



## **Nitrogen budgets of livestock systems in pastoral Sub-Saharan Africa: knowns and unknowns**

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Livestock in developing countries can substantially contribute to better livelihoods by supplying food and generating income. This is especially important in pastoral Sub-Saharan Africa (SSA), where smallholders derive their subsistence from livestock farming, as most of the total income of the households in this region comes from livestock. Population growth is causing an increase in demand for food, and urbanisation in developing countries is characterised by an intensification of agriculture and socioeconomic changes, which subsequently lead to an increasing demand for livestock products. While this offers an opportunity for income increase for smallholders in SSA, livestock intensification is known to have environmental consequences, such as greenhouse gas (GHG) emissions, and other contaminating nitrogen (N) loss pathways such as ammonia emission, mainly through gas volatilization from manure. There is a lack of empirical data for pastoral systems in SSA, and as a result, the use of data derived from the developed world in models may produce inaccurate model outputs due to different climatic conditions and management strategies. Here, we review the currently available scientific literature of N budgets, N flows, and factors affecting N flows in pastoral SSA in order to better understand these processes. We present the relationship between flows and the factors affecting them, and literature available for each of these relationships. By doing so we identify gaps that are needed to be filled in the future, in order to have accurate livestock systems N budgets, and thus understanding the contribution of African livestock systems to the global N budget and related emissions and subsequently identify suitable N mitigation strategies.