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AGRICULTURAL RESEARCH FOR DEVELOPMENT

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Pastoral landscapes in the Sahel: a carbon balance with unexpected potential for climate change mitigation

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In the Sahel, pastoralism capitalises on an extreme environment. Although it is accused of emitting excessive amounts of greenhouse gases per kilogram of milk or meat produced, a research study conducted in Senegal shows that pastoral landscapes can actually have a neutral carbon balance: emissions from animals are offset by carbon sequestration in soils and plants. These findings were obtained using an original evaluation method, known as ecosystem assessment, which integrates the use of the pastoral landscape as a whole, according to the seasons and the areas grazed by herds. These findings indicate that current standards for calculating feeding behaviour and methane emissions from ruminant digestion need to be revised downwards. Other implications are possible, such as improving the carbon balance through specific local practices and promoting these areas on the carbon market. Preserving this livestock system is also one way of fostering development and ensuring greater security in these regions.

Pastoralism is present in all parts of the world and provides a livelihood for more than 100 million people. It primarily concerns ruminants – cattle, sheep, goats, camels, deer, etc. In this type of extensive livestock system, the herds roam landscapes in search of forage and water. In Africa, pastoralism represents 10 to 44% of gross domestic product depending on the country and occupies more than a quarter of the population. In the countries of the Sahel, it provides 70% of milk and more than half of beef and small ruminant meat.

However, at the global level, the livestock sector is responsible for 14.5% of greenhouse gas emissions linked to human activities, according to FAO – these emissions from livestock are composed of 44% methane (CH_4), 29% nitrous oxide (N_2O) and 27% carbon dioxide (CO_2). However, these global figures cover very different realities in terms of productivity and emissions depending on the regions and livestock systems in question. The current debate on agriculture and climate points the finger at pastoralism in the Sahel: the low productivity of herds and the ingestion of roughage, which makes up most of their diet, produce high levels of methane emissions per unit of animal product (milk or meat). But the impact of this livestock system on climate change has never been accurately determined because pastoral ecosystems in dry regions are complex and are studied very little from this perspective.

Pastoralism in the Sahel plays a crucial role in the exploitation of this very harsh environment (see box p. 3). What is its real contribution to the carbon balance of the landscapes? Estimating this balance is complex: it requires attention to all the elements of the ecosystem and their interactions, including animals, their movements and their access to water, plants and soils. A recent study in Senegal has helped to address this issue, with implications for public policies in these regions.

Key findings in the Sahel: methane emissions from ruminants and variations in the carbon balance

