Feed-a-Gene

Newsletter

#1 June 2016

Adapting the feed, the animal and the feeding techniques to improve the efficiency and sustainability of monogastric livestock production systems

Editorial

Dear readers,

We are proud to present the first newsletter of the Feed-a-Gene project funded through the Horizon 2020 program of the European Commission. This newsletter provides you with some very first results and on-going activities of the project.

Feed-a-Gene strives to attain a large audience beyond the project partners. This is not only important for the dissemination of project results so that these can be developed further and brought to market, but we also want your feedback on planned project actions. To keep up-to-date on what we are doing and plan to do, please register at the stakeholder platform at **www.feed-a-gene.eu.**

We hope that this newsletter gives you a first glance of our contribution to make monogastric livestock production systems more efficient and sustainable.

Jaap van Milgen (INRA),
Feed-a-Gene project coordinator

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Introducing Feed-a-Gene

Feed-a-Gene is a EU-funded research programme that started in March 2015.

Feed-a-Gene aims to better adapt different components of monogastric livestock production systems (pigs, poultry and rabbits) to improve the overall efficiency of these systems, to reduce their environmental impact, and to enhance food security whilst maintaining food quality.

9.9 M€
EC contribution 9.0 M€

5 years
March 2015
February 2020

23 partners
from 9 countries

Animal production is constantly facing new challenges. In addition to productivity and efficiency, it has become important to consider animal health and welfare, product quality and security, environmental impact, consumer and citizen expectations as well as competition between food, feed, and fuel. Novel solutions are required to increase the efficiency and sustainability of livestock production systems.

Alternative feed sources and feed technologies

The EU will rely on local resources by unlocking the potential of existing feeds and identifying new and alternative feed sources. The diversity in feed sources and technologies requires a combination of skills and expertise to address this issue.

Adapting animals and feeding techniques

Efficiency in livestock production systems can be improved by better adapting the nutrient supply to animal requirements and by a better selection of animals adapted to feed sources available now and in the future. Monitoring devices allow precision livestock production, including precision feeding. Genetic diversity can be used to breed more efficient and robust animals. High-throughput molecular technologies make it possible to pinpoint variability in traits from metabolites to gene sequence. Breeding schemes can be revisited to enhance selection efficiency. These technologies are essential tools to breed animals able to use feed resources that are not or less in competition with other uses.

Expected results

Feed-a-Gene will deliver the following results by the end of the project in 2020:

- Alternative feeds and feed technologies to make better use of local resources, green biomass and food and biofuel by-products.
- Methods for real-time characterisation of the nutritional value of feeds.
- New traits of feed efficiency and robustness to select more adapted animals.
- Models of livestock functioning to better predict nutrient and energy utilisation.
- New management systems for precision feeding and precision farming.
- An evaluation of the sustainability of those systems.

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1st Feed-a-Gene Annual meeting

Foulum, Denmark

The first annual meeting of the Feed-a-Gene project took place on 26-28 April 2016 in Foulum, Denmark. It was hosted by Aarhus University, one of the project partners. The meeting was attended by 74 people, including 14 representatives of stakeholder organisations.

The meeting was organised in two parts: the Stakeholder Day (26 April), for the stakeholders, and the main sessions (27-28 April), for the consortium partners.

The first annual meeting was the occasion for the Feed-a-Gene partners and stakeholders to meet and discuss, and for the research teams to communicate on the progress made in the past year. Attendees enjoyed the warm welcome and efficient organisation of Aarhus University – Foulum (AU). Feed-a-Gene project coordinator Jaap van Milgen (INRA) and project manager Vincent Troillard (INRA Transfert) would like to thank Professor Knud Erik Bach Knudsen and his team at Aarhus University for their hard work planning and organising this meeting.

Stakeholder Day

The Stakeholder Day was the first opportunity for stakeholders to share their opinions and expectations with the research teams. After a welcome introduction by Klaus Lønne Ingvarsen (AU, Head of the Animal Science Department), an interactive discussion with stakeholders resulted in interesting exchanges, notably on the topics of Near infra-red (NIR) analysis, precision feeding, robustness and consumer acceptance. Stakeholders then participated in the workshop on sustainability assessment of production systems organised by Guy Garrod (Newcastle University). The day ended with a presentation by Søren Krogh Jensen of the activities at AU-Foulum related to circular economy, followed by a guided tour by Ejna Serup of the laboratories (protein extraction, animal tests), pilot plants (green biomass production, hydrothermal liquefaction, biogas production) and other facilities involved in the Feed-a-Gene project.

