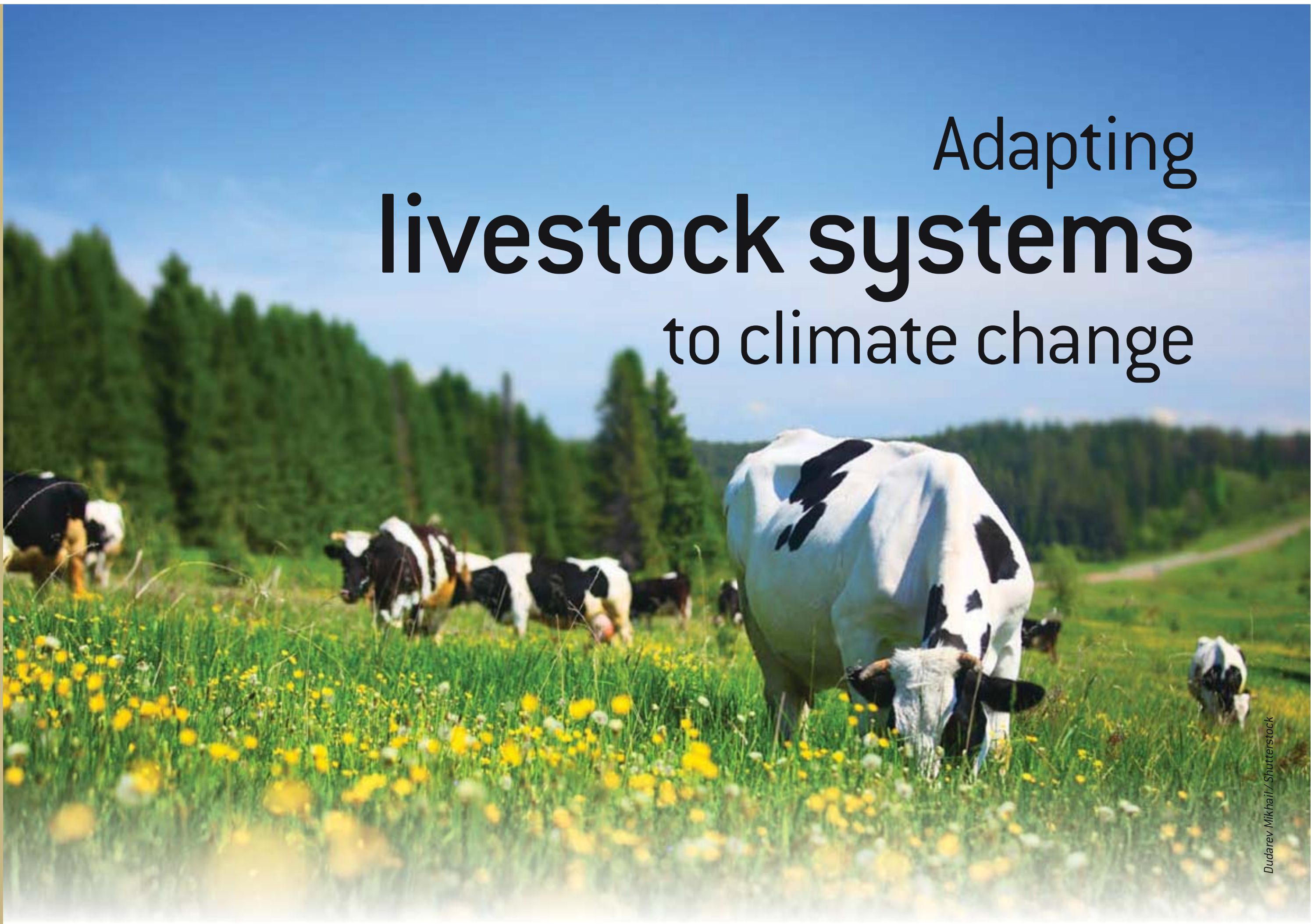

Adapting livestock systems to climate change

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Livestock systems produce a significant amount of greenhouse gases. They contribute to climate change, and conversely, are exposed to its effects. It is therefore urgent to implement adaptation measures, some of which already exist.

