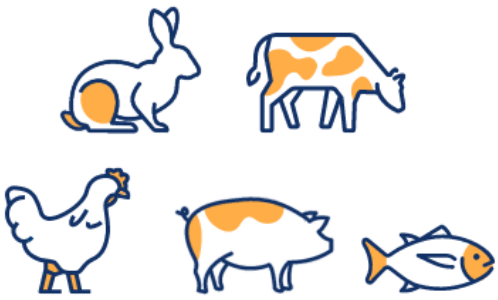
FEFAC
Experts in Animal Nutrition

ADVANCED FEEDING STRATEGIES FOR ENHANCED AND CIRCULAR SUSTAINABLE LIVESTOCK AND AQUACULTURE PRODUCTION

HOW DO THEY WORK?



FEED SUSTAINABILITY CHARTER 2030

JUNE 2023

The European livestock sector is faced with great sustainability challenges. The EU Green Deal & the Farm to Fork Strategy have set the political expectations, while also societal demands have evolved. Livestock and aquaculture production is required to improve its **environmental performance** as well as enhance **animal health & welfare.**

In its Sustainability Charter 2030, FEFAC has taken a commitment to deliver against 5 major ambitions to contribute to a more sustainable livestock and aquaculture production. Delivering against these ambitions requires improving the sustainability performance of premix and compound feed manufacturers and making available to farmers products and strategies that help them improve their own performance.

A RECOGNITION OF THE POTENTIAL OF ADVANCED FEEDING TECHNIQUES

Animals are no longer fed only to achieve better yields or better growth: animal nutrition nowadays integrates the 3 sustainability pillars and has the potential to deliver a significant contribution to environmental protection as well as enhance animal health & welfare. Advanced feeding techniques may be of different nature: it may be linked to the **formulation of the feed**, e.g. the presence of **one or a combination of feed materials and/or feed additives** which exert a function; it may also be linked to a **process** that can improve digestibility or reduce pathogens; it can also be the way the feed is distributed.

A number of these solutions have been developed long ago and are well implemented: this is the case for example for the use of phytase, an enzyme that improves the digestibility of the phosphorous contained in vegetable feed ingredients, and thereby enables to reduce the amount of phosphorous needed in the diets to meet animal's requirements and ultimately to reduce significantly the amount of phosphorous rejected in the environment. Nowadays, livestock emissions of phosphorous in the environment are generally regarded as manageable.

Some of these techniques have been identified as **Best Available Techniques** for the intensive rearing of poultry and pigs in 2017, for example, the use of free amino acids and phase feeding to minimize nitrogen emissions[1]. The legislation on Feed intended for **Special Nutritional Purposes**[2] (so-called PARNUTS) recognizes also that animals may face situations where their process of assimilation, absorption or metabolism is temporary or irreversibly impaired and can therefore benefit from the ingestion of feed appropriate to their condition. A typical example is dietetic feed to address the risk of milk fever for dairy cows.

Concerning animal health and more specifically gut health, the RONAFA[3] report published jointly by EFSA and EMA identifies a number of **strategies to reduce the need for antimicrobial treatment**, in particular feeding techniques that help animals facing a pathogenic challenge. A typical example is the reduction of the amount of proteins in piglet diets.

Nowadays, the development of digital tools offers fantastic possibilities to adapt the diet of animals to their physiological needs: **precision feeding** can really bring a breakthrough on the road to enhanced sustainability. One example of this is the control by a camera of the distribution of feed to fish to adapt to their intake and avoid wastage released in the aquatic environment.

The **FAO** is also engaged in different projects to promote dietary measures to reduce the need to use antimicrobials[4] or to lower enteric methane emissions[5]. The **International Feed Industry Federation (IFIF)** has also engaged in the development of a toolbox for legislators to allow assessing the efficacy of animal nutrition innovation to support animal health and welfare.[6]

FEFAC does not pretend nevertheless that animal feeding can bring solutions to all challenges and can be a solution on its own: animal husbandry is a subtle alchemy between zootechnical sciences like nutrition, animal health and animal breeding and the structure of the farms, the production system and last but not least, farmers' skills.