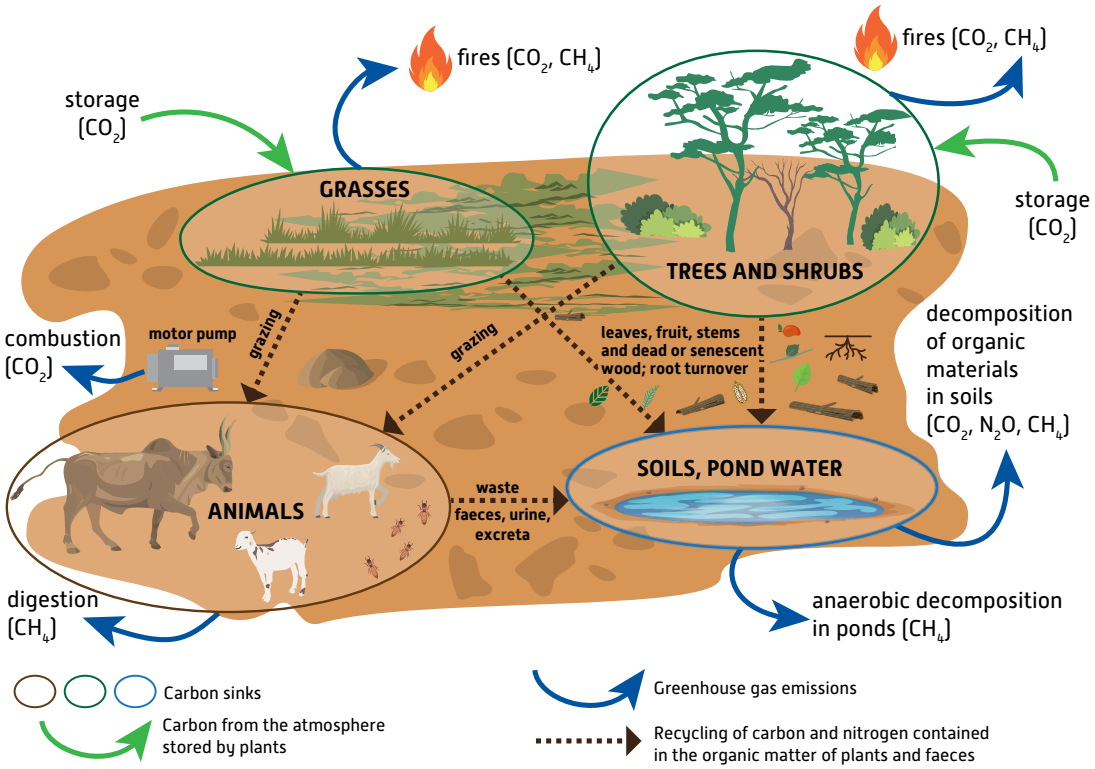
The study, conducted in northern Senegal (see box p. 2), produced new knowledge on these ecosystems. It used an original method to estimate feeding behaviour in ruminants and the methane emissions from their digestion, known as "enteric methane".

Over the one-year cycle, herds (cattle, sheep, goats) eat less than a third of the available herbaceous biomass and less than 5% of the leaves from trees and shrubs in the pastoral landscape. Measurements of daily intake show that the standard reference used in Africa needs be revised: at 25 g/kg (grams of dry matter per kilogram of live weight), this standard is too high for cattle and too low for small ruminants. The study proposes new standards based on the daily measurements taken:

> an intake of 18 g/kg for cattle and 34 g/kg for small ruminants;

> or a single standard applicable to all ruminant species, of 73 grams per kilogram of metabolic weight – in nutrition, metabolic weight corresponds to live weight to the power of 0.75 and the maintenance requirements of an animal are always proportional to the metabolic weight.

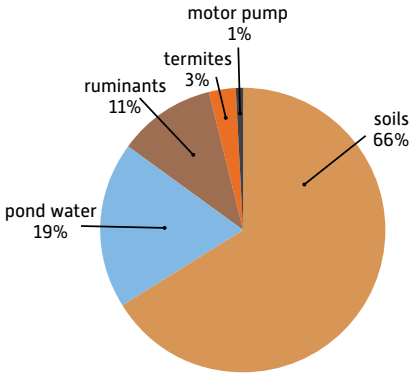
Simplified model of greenhouse gas emissions and carbon storage in a Sahelian pastoral landscape: the carbon balance ecosystem approach is based on this model.



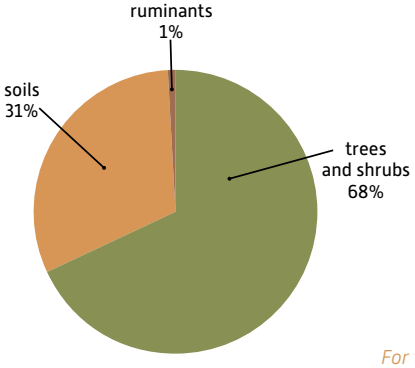
Herbaceous plants, as annual plants, are not considered as a carbon sink. Wildfires, characteristic of grazed ecosystems in the Sahel, are a source of greenhouse gases. Termites, like ruminants, emit methane through their digestion ("enteric methane").

The Sahelian pastoral system is balanced: what emits greenhouse gases and what stores carbon?

Soils emit the most
(as a percentage of total annual emissions).



Trees and shrubs store the most
(as a percentage of total annual storage).



For the year in question, there were no bush fires.

