Livestock and climate change in the global South: it's not the cow, it's the how

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Recommendations

- There is a need to **change common public narratives** about livestock's role in climate change and in overall efforts to attain sustainable food production and consumption. Preliminary research shows that in the global South in particular, livestock family farming (LFF) systems such as pastoralism, seem to produce meat and milk in a carbon-neutral manner and therefore contribute to climate change mitigation.

- **Additional research** is needed to evaluate the role of LFF systems in climate change mitigation. This research should also take into account their environmental services (such as their contribution to biodiversity, improved soil quality, etc.), as well as their overall contribution to sustainable food systems. This means including also their economic and social contribution to sustainable development.

- Livestock family farmers have developed indigenous ways to deal with the consequences of climate change to increase their resilience. In order for them to play a key-role in climate change mitigation, these **adaptation strategies** must be supported by enabling policies and investments through development projects and programs.

Abstract

Since early 2019, climate awareness in Europe is growing. In addition to topics such as migration and security, climate change now occupies a permanent place in the public and political debate. It is worth noticing that in these debates, livestock is considered a major cause of greenhouse gas (GHG) emissions and broader environmental degradation. Indeed, livestock breeding – cows, sheep, goats, pigs and poultry – is estimated to contribute up to 14.5% per year to global emissions of GHG, both directly and indirectly (Rojas-Downing et al. 2017). These emissions are due, among other things, to land-use changes, manure production and to the transport of meat and animal food products over long distances. All these processes are inherent to industrial production systems.

Note: In this document, use of the masculine is generic and applies to both women and men.

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Additional research is needed to document how LFF-systems both adapt to climate change and mitigate it at the same time, through their social, economic and environmental importance.

Environmental groups, vegans and vegetarians movements, defenders of animal welfare and consumer organizations rightly demand for this system to change in order to fight climate change. Some, however, go further and are convinced that the only salvation is to stop producing and consuming animal products altogether. This reflects the lack of nuance in understanding the relationship between livestock and climate change by refusing to take into account regional differences regarding greenhouse gas emissions and the important contributions of certain types of livestock to all three pillars of sustainable development including their social, economic and environmental added value.

In Livestock family farming systems, livestock play a key role in providing food security and income to millions of families and their communities. They contribute significantly to higher agricultural yields due to their integration with crop farming (using animal traction and manure). Unlike industrial livestock farming, LFF therefore fulfils many roles including an important environmental one as it has a positive impact on biodiversity and soil quality. Furthermore, grazing systems – as part of LFF systems – seem to have an often underestimated capacity to offset emissions of GHG thanks to their ability to keep grasslands in good state. This means that even though additional research is required, LFF systems can play a key-role in climate change mitigation.

Trying to understand the complex relationship between livestock and climate change requires a multi-dimensional approach. Trade-offs should be considered between social, economic and environmental pillars of sustainability. The relationship between livestock and climate change should be also considered a two-way street as climate change also affects livestock keeping systems and LFF in particular. Rising temperatures and extreme weather conditions resulting from climate change have a significant impact on livestock family farmers and threaten their positive contributions to overall sustainable development.

Therefore, additional research is needed to document how LFF-systems both adapt to climate change and mitigate it at the same time, through their social, economic and environmental importance. Research needs to be combined with an enabling policy framework, supporting livestock family farmers in their efforts to come up with adaptation strategies. A first step to achieve this would be to change the current narrative of livestock versus climate change or even broader (environmental) sustainability. “It’s not the cow, it’s the how!”

1.

Livestock’s contribution to climate change: where it comes from

Climate change is caused by massive emissions of greenhouse gases which block heat from escaping into the atmosphere. Livestock production contributes to this through the emission of methane (CH_4), nitrous oxide (N_2O) and carbon dioxide (CO_2). The Global Livestock Environmental Assessment Model (GLEAM) developed by the Food and Agriculture Organization of the United Nations (FAO) calculates livestock’s contribution to emissions of greenhouse gases globally using a Life Cycle Assessment (LCA) approach. In 2017 according to the GLEAM, livestock farming was responsible for 14.5% of total annual emissions of anthropogenic greenhouse gases (Rojas-Downing et al, 2017). This calculation is based on the various processes inherent to livestock farming systems and checks the quantity of CH_4, N_2O and CO_2 emitted during these processes.

A first process related to livestock keeping which is responsible for greenhouse gas emissions, is **land-use change**. For livestock, pastures and fodder crops (for animal feed) are essential. In order to create grazing areas or agricultural land to cultivate fodder crops, forest areas are often cleared and/or converted for livestock keeping. Forests, however, play a crucial role in the absorption of CO_2 to fight against climate change. Burning and cutting them down to make space for pastures and fodder crops generates direct emission of CO_2, but it also releases in the air the carbon that was previously stocked by plants.