[1] BAT Reference document for Intensive Rearing of Poultry or Pigs - 2017

[2] Regulation (EU) 2020/354 establishing a list of intended uses of feed intended for particular nutritional purposes

[3] EMA and EFSA Joint Scientific Opinion on measures to reduce the need to use antimicrobial agents in animal husbandry in the European Union, and the resulting impacts on food safety (RONAFA)

[4] FAO. 2021. Animal nutrition strategies and options to reduce the use of antimicrobials in animal production.

[5] FAO Livestock Environmental Assessment and Performance (LEAP) Partnership. 2023. Guidelines on Methane emissions in livestock and rice systems: Sources, quantification, mitigation and metrics.

[6] IFIF. 2023. Nutritional Innovation to promote Animal Health and Welfare

A NEED TO STIMULATE THE UPTAKE OF ADVANCED FEEDING TECHNIQUES

The Green Deal and in particular the Farm to Fork Strategy stimulated **research** to tackle new challenges in particular Climate Change and Deforestation. Innovation is accelerating and the number of publications on animal nutrition is permanently on the rise. Still, **the level of uptake of these solutions is not optimum**: the potential of advanced feeding techniques to reduce the environmental impact of feed production and use or to maintain the health status and enhanced the welfare of livestock and aquaculture animals lacks visibility and these solutions remain consequently underrated. One illustration of this is the level of uptake of dietary interventions in the design of the CAP **National Strategic Plans** by Member States in 2023: out of 27 Member States, only Portugal and Belgium (Flanders region) have made eligible to CAP support certain animal nutrition solutions to improve resp. feed efficiency and reduce enteric methane emissions.

The EU Commission invested recently in tools to improve this visibility and also analyse the parameters that may impact the decision of farmers to take up one or the other technique. Several Research projects as part of the Horizon 2020 framework programme focused in particular on solutions to reduce the need for antibiotics **(DISARM, AVANT, ROADMAP)**. But the most emblematic example is the IMAP[7] project run by the Joint Research Center. The **IMAP** initiative aims to provide robust scientific evidence to support the implementation, monitoring and evaluation of the CAP, in the context of the environment and climate change objectives. A significant part of the project consists in synthesizing large amounts of published scientific evidence on the impacts of farming practices, including dietary interventions, on the environment as well as animal welfare and health.

Feed manufacturers are communicating towards their customers and are required by law to provide justification for any **claim** they make in relation to the ability of their products/strategies to support farmers in their transition towards more sustainable production conditions. They can also rely for that on the **assessment by EFSA of the efficacy of feed additives** or on scientific publications. The **Copa-Cogeca/FEFAC Code of Good Labelling Practices** for the labelling of compound feed for food-producing animals provides in particular guidance on the type of claims that can be made and the nature of the substantiation. This Code, which is officially recognized by the EU Commission, is undergoing a further upgrade in 2023 to provide additional guidance on green labelling (environmental performance of feed production and feed use).

Still, the **level of awareness of the potential of feeding techniques remains very limited**. This is the reason why, as FEFAC, we have taken the initiative of launching **our own communication tool** to further **promote advanced feeding techniques** and show their **potential efficacy and inform on conditions of use.** But we want also to provide factual information on possible restrictions due to logistics or legislation, usability in the different farming systems, economic impact, etc. **This is why a set of fact sheets showcasing practical feeding strategies is available on the FEFAC website.**

We strongly believe that improved access to information on the efficacy of dietary interventions to address environmental, animal health & welfare challenges will convince national authorities that **boosting the sustainability of livestock production revolves around more than discussions on livestock numbers** and encourage them to **invest in feeding techniques** to stimulate their uptake by farmers.

[7] IMAP.2021. (Integrated Modelling platform for Agro-economic and resource Policy analysis) - Livestock dietary manipulation techniques

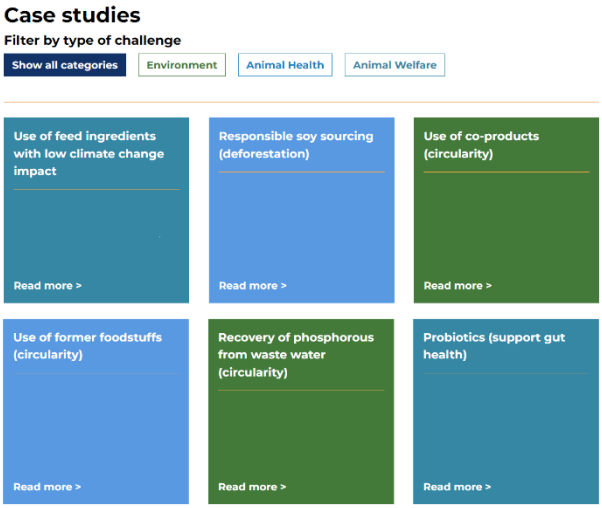
ADVANCED FEEDING STRATEGIES FOR ENHANCED AND CIRCULAR SUSTAINABLE LIVESTOCK AND AQUACULTURE PRODUCTION