A carbon balance including all ecosystem elements: application to the Sahel

The carbon balance of a system is calculated by evaluating all greenhouse gases emitted (CH_4, CO_2, N_2O) as well as carbon sequestered. The balance expresses all of these flows in carbon equivalent.

The study was conducted in the sylvo-pastoral region of Ferlo in northern Senegal, more specifically in the Widou borehole service area (706 km^2). This semi-arid region is representative of Sahelian pastoral ecosystems, where pastoralism is the main activity. Over a full year, the monthly monitoring of this landscape produced a large-scale carbon balance (see figures).

The ecosystem method used here, also known as "landscape level", takes account of all ecological functions in a landscape to calculate its carbon balance. All flows are counted, in other words greenhouse gas emissions in the atmosphere and carbon sequestration in the ecosystem. The boundaries of the landscape are defined, then its main elements (animals, soils, plants) and the interactions between them and with the atmosphere are described. This method produces a spatial and dynamic representation of emissions and variations in stocks, according to the seasons and areas.

This method is well suited to the Sahel because there are almost no external inputs. Traditionally, balances are calculated at the scale of a farm by focusing on inputs without taking account of variability over the year or of the spatial heterogeneity of the ecological processes behind emissions and sequestration. On the contrary, the ecosystem approach takes account of specific processes: for example, the presence of animals consuming standing fodder reduces the risk of fires and termites.

These new daily intake standards can be modulated (± 12%) according to resource availability in the landscape, the livestock practices and the seasons. Despite this, they have an impact on the estimation of enteric methane emissions: for Sahelian cattle, current official estimates could be twice the actual figure. These standards could contribute to revising those used in the guidelines by the Intergovernmental Panel on Climate Change (IPCC).

The research shows that the carbon balance of the landscape is neutral, even if it varies according to the place and the season. In the area studied, over one year, one hectare of pastoral ecosystem emits 0.71 tonnes of carbon equivalent and sequesters 0.75 tonnes: in other words, it stores the difference, i.e. 40 ± 6 kilograms of carbon equivalent. In the Sahel, storage in trees, shrubs and soils offsets the greenhouse gas emissions herds produce through their feeding and their faeces (see figures p. 2).

More precisely, the annual carbon balance varies from one place to another and this variation is linked to livestock practices. The grasslands, shrublands and wooded areas in which herds graze are places where sequestration is predominant. On the contrary, the resting spots close to camps and watering points, which receive large amounts of faeces, are high-emitting places.

Seasonal variations in the carbon balance, which are not widely studied, were measured for the whole pastoral ecosystem, for all locations. In the rainy season, the ecosystem emits far more greenhouse gases than the carbon it stores – animals and watering points are the main sources of emissions. Conversely, in the dry season, the ecosystem stores carbon – faeces and grasses are worked into the soil through trampling by herds.

Although the study was conducted during a year with lower than normal rainfall, the equilibrium of the carbon balance in Sahelian pastoral landscapes is not called into question, since herd mobility enables pastoralists to adapt to grass production and to reduce pressure on grazing areas (see box opposite).

Herd mobility: a response to climate variability in the Sahel

Pastoralism fosters herd mobility, based on shared access to and community management of watering points (wells, boreholes and natural ponds) and rangelands (natural grasslands, wooded areas, fallow lands and harvested fields). Mobility is a strategy for adapting to local seasonal and interannual variability in rainfall and resources, which fluctuate according to the climate.

In the Sahel, plants regenerate during the four months of the rainy season, from July to October. This renewed stock is also the main source of food for ruminants during the eight months of the dry season. Pastoralists take their herds to the best resources available at the time, within the limits of acceptable efforts, meaning they have to move every day and according to the seasons. In the rainy season, herds move daily around the camp. The dry season involves long journeys of tens or hundreds of kilometres: this is known as transhumance, and may cross several regions within a country or even pass from one country to another.

