MINISTERO DELL'AGRICOLTURA DELLA SOVRANITÀ ALIMENTARE E DELLE FORESTE

ALMA MATER STUDIORUM UNIVERSITÀ DI BOLOGNA

SustMilk4IT

2nd Artificial Intelligence for Animal Science Conference

Application of machine learning to predict enteric methane emission and enhance dairy cattle farm management

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Project: SustMilk4IT
Presenter: Anis Mansouri

Plan of the presentation:

- Materials and methods of the study (6 min)
- Presentation of the web application (4 min)
- Poll to collect feedback to improve the tool (2 min)

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Prediction of enteric CH4 emission using dairy farm variables

Methods

Data: 11 variables and 252 observations.

Period: 06-2024 to 06-2025.

Model: Elastic Net algorithm.

Construction of the model: 80 % of the data (201 observations) were used to train the model.

Validation of the model: the remaining 20 % (51 observations) were used to validate the model.

Variables measured in the farm

Outcome:

Enteric CH4 emission

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Predictors:

Cattle’s weight
Number of cows
Parity
Farm temperature
Milk production
Fat % in the milk
Protein % in the milk
ECM
Forages fed to the cow
Concentrates fed to the cow

Models’ performance

Model	Mean Absolute Error	R^2	Err %	CH4 range
L CH4/Cow/Day	25 L/Cow/Day	0.87	[3, 6]	[391, 814]
L CH4/Farm/Day	2440 L/Farm/Day	0.92	[3, 8]	[32079, 83822]
Gram CH4/Kg Milk/Day	1.2 Gram CH4/Kg Milk/Day	0.34	[4, 10]	[12, 30]

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Decision-making tool for farm management

Decision-making tool

Data: 11 variables and 252 observations.

Model: Bayesian Network.

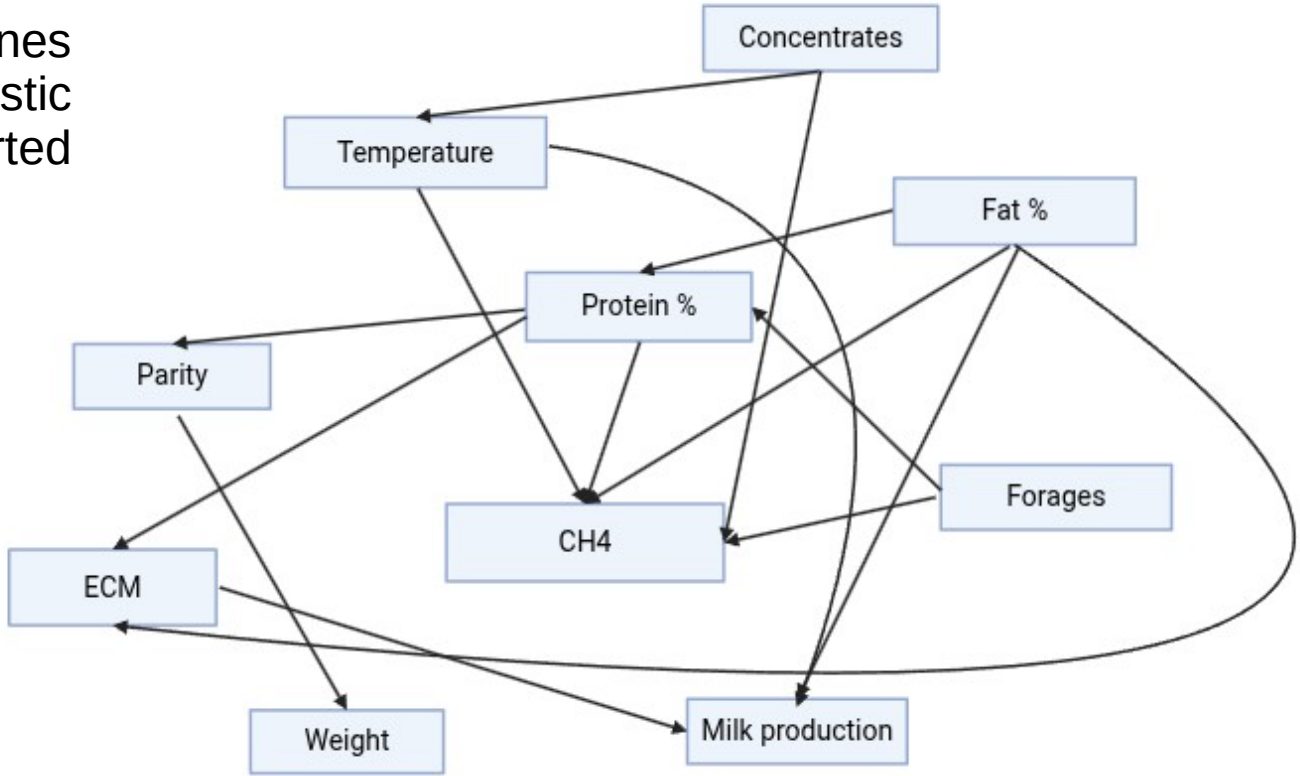
Construction of the model: structure and parameter learning using 80 % of the data (201 observations).

