Food and Agriculture Organization of the United Nations

AFRICA SUSTAINABLE LIVESTOCK 2050

Livestock and environment spotlight

NIGERIA

Cattle and poultry sectors

Federal Republic of Nigeria

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Financial support provided by the United States Agency for International Development (USAID)

ASL 2050

Livestock and Environment Spotlight

Cattle and Poultry Sectors in Nigeria

1- Introduction

While the livestock sector provides a variety of goods and services to society, from food to income to social functions, its complex interactions with the ecosystem have large environmental implications. The livestock sector is the world's largest user of agricultural land, considering both grazing and feed-crop lands, and thus has a major impact on soil, water and air quality as well as biodiversity (Monfreda *et al*., 2008; Ramankutty *et al*., 2008; FAO, 2017a).

Nigeria's growing population, rising incomes and urbanization are translating into an increased demand for livestock products. One estimate suggests that, between 2010 and 2050, beef, poultry meat and milk consumption will increase by 117, 253 and 577 percent, respectively (ASL2050 FAO, 2018). As a consequence, the livestock sector will grow and transform, resulting in new relationships between domestic animals, populations, natural resources and wildlife (FAO, 2009). Assessing the current livestock impact on the environment is thus critical to understand how the growth and transformation of the sector can impact society in the future, and to identify actions to take to ensure a sustainable development of the livestock sector in the mid- and long-term basis.

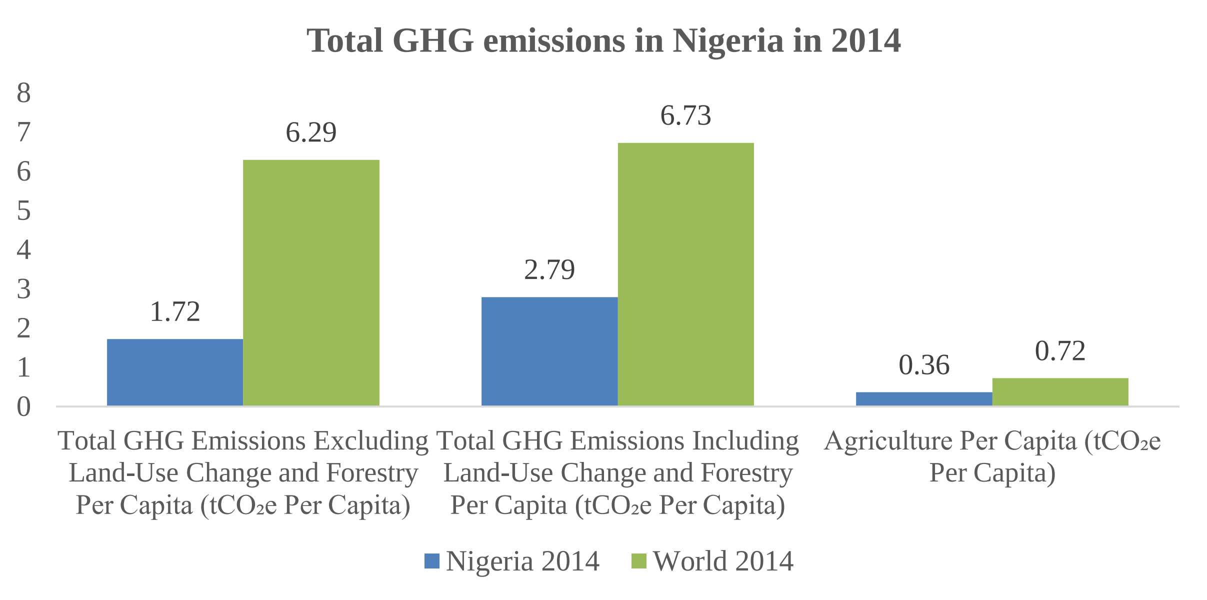
This brief summarises the available evidence of the impact of cattle and poultry production systems on the environment in Nigeria. It relies upon published research reports and papers, and *ad hoc* datasets, when available. It explores the correlations between different cattle and poultry production systems and greenhouse gas emissions; water usage; land degradation; and biodiversity loss. Livestock production systems were characterized by national stakeholders - including the Federal Ministry of Agriculture and Rural Development (FMARD), the Federal Ministry of Environment (FMoE) and the Federal Ministry of Health (FMoH) – and include free-range, semi-extensive and commercial poultry production systems; and pastoral, agro-pastoral and intensive cattle (dairy) production systems (Annex 1).

