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Development of a Simplified Tool for Assessing Climate Change Impact in Dairy Cattle Farms

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BACKGROUND

From studies carried out in the last 10 years, on a very large number of dairy cattle farms in Northern Italy, mostly intensive, it has been estimated that the production of a kilogram of fat and protein corrected milk results in emissions ranging from a minimum of 1.3 to a maximum of 2.7 kg of CO_2 eq, with an average value of about 2.0 kg of CO_2 eq /kg milk

ENVIRONMENTAL IMPACT ASSESSMENT

Life Cycle Assessment-LCA

SHARED EVALUATING METHOD

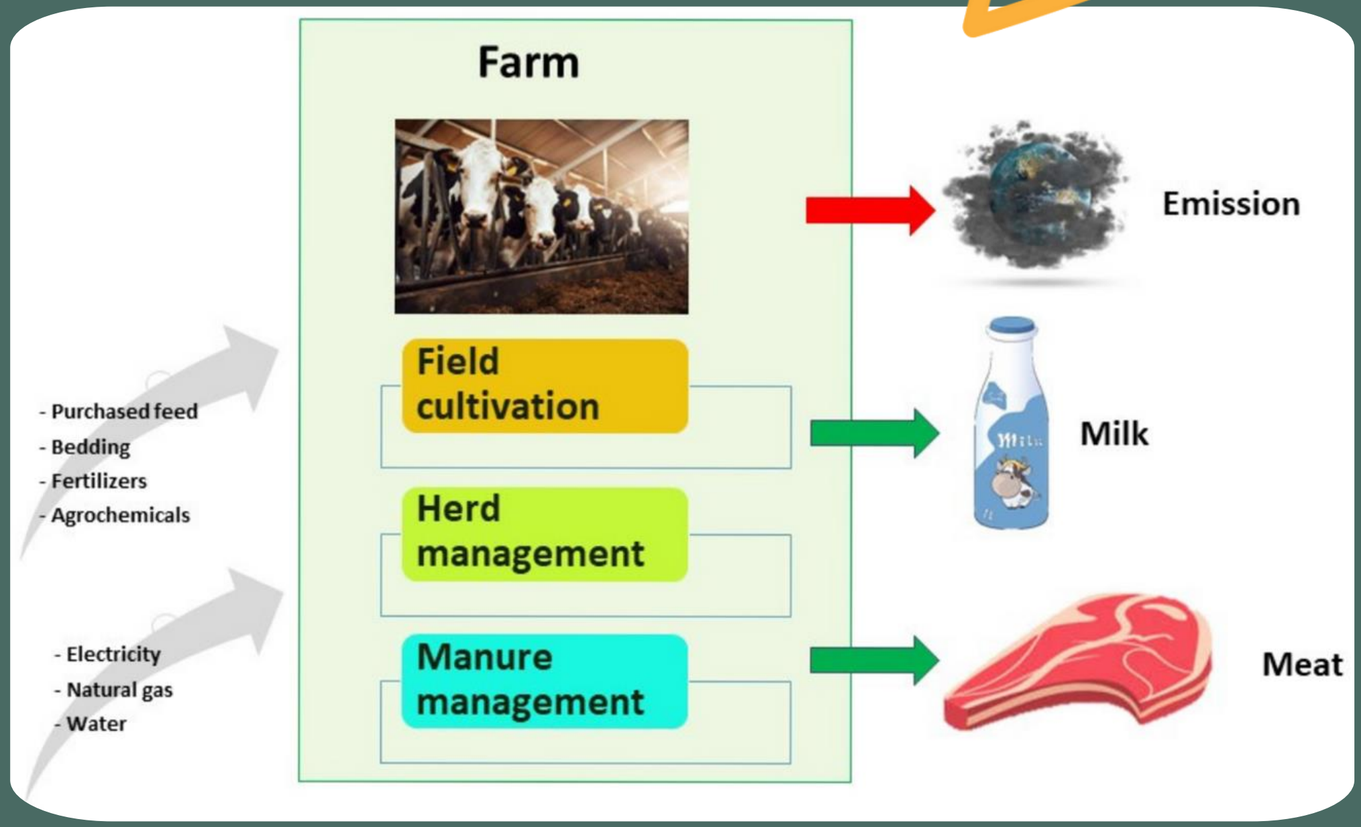
TIME CONSUMING METHOD

01 Allows to assess the overall impact of each phase of the production process, considering the entire life cycle of the product.