Should we reduce our consumption of animal products (meat, milk, eggs) to fight against climate change? This question has been the subject of debate for over a decade. The issue: greenhouse gas emissions caused from livestock supply chains which, according to the Food and Agriculture Organization (FAO), account for nearly 15 percent of total human contribution to greenhouse gas emissions. This share could increase: while meat consumption has started to decline in some Western countries, the demand for animal products will grow in developing countries. By 2050, global consumption could increase by 70 percent. But what would happen if climate change, summer heat waves and droughts continue to affect livestock production a bit more every day?

The situation is complicated by the fact that livestock production occupies 30 percent of the Earth's land surface: 3.4 billion hectares of grasslands and pastures and half a billion hectares for feed crops. More than 800 million of poor people depend on livestock farming for their survival and the sector contributes to the employment of more than 20 percent of the total world's population. Ruminants are able to produce food on non-arable lands (due to slope, altitude or climate) and to transform resources not used for human consumption, such as grass and fodder, into edible products.

Through grazing and sustainable use of grasslands, extensive livestock farming, if it is well managed, can contribute to protecting biodiversity, soils and surface water and to limit the development of scrubs. Livestock also accounts for 40 percent of the economic agricultural sector and is experiencing dynamic growth (more than 3 percent per year).

Meat, milk and eggs provide 18 percent of calories for human consumption and close to 40 percent of essential proteins and micronutrients (for example, vitamins, minerals and unsaturated fatty acids).

Causes of the footprint

Given the diversity of producers and situations, quantifying greenhouse gas emissions from agricultural activities, especially livestock production, is complex and subject to many uncertainties. In addition, microbiological processes at the source of methane or nitrous oxide emissions are highly variable and we do not yet know how the global carbon stocks in soil organic matter is changing.

Despite these uncertainties, the FAO estimated livestock emissions, from land use for feed production to the processing and transport of animal products, through several economic sectors. The livestock supply chains were found to represent globally 7.1 gigatons of equivalent carbon dioxide per year, i.e., 14.5 percent of anthropogenic greenhouse gas emissions. In a separate assessment, the Intergovernmental Panel on Climate Change (IPCC), showed in its fourth report that the entire agricultural sector contributes directly to more than 14 percent of emissions, while changes in land use like tropical deforestation, contribute as much as 17 percent.

The main sources of emissions identified by the FAO are related primarily to the production and processing of animal feed: this corresponds to 45 percent of total emissions, 9 of which are related to the expansion of grazing and crop areas at the expense of forests. Next come methane emissions from the digestive process in ruminant animals (39 percent), followed by emissions from manure (10 percent). The remainder comes from the processing and transportation of animal products.

Climate change resulting from accumulated greenhouse gas emissions impacts agricultural and livestock production. Between 1980 and 1999, severe droughts were estimated to cause the disappearance of 20 to 60 percent of herds in several sub-Saharan African countries. In the summer of 2003, an exceptional heat wave hit Europe resulting in a drop of crop yields of 20 to 30 percent and a forage deficit of 60 percent in France.

The number of hot summers is predicted to increase over the next 40 years. Changes in the water cycle related to climate warming is expected to lead to an even more uneven distribution of rainfall, more intense in some regions, more rare in others, which will lead in turn to prolonged droughts with increased risks of soil erosion and a reduced capacity to store water and provide nutrients.

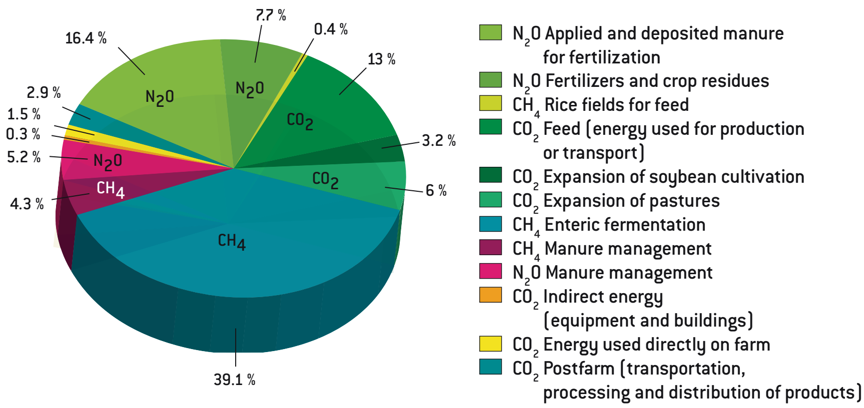
In France, the VALIDATE project, coordinated by the French National Institute for Agricultural Research (INRA), proved through experimentation that climate change could reduce production in temperate grasslands by 20 to 30 percent. However, its impact would be less pronounced in grasslands based on resistant Mediterranean grass varieties, as would also be the case in the Alps where variations in temperature are already significant. An increase in atmospheric carbon dioxide should also limit the impacts of drought on vegetation as an increase in the concentration of this gas in the atmosphere causes partial stomatal closure at the level of leaves. Partially closed stomatal pores reduce water loss in plants.