2- Livestock and Greenhouse Gas Emissions

Greenhouse gas (GHG) emissions from human activities are the most significant drivers of observed climate change, and reached 49 $GtCO_2$eq. in 2010, with agriculture, forestry and other land uses accounting for 24 percent of these emissions (IPCC, 2014).

Nigeria's GHG emissions reached 1.72 tCO_2eq. per capita in 2014, less than one third of the world average (6.3 tCO_2eq. per capita) (Figure 1) (CAIT, 2015). The government, however, fully recognizes the importance of mitigating global carbon emissions: it ratified the Paris agreement in 2017 and aims at ensuring a rapid and climate smart development.

Figure 1. Per capita GHG emissions ($tCO_2eq.$) in Nigeria versus world average (2014)



Source: CAIT (2015)

To quantify GHG emissions from the different cattle and poultry systems we used data from the Global Livestock Environmental Assessment Model (GLEAM). GLEAM is a Geographic Information System (GIS) framework that simulates bio-physical processes and activities along livestock supply chains using a life cycle assessment approach. It quantifies production and use of natural resources in the livestock sector and measures its GHG emissions, which allows assessing the effectiveness of alternative adaptation and mitigation options. GLEAM identifies three main groups of emissions: upstream emissions include emissions related to feed production, processing and transportation; animal production emissions comprise emissions from enteric fermentation, manure management and on-farm energy use; downstream emissions are caused by the processing and post-farm transport of livestock commodities. Three gases are considered in GLEAM: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). All emissions are converted into $CO_2eq.$ using the global warming potential from IPCC (2014) (298 for N_2O and 34 for CH_4). We run the model using 2010 data for animal numbers and distribution, herd parameters, feed yields and rations, and manure management systems.

2.1- Poultry production systems and GHG emissions

Poultry production systems emit a total of 1.3 $MtCO_2eq.$ per year. Commercial poultry production systems contribute to about 85 percent of all GHG emissions from the sector, with the backyard production systems responsible for the remaining 15 percent. Emissions per bird are six times higher in commercial than in backyard production systems: one bird in a commercial production unit emits 20.86 kg of $CO_2eq.$ per year versus 3.63 kg for a bird in a backyard production unit (Table 1).

Besides the overall quantity of $CO_2eq.$ emitted, there are also differences between the source of emissions per head by production systems. In commercial production systems, feed production is the biggest source of GHG emissions, while in backyard production systems manure management contributes most to GHG emissions.

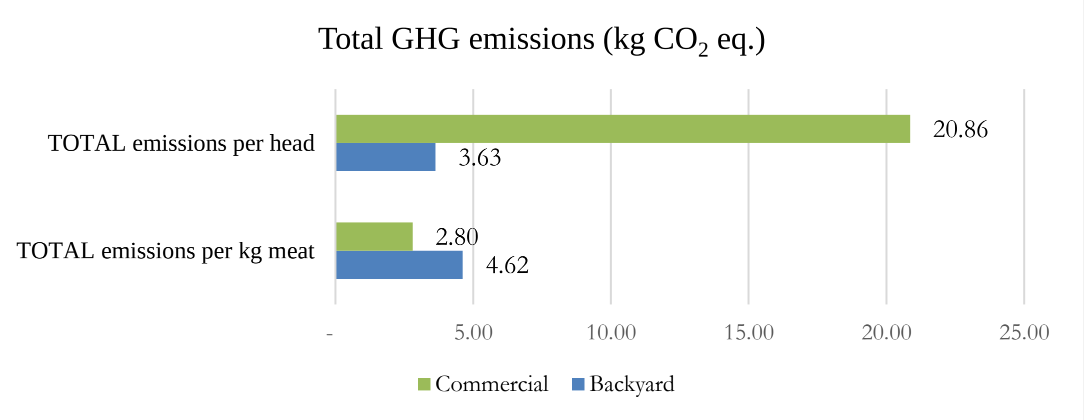
Table 1. Nigeria: GHG emissions in poultry production systems (kg CO_2eq./head/year)

Emission	Backyard system	Commercial system
Fertilizer, N_2O	0.14	1.22
Applied manure, N_2O	0.08	1.68
Crop residues, N_2O	0.49	1.44
Feed, CO_2	0.01	13.29
LUC: soy & palm, CO_2	0.33	0.10
Manure management, CH_4	0.30	1.24
Manure management, N_2O	2.30	1.89
Total	3.63	20.86

Source: FAO (ASL2050 FAO, 2017); authors' calculations based on GLEAM (FAO, 2017b)

However, the picture changes if we look at the quantity of CO_2eq. emitted per unit of product (kg meat) rather than per bird. Figure 2 shows that 1 kg of chicken meat produced in commercial systems generates 2.8 kg of CO_2eq. per year versus 4.62 kg of CO_2eq. per year in backyard systems. The difference mainly comes from the fact that chicken reach their slaughter weight much faster in the commercial systems.

