Agricultural Institute of Slovenia

Farm sustainability index using dairy cattle recording data: the case of Slovenia

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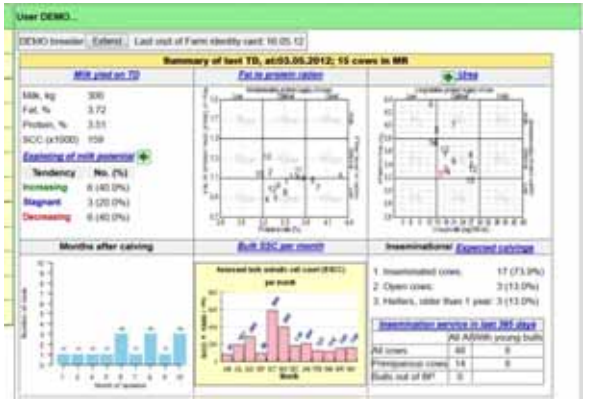
Introduction

- Modern dairy farming faces **numerous challenges**
  - These increase the **need for optimisation and improved efficiency in milk production**
- **Sustainability** of dairy systems is very **complex** and the lack of **data** is an issue in sustainability studies



- Slovenian dairy farms in the milk recording scheme have access to many management support tools
- Tools that directly address sustainability are lacking

- ICAR Sustainability Task Force proposed a set of sustainability indicators that can be derived from routine dairy recording data (ICAR guidelines, Section 22)

Introduction

Study aim

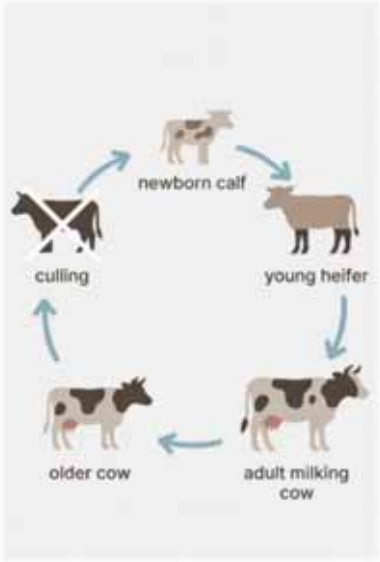
The aims and steps of the work:

1) **Identify and define sustainability indicators** covering a wide range of sustainability dimensions, adapted to Slovenian conditions and available national data
2) **Calculate indicators** at farm and national levels
3) Prepare **visualisations** and **integrate them into the IT system**

Material and methods

Data

- **Slovenian dairy recording scheme**: 2,500 herds, 29 cows per herd
  - covering 60% of all dairy farms and 80% of the total dairy cows
- Goal to **follow the entire life cycle** on a dairy farm (from birth to culling) with sustainability indicators
- **Recording year** used for the calculations
  - 1st November to 31st October



Material, methods and results

Sustainability indicators: Feeding and production

1. Adequacy of nitrogen balance in the rumen
   - **Urea content** helps to determine whether cows receive adequate protein in their rations
   - Calculated as **%** of individual urea in milk records with urea concentration in milk within 15–30 mg/100 ml; target value is 100%
2. Milk production efficiency
   - **Energy-corrected milk (ECM)** enables comparison of milk amounts based on their energy value by accounting for fat, protein, and lactose content
   - ECM as **kg**/cow/day (Sjaunja et al., 1990); higher values are preferable
3. Protein utilisation efficiency (PUE)
   - Indicates amount of **nitrogen deposited in milk and the amount of nitrogen excreted in urine and faeces** (Šebek et al., 2014 and Verbič, personal communication)
   - PUE in **%**; higher values are preferable

Material, methods and results

Sustainability indicators: Fertility

4. Reproduction efficiency
   - **Calving interval (CI)**, the period between two consecutive calvings
   - 400 **days** was used as an ideal CI for dairy cows

5. Cows culled due to reproductive disorders
   - **% of cows that were inseminated after last calving and then culled**
   - The smallest possible value is desired

Material, methods and results

Sustainability indicators: Health

6. Risk of rumen acidosis
   - Under the balanced cow nutrition, FPR ranges between 1.1 and 1.5.
   - **FPR < 1.1 indicates rumen acidification** with a probable risk of acidosis
   - Indicator as **%** of TD records with **FPR < 1.1** during the first 90 days after calving

