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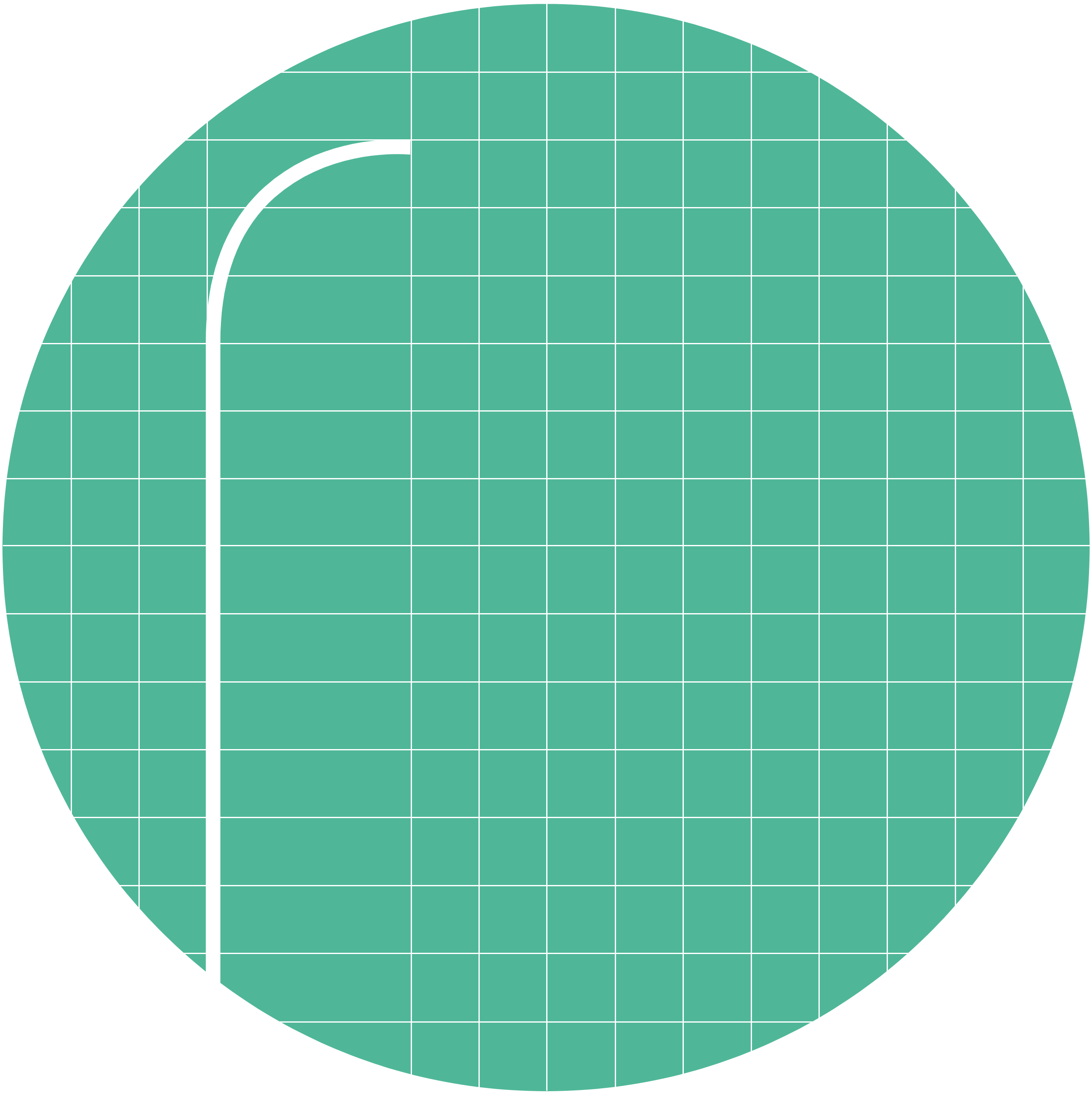
Focus: Zootechnics of the future