Figure 2. Nigeria: GHG emissions (kg CO_2eq.) in poultry production systems



Source: FAO (2018); authors' calculations based on GLEAM (FAO, 2017b)

2.2- Dairy production systems and GHG emissions

The Nigeria dairy sector generates about 34.4 MtCO_2eq. of GHG emissions per year. Emissions per head are higher in intensive systems than in pastoral or agro-pastoral systems: one dairy cow in an intensive production unit emits 3 569 kg CO_2eq. per year versus 1 927 kg CO_2eq. and 1 477 kg CO_2eq. in pastoral and agro-pastoral systems, respectively (Table 2).

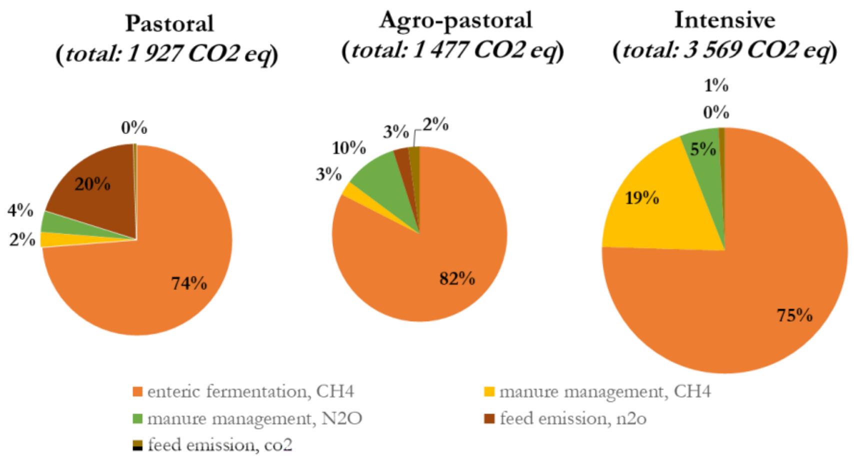
Table 2. Nigeria: GHG emissions in dairy production systems (kg CO_2eq./head/year)

Emission	Pastoral system	Agro-pastoral system	Intensive system
Enteric fermentation, CH_4	1 422	1 219	2 694
Manure management, CH_4	49	40	661
Manure management, N_2O	68	146	182
Feed emission, N_2O	379	41	2
Feed emission, CO_2	9	31	30
Total	**1 927**	**1 477**	**3 569**

Source: FAO (ASL2050 FAO, 2017); authors' calculations based on GLEAM (FAO, 2017b)

Methane from enteric fermentation contributes to between 74 and 82 percent of CO_2eq. emissions, in all dairy production systems (Figure 3). Manure management (emitting CH_4 plus N_2O) is the second largest source of GHG emissions in intensive systems (24 percent; 843 kg CO_2eq./head/year) and agro-pastoral systems (13 percent; 186 kg CO_2eq./head/year), whereas feed emissions (emitting CO_2 plus N_2O) generate 20 percent of GHG emissions in pastoral systems (379 kg CO_2eq./head/year).

Figure 3. GHG emissions by source for pastoral, agro-pastoral and intensive production systems



Source: FAO (2018); authors' calculations based on GLEAM (FAO, 2017b)

Total GHG emissions per unit of milk produced are higher in pastoral systems than in intensive systems, suggesting that intensification is associated with a reduction in GHG emissions progresses per litre of milk produced (Table 3). This is due to higher efficiency in resource utilization in intensive than in all other dairy production systems.

Table 3. Total GHG emissions in dairy production systems by source

	Pastoral	Agro-pastoral	Intensive
Litres per lactation	360	1 440	3 600
Total emissions per head (kg CO_2eq.)	1 927	1 477	3 569
Total emissions per one litre of milk produced (kg CO_2eq.)	5.35	1.03	0.99

