

Issue 2

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GERONIMO



Newsletter

Genome and Epigenome eNabled
breeding in MOnogastrics



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EDITORIAL

**Frédérique Pitel
and Tatiana Zerjal
Project Coordinators
INRAE**



Time has flown by, and it feels incredible to be writing our second newsletter.

Two years have passed since the start of GEroNIMO, and we are excited to share with you some of our initial results.

During this period, we have dedicated our efforts to build customized experimental designs, allowing us to collect a large range of phenotypes and samples required to produce methylation and transcriptomic data. Our diligent GEroNIMO partners have collected a vast assortment of animal samples including blood, sperm, and a variety of tissues. In addition we have registered a wide range of performances, encompassing growth and reproduction traits, as well as physiological and behavioral characteristics. DNA and RNA extractions protocols have been optimized, and a workshop was conducted in Uppsala to learn how to analyse methylation data obtained from GBS-MeDIP, the new technique developed by our Swedish partner. Initial analysis on trait genetic parameters as well as QTL identification have also been achieved.

A first objective was successfully achieved by conducting a comprehensive multilingual survey, which allowed us to characterize the management programs of EU local pig and chicken breeds.

We also made remarkable progress in building a comprehensive NIRS spectral database, which is actively being enriched to facilitate the calibration of yolk fine lipid composition and intramuscular fat in pig muscle.

This achievement has been supported by the creation of tutorial videos in various languages, providing guidance for field sampling procedures.

Furthermore, we have developed a SNP based parentage assignment tool for a local chicken breed, and optimized the OptiSel package for the use of the optimal contribution selection method considering the influence of major genes. Additionally, we have initiated research focusing on how to model non-genetic inheritance, a complex and fascinating aspect of GEroNIMO investigations.

To explore the societal and ethical implications of novel technologies in livestock breeding, we have engaged in extensive literature studies, conducted

a series of interviews with an interdisciplinary audience, and prepared for focus group discussions.



To establish effective communication channels with stakeholders and society, we have created portals encompassing a wide range of communication tools such as social media channels, project website, brochures or press releases. In parallel we conducted initial research on intellectual property (IP) and performed market analysis related to our first Key Exploitable, which allowed us to better understand the IP landscape surrounding our project and gain insights into potential market opportunities. To ensure the project's success, we have sought valuable input and guidance from our Stakeholder Advisory Board (SAB) members that gave us relevant advices during SAB meetings. Through these collective efforts, we are seeking to promote effective communication, improve visibility, and lay the foundation for future progress and collaborations in our project. It is gratifying to note that these mutual efforts have been widely acknowledged, particularly during our first project reporting, highlighting the importance of our collaborative commitment to ensure the success of our project!

Until now, genomic prediction has been based on models that take into account, as molecular information, exclusively DNA variants. However, the relationship between the genome and the expression of traits (phenome) is more complex than this, as epigenetic mechanisms also influence phenotypic variation, contributing to rapid adaptive responses to environmental changes. Future models in animal selection should represent this complexity to improve prediction.

Increasing breeding sustainability by enhancing our knowledge about genetic and non-genetic components of phenotypic variability at the population scale, under various environments, is the essence of the GERoNIMO project. The success of the project depends on a close-knit and interdisciplinary team. From the outset, we adopted a 'multi-actor' strategy by organising transdisciplinary discussions involving scientists and major players of the pig and poultry production sector as private breeders, associations and farmers' unions. With them, we identified the major issues of the sector that needed to be addressed in the project. We then enlarged the consortium by integrating partners from other European countries and other disciplines, in particular the humanities and social sciences.

We welcome you to GERoNIMO, a 5-year program involving 21 partners from 11 countries, organized in 8 work packages. In this first year of work, we have largely advanced in phenotype recording and sample collection on commercial populations as well as on local breeds, performed the first large-scale surveys, and will shortly start with the genomic and epigenomics analyses.