Precision feeding and environment



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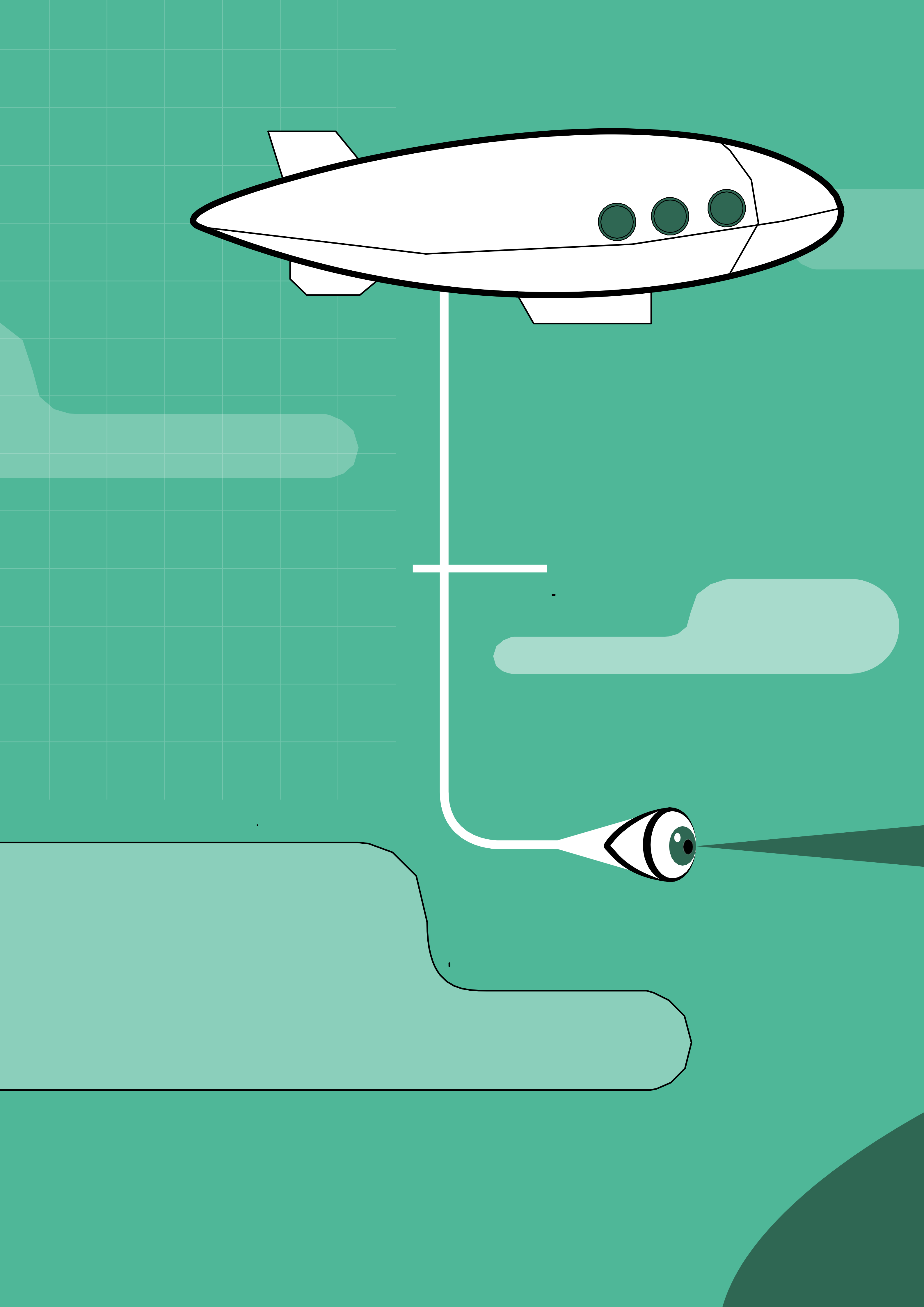