PRIORITY AREAS

FEFAC asked in autumn 2022 to its members what they can do to support European livestock and aquaculture in the transition towards more sustainable production practices. This consultation showed that **animal nutrition has the potential to address many challenges** that may be common to all species or species-specific and are applicable to all or some production systems (intensive, extensive, organic, etc.).

The purpose of the following four factsheets is to provide general information on **how animal nutrition solutions work** to address key priority challenges, broken down into three categories: **environment, animal health and animal welfare**. The first factsheet is dedicated to challenges and solutions common to **all species**. The three following factsheets are dedicated to additional challenges that may be more specific to ruminants, monogastrics or fish or to additional techniques to address common challenges but which are more specific to a category of animals.

In addition, a number of specific techniques, strategies and formulations, supported by strong scientific evidence have been selected by FEFAC members and **showcased on the FEFAC website**, with detailed information on the conditions of use, the trade-offs, the economic aspects, the regulatory limitations when exist, as well as bibliographic references (mostly meta-analysis) for those who want to learn more.



ALL FARM SPECIES

EXTENDED CASE STUDY DESCRIPTIONS AVAILABLE ON FEFAC WEBSITE

ENVIRONMENTAL CHALLENGES

Environmental challenges concern both the impact on the environment from **the production of feed materials** and the impact of **feed following its digestion**. The livestock sector is a source of GHG emissions and therefore an important factor to take into account in tackling climate change. LCA science has determined clearly that the majority share of GHG emissions related to animal production lies with how feed materials were cultivated and what their origin is. In particular for soy, when the origin is not secured as not contributing to deforestation, the impacts of 'land use change' are a significant driver of the **carbon footprint**. After the stage of feed digestion, for all animal species the **emissions from ammonia** in manure are a challenge. Through manure excretion, livestock production also has to deal with **nutrient losses**.

The origin of feed materials is also a factor in determining the impacts **on resource depletion** and the competition between food and feed production. The current use of certain minerals, such as phosphorus, depends on sources that are finite as well as highly geographically concentrated. The supposed **use of feed that could have been consumed directly by humans** is a societal and political concern increasingly presenting itself as a challenge that needs to be tackled.

The key environmental challenges identified by FEFAC members where animal feeding strategies can play a role the same way for all species are: i) the use of **low-carbon footprint ingredients**, ii) the assurance of using **deforestation-free soy** and iii) **increased circularity** through feed production.

How can animal feeding strategies help tackle environmental challenges?

As regards identifying the **GHG emissions** related to feed materials production, a key first step is obtaining data. Together with global feed industry partners, FEFAC invested in the development of the **GFLI Database**, which currently contains the most comprehensive information source for datasets on the environmental impacts of the feed materials sourced by compound feed manufacturers.

Securing the **deforestation-free** status of soy is possible through the use of certified responsible soy production. The **FEFAC Soy Sourcing Guidelines** provide a comparison level for producers of responsible soy and thereby facilitate the linking of market supply and demand for this environmental challenge.

Although **the competition between food and feed** consumption for the same resources is a debate that requires a lot of nuances, the feed industry has access to a large variety of **co-products** from food and non-food primary processing and former foodstuffs, which are demonstrably contributing to **closing cycles** and examples of **circular economy practices**.

ANIMAL HEALTH CHALLENGES

Feed is a potential **carrier of hazards** of various nature: microbiological (e.g. Salmonella), chemical (cadmium, mycotoxins, dioxins, etc.) or physical (glass or metal fragments), which can have deleterious effects on animal health. Sick animals need treatment and the **use of antimicrobials in case of bacterial infections**. In addition, suboptimal nutrition and (subclinical) diseases prevent reaching the full genetic

potential of animals. Certain physiological stages can translate into health issues, for example, milk fever for dairy cows. And not to forget, the health status of farm animals is a primary factor determining **the quality, safety and wholesomeness of foods** of animal origin for human consumption.

