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Policy Paper
Milk Quality Forecasting: Increasing efficiency of milk processing

Authors: Harald Sundmaeker[1], Gunnar Grosse Hovest[1], Joris Jaruschewski[2], Lukas Muedeking[3], Dirk von Aschwege[3], David Reinhardt[3]
1: ATB Institute for Applied Systems Technology Bremen GmbH, 2: OHB Digital Services GmbH, 3: DMK Deutsches Milchkontor GmbH

RILab: ScaleAgData Research & Innovation Lab 6 – Dairy

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1 Highlights

The Situation: Dairy cooperatives receive all daily milk deliveries from their farmers, aiming to process the milk at highest efficiency and sell dairy products at the best margin to ensure an adequate milk price for their farmers. This requires an optimal production planning and control for a balanced dairy product mix in relation to consumers' demand and the varying milk quality over the year.

The Findings: It is known that milk quality varies over the year in a certain relation to the season and region, but comparing historic data of different years shows varying curves, and the existing milk quality forecasting method is based on rules of thumb combined with experts' experience. At the same time, not all data that may be relevant for milk quality forecasting are shared, residing at diverse dairy chain stakeholders.

The Recommendations: The interorganisational data exchange shall be facilitated by the wide use of data spaces, facilitating both interoperability of agri-food systems and trusted consent management. This shall allow not only an improved milk quality forecasting, but an evolution of a wide range of data-powered services for the overall food system, while farmers should not be disadvantaged.

The Impact: The improved availability of data, controlled by data space technologies, will enable specifically SME-type solution providers to realise innovative solutions that go beyond the portfolio of large equipment manufacturers, avoiding vendor lock-in and offering the opportunity for an open innovation ecosystem.

2 Context of the Issue

Dairy cooperatives are collecting and aggregating data from thousands of farmers, then using the data for production planning and to comply with diverse legislation as well as retailer and consumer expectations. At the same time, data of farms is highly fragmented and the interoperability is limited.

Each legislative initiative leads to additional burden, while not necessarily being harmonised in terms of information architecture, administrative reporting and interoperability.

The ScaleAgData Dairy Research & Innovation Lab (RILab) was addressing the aggregation and analysis of historic milk data to be able to forecast the milk quality. Therefore, the Dairy RILab had to set up a digital infrastructure that allows to compile different sources of data and to offer a service-based access to innovative applications.

3 Policy Recommendations

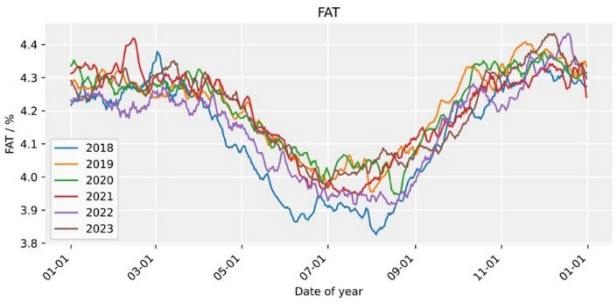
A harmonised digital framework to support compliance in the dairy chain could facilitate the reporting and decrease the overhead/administrative efforts for both the farmers as well as the cooperatives.

The use of data space technology in combination with agreed governance frameworks could facilitate the set-up of infrastructures that enable the farmers themselves to determine the accessibility to their data as well as to define the rules for system providers, avoiding vendor lock-in. This approach shall be further harmonised with other agricultural sectors as well as non-agricultural business domains to limit investment costs and to facilitate technical, semantic and legal interoperability.

An improved data availability would also offer third-party developers to come up with additional solutions as well as enable the integration of services and data sources, facilitating a more impactful analysis of historic data and the use of AI-based solutions. At the same time, this would also facilitate the use of secondary data for the realisation of Life-Cycle Analyses, considering challenges of the dairy industry with respect to environment, animal-health, animal-welfare, water, manure, climate, food safety, traceability and sustainability reporting.

4 Evidence and Analysis

When analysing historical milk quality data, it deviates over seasons and regions. A general pattern of fat and protein content can be identified. As an example, shown in the figure, the yearly time series of fat content in the milk varies along the seasons but also between years. Since fat and protein are the key components of milk to be considered for its subsequent industrial processing, even small variations represent a significant impact on the amount of milk that is required to realise an intended production programme. In numbers, a variation of 0.4% of fat represents around 10% of the fat required when producing products like butter or cheese.