02 Allows the identification of critical points and emission-related issues, using a common method evaluating

03 All the inputs necessary for production are considered, e.g. raw materials and energy used in processes.

04 All that is produced by the system (all the outputs) are calculated, namely milk and meat, but also emissions.



AIM

To develop a simplified system for estimation of the carbon footprint of cow milk, which can be used by farmers:

- as a self-assessment system
- to simulate what would happen if some indicators varied

SIMPLIFIED SYSTEM FOR THE EVALUATION OF CLIMATE CHANGE OF MILK PRODUCTION

ANAFIBIJ

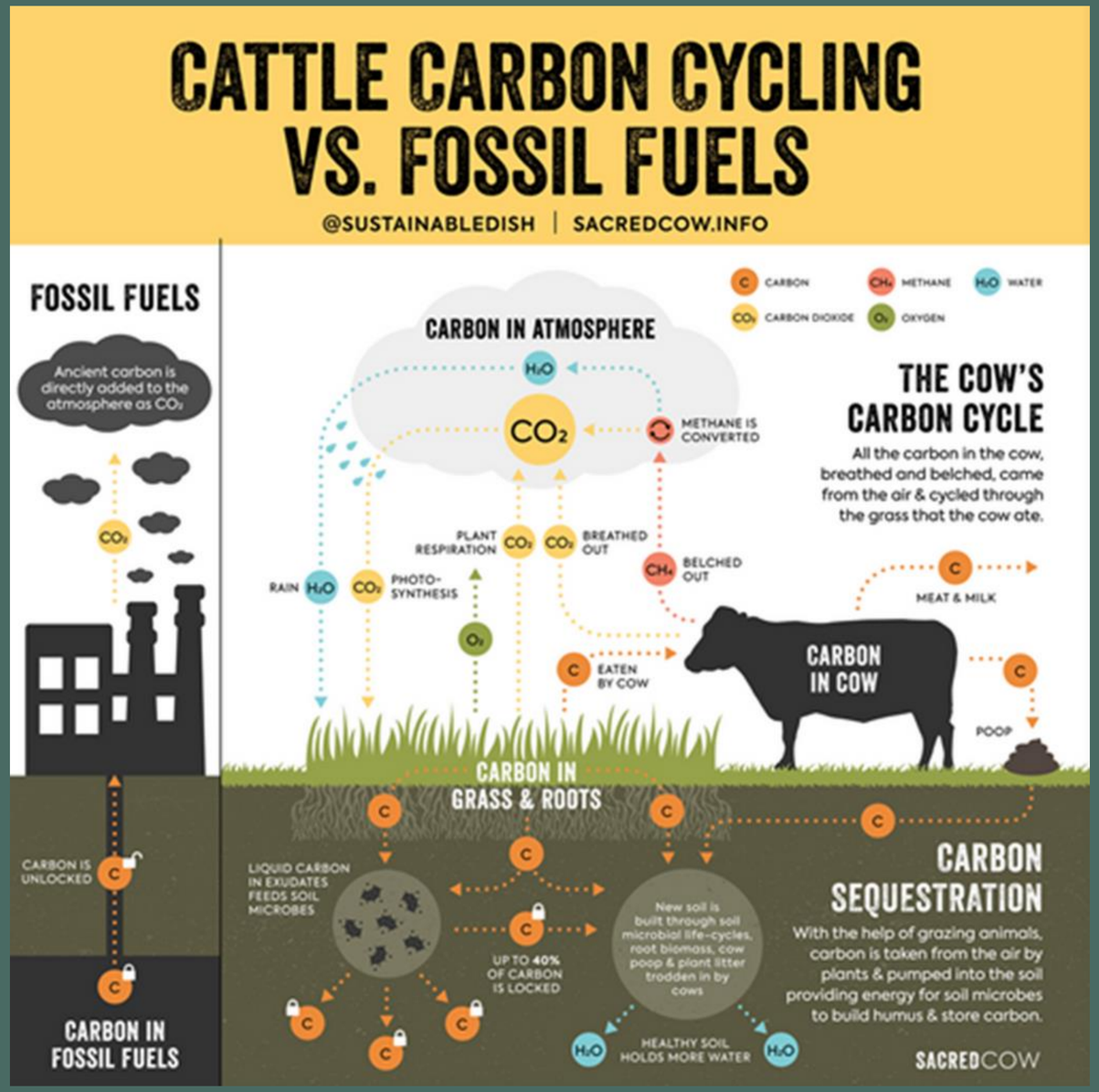
- Data of animal management
- Data of fertility
- Genetic Indices

DISAA

- Calculation for estimating environmental impact
- Experience in applying Life Cycle Assessment method