GEroNIMO's 2nd Annual Meeting: *Highlights from Bern*

By Tamara Rodriguez - FEUGA, Noraly van Hemert & Çağla Y. Kaya, EFFAB - FABRE TP

The GEroNIMO project partners gathered in beautiful Switzerland for their second annual meeting, hosted by the University of Bern at its satellite location at AviForum in Zollikofen.

The meeting started with a presentation from the project's Project Officer, followed by updates on the work packages.

Work Package 1 is working to unravel the biological mechanisms underpinning efficient livestock production (ELP) traits by conducting in-depth combined analyses on phenotypes, genotypes, epigenotypes, and transcriptomes.

They have found moderate heritabilities for genetic parameters in the background of semen traits in pigs, and preliminary results from the study for causative genes for abdominal fat mass have shown serious candidates.

Work Package 2 is focusing on improving the knowledge about the epigenetic marks that contribute to epigenetic memory in response to environmental factors, in order to quantify the non-genetic inheritance more accurately. Preliminary results from one of the tasks in this project showed that hens transported before hatching rather than hatched on farms showed lower stress, suggesting that their early transfer may have primed them.



2. NEWS

Work Package 3 is focused on biodiversity management using phenotypic, genetic, and epigenetic information. For the case study of the Krškopolje pig – the only autochthonous pig breed in Slovenia – they have collected phenotypes and pedigrees, and calculated the first heritabilities. The next step will be to genotype the animals, allowing for more research outputs to be completed. In chickens, this work package is developing an approach to managing the genetic diversity of local breeds in situ for the Noire de Challans breed. The mating plans are currently under development, with the ultimate goal of scaling up to other European local breeds.

Work Package 4 is focused on improving the predictive breeding models in monogastric animals. This includes investigating existing genomic prediction models that can accommodate epigenetic profiles. The models will be further tested and tried along the project's progress, especially when additional project data becomes available.

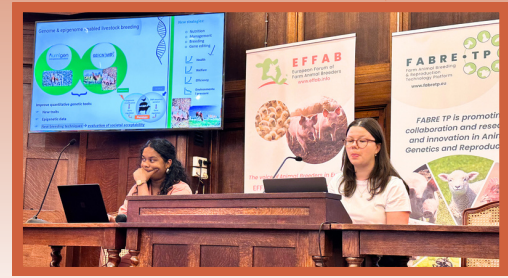
Work Package 5 is focused on the ethical and societal implications of breeding innovations. The first task focused on mapping and analysing the societal context of genetics and animal breeding, and found no new directions compared to a literature review. In general, the respondents were more open towards using breeding technologies for animal welfare purposes than for human purposes (e.g. allergen-free or productivity). It was noted that genome editing could be the wrong solution for the existing problems, and a system change is needed. Follow-up research is currently in progress, exploring the importance of cultural, national, and regional differences.

The meeting was a productive opportunity for the partners to share updates and progress, and to discuss the future of the GERONIMO project.



Bridging Innovation: *GEroNIMO at EFFAB Annual Meeting*

By Çağla Y. Kaya & Noraly van Hemert, EFFAB - FABRE TP



On Wednesday, May 31st, the FABRE TP (Farm Animal Breeding and Reproduction Technology Platform) held its Annual Meeting, bringing together members of the FABRE TP and EFFAB (European Forum of Farm Animal Breeders) to discuss the latest developments in animal genetics and reproduction.

During the meeting, the GERO NIMO project was also presented to the representatives of the breeding sector. It was showcased that the project provides a major step forward in the development of more sustainable and efficient livestock breeding. With the use of Omics technologies the project will characterize animals phenotypically, genetically, and epigenetically. This information will be used to identify the underlying biological mechanisms that affect trait variation and to develop improved selection strategies. The project will also propose strategies to optimize the conservation of genetic and epigenetic diversity.

The participants also engaged in a workshop to define the research and innovation needs in animal genetics and reproduction. Esteemed guest speaker Nikos Zampoukas from DG RTD, European Commission, shed light on the Horizon EU 2025-27 and the next EU Research Framework, outlining the strategic direction for future endeavours.