Most livestock animals are homeotherms: their survival depends on their capacity to maintain a constant internal temperature. When exposed to heat, they reduce their feed intake with subsequent negative effects on their performance and health. Summer heat waves result in a significant number of animals' deaths. In California, heat weaves in 2006 resulted in the death of 700,000 poultry and more than 25,000 dairy cows.

Emergence or re-emergence of diseases affecting livestock animals is another risk associated with climate change, which could have serious health, ecological, socio-economic and political consequences. An example is the bluetongue virus, a viral disease affecting sheep, which has already begun to spread to temperate zones in Europe.

In this context, reducing emissions is a priority for the livestock sector. This is reflected in a variety of international initiatives, such as

Distribution of greenhouse gases produced by livestock



N_2O: nitrous oxide; CH_4: methane; CO_2: carbon dioxide

AnimalChange, a project funded by the European Union involving more than 100 scientists from 21 European countries for coordinated research on livestock, climate change and food security. In France, a study conducted by INRA highlighted the potential for important mitigation in the French agricultural sector: by 2030, emissions could be reduced by 32 million tons of equivalent carbon dioxide per year. Several measures target livestock in this study: grassland and waste management, feeding practices and methanisation (see box on this page).

A study conducted by the FAO found that greenhouse gas emissions vary considerably between neighboring farms. This finding is encouraging as it implies that by applying 'cleaner' farming techniques we could reduce the carbon footprint by about 30 percent. In theory, emissions could be reduced in all systems, from industrial poultry farming in Asia to transhumant sheep and goat farming in arid zones in Africa. This objective could be achieved by using techniques that currently exist but which are not yet widely used. For example, extensive sheep and goat farming systems in western Africa could produce more while emitting fewer greenhouse gases by increasing the use of crop residues, by improving the health of the animals with vaccinations and deworming treatments and by implementing improved pasture management. This study also highlights the global potential for carbon storage in grassland soils via root systems and aboveground biomass. This could be achieved through moderately intensified farming in certain regions and taking restorative actions for degraded grasslands in others, and through the development of agro-pastoral systems.

Research for adaptation

Can we make the livestock farming sector less vulnerable to the effects of global climate change? Complex strategies are beginning to take shape. The first focuses on livestock feeding. It is aimed at limiting fluctuations in productivity through, on one hand, the selection of more resistant forage species for temporary grasslands and, on the other, improving management of grazed permanent pastures. It also addresses, notably for poultry and pigs, strengthening the use of resources that do not compete with human food (industrial by-product meals, for example). At the same time, it will be necessary to continue to improve how efficiently animals utilize their feed rations for the production of meat, milk or eggs. One example of the various possible pathways would be to improve the ration quality or to breed and select animals with a high efficiency of feed use and/or with a high ability to digest alternative feed resources.

A second strategy consists of developing selection programs for animals less susceptible to harsh conditions (heat, restriction of water or food). Due to their high capacity for adaptation, hardy local breeds are the main focus of these breeding

Methanisation (or anaerobic digestion) is becoming increasingly important all over the world


A.Mottet, FAO

These methanisation plants (in Germany, left, and in Ghana, right), considerably different in size, both produce renewable energy (biogas) from livestock manure.

Under the actions of microorganisms and in the absence of oxygen, anaerobic digestion degrades organic matter from livestock manure. This process leads to two by-products. The first is the digestate: an organic substance rich in nutrients, it is generally used as fertilizer. The second is a gaseous mixture (biogas) composed mainly of methane and carbon dioxide. Part of the methane in manure is converted into carbon dioxide, for which the warming potential is 25 times lower than that of methane.

