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Technical Session 5

From Milk Analysis to Decision Support: Unlocking Insights for Sustainable dairy management

Intra- and cross-laboratory monitoring framework for MIR-integrated milk laboratory data

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Mid-infrared (MIR) spectrometry of milk has increasingly evolved from a method for the determination of main milk components to a technique used for large-scale prediction of metabolic, efficiency, and emission-related phenotypes. The rapid growth of predictive applications and routinely collected MIR spectra requires harmonized quality assurance across laboratories and instruments. However, operational cross-laboratory monitoring frameworks under real-world recording conditions are lacking. This study presents an interactive dashboard enabling the monitoring of routine laboratory data, including MIR spectra and derived traits, across multiple laboratories since 2021, supporting data governance within the milk recording infrastructure.

Routine milk recording data from eight German milk laboratories of vit DHI member organizations, currently comprising 19 FOSS instruments and up to 90,000 analyses per working day, are automatically aggregated and processed the same day. After linkage to animal-related data, spectra undergo the vit-standardization, a recently introduced statistical framework allowing daily harmonization across instruments under routine conditions. Within the data processing pipeline, it is possible, and also expandable, to insert models that enable the prediction of both milk components and innovative phenotypes. The dashboard provides laboratory- and instrument-specific monitoring of data completeness, main milk components, and model-derived phenotypes. Spectral drift can be evaluated via temporal bias analysis using pilot samples with certified reference values, based on the comparison of routine laboratory results and re-predictions from raw and standardized spectra.

The system establishes a scalable intra- and cross-laboratory quality control infrastructure within milk recording. Multi-year visualizations enable first longitudinal assessment of both standard and novel phenotypes under practical conditions. Drift monitoring supports early detection of instrument-related anomalies and improved traceability of technical events. Although primarily descriptive, the framework substantially enhances transparency, harmonization, and reliability of MIR-derived data streams. This approach strengthens quality assurance in milk recording, supports methodological innovation, and contributes to robust phenotype delivery for farm management and breeding applications.