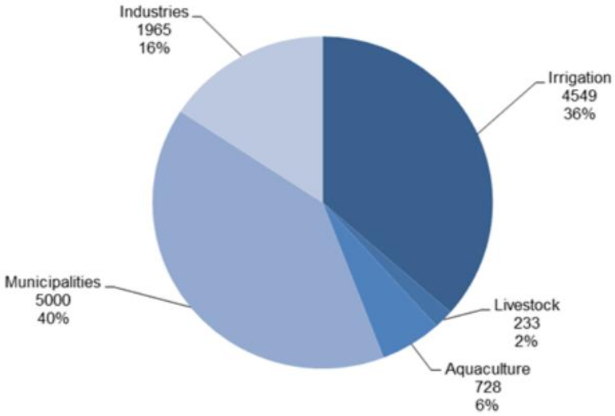
Source: FAO (2018); authors' calculations based on GLEAM (FAO, 2017b)

3- Livestock and water usage

Livestock is a major user of water. About 500 litres of water are needed to produce 1 kg dry matter while the amount of drinking water used varies from 5 to 50 litres per Tropical Livestock Unit (TLU) per day, depending on species, dry matter intake, feed composition and water content, physiological status of the animal and the broader climatic conditions (Peden *et al*., 2003; Steinfeld *et al*., 2006; Lardy *et al*., 2008). The impacts of livestock production on local/regional water balances, therefore, vary widely, though feed production is the predominant source of livestock-related water consumption.

In Nigeria, situated in the tropical zone of West Africa, water deficiency is an issue in the northern part of the country, which is semi-arid. In the other parts of the country, the time distribution of rainfall is of concern (FAO, 2005). Agriculture is the sector withdrawing the largest share of water, contributing 44 percent to the total annual water withdrawal (12 475 million m^3) in 2010 (FAO, 2016) (Figure 4). Livestock is responsible for 233 million m^3 of water withdrawn, representing over 4 percent of the agriculture water withdrawal and 2 percent of the total annual water withdrawal (FAO, 2016). It is important to note that this 2 percent includes only direct consumption (watering and cleaning), while the water used for feed is included in irrigation.

Figure 4. Water withdrawal by sector for a total of 12 475 million m^3 in 2010



Source: FAO (2016)

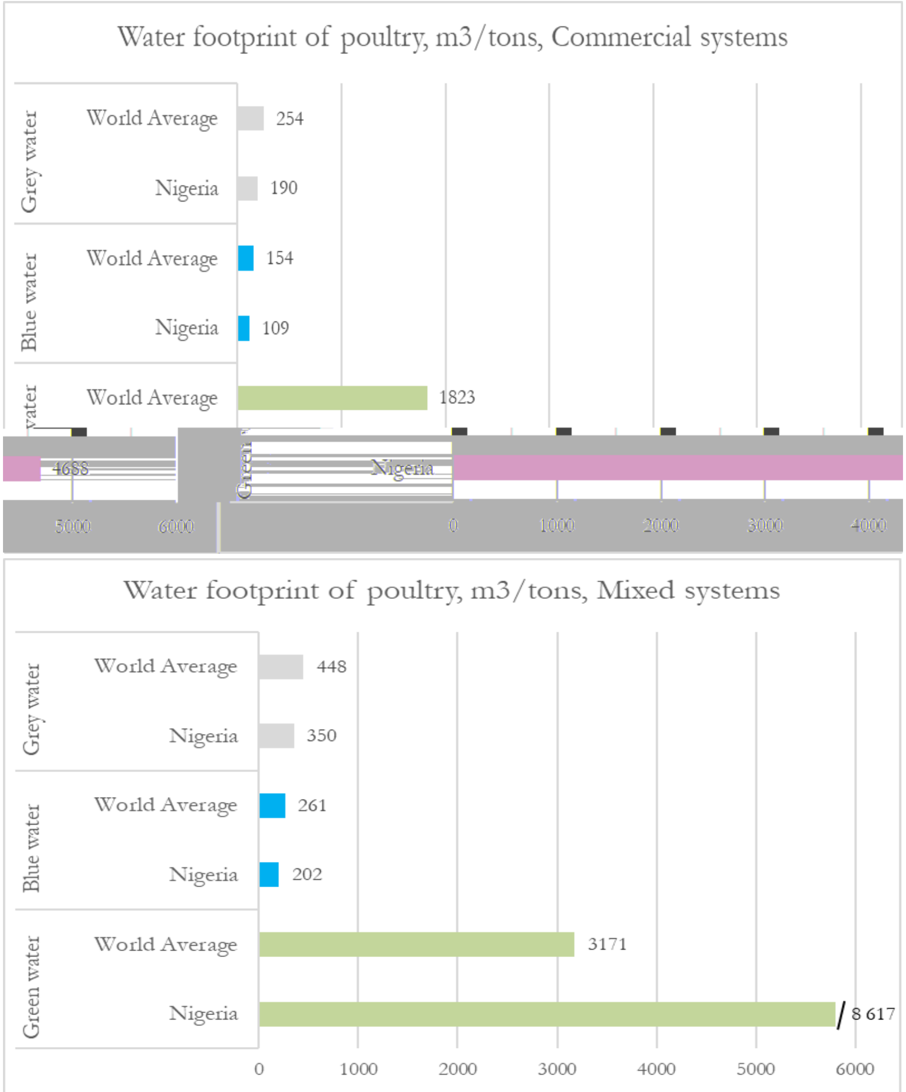
In this brief, we rely on Mekonnen and Hoekstra (2012) to assess the water footprint of farm animals in cattle and poultry production systems by source of water, including blue, green and grey water. Blue water footprint refers to the amount of water consumed from surface and groundwater along the value chain of a product, which is evaporated after withdrawal. Green water refers to rainwater consumption and grey water footprint refers to the volume of freshwater needed to assimilate the load of pollutants emitted. The water footprint of a farm animal consists of direct consumption via drinking and service water as well as indirect consumption through the water used for feed production (Chapaign and Hoekstra, 2003; Mekonnen and Hoekstra, 2012).

