atf animal task force
A European Public-Private Partnership

EAAP
European Federation of Animal Science

2nd one-day symposium
Animal Task Force
& EAAP Commission on Livestock Farming Systems
Monday 05th September 2022
EAAP Annual Meeting 2022 – Porto, Portugal

Report

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Since 2013, the ATF-EAAP Special Session during the EAAP Annual Meeting aims to bring together animal science with practice of animal production and connect researchers, policy makers, industry representatives and societal organisations. Every year, a different topic is addressed during this session.

http://www.eaap.org/.

Background

Greenhouse gas (GHG) emissions are among the greatest challenges faced by livestock farming and it has become an issue of the greatest importance for consumers and policy makers. At the same time, livestock has a strong mitigation potential: "*improved management practices could reduce emissions from livestock systems by about 30%*", says FAO.

Several reports have been recently published by international organisations (IPCC, FAO, DG Agri) that will influence decision making with impacts on the livestock sector.

The ATF would like to draw together the state of the art on GHG emissions from livestock, the role of methane, the different metrics to measure emissions and mitigation levers at various scales, inviting international organisations, research organisations, farmers, industries, NGOs and policymakers.

Format of the one-day symposium

In 2021, the EAAP Livestock Farming Systems Study Commission and the ATF Special Session have joined into a one-day symposium. In 2022, they have decided to continue the collaboration.

The symposium would like to engage discussion with farmers, industries, scientists, policymakers and with the society. The outcomes of the symposium are discussed with a large panel of European stakeholders during the ATF seminar, in Brussels, in November 2022.

Aim

This one-day symposium aims to contribute to:

- Addressing **how research and innovation can support the livestock sector**: needs in R&I to help the livestock sector to adapt to climate change and mitigate emissions;
- **Providing input to European research and innovation agendas and to public policies** to secure Europe's role as a leading global provider of safe and healthy animal-derived products;
- **Engaging a dialogue with various stakeholders;**
- **Fostering ownership by farmers and industries.**

The Animal Task Force (ATF) promotes a sustainable and competitive animal production in Europe. We are a public-private partnership of experts from knowledge institutes and industry representative organisations from across Europe. We work closely together with EAAP on setting the European agenda for research and innovation in the animal domain.

For more information:

www.animaltaskforce.eu	@AnimalTaskFrc
www.eaap.org/	@EAAPofficial

Welcome and Introduction

Frank O'Mara, Michael Lee and Isabel Casasús introduced the session and welcomed participants.

Frank O'Mara was happy to open the second symposium of the ATF and the EAAP Commission on Livestock Farming Systems, at the EAAP annual congress. The topic of the day deals with livestock emissions and the COP26 targets. GHG emissions are among the greatest challenges faced by livestock farming, which has become an issue of the greatest importance for consumers and policymakers. However, a strong mitigation potential exists (30% of reduction). The symposium will draw together the state of the art about emissions and specifically methane, metrics to measure emissions, and mitigation levers at various scales.

Isabel Casasús explained the reason of a joint session between ATF and EAAP: both share the same objectives. Hot topics about animal farming are as follows: innovation, efficiency, relationships livestock/biodiversity/soil fertility.

Michael Lee recalled the discussion at COP26 in Glasgow: we owe it to our children and our children's children to produce in an environmentally safe way. We have to focus on producing enough food, but also without destroying the planet. This has long been a focus of the animal science community, we are not standing still.

Morning session - EAAP session #02

State of policies and research about climate impacts from livestock, metrics & mitigation options

IPCC AR6 Working Group III report: overview of agricultural sector GHG emissions

By Harry Clark, NZAGRC *@nzagrc* *www.nzagrc.org.nz*

Harry Clark is the Director (Domestic) of the New Zealand Agricultural Greenhouse Gas Research Centre (NZAGRC), a government funded entity established in 2009 to develop technologies and practices to reduce GHG emissions from the New Zealand agricultural sector. He developed the current national New Zealand methodology for estimating enteric methane emissions. He was a Lead Author for the agricultural chapters of two International Panel for Climate Change Assessment Reports (AR5 and AR6) and sits on numerous international and domestic science advisory panels.

Abstract # 40336:

Agricultural CH_4 and N_2O emissions averaged 156 (± 46.8) MtCH4 yr-1 and 6.0 (± 3.6) MtN_2O yr-1 6.8 (± 2.3) GtCO_2-eq yr-1 (using IPCC AR6 GWP100 values for CH_4 and N_2O) respectively between 2010 and 2018. CH_4 emissions continued to increase, with enteric fermentation forming the main source and increasing ruminant animal numbers a key driver. N_2O emissions also increased, notably from manure application, nitrogen deposition, and nitrogen fertiliser use. Modelling studies indicate that between 2020 and 2050, agricultural mitigation measures could potentially reduce emissions by 5.3 ± 0.2 GtCO_2-eq yr.- (assuming carbon prices up to USD100 tCO_2-eq-1) from cropland and grassland soil carbon management, agroforestry, use of biochar, altered rice cultivation, and livestock and nutrient management. Demand-

side measures including shifting to healthier diets in some regions, reducing food waste, building with wood and biochemicals and bio textiles could potentially reduce emissions by a further 1.9 $GtCO_2$-eq yr^{-1}. Considering trends in population growth, income, consumption of animal-sourced food, fertiliser use and disturbances from climate change, effective policy interventions and financing will be required for agriculture to achieve the identified mitigation potential. Realisation of mitigation potential can only be achieved when stimulated by concerted, rapid and sustained effort by all stakeholders, from policy makers and investors to landowners and managers.

Questions & answers:

The audience notices that EU emissions are low compared to other regions. In which direction should we develop our research?

⇨ We need to investigate more about mitigation. All developed countries should be investing in mitigation research. We need global research and effort, to reach our challenge.

Moreover, there is sometimes a huge trade-off between mitigation and biodiversity for instance. How do we balance it?

⇨ We have to find the right place where animals fit in.

The audience asks about the industry-driven measure to adopt innovation.

⇨ An obvious change in the last few years: industry driving the change and having very ambitious target to reduce emissions. We have observed massive change in the last 2-3 years. But which policies are going to help the uptake in mitigation? Mitigation is a cost on the business, carbon price fine if you can get some added value in exchange for "doing" the mitigation. If the carbon price is high, it can damage the agriculture sector, but if it is too low, we won't get any reduction on emissions. There is a huge challenge to marry the government policy and incentive measures by industry.

Frank O'Mara relates that Ireland has just set some important targets. Do developed countries have to take the lead?

⇨ We are seeing some hopeful signs, but these targets are not that ambitious. But there are some hopeful signs, with some policies going in the right direction. The developed world must take the lead.

More information in the slideshow

FAO report: Technical Advisory Group on Methane emissions from the livestock systems and Working group on metrics

By John Lynch, Oxford University *@UniofOxford* *www.ox.ac.uk*

John Lynch is an environmental scientist based in the Department of Zoology, University of Oxford. He is interested in the environmental impacts of agriculture, and different ways of achieving a 'sustainable' food system. He is particularly focussed on the role of agricultural production in anthropogenic climate change, and potential compatibility with overall global warming targets. His current research explores on greenhouse gas removal methods, particularly those associated with land-use.

Abstract # 40335:

Globally, livestock systems are important contributors to nutrition and improved livelihoods, especially among developing countries. With the increasing occurrence of extreme weather events and rising global temperature due to climate change, focus has shifted to the livestock's contribution to the greenhouse gas (GHG) emissions such as methane, nitrous oxide and carbon dioxide. According to the Food and Agriculture Organization of the United Nations (FAO), livestock contributes around 14.5% to global

anthropogenic GHG emissions, mainly in form of methane, which originates from rumen fermentation and manure management systems. Globally, methane emissions from the livestock sector represent 32% of the total anthropogenic methane sources. More focus has been placed on methane, a short-lived climate pollutant, to reduce the impact of climate change by 2030. Methane is central at the forthcoming UN Climate Change Conference (COP27) discussions and many countries have joined the Global Methane Pledge, led by the United States of America and the European Union, to slash methane emissions by 30% from 2020 levels by 2030. The Livestock Environmental Assessment and Performance Partnership (FAO LEAP Partnership) has recently released a technical document methane reviewing methane sources, mitigation strategies and climate change metrics. Besides methane, the LEAP Partnership has developed guidelines to assess the environmental impacts of livestock systems on climate change, biodiversity, water use, soil carbon, and those tied to nitrogen and phosphorus use. The FAO LEAP Partnership is a multi-stakeholder initiative, composed of Countries, Private Sector, Civil Society and Non-Governmental Organizations, that seeks to improve the environmental sustainability of the livestock systems through harmonized methods, metrics and data.

Methane is the second largest contributor to global warming after CO_2. At present, concentrations of both CO_2 and CH_4 are increasing, causing increased warming, and we are still a long way from zero net CO_2. The largest source of anthropogenic methane is from agriculture, and enteric fermentation the biggest source within this. While this talk focuses on methane, and methane emission reductions can still be a valuable part of climate change mitigation, it should be reiterated that net-zero CO_2 is still the priority, as without this we will still eventually have increasing temperatures regardless of action taken on methane. As methane is a precursor to tropospheric ozone, there are also air quality benefits in terms of public health and crop production that can be gained through reducing emissions.

