BOOK OF ABSTRACTS

NORDGLOBAL-26

4th International Joint Conference on Global Change: Nordic Solutions through Sustainable Resource Management and Animal Production

April 22 – 24, 2026

InnoCamp, Steinkjer, Norway

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PREFACE

In these times, we live in an unsettled, rapidly changing world. The geopolitical situation is unstable, and we have seen how armed conflicts—beyond the immense human suffering they cause—also negatively affect supply chains, including food systems and essential inputs for food production. In addition, such conflicts have a strong adverse impact on the environment.

This is happening at a time when we are already witnessing significant consequences of climate change. Global warming is accompanied by increasingly extreme weather events, including droughts and floods, and—as is so often the case—it is the most vulnerable members of the global community who are most severely affected.

Against this backdrop, dialogue and cooperation across national borders and academic disciplines are more important than ever. Together, we must work to develop sustainable solutions for food supply systems while safeguarding the climate and biodiversity. With a continuously growing global population, food security and resilience are critical challenges of our time.

The joint conference NordGlobal 26, “Nordic Solutions through Sustainable Resource Management and Animal Production,” will take place in Steinkjer from 22 to 24 April 2026. This is the fourth conference in a series resulting from the collaboration between Nord University in Norway and the University of Veterinary Medicine and Pharmacy (UVMP) in Košice, Slovakia. The first joint conference was held in Košice in 2017, followed by Bodø in 2019, Košice again in 2023, and now Steinkjer in 2026.

NordGlobal 26 is an interdisciplinary conference focusing on key themes, including sustainable food production and ecosystems, animal welfare, one health, and the circular bioeconomy. By addressing these topics together, the conference highlights the necessity of interdisciplinary approaches to positively influence future development.

I would like to thank all members of the scientific and organizing committees, as well as all presenters and contributors, for their valuable efforts. I also wish to express my gratitude to the Research Council of Norway and the Research and Development Division at Nord University for their financial support of the conference.

Finally, I wish you all a pleasant stay in Steinkjer and a productive and inspiring conference.

Geir Næss

Conference coordinator

Associate Professor and Head of Animal Science, Production, and Welfare Division

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DISCLAIMER

This Book of Abstracts contains only the abstracts submitted for the 4th International Joint Conference on Global Change: Nordic Solutions through Sustainable Resource Management and Animal Production (NordGlobal 2026). The authors are solely responsible for the content of their abstracts, and the views expressed do not necessarily reflect those of the NordGlobal 2026 Scientific Committee.

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SESSION 1: CIRCULAR ECONOMY AND SUSTAINABILITY

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[1]

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Keynote presentation

Circular economy from the perspective of acceleration and resonance

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This keynote examines the concept of the circular economy through the lens of critical social theory, arguing that its transformative potential can only be understood in relation to the structural dynamics of modern growth-oriented societies. While the circular economy is often presented as a technical solution to ecological degradation, this chapter situates it within a broader critique of modernity, drawing on Hartmut Rosa's theory of acceleration and resonance and Thomas Piketty's analysis of inequality. The central argument is that circular economy initiatives operate within a social system characterized by "dynamic stabilization," in which continuous growth, innovation, and expansion are required to maintain institutional stability. Under these conditions, circular strategies risk being absorbed into the very logic they seek to transform, serving efficiency and resource optimization while leaving underlying growth imperatives intact. Piketty's analysis further highlights how such systems reproduce inequality, sustained by dominant narratives that equate growth with progress. From this perspective, the circular economy cannot be reduced to improved recycling, efficiency, or technological innovation. Rather, it must be understood as part of a deeper transformation of societal values and institutional arrangements. Integrating Rosa's concept of resonance, the keynote suggests that a truly transformative circular economy would reconfigure the relationship among economy, society, and nature, shifting from extractive and acceleration-driven systems toward regenerative, relational, and socially embedded forms of production and consumption. By framing the circular economy within a critical-theoretical approach of analysis, diagnosis, and therapy, the keynote positions it as a potential pathway toward post-growth futures. However, realizing this potential requires not only new economic models, but a shift in collective imagination toward sufficiency, social justice, and meaningful human–nature relations.

Keynote presentation

Epizootological situation in Slovakia: Eradication of foot and mouth disease in 2025

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In 2025, several outbreaks of diseases currently listed under the EU animal health law as A diseases occurred in Slovakia. By using the procedures described in the eradication plans, several actions have been introduced. The goal was to stop the spread of these diseases or eradicate them. African swine fever has been present in Slovakia since 2019. In 2025, only one outbreak in domestic pigs and a slow spread in wild boar was confirmed. Proper enforcement of the measures ordered by Veterinary authorities is a key element to have the situation stable. Several outbreaks of Avian influenza were confirmed in Slovakia, and a key element of the threat is the strict biosecurity measures adopted by operators to protect domestic poultry holdings. This must be promoted by an efficient surveillance system in wild birds. After more than 50 years, foot-and-mouth disease was confirmed in Slovakia in 2025. First, it was observed in Hungary and then, after 14 days, also in Slovakia (21.3.2025). The relevant local DVFAs (District Veterinary and Food Administrations) immediately implemented veterinary measures for municipalities, breeders, and hunting associations in the zone in line with national and EU legislation. In total, 6 outbreaks were confirmed in March -April 2025, all in cattle holdings. Emergency measures issued by the Chief Veterinary Officer of Slovakia were enacted, binding across the entire territory of Slovakia under the national Veterinary Care Act, and included many restrictions, with extensive work by the National Disease Control Center (NDCC). After the outbreak was confirmed, stamping out was started as soon as possible in the holding where the outbreak occurred. Emergency suppressive vaccination was carried out in five of the six outbreaks to reduce the spread of the virus among susceptible animals on the affected holding until the animals could be culled and safely disposed of. A total of 8,341 cattle were killed in commercial farms under the supervision of official veterinarians. The bodies of killed or deceased animals were disposed of by incineration or were buried under official supervision. Before moving animals to another holding or to the designated slaughterhouse, samples had to be taken from them within 48 hours prior to transport. Transport was only permitted after favorable test results were received. Critical points determined included the quality of the emergency plan, depopulation procedures for outbreaks, methods for killing animals, movement restrictions within zones and the country, contact farms and preventive killing, financing, communication with different bodies, and the legal basis for adopting the measures. Slovakia asked WOAH on 26.9.2025 for the recovery of the former status of the whole territory of Slovakia as a country free from FMD, where vaccination is not practiced. This has been successfully reached on 31.10.2025.

SESSION 2: SUSTAINABLE FOOD AND FEED RESOURCES

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[2] Created in BioRender. Khanal, P. (2026) https://BioRender.com/5m6cdpy

Keynote presentation

Potential of alternative feed sources in pet nutrition

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Pet populations are increasing globally, putting pressure on the supply of conventional pet food ingredients, which have traditionally been largely derived from slaughter and cereal processing by-products. A continued reliance on conventional ingredients can negatively impact the industry's long-term sustainability. There is a need to understand such impacts also for novel alternative ingredients, including land, water, and circular-economy attributes, which are safe and nutritionally adequate for pets. Insect meals, single-cell protein and fat sources, and underused cereal crops and legumes have emerged as potential solutions. The novel ingredients should optimally offer high protein levels, valuable fatty acids, vitamins, and minerals. However, anti-nutritional factors, potential toxins, and other components often limit palatability, nutrient bioavailability, and overall safety. Therefore, testing of potentially promising novel ingredients should include independent analyses of nutrients, trace and heavy metals, antinutrients and other secondary metabolites, microbiological factors, and xenobiotics (e.g., mycotoxins, pollutants, and other contaminants). An understanding of any processing that the potential ingredient undergoes is also vital. Yet these will not identify all components present, including potential toxins that may pose a risk for cats and dogs. Therefore, any *in vitro* investigations and safety testing in other animal species help establish a general risk level and a potential maximum limit for diets containing a given novel ingredient. These can also help provide background for parameters to test during short acute safety testing and chronic, robustly powered in vivo studies that aim to demonstrate the long-term safety and nutritional adequacy of novel diet ingredients. Optimally, nutritionists, toxicologists, veterinarians, and formulators should all be involved in a thorough process of testing novel ingredients for use in pet foods.

Keynote presentation

Development of a feed formula based on probiotics and humic substances for use in salmonid aquaculture

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The goal was to isolate bacterial strains from the gastrointestinal tracts of rainbow trout *(Oncorhynchus mykiss)* and use them as probiotics to improve the health of farmed fish. Strains isolated from different age categories of rainbow trout were tested *in vitro* for survival under fish gastrointestinal conditions, and an *in vitro* test of antagonism against selected fish pathogens was performed. Finally, the ability of selected potential probiotic strains to colonize the gastrointestinal tract of rainbow trout was determined. All the tests have been carried out in accordance with the current physico-chemical and microbiological conditions of the water environment in rainbow trout farming. Based on the tests, two strains, *Lactobacillus plantarum* R2 Biocenol™ and *Lactobacillus fermentum* R3 Biocenol™, were sent to the Czech Collection of Microorganisms (CCM) at Masaryk University in Brno. Following a successful deposit process, these strains were assigned the numbers CCM 8674 and CCM 8675, respectively, in accordance with the Budapest Treaty on the International Recognition of the Deposit of Microorganisms for the Purposes of Patent Procedure. In the next phase, the selected strains were used to supplement feed and prepare a feed formula in combination with humic substances. The stability of the feed and, consequently, the impact of different environmental conditions on its stability were assessed. Feed supplemented with probiotic bacteria and humic substances was administered to different age groups of rainbow trout. Subsequently, a test of the ability of selected probiotic strains to colonize the gastrointestinal tract of rainbow trout was carried out. This work was supported by the project APVV-24-0348.

Oral presentation

Blue mussels - a promising organism in a circular green-blue feed-food system

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The innovative concept behind BlueMusselFeed is to develop novel feed products from cultivated mussels. Blue mussels efficiently capture carbon, nitrogen, and phosphorus. Their preferred feed is phytoplankton. Thus, using mussels in animal feeds will recycle nutrients back into our food chain. This is particularly important, as eutrophication and ocean acidification are accelerating challenges that need to be addressed. Utilizing such a truly circular economy system will increase the sustainability and self-sufficiency of Norwegian food production and also help address nutrient accumulation in our coastal waters. Specifically, the project aims to partially replace protein-rich feed ingredients such as fish, corn, and soybeans with mussel protein in broiler chicken feed. The biological value of mussel protein is high, as its amino acid composition is attractive and it is highly digestible. Mussel shells can replace limestone from mining, since they are identical in chemical composition ($CaCO_3$), thus recycling carbon rather than introducing new carbon. Broilers are used as model animals for livestock as they have a high protein requirement and a short production cycle. Our trials showed that 2% inclusion of blue mussel protein meal results in similar production and meat results. Extrapolating the inclusion rate to the annual volume of chicken feed in Norway yields a demand of 6000 tonnes of blue mussel protein meal, corresponding to 120000 tonnes of raw, wet mussels. This represents a substantial volume even before including the potential inclusion in feed for farmed fish. Cultivation of blue mussels in Norway today amounts to approximately 3000 tonnes, while the Institute of Marine Research (HI) has reported that less than 10% of Norway´s coastline could yield two million tonnes of blue mussels annually.