The FABRE TP Research Agenda 2025-2030 was also presented, highlighting the focus areas and key objectives for advancing animal genetics and reproduction research. Furthermore, the EuroFAANG project took the stage, showcasing the benefits of research infrastructure for research institutions and breeding companies. The day concluded with a dynamic World Café session, allowing participants to engage in lively discussions and exchange ideas on pertinent topics. The insights gathered from this interactive session will contribute to shaping the future direction of animal genetics and reproduction research.

In the closing remarks, the conclusions drawn from the day's discussions were highlighted, emphasizing the collective commitment to advancing knowledge and innovation in the field.

The FABRE TP Annual Meeting proved to be an essential platform for fostering collaboration, sharing expertise, and charting a course for future animal genetics and reproduction advancements. The event successfully showcased the remarkable progress of the RUMIGEN project and established a strong foundation for future collaborations within the scientific community and industry stakeholders.



What is the EuroFAANG Research Infrastructure Project?

By Geena Cartick, EFFAB - FABRE TP

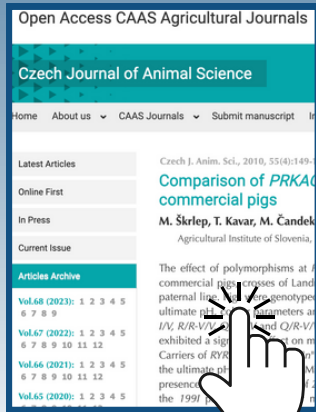
The EuroFAANG cluster, consisting of six Horizon 2020 projects associated with the FAANG initiative, focuses on understanding the functional aspects of animal genomes and their impact on physical traits in farmed animals. The cluster aims to address challenges in animal production, such as resource efficiency, animal welfare, and environmental impact. In 2022, the cluster submitted a proposal to establish the European Research Infrastructure (RI) project, which the EU approved. The project aims to develop a formalised infrastructure for genotype-to-phenotype(G2P) research in European farmed animals. The kick-off meeting in Berlin in February emphasised collaboration and milestones, focusing on creating a web portal for centralised access to resources and data.

Surveys will be conducted to build a network of experts and gather insights on technological advancements for genotype-to-phenotype prediction. The EuroFAANG RI project will establish a common infrastructure and service access policy in collaboration with other research infrastructures. It will engage breeding companies, scientific experts, and the FAANG initiative to drive G2P research in European-farmed animals. For more information, feel free to contact the project team.

*EuroFAANG RI Project
Coordination:
[EuroFAANG-RI@fbn-
dummerstorf.de](mailto:EuroFAANG-RI@fbn-dummerstorf.de)*



3. PUBLICATIONS



Comparison of PRKAG3 and RYR1 gene effect on carcass traits and meat quality in Slovenian commercial pigs

Škrlep, M., T. Kavar, and M. Čandek-Potokar. 2010. Comparison of PRKAG3 and RYR1 gene effect on carcass traits and meat quality in Slovenian commercial pigs. *Czech J. Anim. Sci.* 55:149–159. doi:10.17221/6/2009-CJAS.

[Read the full version here](#)

4. MEET THE CONSORTIUM

WPI Genetics & Epigenetics in ELP Traits



Ole Madsen is an associate professor at Wageningen University (WU) in The Netherlands, working in the Department of Animal Breeding and Genomics (ABG), leading the epigenomics research.

Ole Madsen - WPI Leader



Peter Karlskov-Mortensen is a veterinarian from the Royal Danish Veterinary and Agricultural University, where he also earned his PhD in animal genetics.

**Peter Karlskov-Mortensen
WPI Co-Leader**

After finishing his MSc in molecular biology at Aarhus University Denmark, he moved to The Netherlands, where he obtained a PhD at Radboud University Nijmegen in mammalian evolution and systematics. Hereafter he worked as a post-doc at Radboud University Nijmegen to continue his PhD work until he started as a post-doc in the ABG department. After a couple of years as a post-doc, he enrolled on the tenure track system.