The forthcoming FAO LEAP report provides an overview of different agricultural methane sources and sinks, including discussion of different measurement techniques and the potential for improved quantification. One route to improved assessments will be the complementary use of 'bottom-up' (e.g. sources and process models focussed on point of emission) and 'top-down' (observations of methane concentration and atmospheric transport models) approaches to ensure alignment. The report also outlines a large number of promising routes to reduce agricultural methane, covering enteric fermentation (e.gs including animal breeding, dietary supplements, immunisation against methanogens), manure management (e.g. cooler storage, precision applications), and rice production (e.g. water table management, planting methods, breeding).

Finally, the report discusses different metrics for quantifying the impacts of methane. The most commonly applied metric, the 100-year Global Warming Potential, can describe the relative benefits of avoiding a given methane emission, in 'CO_2-equivalent' terms by comparing average future difference vs a 'no emission' baseline over the following 100-years. While this approach may be deemed useful for some decision-making purposes, it was highlighted that it can fail to reveal the qualitative distinction in their dynamics, whereby CO_2 emissions act cumulatively into the long-term, but the contribution of methane to global depends only on current/recent emissions, given their short atmospheric lifetime. The ultimate requirements to stop ongoing temperature increases therefore differ between the two gases, with net-zero emissions required for CO_2, but not methane. Novel metrics such as 'GWP*' can reflect these differences, or climate modelling approaches can be used to explore the impacts of different emission pathways in more detail. Ultimately, all simplifying emission metrics entail potentially subjective decisions, and the most appropriate metric depends on intended purpose.

Questions & answers:

What do we know of the correlation between sinks/removal and production, is there a concentration dependence?

⇨ The science is still emerging in this area. We have observed increases in the concentration of methane in the atmosphere, and the isotopic signature suggests this is largely due to biological sources, and while increases in ruminant livestock are one of the most likely causes, there may also be increased fossil methane emissions and enhanced natural methane from wetlands due to temperature feedbacks. Some papers also suggest there may be a reduction in hydroxy sink capacity (the main process by which methane is removed from the atmosphere), but this has been challenging to confirm or quantify. We also know there is a small soil methane sink, and that this tends to be higher the lower the management intensity, but this is also a developing area – emerging eDNA techniques to screen for soil methanotrophs may help better understand whether and how different managements can enhance soil removals.

What kind of production systems are needed?

⇨ Sustainable intensification is possible, and the wide range in environmental performance and efficiency among different farms highlights the potential for improvements. But trade-offs for wider factors such as welfare and biodiversity should be identified, and interventions and management should be aware of these potential side-effects and try to minimise them. Climate change mitigation should not necessarily be the single focus of designing a 'sustainable' food system. In the presenter's personal opinion, separate targets and policies for the different gases could be a sensible route forward, which may point to wider options for sustainable production systems. Further research and political discussion is needed on the practical application of targets and policies taking a holistic approach.

More information in the slideshow

EU policy tools to decrease emissions from the livestock sector

By Valeria Forlin, DG Clima, Unit C3: Low Carbon Solutions (III): Land Economy & Carbon Removals *@EUClimateAction*
https://ec.europa.eu/info/departments/climate-action_en

With Andreas Pilzecker, DG Agri, Unit B2 - Environmental sustainability *@EUAgri*
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Valeria Forlin holds a PhD in Economics from the Catholic University of Louvain-la-Neuve (BE). She has been working at the European Commission since 2016, focusing on the interplay between climate policies and the agriculture and food sectors.

Abstract # 40103:

EU climate policies for the land sector address the Member State level by means of national targets. Until 2030, under the current framework, there is no separate mitigation target for the agricultural non-CO_2 sector; together with other sectors (buildings, transport, waste) national GHG emission reduction targets under the Effort Sharing Regulation point to emission reduction objectives. In the context of the 'Fit for 55' revision, the Commission has proposed more ambitious national targets for the LULUCF sector and an EU target to achieve a climate-neutral land sector (then combining land use, forestry and agriculture) by 2035, implying a balancing of land removals and agricultural emissions. In addition, the Commission published the Communication on "Sustainable Carbon Cycles" (COM(2021) 800 final, "Sustainable carbon

cycles") to promote the development and deployment of natural and technological carbon removal solutions at scales conducive to the EU objective of climate neutrality. In view of delivering on the EU commitments, and in accordance with its Farm to Fork Strategy (COM/2020/381 final) and Methane Strategy (COM/2020/663 final), the Commission implements actions, prepares new and revises existing legislation to enable the livestock sector to reduce its methane emissions. Within the new Common Agricultural Policy, the Commission will ensure that support from the European Agricultural Guarantee Fund and European Agricultural Fund for Rural Development contributes to climate change mitigation. A specific objective is indeed dedicated to climate and includes the reduction of greenhouse gas emissions. A result indicator will reflect the share of livestock units supported to reduce emissions, and several relevant instruments can be used for the purpose of reducing methane emissions, like eco-schemes, agri-environmental management commitments an, investments support (Regulation (EU) 2021/2115).

A drastic decrease is foreseen in CO_2 emissions from different sectors, and these go almost to zero by 2050. However, that won't be enough because there will be some emissions that remain from aviation fuels and agriculture. The mitigation potential of biogenic emissions is smaller and that is the reason why agricultural emissions will continue to be important until 2050. The other side of the story is more positive with the land sector which can also provide CO_2 removals that are needed to compensate for these residual emissions. In 2050 the agricultural sector and land sector together will make up the largest part of the EU greenhouse gas profile. Therefore, the EU needs to make climate policies that are consistent with the importance of the agricultural sector in 30 years from now.

The LULUCF (Land Use, Land Use Change and Forestry) regulation covers CO_2 emissions' removals from land use and forestry. However, it does not cover the CH_4 emissions from the livestock sector but covers the CO_2 removals in grassland when grazing. The methane emissions from livestock and fertilizer use are covered by another legislation which is the Effort Sharing Regulation. The European Commission has put a new target for LULUCF to increase EU carbon removals to at least 310 Mt by 2030 which is much more ambitious than before. The Commission has also proposed (in November 2022) a Regulation on the certification of carbon removals.

More information in the slideshow

Global Research Alliance on Agricultural Green House Gases GRA-GHG

By Hayden Montgomery, Special Representative of the GRA *@GRA_GHG*
https://globalresearchalliance.org

Hayden Montgomery was recently appointed as the Agriculture Programme Director of the Global Methane Hub and has been the Special Representative of the Global Research Alliance on Agricultural Greenhouse Gases since 2016, representing its 66 member countries in all international fora and facilitating mitigation research between its members and partner organisations.

The GRA was launched in 2009 during the COP in Copenhagen. At launch, climate change was already an issue. However, it has become more emergent over the past years. The GRA has 66 member countries, and there is a collaboration between countries to mobilize resources to support research. Together with a growing group of partner organisations on a regional and national level, the GRA seeks activities that benefit different groups and communities that are represented. The livestock research group is composed of various networks, focusing on linking and growing the capacity to reduce emissions.

There are opportunities for low-hanging fruit concerning improved and increased productivity. Furthermore, animal health actions should become part of the mitigation policies. The GRA operates close

to policy, as for instance, in the project pathways to dairy net zero. Part of this project is a review, it shows that different systems lead to different outputs and different emissions. Therefore, different interventions are needed.

More information in the slideshow

Production profiles and GHG emissions – pilot study on farm practices towards circular bioeconomy

By Dana Peškovičová, NPPC *http://www.nppc.sk*

Dana Peškovičová, head of project management department and external relations, National Agricultural and Food Centre (NPPC), Slovakia, has 30 years of experience in the field of animal science, and is currently engaged in the research management of agro-food research at NPPC. She has been active in the field of animal science since 1992 with a focus on population genetics, animal breeding, genetic evaluation, economic efficiency of animal production systems, application of statistical methods in biological sciences.

Abstract # 39234:

The key objectives of the study were to provide information for more accurate evaluation of farm emission profile of GHG emissions and to map current practices of mitigation and application of circular bioeconomy principles. Pilot survey among 36 Simmental cattle breeders in Slovakia was performed by an expert via face-to-face meetings and data collection on farms. 11,012 cows in the study represent 31% of the total Simmental population in the national milk recording scheme. Top quartile reported average annual milk production more than 8,237.5 kg. The lowest quartile reported mean annual milk production less than 7,112.25 kg. Most of the farms (29; 80.5%) produced from 7,343 to 9,070 kg of milk. There were 22 farms with intensive system, 2 with extensive and 12 semi-intensive farms. Farms that applied grazing (12) covered 23.7% (5,257 animals) of all cows and heifers. In addition to the quantitative parameters defining the production system itself, the animal waste management systems and pilot mapping of mitigation techniques and innovations were studied. Most of the farms house animals in roof-insulated stalls with air ventilation (22) and straw for bedding (30). Other types of bedding were reported, such as solids from slurry separation (5) and sawdust (1). Majority of farms produce solid manure (30; 83.3%) coming from animal waste management systems utilizing solid manure from producing cows and deep bedding used in housing for dry cows. Almost half of the farms (48%) were equipped with roof-insulated stalls and air ventilation or slated floor, while 19% of farms used combination of both. The use of these technologies has led in some cases to a slight reduction in nitrous oxide and ammonia. Preliminary findings showed that an ammonia reduction of more than 10% was achieved on 4 farms (maximum 11.97%). Our study contributes to a better insight into farm practices and provides other relevant information aimed at level of understanding of the bioeconomy principles and the use of innovation and new technologies by livestock farmers.