7. Risk of negative energy balance
   - **FPR > 1.5 indicates a ketosis risk**
   - Indicator as **%** of TD records with **FPR > 1.5** during the first 90 days after calving

8. **Somatic Cell Count Index** (SCCI):
   - SCCI as proposed by Jeretina et al. (2017) as udder health indicator
   - Average SCCI for all test day records on a farm, in **%**
   - Lower values (below 5%) correspond to better udder health

Material, methods and results

Sustainability indicators: Longevity and young stock

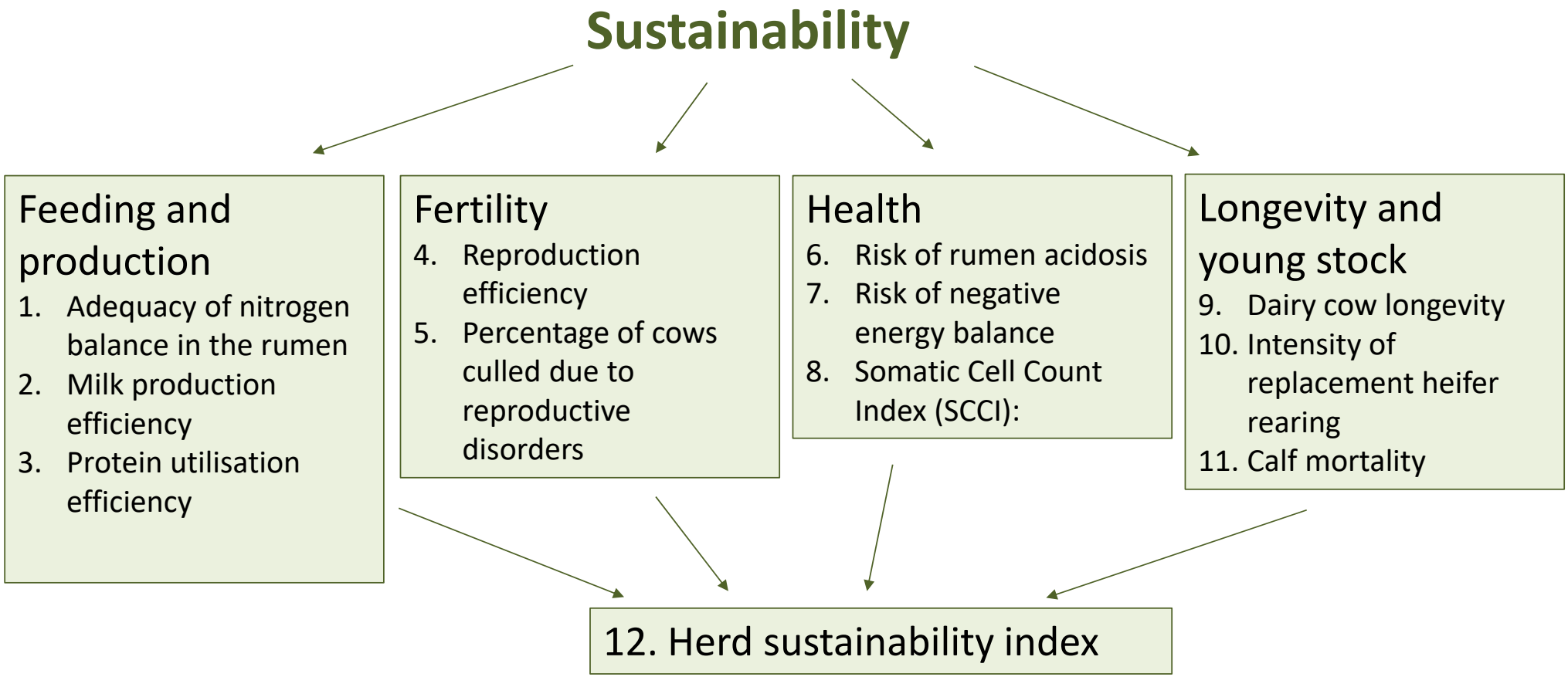
9. Dairy cow longevity
   - **% of cows in the third or higher lactation**; higher values are desirable

10. Intensity of replacement heifer rearing
   - Expressed as **age of heifers (in months) at calving**
   - Age of **25 months** was used as an ideal age

11. Calf mortality
   - **% of live-born calves that died between birth and 35 days of age**
   - Calves that died within the first 48 hours and died between 3 and 35 days of age
   - Goal is to minimise losses, ideally close to zero