3.1- Poultry production systems and water usage

Figure 5 shows the water footprint for poultry by production system, measured in cubic meters (m^3) per ton of live animal. The poultry water footprint is approximately 7 000 m^3 per ton of live animal. In mixed systems, it reaches 9 169 m^3 per ton and in commercial systems about 5 000 m^3 per ton. In the two poultry production systems considered here (commercial and mixed), green water consumption is the highest. Green water use decreases with the level of intensification as a result of higher level of efficiency in water use in intensive production systems.

The same figure also compares the poultry water footprint in Nigeria with world averages. Nigerian green water consumption is approximately 2.5 times the world average. However, across both production systems, blue and grey water consumption is relatively low in Nigeria. Grey water footprint reflects the amount of freshwater needed to assimilate the load of pollutants emitted and, in aggregate, the Nigerian poultry sector shows almost no such pollution.

Figure 5. Grey, blue and green water footprint (m^3 per ton) by poultry production systems in Nigeria and the world



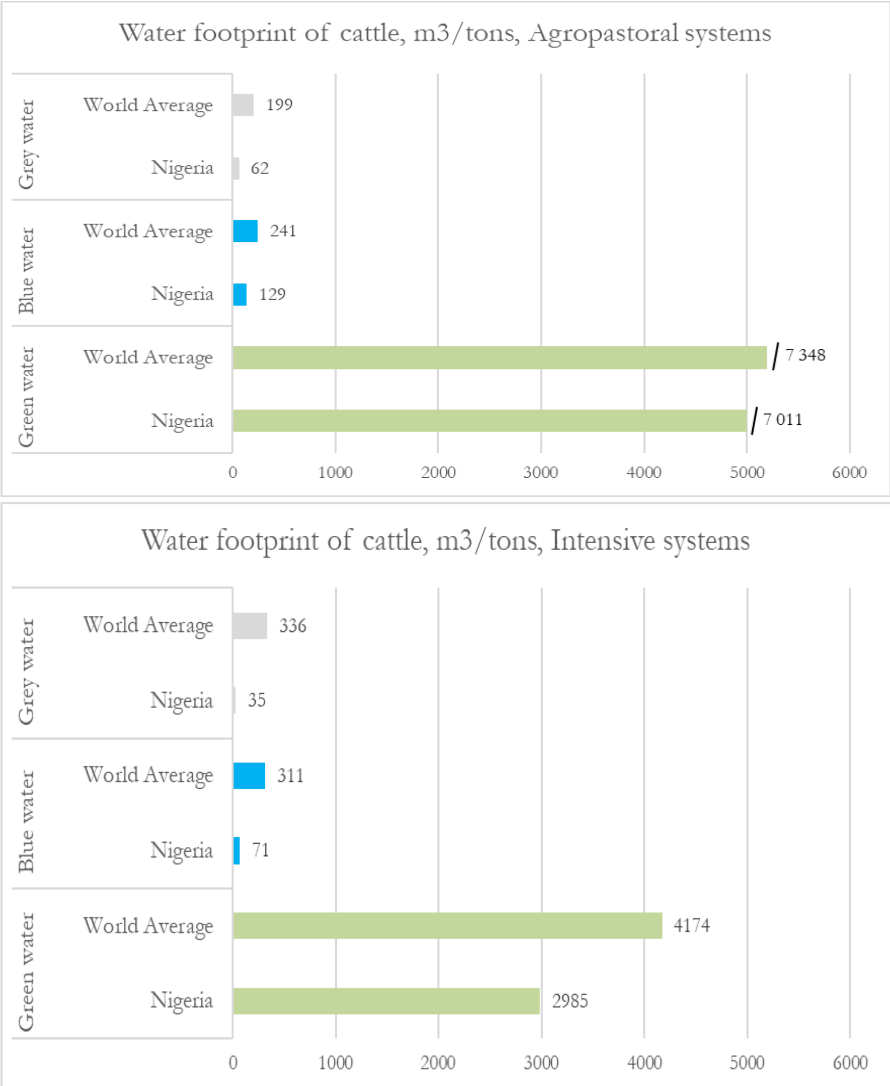
Source: Mekonnen and Hoekestra (2012)