FARM SAMPLE

- 54 farms (Holstein Friesian cows) located in Northern Italy, in plain and hill areas
- Complete LCA analysis
- Performance data: production, management and fertility data (i.e. pregnant cows at 120 d, and milk sold per Livestock Unit, LU), and genetic indices (i.e. Health and Economic Index - IES, predicted Methane Emission Index - pCH4)



CLIMATE CHANGE

Carbon from enteric fermentations

The biogenic carbon is part of a short cycle that is considered in equilibrium with carbon fixed and stored by plants in the form of carbohydrates, and ingested by animals

Carbon from fossil fuels

It represents new carbon transfers, from long-term geological reserves to the atmosphere, meaning a net addition of carbon in the atmosphere

STATISTICAL ANALYSIS

- **SAS and R studio Software**
- **Descriptive statistics: The complete data set was analysed for descriptive statistic (Proc MEANS).**
- **MULTIVARIATE ANALYSIS: A Principal Component Analysis** (PCA, Proc PRINCOMP) was performed to find a multidimensional relation between variables.
- **PREVISIONAL EQUATION: linear model with stepwise selection.**
  Starting from a **collinearity test**, variables with high VIF (**Variance Inflation Factor**) were excluded from the dataset.
  Stepwise procedure (Ordinary Least Squares, OLS) to select the best parameters for CC_es. **Validation** of the equation was performed by randomly selecting 15 farms from the database 1,000 times to test the equation, and the average correlation coefficient between CC_es and CC was calculated.

ACKNOWLEDGMENTS: Dr. Alberto Cesarani and Dr. Arianna Bionda for statistics advises

RESULTS-DESCRIPTIVE STATISTICS

Table 1. Summary of descriptive statistic

Table 1. Summary of descriptive statistic.

Variable	Unit	Mean	Std	Min	Max
Lactating cows	n	232	186	56.0	817
FPCM[1] per lactation	kg	9591	1357	6754	13284
Fat	%	3.83	0.23	3.28	4.23
Protein	%	3.40	0.12	3.02	3.70
Soybean meal in the ration	%	10.7	5.28	0	22.5
IES index[2]		161	159	-93.6	733
CH4 index[3]		100	1.42	97.1	105
Age at first calving	month	26.9	2.47	23.0	34.7
Pregnant cows at 120 d	%	58.3	9.25	37.0	73.0
Milk sold per LU[4]	kg	6239	827	4494	8093

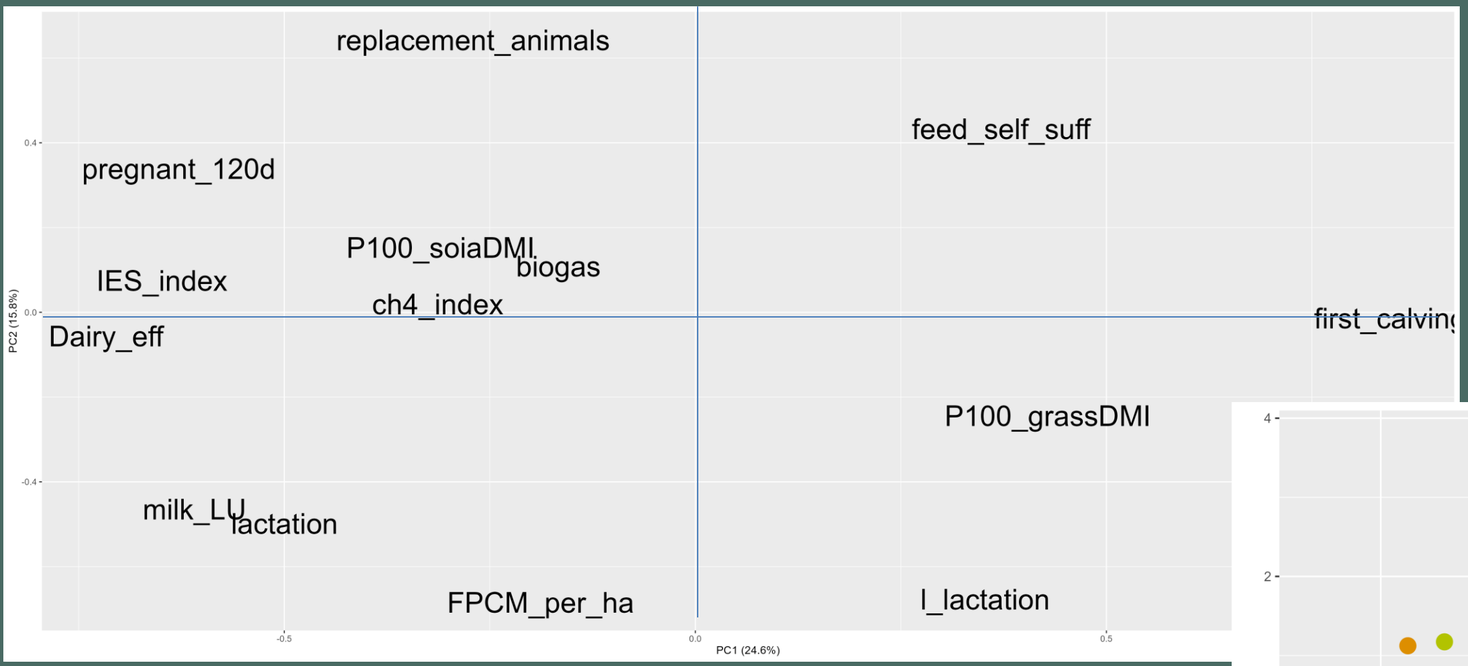
[1] FPCM, Fat and Protein Corrected Milk

