CLIMATE CHANGE AND LINKS TO ANIMAL DISEASES AND ANIMAL PRODUCTION

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Summary: *The threat of climate change is well known and its impact is being noted at many levels. The scientific reports of the Intergovernmental Panel on Climate Change (IPCC) indicate that climate change will impact the American continent severely, and that 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. 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.

The response to these challenges requires the development of the ability to adapt, not only for agro-ecosystems, but also for institutions. 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 – Americas – animal health*

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1. Introduction

The scientific evidence points 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 —they are already happening. Within this framework, 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 (CO_2), human activities add methane (CH_4) and nitrous oxide (N_2O) to the atmosphere. These gases are generated in city landfills, livestock farms, rice fields and through the use of nitrogenous fertilisers. 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.

2. Benefits of animal production

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 1 billion people, 700 million of whom live in poverty, depend on their animals for food, income, traction and transport.

Ruminants play a key role in maintaining pastures worldwide. In this way, ruminants not only provide the major benefit in the trophic chain of acting as transformers of the fibre in these pastures into protein with a high biological value. They also preserve ecosystems that provide important services, such as maintaining or increasing reserves of carbon, preventing erosion, producing organic fertiliser that saves on chemical fertilisers, improving the quality of water and maintaining high levels of animal and plant biodiversity.

Some controversial studies, in particular *Livestock's long shadow*, published by the FAO [9], put on the table the negative impacts of animal production on the environment, including a study of the carbon footprint of meat and its contribution to climate change.

Other later studies, including those of FAO, highlighted the many benefits of livestock farming. The key would appear to be distinguishing between animal production using good practices and environmental sustainability criteria, which provides numerous benefits, and animal production that leads to contaminated water, degraded soils, deforestation and the erosion of biodiversity. Progressing towards sustainable livestock practices, which optimises systems, would therefore be a more intelligent approach than reducing the production and consumption of meat.

We need to analyse the negative impacts of animal production on climate change within a broad context of its environmental and socioeconomic benefits. Looking at the wider perspective, many alternatives emerge for reducing the current negative impacts, highlighting the huge potential of pastoral farming to mitigate climate change, increase the efficiency of the production process, reduce deforestation and sequester carbon in the soil under pastureland.

3. 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. The impacts on animal health are increasingly being recognised, and this theme occupies a special section of this document, as we shall see below.

3.1. 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) [5].

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 [9]. 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% [5].

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 [7].

A study published by the OECD[2], states that livestock production is seen as being more intensive in terms of emissions than other forms of food production [10]. 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. The OECD report acknowledges that for the moment these pastures and pastoral farming provide the only viable option for producers in their agro-ecosystems. The key question is therefore how to reduce the intensity of emissions from livestock production, while safeguarding its basic features and all the goods and services that it produces. Perhaps the real solution —also in response to the question in the title of the OECD article "Less meat or less carbon?"— is to produce the meat required by the world population using low-carbon systems.

The main contributors to emissions from animal production are, first, enteric fermentation in ruminants and, second, manure management. At the same time, it should be recognised that there are options for reducing absolute emissions (associated with manure management and deforestation) or per unit of product (enteric fermentation). There are also major opportunities for sequestering carbon in the soil using carbon sinks in degraded pastures, which also generates benefits in terms of restoring natural fertility, increasing productivity and reducing erosion. 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.

2 OCDE: Organisation for Economic Co-operation and Development

3.2. 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 [5]. From this report we extract Table 1, which identifies the main trends expected in the 21st century on a global scale.

Table 1.– Recent trends and projections for extreme weather events for which there is an observed late-20th century trend

Phenomenon and direction of the trend	Likelihood of future trends based on projections for the 21st century using scenarios from the Special Report on Emissions Scenarios (SRES) [3]
Over most land areas, warmer and fewer cold days and nights	Virtually certain (>99%)
Warm spells/heat waves	Virtually certain
Heavy precipitation events. Frequency increases over most areas	Very likely
Area affected by drought increases	Likely
Intense tropical cyclone activity increases	Likely
Increased incidence of extreme high sea levels	Likely

Source: IPCC, 2007 [5]

As we can see, livestock production faces increasing climate risks because these changes attack its very foundations: the productivity of ecosystems and the availability of water.

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 stress and crops in sensitive stages of their life cycle;
- more frequent and/or more intense extreme weather events.

Higher average temperatures have various effects:

- they shorten the growing season of winter fodder crops, reducing primary productivity;
- they increase evapotranspiration from crops and evaporation from the soil and water reservoirs; and
- they increase 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 south-eastern part of South America more frequent high-intensity rainfall has already been recorded.

