A unified Python implementation of standardized cumulative milk yield calculation methods

M.B. van Leerdam, D. de Kok, J. Osei-Tete, L. Trapanese, M. Hostens

Question from the ICAR Milk Recording Group

How are ICAR methods implemented across milk recording organizations?

P. Bucek et al. 2015

Table 3 Lactation calculation methods used in milk-recording organisations.

Answer options	Number of organisations
Test Interval Method (TIM) (Sargent, 1968)	29
Interpolation using Standard Lactation Curves (ISLC) (Wilmink, 1987)	8
Multiple-Traits Procedure (MTP) (Schaffer and Jamrozik, 1996)	2
Best prediction (VanRaden, 1997)	5
Other methods	7

Take home messages from 2015

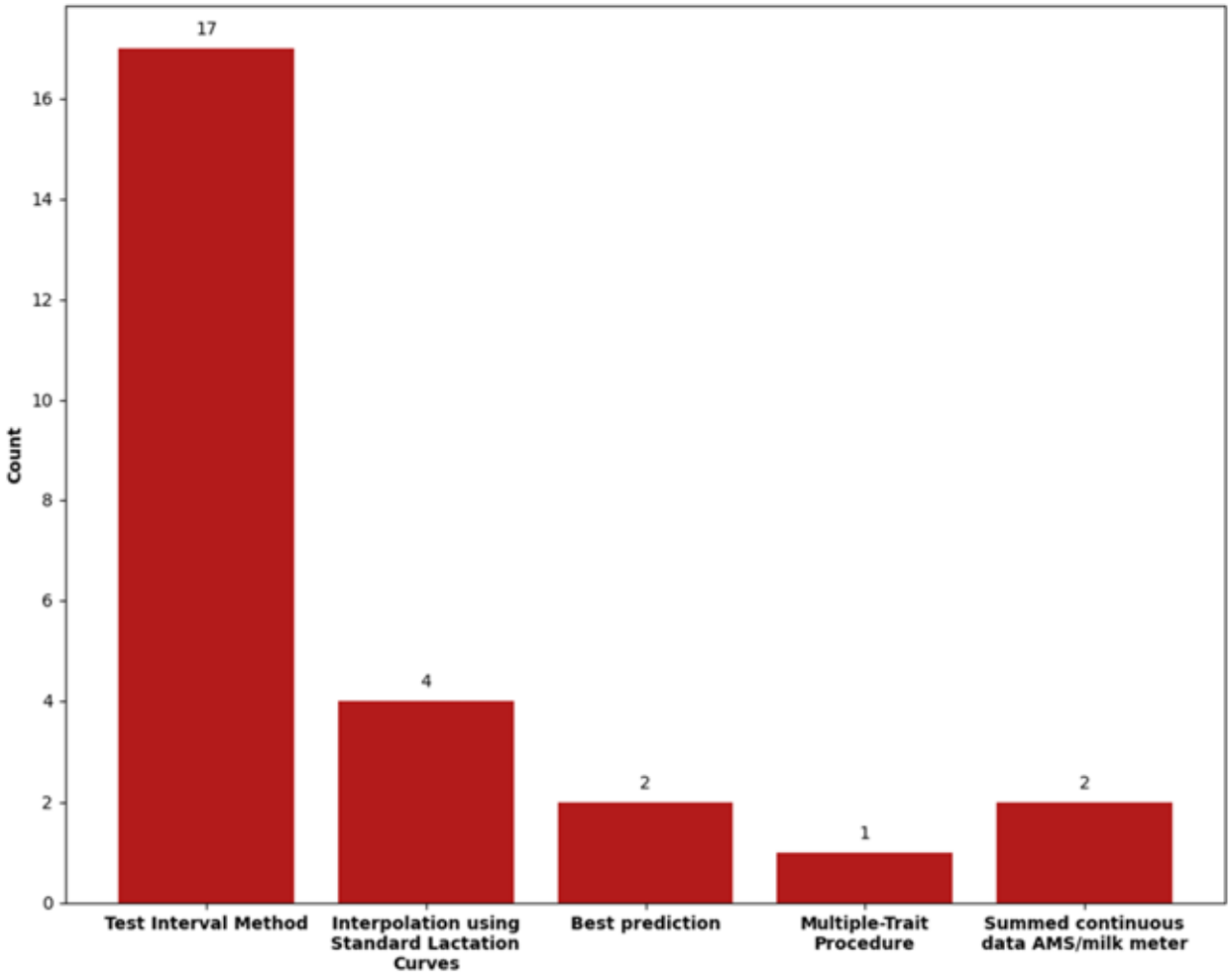
- Need for improved quality management
- Greater flexibility toward high-frequency data from automatic milking systems and in-parlor meters
- Update lactation calculation methods

NEW POLICY: The future policy of the Dairy Cattle Milk Recording Working Group is to continuously monitor development and keep the ICAR Guidelines updated in this field.