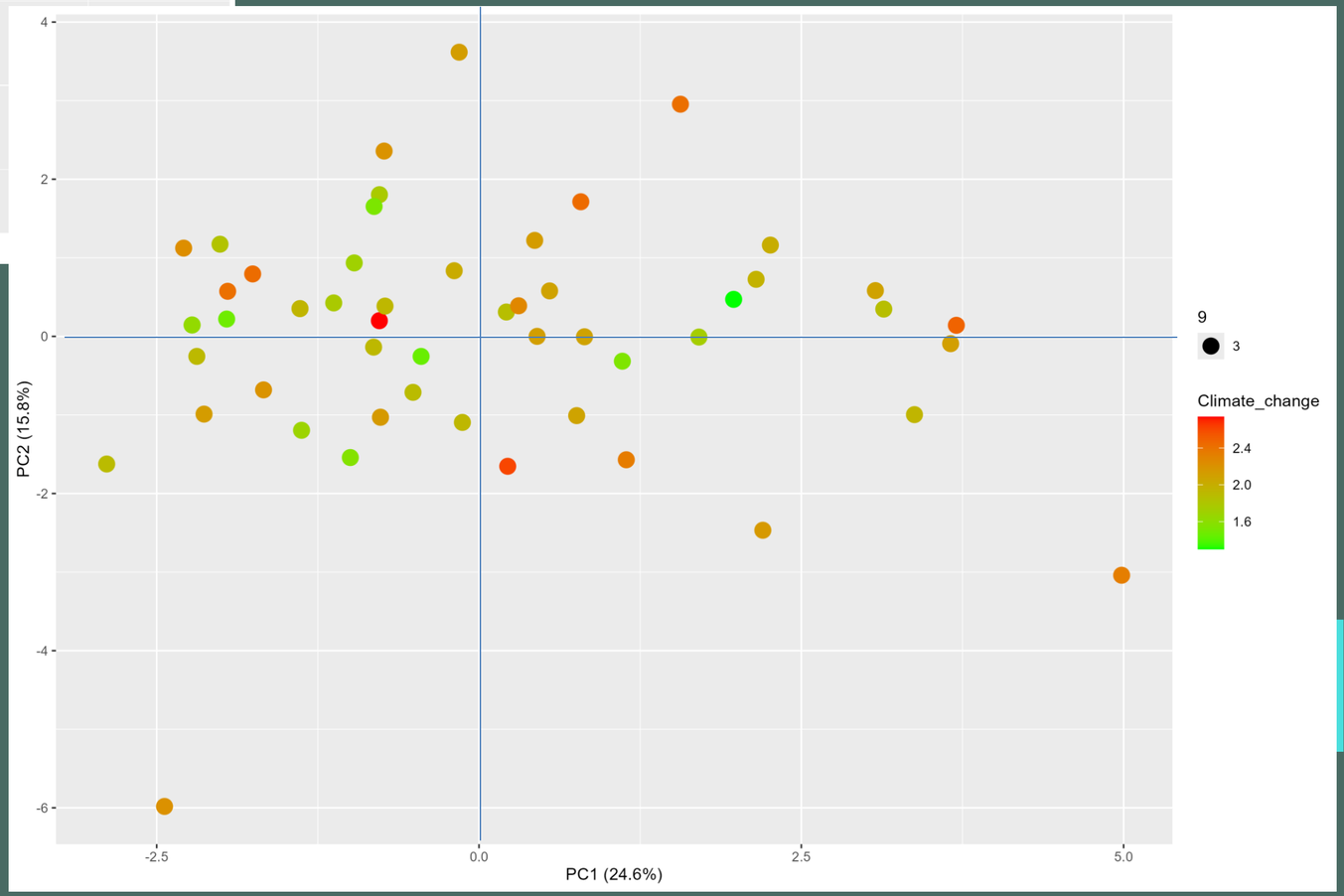
[2] IES index, Health and Economic Index, Expresses as the expected economic difference (€) of individual animals (or daughters of bulls) from the reference genetic basis.