As part of a project, a small pilot study is done in Slovakia that focuses on farm practices. There are different systems in Slovakia: intensive, extensive and semi-intensive; mostly the intensive systems use innovation. The pilot study aims to map technology and circularity. Most farms in Slovakia are crop specialised, and there is a decrease in livestock farms, a mixture of both is also seen. To account for GHG and ammonia, the best available practices and the national code of the IPCC were used. On average there are higher GHG emissions for all farms compared to the national average. Yet for some, ammonia reduction was recorded, it is suggested that this is caused by slated flooring and roof-insulated stalls and air ventilation.

More information in the slideshow

Territorial-scale trade-offs of livestock performance: cattle diet composition perspective

By Ruizhen Wang, INRAE *@INRAE_France* *https://www.inrae.fr/*

Ruizhen Wang is a first-year PhD student at INRAE, France. Her current research is focused on ecological modelling, especially to explore the relationships between animals and environment.

Abstract # 39369:

For promoting food system's sustainability, it is paramount to study the trade-offs related to livestock system, considering food provision, emissions and land use, with a systemic approach. Livestock diet connects livestock performance with land use. We focus on cattle dietary composition (i.e., dry matter content, digestibility and gross energy content) and develop a model to explore the trade-offs among animal production (measured as total weight gain), methane emissions and land use impact indicators. Body growth is modelled through a metabolism approach based on energy balance. Methane emission is estimated using the IPCC tier 2 approach. This building block is integrated into a territorial-scale model in order to calculate a feed-food competition indicator and feed import needs, as indicators of impacts on land use. We simulated two scenarios in a grassland-dominated case study region, Bocage Bourbonnais (France), considering two events that might affect cattle diet characteristics: (1) drought and (2) pasture quality improvement. (1) is simulated by decreasing average yield (-10%) and dry matter content (-20%) of crops and grass, the grazing time on pasture (-20%) and cattle grass intake (-20%). To reach the same daily energy intake from the diet, the ratio of concentrates was increased. The results showed an increase in total weight gain (+6.3%), however with an increase in methane emission (+4.1%), feed-food competition (+1.7%) and considerable feed importation (+54.8%) compared to baseline. (2) was simulated by increasing both grass digestibility and gross energy content by 2%. Results showed that total weight gain increased by 2.6% while methane emission decreased by 1.9% and feed-food competition decreased by 2.5%, with no additional impact on feed importation. Our findings indicate that trade-offs exist in livestock system and diet composition is a lever to handle trade-offs related to livestock performance and land use. Relevant practices on pasture can provide a win-win opportunity on integrated cattle management of production, emission and land use.

Can livestock diet be a lever to soften the trade-off in livestock performance? A modelling approach is used to investigate this. The aim is to maximise production with minimal feed and GHG emissions, which creates a trade-off on a territorial scale. The modelling approach thus includes 3 sub-models: animal body growth, agricultural land use and methane emission. Currently, body growth model is only finished with beef cattle. We use feed's characteristics (DE, GE, quantity) to evaluate the net energy needed for body growth and the emissions generated. These two sub-models will be then integrated into the sub-model of agricultural land use to envision the feed imports and feed-food competition. The initial study compares a grain-based diet with a grass-based diet. The initial results show that diet composition can be a lever. Improving grazing quality provides a win-win situation.

More information in the slideshow

State of the art in Research and Innovation – Nutrition and supplements

By John Newbold & Jamie Newbold, SRUC *@SRUC* *www.sruc.ac.uk*

Jamie Newbold joined Scotland's rural college (SRUC) as Academic Director in 2017. His research interests have focused on the understanding and manipulation of gut ecosystems to improve animal productivity while reducing the environmental impact of animal husbandry. He has published over 230 papers in peer-reviewed journals. He has filed eight patents, four of which are currently licensed to commercial partners for further development and exploitation.

John Newbold had a 30-year career in R&D and technical positions in the animal feed industry, working in the UK and internationally. In August 2019, he took up the position of Professor of Dairy Nutrition at SRUC, based in Scotland's dairy heartland of Dumfries and Galloway. John is keen to work collaboratively and broadly across dairy farming, the agricultural supply industries and academia, understanding and applying science to improve the efficiency of conversion of primary natural resources into nutritious, healthful and delicious food (i.e., milk and dairy products).

Abstract # 39653:

Why isn't nutrition making a bigger contribution to the reduction in greenhouse gas emissions from ruminants? One answer is that it might be, but effects of nutrition are not represented adequately in current accounting systems (e.g., Tier II methodologies). The effect of macro-nutrition (e.g., level and type of oil) on methane emissions is predictable (and can be modelled in feed formulation systems), while a small number of feed supplements (3-nitroxypropanol, nitrate, garlic and essential oils) are now on, or very close to, market. Their adoption will require incentives, such as payments to the food chain from food retailers or emerging carbon trading systems. Other feed supplements hold promise but currently lack sufficient evidence of efficacy, and/or regulatory approval and/or a viable supply chain. Identification of new candidate mitigators has been over-reliant on empiricism, for example through the blanket screening of plant extracts without complete chemical characterisation of what is being tested and clarity on what part of microbial metabolism is being targeted. However, knowledge on rumen microbiology and enzymology is advancing, for example the recognition that host genetics and nutrition differentially affect methylotrophic and hydrogenotrophic archaea. Such deeper understanding holds promise as a source of much-needed new ideas for methane mitigation.

Methane is directly related to the rate and extent of rumen fermentation. Organisms that have low levels of fermentation produce low levels of hydrogen and thus promote low levels of methanogenesis which is a natural consequence of fibre breakdown in the rumen. How are we going to reduce methane production while continuing to improve productivity? There are different approaches and solutions to reduce emissions through husbandry, health, keeping the animals on the farm for the right amount of time, pasture management… Another important tool to mention is improved genetics which needs to hand in hand with feed additives. Theoretically, we can produce zero methane cows.

By far the most active area of research in terms of additives to use methanogenesis is the development of compounds that directly inhibit methanogenesis. We are currently working on daffodils which are ornamental flowers. They have recently been discovered to be a good source of haemanthamine which has very specific effects on rumen methanogenesis and can take methane down to zero. The most successful relevant additive in the market is 3-NOP developed by DSM which decreases methane by as much as 70% when you feed it.

A genetic index, that has been launched by AHDB in the UK, and called "EnviroCow", is expected to reduce CO_2 emissions per kg of milk production by 1% each year. The question is "could we go faster?".

Of all the additives out there, only one has made it through the EU regulations and that's Bovaer (3-NOP). The rest tend to rely on the fact that they can be included in the diet as a feed ingredient, but this will likely be challenged in due course.

The supply chain to the farm is again an area of real challenge. Mostly these products are initially focused on dairy cows, but we have to solve the problem of reaching extensive beef and sheep.

More information in the slideshow

Research and innovation for climate change mitigation from an animal breeding perspective

By Oscar González Recio, INIA-CSIC *@OscarGenomics* *@INIA_es* *www.inia.es*

Oscar González Recio is a researcher at INIA (Madrid). His research focuses on the use of genomic information to improve the productivity, sustainability and health of livestock. His projects and collaborations focus on feed efficiency, methane emissions and several important diseases like mastitis and Johne's disease in cattle, with the objective to breed more productive and healthy livestock that provide more food for human consumption with a reduced use of raw material and lower environmental and land footprint. Oscar is also interested in the development and application of statistical methods to analyse high throughput genomic, metagenomic and epigenetic information.

Abstract # 39041:

Livestock will face an important challenge within the next decade to cope with the objective of cut by 30% methane emissions, as agreed in the COP26. Selective breeding can contribute to reducing methane emissions from ruminants. The situation of concern about climate change makes necessary to implement direct selective breeding in order to reduce the carbon footprint of livestock and improve their adaptation to global temperatures that are expected to increase. Historically, the breeding objectives in livestock focused on maximising the profitability, balancing high productive levels and functionality while guaranteeing optimum animal welfare. More recently, and because of a raising societal concern about sustainability, a constructive debate arose on how to include sustainability, mitigation and adaptation in the breeding objectives of livestock. The impact on sustainability due to selective breeding on the traditional traits needs to be evaluated. New traits must be included in the breeding objective to achieve faster genetic gain. Some of these traits are not routinely recorded in farms, and large efforts need to be done in phenotyping these traits such as methane emissions or nitrogen accumulation. However, selective breeding faces unclear policies that pose uncertainty on designing breeding objectives in the long term. This uncertainty precludes more direct strategies to include direct mitigation strategies in the breeding goal.