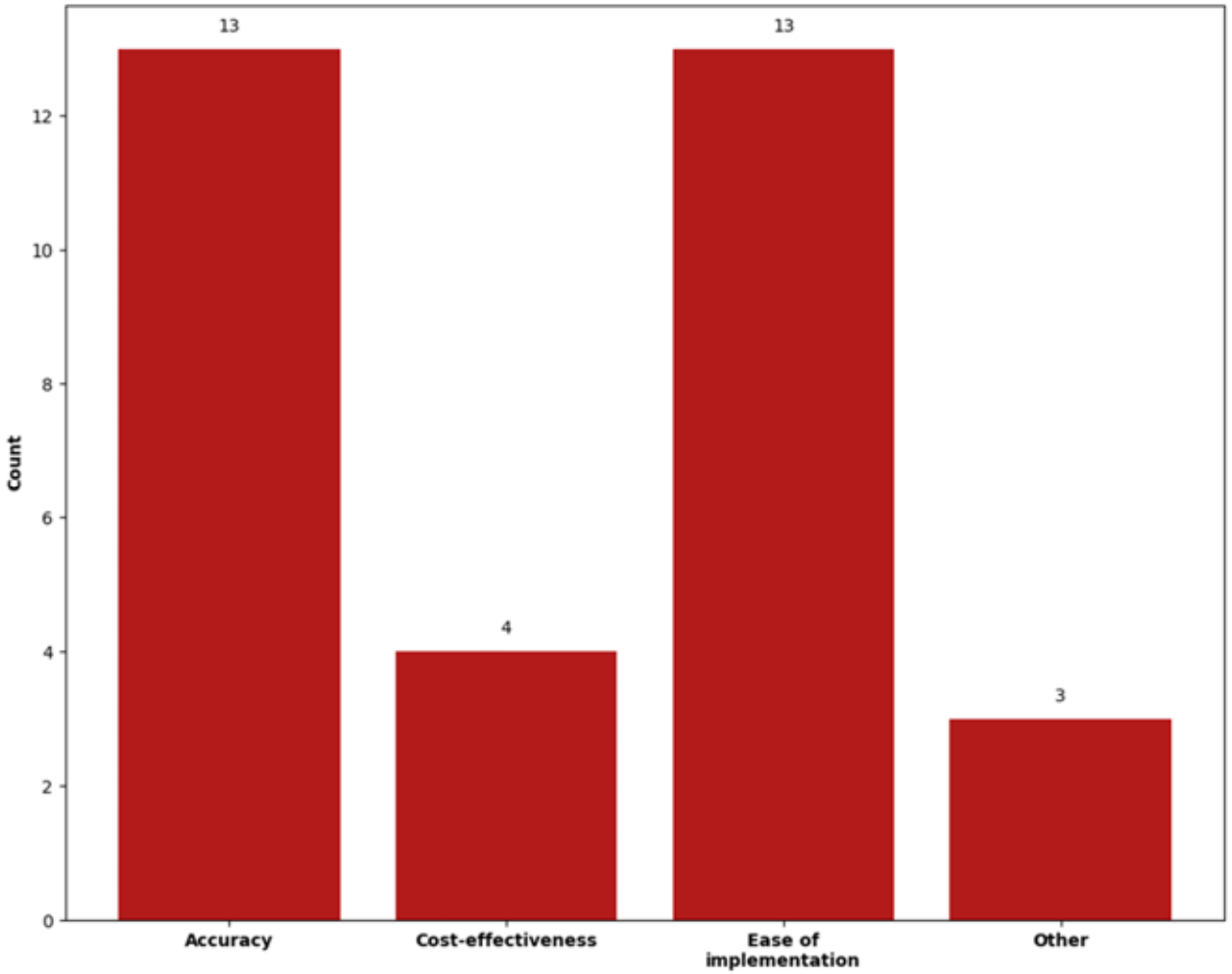
10 years later > where are we now?

- New survey summer 2025
  - 23 respondents (18 fully completed)
  - 36 questions about milk recording