[3] CH4 index, Methane Emission Index

[4] LU, Livestock Unit

RESULTS-PCA


replacement_animals
feed_self_suff
pregnant_120d
P100_soiaDMI
biogas
IES_index
ch4_index
first_calvin
Dairy_eff
P100_grassDMI
milk_LU
lactation
FPCM_per_ha
l_lactation
0.4
0.0
-0.4
PC2 (15.8%)
-0.5
0.0
0.5
PC1 (24.6%)


4
2
0
-2
-4
-6
PC2 (15.8%)
-2.5
0.0
2.5
5.0
PC1 (24.6%)
9
3
Climate_change
2.4
2.0
1.6

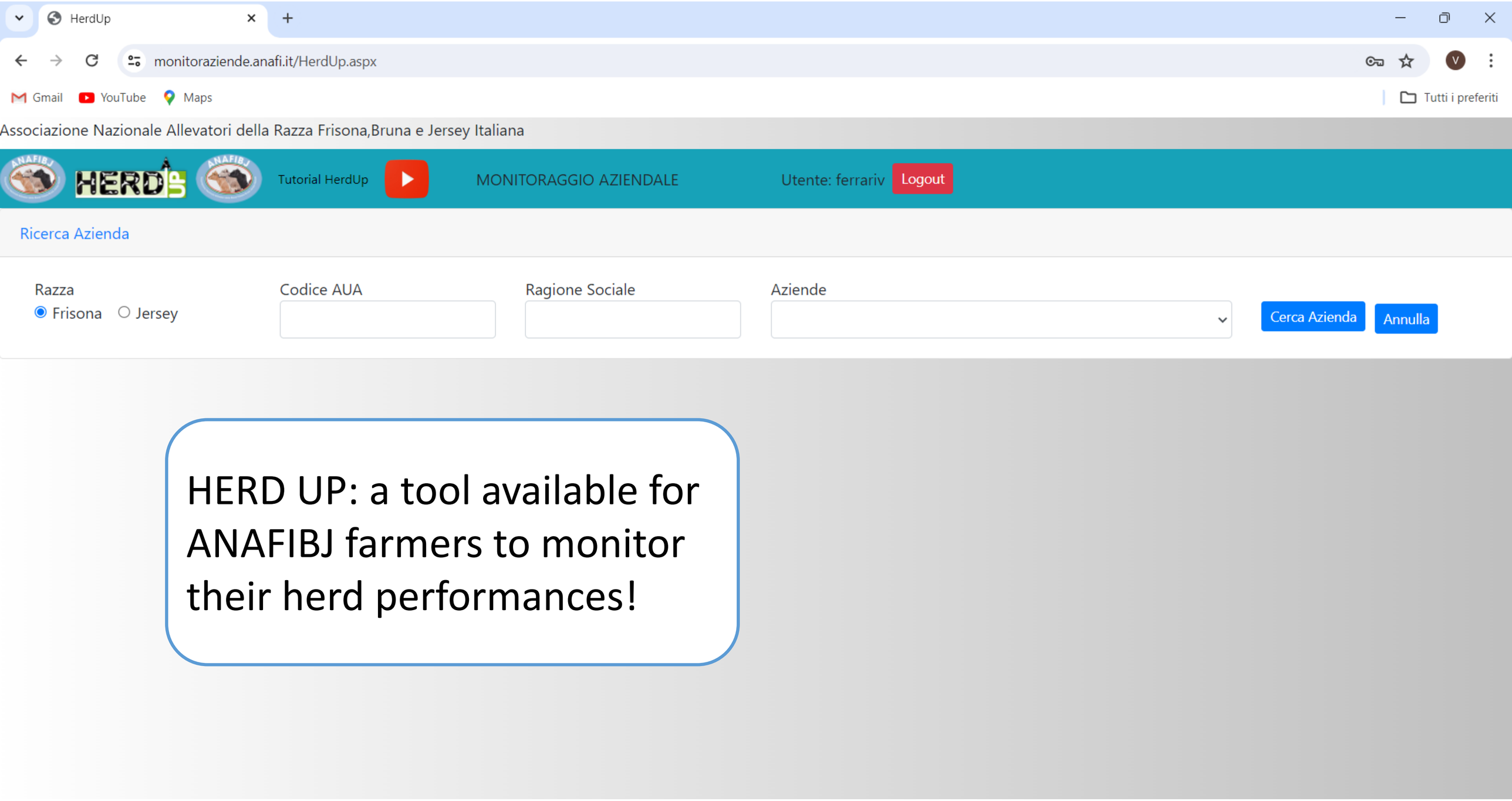
RESULTS-ESTIMATION OF CC

Table 2. Variables selected for the estimation of CC

Variable
Biogas
Percentage of soybean meal in the ration
IES (health and economic) genetic index
CH_4 (methane emission) genetic index
Age at first calving
Pregnant cows at 120 d
Milk sold per LU (livestock unit)