Resilience, in terms of the ability to recover from a shock while maintaining the basic configuration of a system, is one of the properties of ecosystems in relation to environmental change. It is very likely that many ecosystems will be overwhelmed by an unprecedented combination of climatic disruptions (flooding, drought, fire, insects) and other global changes (changes in land use, pollution and over-exploitation of resources). 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 [4]. 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. It should be noted that the IPCC latest Assessment Report (2007) does not include in volume II a specific section on the vulnerability of animal production and animal health to the impacts of climate change [5].

Increases in the variability in relation to the average will also tend to increase the risks. Because the productivity of pastures depends on rainfall, more irregular rainfall distribution, with more frequent droughts, will mean that livestock will suffer more periods of fodder shortages, particularly in zones with shallow soils. In some regions, such as the south-east of South America, Niño/Niña events have a marked influence on the climate. If these events become more frequent the climate will become more extreme.

Table 2.– Expected negative (–) and positive (+) effects on animal production

Description	Expected effects	
Meat and dairy livestock	1. Increase in the average productivity of pastures because of higher temperatures, rainfall and CO_2	+
	2. More severe droughts with more frequent fodder shortages	–
	3. Greater risk of not obtaining water for livestock	–
	4. More summer heat stress events: reduction in pastoral farming, milk production and fertility	–
	5. Lower average winter weight losses through less effort required for thermal regulation	+
	6. More animal health problems because of the greater incidence of diseases and pests (insects and mites)	–
	7. Greater risk of degradation of the botanical composition of pastures and lower resilience (ability to recover from extreme events)	–
	8. More variability in the availability of fodder grains	

As you can see, there are both plus and minus signs, the net result of which will depend greatly on the conditions in a given year, introducing growing uncertainty into the results of agricultural activities.

In this context of increasing risks we need to identify and implement methods of adaptation. Some can be implemented within the ambit of farms and others relate to government policies. Research also has a key role to play, for example in identifying vulnerabilities and ways of reducing them (genetic materials more resistant to disease or water stress, management practices, etc.).

The main pillars of any strategy for the adaptation of animal production to climate change would be:

a. Introduce changes in management, technologies and infrastructure, for example:
   - protect pastureland and its biodiversity from degradation;
   - draw up surveillance and rapid response strategies for threats to animal and plant health;
   - use good land use practices to minimize the risks of erosion;
   - increase the availability, in terms of quantity and quality, of water for livestock;
   - use genotypes with greater resistance to drought and to the greater pressure from disease vectors;
   - create fodder reserves for crisis periods;
   - improve the distribution of shade and shelter for livestock and promote silvopastoral systems.

b. Reinforce research, development and technology transfer.

c. Develop information and support systems for better public sector and private decision-making (using quality meteorological information, including early warning systems).

d. Develop and generalise the use of agricultural insurance suitable for climate risks.

e. Improve territorial planning and protect ecosystem services, the functioning of hydrographic basins and biodiversity.

f. Develop appropriate institutional capacities for adaptation and coordination at national and local level. This implies adapting organisations and standards and creating new capacities to make then more effective in dealing with climate change. Strengthening institutions and training are big steps in this direction.

Appropriate means of adaptation in a continent as diverse as America depends on the location, the sector and the production system. Certain measures are available but others require much more research. A proactive approach is key to the management of climate risks. It is also important to keep in mind that a set of adaptation measures has synergies with mitigation and could generate major benefits in terms of the efficiency of production processes, but promoting them would not lead to regrets if the future behaviour of the climate (always uncertain) should fail to follow the predicted pattern.

4. Perception of climate change and animal health in the Americas Region

Climate change is attributed directly or indirectly to human activity that will alter the composition of the Earth's atmosphere, combined with the natural variability of climate observed and compared over long periods of time.

Every time there is a major climate disruption, major biological changes also occur, for which reason it is not unreasonable to consider the impact of climatic and environmental change as part of the health/disease dynamic of animal populations. In the health/disease process there is a constant fluctuation between the health situation and the disease occurrence, where the change from one to the other is determined by a change in the balance between the three elements that comprise the ecological triad: the agent, the host and the environment. Although the environment surrounding the animal health system is constantly changing, the system is not immune to such changes.