Cumulative milk yield methods used



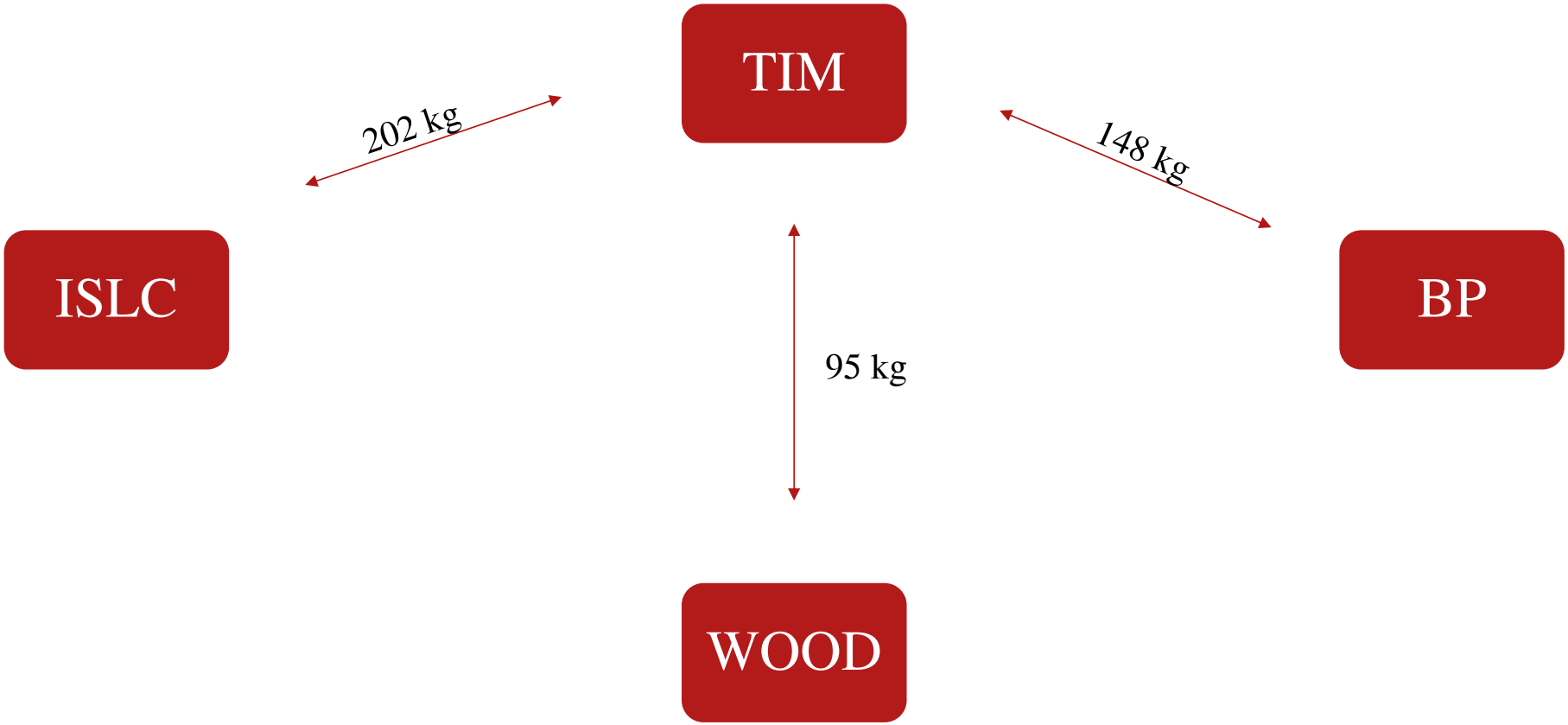
Motivation for methodology



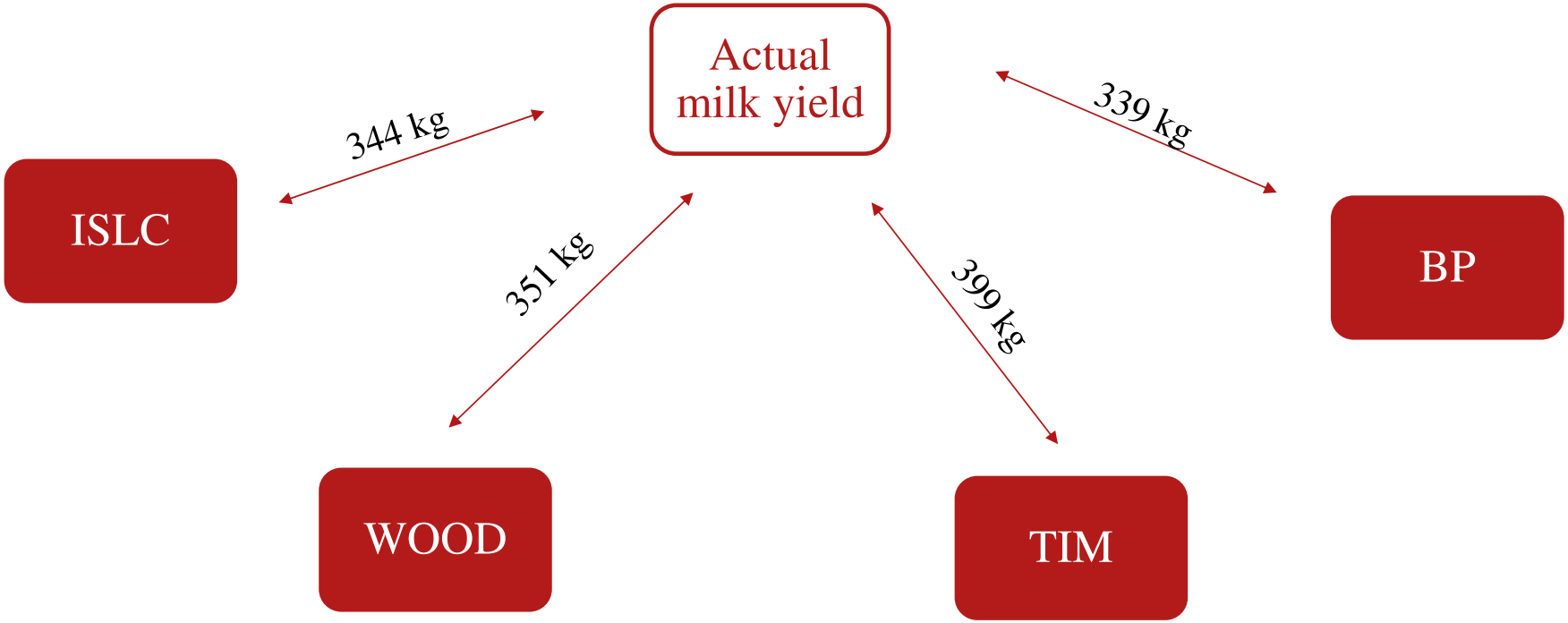
Take home messages 2025 survey

- TIM is still the most popular
- Accuracy and ease of implementation best motivation
- Methods based on standard Lactation Curves > variation in stratification
- No consensus on data preprocessing methods

How much variability does this cause?



How close to reality?



Challenge #6 VERONA_DEMO DEMO DATASET

Submit a challenger - a Bovi model or your own CSV - and select a benchmark for this benchmark dataset.

Challenge dataset

407 lactations · 4.467 test-day rows · 407 ALY rows

Test-day records: TestDataSet.csv Ground-truth ALY: ActualMilkYields.csv

Submit a challenger

Pick a Bovi model to run, or upload the results of your own calculation. Bovi compares it against the selected benchmark for this challenge.

Bovi model | Own method (CSV)

CHALLENGER BOVI MODEL

305-day yield | Curve fit | Deep learning

Pick a challenger model

TIM (Test Interval Method)

Direct ALY estimators from test-day records.

BENCHMARK BOVI MODEL

305-day yield | Curve fit | Deep learning

Pick a benchmark model

ISLC (Standard Lactation Curve interpolation)

Direct ALY estimators from test-day records.

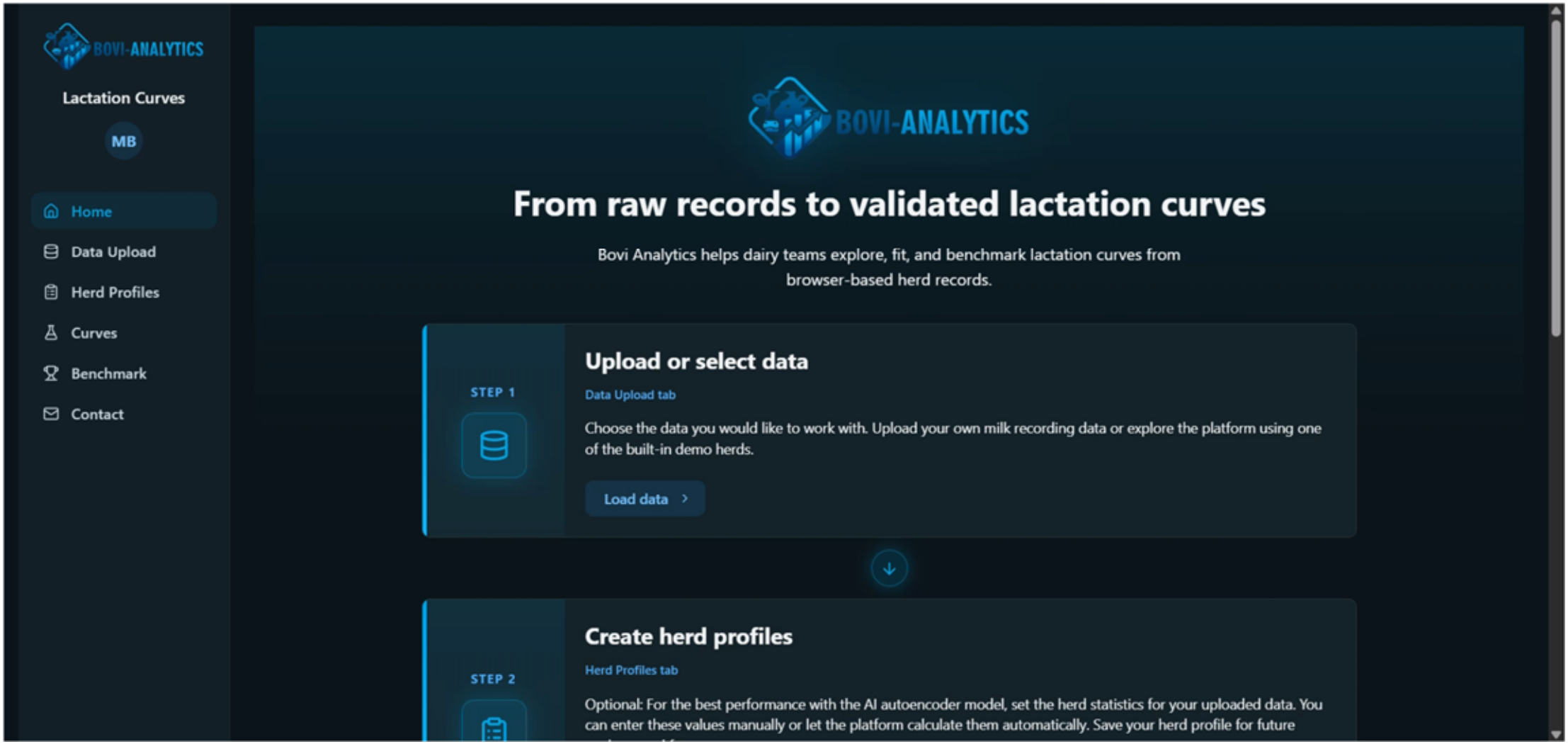
Organization (optional)