Oral presentation

Non-antibiotic feed additives in pig diets: Effects on growth performance and nutrient excretion

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The restriction of in-feed antibiotics has intensified the search for effective nutritional strategies to sustain pig productivity while minimizing environmental impact. The aim of efficient pig production is to maximize growth. This can be aided by the inclusion of specific growth-promoting substances in the feed. Additives examined included amino acids, selected micro minerals, probiotics, acidifiers, and several plant extracts, administered individually or in combination. The inclusion of synthetic forms of limiting amino acids and certain acidifiers has been reported to improve pig performance. It is also possible that the use of probiotics, prebiotics, and several plant extracts may have positive effects on pig performance, but results have been less consistent, and further research is needed in this area. Our research showed the potential of a balanced amino acid intake in the nutrition of growing pigs, with reduced total protein concentration in the feed mixture, to enhance production parameters, lower serum urea levels, and reduce environmental burden by lowering nitrogen excretion in feces. Acidic growth promoters act by either lowering the pH of the intestinal contents or having an antibacterial effect. Acidifiers are often used as alternatives to antibiotic growth promoters because they can create a favorable intestinal environment for beneficial microbes. The addition of a blend of organic acids in our studies improved the growth performance of weaned pigs. Our findings suggest that several feed additives can effectively replace antibiotic growth promoters, supporting both productive performance and environmental sustainability in pig production systems. However, the efficacy of these additives depends on their type, dosage, and interactions within the diet. Further research is recommended to optimize additive combinations and evaluate long-term impacts under commercial conditions.

Poster presentation

From blue resources to yellow protein: Recycling fish sludge using yellow mealworm (*Tenebrio molitor*) larvae

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Fish sludge (FS) management is a major challenge that hinders sustainable aquaculture. This study hypothesized that yellow mealworm (*Tenebrio molitor*) larvae (YML) can be employed to recycle FS while improving the nutritional value of YML. Growth performance, nutritional composition, and heavy metal contents were evaluated in YML exposed to various FS-added diets. The dietary treatments included: flow through FS 25% inclusion (FT25), flow through FS 50% inclusion (FT50), post-biogas FS 25% inclusion (PB25), post-biogas FS 50% inclusion (PB50), flow through FS 12.5% + post-biogas FS 12.5% inclusion (FTPB25), and flow through FS 25% + post-biogas FS 25% inclusion (FTPB50) in wheat bran (WB) or 100% WB as control. Across all dietary treatments, specific growth rate (~6.8–7.8%) and larval biomass yield (~150-259 g) did not differ significantly, indicating comparable growth performance regardless of diet composition. Crude fat (CF) was reduced in all FS diet groups compared to the WB diet (~41%), with a significant difference in FT25 ~35% (P = 0.01), FT50 ~29% (P < 0.001), and FTPB50 ~34% (P = 0.005). In contrast, both the crude protein (CP) and ash contents were higher in YML fed with FS-based diets compared to the WB diet. CP values were significantly increased in the FS diets (~43 to ~50%, P < 0.001) than in WB (~41%). FT50 (4.63%, P = 0.01) and FTPB50 (4.49%, P = 0.03) resulted in higher ash content in YML compared with those fed WB (~3.63%). Energy was significantly lower in the FT50 diet (~24 MJ/kg, P = 0.008) than in the WB diet (~26 MJ/kg). In case of heavy metals, As (~0.04–0.15 mg/kg, P < 0.01) and Hg (~0.02–0.07 mg/kg, P < 0.01) were significantly increased in YML in all FS diets compared to the WB diet (As: 0.003 mg/kg; Hg: 0.0009 mg/kg). Whereas Cd decreased in YML-fed FS-based diets with significant reduction in FT diets (0.015–0.019 mg/kg, P < 0.001) and FTPB diets (0.02–0.023 mg/kg, P < 0.001) compared to those fed the WB diet (0.05 mg/kg), and treatment groups did not have differences in Pb content. This study showed that the inclusion of FS in YML feed could be an efficient way to valorize aquaculture waste into a high-value protein. Although YML fed FS had higher accumulation of certain heavy metals (As ad Hg), the values were way lower than EU threshold levels for feed (As: 2 mg/kg; Hg: 0.1 mg/kg), allowing reasonable inclusion levels of FS-fed YML in the feed.

Poster presentation

From waste to protein and fertilizer: Utilizing fish sludge as a feed ingredient for black soldier fly larvae

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The expansion of the aquaculture industry has increased the production of nutrient-rich fish sludge, which is often underutilized because of environmental and regulatory constraints. At the same time, the insect farming sector continues to search for safe, sustainable, and economically viable feed substrates. This study hypothesizes that 1) fish sludge, upon combining with side-streams from the food and beverage industry, can be successfully recycled as a feed ingredient for black soldier fly larvae (BSFL; *Hermetia illucens*), and 2) the nutritional profile of BSFL can be improved due to high protein content in the fish sludge. Controlled feeding trials will be conducted using two promising side-streams mixed with different proportions of fish sludge, including single-substrate controls. BSF larval survival, growth, development time, and biomass yield will be monitored. The accumulation of heavy metals and minerals in BSFL will also be determined and evaluated in accordance with the EU feed regulation. Frass produced from each treatment will be characterized for plant nutrition (macro- and microminerals), organic matter, and heavy metals. The research, which is part of the NFR project Up-Sludged (Project nr. 358529), will determine the fish sludge inclusion level that results in the best larval performance, evaluate the potential for contaminant transfer, and generate substrate-specific information on frass quality. Overall, the findings will support sustainable waste valorization, promote insect-based feed production, and provide data important for regulatory purposes regarding contaminant transfer and feed safety when incorporating fish sludge into insect farming systems.

Poster presentation

Baltic Sea macroalgae as a sustainable bioresource for food, feed, and circular bioeconomy

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Macroalgae are increasingly recognized as promising bioresources for sustainable food, feed, and biobased production systems. In the Baltic Sea, specific environmental conditions, including low salinity and high nutrient loads, influence both the composition and properties of macroalgal communities, shaping their potential applications. This study presents a comprehensive review of the biotechnological and economic potential of Baltic macroalgae, with particular emphasis on their role in sustainable resource management. Baltic species such as *Ulva* spp. and *Fucus* spp. are rich in valuable compounds, including polysaccharides, proteins, essential fatty acids, vitamins, and minerals, making them suitable for applications in food products, nutraceuticals, animal feed, and cosmetics. Additionally, macroalgae-derived hydrocolloids are widely used in the food and pharmaceutical industries as gelling agents and stabilizers. An important aspect of macroalgae utilization is their capacity to absorb nutrients, such as nitrogen and phosphorus, which supports their application in integrated aquaculture systems (IMTA) and improves resource efficiency. In such systems, macroalgae can function as biofilters, linking environmental processes with biomass production and enabling circular use of nutrients. Despite their potential, macroalgae production in the Baltic Sea remains limited, with current activities concentrated in a few countries and relying largely on wild harvesting or small-scale aquaculture. Key challenges include environmental variability, regulatory constraints, spatial conflicts, and biomass quality. Overall, Baltic macroalgae represent a multifunctional resource that can contribute to sustainable food and feed systems, circular bioeconomy, and more efficient use of marine resources in coastal regions.

Poster presentation

Partial replacement of soybean meal with yellow mealworm (*Tenebrio molitor*) larvae protein: Effects on production performance, egg quality, and jejunal histomorphology in laying hens

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The increasing global demand for animal-derived protein necessitates identifying sustainable alternative feed ingredients for livestock production. Edible insects, particularly yellow mealworm (*Tenebrio molitor*, YM) larvae, have emerged as promising protein sources due to their high nutritional value, favorable amino acid composition, and lower environmental footprint compared with conventional protein ingredients such as soybean meal (SBM). This study evaluated the effects of partially replacing SBM with YM larvae meal on production performance, egg quality traits, and jejunal histomorphology in laying hens. A total of 96 Lohmann White laying hens (16–28 weeks of age) were randomly allocated to three dietary treatments: TM0, TM25, and TM50, with a control diet containing SBM, 25% and 50% replacement of SBM protein with YM larvae meal, respectively. Each treatment consisted of eight replicate cages, each with four hens. Body weight, feed intake, egg production, and egg quality parameters were recorded throughout the experimental period. At 28 weeks of age, jejunal tissues were collected for histomorphometric evaluation. Final body weight was significantly higher in hens fed TM25 and TM50 diets compared with the control group (P = 0.008). Egg weight was also increased in hens receiving the TM50 diet (P = 0.002), whereas feed intake, feed conversion ratio, and laying percentage were not significantly affected by dietary treatment (P > 0.05). Dietary inclusion of mealworm larvae significantly increased egg shape index and yolk color (P < 0.001). Histomorphometric analysis revealed greater longitudinal muscularis externa thickness (P = 0.034), submucosa thickness (P = 0.011), villus height (P = 0.020), and crypt depth (P = 0.023) in hens fed mealworm-based diets, while the villus height-to-crypt depth ratio remained unchanged. These findings indicate that yellow mealworm larvae meal can partially replace soybean meal in laying hen diets without compromising production performance while promoting favorable intestinal morphological development. Gene expression and muscle quality analyses are currently ongoing and will further elucidate the physiological responses associated with dietary mealworm inclusion.