His current research focuses on studying various aspects of mammalian diversity and (epi)genetic mutational processes shaping mammalian genomes during evolution, domestication and animal breeding.

He is leading WPI with Peter Karlskov-Mortensen, which aims to unravel the genetic and epigenetic components underpinning efficient livestock production traits in chickens and pigs.

The university is now a part of the University of Copenhagen (UCPH), where he is an associate professor in Animal Genetics and Breeding, at the Department of Veterinary and Animal Sciences. Additionally, he is the head organiser of a UCPH cross-disciplinary network called Scenarios for Sustainable Animal Production in the Future.

Peter has worked with genetic mapping and genomics in different domesticated animal species, investigating the genetic and molecular mechanisms underlying a broad selection of phenotypes from monogenic inherited diseases to genetically complex production traits. His main activities today still include one leg in the world of disease genetics in pet dogs and another in pig genetics. The latter includes his work in GERONIMO, focused on identifying the genetic and epigenetic components underlying efficient livestock production traits in pigs (WPI). Furthermore, it includes his work in a project called PigParadigm, which employs a broad array of omics technologies to determine factors of importance for animal health to reduce the use of antimicrobials in pig production.

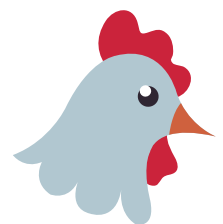


Perceptions of stakeholders involved in preserving local breeds: a survey by the *GEroNIMO* project

By Marie-Jose Mercat, IFIP

As part of the GEroNIMO project, a broad survey was conducted with stakeholders (breeders, managers, advisers and processors) involved in preserving local pig breeds (LB) to collect their perceptions and involve them in the project. It was designed in seven languages, including English and was carried out online. An overall descriptive analysis of the responses of 339 participants is presented; results by country or breed are also mentioned. The data collected covers 11 countries and 32 breeds, with unequal representation by breed and country. Preserving genetic diversity is the main motivation stated by the stakeholders surveyed, followed by the economic activities associated with LB. The animals are raised purebred in small (median size: nine sows) and relatively recent farms (median existence: 7 years); their selection is based mainly on phenotypic features (breed standards, number and quality of the teats). Participants expressed interest in selection, particularly for reproductive traits, but many barriers exist to implementing breeding programmes. Most of them expressed concern about the sustainability of LB, especially for economic reasons. Concerns about compliance with health regulations and fears of infection by pathogens came next. Stakeholders expected support from public authorities, especially to improve productivity and to protect the use of breed names.

For more information, [read the article in French](#) or [watch the presentation in English](#).