Cornell

Country (optional)

USA

Run & Compare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From raw records to validated lactation curves
Bovi Analytics helps dairy teams explore, fit, and benchmark lactation curves from browser-based herd records.
STEP 1
Upload or select data
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Choose the data you would like to work with. Upload your own milk recording data or explore the platform using one of the built-in demo herds.
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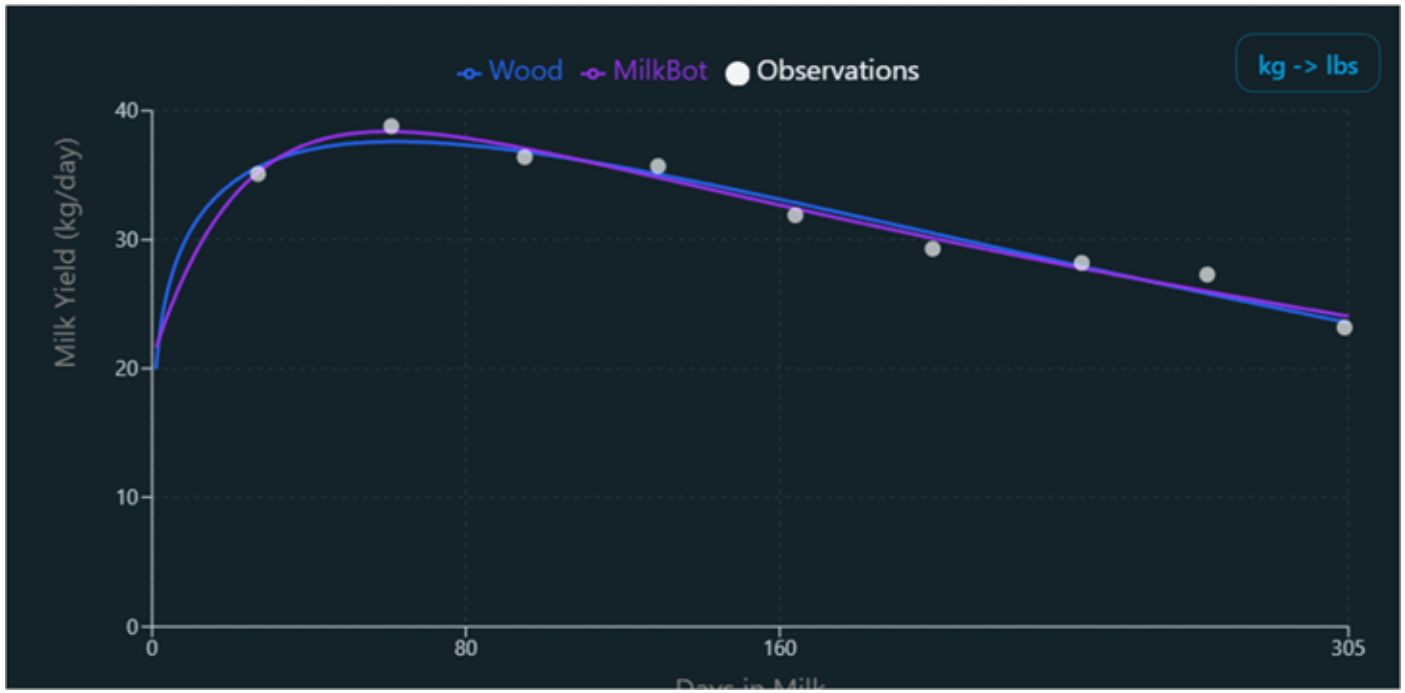
Optional: For the best performance with the AI autoencoder model, set the herd statistics for your uploaded data. You can enter these values manually or let the platform calculate them automatically. Save your herd profile for future

The backbone: Lactation curves

```
pip install lactationcurve
```

```
from lactationcurve import ...
```



BOVI-ANALYTICS

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API Documentation

lactationcurve

A package for fitting **dairy animal lactation curves**, evaluating **lactation curve characteristics (LCCs)** (time to peak, peak yield, cumulative yield, persistency), and computing **305-day milk yield** using the **ICAR guideline**.

Contact: Meike van Leerdam, mbv32@cornell.edu

Authors: Meike van Leerdam, Douwe de Kok, Judith Osei-Tete, Lucia Trapanese

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Updated: 2026-05-26

The 305 day yield for milk, fat, and protein is a widely used metric in dairy production, and the International Committee for Animal Recording (ICAR) provides guidelines outlining approved methods for its calculation. However, a global survey of milk recording organizations revealed substantial variation in how these methods are implemented. The Test Interval Method is used by 74% of the organizations, reflecting a preference for methodological simplicity, but it comes with trade-offs in estimation accuracy. The use of the other approved methods showed wide variation in correction factors, standard lactation curves, test day definitions, minimum sample requirements, and exclusion criteria. Such inconsistencies can introduce yield variability that complicates comparisons, for example in international breeding value evaluation, and limit the metric's usefulness in universal models, such as decision support tools. Thus, the objective of this work was to reformulate the ICAR guideline section 2, procedure 2, into a unified, transparent, and accessible software implementation to improve standardization, enhance documentation, support continuous development, and increase the accuracy of 305 day yield estimation.

To achieve this, the ICAR guideline was translated into an open-source Python package that serves as a reference implementation for 305-day yield calculation, with lactation curve modelling at its core. In addition to the methods described in the original guideline, the package incorporates 14 lactation curve models, including both traditional and Bayesian fitting approaches as well as AI-based models. It also provides tools to derive biologically relevant characteristics such as time to peak, peak yield, cumulative yield, and persistency.