Poster presentation

Impact of dietary yellow mealworm (*Tenebrio molitor)* larvae inclusion on hepatic lipid metabolism in laying hens

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The growing demand for animal-derived food products and the environmental impact associated with conventional feed ingredients, particularly soybean meal, have intensified the search for sustainable alternative protein sources in poultry nutrition. Insects have emerged as promising candidates due to their high nutritional value, efficient feed conversion, and lower environmental footprint. Among these, the yellow mealworm (*Tenebrio molitor*) has received increasing attention as a potential ingredient in poultry diets. This study aimed to evaluate the effects of partial replacement of soybean meal with *T. molitor* meal on liver morphology and lipid metabolism in laying hens. A total of 96 Lohmann LSL-Classic hens were randomly allocated to three dietary treatments consisting of eight replicates with four hens each. The treatments included a control diet without insect meal (TM0), and diets in which soybean meal was replaced with *T. molitor* meal at 25% (TM25) and 50% (TM50). The feeding trial was conducted from 16 to 28 weeks of age under controlled environmental conditions. Production performance parameters were recorded throughout the experimental period as part of the feeding trial. At the end of the experimental period, liver samples were collected for histological and molecular analyses. Liver tissues were processed for histology, and sections were stained using hematoxylin and eosin to evaluate liver morphology and lipid vacuolation. Histological slides have been prepared, and digital image analysis is underway to quantify liver morphological characteristics. The histological observations will guide the selection of lipid metabolism–related genes for subsequent molecular analysis by quantitative real-time PCR. This study aims to provide insights into the physiological responses of laying hens to insect-based diets and contribute to the evaluation of *T. molitor* meal as a sustainable protein source in poultry production systems.

Poster presentation

Comparative growth performance and bioconversion efficiency of black soldier fly *(Hermetia illucens)* on diverse organic waste

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The rapid growth of organic waste worldwide and the demand for sustainable upcycling solutions in a circular economy call for new ways to recycle it effectively and sustainably. Bioconversion of organic waste into high-value biomass using the larvae of the black soldier fly (BSF) (*Hermetia illucens*) provides an innovative and efficient method for managing waste while producing a sustainable, high-quality source of feed for animals. The study highlighted the influence of the type of organic waste (substrate) on the overall growth and development of BSF larvae, including bioconversion rate and life history parameters. The various food sources rich in carbohydrates (such as noodles, bread, potato peel, and cooked rice) and protein or energy sources (such as soybean, groundnut, molasses, and yeast) were included as feeding substrates in the experiment. There was a marked variation in larval growth characteristics, with larvae fed the noodles (80%) + soybean (20%) diet achieving the highest larval weight (~0.26 g) and demonstrating improved biomass accumulation. In contrast, larvae that were fed a chicken feed (80%) + molasses (20%) diet had the greatest pupal weight (~0.17 g), suggesting unique nutritional requirements for optimal development before metamorphosis. Bread (80%) + groundnut (20%) supported the longest lifespan, whereas potato peel-based diets resulted in the shortest lifespan. These results further suggest that substrate composition for BSF larvae should be adjusted to reflect specific production needs. Overall, this study shows that BSF larvae exhibit extreme plasticity, yet achieving maximum yield will require incorporating strategically blended waste streams with varying nutritional compositions.

Poster presentation

Assessment of the potential of black soldier fly larvae as an alternative to imported protein sources in poultry feed in Chitwan, Nepal

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The demand for animal protein is rapidly increasing in Nepal. Among the livestock sector, poultry has emerged as the most commercially dynamic, driven by a shift towards a feed-intensive production system. Thus, understanding how efficiently feed is converted into poultry products and the viability of using alternative feeds, such as Black Soldier Fly Larvae (BSFL), is essential for assessing the sector's productivity and sustainability. This study was conducted in the Chitwan district, the largest poultry production hub in Nepal. Primary data were collected through household surveys of 120 farm households and three key informant interviews, each with technicians from poultry feed companies and BSFL producers. In contrast, secondary data were obtained from the Central Bureau of Statistics of Nepal and relevant journal articles. A material flow analysis was conducted to examine the flow of poultry feed within the industry, considering the inclusion of BSFL at 5%, 10%, and 15%. The findings reveal that Chitwan produces approximately 700 metric tons of poultry feed per day, accounting for only 30.45% of the district's total feed consumption, while the remaining 69.55% is supplied from other districts of Nepal. Of the total feed consumed, 69.46% of poultry feed mass is used for broiler production and 30.54% for layer production. The study further shows that the combined meat and egg output accounts for 50.7% of total feed consumed, yielding an overall feed conversion ratio of 1.97. Meat accounts for 40.5% of the total desired output, while eggs constitute 59.5%.

Poster presentation

Market potential of black soldier fly meal for poultry feed management in Rupandehi District of Nepal

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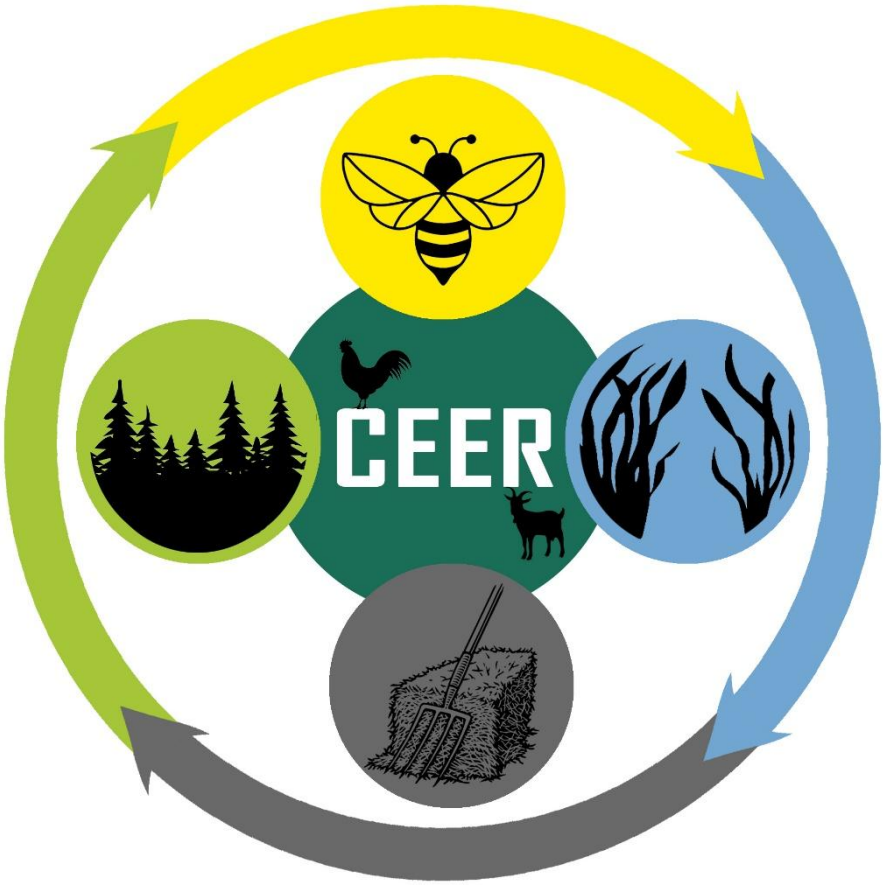
The poultry sector in Nepal is highly reliant on imported feed materials, which puts businesses at risk of supply and price fluctuations. There is a growing need for an alternative local protein feed source, and black soldier fly *(Hermetia illucens)* offers a promising solution. This research aims to investigate the poultry farmers' willingness to pay (WTP) for black soldier fly (BSF) meal and identify its key determinants. Simple random sampling was done to collect primary data from 108 registered poultry farmers of Rupandehi district. The poultry farmers' willingness to pay for BSF-integrated feed was analyzed using a double-bounded dichotomous-choice contingent valuation method, and its determinants were assessed using maximum-likelihood interval regression. Classification and Regression Tree (CART) analysis captured non-linear patterns and farmer segmentation. Results show the mean WTP of NRs. 83.47 per kg, representing a premium of approximately 16% above the prevailing average feed price. 29.6% of farmers accepted higher bids (Nrs. 80 – 90 per kg; YY), suggesting strong demand in one-third of the sample. Attitude towards insect-based protein ($P = 0.003$), trust in feed companies ($P = 0.010$), and cooperative membership ($P = 0.003$) were the strongest positive determinants of WTP. Broiler farming ($P = 0.012$) and training received ($P = 0.035$) were negatively associated with WTP. The CART model identifies trust score as the primary splitting variable, followed by training status and purchase intention, segmenting farmers into four distinct WTP profiles. These findings suggest an economically viable market entry condition for BSF-integrated feed in Nepal. Market segmentation strategies should prioritize layer and local bird farmers, who exhibit higher WTP than broiler producers.

SESSION 3: CEER PROJECT WORKSHOP

NORDGLOBAL-26



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[3] Logo of the CEER project, Source: https://site.nord.no/ceer/

Oral presentation

The CEER project in numbers

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The CEER (Circular Economy via Education and Research) project is a collaborative initiative between Nepal and Norway aimed at promoting circular livestock production by building capacity in alternative and novel feeding resources. The project has significantly contributed to academic mobility, curriculum development, and research capacity building. To date, three PhD students have completed research stays at Nord University (NU), Norway, and completed their laboratory training and coursework. Additionally, two full-degree Master students have completed their MSc in Biosciences at NU, while four others are currently conducting research and are expected to defend their theses in June 2026. The project has also supported 16 Master-level exchange students (eight from Kathmandu University, KU, and eight from AFU) who participated in a six-month academic program in Norway. In curriculum development, the course ESEE 534: Resource Recycling and Circular Bio-economy (3 credits) has been approved at KU. At AFU, Insects as Food and Feed (ENT 617; 3 credits) and Sustainable Livestock Nutrition and Feeding (3 ECTS) courses have been approved at the departmental level and are under review by the Academic Council. The project has resulted in ten peer-reviewed publications, with additional manuscripts under review, and 18 abstracts presented at international conferences. Research activities include evaluating insect species, freshwater halophytes, and marine algae as alternative feed resources. Furthermore, a research facility for black soldier fly larvae has been established at AFU, supporting both academic research and emerging start-ups in Nepal. The project was funded by the Norwegian Agency for International Cooperation and Quality Enhancement in Higher Education (HK-dir) under the Norwegian Partnership Program for Global Academic Cooperation (NORPART) with support from the Norwegian Ministry of Education and Research (MER), and the Ministry for Foreign Affairs (MFA) (Project: 2021/10345).

