refrigeration and air-conditioning systems. Although methane and nitrous oxide have a potentially very powerful greenhouse gas effect, they have not been released into the atmosphere is such large quantities as CO_2, and their half life in the atmosphere is shorter. This means that CO_2 originating from human activities is the gas with the biggest impact on climate change. Animal production is a major component of food security. Through it we obtain products such as milk, eggs and meat, which are an intrinsic part of any global food security policy. Moreover, worldwide demand for these products is high and threatens to increase substantially in line with rises in population and average per-capita incomes. Raising livestock provides other non-food essential products, such as milk and leather, as well as important services such as transport and traction, with around 250 million animals being used as a means of locomotion and motive force throughout the world. Domestic animals also represent the only means of subsistence for hundreds of millions of families worldwide. It has been calculated that approx.1 billion people, 700 million of whom live in poverty, depend on their animals for food, income, traction and transport. Unfortunately, in the animal health realms, comprehensive, formal reviews are rare (de la Rocque, Rioux and Slingenbergh, 2008).

Climate change and transmission ecology

From a climate change perspective, it is important to assess the extent to which a pathogenic agent is exposed to the conditions outside the host body. A free-living pathogen stage plays a role even in the direct transmission of respiratory diseases. The survival of the common flu virus on doorknobs or during aero-gene transmission or by means of handshakes is influenced by ambient temperature and humidity (Lowen *et al*., 2007). The role of environmental pathogen load is perhaps more obvious still in the case of faecal-oral or water-borne transmission. The natural cycle of avian influenza viruses in mallard ducks, its foremost natural host, involves ingestion of water containing the virus. Natural avian influenza virus replication occurs mainly in the distal end of the enteric duck tract (Jourdain *et al.,* 2010). Viruses deposited by migratory waterfowl during summer breeding at higher latitudes may be stored in permafrost conditions in subarctic regions and survive for centuries (Zhang *et al*., 2006). Likewise does the anaerobe *Bacillus anthrax* bacterium survive for decades in the form of spores in the soil (Dragon and Rennie, 1995).

Disease agents transmitted by arthropods form a distinct, albeit related category. Indirect transmission of protozoan disease agents may be facilitated by three-host ticks. Soft ticks feeding on warthogs play a role in the transmission of African swine fever (ASF) (Kleiboeker and Scoles, 2001). The causative agent of ASF, a DNA virus, may survive for eight years in the tick vector. There are also a number of midge- or mosquito-borne disease complexes that involve a dormant pathogen stage. For example, Rift Valley fever (RVF) virus may survive in mosquito eggs for years, until a prolonged heavy rainfall facilitates an awakening of *Aedes* mosquitoes, feeding on ruminants and thus kick-starting a RVF outbreak (Mondet *et al*., 2005; Anyamba *et al.*, 2009). The JEV is transmitted to vertebrates by mosquitoes. Mosquito transmission was suspected during the early 1930s; in 1938, Mitamura et al. reported isolation from*Culex tritaeniorynchus* (Burke DS, Monath TP.,2001). The ecology of JEV has come from various studies carried out in Japan by Scherer et al.,(Buescher EL.*et al*.,1959) and JEV ecology has been the subject of several reviews (Vaughn DW and Hoke Jr CH.,1992; Burke DS and Leake CJ.,1988; Endy TP and Nisalak A.,2002). In Asia, pigs are considered to be the most important amplifying host, providing a link to humans through their proximity to housing (Kabilan L, *et al.,*2004). Environmental and ecological factors are responsible for the spread of JEV(Sarika Tiwari, *et al,* 2012).

The links between animal production and climate change

The links between animal production and climate change are complex and multi-directional. On the one hand, animal production has an influence on climate change, with mainly ruminants generating emissions of greenhouse gases. In particular, animal production is a very important source of methane and nitrous oxide released into the atmosphere. On the other hand, climate change influences livestock production by affecting the conditions governing animal production, fodder crop production and animal health.

Contribution of animal production to climate change

According to the IPCC, the agriculture sector contributes between 10% and 12% of global emissions of greenhouse gases, in terms of CO_2 equivalent. It contributes 40% of the total of anthropic emissions of CH_4 (from enteric fermentation, decomposition of manure and flooded rice fields) and 65% of the total of anthropic N_2O (agricultural land, use of nitrogenous fertilisers, spreading manure and burning biomass) (IPCC, 2007). In the mentioned 2006 report, applying life cycle analysis methodologies, FAO concluded that 18% of total emissions of greenhouse gases were attributable, directly or indirectly, to animal products (Steinfeld H. *et al*, 2006). This calculation includes a very substantial contribution from the use of the land for livestock production (mainly deforestation to create pasture and arable land). The IPCC instead analyses the contributions by sector, estimating that deforestation is responsible for almost 20% of global emissions and agriculture (arable and livestock) is responsible for only 10–12% (IPCC, 2007). Looking at the contribution at country or region level, we see important differences in the intensity of emissions, which result from the wide diversity of production systems, many of which do not produce deforestation as they take place on natural or improved pastureland. As Mitloehner et al. point out, unfortunately some of the conclusions of the FAO report were taken out of context, influencing consumer policies and behaviour, opinion leaders and large supermarket chains (Pitesky M.E. *et al*, 2009). A study published by the OECD2, states that livestock production is seen as being more intensive in terms of emissions than other forms of food production (Stephenson J., 2010). Of particular concern is the impact of changes in the use of land. The demand for arable land for crop production and pastureland has been the main driver of deforestation in certain developing countries. But at the same time, livestock production is vital for millions of persons as a source of food, the generation of co-benefits and a source of income. There are also opportunities to increase carbon sequestration in woody biomass, associated with silvopastoral systems and with adaptation measures that provide shade and shelter for animals. We therefore need to seize every opportunity to minimise the contribution of livestock farming to climate change and enjoy the associated benefits.