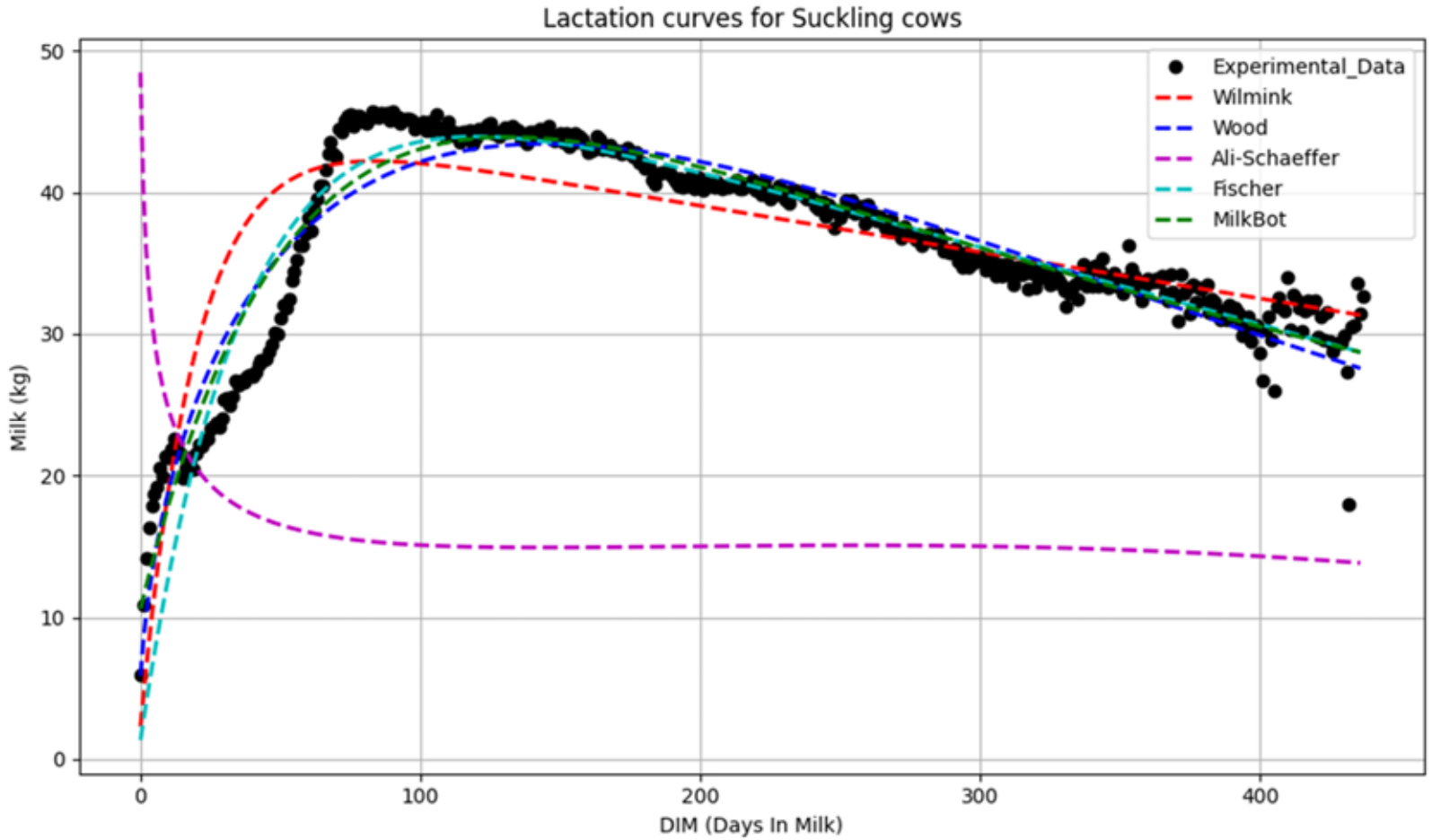
The framework can be directly integrated into analytical workflows, allowing users to calculate 305-day yields, fit and compare lactation curves, and derive key lactation characteristics through a single function call. These functionalities are further supported through an interactive website and an openly available GitHub repository. In addition, the project includes an online validation platform that enables users to use standardized lactation data to compare self-estimated 305-day yields against both reference calculations (from the package) and observed daily milk yields.

We encourage everyone to use, test, and contribute to the package, which is available under the MIT license. We welcome feedback and suggestions for improvement, and we are committed to maintaining and updating the package to ensure it remains a valuable resource for the dairy industry and research community. For bug