Methane emissions in the world have increased in the last 1.5 centuries, mainly since the 1950s. In this period, more meat and milk were consumed, and food security and availability were increased. However, the main point is that the human population has grown exponentially also in this same period. Food security is a challenge with a growing human population. We hear a lot of the message that we need to reduce the consumption of animal products, and the number of livestock without any debate or consideration. Livestock contributes to healthy diets, rural development, and landscape maintenance.

Certainly, methane is an important greenhouse gas with a warming potential between 28-34 times that of carbon dioxide (CO_2) over a 100-years period. However, it only lasts between 10 to 20 years in the atmosphere, and then it degrades into CO_2, which is absorbed by plants and eaten by ruminants again. This is the short cycle of carbon, which is different from the long cycle of carbon coming from burning fossil fuels. Hence, most methane that is currently in the atmosphere will disappear in 10 or 12 years, and

will stop warming the planet. If we don't add more methane, or at least we add a much lower amount of it, we could reduce warming with more efficient livestock. Selective breeding is recognized as one of the most promising strategies to mitigate methane emissions. Genetics account for 20-40% of the total phenotypic variability of traits related to methane and feed efficiency but we need to combine them with the rest of the traits that we are selecting for. We evaluated the potential of genomics as a tool to reduce methane emissions in 3 scenarios. Reducing methane from breeding is possible, but a 30% reduction is unrealistic if no action is taken and other technological tools are also implemented (nutrition, biofuel plants, etc). A lot of effort is being done into dairy but more effort needs to be made in beef and small ruminants. It is important to increase private and public acceptance and understanding of this technique.

More information in the slideshow

State of the art in Research and Innovation – Manure management

By Henrique Trindade, UTAD *@UTAD_RS* *www.citab.utad.pt*

Henrique Trindade is associate professor at the Department of Agronomy from the Universidade de Trás os Montes e Alto Douro (Portugal) and member of the Centre for the Research and Technology of Agro-Environmental and Biological Sciences - CITAB. He coordinates the Animal Manures, Nutrient Cycles and Agriculture Sustainability group and the Agriculture & Environment Lab from CITAB in studies to evaluate the effects of mineral and organic amendments on N and C flows and losses in soils throughout nitrate leaching, ammonia volatilization and, particularly, emission of biogenic GHG (CH_4, N_2O and CO_2) and other gases (NH_3, NO_2, NO) from crop and animal production systems.

Abstract # 40111:

Animal manures are an important source of ammonia (NH_3) and greenhouse gases (GHG) emissions. Emission of methane (CH_4) and nitrous oxide (N_2O) occur in all manure management stages – barn, storage, processing and recycling as crop fertilizer after field application. At the barn level, rapid separation of the urine and faeces by using floors with built in urine channels and the frequent removal of manure using scrappers and cleaning robots are important direct measures to reduce emissions. Indirect measures as indoor climate and ventilation control may also strongly contribute to emissions reduction. During storage, treatments like acidification, storage cover, solid-liquid separation and addition of biochar show great potential for mitigation of both GHG and NH_3 emissions. Acidification is a technique that allows the reduction of NH_3 volatilization in different stages of effluent management, also producing a reduction in CH_4 emission during the storage of animal slurries, but with inconsistent effects on N_2O emissions. Covering slurry storage tanks effectively reduces NH_3 emission and total GHG emission by reducing CH_4 emission, but with little noticeable effect on N_2O. Anaerobic digestion of slurries previous to their storage also contributes to the reduction of GHG emissions but can significantly increase NH_3 volatilization. At the field level, manure application by shallow injection and the use of nitrification inhibitors are the most promising GHG and ammonia abatement options. Properly evaluation of the effects of manure treatments or the combination of distinct treatments on the mitigation of different emissions processes should change from a single stage approach to include farm-scale and/or pilot-scale studies with a manure whole-life-cycle scale to avoid pollution swapping and simultaneously to determine the most efficient solution for manure energy and nutrients recovery.

The most promising manure treatments at the storage and field are about the cleaning frequency. For ammonia the reduction could be around 70% if we increase the cleaning frequency. For instance, removing the manure every day or twice a week instead of the practices that we are doing now would increase the costs, but these can be offset by improved health of animals. Urine and faeces separators

could also be useful in this case, since urine is much more prone to emissions than faeces. There are floors that separate the two automatically by small holes in the floor but they are costly.

Regarding the measures at barn-storage-field level, acidification is one of the most studied ones in the last ten years. When we acidify slurry, we keep the nitrogen in the form of ammonium and thus reduce the emission of ammonia. Other two techniques at the storage and the field level are the separation of slurry and the anaerobic digestion (AD). To make AD processing cost-effective, it is important to apply, in the initial phase of the manure flow, measures that prevent the early degradation of organic matter. In general, ammonia losses increase with AD treatment.

There are a lot of available manure treatments but we need to apply the correct solution for each farm situation. We should avoid always the pollution swapping from different parts of the cycle. Due to the fact that many of the studies have been carried out only on one single manure stage, it is necessary to take the approach of the whole farm and the whole cycle of the manure. In addition to these treatments, the political and technical actions that support solutions should take into consideration the investments at the farm level. When we look at countries like Portugal, there is a small percentage of farms that are applying these.

More information in the slideshow

Panel discussion with speakers and the audience

Moderated by:

- ***Ana Granados, EFFAB-FABRE TP & ATF Vice-President representing the private sector*** - *@AnaGranadosChap*
- ***Ana Sofia Santos, APEZ - FeedInov CoLab & ATF Vice-President representing research providers*** - *@SofiaSantosAna*
- ***Tommy Boland, University College Dublin & Secretary of the EAAP Commission on Livestock Farming Systems*** - *@PallasTb*

The panel discussion started with short presentations of EU projects or past events related to the topic of the day.

- David Yañez-Ruiz, CSIC: presentation of the "*Re*-Livestock" project
- Ana Granados, EFFAB/FABRE TP: Review of research in genetics from the WCGALP2022, World Congress on Genetics Applied to Livestock Production
- Michael Lee, Harper Adams University as representative for the BSAS2022 conference, British society of Animal Science Conference
- Nicolas DiLorenzo, University of Florida, as representative for the GGAA2022 conference, International Greenhouse Gas and Animal Agriculture Conference

Audience: I have heard a lot of times "measure" today. I'm from the Netherlands, so we have those expensive floors a lot. But what I see is that the farmer and the management is really the key. I want to know how you want to achieve these.

David Yañez-Ruiz: In our project, part of the work we are going to do is to evaluate the adoption of innovations that are ready to take up. For example, implementing devices to record individual methane production in dairy cattle farms to eventually include that phenotype into the breeding selection programs. We will evaluate the whole process of implementing those systems in the farm, what is the farmer role, how the data are processed and how they perceive the barriers for implementation. We will account for the role of farmers in many other case studies (13 in total) to cover a range of GHG mitigation options.

Michael Lee: I would like to emphasize the importance of demonstration farms and not just within research organisations or institutes but actually within the farming community. We have lots of networks in the UK working with farmers, including the National Farmers Union, the act of seeing interventions on the ground makes the real difference in adoption and change in husbandry management. I think it is really important question. Really great demonstration networks which are not just relying on the research establishments are crucial.

Ana Granados: When it comes to farmers, perhaps one thing scientists can also do is to give more positive image and explain their achievements. Before explaining the challenge they are facing. We have been showing today a lot of ways to measure the impact of animal farming and what they should do to reduce emissions. We need to reduce emissions, no doubt about it. However, we do have to show the essential role that farmers play and we have to motivate them to continue because very soon we will not have any more. And I'm not exaggerating. So more positive wording about the challenge they are facing and how farmers are already responding, is also important.

Audience: What are the risks of trade-offs for selecting animal for low emission and high efficiency of cellulose digestion? Because for the future we need ruminants which use much more cellulose and less grain but selecting for methane reduction can also select for lower cellulose.

Oscar González Recio: It is true that we want to reduce methane emissions, feed them with grain but then they are competing with human edible foods. If there is this trade-off, I think that more discussion is needed on what are we going to do. We need to consider whether we aim for a type of animal that emits less methane but with feed that competes with human edible food or if we can pay the tax of emitting more methane but with the advantage of feeding them with non-human edible food. In terms of genetics, we know that there is some variability in the population. Regardless of the option we choose, we can breed for more type of animal. And they may be different depending on the scenarios.

Ana Granados: We can also take these triggers as opportunities because farmers and livestock have other roles to play as you always explain to us very well. We don't have to go so far with the reductions of emissions because we are providing these other benefits ; we need to balance both to safeguard the benefits. Then, they need to be measured and taken into account to be integrated to the LCA.

Audience: It's a kind of follow up question: when you get in more of these measurements, estimates of methane on individual animals, are you finding genetic correlations with other traits or conformational, production or health traits or any evidence of that?

Oscar González Recio: Yes, a lot of correlations are estimated with some important traits from the productive point of view: milk yield, protein yield, etc. Also, it is important to take into consideration the positive correlation with feed efficiency. It's a complex production system.