Oral presentation

Invasive pest threats on food security, livelihood, and biodiversity: Advancing nature-based agroecological strategies for sustainable solutions

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Nepalese agriculture is threatened by the climate crisis, drought, erratic and heavy rainfall, agricultural intensification, high input costs, labor shortages, and many other biotic threats. Invasive insect species are biotic non-native threats to agriculture in both traditional and modern farming systems in Nepal. Lower food production, escalating economic losses, increased human and environmental risks, and disruption of ecosystem functions are associated with invasive threats. Over the past few decades, most South Asian countries, including Nepal, have been threatened by invasive species in major agri-commodities, which ultimately affect food security, economic losses, livelihoods, and environmental challenges. The invasive species threats and associated crops in Nepal are: *Phthorimaea operculella in potato*, fall *Spodoptera frugiperda* in corn, *Tuta absoluta* in tomato, *Bactrocera minax* in sweet orange, and *Thrips parvispinus* in chili. Yield losses range from 20-35% in maize, and more than 50% an unmanaged tomato field. Although yield loss assessment of other invasive species, including their potential threats and future consequences, has not yet been recognized and systematically studied. Reduction in crop production has affected millions of smallholder farmers, while the increased use of pesticides to control invasive species has further intensified environmental challenges. Pesticide use in Nepal is increasing by 10-20% per year, with imports totaling 1664 ai MT in 2023/2024. Even though Nepal uses only 396g ai/ha of pesticides, health and other associated risks associated with pesticide use remain a serious concern. Therefore, alternative and sustainable pest management approaches have been widely recognized. The Food and Agriculture Organization has identified three pillars for the sustainable management of invasive species: Prevention, Preparedness, and Response. However, in Nepal, prevention and preparedness measures have not been well implemented, with minimal attention paid to response strategies. Under the response category, nature-based agroecological strategies are widely promoted by the government and research institutions in Nepal to minimize the pesticide crisis in agriculture. Agroecological strategies are economical, environmentally friendly, and locally available, and are popular among smallholder farmers in Nepal. Some examples include habitat, crop, and soil management practices that maximize ecological benefits in agriculture. Augmentation and conservation of biological control agents, adoption of local and traditional practices, including other integrated pest management approaches, are other sustainable pest management strategies. Consolidated, problem-focused management efforts at local, provincial, and national levels can effectively address current invasive pest challenges in agriculture.

Oral presentation

Determinants of the adoption of climate-friendly practices in dairy cattle farming

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Climate change is causing serious impacts on the dairy sector through heat stress, water scarcity, and increased disease prevalence. However, the dairy sector also contributes considerably to global greenhouse gas emissions through methane gas production. The adoption of climate-friendly practices (CFPs) in dairy cattle farming enhances milk productivity while reducing adverse environmental impacts. This study examined the socio-economic factors influencing the adoption of CFPs among dairy cattle farmers in Bagamati Province, Nepal. Using a multistage sampling technique, 198 dairy farming households from Chitwan, Dhading, and Makwanpur districts were surveyed in March-April 2025. An adoption index was constructed based on 20 CFPs across five management categories. Farmers were categorized into low (24.75%), medium (55.35%), and high (19.70%) adopters of CFPs. Beta regression analysis reveals that five factors significantly influence the adoption of CFPs by dairy cattle farmers. The perceived impact of climate change on cattle rearing and net return per head of cattle are the strongest positive determinants ($P < 0.01$). Cattle milk sales as the primary source of income and land allocated to cattle farming are also significantly associated with the adoption index ($P < 0.05$). Additionally, subsidies received by farmers show a significant positive effect ($P < 0.10$) on the adoption of CFPs. These findings suggest that financial viability and institutional support mechanisms are more important than demographic factors in driving CFPs adoption. Therefore, enhancing climate risk awareness among farmers, ensuring profitable returns, and strengthening technical support mechanisms are vital to promoting the adoption of CFPs in dairy cattle farming.

Oral presentation

ICT-enabled agricultural extension for sustainable bioproduction: Evidence from Nepal

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Sustainable bioproduction relies on climate-smart agricultural practices, as well as on resource-efficient and mechanized agriculture. Nepal, where over 60% of the population is engaged in agriculture, continues to face challenges such as land fragmentation, smallholder dominance, and limited technology adoption. A lack of adequate knowledge and information across various aspects of agriculture is limiting the agricultural sector's growth. In this context, ICT-based agricultural extension may play a crucial role in enhancing sustainable bio-production, a notion now supported by various governmental and non-governmental organizations. To understand farmers' perceptions, knowledge, and access to ICT tools, a study was conducted in Jhapa, Kapilbastu, and Bardiya, Nepal, among 390 paddy farmers, as these areas are considered super-zones for paddy cultivation. A survey, focus group discussions, and observations were conducted to collect data, and appropriate statistical analyses were applied to interpret the findings. The results showed a moderate-to-high level of innovativeness and a scientific and economic orientation among the farmers, indicating their readiness to adopt technology. Most farmers owned basic ICT tools rather than more advanced tools. Farmers with better access to ICT tools were more likely to adopt improved agronomic and climate-smart practices. Farmers perceived that ICT tools provide real-time weather information, mechanization guidance, crop management advisories with market information, and facilitate rapid, easy information sharing to support better decision-making. Younger respondents were more likely to use ICT tools, particularly for marketing and within the agricultural value chain. The main constraints to ICT use included poor digital literacy, limited infrastructure, affordability issues, and the high level of technical knowledge required to use tools. Increasing awareness, providing training, and establishing institutional linkages can enhance farmers' efficiency and participatory learning. Incorporating digital extension advisory services in an inclusive and coordinated manner can significantly boost sustainable bioproduction, resilient food systems, and environmentally responsible farming practices in Nepal.

SESSION 4: ONE HEALTH

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[4] Created in BioRender. Khanal, P. (2026) https://BioRender.com/dkppqvn

Keynote presentation

Behavior change in livestock systems: Targets, theories, stakeholders, outcomes, evidence, and future directions

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Human behavior change in livestock systems is fundamental for achieving sustainable, ethical, and productive animal agriculture. Individual interventions can yield rapid, measurable changes in behavior, but these are often limited to personal or farm-level outcomes. Community and systems interventions—though slower to manifest—can produce societal benefits such as better-informed public attitudes to farm animal welfare and social license for farmers and farm production methods. The focus here is primarily on individual interventions. Attitudes, norms, motivation, and capability shape farmer behavior in livestock management, which, in turn, leads to improved livestock welfare and productivity. Many theories, mainly developed to address health-related behaviors, are relevant to human behavior in managing and interacting with livestock. Such theories help identify the relevant human variables that need to be targeted. These variables can be considered as a hierarchy from social structures and constraints through to values, attitudes, and norms to behavior. Empirical evidence from experimental, on-farm, and post-farm-gate studies demonstrates the successes and limitations of current interventions. Stockperson training programs that have utilized experimental and on-farm research have been developed for use on-farm in the pork and dairy industries and have demonstrated effectiveness in bringing about behavior change leading to improved animal welfare and productivity. While there has been some discussion of the cost-benefits of targeting human factors in intensive farming contexts, the implications for extensive systems, the impact of changing of technology and automation need further work as does the need for robust post-farm-gate research, monitoring, and evaluation. Integrating these individual approaches with community-level approaches, engagement with relevant stakeholders, and aligning them with policy and market incentives, is essential for mobilizing sustainable livestock systems reform.

Keynote presentation

Wings, vectors, and pathogens: Birds, bats, and one health implications of vector-borne pathogens

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Flying vertebrates, primarily birds and bats, occupy a unique niche in global ecosystems. Their capacity for powered flight allows them to traverse vast distances and bypass geographical barriers, making them pivotal players in the global dynamics of infectious diseases. This plenary session explores the complex interplay between these hosts, the vectors they support (such as ticks, mosquitoes, and nycteribiid flies), and the pathogens they transmit, emphasizing the critical "One Health" perspective. As long-distance migrants, birds act as "flying reservoirs" and transporters of infected vectors, facilitating the intercontinental spread of pathogens such as West Nile virus, Usutu virus, and *Borrelia* species. Conversely, bats, with their specialized immune systems and unique social structures, host a diverse array of viruses with significant zoonotic potential. However, a crucial distinction exists in their vector ecology. Unlike the generalist parasites often found on birds, bats harbor many strictly host-specific ectoparasites with a very limited host spectrum. This high degree of specialization suggests that the direct transmission of certain vector-borne pathogens from bats to humans may be naturally constrained, as these specialized vectors rarely bite non-chiropteran hosts. Anthropogenic drivers, including climate change and habitat loss, are increasingly forcing these animals into closer proximity with humans and livestock. This shifting interface enhances the risk of "spillover" events, yet the host-specificity of bat parasites adds a layer of complexity to risk assessment. This presentation analyses how vectors exploit the mobility of their hosts and how environmental shifts are expanding their geographic ranges. This publication is the result of the project KEGA 007UVLF-4/2025 funded by the Ministry of Education, Research, Development, and Youth of Slovakia.

Oral presentation

The *pRAS* plasmid family of *Aeromonas salmonicida* shares core backbone modules with other conjugative plasmids that pose a global threat in the spread of antimicrobial resistance

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Conjugative plasmids are self-replicons that carry complete genetic information essential for their self-transfer and replication in bacterial cells. As such, gene clusters that form the core backbone modules encode genetic information relevant to their self-transfer, replication, maintenance, and to ensuring stable inheritance. Despite this, gene clusters that form the backbone modules of the pRAS plasmids found in Aeromonas salmonicida, the causative agent of furunculosis in salmonids, have not been characterized. Thus, we sought to identify the gene clusters that form the backbone modules of some pRAS family plasmids, with a view to characterizing their conjugative apparatus. Using archived isolates of A. salmonicida collected prior to the mid-1990s, before Norway introduced rigorous vaccination programs that significantly reduced furunculosis cases and antibiotic use to almost zero in Norwegian aquaculture, our findings show that the large pRAS plasmids encode three different modules in their backbone structures responsible for the self-transfer, while small plasmids function as mobilizable agents needing the help of large plasmids for transfer. Module I mainly comprises virB genes that form the canonical type IV secretory system (T4SS) that forms the nanomachinery needed for plasmid DNA transfer. Module II consists of genes associated with plasmid ssDNA transfer, replication, maintenance, and ensuring stable inheritance in recipient cells after conjugative transfer from donor cells. Finally, module III encodes transposons that copy and paste antimicrobial resistance (AMR) genes and efflux pumps associated with multidrug resistance (MDR) among different bacterial species. The high similarity in the composition and organization of gene clusters that form the backbone modules of the pRAS plasmids with genes found in plasmids of other bacterial species in different geographical regions in the world suggests that plasmid-mediated spread of AMR and MDR could pose a significant One Health Challenge globally.