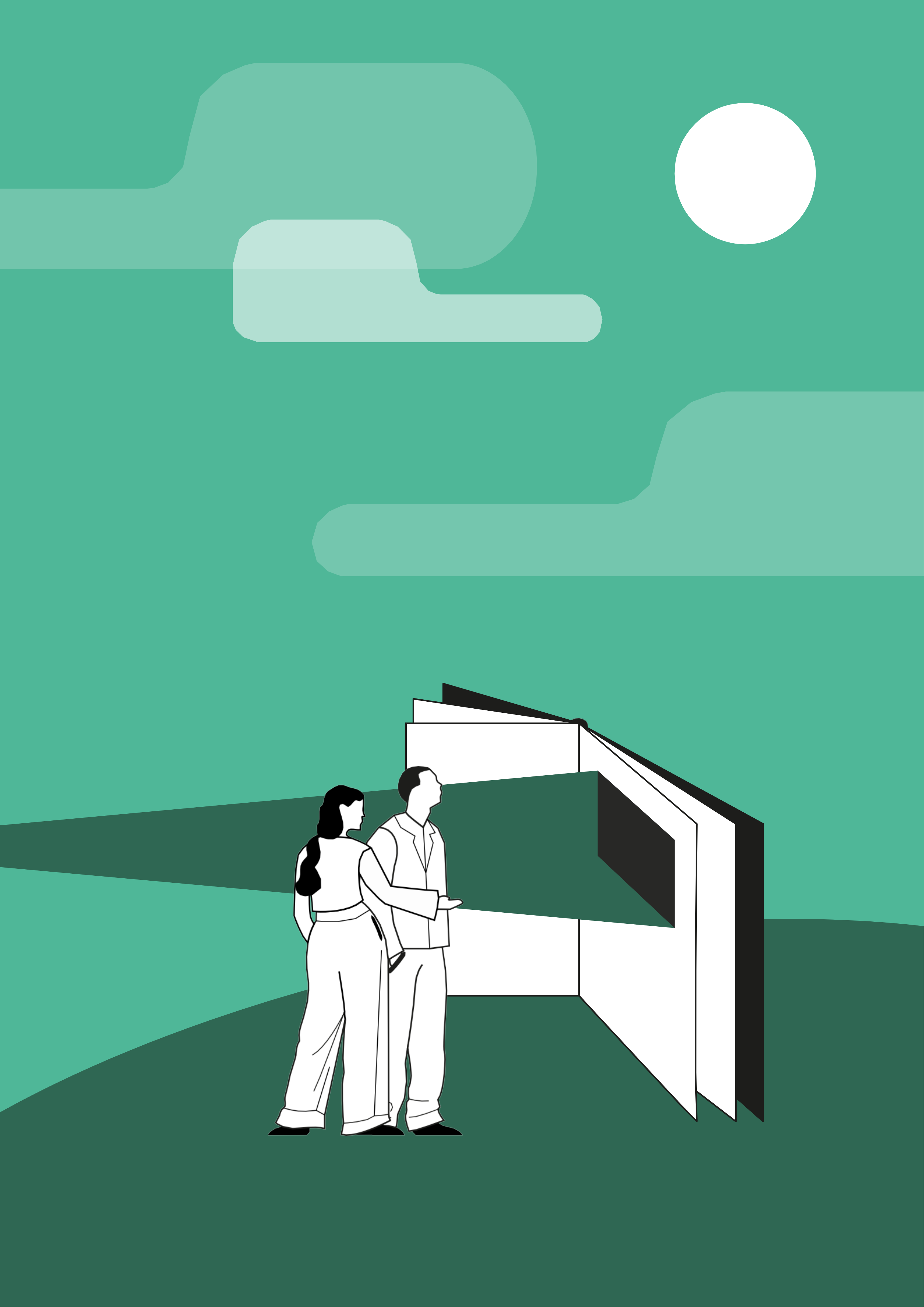

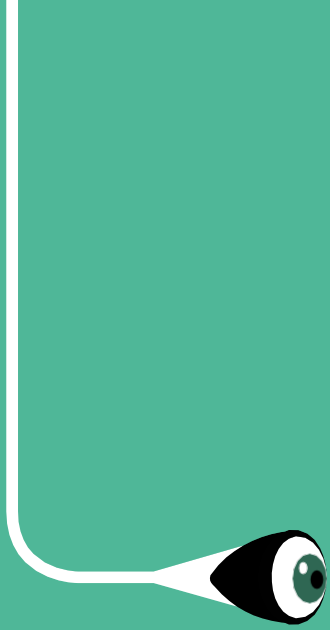

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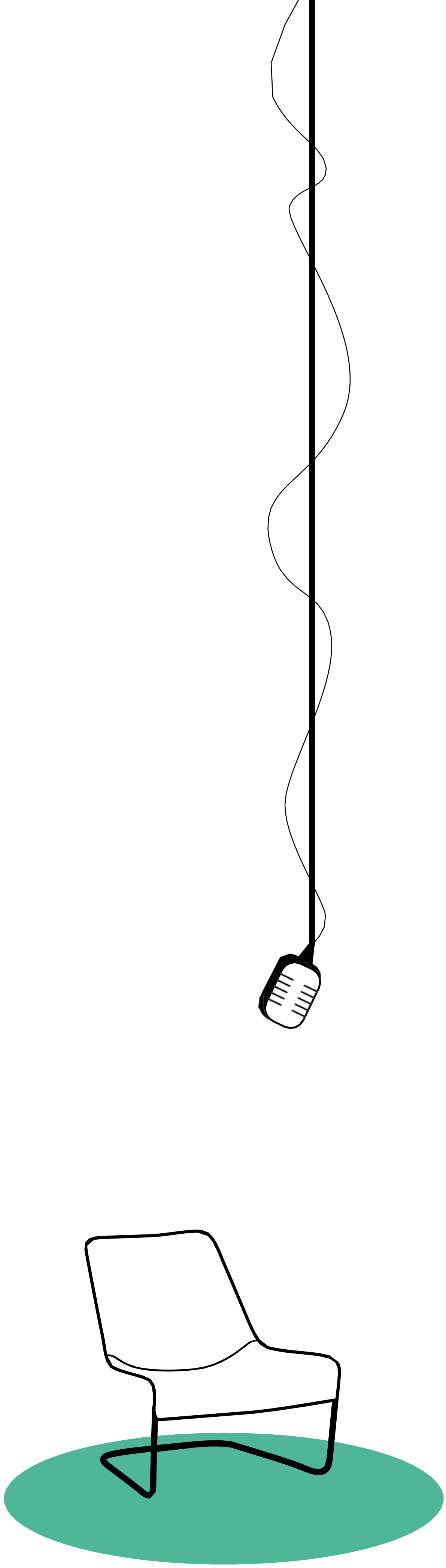


Introduction

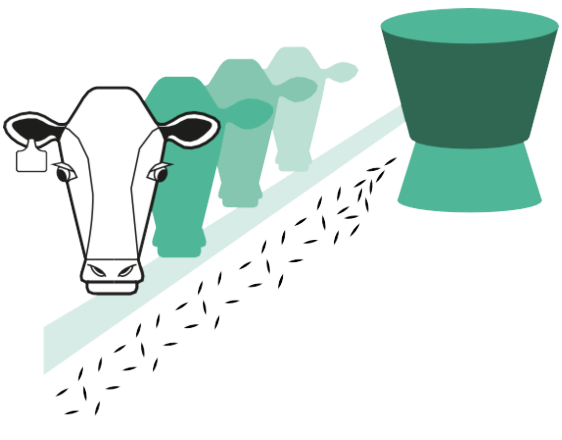
The "livestock farming of the future" series aims to focus on "the stable of tomorrow" from multiple points of view. In particular, it focuses on the strategies that the cattle breeding sector will adopt to respond to the challenge of "*improving production performance, reducing the impact on the environment*".