Impact of climate change on livestock production

The IPCC report updates the information on the global and regional climate change situation, including the scientific bases, vulnerability, adaptation and mitigation (IPCC, 2007). The main factors linking climate change to animal productivity are: changes in the quantity, intensity and distribution patterns of rainfall within the year and from one year to the next; higher average temperatures and heat waves, affecting livestock through thermal stres and crops in sensitive stages of their life cycle; more frequent and/or more intense extreme weather events.

Higher average temperatures have various effects incluid shortening the growing season of winter fodder crops, reducing primary productivity; increasing evapotranspiration from crops and evaporation from the soil and water reservoirs; and increasing the risk of severe drought due to the higher atmospheric demand. More intense rainfall increases the risk of soil erosion and flooding in low-lying areas. Following the same global trend, in the so many areas in the world more frequent high-intensity rainfall has already been recorded. Average temperature rises in excess of 1.5°C–2.5°C could well trigger massive changes in the structure and functions of ecosystems and species, depending on the geographic area, with predominantly negative consequences for biodiversity and goods and services, such as food production and water supplies.

In the IPCC Third Assessment Report (2001) there is a section devoted to the vulnerability of animal production, warning that animal production facilities will be affected both directly and indirectly by climate change (IPCC, 2001). The direct effects include the interchange of heat between the animal and its environment, associated with air temperature, humidity, wind speed and thermal radiation. These are factors that influence animal performance (growth, milk and wool production, reproduction), as well as animal health and welfare. The indirect effects include the influence of climate on the quantity and quality of fodder crops and grains, and the severity and distribution of diseases and parasites. When the magnitudes (intensity and duration) of adverse climatic conditions exceed certain limits, with little or no possibility of recovery, animal functions are adversely affected as a result of stress, at least in the short term. Genetic variation, the stage in the life cycle and the nutritional status also influence their vulnerability and resilience to environmental stress. For example, milk production from dairy cattle and conception rates can fall dramatically, and vulnerable animals may die as a result of extreme events.

Perception of climate change and animal health

It is currently accepted that 80% of all animal pathogens are zoonotic agents and that 75% of emerging animal pathogens are zoonotic. It follows that zoonotic animal pathogens tend to associate with emerging processes twice as often as non zoonotic animal pathogens. With reference to the latter, various countries in different region have identified the emergence of leishmaniosis as a zoonosis linked to climate and environmental change.

In some regions climate change is believed to increase the risk of human exposure to cutaneous leishmaniosis by transforming the area into a more suitable habitat for the vector and reservoir species that transmit this disease. From the survey, proposals emerge for specific actions at regional level, requiring the support of various international organisations for research and training on these themes. For this purpose, research will need to be accompanied by substantial technological development for optimising animal production while caring for the environment. There is a perceived need to create training bodies for managers and agents of the official Veterinary Services, focusing on the need to share information and experiences between the countries in the region for the implementation of preventive measures.

Adjustment of animal husbandry to climatic changes

Improvement in sanitation, hygiene or biosecurity may conveniently take a whole-of-society approach. Risk factors vary with animal production subsectors and systems. The management of animal genetic resources, feeding practices, housing and bio-containment together play a key role in the maintenance of robust, healthy and productive animals. Agro-ecological resilience matters most where production environments reflect the local conditions. Local breeds may harbour genetic disease resistance and other traits reflecting their adjustment to the locally prevailing conditions.

Ruminant grazing in the open brings exposure to multiple arthropod-borne diseases. A growing armoury of quality vaccines is required to confront a vast array of old and new diseases. Vaccination is particularly a priority in developing countries.

CONCLUSIONS

There has been a tendency to oversimplify the mechanisms by which climate change affects disease transmission and animal health status. Indeed, only a limited number of studies present validation of the direct effects of climate change itself. Climate change is to be considered in conjunction with the set of global factors today altering the earth terrestrial surface area and associated global biophysical systems. The flare-up of novel pests and diseases of wildlife and livestock origin, and also the surge of food safety hazards, is likely to continue in upcoming decades. Risk analysis highlighting the implications of climate change in its broader context relies on the full consideration of the transmission ecology of pests and diseases. Transmission involving prominent free-living parasite stages is arguably more likely to be modulated by environmental factors including temperature, humidity and seasonality.

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