

## **The role of ruminants in sustainable agriculture - emissions and efficiency within dairy production**

Ruminants play a vital role in food security by converting inedible food, such as roughage and by-products, into edible products like milk and meat. This makes them essential to sustainable agricultural practices, especially in utilizing resources that are not directly consumable by humans. However, the digestion and fermentation of feeds in the rumen also produces a significant amount of methane gas. Therefore, there is an increasing demand to lower enteric methane emissions from meat and milk production, both as total emissions and emissions relative to animal product outputs (e.g. meat, milk). Reducing methane from ruminants is challenging since it is a by-product from the ruminant's digestive system. Huge research effort have been ongoing the last 20 years to find strategies to reduce enteric methane.

My research has primarily focused on understanding factors that determine methane emissions from dairy cows and the development of management strategies for methane emission suppression. This with a particular focus on feed and feed additives and its effect on animal performance. Part of my research has focused on to explore the role of the rumen microbial community in determining variation in methane emissions and responses to interventions. My research aims to interpret results in a broader context e.g. examining how feed supplements affect not only methane emissions from animals but also emissions from manure.

The inputs used in agricultural systems impact all three dimensions of sustainability (social, environmental and economic). I see a risk of only focus on improving "emissions efficiency" in dairy production with the main aim to increase output to dilute emissions per kilo milk. While it's true that emissions per kilogram of product decrease with higher production, it's crucial to consider the type of inputs required for this increase. Intensified production often demands more inputs, such as high-protein feeds, energy-dense feeds, and increased use of fertilizers and water, which can strain resources and reduce the system's overall sustainability. This shift undermines the cow's unique ability to convert non-human-edible food, raising questions about their role in such systems. Therefore I also focus on the role of ruminant livestock within grass-based production systems. Grazing, in particular, is essential for maintaining semi-natural pastures. At European Union level, 75 % of all grassland habitats have poor or bad status of biodiversity, with cessation of farming and subsequent overgrowth posing the greatest threat. To achieve favourable conservation status of natural grasslands, the area given over to grazing livestock or hay mowing needs to increase in many regions. In Sweden, increasing the number of grazing animals is crucial for preserving these pastures, which also support biodiversity. Balancing biodiversity and ecosystem services against greenhouse gas emissions is essential. Currently, comprehensive calculations that consider these trade-offs across different production systems are lacking. However, methods for calculating environmental impact are continually updated to reflect advances in knowledge.