Moreover, the **production of animal feed** also has an impact on CO_2 and N_2O emissions. Most fodder crops are produced in intensive monoculture systems, with widespread use of synthetic fertilizers and pesticides. These agrochemicals are associated with high levels of GHG emissions during their production phase. **Transport** is directly linked to the production of animal feed, since it is often grown and consumed in different parts of the world. This, along with the transport of the end products (meat and dairy products, including milk powder) over large distances, generally explains the large contribution of the livestock sector to CO_2 emissions.

In 2013, the European Union imported about 27 million tons of soy and soy derivatives from Latin America to be used for animal feed and for oil, which largely illustrates the above (Maguire et al, 2017). Transport requires **high energy consumption**, which is inherent to industrial livestock production and which is also necessary to heat stables and cool them down, to process meat and milk products, to provide packaging, etc. High energy consumption (often through the consumption of fossil fuels) is therefore another key process which explains livestock's contribution to climate change.

In addition, because of ruminant digestion and manure production and management, livestock is responsible for 44% of anthropogenic methane production (CH_4). **Anaerobic decomposition of organic matter (manure) and enteric fermentation (through ruminant's digestion)** are therefore two other processes which illustrate how livestock farming contributes to climate change. The amount of methane produced through livestock keeping depends heavily on the types of production systems, the animal feed and the animal breeds that are used. Manure production and management is also related to the production system. The impact of the production, management and stabilization of manure depends mainly on the duration and the treatment of manure.

These different processes can help explain why there is a particular cause-effect relationship between livestock and climate change. However, there is a need to take a closer look at the systems in which livestock is raised. Not all livestock systems add to climate change in the same way and it all depends on how and where livestock is raised and what processes are being used to produce milk, meat and eggs.

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2.

Livestock family farming (LFF) in the global South

What?

Around the world, about 1.5 billion men and women work on 404 million family farms of less than 2 hectares (McIntyre, et al, 2009). Livestock family farming refers to a huge variety of production systems going from extensive grazing systems over backyard pig and poultry keeping to mixed crop-livestock production systems (irrigated or rain-fed, sedentary or mobile). In family farming systems, "family" (to be understood in a broad sense) is at the heart of the production system (Vétérinaires Sans Frontières Belgium, 2014). There is a structural link between the economic activity and the family structure as the employees on the farm usually have family ties. This relationship influences the decision-making process, the organization of the farm, the production management and the handing down of the farm as an inheritance. The family is at the same time the owner of the land, the worker and the decision-making unit. Livestock family farming systems are often referred to as small and middle-scale farming systems. On the contrary, in large-scale livestock farming systems, often referred to as industrial production systems, the economic driver to rear animals prevails over other considerations. The FAO defines industrial livestock systems as farms which purchase at least 90% of their animal feed from other enterprises (FAO, 2009). They often raise a single species which is fed on animal feed instead of byproducts from the harvest or through grazing.

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Why?

As mentioned in the above, in LFF systems, decisions are based on a broad range of considerations besides economic drivers. These considerations can be socio-economic and environmental and relate to the important roles of animals in LFF systems, which distinguishes them from industrial livestock farming. Firstly, livestock play an important economic role in **creating employment**. It provides an income for their owners and all actors involved in the further steps of the value chain including processors and sellers.

In food insecure areas, livestock not only provide income but also contribute significantly to the **food and nutritional security** of entire communities. In 2019, over 820 million people were still malnourished and/or hungry (FAO, et al. 2019). For these populations, regular consumption of meat, milk or eggs can have a huge impact. This is clearly the case in Sub-Saharan Africa, where 22% of the population continues to suffer from undernourishment and where an increased consumption of milk, eggs and meat has a direct positive impact on the health of people, especially children

(FAO,2017). Animal products are an important source of macro- and micronutrients with a high nutritional value (CELEP, 2018). Consuming even small amounts of milk, eggs or cheese has a considerable impact on the cognitive development of children. The consumption of animal products as part of a healthy diet is still very low in many parts of the world and in Africa in particular.

In livestock family farming, animals are also used for **crop production**. Worldwide, over half of family farmers use more than 250 million animals for crop production (CIRAD, 2012). The role of livestock in crop production is often underrated: livestock is used for traction, to fertilize the land, to transport the harvest, etc. This ensures higher and more qualitative crop yields. The use of cattle for crop production also has advantages for the **environment.** Using cattle for traction enables livestock keepers to reduce their use of fossil fuels (CIRAD, 2012). Moreover, animal manure can replace chemical fertilizers which are harmful for the environment.