The key animal health challenges identified by FEFAC members where animal feeding strategies can play a role the same way for all species are: i) **feed safety** and ii) **antimicrobial resistance**.

How can animal feeding strategies support animal health?

The first leverage is to **minimize the risk of exposure of animals to hazards**: most of the physical and chemicals hazards are introduced in the feed chain via feed ingredients. It is therefore essential to secure the supply chain from the supplier of feed ingredients to the farm. The feed industry was pioneer in developing **feed safety assurance schemes** in order to intercept hazards at the earliest stage of the chain. This is illustrated by the FEFAC concept of "top-of-the-pyramid"[8] which is the cornerstone of effective feed safety management along the chain.

Microbiological contamination can also find its origin in feed ingredients but may also occur in feed mills and during transport to the farm. Selection of feed ingredients may not be sufficient and a **treatment (chemical or thermal)** at the feed mill is often an effective tool to control the risk of pathogens such as Salmonella.

The other major leverage is **to help animals to cope with pathogens**. This is what is referred to as tertiary prevention by EFSA and EMA in the so-called RONAFA report[9]. The tertiary prevention therefore built on the natural ability of animals to resist stressors, up to a certain level. In particular, the gastrointestinal tract of animals provides a natural defence to avoid the development and activity of deleterious microorganisms and substances. Recent research indicates that **nutrition is interlinked with the animal's microbiome and gut & immune function**. Animal health & well-being, and as a result animal performance, is therefore always related to a proper balance of those three domains. This new paradigm is often referred to as '**eubiosis**'. Animal strategies will consist in using micro-ingredients contributing to enteral stimulation (e.g. dietary fibres), microbiota management (probiotics, organic acids, Medium Chain Fatty Acids, bacteriophages), support of the mucosal barrier function (Short Chain Fatty Acids), immune modulation (plant extracts, essential oils, yeast products, prebiotics, synbiotics, chitosan), etc.

ANIMAL WELFARE CHALLENGES

Freedom from hunger is among the 5 freedoms used to characterised animal welfare. Access to nutritionally balanced and safe feed is therefore among the prerequisites for animal welfare. Beyond that, animals experience stressful situations inherent to their life cycle and the onset of productivity (such as milk, growth and reproduction). These **physiological and metabolic stressors**, which are usually species-specific may affect the welfare of an individual. They may end up in typical (sub)clinical symptoms, usually not related to infectious diseases. Another attempt at animal welfare is with **mutilations** performed for food quality reasons (e.g. castration) or to minimize the risk of injuries (e.g. beak trimming) inherent to group housing.

The key animal welfare challenge identified by FEFAC members where animal feeding strategies can play a role the same way for all species and which can be tackled by the same solution is the **presence of mycotoxins** at low levels in feed.

How can animal feeding strategies support animal welfare?

Maximum limits and guidance values are set for mycotoxins in complete feed at No Observed Adversed Effect Level (NOAEL) in terms of animal health in particular. However, the presence of mycotoxins at low levels may still create some discomfort which may interfere with the animal's ability to process and absorb nutrients, particularly energy. Certain feed additives help reduce the contamination of feed by mycotoxin, e.g. by preventing the absorption of the mycotoxins from the intestinal tract of the animal by adsorbing the toxins to their surface.

[8] FEFAC (2016). Vision on feed safety management 2030.

[9] EMA and EFSA (2016). Joint Scientific Opinion on measures to reduce the need to use antimicrobial agents in animal husbandry in the European Union, and the resulting impacts on food safety (RONAFA).

MONOGASTRICS

EXTENDED CASE STUDY DESCRIPTIONS AVAILABLE ON FEFAC WEBSITE

ENVIRONMENTAL CHALLENGES

Environmental challenges concern both the impact on the environment from the production of feed materials and the impact of feed following its digestion. When it comes to the exposure to **soy-related deforestation** in the feed materials production stage, it applies to all farm animals, but one could argue it concerns in particular **poultry farming** as there the reliance on soy products is highest. After the stage of feed digestion, the **handling of manure** is the key challenge to tackle, with the consequent release of **ammonia** in the air and **phosphorous, trace elements** (copper, zinc) and **nitrates** in the soil/water. In particular, pigs produce a considerable amount of manure, which, if not managed correctly, can impact water quality and soil health, leading to environmental degradation. Manure management is a field of expertise on its own for all animal types, where the majority of environmental impacts must be neutralized.