3.2- Cattle (dairy) production systems and water usage

The water footprint for dairy by production system, measured in cubic meters (m^3) per ton of live animal, is represented in Figure 6. The cattle water footprint is approximately 5 100 m^3 per ton of live animal. In agro-pastoral and intensive systems, it reaches 7 202 m^3 and 3 091 m^3 per ton, respectively. Green water footprint represents almost all of the cattle water consumption in both agro-pastoral and intensive production systems. No data are available for pastoral systems.

Nigerian's cattle water consumption is lower than the world averages for the three types of source of water and the Nigerian cattle sector reports little consumption of grey water. In particular, in the cattle intensive systems: consumption of blue and grey water is one fourth to one tenth of the world averages.

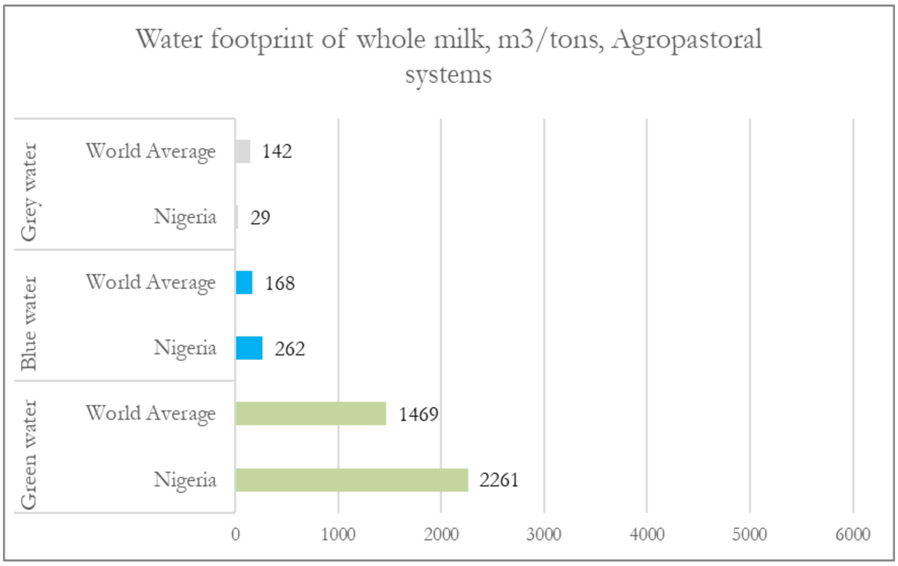
Figure 6. Grey, blue and green water footprint (m^3 per ton) by dairy production systems in Nigeria and the world



Source: Mekonnen and Hoekestra (2012)

Figure 7 shows that the water footprint of whole milk production is 2 552 m^3 per ton of milk in agro-pastoral systems, with green water contributing the most to the water footprint. Green and blue water consumptions are higher than the world average, whereas grey water footprint is lower. Therefore, while agro-pastoral systems consume more water than the world averages, they pollute the environment to a significantly lower extent. No data on intensive dairy production systems are available.

Figure 7. Grey, blue and green water footprint (m^3 per ton) of whole milk in Nigeria and the world



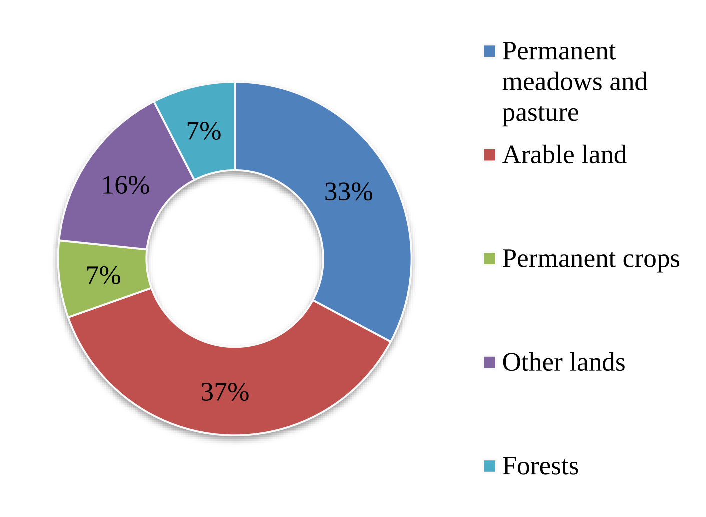
Source: Mekonnen and Hoekestra (2012)