Main sessions

The programme of main sessions of the annual meeting consisted in two days of talks and workshops that involved Feed-a-Gene researchers, consortium members and the Members of the Stakeholder Advisory Board. The latter actively participated to all sessions and provided much valued feedback at the end of the meeting.

Presentations

After a presentation of the meeting's objectives by Jaap van Milgen, the coordinators of the European projects ECO-FCE (Elizabeth Magowan, AFBI) and EU-PLF (Daniel Berckmans, KU Leuven) shared their experience and provided useful advice for the management of the programme.

The first – and very promising – results of the Feed-a-Gene project were then presented by researchers in a series of ten presentations. A summary of the progress during the first year is presented on pages 4 to 8 of this newsletter.

The last talk (Richard Finkers, Wageningen UR) concerned the long-term data management in scientific projects. A summary of this talk is provided on page 9.

Parallel workshops

Feed-a-Gene research teams met together in six workshop sessions to prepare and coordinate scientific activities in the coming months.

From left to right, top to bottom:

- Jaap van Milgen (INRA), Feed-a-Gene project coordinator
- Meeting session at AU-Foulum
- Veronika Halas (Kaposvár University)
- Knud Erik Bach Knudsen (AU-Foulum)

Progress reports for the Feed-a-Gene project

Alternative feed ingredients and real-time characterisation

Feed-a-Gene aims to develop alternative high-quality protein ingredients.

Feed-a-Gene is conducting research in the following areas:

- Novel feed processing and enzyme technologies for enhancing nutritional value.
- Green protein extracted from plant biomass.
- Real-time characterisation of the composition and nutritive value of feeds.

Enzyme technologies

Commercial samples of European rapeseeds and soybeans chosen by IFIP have been sent to partners for *in vitro* tests and for selecting novel proteases and NSPases by DuPont. Commercial rapeseed meal will be upgraded at Hamlet Protein late 2016 and used in a nutritional study at IRTA early 2017. IRTA will study the use of the selected enzymes for improving the nutritive value for pigs. A study with broilers is planned in 2017 at Newcastle University.

Processing technologies

IFIP worked to determine the most efficient parameters for the extrusion pressing and flaking-pressing-cooking of Europe-grown soybeans. In summer 2016, four soybean meals (700 kg each) will be produced using these technologies on dehulled and whole soybeans for a pig trial at Kaposvár University early 2017.

Green protein

Protein extraction from green biomass (red clover, white clover, ryegrass and alfalfa) was carried out at a laboratory scale at AU-Foulum. The resulting products were analysed and used in nutritional assays with rats. In Spring and Summer 2016, green protein extraction will be carried out in a pilot plant. The use of NSPases to increase protein yield will be tested. Early 2017, green protein and the pulp by-product will be used in feed trials in pigs (AU) and rabbits (IRTA) respectively.

Real-time characterisation

Samples from the biological database at AU were selected for NIR scanning and catalogued. These samples include more than 550 samples of feed ingredients and more than 400 samples of feed mixtures with known chemical and biological data from pigs. A postdoctoral researcher was hired to perform NIR scans and data analysis that will correlate NIR data to chemical and *in vivo* data. The work will start in the second quarter of 2016. Wet chemical methods for measuring heat-damaged protein will be developed at Wageningen UR (WUR) starting in the second quarter of 2016. The samples analysed by wet chemistry at WUR will be scanned by NIR at AU.

Working with China

During the meeting, European and Chinese scientists decided that China Agricultural University would work on identifying novel protein sources available in China that could be used to replace imported soybeans, and on enzymes that could improve the nutritional value of feed ingredients.

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Identification of feed efficiency traits related to individual diversity

Feed-a-Gene aims to identify animal traits related to individual variation in the animal response to feed, and overall feed efficiency under different environmental conditions.

Research will focus on:

- Between-animal variation in voluntary feed intake and feed intake behaviour and its consequences on feed efficiency. Progress is being made to determine voluntary feed intake in individual broilers and rabbits which are group-housed.
- Nutrient digestibility with emphasis on the intermediary role of symbiotic intestinal microbiota. New, more rapid NIR-based methods are in development to evaluate nutrient digestibility in pigs. The relationship will be determined between microbiota composition of faeces and excreta, nutrient digestibility and feed efficiency in pigs, poultry and rabbits.
- Nutrient metabolism as affected by nutrient and ingredient supply, feeding strategy, environmental conditions and genotypic differences within and between populations of animals. Studies are scheduled in pigs exploring reasons of variation in protein efficiency in pigs and related traits in dependence of genotype.
- The value of behavioural traits on feed efficiency in pigs. Physical activity, group behaviour and feeding patterns are studied using feeding stations allowing measurement of individual feed intake using new video recording and analysis techniques for studying individual animal behaviour.

