A scalable, automated data pipeline and interactive dashboard for high-throughput methane phenotyping

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Nation-wide collection of high-frequency methane data from sniffers installed on commercial farms poses a significant challenge. Key issues include intermittent connectivity, data fragmentation, limited on-site technical oversight, number of sniffers, and daily volume of data to monitor. We present a robust, automated pipeline designed to streamline the collection and monitoring of data from MooLogger sniffers (Tecnosens S.p.A., Brescia, Italy).

The infrastructure utilizes a VPN mesh to establish secure, persistent remote access to sniffers. A Python core executes automated routines, enforcing data completeness prior to ingestion into a SQL database. Quality control employs multi-tiered alerting: temporal consistency checks, bilateral range validation for gas concentrations, and sniffer-specific rolling baselines to detect sensor drift. An RShiny dashboard serves as the pipeline command centre. It provides visualization of gases, airflow, and live uptime monitoring. The interface integrates a log system to track events, such as calibrations, and parts maintenance, directly linking hardware status to data quality. Furthermore, an automated synchronization module facilitates seamless data sharing with external collaborators. Scalability was demonstrated through the deployment of independent, self-contained instances of the software stack for major international organizations. In Canada, Lactanet manages a national fleet of 59 sniffers (51 Holstein, 6 Jersey and 2 Ayrshire). Sniffers have been deployed across four provinces: 10 sniffers (4 farms) in Alberta, 10 (2 farms) in British Columbia, 26 (15 farms) in Quebec (Methane Quebec Project), and 13 (5 farms) in Ontario, in collaboration with the University of Guelph (Net-Zero Dairy Genome Project). A separate instance supports Qualitas AG (Switzerland) in complex study designs. Project CH4COW monitors 64 sniffers (30 Holstein, 34 Brown Swiss) over a continuous 2.5-year period. The EMBRACE-BS (Global Methane Genetics) project maximizes throughput via synchronized 4-5 months rotations, managing 8 sniffers across two stages: initially split between Austria and Switzerland (48 farms), then consolidated in Germany (24 farms).

This scalable, automated data pipeline and interactive dashboard accelerate the translation of raw sensor streams into reliable phenotypes for global genetic evaluation.