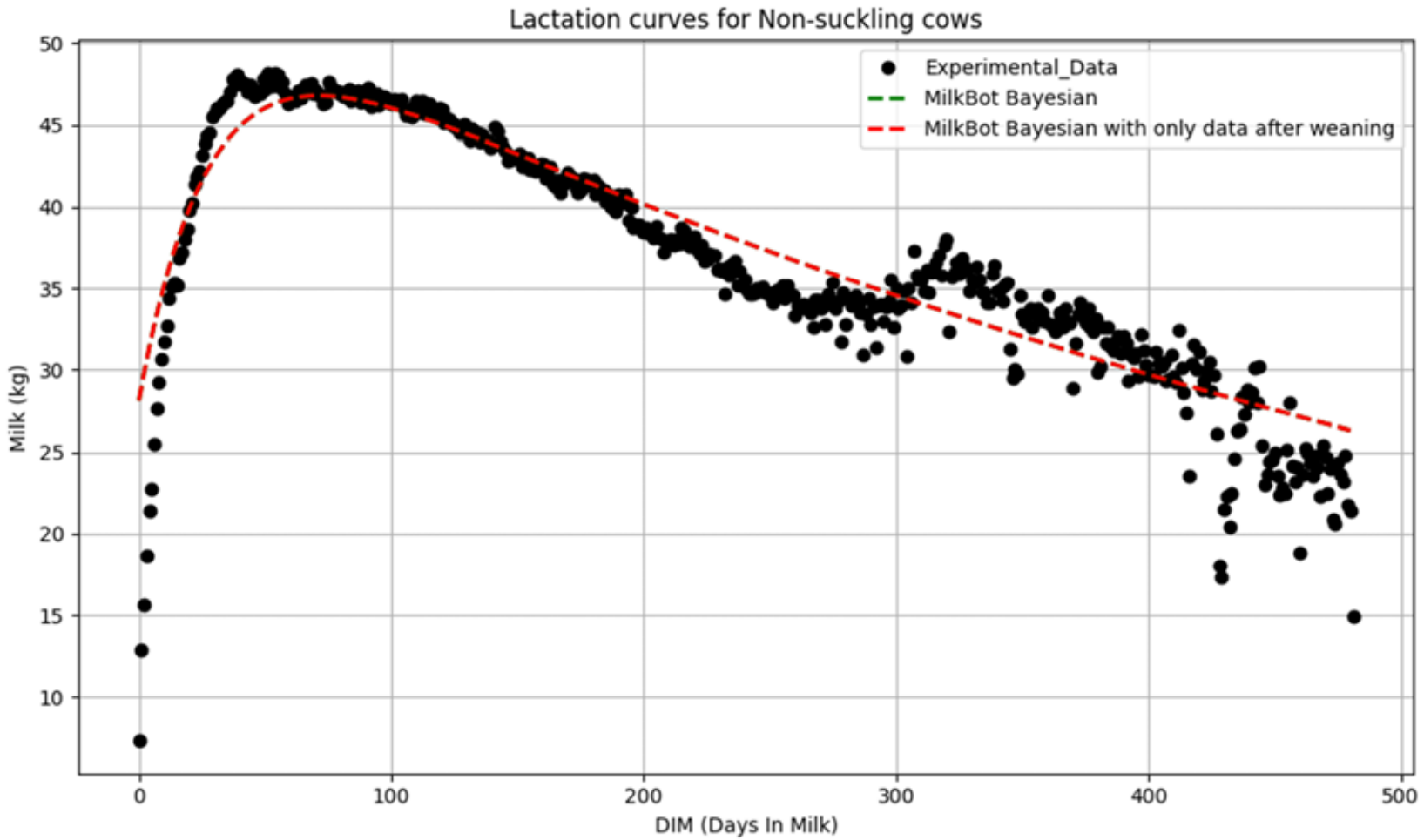
Examples of applications of the package

Suckling cows

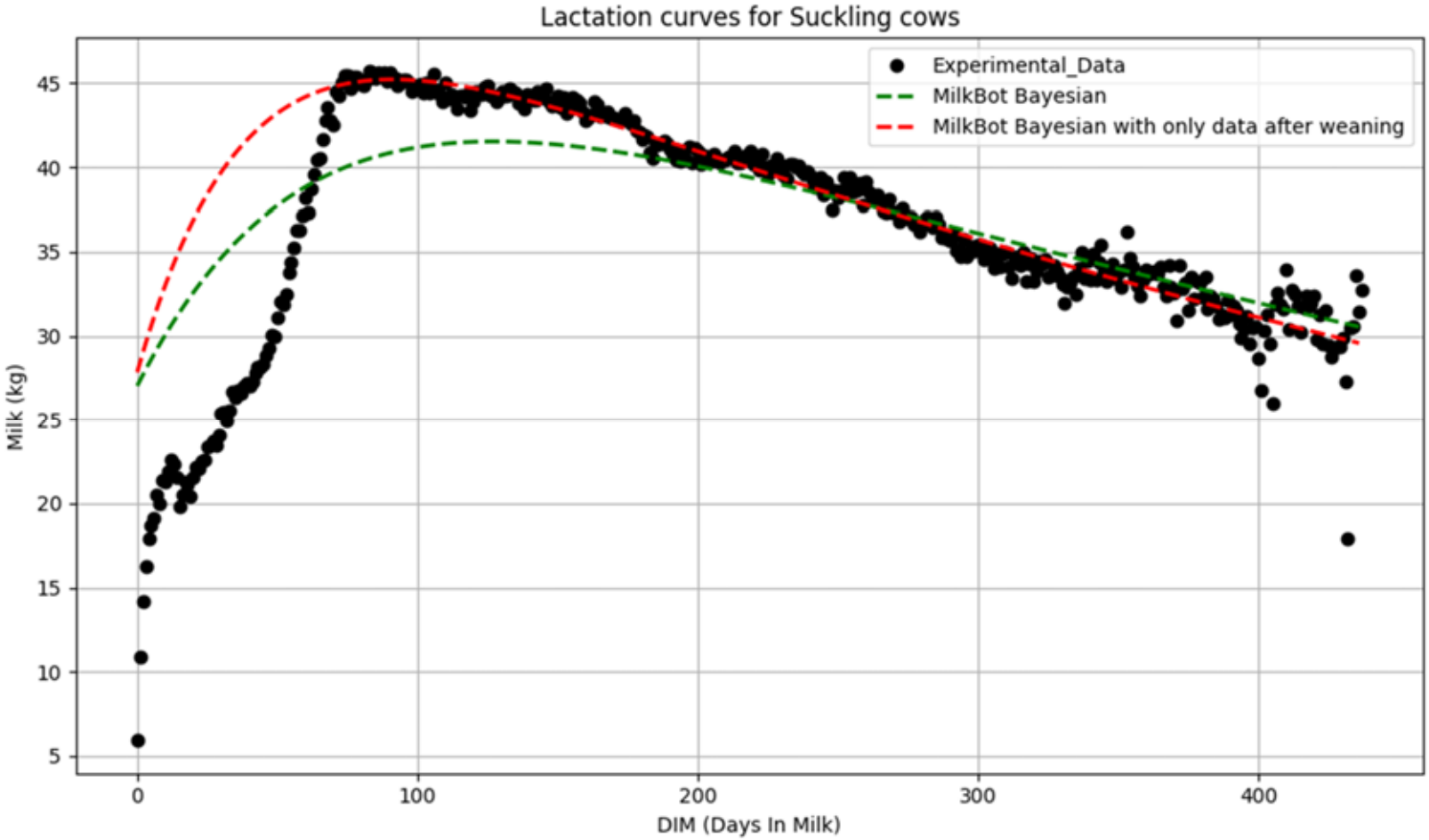
Suckling cows



Non suckling cows



The power of priors

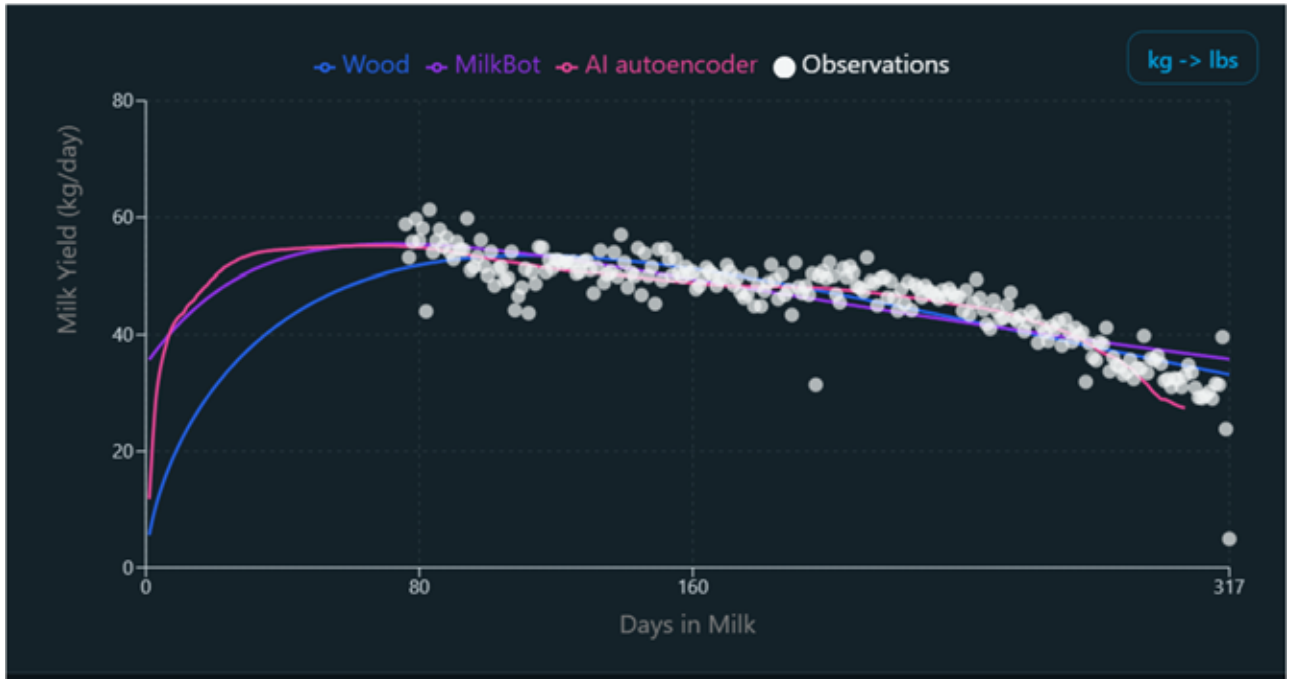


Estimation of LC characteristics

Characteristic	Suckling	Non-Suckling
Summed milk yield 305	11645.10 kg	12326.26 kg
Cumulative milk yield	12446.27 kg	12548.77 kg
Difference in milk yield	**-801.17 kg**	**-222.51 kg**
Time to peak	92 days	72 days
Peak yield	45.23 kg	46.78 kg
Persistency	-0.0455	-0.0534

