**Application**

Phenomics in livestock focuses on systematically describing of the animal phenome, which includes the physical and molecular traits of an animal. EU-LI-PHE is a Europe-centred multidisciplinary, interconnected and inclusive network of experts aiming to enhance scientific collaboration, catalyse developments, and transfer livestock phenomics concepts and applications to improve the sustainability of the European livestock production sector, with a global vision.

**Introduction**

Phenomics is emerging as a major new technical discipline in applied biology, including animal husbandry and breeding. Phenomics, when applied to the livestock production system, has one major aim: to systematically describe the phenome, which refers to the physical and molecular traits of an animal. This discipline is defined as the ensemble of methodologies and technologies for the acquisition, analysis, and exploitation of high-dimensional phenotypic data on an animal-wide scale (Houle et al., 2010).

In the animal production sector, the availability of accurate and specific phenotype data can inform new breeding objectives, related breeding and selection programs and provide novel essential information for the farmer’s daily activities and choices needed to improve reproduction strategies, disease control and animal welfare. Therefore, phenomics applied to animal breeding and husbandry is considered an essential innovation to support the sustainability of all animal production systems.

The development and application of phenomics in livestock clearly require a multi-disciplinary and multi-actor approach to bring together different expertise, resources, and expectations. Livestock phenomics necessitates experts in many fields, with a critical mass of knowledge and technical expertise. To address this need, we developed a European-based network that has been funded by the European Union. The network is a COST Action (European Network on Livestock Phenomics – EU-LI-PHE - https://www.cost.eu/actions/CA22112/; COST – European Cooperation in Science & Technology, 2023 ) designed to tackle four main challenges and structured across activities in four working groups (WGs). This COST Action is funded until 2027.

**Materials and Methods**

The development and application of livestock phenomics tools, methods, and data analytics approaches require significant investments in time, human resources, and capital. The main challenges in livestock phenomics for research and innovation, which are largely unaddressed or only partially addressed, are grouped into four main areas that reflect the structure of the EU-LI-PHE Working Groups (WG): WG1 (Phenotyping technologies) aims to provide an overview of current phenotyping technologies and infrastructures for livestock phenomics applications and define research needs to capture high-dimensional phenotypic information on a large scale; WG2 (Genome to Phenome integration) aims to provide an overview of the links between genome/epigenome variation and phenotypic variation in livestock species, identify synergies with related initiatives on functional analyses of livestock genomes and identify knowledge gaps and research needs to pave the way for new applications; WG3 (Computational resources and methodologies for data analyses) aims to provide an overview of the computational models, methods and tools available, as well as current and future needs for the development of applications in the context of livestock phenomics and to identify the needed synergies and develop-ments required in terms of cyberinfrastructures and computational capabilities; WG4 (Economic impact, regulations, policies, and society) aims to provide an overview of the potential technological and economic impact of livestock phenomics and to summarize the regulatory frameworks around this discipline and evaluate access to information and data generated; and iii) to analyse societal perceptions of livestock phenomics. In addition to the four main technical areas that provide the scientific backbone of the project, an additional working group, WG5 (Stakeholder engagement, communication, and dissemination) is part of the founding pillars of EU-LI-PHE. WG5 links all the activities carried out in WG1-4 as follows: i) to ensure continuous engagement of stakeholders; ii) to ensure productive and efficient communications; and iii) to ensure publication of reviews, reports, surveys and the establishment of a website and an active social media presence.

**Results**

The specific research and coordination objectives of EU-LI-PHE are focused on: (i) advancing the state-of-the-art of high-throughput technologies and protocols required for deep phenotyping to describe phenotypic information at multiple levels in farmed an-imals; (ii) providing cross-disciplinary knowledge to develop new standards in pheno-typing technologies, phenome data descriptors, phenotype ontologies, databases, data structures, storage and sharing; (iii) evaluating available software and bioinformatic tools and defining methods for effective data mining, processing, summarising, integration and visualization of genome/epigenome to phenome data in livestock; (iv) exploring integrative dynamic responses and adaptations of animal phenomes to variable environmental factors; (v) exploring novel data integration and fusion approaches including omics and sensor data, images, videos and animal movement and sound data for generation and visualisation of complex system models of livestock populations to facilitate prediction of interventions and outcomes; (vi) investigating and proposing new applications for genomic selection and precision livestock farming; (vii) exploring the regulatory landscape around livestock phenomics, including ownership of the data, open access data policies and intellectual property rights; and (viii) analysing stakeholder opinions and societal perceptions of innovations in this field for the reduction of negative impacts on the animals and on the environment. EU-LI-PHE has specific capacity-building objectives to foster knowledge exchange by: (i) providing well-trained young researchers and professionals in livestock phenomics and related disciplines that complement and complete the background and knowledge needed for the alignment of scientific progress and industry demands; (ii) fostering the exploration and implementation of new training routes and methodologies, with the aim of widening career prospects for highly specialised researchers who can accumulate integrated skills of different disciplines around big data production and analysis, with an interdisciplinary vision; (iii) stimulating new ideas and innovative methodologies in an open innovation framework to address new opportunities generated by livestock phenomics approaches with a comprehensive strategy of communication and dissemination to attract parallel and synergistic research fields and to benefit the whole scientific community, the relevant industrial sectors and all stake-holders, including policy and decision makers; and (iv) fostering the involvement and collaboration of teams from less research-intensive countries across Europe, promoting their inclusiveness, through the sharing of new knowledge around a network of opportunities focused on livestock phenomics.

**Conclusions**

It is expected that EU-LI-PHE will become a reference network for animal phenotyping, not only in Europe but also worldwide. This will contribute to the development of novel solutions for the benefit of the animal production sectors. Phenotyping systems, which involves sensors, cameras, noise recorders, molecular phenotypes and artificial intelligence to extract relevant information, can change the phenotyping paradigm of animals. This will accelerate the transition towards phenomics applied in animal breeding and for various other purposes.

**References**

COST – European Cooperation in Science & Technology, 2023. CA22112 – European Network on Livestock Phenomics (EU-LI-PHE). <https://www.cost.eu/actions/CA22112/>. Accessed 10 January 2024.

Houle, D., Govindaraju, D.R., Omholt, S. 2010. Phenomics: the next challenge. *Nature Reviews Genetics* **11**, 855-866.