Adjusted R2 of the equation was 0.63
Average correlation coefficient between CC_es and CC was 0.77

EXAMPLES OF APPLICATION


HerdUp
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Gmail
YouTube
Maps
Tutti i preferiti
Associazione Nazionale Allevatori della Razza Frisona,Bruna e Jersey Italiana
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MONITORAGGIO AZIENDALE
Utente: ferrariv
Logout
Ricerca Azienda
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Frisona
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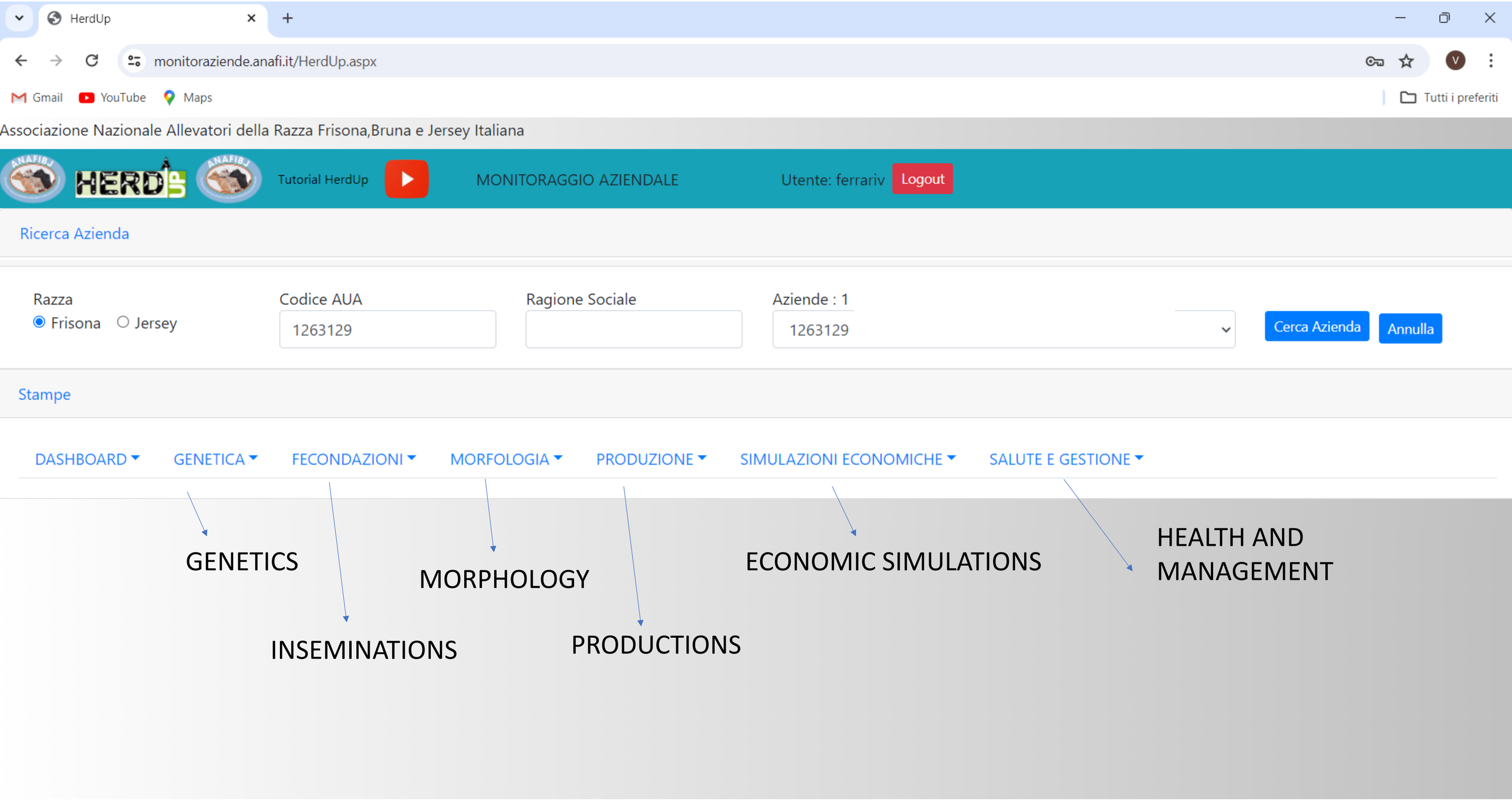
Codice AUA
Ragione Sociale
Aziende
Cerca Azienda
Annulla
HERD UP: a tool available for ANAFIBJ farmers to monitor their herd performances!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Stampe
DASHBOARD
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MORFOLOGIA
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SIMULAZIONI ECONOMICHE
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Tutorial HerdUp MONITORAGGIO AZIENDALE Utente: ferrariv Logout