Oral presentation

Giardia in the forest: Wild cervids and One Health

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In recent years, southern Norway has experienced a marked decline in moose (*Alces alces*) calf recruitment, alongside increased reports of disease, poor growth, and calf mortality. Surviving calves are frequently described as small and in poor body condition, indicating that factors affecting gastrointestinal function and nutrient uptake may play an important role. Identifying pathogens that may contribute to reduced growth and health is, therefore, a key priority. The “Elgkalven Trampe” project aims to facilitate the submission of moose calves found dead or culled due to illness, enabling detailed health investigations. This presentation focuses on preliminary results from parasitological examinations, with particular emphasis on the occurrence and potential significance of *Giardia duodenalis*. Fecal samples from moose calves collected during 2024 and 2025 were examined for gastrointestinal parasites. *Giardia duodenalis* was by far the most frequently detected parasite in both years, identified in 22 of 45 calves examined in 2024 and in 19 of 52 calves in 2025. These findings indicate that *G. duodenalis* is common among moose calves in this region. Infections with *Giardia* are known to cause diarrhea, malabsorption, and impaired weight gain in a range of host species. In moose calves, reduced nutrient uptake associated with giardiosis may contribute to poor growth and lowered body condition, particularly during periods of nutritional stress or when combined with other physiological or environmental challenges. Multilocus genotyping of *Giardia* isolates revealed the presence of zoonotic assemblages. This demonstrates that moose calves can carry *Giardia* genotypes commonly associated with humans and domestic animals, highlighting possible transmission routes across host species. While the clinical impact of *Giardia* infection in free-ranging moose remains incompletely understood, the high prevalence observed suggests that giardiosis may represent an underappreciated factor influencing calf health, growth, and survival in southern Norway.

Poster presentation

Evaluation of antimicrobial potential of seaweed extracts against major bacterial pathogens of Atlantic salmon (*Salmo salar)*

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Aquaculture continues to expand globally, with Atlantic salmon (*Salmo salar*) ranking among the most economically valuable fish species. Despite this, salmon farming faces significant challenges from bacterial pathogens such as *Aeromonas salmonicida*, *Yersinia ruckeri*, *Vibrio anguillarum, Moritella viscosa, and Tenacibaculum maritimum*, resulting in significant economic losses and a growing threat of antimicrobial resistance (AMR), highlighting the urgent need for sustainable and eco-friendly alternatives. This study aims to investigate the *in vitro* antimicrobial potential of selected seaweed extracts against key bacterial pathogens affecting Atlantic salmon. Seaweeds such as *Ulva* spp. (green), *Fucus vesiculosus* and *Ascophyllum nodosum* (brown), *Furcellaria lumbricalis* and *Chondrus crispus* (red) will be collected and extracted using aqueous and organic solvents. Phytochemical screening will be used to identify bioactive compounds, such as phenols, tannins, flavonoids, terpenoids, and saponins, using the Folin-Ciocalteu and aluminum chloride colorimetric methods. The disc diffusion method will be used to assess the antibacterial activity, while the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) will be determined using microdilution assays. All the experiments will be conducted in triplicate, with positive and negative controls, and the results will be statistically analyzed using one-way ANOVA. The study is expected to identify promising seaweed extract species and extraction methods with potential inhibitory effects against salmon bacterial pathogens. Findings will address an important knowledge gap in salmon health management and contribute to innovative, nature-based strategies to reduce antibiotic use and lower AMR risks, thereby supporting sustainable and responsible salmon production systems.

Poster presentation

Caring under pressure: Self-perceived workload and sense of meaning in dairy farmers, and associations with animal care and welfare improvements

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Norwegian dairy farming has undergone major structural changes over the past two decades, with fewer farms, larger herds, and increased technological complexity. While national milk production remains stable, individual farmers now manage more animals and face greater operational demands. Previous research shows that farmer well-being is closely linked to animal welfare. However, there is limited research on whether farmers' perceived workload and sense of meaning may be influencing animal care. The major objectives were to evaluate 1) the association between farmers' self-reported work hours and perceived workload, 2) the association between perceived workload and reporting having enough time and energy available for animal care tasks, and 3) the association between farmers' perceived meaningfulness of their work and their intentions to implement animal welfare improvements on the farm within the next two years. The study uses cross-sectional survey data collected jointly by the WelCow and FarmeMERGE projects (N = 350 Norwegian dairy farmers, response rate of 8.6%). Participants were randomly selected from selected members of The Norwegian Dairy Herd Recording System. The survey included questions on work conditions, workload perception, meaningfulness , and animal welfare practises. Descriptive statistics and regression analyses will be conducted using R. By integrating occupational psychology and animal welfare science, this study adopts a One Welfare perspective, emphasizing the interconnectedness of human and animal well-being. Findings may inform advisory services and agricultural policy by highlighting how psychological and organizational factors shape animal care. Understanding farmers as caregivers operating under structural and economic pressure may contribute to more sustainable welfare-oriented dairy production systems.

Poster presentation

Coinfection of two lysogenic bacteriophages in *Aeromonas veronii* isolated from catfish pond sediments

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Bacteriophages are viruses that infect bacteria. They are ubiquitously found in nature. Their mode of infection can be broadly classified into lytic phages and lysogenic phages. In aquaculture the lytic phages are considered to be important and useful for the killing of pathogenic bacteria. However, the lysogenic phages will infect bacteria and remain in bacterial genome, only becoming pathogenic when the conditions become favorable to kill the bacteria. In the current study, we demonstrate co-infection of two types of phages infecting *Aeromonas veronii* isolated from pond sediments. Using whole genome sequencing, we demonstrate that *A. veronii* was infected by two different phages. The first phage is an Inovirus, which was integrated at three locations in the bacterial genome. The second phage was only found at one location in the bacterial genome, and it was designated as *A. veronii* AhS5. Based on these findings, we demonstrate that the Inovirus phage encoded all the relevant proteins that are essential for its replication. BLAST analysis showed that the *A. veronii* AhS5-24 phage was highly similar to *Aeromonas* Phage phiARM81ld_KT898133. Both phages encoded terminase, head protein, plate protein, tail protein, lysin protein, and other phage proteins. This study shows that bacteria can be vulnerable to multiple phage infections.

Poster presentation

Prevalence of bacterial pathogens in rainbow trout farming during the year and determination of antimicrobial susceptibility

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Important bacterial pathogens of fish include *Yersinia ruckeri* and members of the genus *Aeromonas*, such as *A. sobria*, *A. veronii*, *A. hydrophila,* and *A. salmonicida.* These bacteria are associated with high mortality and significant economic losses, especially in salmonid farming, e.g., rainbow trout, brown trout, Atlantic salmon, or Chinook salmon. Before stricter regulations on antibiotic use in aquaculture were introduced, antimicrobial agents were frequently administered without proper diagnosis and at subtherapeutic doses, which contributed to the emergence and spread of antimicrobial resistance. This study aimed to monitor the prevalence of selected bacterial pathogens in rainbow trout farming throughout the year and to evaluate the antibacterial resistance of the isolated strains. Seasonal sampling of intestinal contents of rainbow trout (*Oncorhynchus mykiss*) was carried out in spring (March), summer (August), autumn (October), and winter (January). The results showed the occurrence of seven *Y. ruckeri* isolates, five *A. sobria*, five *A. hydrophila,* and thirteen *A. salmonicida* subsp. *masoucida* isolates from the intestinal contents of rainbow trout (n = 80). The genus *Aeromonas* was more prevalent during warmer periods, whereas *Y. ruckeri* occurred more frequently in colder seasons. Antimicrobial susceptibility was determined by disk diffusion. The highest resistance was observed to ampicillin (100.0 %) and sulfisoxazole (71.4 %) in *Y. ruckeri* and to ampicillin (100.0 %), amoxicillin (97.1 %), and sulfisoxazole (85.3 %) in *Aeromonas* spp. Overall, the highest susceptibility among all isolates was observed for tetracycline, streptomycin, and trimethoprim-sulfamethoxazole. These findings highlight the importance of continuous monitoring of bacterial pathogens, both for preventing fish disease outbreaks and for guiding appropriate antimicrobial therapy to limit the spread of resistance. This work was supported by the project APVV-24-0348.

Poster presentation

Brown macroalgae as a sustainable alternative to antibiotics in pig production: Implications for gut health and performance

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The intensification of pig production and early weaning practices has increased reliance on in-feed antibiotic growth promoters (AGPs) to mitigate postweaning stress, gut dysbiosis, and disease. However, regulatory bans on AGPs and pharmacological zinc oxide in the European Union, driven by concerns over antimicrobial resistance (AMR) and environmental impacts, have accelerated the search for sustainable alternatives. This review evaluates the potential of brown macroalgae (BMA) as a natural strategy to improve pig health and performance during the critical weaning period. BMA are rich in bioactive compounds, including polysaccharides (laminarin, fucoidan, alginate), polyphenols (phlorotannins), carotenoids (fucoxanthin), and bioactive peptides, which exhibit antimicrobial, antioxidant, anti-inflammatory, and immunomodulatory properties. These compounds can enhance gut health by modulating microbiota composition, improving intestinal barrier integrity, and promoting nutrient digestion and absorption. Evidence from in vitro and in vivo studies suggests that BMA supplementation may reduce pathogenic bacteria such as *Escherichia coli*, increase beneficial microbial populations, and mitigate postweaning diarrhea. Despite these promising benefits, challenges remain regarding variability in bioactive composition due to species, season, and processing methods, as well as limitations related to low digestibility, the presence of antinutritional factors, and the accumulation of heavy metals. Optimal inclusion levels and effective extraction techniques are critical to maximizing benefits while minimizing risks. Overall, BMA represent a promising functional feed additive for reducing antibiotic dependence in pig production. Future research should focus on standardizing processing methods, establishing dose–response relationships, and elucidating mechanisms of action to enable their practical and safe application in commercial systems. This work was funded by the European Union's Horizon European Research and Innovation Program under the Marie Skłodowska-Curie Grant Agreement No. 101147079 for Gizaw D. Satessa.

SESSION 5: SUSTAINABLE ECOSYSTEMS

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[5] Created in BioRender. Khanal, P. (2026) https://BioRender.com/5m6cdpy

Keynote presentation

An ecologist's perspective on sustainable ecosystems: Do we have the right data, and do we have the right indicators?