From this perspective, this first focus delves into the contribution of animal nutrition, considered one of the main functional areas for improving the environmental sustainability of animal production. Greenhouse gas emissions in agriculture in the EU-27 have already decreased by 18.4% compared to 1990 levels (Paper 01 “Green Bill”, Divulga Study Centre) and further reductions can be achieved through feeding strategies that are able to offer solutions, even in the very short term.

Precision feeding plays a decisive role, especially with regard to the reduction of methane production, and new technologies, as well as research on the rumen microbiota, can offer enormous benefits for the sustainability of the sector. In fact, this will be one of the variables to be considered more carefully to encourage an ecological transition that is also sustainable from an economic point of view.

This work, similar to the others that will follow, is based on the contribution of authoritative experts who were asked to provide their vision of the future of animal husbandry (with particular attention to dairy cattle breeding) and of the various aspects covered in the series.

1.



1. Precision feeding in the cattle barn

Interview with Prof. Andrea Formigoni

Tenured professor of the Department of Veterinary Medical Sciences - University of Bologna

Research area: nutrition and feeding of dairy cattle

What is meant by precision feeding?

Precision feeding refers to the complex of actions that nutritionists and breeders implement to optimise nutritional intake according to the specific needs of the animals being bred.

To achieve precision feeding, the first important step is represented by the calculation of the needs of each category of animals bred; in the case of dairy cattle, the main categories of animals present on the farm are calves, heifers of different ages, dry cows and lactating cows. The same applies for buffaloes. In the case of meat production chains, the needs of mares, heifers and fattening calves must be taken into account. The aspects to be considered are the genetic heritage, age, maintenance (significantly influenced by breeding conditions including environmental temperature and humidity) and production performances such as weight gain, pregnancy and milk synthesis.

No less important is the knowledge of the composition of farm foods and, in particular, of fodder which in practice is very variable depending on the species and the variety of cultivation, harvesting and storage systems. For this purpose, precise chemical analyses are required, aided nowadays by rapid analysis methods.

The "optimal" ration is based on the maximum exploitation of company resources which are integrated with the purchase of what is missing to satisfy needs in terms of energy, carbohydrates, fatty acids, proteins and amino acids, minerals (macro and micro) and vitamins.

Food costs account for over 55-60% of the entire cost of milk production; in the case of meat production the incidence is even higher; therefore, the ration must also be optimized based on the costs and benefits expected from the inclusion of the most expensive elements and in particular nutritional additives in the rations.

The third point to consider is the method of preparation and distribution of the daily rations. From this derives the usefulness of obtaining advanced control systems and, in the most advanced cases, the adoption of automatic tools for the preparation and distribution of rations. On the subject of precision feeding, it is important to mention the possibility of differentiate rations for the most productive animals through the use of tools for individual distribution of nutritional supplements required by the most demanding production categories. This in particular is possible with the use of self-feeders and in particular those with which automatic milking stations are equipped (milking robots).

A precision feeding plan must include verification of the expected results in terms of zootechnical performance and nutritional efficiency. The data obtainable from the various IT systems present on the farms allow the effectiveness of the different feeding plans to be assessed. However, it should be noted how, frequently, the large number of animals bred and the data collected automatically in the stable are not easy for operators to manage.

Therefore, in this regard, of interest are the management programs capable of highlighting to farmers the critical issues present on the farm and for the individual animal on the basis of algorithms that take into account various factors. In the future, these systems will be of great help in identifying the best performing animals on farms with the possibility of more precisely directing the choices of the breeder and nutritionists to the exclusive advantage of the economic and environmental sustainability of the farms.

How can emissions be influenced through precision feeding?

The main environmental emissions from livestock activities that arouse concern and attention are linked to methane of enteric origin, nitrogen and minerals. The adoption of precision nutrition can generate significant advantages in relation to all these pollutants.