In addition to its economic and environmental role, livestock also plays an important social role in LFF systems. **As "families" are the key decision-making unit, social considerations are an inherent part of the livestock raising system**. Livestock also plays an important social role in ceremonies such as weddings, where animals are used to pay the dowry.

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3.

Climate change mitigation through livestock family farming

The above description of LFF systems in the global South shows significant differences between LFF and industrial livestock production. These differences are important when considering the cause-effect relationship between livestock and climate change. In the following paragraphs, it is argued that the processes causing excessive emissions of greenhouse gases are specific to industrial livestock farming and do not relate to LFF systems.

Low use of energy

While industrial systems use fossil fuels, LFF systems usually make lesser use of energy for production, processing and distribution of animal products. Family farmers in the global South use either grasses, shrubs, byproducts from crop production or fodder grown on the farm to feed their livestock. There is therefore no need to transport fodder over long distances, which causes the emission of CO_2. In addition, family farmers often use animal traction for crop production, which ensures an **integration of crop and livestock production**. Use of machinery and equipment running on fossil fuels is therefore very limited or even non-existent. Finally, the final outputs of the production system in LFF systems in the global South are traditionally sold on local and regional markets and require few packaging and transformation. Hence, greenhouse gas emissions related to these processes are very limited.

Better manure management

Manure generated by livestock is an important source of methane and nitrogen dioxide emissions. In livestock family farming however, agriculture and livestock farming are usually closely linked and operate as an integrated system. Locally produced manure is used as a natural fertilizer for crops and, in some cases, as a source of energy for the household (biogas). This means that the amount of manure to store and manage is considerably lower in livestock family farming, as compared to industrial livestock farming. This in turn reduces methane emissions. Moreover, these methane emissions are mainly caused by liquid manure, which is rarely used by family farmers. LFF systems in the global South mostly produce dry manure (e.g. grazing systems), with very low emissions.

No land-use change and optimal use of grasslands

Land-use change is one of the main causes of GHG emissions in industrial livestock farming systems. This practice is however very limited in LFF systems as land does not need to be burned to make space for pasture or fodder crops. LFF systems use the available resources in a sustainable manner, as illustrated in grazing systems. Globally, 40.5% of the world land surface consists of grasslands (World Rangeland Learning Experience, 2019), which are the main source of food for nearly 70% of ruminants worldwide (Lund, HG, 2007). Extensive livestock grazing or pastoralism – as part of LFF systems – makes use of these grasslands and is often defined as a production system where at least 90% of the total dry matter fed to the animals derives from pasture (FAO, 2011). Pastoralists are experts in managing natural resources available to them. Over the centuries, they have developed strategies to manage grasslands in a sustainable and variable way. One of these strategies involves mobility. In order to access water and quality grassland throughout the seasons, they travel distances with their herds along transhumance and migration routes. For livestock, mobility ensures continuous and high-quality feeding. Another strategy involves herd diversification. By associating different ruminant species with complementary grazing habits (i.e. goats, cows and sheep have different diets and grazing behaviors), pastoralists prevent pasture degradation and enable quick grass regrowth.

The mobile character of pastoralism – as a model and under normal circumstances – implies respect for the carrying capacity of pastures. As herds are constantly on the move, grasslands have sufficient time to recover after being grazed. This also enhances their capacity to absorb carbon, which is important for tackling climate change. Grasslands as such play an important role in mitigating GHG and in particular carbon dioxide emissions. By stocking carbon in the roots and leaves, grasslands contribute to reducing the CO_2 concentration in the atmosphere. This phenomenon is known as carbon sequestration (Derner, JD et al, 2007). Increasing grassland productivity through improved sustainable grassland management can therefore be seen as an effective climate change mitigation strategy. According to Liu et al. (2017), light and strategic grazing without soil compaction – through extensive grazing systems such as pastoralism – might even increase methane uptake by soils. A recent study conducted in a pastoral area in Northern Senegal proved that the carbon balance of the studied landscape is in fact neutral, meaning that more or less the same amount of greenhouse gases are emitted and absorbed (Habibou Assouma, M., 2019). This research did however suggest three ways to improve the carbon balance in pastoralist/grazing systems, which are (i) to develop water points, (ii) to make use of animal waste through anaerobic digestion and (iii) to store fodder when it is abundant and in high quality. Moreover, it is also increasingly argued that if domesticated ruminants no longer grazed grasslands, they would be replaced by wild populations of ruminants and termites, causing equally high methane emissions. In addition, spontaneous break-outs of bush fires would increasingly occur, causing massive emissions of CO_2 (Manzano, P., 2019).