Average milk consumption calf per day: 10,68 kg
van Zyl et al. 2026: avg ~15 kg per day first 90 days

For the individual cow

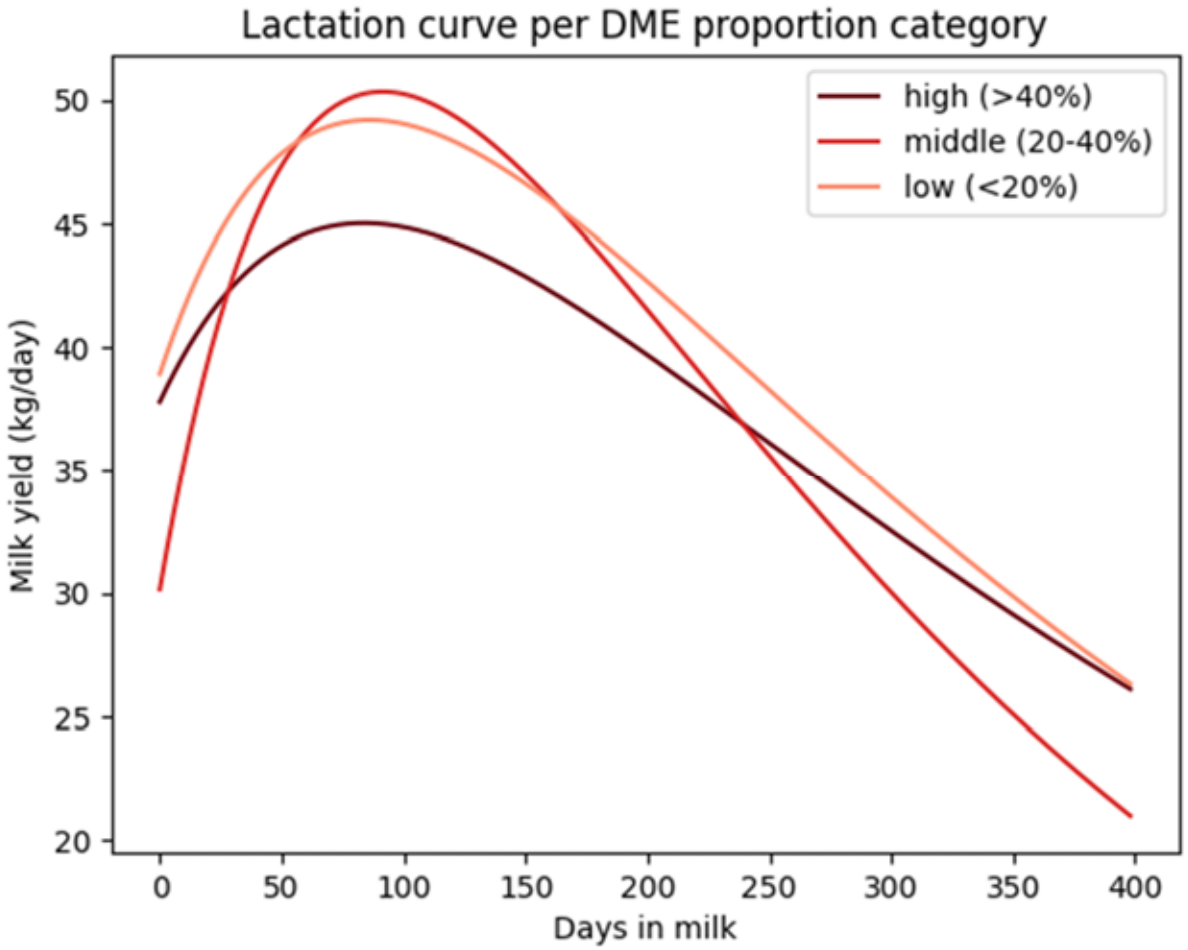


Characteristics

Model	Peak Yield	Time to Peak	Cumul. Yield	Persistency
Wood	53.4 kg/day	112.2 days	13554.5 kg	-0.098
MilkBot	55.4 kg/day	72.6 days	14477.8 kg	-0.081
AI autoencoder	55.1 kg/day	68.0 days	14413.2 kg	0.869

Different species

Does Bi-modality have negative impact on milk yield?



Your use case could be next!

If you have a dataset and a question > come talk to me!