In coordination with the other Feed-a-Gene research teams, the new and refined traits will be used to model the response of animals to the nutrient supply and environmental conditions, to further develop the concept of precision feeding and to ease development of breeding strategies with emphasis on feed-efficient animals.

Modelling feed use mechanisms and animal response to nutrient supply and environmental challenges

Feed-a-Gene will develop dynamic-mechanistic models to assess feed and nutrient utilisation for pigs and poultry raised in different environments.

These models will predict nutrient utilisation in different species and between individuals of the same herd/flock. A model is designed to forecast impact of perturbations such as environmental changes and other factors. These models will be the basis for creating a Decision Support Software. In 2015, a conceptual model of dry matter digestion was developed. It

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accounts for different factors of variation including the species and physiological stages. The nutrient flows through the gastro-intestinal tract are represented. The prediction of actual feed intake is crucial for the digestive and the metabolic modules: for this reason, factors affecting daily feed intake were reviewed and quantitative data were collected to develop the equations of the model. Concept of the module for calcium and phosphorus metabolism has also been developed.

Unknown factors that impair growth performance (including daily feed intake) have been described by a spring-damper system. Accordingly, the perturbation can be characterized by two variables that correspond to the animal resistance and resilience. For characterising and estimating variation among individual livestock (pigs and chickens), methods and tools have been developed for estimating individual variation and uncertainty in performance. In addition, these methods are used to estimate uncertainty in future performance, to scale-up to the population level. Through scenario exploration, they can support management decisions across a range of practical situations.

Management systems for precision feeding to increase resilience to fluctuating environments

Feed-a-Gene will develop management systems and automatic feeding devices capable of supplying a diet in real-time adapted to the needs of individual animals or groups of animals.

During the last year, progress has been made on the components of the future management system for precision feeding. The architecture of the decision support tool for real-time determination of nutritional requirements has been designed. This comprises modules such as biological models for requirement calculations or data management system for exchange of input and output data between the different modules. The inventory of situations to be treated by the system has been done. The piloting rules to handle these situations in terms of available data have been decided. The development of the precision feeder device is in progress, with redesign and implementation for growing pigs. This device will be used for experimentation and demonstration activities.

Use of new traits in animal selection

Feed-a-Gene will propose new selection strategies that improve selection for feed efficiency and changes in feed composition in pigs, chickens and rabbits.

The improvement of feed efficiency in monogastric systems raise the following concerns:

- Selection of purebred animals in high quality nucleus farms for the production of crossbred individuals in production farms under optimal conditions.
- Cost of individual phenotyping of on-farm feed efficiency.

Feed-a-Gene studies will target the use of new measurements that take crossbred performance and genomic information into account for selection, with a control of the correlated impacts on the animal sensitivity to environmental changes, product quality, environment and welfare. During the first year, the main tasks consisted in developing statistical

models that include the genetics of feed efficiency to account for longitudinal data (PhD project at INRA), variability of the animal responses to select for robustness, and social interactions between animals raised in groups (post doctoral researcher at IRTA).

First developments were presented during the annual meeting. Some results will be presented at the World Rabbit Congress in China (June 2016). Trials are on-going to collect data on pig behaviour, welfare and robustness (Topigs Norsvin, INRA, IRTA) in relation with feed efficiency, as well as trials in layers to produce genomic samples for understanding the response to high dietary fibre/low energy diets (INRA). Analyses of biological samples have been organised, with partial sequencing of gut microbiota and animal genotyping in rabbits (INRA and IRTA, with CRAG), pigs (INRA) and broilers (INRA). Studies of selection strategies using crossbred and genomic information will start mid-2016.

In 2017, individual phenotyping of feed intake in chickens (INRA, Cobb) and rabbits (IRTA) and on-farm digestibility data in pigs will be available from other Feed-a-Gene teams to measure large cohorts of animals for genetic studies. Genetic and genomic studies interrelating feed efficiency and gut microbiota in pig, rabbit and poultry will start mid-2016. The link between feed efficiency and robustness to different diets will be studied through the results produced by on-going trials with different partners. In poultry, a deeper understanding of the viability of the traits will be provided using metabolomics analyses and will result in biomarkers of feed efficiency. A post-doctoral researcher will be hired by WUR to produce results on the use of genomic information for selection on feed efficiency. Development of a statistical model will continue and will be applied to the project data (Topigs Norsvin, INRA, IRTA and IFIP). Actions to reinforce interactions with studies on trait definitions and modelling of feed efficiency are planned for the next year.

Sustainability assessment of production systems

New animal production systems resulting from the Feed-a-Gene project will have to comply with sustainability criteria.

