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Environmental Impact of Livestock Production

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Mini Project

A growing world population, estimated to reach nine billion people by 2050, is increasing the pressure on global agricultural production to ensure food security for all [1]. Between 2005 and 2050 the demand for meat and milk products is projected to increase by around 70-80% and the demand for crop protein by 100-120% [2,3]. Rising prosperity, growing populations, and dietary change lead to increasing demand for meat and milk, particularly in developing countries [4]. In addition, livestock production plays an important role in guaranteeing food security worldwide and has an important contribution to the economy of many countries [5]. Over the same 25-year period, energy derived from livestock products increased by more than 20% in Latin America and the Caribbean; about 7% in developed countries, and remained stable in sub-Saharan Africa [6].

In past decades, the livestock production system has evolved, pushed on one side by the increasing demand for animal protein, and on the other side by high economic growth rates and technical innovations. To maintain market competitiveness, specialization of animal production systems has occurred: adoption of high-energy diets (largely grain), genetic improvements (which led to international and highly oriented gene flows), and the introduction of new management techniques with high-density animal populations in confinement housing and the use of growth hormones and antibiotics. This production model is mainly driven by economic processes and focuses on short-term cost margins and economies of scales, rather than ecological processes and long-term sustainability [7].

Increasing global animal production is an important cause of various environmental problems [8-11]. This is due to the livestock supply chain requiring significant inputs of feed, energy and water, generates CH4, NH3 and other emissions to air, and pollution risks arising from inefficient waste management practices [12]. Expanding livestock sectors can contribute to greenhouse gas (GHG) emissions, agricultural land expansion and associated deforestation [9], surface water eutrophication [13,14], decrease in terrestrial biodiversity [15] and nutrient imbalances [16,17].

Livestock production is one of the most widespread human activities; 30% of global land is farmed for herbivores for livestock products [18]. According to Foley et al. [14] the global livestock sector uses about 75% of all agricultural land, and is responsible for about 30% of global agricultural water requirements, including rain and irrigation water used for production of feed and withdrawals for animal husbandry [18]. Compared with crop production, water use in the animal production system is generally very high because both the direct water consumption by animals and the water used to produce the animal feed must be taken into account [9]. Overall, livestock systems account for about 8% of water consumption world-wide [19].

At a global level, the livestock sector accounts for approximately 14.5% of total human-induced global warming potential (GWP); within the livestock impact on climate change, milk sector contributes 20%; beef production 41%; pig and poultry 9 and 8%, respectively [20]. For livestock production, enteric fermentation and manure management are the two major sources of methane [6,21]. Found large variation in the GHG emissions and their uncertainties for different continents, livestock sectors products or source categories. The uncertainty of total GHG emissions from livestock sectors is higher in Africa and Latin America than in the European Union, reflecting the lack of data associated with GHG emissions or the poor data quality. In this sense, no studies have yet been performed.

Environmental impacts per kg of edible beef, vary largely due to differences in beef production system [22]. Understanding these differences is crucial to mitigate impacts of future global beef production [23]. This variation in environmental impact

between studies partly results from differences in methodological choices, but might also partly reflect fundamental differences among beef production systems [24]. Beef production systems differ, for example, in the origin of the calves, i.e. beef calves can be bred by dairy cows or suckler cows, and the type of feed used during fattening of beef calves, i.e. roughage-based or concentrate-based [23]. In general, the range of environmental impact estimated for beef production was greater than pork or poultry production [12].

Poultry productions have the smallest impact on land use, energy use, and global warming potential [24] comparison with beef and pork production. This is mainly due to the high efficiency in converting feed into meat [25]. Although the poultry production generates smaller impacts than other meats, it is a recognized pollution source due to the large generation of manure and the large consumption of grain for animal feed [26]. A cradle to farm gate analysis of the US broiler industry showed that the clear majority of environmental impacts associated with broiler production were embodied in the feed production phase [17]. This phase represented 80% of energy use, 82% of global warming potential, 98% of ozone depleting emissions, 96% of acidifying emissions, and 97% of eutrophying emissions. On average, emissions associated with on-farm inputs only contributed 9% of the environmental impact [6]. Chicken meat production face increasing pressure to quantify and improve their environmental performance over time, while simultaneously increasing production to meet global demand [27].

The pig sector is a highly complex global system which involves the production of fertilisers and pesticides for crop production, land transformation, transportation to and from farms, energy for light and heat, water for animal consumption and farm yard washing, and waste management [11]. Worldwide pig production produces 668 million tonnes CO_2-eq $year^{-1}$ [28]. Which is higher than chicken production (606million tonnes CO_2-eq $year^{-1}$ meat and eggs combined) [28] but significantly lower than beef and bovine dairy production combined (4623 million tonnes CO_2-eq $year^{-1}$) [29]. Menzi et al. [16] Investigated fossil energy and GHG (greenhouse gas) saving potentials of pig farming in Europe. Pig-meat production in North-West Europe (as a base case) was examined (based on different scenarios) to examine how improvements (in terms of energy and GHG savings) can be feasibly achieved. The analysis showed that pig farming in Europe presents a high potential to reduce fossil energy use and GHG emissions by improving the following aspects: feed use, manure management and manure utilization.

A useful methodological tool for the assessment of the environmental performance of complex systems (such as livestock) is the Life Cycle Assessment (LCA) [30]. At present, this methodology has been widely used in livestock systems of beef [22,23,31] pork [11,26,32-34] and chicken [26,27,33,35,36]. LCA has been used to evaluate the environmental impact of different livestock production systems [22,33] to compare different meat (beef, pork, poultry) [25], to compare meal with different protein source (vegetables and meat) [24], to improve the environmental management of livestock systems [26,30], to evaluate the GHG emission [21], among others.

We believe that to meet the challenge of sustainable long-term livestock production, it is essential to incorporate methodologies such as LCA and others into the planning and environmental assessment processes. These methodologies allow quantification of impacts, identify environmental hotspot [37], and manage the environmental aspects of livestock. It is necessary to model the complexity of the phenomenon properly, and it is necessary to have detailed and updated information of each type of system [38-41].

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