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Across the globe, anthropogenic pressure is increasingly affecting terrestrial and marine ecosystems, with changes in land use and the extraction of biological resources being the dominant factors. This situation has resulted in a high number of threatened species and habitats, and the loss of important and highly valued aspects of biodiversity. To measure and potentially mitigate the environmental sustainability of biological resource use, we often rely on a set of local and global indicators designed to assess changes in the state and functioning of different aspects of biodiversity. Such indicators might focus on different levels of biological organization, including genes, species traits, populations, communities, and ecosystems. In this talk, I will discuss a suite of indicators currently used across different levels of biological organization that can be applied in global or local settings. I will focus on their ability to deliver timely, meaningful information on sustainability. Then I will focus on the data needs and highlight important data gaps. I will end with a discussion of how open science practices are vital for the future development of indicators that can be updated regularly with empirical data, and how they are essential if we want indicators produced in a transparent and reproducible way.

Oral presentation

Tree diversity and restoration success of degraded forests: An experimental approach

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Forests are increasingly threatened by land degradation, deforestation, and the impacts of climate change. Restoring these degraded landscapes is crucial for environmental protection and the well-being of the communities that depend on them. One promising strategy for restoration is planting multiple tree species, which can help mitigate these issues. However, various challenges have slowed the growth of young trees, hindering restoration efforts. This study aims to evaluate how tree species diversity and management techniques, such as artificial sheltering and watering, can enhance forest restoration. The research focused on 3 primary objectives: (I) to investigate the effects of varying levels of tree diversity and artificial shading on the survival and performance of tree species; (II) to analyze how these factors influence the growth and productivity of young trees; (III) to examine how morphological leaf traits respond to shading and diversity. Conducted through controlled experiments in Ethiopia (IDENT-Ethiopia), the study revealed that higher species diversity significantly enhances seedling survival and productivity. Shading improved survival rates and physiological health, particularly during early seedling development. These findings suggest that implementing mixed-species plantations along with appropriate sheltering and irrigation practices can enhance the success of forest restoration efforts. The results provide valuable insights into effective restoration strategies for degraded ecosystems, fostering biodiversity and promoting long-term environmental sustainability.

Poster presentation

Effect of yellow mealworm (*Tenebrio molitor*) larval frass on germination and growth attributes of coriander (*Coriander sativum* L.)

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Modern agriculture has led to increased environmental issues, such as soil degradation, nutrient leaching, and disruption of soil microbial communities, due to the intensive use of synthetic fertilizers. Consequently, there is growing interest in sustainable and circular agricultural systems that use organic waste products as alternative nutrient sources. Insect frass, a by-product of insect farming, consists of insect excreta, feed residues, and exoskeleton fragments and has recently attracted attention as a potential organic fertilizer with high nutrient content and bioactivity. The yellow mealworm (*Tenebrio molitor*) larval frass is rich in nitrogen, phosphorus, organic matter, and chitin, which can enhance plant growth and soil health. This study investigated the effect of different application rates of yellow mealworm larval frass on the germination, growth, and biochemical properties of coriander. The experiment was conducted under controlled conditions at Nord University, Steinkjer, Norway. The experiment was arranged in a completely randomized design with six treatments, each consisting of 0%, 1%, 2%, 3%, 4%, or 5% frass added to the growth substrate (v/v). The germination parameters, including germination percentage, average germination time, days to germination, and days to 50% germination, were recorded. Growth and morphological attributes, including plant height, leaf number, root length, and biomass, were measured during the plant growth period. In addition, physiological and biochemical parameters such as chlorophyll content, total phenolic content, antioxidant activity, plant and soil C: N ratios, substrate pH, and water-holding capacity were measured. The ongoing study aims to determine the optimal application rates of frass to promote coriander growth and assess the feasibility of mealworm frass as a sustainable organic fertilizer in the production system.

Poster presentation

Evaluation of soil fertility and nutrient retention in agricultural soils of Upper Mustang, Nepal

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Soil quality is essential for sustainable agriculture as it influences nutrient availability, crop productivity, and long-term soil fertility. Different land-use systems, such as wheat, potato, apple orchards, and grazing lands, can significantly affect soil properties and nutrient retention capacity. Understanding these differences is important for improving soil management practices. Therefore, this study was conducted to identify variations in nutrient status and to evaluate soil fertility across different land-use types in the Upper Mustang region of Nepal. In this study, 100 soil samples were collected (50 bulk and 50 loose samples) from wheat fields, potato fields, apple orchards, and grazing lands in Upper Mustang at an altitude of 3,810-3,840 m above sea level during April, 2025. Soil samples were collected using standard procedures. The samples were air-dried, ground, and passed through a 2 mm sieve before laboratory analysis. Soil pH, organic matter, total nitrogen (N), available phosphorus (P_2O_5), available potassium (K_2O), and cation exchange capacity (CEC) were determined using standard laboratory methods. Descriptive statistics were calculated to summarize soil properties. Pearson correlation analysis was performed to examine relationships among soil parameters, and regression analysis was conducted to evaluate the influence of key soil properties (e.g., organic matter) on nutrient availability and CEC. Based on the available results so far, the mean soil organic matter and soil organic carbon were 4.83 ± 2.85% and 2.80 ± 1.65%, respectively, indicating variation among land-use systems. Laboratory analysis for N, P_2O_5, K_2O, and CEC is underway. It is expected that significant differences in soil properties will be observed among land-use types driven by differences in management practices and vegetation cover. The findings will provide baseline information on soil fertility status and nutrient distribution patterns. They will help improve nutrient management strategies and support sustainable soil management by enabling more efficient nutrient cycling and better land-use planning.

Poster presentation

Evaluation of the effectiveness of the wastewater treatment system at Dhulikhel Hospital in Nepal

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Wastewater treatment systems are essential for preventing the discharge of harmful pollutants into the environment and protecting public health. Hospital wastewater often contains a complex mixture of organic matter, nutrients, and chemical contaminants that require effective treatment before disposal. However, the performance of wastewater treatment plants in many developing countries is often affected by inadequate monitoring and operational challenges. Therefore, this study was conducted to evaluate the efficiency of the wastewater treatment system at Dhulikhel Hospital, Nepal. A mixed-method approach was adopted, incorporating both quantitative and qualitative data collection and analysis. Wastewater samples were collected twice a day on Sundays, Wednesdays, and Saturdays over two weeks from different points of the treatment system. Various physical and chemical parameters were analyzed, including pH, turbidity, ammonia, phosphate, chemical oxygen demand (COD), biochemical oxygen demand (BOD), total solids (TS), total dissolved solids (TDS), and total suspended solids (TSS). In addition, interviews were conducted with key informants who had extensive knowledge of the treatment plant to understand their perspectives on the system's effectiveness. The results indicated that the wastewater treatment plant was partially effective in removing pollutants, with removal efficiencies of 83.2% for turbidity, 75.6% for COD, 59.5% for BOD, 72.5% for TS, 74.3% for TSS, 82.2% for TDS, 3.8% for ammonia, and 36.3% for phosphate. Most treated wastewater parameters were within permissible limits except for TSS. Overall, the findings highlight the importance of regular monitoring and maintenance of wastewater treatment systems. Future improvements should focus on upgrading treatment units, adopting advanced treatment technologies, and conducting long-term monitoring to enhance treatment efficiency and promote sustainable wastewater management.

Poster presentation

Pollen DNA metabarcoding for assessing plant–pollinator interaction networks across diverse habitats

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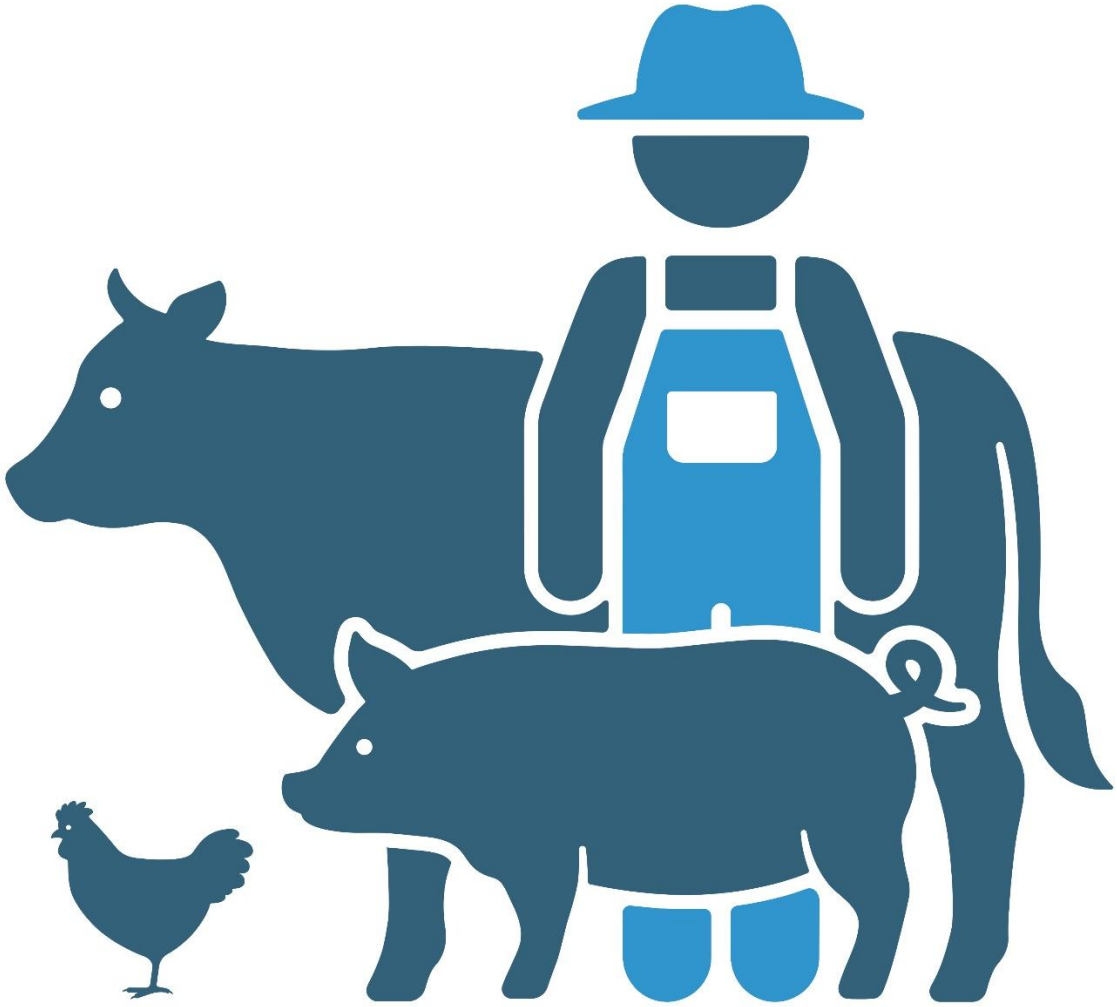
Pollinators support most flowering plants and major food crops, yet global declines driven by habitat loss, agricultural intensification, pesticides, and climate change threaten ecosystem stability. In Norway, particularly in Steinkjer, seminatural grasslands are diminishing, agricultural fields are increasingly intensified, and forest edges are expanding, but the consequences for pollinator diversity and plant–pollinator interactions remain poorly understood. Traditional surveys are limited by taxonomic expertise and incomplete detection, whereas pollen DNA metabarcoding can identify plant taxa carried by insects with high resolution, revealing hidden interactions not detectable through field observations. This study aims to compare pollinator diversity and plant–pollinator interaction networks across grasslands, agricultural fields, and forest edges in Steinkjer. Insects will be collected using standardized hand-net transects across nine sites (three per habitat type). Pollen will be removed from insect bodies, and DNA will be extracted using the DNeasy PowerSoil Pro protocol. Plant taxa will be identified using ITS2 metabarcoding on an Illumina MiSeq platform, followed by bioinformatic processing including quality filtering, ASV inference, and taxonomic assignment. Pollinator diversity will be assessed using Shannon and Simpson indices, rarefaction, GLMMs, PERMANOVA, and NMDS. Interaction networks will be constructed and compared among habitats using connectance, nestedness (NODF), specialization (H2′), and null-model analyses. We expect grasslands to exhibit the highest pollinator diversity and most complex networks, agricultural fields to show simplified interaction structures, and forest edges to support distinct assemblages. Metabarcoding is anticipated to reveal cryptic plant–pollinator links, providing habitat-specific insights that can inform pollinator-friendly management and sustainable landscape planning in Nordic agricultural systems.