To sum up, total water consumption is generally higher in Nigeria than the world average, though the bulk of this consumption consists of green water. Green water has the lowest opportunity cost since it is sourced from rainwater, and especially in the case of pastoral systems, it happens in remote areas where it would not be used for other purposes. Blue water consumption is higher than the world average, in the dairy system; this reiterates the importance of productivity increase in the sector. Grey water consumption is lower than the world average, but as intensification increases, so will the blue and grey water consumption. It is important to monitor water use by production systems and source and strive for high water productivity to ensure sustainability as the livestock sector grows.

4- Livestock and land degradation

Land degradation is a major threat at the global level. Stocking (2001) defines land degradation as "*the temporary or permanent decline in the productive capacity of the land, and the diminution of the productive potential*". Increased cropping and grazing intensity as well as inappropriate pastoralism production practices are deemed to contribute to land degradation, often resulting in decreased agricultural production and productivity (Maiangwa *et al*., 2007; Macaulay, 2014; Taiye *et al*., 2017). In Nigeria, a total 92 377 000 hectares (or 923 770 sqkm) of land (FAO, 2014) comprises permanent meadows and pasture (33%), arable land (37%), permanent crops (7%) and forests (7%) (Figure 8).

Figure 8 Land use in Nigeria in 2015.



Source: authors' calculations based on FAOSTAT (FAOSTAT, 2017)

Free-range grazing by cattle, sheep, goats, donkeys and camels is a common practice in pasture areas, where the land is not privately owned. Herders, therefore, tend to overexploit available common lands, for example through overgrazing, which results in the creation of bare soil surfaces subject to wind and water erosion, soil compaction, decrease of soil organic matter and nutrients, reduction of water infiltration, and removal of desirable plant species (de Haan *et al.*, 1997; Maiangwa *et al.*, 2007; Orheruata and Omoyakhi, 2008; Taiye *et al.*, 2017). Northern Nigeria regions are particularly affected by excessive grazing contributing to desertification (Orheruata and Omoyakhi, 2008).

Olagunju (2015) estimates that 64 percent of Nigerian total land is at risk of desertification, affecting directly or indirectly about 62 million people, with livestock often considered a major contributing factor to this trend. Over the last 5 to 10 years, over 70 percent of farmers and pastoralists have reported a decrease in the density of vegetation, reduction of water levels and reduction in the diversity of tree species and wildlife (Omotayo, 2003). Olagunju (2015) also estimates that the forage needs for livestock have exceeded the carrying capacity of the Nigeria grasslands, which is one of the reasons of increased herder-farmer conflicts. The violent clashes are a major issue in the country, already claiming hundreds of lives in 2018.

5- *Livestock and biodiversity loss*

According to the Convention on Biological Diversity (CBD, 1992) signed in Rio de Janeiro, biological diversity is defined as "*the variability among living organisms from all sources; (…) this includes diversity within species, between species and of ecosystems*". The loss of biodiversity has important implications on the ecosystem functions and on the goods and services that the ecosystem provides (Cardinale *et al.*, 2012).

Nigeria is rich in biodiversity and hosts many endemic species, thanks to a complex topography and various ecosystems, from rainforests to savanna woodlands to coastal mangroves (CBD, 2015). Adler *et al*. (2001) report there are 5 303 plant species in Nigeria, 247 mammal species, 831 species of birds, 648 species of fish and 109 species of amphibians. This diversity makes Nigeria as one of the richest country in Africa in terms of biodiversity (Meduna *et al.*, 2009). However, the 2013 IUCN red list identified 309 threatened species in Nigeria including 26 mammals, 19 birds, 8 reptiles, 13 amphibians, 60 fishes and 168 plants (CBD, 2015).