Audience: When you looked at the traits that led to reduced methane emissions, you get a measure of methane emissions per unit of milk. Is that a small-time scale measurement or is it for the full life cycle of the animal? When you are making those comparisons, are the animals being fed the same thing and are you guaranteeing that they are in fact eating the same thing? Could it be the case that they have reduced methane emissions but that is because they are selecting different feed from what you are giving?

Oscar González Recio: We are measuring with devices for 15 days or one-month period, so we measure every cow individually during one month in the farm and then we come back later and at the end we do this in a lot of farms. We try to get like a longitudinal overview because it's not the same if they are at the beginning of the lactation or at the end. Then, we try to correct the model. The animals in the farm have the same diet. We know the characteristics of the ration, and they may differ between farms. We need to consider that, as you said, it's not the same if they are in a grain feed scenario or more cellulose based. We apply our genetic models and what we aim is to see differences between animals that are under same circumstances, so we may know that, under these circumstances, which animals are more efficient.

Afternoon session - EAAP session #13

GHG emissions mitigation in practice

At farm gate: feed systems, increased soil carbon sequestration and energy production

By Anne-Catherine Dalcq, CEJA *@_CEJA* *@AnneC_Dalcq* *www.ceja.eu*

Anne-Catherine Dalcq comes from Wallonia, Southern Belgium. She works on the family farm which produces milk, meat and cereals. Anne-Catherine is a bioengineer and holds a PhD in agricultural sciences. She also taught rural economy and statistics at Gembloux Agro-Bio Tech (University of Liège). She travelled to France, Ireland, Estonia and Canada in the framework of her academic duties to study the diversity of farming practices. She joined in 2009 the "Fédération des Jeunes Agriculteurs" (FJA), the Walloon young farmers organisation, where she was first a representative at the local level before moving to the national level becoming in 2019 Vice-President of FJA's Board. She has been CEJA's Vice President since June 2021, working more specifically on soils and land access and land use.

Abstract # 39229:

At the farm "de la Gobie" in the centre of Belgium, several practices are implemented to deal with carbon at the level of the farm. Grazing was kept to feed the cows and is optimized. So the permanent grasslands allow carbon sequestration. The temporary grasslands also, they are seed for minimum 3 years, which allows also to sequestrate carbon. Moreover, the mix of seeds contains an important part of legumes. This decreases the needs in nitrogen fertilization and produces a forage more concentrated in protein, decreasing our dependence to purchased protein. We sow also alfalfa to have more forage with higher amount of nitrogen. We are going to test the direct sowing of corn silage in the temporary grasslands for the first time this year. We use mix of cereals and legumes as cover crops that we harvest at Spring to feed a part of our herd. Manure, slurry and soil analyses are realised to have an optimised use of nitrogen. We also calculate the benefit of nitrogen fertilisation on the delay of the first cut. Indeed, in time of high of price of nitrogen fertilizer, it can be more interesting to wait two weeks more for the first cut.

Farmers have faced big problems this year because of the drought (almost 0 unit), which arises questions for the future. To cope with these extreme conditions, Anne-Catherine Dalcq stresses the importance to implement certain practices as it can help in drought context: lucerne produces even in dry conditions, temporary grassland rich in legumes need less nitrogen fertilisation and are more resistant than a rye grass alone and less soya is needed because there are more proteins within the grass, etc. Trees can be a solution to keep humidity but can impact the yield and need time for the maintenance. Irrigation would maybe be needed to keep cows grazing on permanent grasslands, as a strategy of a dairy farm but represents a cost. Forage intercrops may be useful for the suckling cows but not a total solution for dairy cows.

Solutions to avoid loss of carbon: no tillage practices if earlier harvest of forage intercrops and early passage of the machine on all the parcels. Droughts decrease the climatic window to implement no tillage practices. These ones are ever more difficult to implement if you practice no tillage for a short time.

Anne-Catherine Dalcq has also the plan to develop biomethanisation on the farm. This opportunity may help the fertilisation of crops with more mineralised organic matter produced from the manure, produce

energy and decrease the GHG emissions. For small and middle size farms, collective biomethaniser can be a solution to share work, responsibilities and the level of investment.

More information in the slideshow

Breeding towards efficiency in Finnish dairy and beef cattle improves environmental performance

By Sanna Hietala, LUKE *@LukeFinlandInt* *www.luke.fi/en*

Sanna Hietala is research scientist in Natural Resources Institute Finland. Sanna's research focuses on environmental sustainability of food production and consumption. Her expertise is in environmental life cycle assessment and environmental footprints. She is involved in several projects concentrating on livestock production development and emission mitigation from livestock. Besides sustainability analyses, she has focused on method development for LCA.

Abstract # 39940:

Livestock production is acknowledged for its large footprint on environment, and it has been estimated that it is responsible for 14.5% of all anthropogenic GHG emissions (Gerber et al., 2013). The emissions of the food system are understood to be mainly generated in primary production and agricultural processes, on farms. As a large part of livestock sector's emissions are generated in ruminant production, especially the cattle-based primary production is driven to mitigate its climate change impact. Regarding cattle production, good feed efficiency and improved production yields can be seen as major factors in also improving the environmental performance and efficiency. The key elements in improving these relies in genetic improvement. In the ongoing project A++ Cow in Finland, the main objective is to develop genomic prediction models to identify dairy cattle that inherit genetics for improved feed efficiency, lower methane emissions from enteric fermentation and thus, to improved resource efficiency and environmental impacts. This work is conducted in close collaboration with dairy cattle breeding stakeholders and with the largest Finnish dairy producer Valio ltd, utilizing vast farm data from company's suppliers. Here, the life cycle assessment and impacts of genetic selection of dairy cattle to climate change impact are presented for Finnish dairy in collaboration with Valio ltd. In preliminary results for dairy cows, the impact of breeding was seen to achieve -10% to -19% reduction to dairy and dairy beef production at farm level with scenarios for breeding to 2035 and 2050. Similarly, in ongoing BeefGeno project, the preliminary results indicate up to 15% difference in climate change impact of beef fattening phase, when assessed cattle was ranked based on the Finnish breeding scheme traits. Thus, it can be stated that efficient breeding is an effective tool to mitigate emissions to environment.

The aim in this study has been to breed towards efficiency in Finnish dairy and beef cattle and estimate the reflected improvement of environmental performance. A life cycle assessment (LCA) was conducted utilizing the previously constructed Finnish LCA model for beef and Valio's LCA model for dairy, from the cradle to farm gate as part of the projects A++ Cow and BeefGeno. For the assessment of dairy production, the Nordic Total Merit was used in genetic evaluation of the cattle and project will produce the first genomic prediction for feed efficiency. The preliminary results show that, based on genetic improvement alternatives, a 13% reduction of GHG emissions is possible in dairy production until 2050. For this, a reduction in feed requirement is needed due to improved feed use efficiency which will provide a dilution effect. Ultimately, less cows will be needed to produce the current amount of raw milk. In the BeefGeno project, the aim has been to work on genomic selection to improve self-sufficiency and efficiency. The slaughter animals were categorised to better performing and worse performing based on genetic evaluation data. Suckler cows were categorized based on number of calvings during their life span. For the analysis of different cow-calf systems, different combinations of suckler cows and offspring were

made. Results showed that the best performance could be yielded by combining an average suckler cow with a Q75 upper quartile, genetically estimated as better performing, calves. The analysis was conducted for Hereford and Charolais separately and a 12% reduction potential in climate impact of between worst performing and best performing quartiles was found for Finnish Hereford and 14% for Charolais.

More information in the slideshow

GHG emissions mitigation in practice: a Dutch farmer with monogastrics & ruminants

By Iwan Gijsbers, ZLTO *@ZLTO* *www.zlto.nl*

Iwan Gijsbers was born on a small farm with cows and pigs in the Netherlands. In those days, his parents were stimulated by the government, advisers and banks to expand their farm. The farm expanded and specialized into a pigfarm. After his study, he became a consultant for farmers and developed the pigfarm together with a companion. As a consultant, he helped farmers with developing their farms. Then, he started his own consultancy agency and an agricultural lab. In the lab they analyse soil, manure, nematodes and water for the farmers and microbiological analyses for the feed- and food industry. In addition to his work, he joined local politics and the farmers association to represent the interests of the farmers.

Abstract # 40350:

In the Netherlands, there is a 'climate-deal' with industries and farmers. As farmers, we work with the government, scientists and farmers in a programme to reduce GHG emissions that is based on an integrated approach to feed animals, manure and housing. As farmers, we already produce with a very efficient carbon footprint by state of the art production systems. Now we are going to the next level: our carbon footprint becomes even more efficient by integrating smart solutions. Our ruminants eat all the feed we can't digest, our monogastrics eat all our leftover food. With smart animal- and feed management we reduce digestive GHG emissions. With smart manure removal systems, we mitigate GHG emissions from animal housing. We also realtime monitor these emissions so we can hold accountable based on real emissions. In combination with manure processing, we produce natural gas and organic fertilisers to replace synthetic fertilisers. With this integrated approach, we farm in a circular and sustainable way to keep feeding the world.