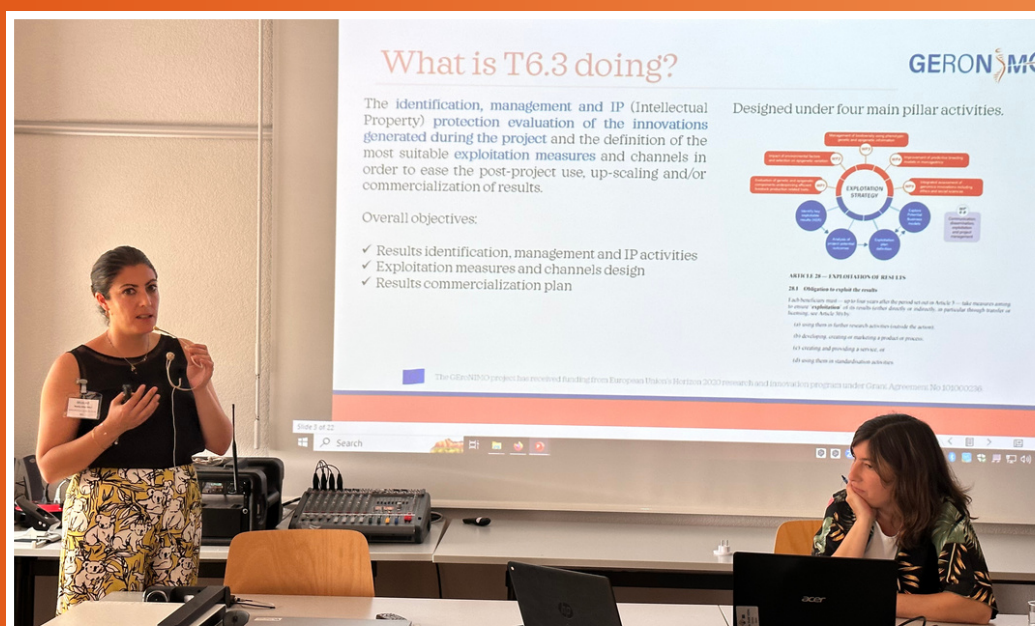


GERoNIMO's Exploitation Strategy: *in constant improvement*

By Noelia Vilar, FEUGA

Within the WP6 the Task 6.2 Exploitation strategy is mainly focused on the identification, management and IP (Intellectual Property) protection evaluation of the innovations generated during the project together with the definition of the most suitable exploitation measures and channels in order to ease the post-project use, up-scaling and/or commercialization of results. Maximizing exchanges among partners and industrial stakeholders is crucial to ensure the project results and tangible outcomes post-project use. At the moment the D6.3 GERoNIMO Exploitation Plan and the Milestone 20 Preliminary version of the Exploitation Plan were successfully submitted.

During this first project period, the project results exploitation officer has carried out the first First IP Workshop for the consortium aiming to raise awareness of IP protection, identify threats and collect interests and Doubts regarding exploitation activities. Besides, to facilitate the understanding of this activity by the partners, a dedicated section has also been created to the Exploitation of GERoNIMO results was implemented together with a self-explanatory video in the collaborative platform of the project together with the design of a specific form to collect the whole range of information necessary for the evaluation of possible exploitation of results at different levels of project development.



5. PROGRESS

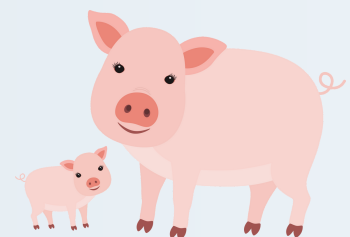
As a complementary activity to well-understand the needs, utility and main drawbacks related to the industrial exploitation of GEroNIMO results a dedicated Round Table on the uptake of the exploitable results was held during the GEroNIMO & GENE-SWitCH Joint Stakeholder Event "Bitcoin or Genomics: Which Bring More?" gathering important stakeholder feedback about the new genome and epigenome-enabled selection models and breeding methods results that are going to be developed within Geronimo and perform a categorisation about the type of results could be the most interesting to exploit industrially and with an obvious societal advantage and why, including among them: to increase livestock production-optimize fertility-optimum feed efficiency, to increase robustness livestock- better resistance to diseases, to improve livestock quality and productive longevity, to decrease greenhouse gas emissions, to follow new breeding methodologies (nutritional and environmental) and to improve animal welfare and health in general lines.

Different main identified needs were identified with a general aim of Pursuit of robustness of livestock and animal welfare. It was also pointed out that Geronimo could contribute to the breeding companies with significant data obtained in the projects to improve their techniques and increase their knowledge in a concise language to improve the knowledge transfer and implementation of the new methodologies improved.

Finally, a review of the state of the art in research and market analysis of IP assets related to the first identified exploitable key results is also carried out continuously in order to carry out a more in-depth analysis of the industrial stakeholders that may have an interest in Geronimo's results.

A preliminary list of 20 EU industrial stakeholders has already been obtained for two main lines of research in the GERONIMO project: (1) 10 key industrial actors were identified within the sector of animal feed companies related to GERONIMO's line of research on the influence of animal feed as a generational change in pig and chicken farming (2) 10 key industry players focused on livestock housing systems, breeding companies and livestock transport companies related to research conducted on how environmental factors such as heat, housing systems, stress could have an effect on reproduction, quantity and quality of eggs and meat, growth, feed efficiency, health or behaviour. Always keeping breeders and animal genetics companies in mind as important stakeholders for the exploitation of GEroNIMO results.