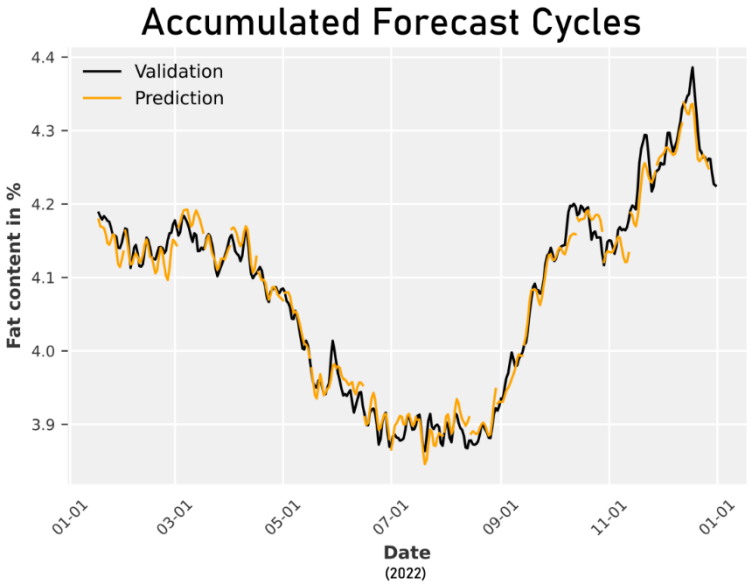


In the case of a large cooperative like DMK, processing over 5 billion kg of milk, deviations of up to 10% of milk components are representing millions of kg of fat. This asks for a careful analysis of supplies and forecasting of milk quality.

Therefore, the ScaleAgData Dairy RILab was collecting historical laboratory data of milk

deliveries from a homogeneous and specific pedoclimatic region in the Northern part of Germany. Data of the years 2018 to 2023 was collected and analysed accordingly, also to be used as input for the algorithmic analysis and combination with meteorological data, provided by ERA5-Reanalysis and ECMWF IFS Forecast.

The ScaleAgData Dairy RILab was analysing different models to realise the forecasting, while focusing on historical milk and meteorological data to be able to validate the related forecasting results.



The graphic is presenting the accumulated milk quality forecasting cycles for one year. Each forecasting was done with a horizon of 14 days, due to the accuracy of meteorological data.

Longer forecasting horizons would be preferred by the involved stakeholders. Therefore, the Dairy RILab team is further investigating potential meteorological data, considering the necessary trade-off between longer forecast horizons but lower accuracy. The team is also continuously discussing additional influence factors that may be beneficial to further improve the milk quality forecasting. A better availability of data from diverse dairy chain stakeholders would allow to take such additional factors into account when doing the forecasting.

5 Strategic Alignment

The main objective of the ScaleAgData Dairy RILab is to increase the resource efficiency regarding milk production, producing the required quantity and quality of products with fewer waste of input milk and less uncertainty, aiming to optimise the supplies to retail.

As an underlying objective, the Dairy RILab also addresses sustainability improvements that are facilitated by a better prediction of milk quality. It is assumed that its wide application will improve the collection and production planning, facilitate processing decisions and reduce mismatches between raw material availability at the processing sites and the processing requirements. This shall generally contribute also to an optimisation of the milk price for the farmers.

Therefore, rather than directly targeting individual Farm-to-Fork reduction targets, the Dairy RILab aims to provide data and digital decision-support capabilities that enable the dairy cooperative and subsequently also farmers to measure, manage and optimise their production.

As a consequence, the ScaleAgData Dairy RILab addresses the following United Nations Sustainable Development Goals (SDGs):

SDG 2 (Zero Hunger / Sustainable Agriculture): By increasing the efficiency of milk processing in the dairy cooperative.

SDG 9 (Industry, Innovation and Infrastructure): Contribution to the digital innovation and transformation and making use of AI/forecasting as well as data integration for agricultural innovation.

SDG 12 (Responsible Consumption and Production): Providing forecasting data for an improved balancing of retailers'/consumers' demand and milk availability in the different regions.

SDG 13 (Climate Action): Facilitating an improved resource efficiency and potentially lower GHG intensity of the dairy production chain.

The Dairy RILab also aligns with strategies like the Common Agricultural Data Space initiative, aiming to facilitate the accessibility of data along the agri-food chain, while further investigating the adoption of open-source data space connectors.

6 References

ScaleAgData Consortium, February 2025. Technical Report on Deployment & Evaluation.

[Link to Technical Report]

7 Contact Details

Harald Sundmaeker, ATB, sundmaeker@atb-bremen.de
Gunnar Grosse Hovest, ATB, gr-hovest@atb-bremen.de
Joris Jaruschewski, OHB Digital Services, joris.jaruschewski@ohb-ds.de
Lukas Muedeking, DMK, Lukas.Muedeking@dmk.de

Dirk von Aschwege, DMK, dirk.vonaschwege@dmk.de
David Reinhardt, DMK, David.Reinhardt@dmk.de

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