Internship position		**6 months**	**2025**			

Genetic determinism of photoperiod response and circadian activity on the performance and health of dairy cows

Université Paris-Saclay, INRAE, AgroParisTech, GABI, 78350 Jouy-en-Josas, France

EFISA and GBoS teams

Profil souhaité

- Master 2 student
- Interest in genetics and statistics
- Good level in English

Durée / Localisation

- 6 months from January -March 2025
- INRAE, Jouy-en-Josas (78)

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Context

UMR GABI comprises 7 research teams and a Platforms team. GABI's scientific orientations are aimed at studying the structure and functioning of animal genomes, understanding the determinism of complex traits (immunity and health, product quality, differentiation and growth, adaptation) and proposing strategies for managing, evaluating, improving, and promoting animal genetic resources. These efforts contribute to the development of innovative, competitive and sustainable production systems. The proposed internship will be jointly supervised by two researchers from the *Etudes Fonctionnelles et modèles innovants pour la Santé des animaux* (EFISA) and *Genetics for Bovine Sustainability* (GBoS) teams.

Internship

In the context of global changes (climatic, societal, and economic), the pursuit of consistency and persistence in dairy cow production could represent a key objective in bovine farming. This research would aim to maximize economic returns for farmers while preserving the health and well-being of the animals. The persistence of lactation implies that cows maintain high milk production levels over a longer period, reducing costs associated with herd management and reproduction. Additionally, it contributes to lowering the environmental impact of dairy farming by limiting the need to breed new cows to replace those that have reached the end of their lactation cycle. Avoiding frequent transitions between lactation and rest periods can also reduce stress and promote the well-being of the cows. Finally, better consistency in lactation can help maintain better body condition and avoid health problems related to stress. In this context, exploring ways to improve the consistency and persistence of lactation is crucial to ensuring sustainable, profitable, and animal welfare-respectful dairy production.

We propose to address these questions by examining the relationship between dairy cow performance (notably their milk production and udder health) and their circadian activity (over a 24-hour period) as well as the duration of exposure to natural light, i.e., photoperiod.

Indeed, just as in other living beings, the circadian rhythm of dairy cows plays an essential role in regulating their metabolism, feeding behavior, and rest cycle. This biological clock, closely linked to day length, is important for maintaining the health, well-being, and productivity of cows. Studies have highlighted a strong genetic component in the regulation of the circadian rhythm and a high degree of conservation of the regulatory genes of this clock among different animal species.

The content of the internship will aim to define the chronotypes of the animals, i.e., their circadian activity profiles based on rest, activity, and ingestion data as well as body temperature, and to see if certain chronotypes can be associated with increased or decreased dairy performance. Similarly, these association studies will be conducted with photoperiod data. We will then be able to determine whether certain animals, particular in terms of circadian activity and/or response to photoperiod, also exhibit performances different from the average of the studied population. Genetic data will then be used to map genetic variants that may control the determinism of these animals' chronotypes and response to photoperiod.

To carry out this study, we have two types of data:

- Data from an INRAE experimental farm where Holstein and Normande cows are equipped with MEDRIA collars measuring their continuous activity and boluses measuring their internal temperature;
- Data from farms registered in the dairy control system for national breeds such as Holstein, Montbéliarde, and Normande, as well as for regionally important breeds (Abondance, Tarentaise, Vosgienne, etc.).

The data from the MEDRIA collars are semi-continuous measurements (one measurement every 5 minutes) of the accelerometer type, which allow predicting animal activity over time. The different predicted activities include: ingestion activity (meals) at the trough or pasture, rumination, rest, other activities (movements, etc.), position (standing or lying), and periods of heat (overactivity). The initial objective will be to define chronotypes, i.e., classes of animals with more morning or evening activities. Typically, in humans, four main chronotypes are identified: morning types (lion), intermediate types (bear), late types (wolf), and irregular types (dolphin). Once the

		cows are classified by chronotype, we can assess whether the health and performance of the animals are affected by their classification into a given chronotype. The monthly data from the national dairy control, which are massive, will allow us to estimate the specific effects of photoperiod by isolating these effects from other factors that influence cow production and health, such as parity, lactation stage, feeding, or temperature. The goal will be to determine whether, independently of the chronotypes defined earlier, there are variations between individuals, i.e., cows whose performance is more or less affected by the variation in day length. We will then use genotyping data, produced for all cows on the experimental farm and a portion of the cows from commercial farms, to search for genome regions associated with chronotypes and sensitivity to day length, which may be under the control of the circadian clock. These GWAS analyses, which can be complemented by meta-analyses by combining results from different breeds, will be carried out at the whole-genome sequence level, allowing precise identification of candidate genes and variants.
		To carry out this internship, the student will have the advantage of leveraging the complementary expertise of the two hosting teams. An interest in animal production and data analysis, coupled with knowledge and skills in genetics and statistics (mainly linear models), will be valuable asset for this internship.