The key environmental challenge identified by FEFAC members where animal feeding strategies can play a specific role for monogastrics is **nitrogen emissions.**

How can animal feeding strategies help tackle environmental challenges?

Animal feeding strategies can further contribute to impact mitigation, and are in fact often species-specific. To minimize **soil contamination**, the use of **phytase, free amino acids** and **proteases** in feed is a common solution in pig and poultry farming, which allows for more efficient uptake of the available protein from the feed, thereby also contributing to resource efficiency of feed inputs. The use of **organic trace elements** for example, such as chelates of copper and zinc, facilitates the passage of the mineral ion through the stomach and aids in its absorption in the gut. In pig farming, the use of **phase feeding** is a practice that allows for reducing protein content in feed, while the use of **benzoic acid** presents a specific solution to mitigate ammonia emissions from manure.

ANIMAL HEALTH CHALLENGES

The most critical health issues to be addressed by monogastrics breeders are **viral diseases**: the High Pathogenic Avian Influenza for birds and African Swine Fever for pigs are among the most critical viruses affecting poultry and pig farming globally. **High-level biosecurity** plans remain the baseline to manage these infections.

As for all species, the number one challenge for monogastrics breeders is to **minimize the need for antimicrobial treatments.** The ban on prophylactic treatment with antibiotics, including group treatment via medicated feed triggered a renewed interest in preventative measures, including tertiary prevention as defined by EFSA and EMA in the RONAFA report, i.e. **the ability of animals to cope with pathogens**. As far as pigs are

concerned, the most critical period in terms of animal health is clearly **weaning**, with a high risk of diarrhoea for piglets due to changes from animal to vegetal proteins-based diets, crude proteins from plants serving as a substrate for pathogenic proteolytic bacteria.

Other non-infectious health issues of concern affecting birds are **footpad dermatitis** (often connected with wet litter) and **keel bone fractures.**

The key animal health challenges identified by FEFAC members where animal feeding strategies can play a specific role for monogastrics are: i) **weaning of piglets,** ii) **footpad dermatitis** and iii) **keel bone fractures.**

How can animal feeding strategies support monogastrics health?

There is little that animal nutrition can do in relation to viral diseases, except securing that feed deliveries do not contribute to virus dissemination and avoiding that animals facing nutritional deficiencies that would make them even more sensitive to the disease.

Regarding the risk of **piglet diarrhoea**, a key parameter to play with is to reduce the amount of indigestible protein in the diet by lowering the total amount of protein, which can be achieved by **using highly digestible protein** sources like potato proteins combined with supplementation with **free amino acids.**

Concerning **footpad dermatitis**, a lower level of crude protein, the inclusion of biotin and reduction in electrolytes (Na, K) balance in the diet, as well as feed additives such as enzymes hydrolysating non-starch polysaccharides and organic sources of microelements (zinc), may **reduce the litter moisture** and therefore have a positive effect on incidence and severity of footpad dermatitis in broiler chickens and turkey. Likewise, the addition of **omega 3** in the diets of broilers has positive effects on the incidence of **keel bone fractures.**

ANIMAL WELFARE CHALLENGES

Among the key animal welfare parameters being scrutinized at the moment, the question of mutilation is among the most appealing for EU citizens. **Pig castration** is motivated by consumers preference for meat exempt from boar taint, which is an off-flavour of pork caused primarily by a microbial breakdown product, skatole and a testicular steroid, androstenone. **Beak trimming and tail docking** are motivated by the need to protect animals against feather pecking and tail biting, which are unsuitable behaviours often linked to feeding practices.

Animal nutrition strategies can help reduce boar taint and limit aggressive behaviours.

The key animal welfare challenges identified by FEFAC members where animal feeding strategies can play a specific role for monogastrics are: i) **avoiding pig castration**, ii) **feather pecking** and iii) **tail biting**.

How can animal feeding strategies support monogastrics welfare?