Enteric fermentation

Methane from enteric fermentation and nitrogen oxides from manure account for most of the emissions related to livestock production (Manzano, P., 2019). It is estimated that livestock production is responsible for 37% of anthropogenic methane (CH_4) emissions worldwide (Steinfeld et al., 2010). Following a Life Cycle Assessment (LCA)-approach, it seems that livestock in the global South are emitting more methane per kg of protein/milk produced as compared to livestock in the West. For instance, an average Western European dairy cow emits about 34 g CH_4 emission per kilo of milk produced. An African dairy cow, by contrast, produces on average 99 g CH_4 per kilo of milk produced (IPCC, 2006). This can partially be explained by the use of low digestible animal feed. Indeed, in Africa and other parts of the global South, animal feed is primarily based on grass-rich diets with high cellulose and lignin content and contains very little concentrate- and grain-based inputs. In addition, methodologies such as LCA fail to take all elements into account that would provide a clearer view on the carbon balance of grazing systems. Biodiversity and soil quality, for instance are traditionally not taken into account in common LCA. (Pastoral) grazing systems in dry areas are however very specific and complex, and therefore require a peculiar approach to evaluate their contribution to the carbon balance of landscapes.

If we take the example of **soils** for instance, tropical forest and grassland soils are considered as the largest methane sinks, contributing 58% to the total global methane uptake by soils (Yu et al., 2017). Through an oxidation process, methanotrophic bacteria capture large amounts of methane and stock it into the soil. These methanotrophic bacteria are known to absorb methane moist efficiently in warm and dry conditions. According to the study by Yu et al. (2017), tropical dry grassland soils absorb more CH_4 than any other type of soil in the world. In Africa for instance, the mean value of CH_4 uptake efficiency for grassland soils was found to be almost double to the mean of global grassland or forest soils (4.14 versus 2.11 and 2.18 kg CH_4 ha-1 yr-1 for global grassland and forest soils, respectively). The considerable potential of African grassland soils for stocking carbon stresses the importance of protecting these rangelands and the people depending on and sustainably managing it. Any change in the CH_4 sink strength could alter atmospheric CH_4 concentrations and significantly affect global warming (Dutaur and Verchot et al., 2007).

The role of African grasslands in climate change mitigation

Considering an average methane uptake of 4.14 kg CH_4 ha-1 yr-1 by African grassland soils (Yu et al., 2017) and an average methane emission of 33 kg CH_4 animal-1 year-1 (IPCC, 2006), the calculated methane uptake capacity by the soil equals to the emission of 12.5 cattle per km^2. Compared to an average methane uptake of 1.21 kg CH_4 ha-1 yr-1 by cool temperate moist grassland soils (Yu et al., 2017) and an average methane emission of 110 kg CH_4 animal-1 year-1 (IPCC, 2006), the calculated methane uptake capacity by the soil equals to the emission of 1.1 cattle per km^2. Considering the actual cattle population densities in Sub-Saharan Africa (FAO, 2017), it is clear that compared to Western European soils, African grassland soils play a very important role in climate change mitigation. This parameter should clearly be taken into account when looking at greenhouse gas emission by cattle in Africa.

→ Table 1

Livestock Units and Relative Methane Uptake Capacity per km^2 of agricultural land.

Region	Year	Cattle	Unit Density	Relative methane uptake capacity of the soil
Eastern Africa	2017	35	LSU/km²	36%
Middle Africa	2017	19	LSU/km²	66%
Southern Africa	2017	10	LSU/km²	125%
Western Africa	2017	19	LSU/km²	66%
Western Europe	2017	71	LSU/km²	2%

Sources: FAO, 2017; IPCC, 2006; Yu et al., 2017

It is important to note that soils, through methanotrophic bacteria, are only the second largest global sink for atmospheric methane. The predominant sink being the reaction of methane with hydroxyl radicals in the troposphere. Taking this sink into account, it is clear that Africa's contribution to climate change through methane emissions is rather negligible.

This brief analysis illustrates the potential of LFF systems for climate change mitigation. However, **additional research is needed** to better understand the relationship between climate change and livestock in LFF systems, using appropriate methodologies. As LFF systems are based on important socio-economic pillars, questions may be raised about evaluating the environmental footprint of food producing systems, without considering the other pillars of sustainability. Fortunately, methodologies are increasingly developed to assess the sustainability of food systems as a whole.

Livestock family farming systems in the global South contribute to a lesser extent to climate change compared to industrial livestock systems.

4.

