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Sustainable management of nutrients
Towards a "One Nutrition" approach

Management of nutrients in the agriculture sector and inter-phyla nutrient flows

A major challenge for the livestock sector is to improve further its contribution to optimized nutrient use efficiency. The key elementary nutrients for any living organism are Carbon, Hydrogen, Nitrogen, Oxygen, Phosphorous, and Sulfur (CHNOPS). In terms of plant and animal nutrition, additional strategic nutrients are e.g. potassium and calcium. Nitrogen and phosphorous are of particular importance for the discussion on sustainable management of key nutrients and also the environmental impacts of any nutrient loss and wastage: ammonia emissions lead to increased acid depositions and excessive levels of nutrients in soil and water, which can have negative impacts on aquatic ecosystems and cause damage to forests, crops and other vegetation, subsequently impacting biodiversity.

A major objective of animal nutritionists has been to look at nutrient efficiency for optimal growth, development and maintenance. Scientific Research on optimized nutrient balance in animals diets thanks to improved feed formulation, the use of more digestible mineral feed materials sources and the ability to supplement the diet with feed additives (e.g. amino acids, phytase) resulted in tremendous improvements of this ratio, making the European feed and livestock industry a global leader in nutrient efficiency. Further substantial improvements of this ratio are expected with the implementation of nutritional systems based on protein digestion kinetics, which will allow to reduce further the amount of nitrogen and phosphorous in feed and improve their conversion into animal products. The uptake of digitalization and sensor technology at all levels of the agri-food chain will also support the development and implementation of precision feeding systems providing the optimum nutrient balance to food producing farm animals during all physiological stages and farming practices, while maintaining animal welfare and health.

However, this linear approach of nutrient efficiency is no longer sufficient on its own to evaluate the sustainability performance of a food production system in a circular way and new dynamics must be promoted as many crop and livestock production parameters are interdependent.

- Proximity of livestock and crop production facilitates the use of manure to improve soil organic carbon content and to serve as fertilizer delivering N and P for crop production. Refining of manure may allow transport over longer distances. Manure must no longer be regarded as waste but as an animal-based product in itself: the EU fertilizer policy has undergone a major evolution to encourage the use of organic fertilisers (Regulation (EU) 2019/1009) and this must be integrated in the evaluation of nutrient use efficiency; the potential for reduction of manure nutrients leakage is important[1] and advances animal nutrition can also contribute to it (e.g. addition of benzoic acid in feed to reduce ammonia emissions from manure);

[1] Can investments in manure technology reduce nutrient leakage. to the Baltic Sea? Torbjörn Jansson and al. 2019.

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- Improved knowledge about the links between the genetics of animals and nutrient demand, uptake, use and excretion as well as between the genetics of crops and nutrient quality and composition and quantity, would offer possibilities to optimise crops for feed purposes, and to improve the animal's capacity for improved digestibility and nutrient uptake. Genotype-environment interactions should be considered both in crop and animal breeding as well as in crop-animal adaptation. Along the same lines, breeding of animals and crops may focus on reducing input and loss of carbon from the soil as well as ensuring zero-net contribution of climate gases and emissions to the environment from the food sector.
- The biological value of the nutrient available for the target organism is generally not considered, although this is an essential element for optimization of resources: the biological value of unprocessed grass for human beings or monogastrics is poor but it is very high for ruminants; the biological value of animal proteins is generally higher for consumers than vegetable proteins.
- Research on how to improve the nutritional value of animal tissues via feed is scattered and often considered more from a toxicological point of view than from food production chain perspective.

Unleashing a "One nutrition" concept on ingredients

The Farm to Fork strategy has the ambition to shape sustainable food systems for 2030 and later. This highly valuable ambition will only be reached if based on robust scientific evidence investigating the interlinkage of plant nutrition, animal nutrition and human nutrition in a holistic approach. A "One Nutrition" approach linking human, animals and plant nutrition is essential to underpin scientifically the contribution of all currently used and future food production systems to support a broader sustainable food system strategy promoting effectively the minimization of nutrients leakage at all stages of the chain and improved biological values of the food, feed and fertilisers. As science and technology develop, it is also worth considering integrating in the concept of "One Nutrition" the nutritional systems of other living organisms contributing already today or in the future to the food systems, such as insects, microbes or algae.

Adopting a "One-nutrition" perspective means also rethinking certain concepts from a circular economy.