One of the next steps of this activity will consist of continuing to evaluate the state of the art in patents, preparing corporate material of the results of interest to hold potential meetings with industrial stakeholders and starting to present the project and its progress creating awareness and increasing the impact in the poultry and swine industry.



2nd Annual Meeting of GeroNIMO: *Highlights from the stakeholder workshop*

By Tamara Rodriguez, FEUGA & Noraly van Hemert, EFFAB - FABRE TP

Recently, on June 28th, a stakeholder forum, with the theme "Advancing Monogastric Breeding for Efficiency," was held following the Geronimo AM. The forum was organized to discuss and provide feedback on Geronimo objectives and results. Swiss stakeholders Claudia Kasper, Waltraud Kugler, Alfredo Lepori, and Irene Häfliger were present at the forum to introduce and shed light on the Swiss poultry and pig sector. The forum was an excellent opportunity for the participants to exchange views and opinions on monogastric breeding and find ways to improve efficiency in the sector.



During the discussion, inquiries were made about the potential of epigenetics in estimating breeding values for health traits. Irene from SUISAG responded positively, stating that there is indeed a huge potential for epigenetics, particularly for traits like litter size and the environmental effects of animals interacting with each other. A question was raised about whether working on protein efficiency might counteract with the focus toward lower protein diets. Claudia from Agroscope explained that they have already decreased protein levels in their experiments to address this concern.

Lastly, it was wondered why genetic diversity is important for the participants and what they need to do to maintain it. Alfredo from SUISAG responded that maintaining diversity is their priority. He further expounded that Swiss farmers have a lower stocking density, meaning that they have a smaller number of animals, which is a concern for genetic diversity. Overall, the meeting was a productive discussion of the potential and challenges of using NGT in pig breeding. The participants identified several areas where further research is needed, such as the development of better technologies for behavioural phenotyping and the communication of the ethical aspects of NGT to the public.



THE EUROFAANG MOVIE

By Geena Cartick, EFFAB - FABRE TP

Animals possess remarkable phenotypic variation in different climates, which allows them to adapt to diverse environmental challenges. This variation is influenced by both coding and non-coding regions of their DNA. While coding regions consist of genes and constitute only a small portion of the genome, the non-coding regions, comprising 95% of the genome, play a crucial role in regulating essential traits such as milk production and disease resistance. Understanding these non-coding regions and their regulatory elements through functional genome annotation is vital for effectively selecting and breeding animals with desired traits, enhancing productivity and resilience in agriculture.

The EuroFAANG initiative, part of the FAANG consortium, focuses on three H2020-funded projects: AQUA-FAANG, BovReg, and GENE-SWitCH. These projects are dedicated to unravelling the functional aspects of fish, cattle, chicken, and pig genomes. By advancing our functional genomics knowledge, EuroFAANG aims to drive innovation in animal breeding, sustainable farming systems, and agricultural practices to meet economic and societal demands. To stay updated on the groundbreaking advancements in functional genomics and contribute to a more efficient and sustainable future for animal agriculture, visit the project websites or follow EuroFAANG on social media.

Functional annotation of farmed animal genomes is crucial to fully comprehending these regulatory elements and their interactions. Functional annotation creates a comprehensive map of genome features, acting as a navigational reference for geneticists.



EuroFAANG & GERoNIMO: Showcased at the EAAP 2023 Conference

By Çağla Yüksel Kaya, EFFAB - FABRE TP

The EAAP 2023 Conference in Lyon, France, hosted a well-attended session on August 31st, titled "EUROFAANG: Genotype-to-phenotype research across Europe & beyond." The session showcased the results from AQUA-FAANG, GENE-SWitCH and BovReg projects which are ending soon. The session also hosted the three relatively new projects GERoNIMO, RUMIGEN and HoloRuminant where they shared the first results of their research. GERoNIMO was presented by Sandrine Lagarrigue (INRAE) during the event. The session continued with a breeders panel, chaired by Emily Clark and Christa Kühn. This panel brought together industry stalwarts, including Abe Huisman, Romain Morvezen, Olivier Demeure, and Clotilde Patry, to deliberate on how the European animal breeding sector can harness the EuroFAANG Research Infrastructure and its evolving knowledge.