75% of the emission of methane in the Netherlands come from cattle, and the largest part of the emissions comes from the animal itself. In pigs, the largest part for the emissions comes from the manure and the storage of the manure. To work on this, the NEMA model is used: National Emission Model for Agriculture. It is set up for nitrogen, but it also works for methane. The model shows where the most benefits can be reaped. We need to look at the emissions with an integrative approach, including all GHG emissions in the equation. For ruminants, there are several solutions to reduce GHG emissions on different levels:

- Animal: breeding / rearing young stock
- Feed: reducing raw protein
- Manure: reducing storage / production of biogas
- Management: hygiene / manure management

Applicable low-cost solutions are needed. Housing measurements are expensive, and a lot of investment is needed for this. Management choices are easier to implement.

In monogastrics, the main solution is to reduce storage or the production of RENURE. RENURE is the processing of nitrogen fully or partially derived from livestock manure under controlled conditions. The

use of RENURE can provide a reduction of ammonia emission during land fertilisation. The innovation power needs to be sped up on this point and EU legislation is needed.

More information in the slideshow

Vision industry: Danone & its project that aims to support French dairy farmers in their Carbon footprint reduction

Maëline Baudet, Danone *@DanoneFR*
http://ecosysteme.danone.com/projectslists/les-2-pieds-sur-terre/

Maëline Baudet has a degree as agricultural engineer. She has been working in the dairy sector for 6 years, first in interprofessional organisations and then within the Danone group. She is in charge of the deployment of Danone's Agriculture Regenerative Milk roadmap in France. The aim is to steer a continuous improvement approach on the themes of animal welfare, improvement of soil health, preservation of resources (water, biodiversity…) and reduction of the carbon footprint; this with the 1,500 partner farmers.

Abstract #40340:

Dairy farming contributes to 6% of France's greenhouse gas emissions. More than 90% of these emissions come from animals and farm inputs. As such, there is considerable need for creating awareness and supporting milk producers to improve farming practices. The Danone Ecosystem Fund has joined forces with Danone Produits Frais France, Les Prés rient bio, Idele (French Livestock Institute), and MiiMOSA (a crowdfunding website dedicated to agriculture and food) in order to implement *Les 2 Pieds Sur Terre*. The programme consists of supporting French dairy farmers as they reduce their carbon footprints and improve soil health, while increasing their competitiveness and enhancing the image of agriculture among the general public. The programme covers the following dimensions:

- Measuring the carbon footprint of milk and creating awareness among farmers by conducting carbon diagnostics (1,604 in March 2021).
- Supporting farmers in identifying concrete carbon reduction projects through further carbon diagnostics (351 in March 2021).
- Implementing a collaborative and digital crowdfunding solution to help finance those projects, then offering technical and financial support (149 farmers in March 2021).

With a range of technical partners, les *2 Pieds sur Terre* also launches pilot projects (4 existing in 2020), involving groups of farmers who try out innovative practices regarding soil preservation, feed autonomy and pesticides reduction. The goal is to formalize results & keys for success in order to share them with the professional dairy network.

Beyond the significative benefits on soil health, carbon sequestration, the decrease in emissions and the better understanding farmers have of their levers of action, the programme actually raises pride among farmers since 41% of interviewed producers say they are more eager to talk about their job and feel proud about it.

Danone is determined to conduct the transition to a low carbon economy. Its ambition is to become carbon neutral by 2050 through emission reduction, sequestration and offsetting the emissions that remains. Milk is the huge part of total emissions, hence a dedicated programme on milk production, but of course also on other pillars (reducing waste…). Several programmes have been launched about regenerative agriculture, to accelerate the transition, funded by the ecosystem fund. In France, all the Danone producers can benefit for free from the programme. One of these programmes is "*Les 2 pieds sur Terre*" and aims at reducing the carbon footprint by 15% by 2025 while improving the image of agriculture.

Different partners are involved: Ecosystem fund (funding), Idele - the French Livestock Institute (technical advice and diagnosis), MiiMOSA (setting up projects and crowdfunding).

The idea was to onboard 100% of Danone's French farmers into the project with 4 levels:

- Measurement and awareness (level 1 CAP'2ER®)
- Personalised support (level 2 CAP'2ER® & individual technical advices)
- Funding and implementation (technical and financial support, co-financed by Danone, and the MiiMOSA platform)
- Experimentation and dissemination (collective training, 4 collective pilots launched)

Several levers of actions exist: cattle management (33%), soil and crops management (26%), livestock feed (23%). After two years of implementation, 40% of the actions are finished, 45% are still on-going and 15% are forsaken. 213 farmers contracted a project co-financed by MiiMOSA (1.3 M collected since 2018). Carbon emissions have decreased by 7.8% since the launch of the programme for the milk production. Farmers are mainly satisfied with the programme (decreasing production costs, improving resilience of the farm, improving knowledge on GHG, creation of social link). Even if the pathway is very long, main actors of the programme are already proud of the work achieved and hope for more impact on carbon footprint until the end of the programme in 2023.

More information in the slideshow

Panel discussion with speakers and the audience

Moderated by:

- ***Ana Granados, EFFAB-FABRE TP & ATF Vice-President representing the private sector*** - *@AnaGranadosChap*
- ***Ana Sofia Santos, APEZ - FeedInov CoLab & ATF Vice-President representing research providers*** - *@SofiaSantosAna*
- ***Tommy Boland, University College Dublin & Secretary of the EAAP Commission on Livestock Farming Systems*** - *@PallasTb*

Audience: Concern of ammonium is more about human health than environment. We should not minimize the problem but face it.

Iwan Gijsbers: we really want to face the challenge. We are convinced that if we take the lead, we can bring a real solution. We need facilitation by the EU, legislation (use of RENURE instead of mineral fertilisers…).

Audience: With regards to feed additives, do we have any data on long term effects? Do we have any promising data on it?

Jamie Newbold: This is a real challenge. We need effective tools. Plant extracts have potential especially in the dairy industry. For this, we need 6-months trials. For other products, we need multi-year trials.

Audience: Does Danone have experimental farms? Has nutrition strategy (data analysis) been measured?

Maëline Baudet: Danone does not work on experimental farms but only with commercial farms: experimentations are conducted on farms on a voluntary basis. CAP'2ER® (tool to estimate carbon footprint and actions to improve it) gives a precise measurement of carbon footprint, and levers of improvement to reduce carbon footprint. Nutrition and feed management is one of the most effective, therefore many farmers decided to work on nutrition & feed.

Audience: How can we verify if the products are efficiently used?

Jamie Newbold: It is important to understand why the plant extract have been evaluated differently. We could use sniffers, but we have been using feed additives for a long time and we have established ways to work with them.

Audience: Manure processing is a good lever to reduce impact, but it has a cost (pumping among others). Do we have a cost-effective way to reduce emissions?

Iwan Gijsbers: Processing manure is expensive, but systems have evolved and are more and more efficient (5-10 years of experience in this area). It is also interesting to export manure derivatives (phosphorus for instance). Arable farms are willing to pay for these derivatives. There are still lots of effort to be made to convince farmers to use these products.

Anne-Catherine Dalcq: processing manure is interesting because of the price of the energy and the price of the mineral fertilizer. It costs now 600 €/ton (but before 100€/ton), so it becomes more and more interesting. We currently live with a big economic crisis, but we farmers have a big opportunity to produce energy on the farm and fertilizer, it is time to get more resilient in face of a war. We call for public support (farmers, environment, public) as it will be the deliverer of an exosystemic service.

Audience: There are recommendations about minimum tillage with corn/maize silage. How to deal with soil health to grow these products?

Anne-Catherine Dalcq: Organic matter in the soil is quite good on my farm but we love cows so we still breed cows and have manure. Thanks to the manure we put more organic matter in the soil than the neighbours and keep good soil health.

Audience: Which motivations to do? What you do for climate change (subsidies, cooperative, young farmer…)? As CEJA vice president, how do you see the uptake with young generations?

Anne-Catherine Dalcq: as farmers, we had the feeling to pay lots of inputs but with not enough value for our products in exchange. So, we decided to implement practices with less inputs, to pay less. I am also aware of what can be done thanks to my background (PhD, bioengineer…). European young farmers are really willing to develop these practices and build this new framework for agriculture, to write the path towards sustainability, as it is the programme of our CEJA mandate these two years. Some practices do have a cost, with or without long term benefit and we need time and support to support this. But be sure that we are very motivated.

Audience: What policies or financial supports in your countries?

Anne-Catherine Dalcq: At the beginning of the CAP, money was given for production, but too much production, so it converted into subsidies per ha. Now, there are compensation of revenue because we don't sell the production at the right price, and we receive some money for environmental services. However, at each change of CAP, we have less and less means to reach the increasing ambitions.

Audience: Why is there discussion in Finland about the suckler beef herd? What is the future for the herd?

Sanna Hietala: In Finland, the beef production is based mainly on dairy breed. But today, as the dairy production has already become more efficient and number of dairy cows is reducing we need also the beef breed production to improve self-sufficiency. Beef breed production is needed to compensate for dairy beef production even more when the efficiency of the dairy chain is improved. How this would affect the total emissions from the system, we haven't looked into this.