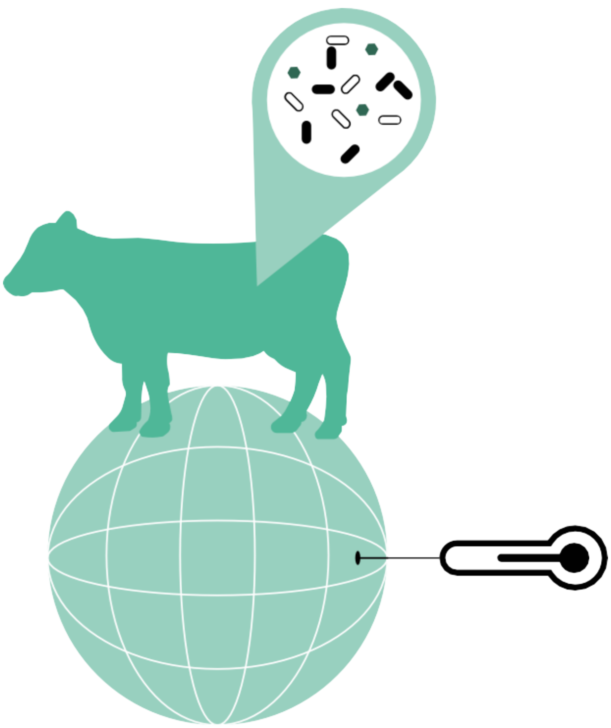
Regarding nitrogen, the reduction of excretions in the environment is mainly achieved by avoiding excessive contributions, improving the digestibility of the sources and balancing the amino acid contributions with energy. Of all the excretions, the one that has the greatest impact on the environment is represented by the amount of urea eliminated in the urine which generates a greater quantity of ammonia in the atmosphere. Research has shown that adequate nutritional strategies are able to reduce the use of nitrogen in rations by more than 10%, increasing conversion efficiency by more than 30%.

Regarding minerals, the most effective way to reduce excretions is to avoid excesses and to use more bioavailable sources.

Regarding methane, numerous studies are underway around the world. The most promising strategies to date concern, in addition to the selection of more efficient animals, the use of fodder with more digestible fibre, unsaturated lipids and the use of food additives that are capable of modifying the activity and composition of the ruminal microbiota. Particularly promising are tannins, saponins, certain algae and, in particular, the synthetic product 3-nitroxypropanol, a compound capable of reducing methane emissions by up to 40% for dairy cattle.

The reduction of methane emissions is an objective of great interest and the numerous research studies underway throughout the world will provide greater and more precise knowledge in the coming years that can be applied in farming practice.

2.



2. The rumen ecosystem

Interview with Prof. Alberto Palmonari

Associate Professor of the Department of Veterinary Medical Sciences - University of Bologna

Research area: nutrition and feeding of dairy cattle

What results has research in animal nutrition achieved to reduce methane production?

Since the 2000s, the number of methane-related research studies has increased rapidly. Several authors have summarised strategies for reducing enteric methane into three broad categories (Knapp et al., 2014):1) Food, feeding management and nutrition: good quality foods that can increase productivity and efficiency, or foods that regulate propionate production or reduce acetate production, decreasing metabolic hydrogen that would be converted to methane;

2) Rumen modifiers: feeding with specific substances that directly or indirectly inhibit methanogenesis;

3) Genetics and other management approaches to increase animal production.

Among these strategies, dietary manipulation has proven to be highly effective as demonstrated in several reviews (Beauchemin et al., 2020; Knapp et al., 2014; Sun et al., 2021).

The intake of dry matter is inevitably linked to the production of enteric methane, due to the direct relationship between the quantity of food ingested and the microbial capacity for methanogenesis. However, the composition and quality of the feed influence the microbial population, and in particular the fate of hydrogen and general fermentation models in the rumen (Fouts et al., 2022).

The main nutritional factors that influence methane production are the quality and digestibility of the forage. Indeed, the efficiency of nutrient use by ruminal microbial organisms leads to a change in the fermentation process, which in turn affects the activity of methanogens compared to other microbial species. Generally speaking, fodder-based diets determine a higher formation of enteric methane than concentrate-based diets. This is because starch (the main component of diets rich in concentrates) promotes propionic-type fermentations, decreasing methanogenesis. On the other hand, diets rich in fodder cause acetic-type fermentation (Samal & Kumar Dash, 2022).