The session encapsulated cutting-edge research to reshape animal breeding practices across Europe and beyond.. The EuroFAANG panel discussion emphasised the significance of genetic diversity, the integration of new information, and the need for basic research and cost-efficient tools to advance genotype-to-phenotype research in farmed animals. Collaboration between industry and research was recognised as a vital component in addressing the challenges and seizing the opportunities within the field of animal breeding.

The recording of the session will soon be available from EuroFAANG [YouTube account](#).

GERoNIMO was presented in different sessions, both by oral presentations and posters throughout the EAAP 2023 conference.



3. UPCOMING EVENTS

GERONIMO Workshop on Limits of Genetic Intervention: *Solving problems of cage-free housing*

By Michael Toscano, UBern

To discuss the limits of conventional selection methods and opportunities for novel strategies, Dr. Michael Toscano (Universität Bern, CH) will organise a workshop (Friday, 10. November, following the 2023 European Symposium on Poultry Genetics).



GENE-SWitCH Final Conference: *Joint Policy & Ethics Workshop with GERONIMO*

GENE-SWitCH is organising its final conference in Brussels from 6 to 8 November 2023 at the University Foundation (Rue d'Egmont 11).

The conference is a hybrid event, attendees may participate in presence or remotely.

GENE-SWitCH delivered new underpinning knowledge on the functional genomes of two main monogastric farm species (pig and chicken) and enabled immediate translation to the pig and poultry sectors.

In full coordination and synergy with global effort and ongoing projects of the Functional Annotation of Animal Genomes (FAANG) community, GENE-SWitCH characterized the dynamics (“switches”) of the functional genome from embryo (chicken) and fetus (pig) to adult life by targeting a panel of tissues relevant to sustainable production.



GENE-SWitCH FINAL CONFERENCE

During the conference, GENE-SWitCH will present its main outputs on:

- Identification and characterization of functional genomic elements
- Implementing FAANG innovation for innovation breeding

Moreover, the conference includes a round table, entitled "The functional genome for future Genotype-to-Phenotype research and applications in swine and poultry", in the framework of the FAANG 10-year anniversary, in particular, discussions will be focused on:

- Genome annotations across developmental phases
- The epigenetic impact of diets
- Genomic selection of swine and poultry.

Policy & Ethics Workshop jointly organized with the GERoNIMO project awaits the participants.

This collaborative event highlights the essence of knowledge sharing and ethical considerations in genomics.

The day begins with an overview of GENE-SWitCH's achievements and its links to GERoNIMO.

GERoNIMO Co-coordinator Tatiana Zerjal (INRAE) and WP4 Leader Mario Calus (WUR) will delve into "What's new in GERoNIMO" before setting the stage for a crucial dialogue on including stakeholders in the ethics debate.

The interactive session, guided by WP5 Leader Franck Meijboom and Koen Kramer from Utrecht University, will explore ethical issues, strategies for policy integration, and the path forward.

For more information on the agenda and registration, please visit the [GENE-SWitCH Project Website](#).



The banner features the GENE-SWitCH logo at the top left, which includes a map of Europe. To the right, a dark blue box contains the dates "6 - 7 - 8 NOVEMBER 2023" and a calendar icon. Below this, a red location pin icon is followed by the text "Brussels, Belgium". The main title "GENE-SWitCH FINAL CONFERENCE" is prominently displayed. A list of key topics is provided: "GENE-SWitCH RESULTS", "DEDICATED PANEL" (with the FAANG 10 Years logo), and "JOINT STAKEHOLDERS & POLICY EVENT". At the bottom, it says "WITH GERONIMO" and includes the GERONIMO logo.