The addition of chicory roots containing **inulin** in the diet during the last 4 days before slaughtering modifies protein fermentation and limits the production of skatole and incidentally boar taint. The provision of a **low-protein, grain-based diet** or beet pulp or palm cake can also have a positive effect.

The addition of **dietary fibres** in the feed increases the feeling of satiety, resulting in less manipulative behaviour directed at other animals and less oral behaviour, thus reducing aggressivity and the occurrence of **tail biting** and **feather pecking.**

Other sources of discomfort for monogastrics are for example the **risk of constipation** for sows, which may be addressed by the use of ingredients stimulating intestinal passage such as vegetable oil. Reduction of the risk of constipation is an officially recognized nutritional purpose (Regulation (EU) 2020/354).

RUMINANTS

EXTENDED CASE STUDY DESCRIPTIONS AVAILABLE ON FEFAC WEBSITE

ENVIRONMENTAL CHALLENGES

The key environmental challenge specific to the farming of ruminant animals is the release into the atmosphere of **methane gas**. Methane comes from the digestive systems of cows, sheep, and other ruminant animals. When these animals digest their food, they produce methane as a by-product, which is then released into the atmosphere through belching and flatulence. Methane emissions from cattle and other livestock animals are a problem because methane is a potent greenhouse gas that contributes to global warming and climate change. Methane has a much higher global warming potential than carbon dioxide, meaning that it has a greater ability to trap heat in the atmosphere. As the global population grows, so does the demand for meat and dairy, which in principle means that the number of livestock is also increasing, and so are the associated methane emissions. Although biogenic methane is part of a cycle and may not be compared with methane from the exploitation of fossil energy, the EU and national policymakers are keen to see methane emissions from ruminants to be brought down as a short-term action to tackle climate change.

The key environmental challenge identified by FEFAC members where animal feeding strategies can play a specific role for ruminants is a **reduction of enteric methane emissions.**

How can animal feeding strategies help reduce methane emissions from ruminants?

There are several animal feed solutions that can help to reduce methane emissions from cattle. **Forage management** would be the first step for a cattle farmer to take into account. An approach that includes complementary feed is adapting the formulated feed that reduces the amount of methane produced during digestion. For example, **adding fats, oils, or certain types of carbohydrates** to the feed can help to slow down the process of digestion and reduce the amount of methane produced. Another approach is to modify the feed diet to include more easily digested feed, such as grains and soy, and **reduce the amount of fibrous feed**, such as hay and grass, which can be more difficult for the animals to digest and lead to more methane emissions.

A lot of research and development has been invested in creating a **methanogenesis inhibitor** that can be added as a supplement to the complementary feed, inhibiting the growth of methane-producing bacteria in the animals' digestive system. Bovaer® (active substance 3-NOP) is the first EFSA-approved feed additive that reduces enteric methane emissions from dairy and reproductive cows and is safe for the animal and the consumer.

ANIMAL HEALTH CHALLENGES

Infectious diseases caused by bacteria are the number one challenge for ruminant health and the need to **minimize antimicrobial treatments** is a key objective, including for young calves being destined for veal production. **Viral diseases** are also a significant threat (Foot-and-Mouth Disease for example). Besides these microbiological threats, cattle are potentially exposed to stressing situation at specific physiological stages, for example, calving: **milk fever** are metabolic disorders that occur at calving when calcium requirements are suddenly increased for colostrum and milk production. They result in a reduction of blood calcium levels leading to muscle weakness. Cattle are also exposed to the **risk of ketosis** (an elevated concentration of ketone bodies in all body fluids, which translates into anorexia, decreased milk production, noticeable loss of body condition, etc.), or the risk of **tetany or acidosis**. Animal feeding strategies may help support some of these ruminant health issues, e.g. to help animals cope with microbial challenges and non-pathogenic diseases.

The key animal health challenges identified by FEFAC members where animal feeding strategies can play a specific role for ruminants are: i) the risk of **milk fever,** ii) the risk of **tetany** and iii) the risk of **acidosis.**

How can animal feeding strategies support ruminant health?