- Optimisation of nutrient conversion into bioresources: in a linear approach, one selects the best resources to obtain the best conversion factor; in a circular context, with a finite amount of resources available, increasingly composed of co-products, the objective is to achieve adequate feed conversion from ingredients, taking into account techniques to achieve this (genetic improvement via plant breeding – New Genomic Techniques, detoxification technologies, increased digestibility via processing); for example, drying can significantly impact on the digestibility of e.g. DDGS (co-product from bioethanol industry), use of mycotoxin binders can improve feed efficiency, which is important considering the expected increase in the proportion of cereals co-products used in feed and the fact that mycotoxins tend to concentrate in the co-product;
- Minimization of waste: what is not used by a living organism is not automatically a waste: it is often a resource for another category of living organism: examples of this are co-products from the food industry or surplus food that can be used to feed farmed animals, insects, microbes or algae; manure may be used as fertilizer; these "resources" should have their product / by-product status preserved as much as possible to allow for direct, safe use; former foodstuffs containing meat or unsold food from retail, are for the time being considered as waste, due to traceability issues that make them not fit for use as feed for food producing animals (difficulty to guarantee

the absence of ruminant material) but the preservation of their resource status could be reconsidered in the future;

- Recovering nutrients from waste: Minimisation of food waste is a clear target but a reduction by half of the amount of food waste by 2030 in the EU leaves still app. 40 mio.t of food waste. It is essential to reflect on how to recover the nutrients from this waste to allow for their safest, most efficient use as resources in the food area, e.g. via algae or insects; likewise, a massive amount of research is put into the recovery of nutrients such as phosphorous from waste streams such as wastewater via algae or physical treatment[2].
- Further optimising the nutrient flow along the nutritional chain, via the integration of new phyla (insects, algae, microbes) and taking into account the biological value of the products produced by each category (protein value of grass vs. protein value of meat in human nutrition).

Developing the concept of "One Nutrition"

The concept of "One Nutrition" can help decision makers to analyse and evaluate the impact of different policy options and legislative / non-legislative initiatives laid down in the Farm to Fork, the biodiversity and the circular economy strategies. A lot of knowledge exists that can be already used for such impact assessments but some aspects require validation. These can be translated into thematic questions to stimulate the debate.

- Is the concept of One-Nutrition fitting social aspirations?
- Nutrient efficiency / losses: Are present indicators of nutrient use efficiency adapted to the "One nutrition" concept?
- Is the biological value of nutrients / bioresources a relevant parameter for a sustainable food system?
- Do we have today the technologies to safely consider the reuse of nutrients in the feed and food chain which are currently going to waste?
- How can animal nutrition reduce nutrient losses in the air (ammonia, nitrous oxide)?
- What are the conditions to enable the concept of "One Nutrition" to become the backbone of sustainable food systems?

On this latter topic, some key elements should be looked at:

- Safety and traceability: recovering nutrients from waste means using often materials whose traceability has not been ensured (catering waste, urban waste waters, etc. Defining end-of-waste status based on safety is therefore essential as a number of past feed safety crises took their roots in materials which, often by ignorance and lack of controls, ended up in the feed / food chain without adequate supervision and control, not providing sufficient guarantees of safety. As for any material "imported" in the feed and food chain, a robust, powerful and knowledgeable gate-keeper is essential, accompanied by strict supervision of these gate-keepers by veterinary control services (approval), evaluation of the safety of the waste processes and traceability further along the chain.
- Lifting legal restrictions: the use of waste material as feedstocks for feed use is prohibited through different pieces of legislation (Regulation (EU) 767/2009 on the placing on the market and use of feed, Regulation (EC) No 1069/2009 on Animal By-products, Regulation (EC) No 999/2001 on Transmissible Spongiform Encephalopathies). The fitness of these legislations should be reassessed, in the light of new technical developments and scientific knowledge, and providing that safety and traceability can be adequately ensured.

[2] FEFAC webinar on circular feed – 31 March 2022

- Respecting the waste hierarchy: the waste hierarchy, putting food and feed of resources and waste as priority uses is a concept that acknowledges that the complexity and high biological and nutritional value of nutrients matrices should be valued as much as possible within the feed and food chain under the “One Nutrition” concepts. Other destinations such as use as bioenergy resources should remain only a default option. Using biomass such as co-products from the food industry as resources for biogas production means using carbohydrates and wasting proteins in the digestate.