SESSION 6: ANIMAL WELFARE

NORDGLOBAL-26



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Keynote presentation

Sustainable beekeeping – new approaches for enhancing honeybee immunity

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Honey bees (*Apis mellifera*) are the most economically important pollinators of agricultural crops. According to COLOSS monitoring data, significant colony losses ranging from 10–40% have been reported in recent years, not only in Europe but worldwide. These losses are associated with long-term pesticide use in agriculture, the shift toward monoculture farming systems, climate change, and inappropriate beekeeping practices. Weakened colonies are more susceptible to infectious diseases; however, the use of antimicrobial agents in apiculture is strictly prohibited in the European Union. Consequently, alternative approaches, particularly those based on natural substances, are increasingly being explored. Maintaining colony health and strength requires appropriate beekeeping practices, including regular monitoring, proper management, and effective disease prevention strategies, with particular emphasis on enhancing the natural immunity of bees. Natural compounds such as probiotics, prebiotics, essential oils, and humic substances have shown promising potential in improving bee immunity while posing no adverse effects on the environment. Findings from our research, as well as from other studies, indicate that the appropriate application of these natural substances can reduce colony losses and disease incidence, either by strengthening immune responses or through direct elimination of pathogens. Within the framework of the Horizon Europe project B-THENET, we are currently developing a manual and instructional videos for beekeepers. These materials are based on the expertise of specialists from 13 European countries and compile the best beekeeping practices aimed at ensuring sustainable and environmentally friendly beekeeping. This work was supported by project VEGA 1/0533/26 and by the European Union under the project 101059812 – B-THENET.

Oral presentation

The Importance of reliability in animal welfare assessments

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Assessing animal welfare is inherently complex due to its multidimensional nature and the inability to directly access animals' subjective experiences. Contemporary welfare frameworks — including the Five Freedoms, Fraser's three dimensions, and Mellor's Five Domains — offer complementary perspectives that integrate internal physical states, external environmental conditions, and affective experiences. The increasing emphasis on positive welfare further underscores the need for robust, scientifically grounded indicators. However, the accuracy of welfare evaluations depends critically on the validity and reliability of the measures used. Validity ensures that an indicator reflects the welfare construct it aims to measure, while reliability ensures consistent scoring across observers and over time when conditions remain unchanged. Despite their widespread use, structured welfare assessment tools such as the Welfare Quality® (WQ) protocols have shown notable limitations in reliability. Test – retest studies in pigs reveal substantial variability in animal-based behavioral measures, such as pen manipulation, with low intraclass correlation coefficients. These inconsistencies impede the protocol's ability to detect meaningful differences between treatment groups or housing systems. Even when indicators are aggregated into broader domains or into an overall welfare score, reliability often remains low. This challenges the utility of such tools for on-farm welfare monitoring and benchmarking. Similarly, findings from Norwegian dairy cattle herds indicate that the national Animal Welfare Index (AWI) is unsuitable for providing an overall welfare status, functioning more effectively as a health-related indicator than a comprehensive welfare metric. Taken together, the evidence highlights the need for welfare assessment approaches that combine multiple, well-validated measures while recognizing the roles of resources, management practices, and animal-based indicators. Improving reliability is essential not only for scientific rigor but also for ensuring fair, transparent, and meaningful evaluations of animal welfare in practice.

Oral presentation

Lameness – a welfare issue in dairy cows

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The aim of this study was to assess some etiological and clinical aspects of dominating claw diseases in dairy cows. DNAzol Direct and column kits were used to isolate DNA from samples of bovine digital dermatitis. The diagnosis of the subclinical laminitis (LS) was based on an observation of symptoms of sole hemorrhage and yellowish-coloured soles. A “slipper foot” was used to diagnose chronic laminitis (LC). On four farms, clinically healthy animals were sampled and divided into three groups of 5-6 dairy cows each: dairy cows between 10-20 days before calving (Group I), dairy cows 10-20 days after calving (Group II), and dairy cows 4 months after calving (Group III). Within these groups, lipopolysaccharides (LPS), BHB, and NEFA concentrations were determined. Five dairy cows with subclinical laminitis and five healthy cows were sampled to determine serum LPS concentrations. In the case of bovine digital dermatitis, *Treponema medium* ssp. *bovis* was confirmed in 14 of 36 skin samples. *Treponema pedis* (9/36), *Treponema vincentii* (1/36), *Treponema phagedenis* (1/36), and *Treponema brennaborense* (1/36) were detected as well. In the orthopedic controls, the sole ulcer was detected in 20% of cows with LS, 41.7% of cows with LC, and only in 4.17% of control cows ($P < 0.05$). One-way ANOVA did not show a significant effect of the lactation period on serum LPS in the study. In conclusion, the results of this study indicate several treponema species participating in the development of skin lesions in bovine digital dermatitis. Moreover, there is an indication of an association between laminitis and the prevalence of sole ulcer in dairy cows. A trend to higher blood LPS concentrations was seen in dairy cows with subclinical laminitis.

Poster presentation

On the road to stress? How horses reveal tension before the journey begins

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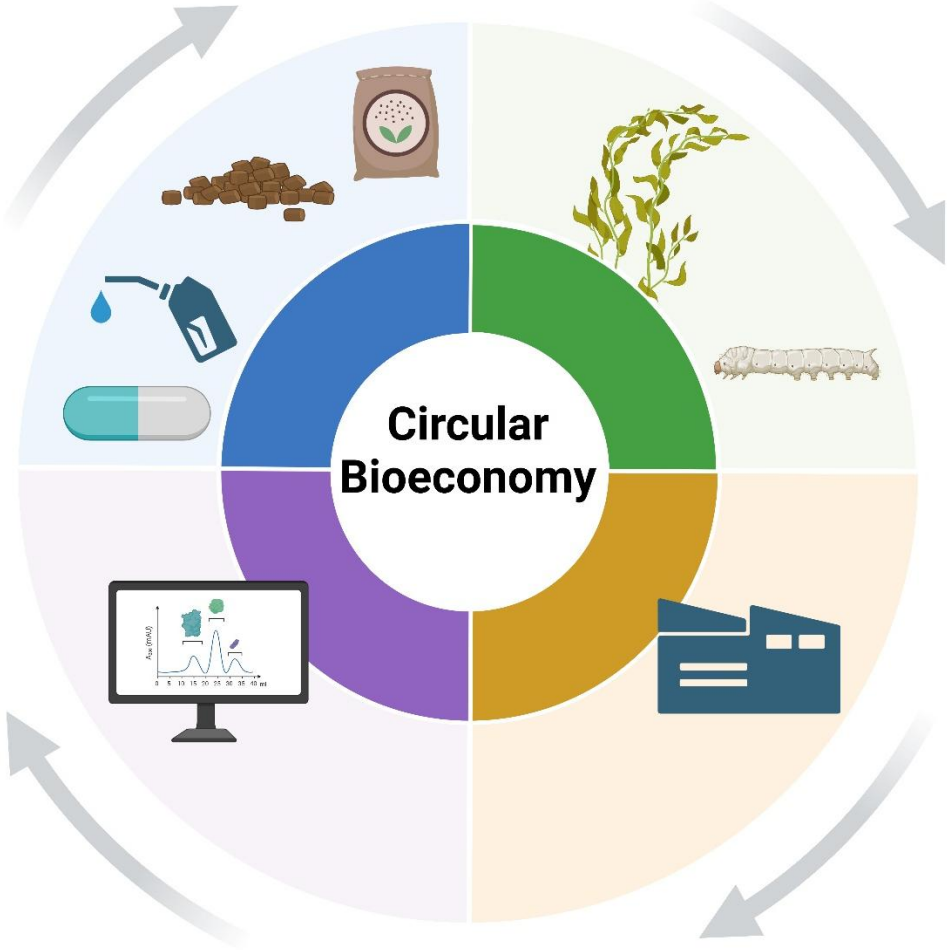
Stress and behavioral responses in horses are of increasing relevance due to growing attention to equine welfare. In addition, improved understanding of stress expression may contribute to safer and more appropriate handling practices. This study aimed to examine heart rate (HR) and heart rate variability (HRV) in relation to conflict behaviors during trailer loading in five horses (12.4 ± 3.67 years). Baseline physiological measurements were taken inside the stable. Collected data on behavior observations from video recordings, and facial expressions from photographs, were combined with HR data from before and during trailer loading, as well as after offloading. Horses were categorized into ELEVATED or LIMITED behavioral response, based on proportion of their exhibited behaviors. Data on HR and HRV from the two categories were compared using Student's t-test in Excel (Microsoft 365, Version 2601). We also analyzed baseline data of HR and HRV, and data from the loading phase using Student's T-test in Excel. There was a significant increase in HR from baseline to loading ($P < 0.05$), but no effect on HRV ($P > 0.1$). Interestingly, we found no differences in HR and HRV between ELEVATED and LIMITED horses. Descriptive analyses of the close-up photos taken before and after the trailer loading indicated that all horses exhibited increased facial tension following trailer loading compared to baseline. The results demonstrate considerable individual variation in both physiological measures and behavioral stress responses. Notably, all horses displayed signs of stress through increased facial tension, even in the absence of significant HRV changes. These findings highlight the importance of assessing equine stress using a combination of physiological and behavioral indicators to promote safe handling and practices and minimize unnecessary stress.