Besides the range of feeding techniques and strategies to reduce the need for antimicrobial treatment that are effective for all species (see factsheet for all species), several feed formulations, mostly based on **supplementation with trace elements, vitamins and macrominerals** have been recognized by the legislator as effective to meet **specific nutritional purposes**[10] associated with certain physiological situations affecting animals' health. The risk of milk fever and hypocalcaemia may be reduced if the **level of calcium in the blood** is maintained. This may be achieved in different manners, e.g. feed with low cations/anions ratios or with the addition of zeolite to mention a few. The risk of tetany may be reduced thanks to feed containing high levels of magnesium and low level of potassium. The risk of acidosis may be minimized thanks to feed with low concentrations of fermentable carbohydrates and high buffering capacity.

ANIMAL WELFARE CHALLENGES

In ruminants, an overall **metabolic stress** response affecting animal welfare is observed for example during the development of a functional rumen (modification of the digestive system and weaning). The period of **weaning** is indeed characterised by a rapid, but transitory, decrease in the feed intake which is partly responsible for structural and functional alterations of the intestines. Weaning has also a major impact on the dynamics of the development of the intestinal microbiota. Moreover, the animal at the weaning stage produces free radicals, which, if present at too high a level, can create oxidative stress. The regulation of the redox system plays a major role in maintaining cell and tissue integrity. Its imbalance may be an aggravating factor of post-weaning troubles.

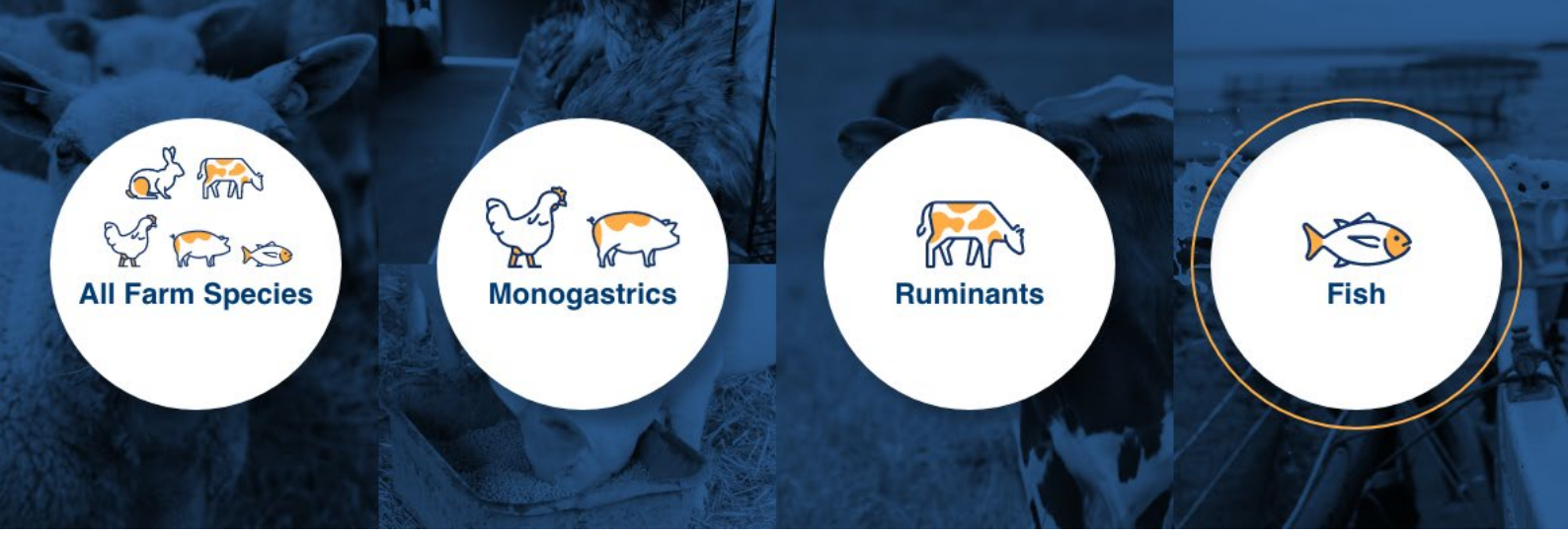
External factors, such as **heat stress**, may affect predominantly outdoor (grazing) animals. Clinical observations related to these stress responses are the prevalence of lameness, hock, knee and skin lesions, and swellings.

The key animal welfare challenges identified by FEFAC members where animal feeding strategies can play a specific role for ruminants are: i) **weaning** and ii) **heat stress.**

How can animal feeding strategies support ruminant welfare?