Pastoralists decide on itineraries so as to ensure watering and, through the choice of plants to be grazed, to meet the dietary requirements of animals. Sahelian ruminants have a genetic potential adapted to pastoral practices, with conditions of extreme heat and dryness, and can adjust to a wide range of plants.

During the dry season, as soon as the quality and quantity of fodder diminishes, the transhumance is organised, leaving just a few animals at the main residence. During the transhumance, the animals lose weight because dried grass is not as rich and moving in this way requires energy.

Technical and political implications: planning these landscapes as a tool for climate change mitigation

Considering three operational mitigation options at the local level – The carbon balance obtained in northern Senegal provides a detailed picture of variations in emissions and storage, both over time and in the different parts of the pastoral landscape. In addition to the recognised option of tree planting, such as the Great Green Wall in Africa, three techniques are suited to pastoralism: developing watering points, making use of animal waste through anaerobic digestion, and storing fodder when it is abundant and high quality.

Areas around watering points emit one fifth of greenhouse gases. To limit this, the amount of faeces deposited there needs to be reduced, by creating well-maintained drinking troughs and deferring grazing in areas where water collects at the surface.

Lairage areas concentrate high levels of faeces. Anaerobic digesters would make use of this waste to produce domestic biogas and a fertiliser by-product that could be recycled in agriculture and forestry.

In one year, less than a third of the grass produced by the ecosystem is ingested by herds, with the rest returned to the soil through their trampling. Harvesting a proportion of the ungrazed grass and storing it as hay would meet the requirements of herds and enable transhumance to begin later. The grass could be harvested before the end of the rainy season to guarantee optimal quality and to ensure regrowth. Fodder banks could be created by stakeholders, with a whole sector to be organised – the management of harvesting, storage sites and structures, the redistribution of stock and its remuneration. This would imply a change for pastoralists, who are not accustomed to collecting fodder, although the recent recurrent droughts have led some of them to begin doing so. This innovation has a threefold positive mitigation effect: lower risk of fire, less enteric methane due to better fodder, and higher animal performances (meat and milk). These practices also foster adaptation to climate change by partially offsetting the variability in plant production linked to the climate, reducing the vulnerability of pastoral systems and improving pastoralists' income.

Continuing research in other low-input ecosystems – The carbon balance ecosystem method needs to be replicated over several years in other tropical agricultural landscapes, whether these are grass-only systems or mixed crop-livestock systems. This would help to better evaluate the direct and indirect effects of livestock activities on climate change, whether negative or positive. The multiplication of new quantified references on greenhouse gas emissions and carbon sequestration would reduce uncertainties and these findings could be integrated into the IPCC guidelines.

Promoting pastoral areas on the international carbon market – In Africa, these areas cover almost 1.3 million hectares, representing significant potential for sequestration. Green funds and carbon credits could also be mobilised in support of pastoralism in sub-Saharan countries. The carbon balance per hectare could become an additional indicator to assess the performance of an extensive grassland pastoral system in tropical regions. To advance the debate on pastoralism, this new indicator fits perfectly into the Koronivia Joint Work on Agriculture process adopted at the 23rd Conference of the Parties to the United Nations Framework Convention on Climate Change (COP23, 2017).

Strengthening policies to support pastoralism – In the countries of the Sahel, the issue of livestock and climate change requires better knowledge and expertise on the subject. The mitigation potential of pastoral landscapes as highlighted by the study in Senegal is one argument to remedy this. More broadly, in sub-Saharan

Africa, fostering the maintenance of pastoral mobility is a key action for preserving both populations and the balance of ecosystems. This mobility is regularly threatened by insecurity and conflicts, population growth and urban and agricultural expansion. Beyond its role in mitigating climate change, pastoralism is an optimal way to develop and occupy vast areas that are unsuitable for other activities: this is one means of increasing security in these regions and stabilising the human populations living there. ■

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Publications resulting from this research include:

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A few words about…

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A few links

Agence panafricaine de la Grande muraille verte *(Panafrican Agency of the Great Green Wall)*. https://www.grandemurailleverte.org/

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