Feed-a-Gene will:

- Identify sustainability indicators through a Delphi questionnaire.
- Provide Life Cycle Assessments of feeds, devices and breeding strategies.
- Evaluate the net social and economic benefits of the new system through Cost-Benefit Analysis.
- Investigate farmers' and consumers' attitude towards the adoption of new practices associated with the new production system.

During the meeting, researchers from Newcastle University conducted a stakeholder workshop that was designed to test a draft version of a Delphi questionnaire that will be used to investigate stakeholder opinions on the usefulness of various sustainability indicators for livestock production. Feedback from participants is being used to refine the design and wording of the questionnaire in preparation for its implementation across a sample of 180 European stakeholders in September 2016. The prospective stakeholder list has to be improved and refined before September 2016. IFIP will provide guidance on information to collect in order to prepare Life Cycle Assessment of feeds, devices and breeding strategies developed by Feed-a-Gene. Creda will carry out a market analysis related to novel feeds developed in Feed-a-Gene.

This progress report was established by Ludovic Brossard (INRA), Guy Garrod (Newcastle University), Hélène Gilbert (INRA), Veronika Halas (Kaposvár University), Alfons Jansman (WUR), Knud Erik Bach Knudsen (AU-Foulum), Jesús Pomar (Universitat de Lleida).

FAIR data management and stewardship

Data interoperability for discovery

Dr Richard Finkers (Wageningen UR, Dutch Techcentre for Lifesciences and ELIXIR–NL) was invited by the Feed-a-Gene project to present the concepts of FAIR data management during the Feed-a-Gene annual meeting on 26 April 2016.

The following text summarizes Dr Finkers' presentation.

The life cycle of scientific data comprises creation, processing, analysis, preservation, access and re-use, but the cycle often stops after publication. The lack of long-term data management results in significant data loss, a problem made more acute by the tremendous growth in scientific data production, and discoveries are impeded because data are never published or stored in non-interoperable systems. For those reasons, funders, publishers and research institutes are now requiring data management and stewardship plans. The EU will invest 2 billion € in the European Open Science Cloud, whereas states and the private sector are expected to invest an additional 4.7 billion € in this project.

The goals of data management are multiple. While funders and institutions want to extract the maximum value from research investments, researchers can benefit directly from good data management. For instance, a researcher interested in genotype-phenotype relations between Alzheimer's Disease and Huntington's Disease will be able to combine datasets from various sources in an efficient, time-saving fashion. However, while some scientific communities have been successful in creating data repositories, many researchers are struggling with the new demands. In January 2014, a group of stakeholders defined the FAIR Data principles:

- **Findable**: (meta)data is uniquely and persistently identifiable. Should have basic machine readable descriptive metadata.
- **Accessible**: data is reachable and accessible by humans and machines using standard formats and protocols.
- **Interoperable**: (meta)data is machine readable and annotated with resolvable vocabularies/ontologies.
- **Reusable**: (meta)data is sufficiently well-described to allow (semi)automated integration with other compatible data sources.

This minimal set of guiding principles and practices should allow data providers and data consumers - both machine and human – to more easily discover, access, interoperate, and re-use the vast amounts of information being generated by contemporary science.

Feed-a-Gene meets FABRE-TP

Juan Pablo Sanchez (IRTA) presented Feed-a-Gene at the annual meeting of FABRE-TP in Barcelona, Spain on 10 May 2016. FABRE-TP promotes research and innovation for sustainable animal breeding and reproduction in Europe.

The scientific programme of the FABRE-TP/EFFAB meeting focused on the role of animal production in circular bio-economy and on topics relevant to the animal breeding sector.

Juan Pablo Sanchez presented the objectives and activities of the Feed-a-Gene team. He encouraged the participants to register to be part of the stakeholders platform and presented preliminary results obtained on feed intake recording in rabbits raised in group, and on statistical modelling of group intake data.

The presentation received positive responses. Participants underlined the importance of dissemination and noted that these activities should target not only farmers and companies, but also consumers and the civil society. The multi-species approach of Feed-a-Gene was appreciated. It was recommended to study feed efficiency as a multifactorial parameter taking into account different physiological processes with their own efficiency.

Upcoming events

Feed-a-Gene researchers will present the following communications in 2016.

World Rabbit Congress 2016

Qingdao, China, 15-18 June 2016

Miriam Piles, IRTA: "Using collective feed intake data to select for feed efficiency on full or restricted feeding regimen"

EAAP 2016

Belfast, UK, 29 August – 2 September 2016

Sonia Roger, INRA: "Conceptual model of digestion for pigs and poultry and its factors of variation"

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