Material, methods and results

Sustainability indicators



Material, methods and results

Sustainability indicators: Percentile ranking

- **Indicator** calculated as an **average of herd over a certain period**
- **Percentile ranks** calculated **(%)** for each herd within every of the 11 indicators
  - **Desirable direction of each indicator considered**
    - If ideal value was neither the lowest nor the highest, the percentile rank was calculated based on the absolute deviation from the ideal value

- **A Herd Sustainability Index (HSI)** computed as the **sum of decimal percentile ranks across all 11 indicators**
- **Farms ranked based on their overall sustainability index**

- Calculations for recording years 2024 and 2025

Results and discussion

Analysis of sustainability: Some descriptive statistics

Field	Indicator	AVG	MIN	MAX	SD
	Sustainability index	5.7	1.7	8.8	1.1
Feeding and production	Urea in milk (%)	59.8	0.0	93.4	17.2
	Energy corrected milk (kg)	21.6	7.8	45.1	5.8
	Protein utilisation (%)	23.0	10.6	32.0	2.9
Fertility	Calving interval (day)	438.5	332.0	1053.0	58.4
	Culled cows (%)	9.9	0.0	100.0	10.1
Health	Risk of rumen acidosis (%)	24.3	0.0	100.0	14.1
	Risk of ketosis (%)	13.8	0.0	92.3	11.2
	Somatic cells index (%)	20.8	1.4	63.8	8.0
Longevity and young stock	Cows in higher (%) lactations	48.9	0.0	100.0	13.9
	Age at first calving (month)	29.5	19.7	72.2	4.2
	Calf mortality (%)	2.5	0.0	100.0	6.1