Climate change adaptation through livestock family farming

It is argued In the above that livestock family farming systems in the global South contribute to a lesser extent to climate change compared to industrial livestock systems. Indeed, it appears that it actually has important potential for climate change mitigation. However, the relationship between climate change and livestock family farming in the global South is twofold. Unfortunately, livestock family farmers also increasingly need to adapt to the effects of climate change. Thanks to their centuries-old culture of livestock keeping, they have developed ingenious ways of dealing with increased climate variability. In many cases, this makes their production system and lifestyle more adapted than others. Their adaptation strategies are numerous and include amongst others herd mobility in pastoralist systems, diversification of animal breeds and species, spreading animals/herd amongst relatives, livelihood diversification (for instance engaging in crop farming) and improved land and soil management.

However, herd mobility is not really a coping strategy as such in pastoralist systems. It is rather a strategy to best manage inputs (such as grasslands). Mobility is therefore rather a form of climate change mitigation than a form of adaptation. Diversification of livestock breeds and species is another strategy well known by livestock family farmers (Rivera- Ferre, MG, Lopez-i Gelats, F., 2012). In doing so they spread risks and become more resistant to herd diseases, shocks (e.g. prolonged drought or severe flooding) and other hazards. They tend to change to species and breeds which involve less risks – as they require less investment in terms of time (breeding) and money (fodder). Due to lower risk and investment, livestock family farmers become increasingly resilient. In addition, as LFF systems have a strong social component, livestock breeders tend to spread their animals amongst relatives and family members in order to cope with climate change induced shocks and hazards. Livestock family farmers also diversify their livelihoods to deal with shocks and engage for instance in fodder crop farming. They also tend to focus on better land and soil management.

This list of adaptation strategies to cope with climate change within LFF systems is non-exhaustive and provides valuable insights into the capacity of such systems to adapt to climate change. One could argue that in many cases LFF systems are better suited to deal with the consequences of climate change than other more intensive production systems/lifestyles thanks to their social, ecological and economical sustainability. However, LFF systems need enabling policies and additional investment, not just to adapt to climate change but also to fully realize their mitigation potential. It is also important to stress that climate change is only one of many threats facing livestock farmers. Especially in the South, they have to deal with demographic pressure and competition for land with other types of land use such as intensive crop farming.

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Conclusion

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Supporting LFF systems in their adaptation efforts will have a positive effect on climate change mitigation. Livestock family farmers have an important role to play in managing and maintaining one of the largest carbon stocks in the world.

The relationship between livestock and climate change is a complex issue. Industrial livestock farming, due to certain processes inherent to its production system, seems to be contributing more to climate change as compared to livestock family farming systems. This is mainly due to land-use changes, manure management, use of chemical fertilizer for animal feed production, and the intensive use of energy (mainly fossil fuels) for production, processing, transport and selling of animal products. Livestock family farming systems on the other hand, are based on grazing and/or domestic production of animal fodder. Such systems make less use of fossil fuels and energy (for production, processing, storing, packaging and transport). In addition, when associated with crop farming, they do not release big amounts of manure, as they tend to close the nutrient cycle by using manure as fertilizer. In livestock family farming systems, families take the main decisions on the farm. This ensures a good balance between economic, social and environmental considerations and makes livestock family farming systems more sustainable than industrial livestock systems. Public debates should increasingly make a distinction between these two types of production systems, instead of considering livestock farming as a whole as responsible for climate change.

Although at first sight, it appears that LFF systems in the global South (and grazing systems in particular) are contributing more to climate change in terms of methane emissions as compared to industrial livestock farming systems, preliminary research shows that LFF systems in the global South can in fact be carbon-neutral. Emissions related to LFF-systems seem to be largely offset by the ecosystem. In Africa for instance, tropical dry grassland soils are among the most efficient for storing large amounts of atmospheric methane thanks to methanotrophic bacteria. In addition, grasslands (which cover an average of 40.5% of the world's land surface), have a huge potential for carbon sequestration. Sustainable grazing through LFF is expected to increase the potential of grasslands to mitigate GHG. This means that LFF can be at the forefront of climate change mitigation strategies. However, additional research using appropriate methodologies (which should also integrate socio-economic aspects of sustainability) is needed to fully understand the potential of LFF in the global South for climate change mitigation and adaptation.

In addition, as livestock family farmers are also in the vanguard of climate change mitigation efforts, enabling policies and investments should focus on supporting their indigenous adaptation strategies. There is no question that supporting LFF systems in their adaptation efforts will have a positive effect on climate change mitigation. Indeed, livestock family farmers have an important role to play in managing and maintaining one of the largest carbon stocks in the world.

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