The biogas produced in methanisation plants can be used in several ways: in combustion for heating or cooking, in cogeneration to produce electricity and heat, or used directly in the natural gas network. Methanisation can produce renewable energy, while diversifying revenues for farmers and reducing their carbon footprint.

In France, this process is developing rapidly with support from public authorities. Nearly 160 methanisation plants currently use livestock manure: whether privately or collectively owned, they produce an estimated at 650 megawatt-hours of primary energy. By 2030, the French Agency for the Environment and Management of Energy (ADEME) estimates that primary energy from methanisation will multiply by more than 100,000, and will reach as much as 69 terawatt-hours - or 3 percent of total energy production. It is estimated further that up to 78 percent of this energy will come from agriculture. In 2050, ADEME suggests, this could rise to 104 terawatt-hours: methanisation would then become the third source of renewable energy in the country.

Marc Bardinal and Julien Thual, ADEME

programs. On this topic, INRA is currently running several ambitious programs mainly focused on pigs and poultry.

A third adaptation strategy is based on controlling the increase in animal health risks associated with climate change. To do this, it will be necessary to anticipate changes in the geographical distribution and the virulence of pathogens and limit their effects on livestock animals. This can be achieved through early diagnostic methods and/or vaccination and/or by promoting new farming systems based on, among other things, the association of several animal species. As an example, to fight against gastrointestinal nematode infections in small ruminants, it is possible to use integrated control managements such as the mixed grazing of animal species (small and large ruminants) bearing different gastrointestinal nematode species.

In agriculture, adaptation also requires better management of climate risks, often necessitating the diversification of crops and farming systems. Small farms, particularly those in harsh environment, have developed strategies that make them less vulnerable to climatic shocks and help them to manage the impacts. Risk-sharing within families and rural communities, anticipation measures (feed storage), and insurance mechanisms are part of these autonomous strategies, which are, however, not sufficient to deal with large-scale climate change.

A number of innovations will be necessary: increased use of biological diversity and breeds, environmental technologies for improved water collection and storage, seasonal weather forecasts... However, the success of these technologies will depend on their technical efficiency and their adoption rate, two factors limited, in many developing regions, by poverty, hunger, lack of financial resources, environmental degradation and conflicts.


Matthew Dixon /Shutterstock

Like all ruminants, sheep release methane during digestion.

Reducing emissions and increasing adaptation to climate change are both achievable goals: for example, by avoiding overgrazing we can restore carbon stocks in soil while fostering better resistance to drought. That said, while synergies exist, trade-offs should also be considered: selecting animals to improve their production potential tends to increase their sensitivity to external factors (such as heat). Solutions for combining adaptation and mitigation are therefore that much more difficult to identify as they need to be adjustable according to livestock farming systems and climatic contexts.

Rapid response

Now aware of the urgency, the livestock sector is reacting. Many initiatives involving public and private actors have emerged over the past ten years. Whole sectors are taking action, such as the French dairy sector, which launched the Carbon Dairy project in late 2013 with the goal of reducing greenhouse gas emissions of 3,900 farms by 20 percent over the next 10 years.

Beyond international political frameworks and negotiations, such as the Kyoto Protocol or the United Nations Framework Convention on Climate Change, it is essential to support concerted actions that bring all stakeholders together: producers, processors, governments, NGOs, civil society and the scientific community.

Scientists must evaluate the potential of different approaches to reduce greenhouse gas emissions and adaptive measures for livestock farming, in order to define priorities. It is also their responsibility to assess possible actions, to continue to develop innovations capable of reducing the carbon footprint and to develop tools to precisely predict the impacts climate change will have on livestock farming over the next 50 years while defining measures that can be implemented... as soon as possible.

References

P. Gerber ***et al.***, *Tackling climate change through livestock. A Global assessment of emissions and mitigation opportunities*, FAO, 2013.

M. Mathieu ***et al.***, *Intensive grazing system for small ruminants in the Tropics : The French West Indies experience and perspectives*, *Small Ruminant Research*, vol. 77, n° 2, pp. 195-207, 2008.