SESSION 7: CIRCULAR BIOPRODUCTION

NORDGLOBAL-26



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Keynote presentation

From organic waste to proteins and biofertilizers

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By 2080, the global human population is expected to exceed 10.3 billion, driving a substantial increase in food demand. Total food consumption is projected to rise by 51% from 2010 to 2050. At the same time, municipal solid waste generation is predicted to grow from 2.1 billion tonnes in 2023 to 3.8 billion tonnes by 2050, exacerbating climate change, biodiversity loss, and pollution. Today, one-third of all food produced worldwide is lost or wasted along the supply chain. These combined challenges highlight the need for innovative and sustainable solutions. One promising approach is to use insect larvae. Insect larvae can efficiently convert a wide range of organic side streams into high-quality biomass. Their bodies contain substantial levels of protein, essential amino acids, and beneficial mono- and polyunsaturated fatty acids—nutrients that are often limiting in conventional fish and animal feed production. Using insects to upcycle organic waste into protein-rich feed can reduce greenhouse gas emissions, land use, and pressure on traditional feed resources. However, insect production also generates a residual material known as frass, consisting of insect feces, exuviae, dead insects, and leftover feed. Frass contains micro- and macronutrients, microorganisms, chitin, and other bioactive compounds. It is increasingly recognized as a valuable organic resource with potential as a fertilizer, soil amendment, and bio-stimulants in agriculture. Integrating insects into waste-processing systems creates new opportunities for circular resource use. However, this circular model remains incomplete unless the resources contained in the residual stream—frass—are also utilized. Using frass as fertilizer, soil amendment, or bio-stimulant returns these resources to agricultural production, closing the loop between food consumption, waste generation, and new biomass production.

Oral presentation

Upcycling of Atlantic herring (*Clupea harengus*) products and implications of life cycle assessment methodological goal-statement paradigms: *Preliminary findings*

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Upcycling side streams and waste can expand nutrient availability, reduce waste, and improve value retention. However, changes in product utilization can also affect environmental burdens, nutrient flows, and market dynamics. Using life cycle assessments (LCA) provides insights into environmental footprints; however, results are sensitive to goal and scope choices, such as intended context, audience, functional unit, system boundaries, and substitution or allocation approaches. An attributional LCA of two upcycled products - herring oil and collagen from filleting cut-offs- was assessed for their life cycle inventory. Using three goal-statement paradigms (consumer, producer, and governmental), the implications of functional units, allocations, and substitution modeling were assessed. Evaluating the benefits and challenges of upcycling, depending on methodological choices. Using these findings, a material flow analysis (MFA) of herring landed in Norway was integrated with the LCA results to conduct a scenario analysis assessing the implications of reallocating herring cut-offs from salmon feed to upcycled food alternatives and tracking nutrient provision, environmental footprints, product quantities, and purchase-cost proxies. The tentative findings show that, measured in mass, almost equal amounts of herring are used for human consumption as salmon feed, once cut-offs are included. Footprint allocation strategies have major impacts on the environmental footprint of upcycled products; however, the footprint of the expected upcycling is highly relevant, and the mass and nutrient retention of upcycled products tend to be lower than in comparable uses.

Oral presentation

Feed self-sufficiency and scarce domestic resources: Emerging conflicts of interest

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[2]RURALIS, Norway

The Norwegian government has ambitious goals to increase the share of domestically produced ingredients in feed for farmed animals and fish. However, a transition in this direction will have implications far beyond feed value chains. Based on a case study from the NFR project *SusFeed* (2021–2026), we examine the consequences of large-scale domestic production of grass protein concentrate and phototrophic microalgae, with particular emphasis on land and energy use. While these feed ingredients have proven technically viable elsewhere, they are still at an early pilot stage in Norway. Scaling up grass protein biorefineries would require substantial areas of high-quality agricultural land. At the same time, such development could encourage more environmentally and soil-health-friendly crop rotation practices. Changes in land use would affect farmers, food value chains, and surrounding local communities, and could also influence common goods such as national food security and food self-sufficiency. Moreover, converting grass into dry protein concentrate requires significant energy inputs. Phototrophic microalgae production has more modest land requirements but depends on energy-intensive processes such as artificial light–driven photosynthesis and water circulation. Current production benefits from synergies with the metallurgical industry by capturing CO_2 and utilizing excess heat. Further scaling, however, may intensify electricity competition, affect other industrial value chains and local communities, and contribute to the conversion of natural land for renewable energy production. High-quality farmland and renewable electric energy are scarce and valuable resources. By analyzing the implications of scaling up grass biorefining and microalgae production in line with current policy ambitions, the SusFeed project highlights how circular business models ultimately face biophysical limits to growth. Finally, our findings raise normative questions about stakeholder involvement, fairness, and allocation: how, and by whom, should scarce land and energy resources be distributed between export-oriented aquaculture and domestic food production, and across competing industrial sectors?

Oral presentation

Optimal post-harvest processing and potential applications of brown seaweeds

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Brown seaweeds are increasingly recognized as sustainable marine resources with considerable potential for food and feed due to their valuable nutritional composition and diverse bioactive compounds. However, freshly harvested seaweed biomass contains up to 90% moisture, making it highly perishable and challenging to preserve for long-term storage and industrial use. Therefore, optimal post-harvest processing is essential to maintain biomass quality and functional value, such as animal feed. This abstract summarizes the key outcomes of two studies addressing post-harvest drying and the anti-methanogenic potential of Nordic brown seaweeds. Post-harvest drying was evaluated as a key preservation strategy for *Fucus vesiculosus*. Our results showed that low-temperature oven drying at 40 °C (OD40) preserved major nutrients and bioactive compounds, particularly polyphenols, more effectively than 80 °C drying. Importantly, OD40 also represents a more practical, industrially scalable alternative to freeze-drying, offering a balance among biomass quality, energy efficiency, and economic feasibility. Additionally, the antimethanogenic potential of brown seaweeds, including *Ascophyllum nodosum*, *Fucus serratus*, and *F. vesiculosus*, was assessed in vitro using grass silage (GS) and maize silage (MS) as basal diets. Notably, only summer-harvested *F. vesiculosus* exhibited pronounced anti-methanogenic activity, reducing methane production by ~27% on a dry matter basis when added to MS. *Fucus* species contained significantly higher polyphenol concentrations than *A. nodosum* ($P < 0.001$), with no seasonal variation observed. Under a grass silage basal diet, summer-harvested FV reduced methane production by ~18% (CH_4%) and ~28% (mL/g DM) compared with *A. nodosum*. Microbial analysis of rumen filtrate after fermentation showed that Bacteroidota and Firmicutes dominated the microbial community irrespective of the basal diet. Overall, these findings indicate that low-temperature drying is an effective and industrially relevant post-harvest strategy for preserving seaweed quality, while *Fucus* spp., particularly summer-harvested *F. vesiculosus*, show promise as dietary additives for mitigating enteric methane emissions in ruminants. Further *in vivo* studies are warranted to optimize CH_4-mitigation strategies using brown seaweeds and their bioactive compounds.

Oral presentation

Research activities within circular bioproduction at Nord University

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To meet the growing global demand for food and feed while safeguarding environmental health and sustainability, circular bioproduction will play a pivotal role in future food and feed systems. Across academia, industry, and the public sector, numerous initiatives have been launched to promote the sustainable recycling of bioresources and the sustainable production of food and feed. At the Faculty of Biosciences and Aquaculture (FBA), Nord University, several recent educational and research efforts have focused on advancing circular bioproduction. In particular, insects have emerged as a promising component of sustainable food and feed systems. A yellow mealworm (YM) research facility has been established at Mære Agricultural School by FBA, where master and PhD students are actively investigating strategies to enhance the nutritional value of YM larvae. Complementing this work, a feeding trial using YM-based diets was conducted at Skjetlein Higher Secondary School to assess the effects of insect-derived feed on the performance and productivity of laying hens. In parallel, significant efforts have been directed toward the valorization of aquaculture biowaste as a sustainable resource for food, feed, and energy production. Moreover, extensive efforts have been made to establish marine macroalgae as a sustainable feed ingredient for livestock and a health-promoting source of bioactive compounds for humans. Research at FBA, Bodø, has extensively explored the use of various nutrient sources, such as insect meal and algal oil, in the Norwegian aquaculture production. Collectively, these initiatives have strengthened collaboration between academia, industry, and public institutions, both nationally and internationally. They have also contributed to capacity building, supporting the continued development and advancement of circular bioproduction.

Poster presentation

Effectiveness of institutional support mechanisms in driving the adoption of climate-friendly dairy practices in Nepal

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The dairy sector is key to strengthening rural livelihoods, but it faces significant challenges from climate change. Promoting climate-friendly practices (CFPs) is a crucial strategy to reduce methane emissions from the dairy sector. The study assessed the adoption of CFPs among 198 dairy cattle farmers (March-April 2025) from Chitwan, Dhading, and Makwanpur districts of Bagamati Province, Nepal. The adoption score for each household was calculated based on the adoption of five dairy management practices. The categorization of low, medium, and high adopters was based on the households' adoption scores. The adoption of CFPs in small and medium dairy farms relies on institutional support. This study determines the influence of institutional factors on the adoption of CFPs in dairy farming. Furthermore, the differences in financial performance among low, medium, and high adopters of CFPs in dairy farming were assessed. Study findings revealed that 24.8% of farmers were low adopters, 55.4% were medium adopters, and 19.7% were high adopters of CFPs in dairy cattle farming. The chi-square values for training, subsidy, credit, and insurance receipts are significantly associated with the level of adoption of CFPs. The average cost of rearing cattle, net return, and benefit-cost ratio (BCR) were positively associated with cattle farmers' level of adoption of CFPs. High adopters of CFPs incurred higher costs per head of cattle than low and medium adopters; however, they also obtained higher net returns and a more favorable BCR. This study establishes that institutional support influences farmers' adoption of CFPs in dairy farming. The superior performance of high adopters demonstrates that investment in CFPs yields tangible economic benefits alongside environmental gains. Hence, policymakers can prioritize strengthening institutional support mechanisms to promote both climate resilience and economic sustainability in Nepal's dairy sector.