Wrap-up of the panel discussion:

- Practical and inspiring solutions,
- Lots of motivation from the farmers representatives and industry,
- Goal legislation vs other legislation: from farmers and for farmers.

State of implementation of good practices in various EU projects

By Josselin Andurand, IDELE *@InstitutElevage* *www.idele.fr*

Josselin Andurand is an engineer specialized in beef systems and environment at the French Livestock Institute. Since 2016, he has been working for the Environmental unit of the French Livestock Institute. He oversees the "Life Beef Carbon" project (mitigation of the GHG emission from the beef sector) and coordinates 49 partners and more than 170 technicians from France, Ireland, Italy and Spain. He is also participating with the French Ministries to a methodology to value carbon credits, related to the mitigation strategies. He is also responsible of the biodiversity thematic for the environment department of Idele since 2020.

Abstract #40337:

To meet the objectives of the Paris Agreement, the EU livestock sectors have taken steps to reduce the products carbon footprint by 15 to 20%. These approaches are based on training for stakeholders involved in the sector, farms environmental and carbon assessment, development of action plans and support for livestock farmers. Thanks to *LIFE CARBON DAIRY*, *LIFE BEEF CARBON*, *LIFE GREEN SHEEP*, more than 20,000 mixed crops and livestock farmers are moving to low carbon production systems. Based on a farm global approach, it makes it possible to ensure consistency between all the productions of a farm and thus to optimise the carbon cycle, forage and protein autonomy, and the use of animal waste... In France a MRV (Monitoring Reporting Verification) *CAP'2ER* & *CARBON AGRI* approach has been developed to ensure the certification of carbon gains under the Low carbon standard. This approach is essential for optimising farm operations, applying low carbon practices and certifying carbon gains. Combined with a multi-criteria environmental assessment (carbon, water, air, biodiversity), it also avoids the transfer of environmental impacts. This mechanism is an operationalisation of the European *CARBON FARMING* initiative which refers to the management of carbon pools, flows and GHG fluxes at farm level, with the purpose of mitigating climate change. For upscaling these initiatives, 3 EU projects i.e. *LIFE CARBON FARMING*, *CLIENFARMS*, *CLIMATE FARM DEMO* with up to 28 countries involved are in progress. They will permit to finalize a common accounting framework at EU scale, to certify GHG reductions and to reward farmers for applying mitigation practices in accordance with the *CARBON FARMING* initiative supported by the commission.

Farmers and advisers are the centre of the game to lower emissions in France. An evaluation conducted about the reasons that incite farmers to implement low carbon practices shows that financial incentives came as 3rd position. There is a need for incentives to foster the implementation of the mitigation or reduction practices. In this context, in parallel of the 3 *Life* projects, a "*low carbon*" label linked to all sectors was built with the French Ministry of Agriculture. It works as follow:

- ⇨ Audit for setting up the baseline (1st audit with *CAP'2ER®* tool - more than 15,000 assessed): life cycle analysis, certified by external organism.
- ⇨ Mitigation action plan among 40 mitigations practices:
  - GHG emissions: inputs, herd management, fuel & electricity, feed, crops management & fertilisation, manure management
  - Carbon sequestration: cover crops, avoid bare soil, agroforestry, grassland management
- ⇨ Application of mitigation measures
- ⇨ Quantification of CO_2 reductions (2nd audit)
- ⇨ Verification and certification of the carbon reduction (carbon credit)
- ⇨ Payment of the farmers for carbon reduction

The idea was to put the farmers in the middle of the reflection. The France carbon Agri Association was created putting around the table farmers, project developers & advise companies, Ministry of Ecological Transition, funders.

Questions & answers:

How do you deal with the issue of permanent soil carbon?

- ⇨ It is a big issue; the main carbon methodology that we use is about carbon emissions mainly and not carbon sequestration.

What about the farmers who were already doing well?

- ⇨ It is based on the carbon credit, as it is a premium for those who are not performing very well. Today the method is not appropriate for these farmers. The Label is not adapted to very optimised farms.

The label "low carbon" is trying to be copied in other countries and the commission is very aware of this programme.

More information in the slideshow

Time off feed affects enteric methane and rumen archaea

By Stuart Kirwan, Teagasc *@teagasc* *@KirwanStuart* *www.teagasc.ie*

Stuart Kirwan is a post-doctoral researcher with Teagasc at the Animal Bioscience Research Centre. Stuart is working on an EU funded project, MASTER, looking at the role of diet, host genetics feed efficiency and rumen microbiome on environmental output in cattle and sheep.

Abstract #40272

Enteric fermentation of feed is the primary source of methane emission in agriculture, accounting for 5% of global GHG emission. Enteric methane is a by-product of microbial fermentation that is exclusively generated by methanogenic archaea in the rumen. In addition to the microbiome, the quantity and quality of feed consumed by ruminants are important factors influencing methane emissions, with higher forage intake associated with increased methane production. However, there is a lack of studies investigating the impact of time off feed on ruminant methane emissions and rumen microbiome. In this study, Portable Accumulation Chambers (PAC) were used to quantify methane emissions from 96 Belclare ewes grazing permanent pasture. All ewes were removed from pasture in the morning and put through PACs in lots of 12, on two separate occasions, 14 days apart, for a duration of 50 min, with methane (ppm) recorded at 0, 25, 50 min. After exiting the PAC, a sample of rumen fluid from each animal was collected using a trans-oesophageal apparatus for further microbial analysis. Statistical analysis of methane production data was conducted using a repeated mixed effects regression. Taxonomic and functional analysis of the rumen microbiome was conducted using Metaphlan3 and Humann3. Statistical analysis of microbiome data was conducted using Maaslin2 and Kruskal Wallace test. BH was used to correct for multiple hypothesis testing. Methane emissions decreased as the duration off pasture increased ($P<0.001$). Time off feed did not influence the taxonomic and functional profiles of the bacterial community ($P.adj > 0.05$). However, the abundance of Methanobrevibacter sp. YE315 was affected by time off feed, showing increased abundance in both early and late time points (Kruskal $P=0.0052$). To conclude, methane emissions and the rumen microbiome are affected as the duration of time off feed increases.

The rumen microbiome is responsible for the breakdown and fermentation of feed within the rumen. During this process, methane is produced as a result of microbial fermentation, which is a potent GHG with a global warming potential, 28 times that of carbon dioxide. Enteric methane production accounts for 40-46% of global agricultural emissions, with national and international commitments to reduce GHG emissions. In Ireland, 6% of the enteric methane is produced by sheep. Sheep are an important enterprise; they promote biodiversity and economic sustainability to rural areas. There is no data on the effect of time off feed on the rumen microbiota. Therefore, the objective was to investigate the effect of time off feed on methane emissions and the rumen microbiome in sheep. The study included metagenomics and transcriptomics including taxonomic and functional profiling. Results showed that time off feed decreased methane emissions and changed the rumen bacterial community. Furthermore, no significant effects for time off feed were found on gene activity.

More information in the slideshow

Alentejo's beef farms economic and environmental performance through a regionally developed decision

By Manuel Dos Santos, Técnico Lisboa *@istecnico* *https://tecnico.ulisboa.pt*

Manuel Paiva dos Santos has a degree in Economics and a degree plus Master in Agricultural Engineering, with a major in Agricultural Economics. After assuming different roles in the agribusiness industry, in Portugal and abroad, he started to collaborate with Animal Future and Food & Biodiversity, among other projects. He is now pursuing a PhD in Environmental Engineering and his research interests regard rural development and the agricultural sector, and include valuation and monetization of ecosystems services, input-output analysis and strategic environmental assessment.

Abstract # 40283:

In this work we applied a decision support tool for extensive animal production, focused on ruminant production in Alentejo (Portugal), in so called pasture-based beef farms (PBBF). This region plays a crucial supporting role for meat production in Portugal due to its availability of grazing land. The applied tool was tailored to the region's characteristics and main production systems and consists of integrated modules for farming management, including environmental and economic aspects. It includes an innovative and specialized grazing management system based on the estimation of pastures productivity, an environmental assessment system for calculating the environmental impact of each farm, based on Life Cycle Assessment. This allows to simulate different scenarios to test the effects of several practices and the consequent environmental and economic outcomes. In this work we used the tool to model 25 beef and/or sheep farms. Farm-level data was collected under the scope of Animal Future project. Results can be divided in two levels. The first refers to economic performance of the surveyed farms in terms of production and efficiency, including a social dimension analysis (as labour and land tenancy indicators). The second level of results refers to environmental performance of PBFF. The accounted environmental impacts were greenhouse gases emissions, water and energy consumptions, and use of pesticides. This work helps to incorporate the consequences of global climate change in terms of farm management, in a regionally adapted way.

Case study results:

- On average, PBBF in Alentejo have 182 ha, 98 LU and occupy 0.39 full-time equivalent AWU;
- A significant share of pastures are sown biodiverse pastures, with additional capacity for carbon sequestration;
- These farms and respective production systems additionally provide a whole range of ecosystem services.