In the mentioned 2007 report, IPCC warned that changes in weather patterns could extend the spatial distribution of vectors such as mosquitoes and ticks [5]. Because arthropods are very sensitive to the environment and seasonal temperatures, the extension of the transmission of diseases such as bluetongue, West Nile fever, Venezuelan equine encephalitis, Lyme disease, yellow fever and visceral leishmaniosis will remain restricted to the distribution of vectors governed by these changes.

The emergence and re-emergence of vector-borne diseases in many regions of the planet provides a clear example of the link between climate change and effects on the human/animal health interface.

Climatic/environmental impacts will be detected and experienced in different forms, depending on where in the world they occur. Until now, some of these vector-borne diseases have been reported in zones of South America, while others are absent from the continent and yet others could change in occurrence and intensity depending on regional factors.

Dealing with animal health will require the characterisation of production systems, taking into account the health risks associated with the intensification of production systems (high density of animals per unit area) and the marketing of live animals involving movements between farms and regions.

With more frequent extreme events, there could be an increase in climate-related deaths and diseases. The damage to the animal health profile will not necessarily come from a specific biological agent; it may be driven by multiple environmental factors that cause what are known as "production diseases".

More than ever we need to consider the threats associated with climate and environmental change in terms of prevention and adaptation for the effective production of proteins.

It is hoped that the current major trend for meat exports from the region will help to meet global demand for animal protein by taking a balanced, environmentally friendly approach to animal production.

To assess the likely impact of climate and environmental change on animal production and emerging and re-emerging diseases, in November 2008 the OIE conducted a survey among its Member Countries worldwide. The survey responses from Member Countries in the Americas were picked out and the data were analysed and compared with the results of the global survey. Although some differences were observed in identifying the diseases most likely associated with climate change, the majority of veterinary authorities are as aware of the issue as the rest of the world. National veterinary authorities in the Americas are greatly concerned that climate change will result in the emergence or re-emergence of animal diseases within a 5- to 10-year timeframe.

The emerging and re-emerging diseases directly associated with climate change in the region include avian influenza and Newcastle disease in wild birds that migrate in the northern winter from the Arctic to South America. Wild birds are known to be reservoirs of various pathogens, including the West Nile virus, and to act as natural hosts capable of multiplying the virus.

With respect to climate change and the occurrence of aquatic animal diseases, *Vibrio tubiashi* and *Vibrio parahaemolyticus* were identified in Pacific oysters and *Icthyophynos hoferi* in Pacific salmon and other fish.

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 the region have identified the emergence of leishmaniosis as a zoonosis linked to climate and environmental change.

In North America climate change is believed to increase the risk of human exposure to cutaneous leishmaniosis in northern areas of the United States, especially the centre-east of the country and extending up to the centre-south of Canada, by transforming the area into a more suitable habitat for the vector and reservoir species that transmit this disease.

To the south of the American continent, the incidence, lethality and geographic distribution of visceral leishmaniosis has increased worryingly in recent years in Argentina, Brazil and Paraguay, where a change in the epidemiology of the disease has been observed, becoming established in urban and peri-urban areas with aggravated virulence. In Argentina visceral leishmaniosis is spreading from indigenous outbreaks, where deforestation, chaotic urban development, migrations and temperature changes are seen as factors conducive to the emergence of this type of leishmaniosis. We note that the mosquito *Lutzomyia longipalpis* is losing its natural habitat through clearance in the region, being now in an active dispersion phase.

Conversely, driven by the increase in forestry production, in Uruguay in 2007 herbivore rabies was reported as an emerging disease in cattle, with the change in land use and livestock production providing an ideal refuge for the reservoir of the viral aerial cycle, *Desmodus rotundus*.

Because of the highly lethal nature of these zoonoses it is vital to ensure surveillance and early diagnosis, increasing interactions between the human health, animal health and environmental sectors in a more coordinated manner and on a larger scale than hitherto.

The urgency of the matter and its socioeconomic impact require updated surveillance strategies for the Veterinary Services in relation to the perceived and foreseeable risk of the occurrence of diseases associated with climate change.

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.

The countries take a positive view of the creation of a regional network of experts, as well as collaboration in the identification of priority areas for capacity building and developing a regional training programme.

It emerges from the above that in order to develop regional strategies for disease prevention it will be necessary to carry out in-depth studies into climate change and the occurrence of diseases.

Finally, we need to keep in mind that preventive action has clear economic, environmental and social benefits, because it anticipates the potential impact and minimises the threats to ecosystems and human and animal health. The institutionalisation of risk management therefore provides an appropriate instrument for minimising these threats, thereby contributing to the necessary adaptation to climate change.

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