Ricerca Azienda

Razza
Frisona Jersey

Codice AUA
1263129

Ragione Sociale

Aziende : 1
1263129

Cerca Azienda Annulla

Stampe

DASHBOARD GENETICA FECONDAZIONI MORFOLOGIA PRODUZIONE SIMULAZIONI ECONOMICHE SALUTE E GESTIONE

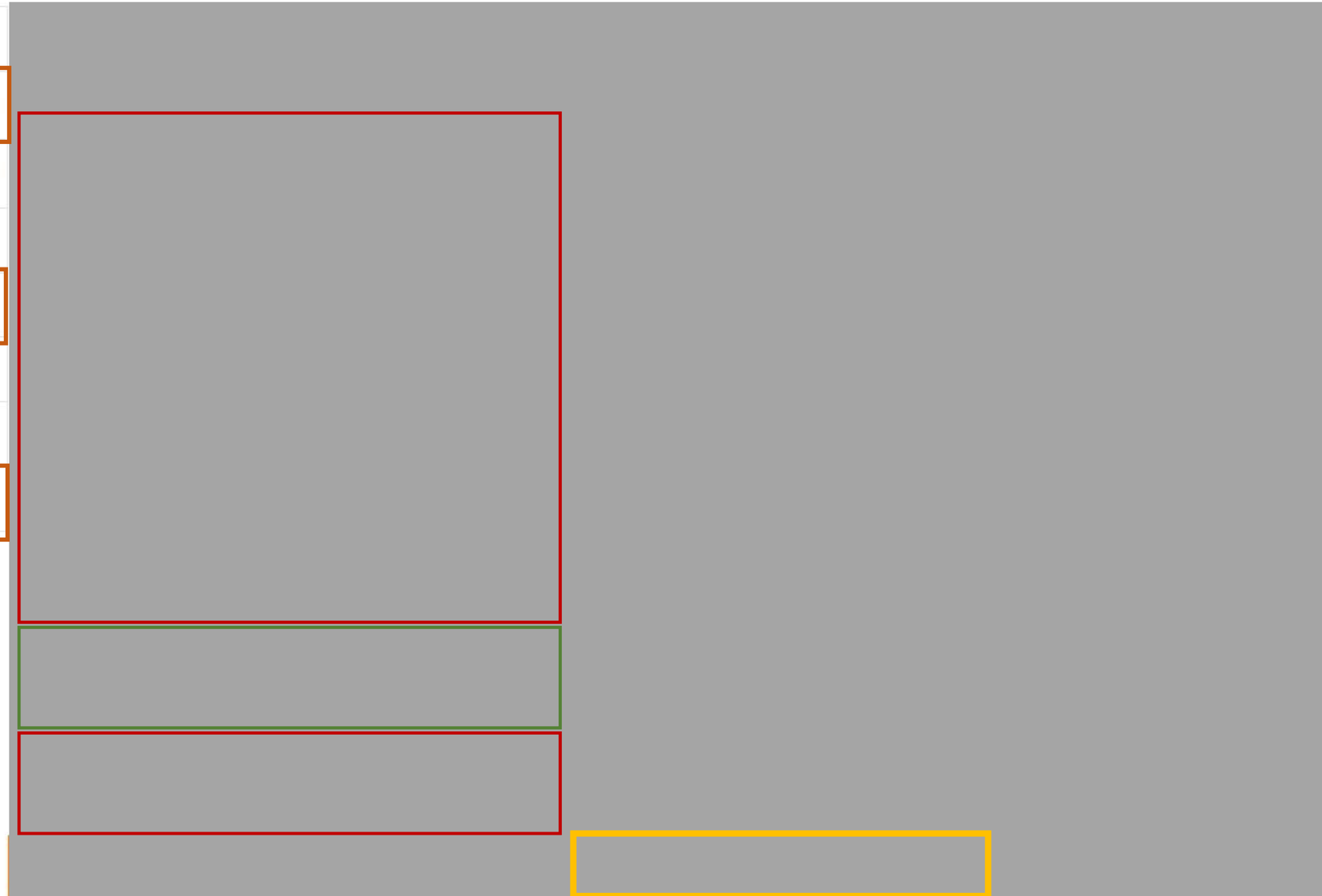
- Key Performance Indicators
- Informazioni SCC
- Impatto Ambientale
- Monitoraggio periodo di transizione