Main take home messages:

- Economically, PBBF are farms specialized in animal production that obtain a very low operational results per ha, being subsidies crucial for the maintenance of their activity;
- In environmental terms, enteric CH_4 is the main source of GHG emissions in PBBF while energy and resources consumption have low relevance;
- For a subset of n=25 PBBF, the average carbon footprint was 22.4 kg CO_2eq/kg LW, but considering carbon sequestration this value decreased to 16.2 kg CO_2eq/kg LW;
- TerraPrima tool is an integrative and useful tool that fully assess the economic and environmental effects of beef production in Alentejo, taking into account regional specificities.

More information in the slideshow

Phytochemical and in vitro methane inhibition of plant extracts as influenced by extractive solvents

By Abubeker Hassen, University of Pretoria *@UPTuks* *www.up.ac.za*

Abubeker Hassen is an Associate Professor of Ruminant Animal Nutrition and Pasture Science at the Department of Animal Sciences, University of Pretoria in South Africa. His research focuses on developing sustainable feeding systems for ruminant production in Africa with an aim to improve feed utilization efficiency while reducing the environmental footprint of the ruminant production system. His research group has identified effective dietary additives based on plant extract for reduction of enteric methane emission, and is currently working to identify marker metabolites associated with methane inhibition to standardize the end products and sustain the efficacy of plant extract based dietary additives.

Abstract # 39984

Plant phytochemicals are an important area of study in ruminant nutrition majorly due to their antimethanogenic potentials. This study evaluated the yields and phytochemical constituents of four plant extracts as affected by aqueous-methanolic (H_2O-MeOH) extraction and their antimethanogenic properties on in vitro methane production. The plant extracts include Aloe vera, Jatropha curcas, Moringa oleifera, and Piper betle leaves with three levels of extractions (70, 85 and 100% MeOH). The plant extract yields were affected by extractive solvents. The extract yields increased with a decrease amount of % MeOH replaced with an equivalent amount of deionised water. The phytochemical screening revealed that aloin A, aloin B, methoxycoumaroylaloeresin B, homocitric acid (in Aloe vera); tryptophan, vitexin-7-olate, isovitexin-7-olate, quercetin rhamnoside, apigenin-O-rutinoside and apigenin-6-C arabinosyl-8-C hexoside (in Jatropha curcas), cinnamoylquinic acids, Dihydrocaffeic acid (in Piper betle) and most metabolites in Moringa oleifera were relatively more hydrophilic. The methane mitigating potentials of these extracts were evaluated as additives on Eragrostis curvula hay at a recommended rate of 50 mg/kg DM. Although, the plant extracts exhibited antimethanogenic properties in various degrees, reducing ($p<0.05$) in vitro methane production on Eragrostis curvula hay, their antimethanogenic efficacy, TGP and IVOMD were unaffected by extraction solvents and yields. This may be due to an increase in the extraction of both useful and counter-useful antimethanogenic bioactive compounds, as well as little variation in the physical and chemical properties of the extractive solvents. Alkaloids, kaempferol, quercetin, neochlorogenic acid and feruloylquinic acid were noted to exhibit methane reducing properties and directly correlated with crude extract yields. Plant extracts could be more promising and hence, further study is necessary to explore other extraction methods as well as encapsulation of extracts for improved delivery of bioactive materials to the target sites and to enhance methane reducing properties.

A lot has been already said about the impact of enteric methane on global warming predictions. There are many options to reduce the enteric methane and among these are the use of feed additives which has already been mentioned. Plant extracts as feed additives could not only reduce enteric methane production but also could have a positive effect on the digestibility of the feed. However, the challenge is the difficulty to get a consistent product as well as ensuring the efficacy of the plant extract as the net effect is associated to the interaction between a number of metabolites. It is difficult to predict the efficacy of the plant extracts from a research perspective without identifying the key metabolites. Therefore, it is important to identify the bioactive compounds associated with methane inhibition to be able to use them as a marker so that plant breeders could produce varieties rich in antimethanogenic metabolites This would also give us the opportunity to standardize the final product and to get consistent results. The plant extract yields are also associated with the extractive solvents that we are going to use because some of these metabolites have hydrophobic or hydrophilic properties.

The objective of today's work is to evaluate the phytochemical constituents and impact on in-vitro methane emissions of plant extracts as influenced by the extractive solvents. For this study, we have used four different plants: Aloe vera, Jatropha curcas, Moringa oleifera, and Piper betle. Some of these were collected from Nigeria and others from South Africa. These were extracted by using 70, 85 and 100% methanol plus water. The yields of these extracts and the number of metabolites that are associated with methane inhibition were affected by the extractive solvents.

As a conclusion, plant extracts could be more promising but further study is necessary to explore other extraction methods as well as encapsulation of extracts standardized with marker metabolites for improved delivery of the bioactive metabolites to the target sites and to sustain methane reducing properties by slowly releasing the bioactive compounds in the rumen over a long period of time.

More information in the slideshow

Considerations from modelling UK livestock farming: How farmers can reduce emissions

By Harry Kamilaris, CIEL *@CIELivestock1* *www.cielivestock.co.uk*

Harry Kamilaris is Innovation Manager – Sustainability, CIEL in the UK. Harry is the driving force behind CIEL's sustainability agenda for the livestock sector. Harry's specialist knowledge and experience include modelling livestock production systems, carbon accounting, measuring environmental impact and offering mitigation solutions.

Abstract # 40038:

A high-level guide, as well as the impact, of some key mitigations that farmers can adopt to reduce their farm carbon footprint and drive down net emissions as reported through the UK National Inventory was compiled. Using real farm case studies, the mitigations with the biggest effects in ruminant systems were, in order of impact: use of dietary methane inhibitors, increased production efficiency (through improvements in such things as fertility, health, and genetic merit) and converting land freed up by such improvements to woodland forestry. Age at first calving, adoption of anaerobic digestion and use of nitrification inhibitors were also addressed, and modelling found that they can also contribute positively. For monogastric systems, their carbon footprint was greatly influenced by source of feed ingredients. The impact of land use change associated with protein ingredients in diets had the greatest impact on carbon footprint within farm case studies (increasing it by 100% in some circumstances), while the type of protein crop had less effect when no land use change was associated with it. The impact of crude protein and the use of anaerobic digestion were also modelled. Outcomes highlighted complementary as well as contradictory scenarios between the LCA outcomes using a farm carbon calculator, in contrast to the

results obtained for the national calculation of GHG emissions and carbon sequestration using the National Inventory. This report highlights that through wide scale adoption of the most impactful mitigations available, a 23% reduction in GHGs and a 15% reduction in ammonia emissions from UK agriculture could be achieved. Much more mitigation and carbon capture are therefore needed to contribute to the Net Zero.

CIEL is one of the four UK agri-tech centres with the aim to bring independent evidence from the research community and translate it for a meaningful impact along the supply chain. Large part is to attempt to tackle the main issue for sustainable food systems: reduced emissions. An independent summary was provided of the current standings. It included the outline of the key GHG mitigations, strategy assessments and the modelling of impact for different approaches. The life cycle analysis tools are different than the UK national inventory, hence it becomes difficult quickly. Part of the summary was case studies for ruminant and monogastric systems, based on case study farms. To reach the objectives of reducing emissions from agriculture by 64% by 2050, a reduction of 23% can be reached with current technologies. New innovations are needed to reach the other 40%. The main findings of the summary are:

- ⇨ Focus on efficiency: adopt mitigations that also increase profit
- ⇨ New technologies: exploit as they become available
- ⇨ Farm carbon calculators: Essential - define standard and features & reward good practice
- ⇨ Collaboration across sector: delivering change requires a collective effort

The full report is available on CIEL's website.

Questions & answers:

Can the use of rapeseed meal have a global effect?

- ⇨ We tried different scenarios for balanced diets. Yes, locally-sourced soya alternatives do have a role to play. But the way forward is to unify our approach with regards to calculators.

The 23% emission is absolute, is it valuable to also measure emission intensity?

- ⇨ Yes, this would be interesting, but all different metrics have their own role to play. We need to be clear on the context before using any of the metrics.

More information in the slideshow

Take away messages and closing

Frank O'Mara thanked all the speakers for this very stimulating day. We are now at an important point for the animal sector, the EU is moving rapidly towards a carbon neutral sector and carbon farming will become a reality. The pressure is really on the livestock sector to reduce the emissions. Two issues were identified today:

- ⇨ How do we evaluate and count methane emissions? We need to focus on that. Livestock will be more and more assessed on this topic.
- ⇨ There is a huge disconnection between mitigation potential identified for a long time and the emissions reduction achieved.

We are currently at an inflection point:

- ⇨ How do we approach the issue?
- ⇨ We must make a more serious attempt to tackle this issue.
- ⇨ Several good projects today are dealing with this issue and are promising.
- ⇨ As scientists, we are here to find solutions.

Frank O'Mara ended the session optimistically. Final thanks go to the EAAP and the very good balance with ATF, his co-chairman Michael Lee, and the discussion moderators (Ana Granados Chapatte, Ana Sofia Santos and Tommy Boland).

The next ATF event on the topic will be held on 17 November 2022 in Brussels (and online).