N =2462 farms

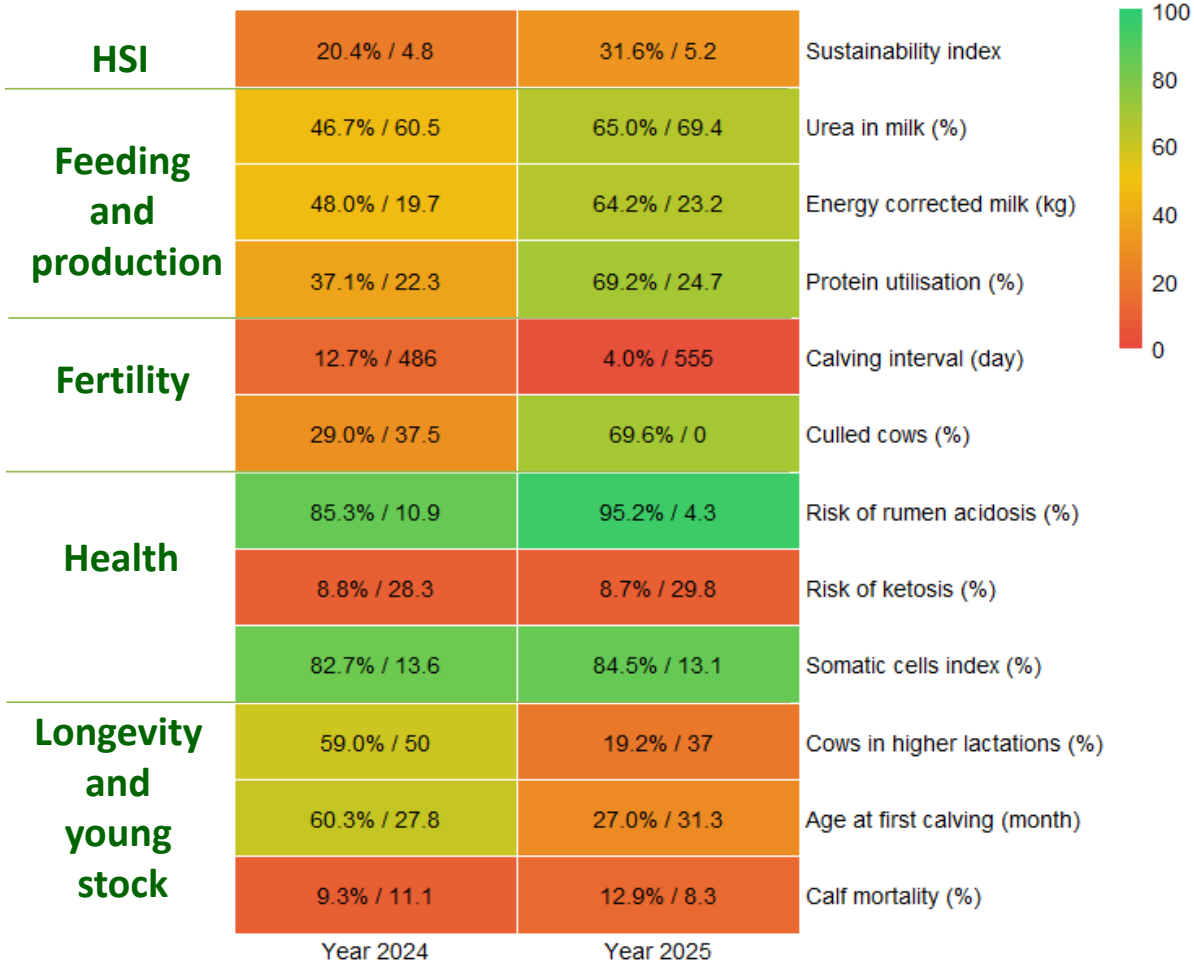
Results and discussion

Tool development: Visualisation (farm level)

- **Heatmaps**
- **Trafic lights colours**

- Very poor
- Poor
- Marginal
- Fair
- Good
- Very good
- Excellent

Percentile rank (%) / Indicator value



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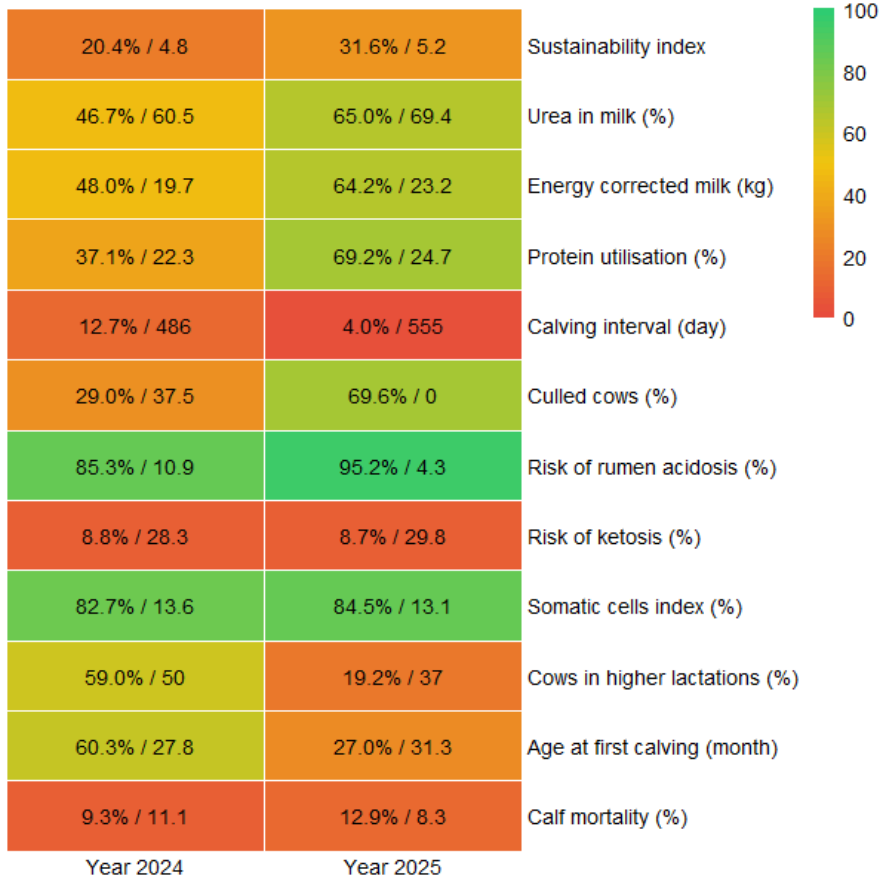
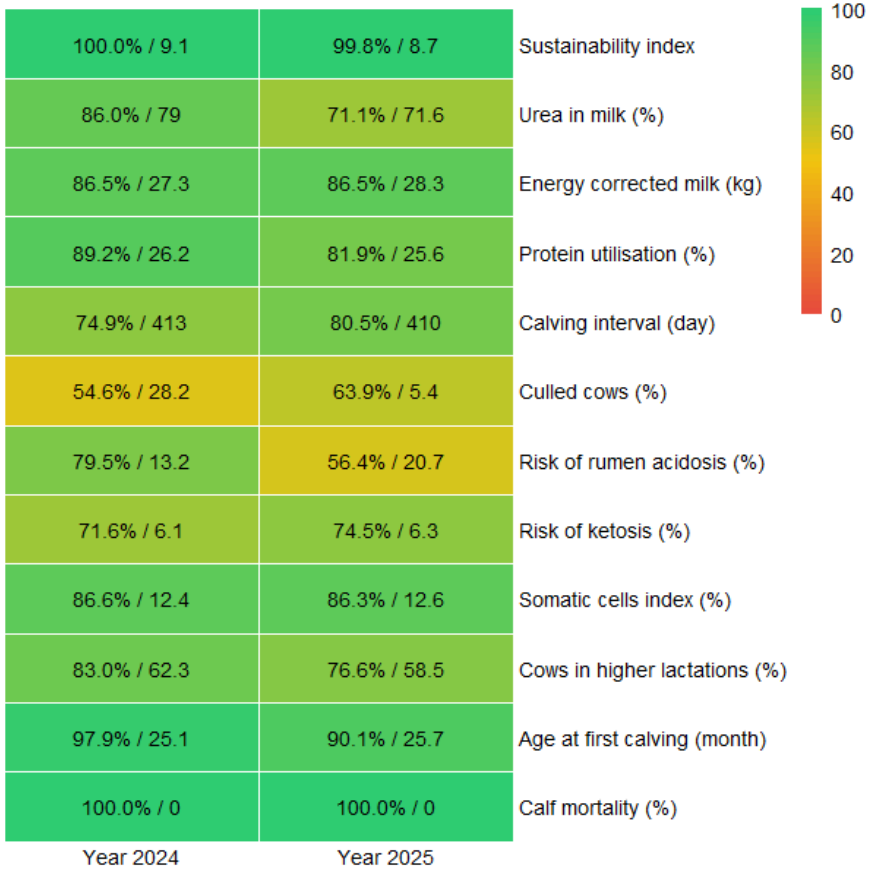
Results and discussion