Environmental impact

Herd environmental impact

Total UAA (Utilised agricultural area)	0
Biogas	◉Si ○No
Organic Farm	○Si ◉No
Amount of hay in the ration (kg/d)	12,30
Amount of soybean meal in the ration (kg/d)	1,73
Total feed quantity (kg/d)	0,00
Amount of protein concentrate in the ration (kg/d)	0,00
Total dry matter intake per day	27,50

Herd 1



Total UAA (Utilised agricultural area)	121
Biogas	○Si ◉No
Organic Farm	○Si ◉No
Amount of hay in the ration (kg/d)	12,30
Amount of soybean meal in the ration (kg/d)	2,70
Total feed quantity (kg/d)	0,00
Amount of protein concentrate in the ration (kg/d)	0,00
Total dry matter intake per day	28,50

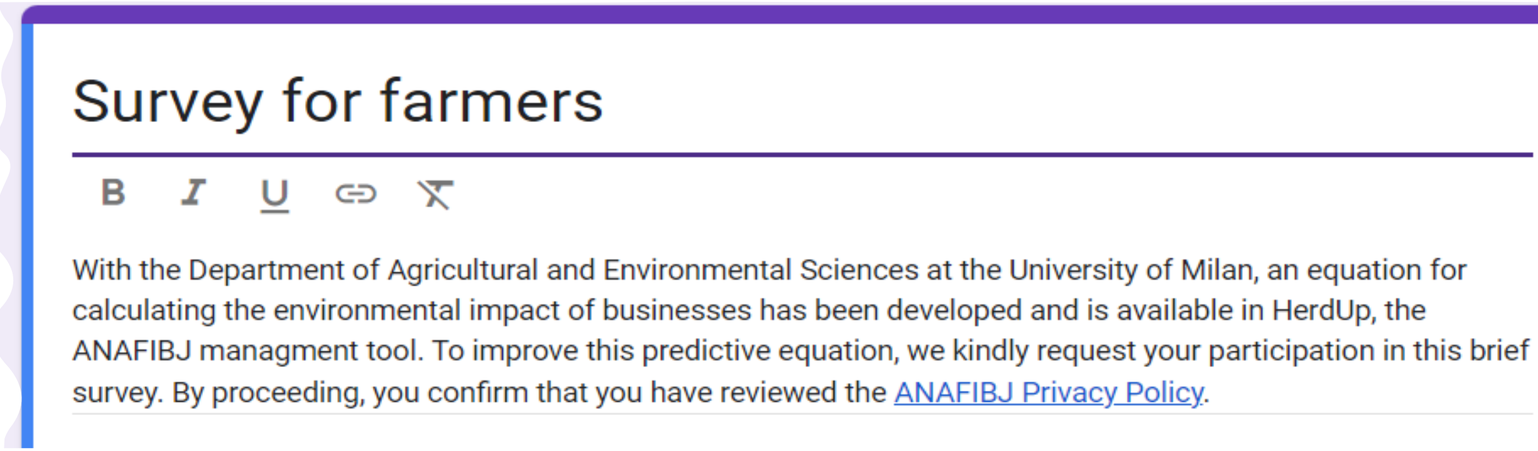
Herd 2

Parametri	Default	Simulazione
Reference year	2024	
Daily milk yield of current cows (kg/d)	39,70	40,00
Estimated annual herd milk production (q/year)	47094,13	47450,00
Fat (%)	4,22	
Protein (%)	3,73	
Cows (lactation + dry) (n)	325	
Heifers > 12 mo (n)	83	
Heifers between 12 and 6 mo (n)	43	
Female calves < 6 mo (n)	51	
Age at first calving (mo)	22,43	
Average IES (Economic Sustainability Index) (Average of last 5 years)	559	
Average Predicted Methane Emission Index	101	
Herd milk yield sold/LU (livestock units)	10761,91	10843,24
Pregnant cows at 120 d (%)	62	70
Herd environmental impact (kg CO2 eq./ kg milk)	1,23	1,16

In progress

To improve this predictive equation, has been set up a survey to be distributed to farmers of both countries and this would help:

1) understand the environmental impact management of farmers;
2) enlarge the number of farmers to be included in the analysis and
3) to test a wider area.



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