The trend in recent years is to use various additives to reduce methane production (Sun et al., 2020). Additives act as modifiers of the rumen environment, including nitrates, essential oils and tannins, acting on conditions that influence methanogens and remove the accessibility of fermentation products necessary for methane formation (Fouts et al., 2022). These compounds are able to impact on the main metabolic channels of the rumen. In general, one of the most effective interventions to reduce enteric methane is the direct inhibition of methanogenesis (Almeida et al., 2021). However, other interventions involve providing alternative routes to the fermentation products required for methane formation or suppressing the activity of microbes involved in symbiotic relationships with methanogens.

Can the study of the rumen microbiota offer solutions in this field?

One of the most effective interventions for reducing enteric methane is the direct inhibition of methanogenesis (Almeida et al., 2021). Modifying the rumen environment to create conditions that are unfavourable to methanogens represents another intervention for methane mitigation. Such modifications include providing alternative pathways for hydrogen or suppressing the activity of microbes involved in symbiotic relationships with methanogens.

Various studies have shown that the use of additives is effective through different mechanisms of action that interact directly with the rumen microbiota. The main categories into which these compounds fall, still the subject of numerous studies today, are: algae, essential oils, tannins and other secondary metabolites of plant origin.

The link between nutritional strategies and evaluation of the ruminal microbiota is therefore immediate. In this case, the archaeal compartment within the rumen, to which methanogens belong, is present, at different concentrations, in every animal. Several families of archaea are currently recognised, the number of which varies. At the same time, however, the relationships that may exist between these families and other bacterial populations are not fully understood.

We know which fermentation products can act as hydrogen "donors" for methanogenic bacteria (including, indeed, acetic acid derived from cellulose fermentations) but we also know that the same substrate is used both by the mammary gland for the synthesis of milk fat and from many other bacterial families. The importance of a better knowledge of the entire ruminal microbial environment therefore appears evident, which would allow us, for example, to favour those interrelationships between competitors of acetic acid, such as to reduce its use by methanogens. At the same time, archaea also require a nitrogen source in order to multiply. Also in this case therefore, adequate knowledge of the bacterial populations that use the same form of nitrogen, and stimulating their growth, would reduce the development of methanogens. Therefore, knowing the rumen ecosystem in depth is of extreme importance in order to optimise feeding strategies and today it remains an area of great interest with numerous potentials that are still under exploited.

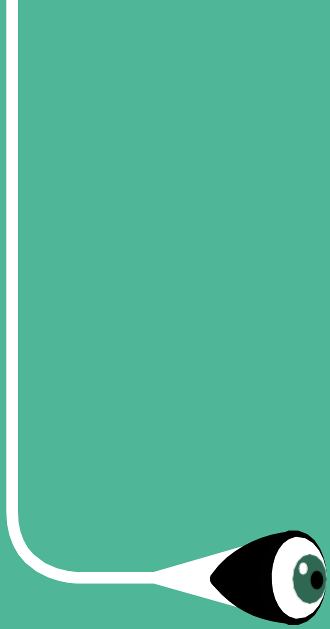
Conclusions

- The feeding of the future will be increasingly "precision-based", i.e. designed for the "actual needs".
of the animal", to improve efficiency both in the conversion of food and to reduce the impact on the environment.

- Precision feeding, as well as recent research on the ruminal microbiota, play a decisive role in reducing emissions in the very short term, in particular methane production from cattle farming.

- The selection of more efficient animals, the use of forages with more digestible fibre, unsaturated lipids and the use of food additives are able to modify the composition of the ruminal microbiota and methanogenesis.

- Numerous studies (Yu et al., 2021) have already demonstrated the effectiveness of certain food additives, such as 3-nitrooxypropanol, the administration of which to dairy and meat cattle reduced enteric methane production by 40% on average, with much higher reductions in some cases.



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