Tool development: Sustainability between farms

Farm 1



Farm 2



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Conclusion

Take home messages

- A preliminary proposal for the **first HSI for Slovenian dairy farms** based on data collected through the regular milk recording scheme
- The development followed these key objectives:
  - 1) **Reducing the number of indicators** while still obtaining useful information at the farm level without placing too much information burden on farmers
  - 2) **Improving the efficiency of available data** by reducing the number of different parameters required, thereby maximising added value per parameter for farmers
  - 3) **Information and visualisation pragmatism**, which involves developing a tool and decision support system (DSS) based on complex information that is as understandable as possible for farmers

Conclusion

Further work

- Integration of **HSI** into **IT system**
- Development of **decision-support system (DSS)**
- **Field launch** of the new HSI (fall 2026)
- Increasing the **frequency** of HSI calculations **to semi-annual**
- Addition of new traits (balances of cumulative methane emission, …)

The approach could be applied by other milk recording organizations

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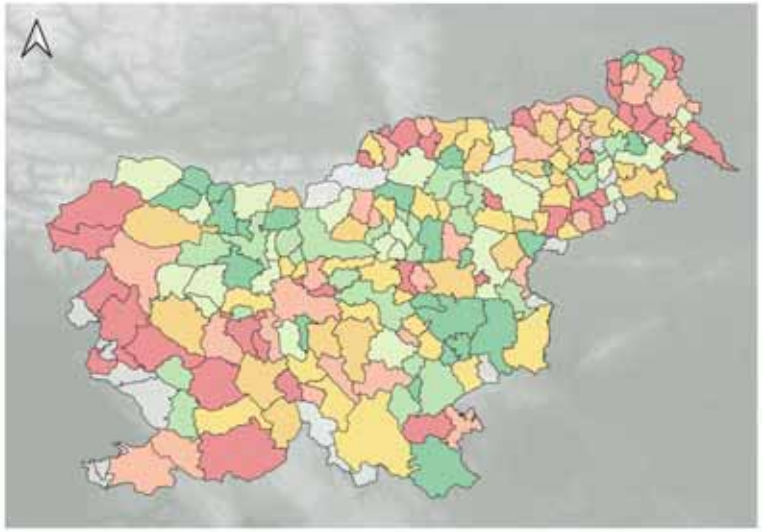

Thank you!

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