The correlation between livestock sector growth and biodiversity loss is complex, but evidences point towards a negative link between the two. Increases in the livestock population as well as inappropriate production practices contribute to the destruction of vegetation and soil damage, leading to biodiversity loss (CBD, 2015; Taiye *et al*., 2017). For example, prolonged livestock grazing reduces biomass accumulation causing a reduction in botanical composition and species diversity: highly edible plants are replaced with their inedible counterparts, herbaceous plants or bushes (de Haan *et al*., 1997; Orheruata and Omoyakhi, 2008; Taiye *et al*., 2017). At the same time, however, there could be positive complementarities between livestock grazing and wildlife supporting biodiversity.

Grazing can also contribute to biodiversity through the distribution of seeds and micro- and macro-fauna (Okaeme *et al*., 1988; de Haan *et al*., 1997; Orheruata and Omoyakhi, 2008). Indeed, a total absence of grazing can reduce biodiversity allowing trees and shrubs development which intercepts moisture and light resulting in the overprotection of some specific species (de Haan *et al*., 1997).

6- Conclusions

This brief summarises available evidence on the impacts of cattle and poultry production systems on the environment in Nigeria, including on air (GHG emissions), water, soil and biodiversity. While available data does not allow measuring with accuracy the connections between livestock and environment, there is clear evidence that the livestock sector – while producing valuable food for the population – is also having negative impact on the environment.

Nigeria is anticipated to dramatically transform in the coming decades as a result of population growth, rising incomes and urbanization. The livestock sector will transform too in order to satisfy a growing demand for animal source food, including meat, dairy products and eggs. The growth and transformation of the livestock sector affect the Nigerian environment, including on soil, water and air quality as well as on biodiversity (FAO, 2009). Understanding with more accuracy the current impact and future impacts of livestock production systems on the environment is critical to take actions now that will ensure a sustainable development of the livestock sector, and of the entire Nigeria more broadly.

October 2018. The production of this document has been coordinated by Lucie Perin[1], Emmanuel Odunze[2], Hiver Boussini[3], Orsolya Mikecz[1] and Alessandra Falcucci[1] under the guidance of the Members of the ASL 2050 Nigeria Steering Committee.

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Annex 1

Table A. Cattle (dairy) production systems in Nigeria

Nomadic pastoral systems (extensive)	In pastoral or free grazing systems, farmers move cattle from place to place in search of pastures and water. They keep indigenous breeds, with herd size ranging from 100 to 300 heads. Production is subsistence oriented and animals are kept on uncultivated pastures and rely on grazing without any feed supplements. Main products include beef, milk, blood, hides, manure and horns. This system is dominant in Northern Nigeria.
Agro-pastoral systems	In agro-pastoral systems, farmers are engaged in growing crops and raising livestock. They keep mainly indigenous breeds, with herd size ranging from 20 to 100 heads. Dairy production's objective is hereditary or commercial. Family labour is mainly used and animals rely on grazing on demarcated rangelands and supplementary feeds. This system is present in the southern regions.
Commercial systems (intensive)	In commercial systems, animals are raised for maximum milk output and they are kept indoors in sheds or paddocks and are well supplied with necessary nutrition and bio-security. Farmers keep mainly exotic breeds, with herd size ranging from 50 to 1000 heads. Feed comes from cultivated pastures and there is no grazing. Eighty percent of the commercial dairy farms are located in the North Central region.

Source: ASL2050 FAO (2017)

Table B. Poultry production systems in Nigeria

Free-range system (extensive)	Farmers keep indigenous chickens flocks, which are left to roam around and scavenge for food and water. Flocks contain birds of different species and varying ages. There may be rudimentary shelter, though most birds roost outside in trees or nest in the bushes. Production is subsistence-oriented, mainly for family consumption. This system is present mainly in the northern regions of the country.
Semi-intensive system	Farmers in semi-intensive poultry systems keep flocks of about 50 to 2000 birds, including both improved and unimproved breeds. It refers as small-scale family poultry keeping by house-holds using family labor and locally available feed resources, often complementary to other farming activities. Housing is not elaborate, sometimes wooden/metal cages are used to provide the chicken with shelter and some commercial feeds are used. The small scale poultry producers tend to sell live birds through informal marketing channels. Semi-intensive poultry farms are mainly located in the southern regions of the countries.
Commercial systems (intensive)	In intensive systems, farmers keep more than 2000 birds of exotic birds of one species, producing either meat or eggs for the market. This system ranges from medium to large scale commercial enterprises and high premium is given to stock breed, feeding, housing and health. In the more advances integrated holdings, there are automated chain feeding and watering systems. Egg collection is mainly based on manually operated next boxes with straw or wood shaving floors. This system is dominant in the southern regions of the country.

Source: ASL2050 FAO (2017)

Note

Note