To support calves during the weaning period, it is important to provide the animal with **supplements of calcium and phosphorous** for the constitution of bone tissues and of **trace elements & vitamins** to prevent the risk of anaemia and contribute to the protein synthesis and especially immunoglobulins, that have a preventive action on the growth crises. Regarding **heat stress**, the addition in the diet of **fat** which releases heat at a slower rate during their metabolism compared to carbohydrates and proteins may help regulate body temperature.

[10] Regulation (EU) No 2020/354 establishing a list of intended uses of feed intended for particular nutritional purposes



FISH

EXTENDED CASE STUDY DESCRIPTIONS AVAILABLE ON FEFAC WEBSITE

ENVIRONMENTAL CHALLENGES

One of the most important environmental challenges for fish feed is the **risk of halieutic resource depletion** linked to the feeding of fish with fish meal and fish oil produced from wild fish. With the huge development of aquaculture worldwide, the need to secure sustainable management of marine fish has become critical and sustainability schemes have been developed during the last decades to secure that fishmeal/fish oil from wild fish used in the EU nowadays are from sustainable sources.

Another important and specific issue for aquaculture is the **prevention of feed wastage**: since the feed is distributed in water, any surplus feed not consumed by fish can deposit at the bottom of deep water.

The key environmental challenges identified by FEFAC members where animal feeding strategies can play a specific role for ruminants are i) **halieutic resource depletion**, further integration in **circular economy** and iii) **nutrient losses.**

How can animal feeding strategies help aquaculture address environmental challenges?

Concerning the replacement of fish-derived feed ingredients, attention was initially put on substituting animal-based proteins with plant-based proteins. However, a plant-based diet has a negative impact on the gut health of carnivorous fishes. Therefore, attention is now put on **using sustainable products of animal origins for feed use.**

- Priority number one is the use of **fish trimmings** coming from the processing of wild and farmed fish, in compliance with the intraspecies recycling ban. This contributes to improving the contribution of aquaculture to the circular bioeconomy.
- The second priority is to use **proteins and oils&fats from farmed insects and polychaetes fed with by-products from the circular economy.** At this stage, it is not legally permitted to feed insects or polychaetes with catering waste or with other non-edible vegetable biomass such as sludge including from fish farming.
- The third priority is to use natural marine resources from lower trophic levels and not used for human consumption: this is the case in particular of **krill and zooplankton**. The exploitation of these resources requires a good understanding of the quantities that can be used without affecting marine biodiversity and ecosystem balance.

Another option is to use **proteins and oil (omega 3) produced with microorganisms such as bacteria, yeasts, fungi or microalgae.**

As far as minimization of **losses of nutrients** is concerned the attention is put on three strategies:

- **Controlling the distribution of feed**: precision feeding based on videos enables to better control of the amount of feed distributed to animals.
- **Increasing the retention of the feed in water:** the incorporation of gums and fats in feed increases the duration of flotation of the feed in water and therefore delays its deposition and sedimentation under cages.
- **Recovering of nutrients**, including from fish faeces by **growing algae** for feed use.

ANIMAL HEALTH CHALLENGES

Like other species, **infectious diseases** are a major threat to fish health. This is even more problematic for carnivorous species, due to the increased need to replace part of the fishmeal with other protein sources preferably from animal origin. Diets based on vegetal proteins are indeed known to have a direct effect on gut microbiota and intestinal barrier. So far, animal protein sources other than fishmeal are in limited quantities at the moment and pending the supply increases, proteins from plant origin are currently the most important alternative.

How can animal feeding strategies support fish health?

Among all potential dietary interventions to help animals face potential pathogenic challenges, the use of **probiotics and yeast** in fish feed are among the most effective solutions to support fish gut health and ongoing research on **bacteriophages** shows also promising results.

ANIMAL WELFARE CHALLENGES

The science around the welfare of fish is under development. So far, one of the most critical parameters affecting the welfare of fish is **parasites**, in particular sea lice.

How can animal feeding strategies support fish welfare?

One strategy to reduce the exposure of fish to sea lice is to **deliver the feed at a depth below 10 meters** since sea lice larvae are usually present in surface waters.

FEFAC aisbl
Rue de la Loi, 223 Bte 3
B-1040 Bruxelles
Belgium
+32 (0)2 285 00 50
fefac@fefac.eu

www.fefac.eu