Food and Agriculture Organization of the United Nations

NUTRIENT FLOWS AND ASSOCIATED ENVIRONMENTAL IMPACTS IN LIVESTOCK SUPPLY CHAINS

SUMMARY OF THE GUIDELINES FOR ASSESSMENT

OVERVIEW

Nutrients such as nitrogen (N) and phosphorus (P) are essential for the production of crop and animals. N and P belong to the four elements with (global) biogeochemical cycles (N, P, Carbon and water), which are regularly recycled around the planet at various temporal and spatial scales. These cycles have been significantly altered by human activities. Biogeochemical flows, encompassing both N and P cycles, are two of the planetary boundaries, which define the safe operating space for the humanity, that have been surpassed. Additionally, P is a finite natural resource. As there are no substitutes for phosphorus nutrients, depletion of P resources may in the long run be relevant for the sustainability of agriculture.

In contrast to the environmental assessment of livestock supply chains with a focus on impact categories of eutrophication and acidification, a thorough description of all flows involved is required for the assessment of impacts on nutrient cycles. This assessment includes not only those flows that directly lead to the emission of a pollutant but also others, which divert nutrients from the production process such as denitrification. The analysis of these flows helps to identify opportunities to improve nutrient management and thus increase nutrient use efficiency and reduce impacts.

The objective of this document is to provide additional recommendations to the existing LEAP guidelines on feed and livestock supply chains by including recommendations for the life cycle impact assessment of livestock supply chains, including methods for estimating and accounting for flows of N and P. Environmental impact categories are restricted to acidification and eutrophication (freshwater, marine and terrestrial). While it is recognised that N and P losses to water, soil and air play a dominant role in stratospheric ozone depletion, soil quality impoverishment, and biodiversity loss, these environmental impacts are not covered in this guidance document. Also excluded is guidance on the assessment of the impact of nitrous oxide (N_2O) on ozone because of strong interactions between N_2O and other greenhouse gases such as CO_2 and CH_4. Guidance to assess the impact of nutrients on biodiversity is covered in the LEAP principles on biodiversity.

CHALLENGES AND SOLUTIONS

The production of animal-source food is associated with significant use of N and P and other natural resources. Such use contributes to several environmental impacts such as climate change, acidification, eutrophication, damage to human health and biodiversity loss. More than 80% of N and P consumed by animals is excreted in manure. Without proper manure management, N and P is lost into the environment causing a cascade of impacts in air, water and soil. Feed production is another source of nutrient emissions into the environment, mainly related to manure and synthetic fertilizer applied to crops and grassland. Further nutrient losses occur during the post-farm processing through wastewater or organic wastes.

The assessment of nutrient flows in different stages of livestock supply chains as well as the associated environmental impacts are challenging due to the rapid transformation of the livestock sector and the lack of harmonized scientific method. The lack of a harmonized method can complicate the benchmarking and monitoring of the nutrient use efficiency, thus resulting in wrong decision-making. For instance, there are large discrepancies in the nitrogen excretion factors used by European Union countries to report the nutrient use performance. Conscious of these challenges, the LEAP Partnership established in 2016 a Technical Advisory Group (TAG) to develop comprehensive guidelines for the quantification of nutrient flows and associated environmental impacts in the livestock supply chains. Through consensus building, TAG experts from all regions of the world developed the guidelines, which strive for alignment with international standards such as ISO 14040/44, IPCC guidelines and other international guidance.

These guidelines are relevant for all feed and livestock systems and provide methods to assess N and P flows, use and emissions from the cradle to primary processing of animal products. The document considers all nutrient flows, including loops and recycling flows, which are essential to integrate livestock sector into circular bio-economy. These guidelines are transparent and comprehensive. They have undergone several review processes. They address different aspects to model N flows, the impact assessment for eutrophication and acidification, uncertainty analysis and sensitivity analysis. They also provide additional indicators such as life-cycle-nutrient use efficiency that are necessary to support the interpretation of results. The guidelines are illustrated with four case studies. Figure 1 describes the system boundary considered in these guidelines from "cradle-to-primary-processor-gate".

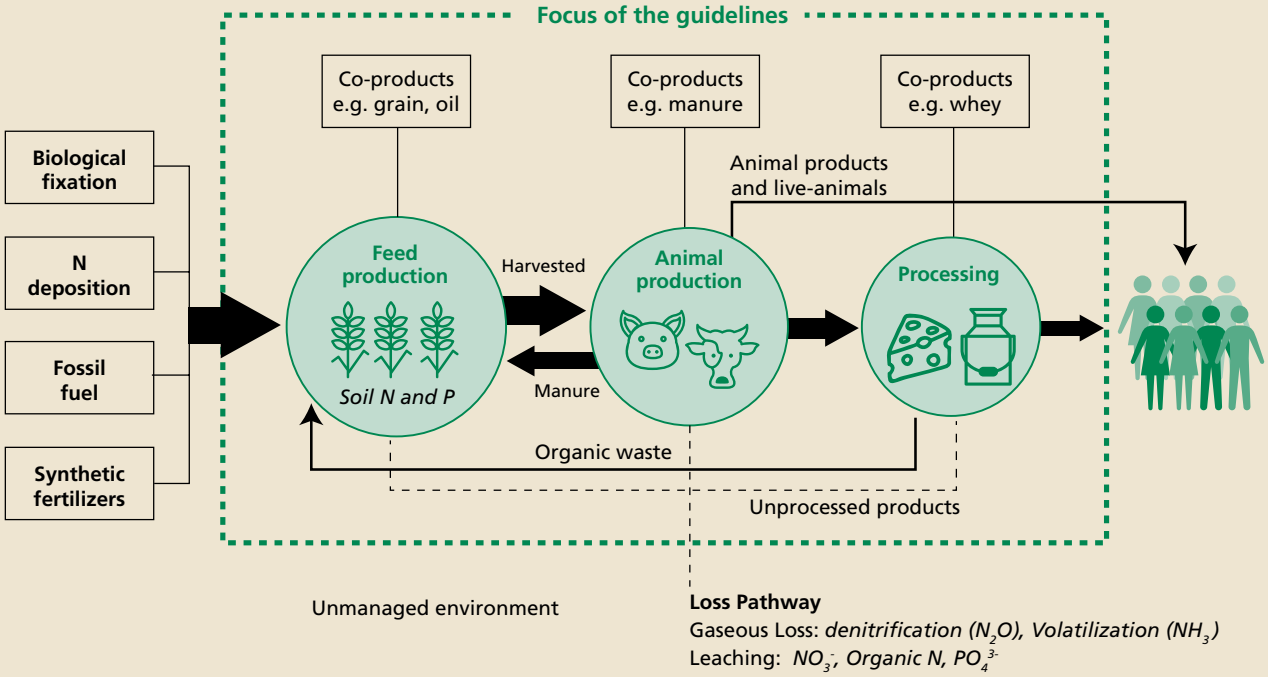

Figure 1. *Overview of nutrient flows in a livestock supply chains*

LIVESTOCK ENVIRONMENTAL ASSESSMENT AND PERFORMANCE (LEAP) PARTNERSHIP

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