Or send me an email: mbv32@cornell.edu

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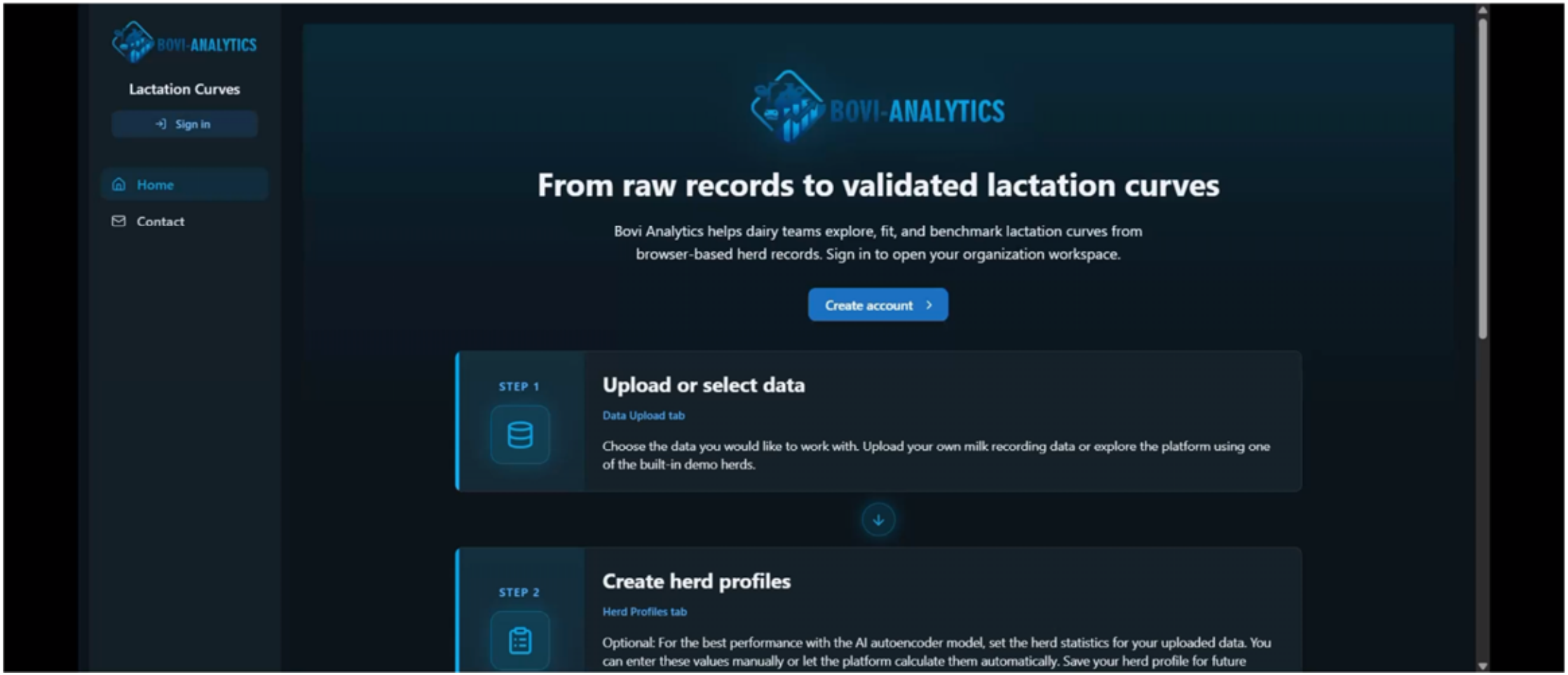
Thank you for filling in the survey!

Check out the platform!

Check out the package!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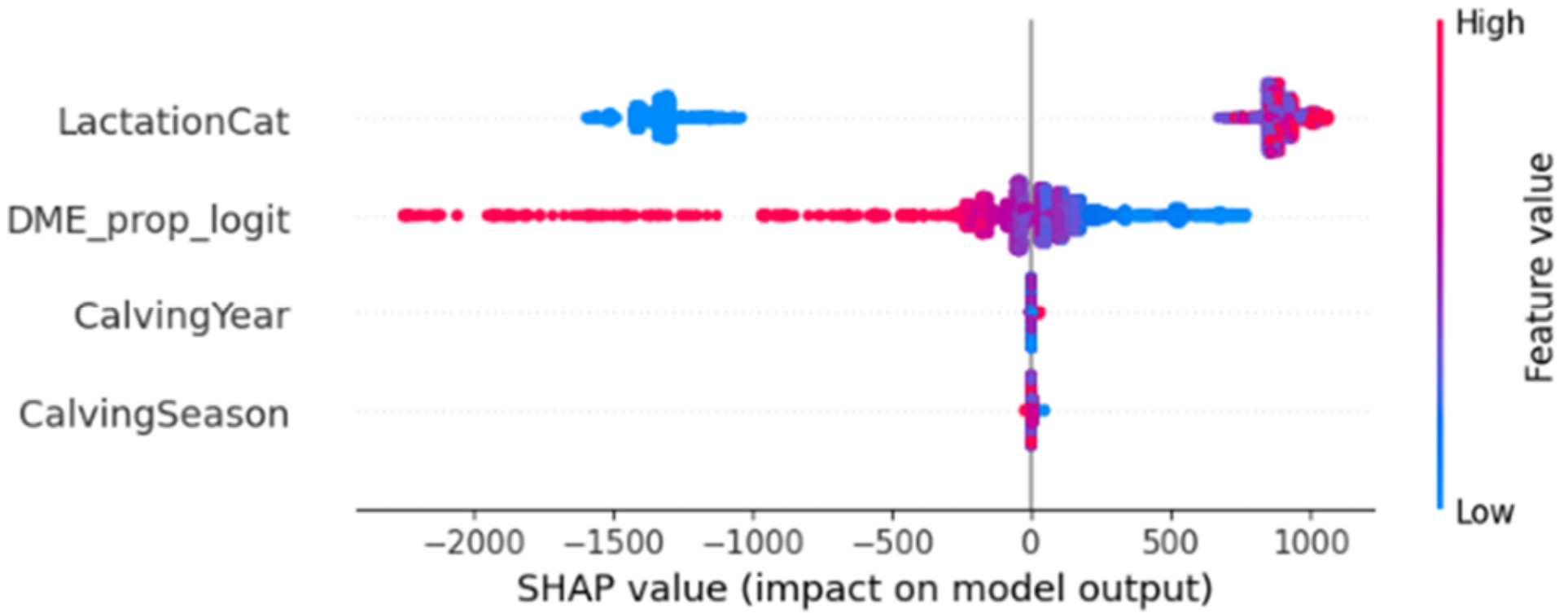
Impact on lactation milk yield



Procedure 2 of Section 2 of ICAR Guidelines – Computing of Accumulated Lactation Yield

- The Test Interval Method (TIM) (Sargent, 1968)
- Interpolation using Standard Lactation Curves (ISLC) (Wilmink, 1987)
- Best prediction (BP) (VanRaden, 1997)
- Multiple-Trait Procedure (MTP) (Schaeffer and Jamrozik, 1996)