Validation of the model: test set validation using 20 % of the data (51 observations)

The model makes predictions at cow level (can be used for farm level or CH4 intensity)

Learning the structure of the BN

Structure learning defines which probabilistic relationships are supported by the data

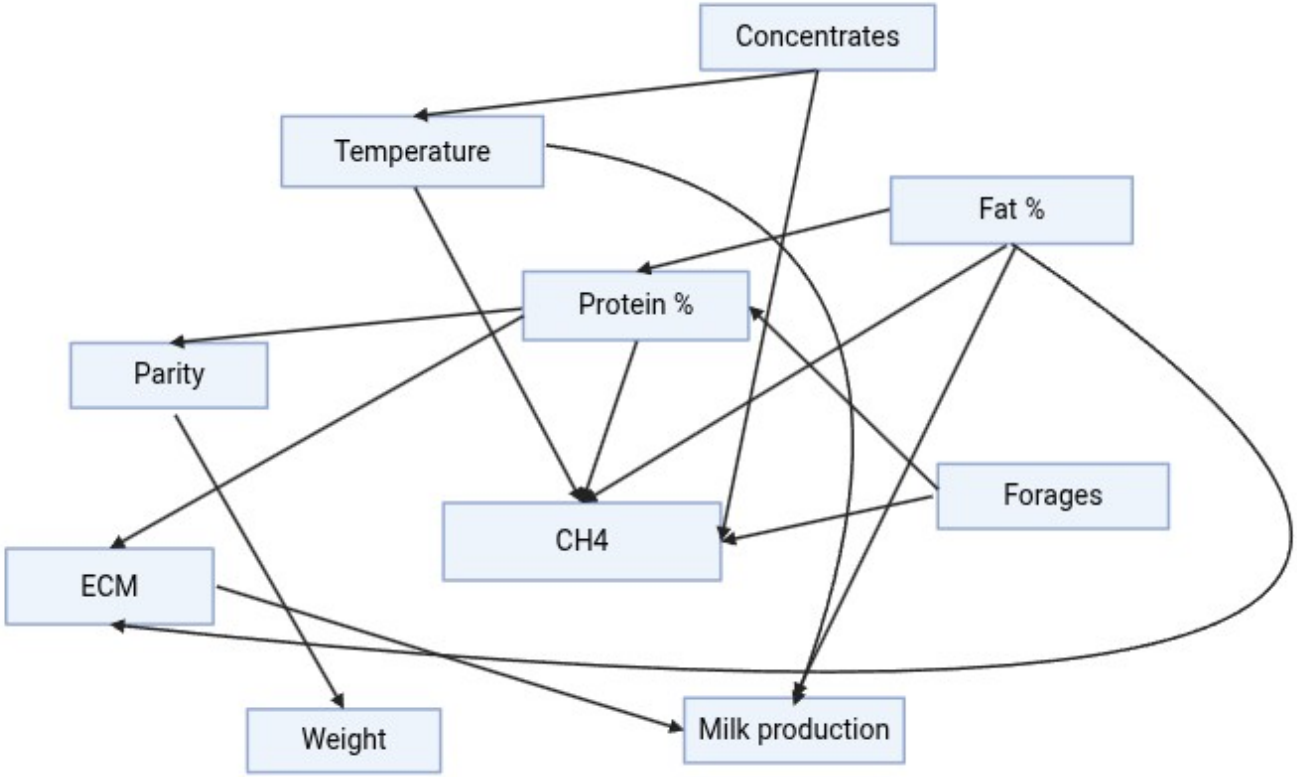


Parameter learning

Parameter learning computes the parameters between the parents and children nodes. Example:

CH4 = - 788.3 Protein -
194.6 Fat -
22.8 Concentrates +
19.2 Forages -
3.1 Temperature +
4442.4

Weight = 180.5 Parity +
285.7



Validation of the model

	MAE	R2	Min value	Max value
Protein	0.02	0.57	3.4	3.66
Cattle's weight	6.21	0.9	685.72	755.16
Milk production	0.15	0.99	12.03	41.57
Parity	0.03	0.91	2.14	2.62
Fat	0.06	0.86	3.52	4.47
ECM	0.24	0.98	13.43	44.29
Concentrates	1.01	0.45	11.98	40.54
CH4	49.32	0.49	391.21	813.81
Forages	1.26	0.48	8.01	33.49
Temperature	4.45	0.24	7.78	30.7

MAE: mean absolute error. Min/Max value: minimum and maximum records, respectively.

Web Application

The predictive and decision-making models are implemented as a user-friendly application (first prototype):

https://anismansouri.shinyapps.io/prt1/

Vai a wooclap.com

Immettere il codice dell'evento nel banner superiore

Codice evento

PDRQHI

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www.unibo.it

Thank you!

Appendix

$$p(x_i|\mathbf{Pa}_i) = \mathcal{N}(\beta_{0i} + \beta_{1i}x_{1(i)} + \cdots + \beta_{ki}x_{k(i)}; \sigma_i^2) = \mathcal{N}(\mu_i^{Pa_i}; \sigma_i^2), \tag{2}$$

where $\beta_{0i}, \ldots, \beta_{ki}$ are regression parameters associated with each parent node of X_i in $\mathbf{Pa}_i$ and σ_i^2 is the (unconditional) variance of X_i. Given that all the nodes in the network have this kind of CPD, we can write the joint density in Equation 1 using Equation 2 as:

$$p(\mathbf{X}) = \prod_{i=1}^{n} p(x_i|\mathbf{Pa}_i) = \prod_{i=1}^{n} \mathcal{N}(\mu_i^{Pa_i}; \sigma_i^2). \tag{3}$$

https://www.bnlearn.com

https://online.bayesserver.com

dbnR: Gaussian Dynamic Bayesian Network Learning and Inference in R:

https://www.jstatsoft.org/article/view/v115i06

Variabile	Foraggio	Concentrato
CH4/vacca	-	-
# Vacche	-	-
Temperatura	-	-
Parità	-	-
Produzione di latte (Kg/giorno/vacca)	-	-
Grasso nel latte (%)	-	-
Proteina nel latte (%)	-	-
Peso vacca (Kg)	-	-
Mangime tipo AB	-	Si
Mangime tipo C	-	Si
Fieno frumento, Medica Fasciata 2023", Paglia, Medica fieno 2 3 Q, Gramin fieno	Si	-
Mangime carro, Megafat 88 ,Melasso, Misto Novellini, Semi_Lino, Soia Farina Estrazione, FIOCCO CAIP, Alma Mater Dairy Integratore	-	Si

Tabella 1: variabili raccolte della stalla sperimentale DIMEVET.

Ingrediente	*U.M.*	Mangime A e B del robot
Soia f.e. 47%	%	25.00
Soia buccetta	%	21.00
Mais farina fine	%	16.50
Crusca di grano tenero	%	14.00
Soia intera tostata macinata	%	12.50
Seme di lino estruso	%	0
Melasso di canna	%	5.00
Sodio cloruro	%	2.30
Calcio carbonato	%	2.30
Fosfato bicalcico	%	1.40

Feed A/B

La composizione del mangime liquido (feed C) è in parte sconosciuta perché coperta da segreto industriale. Queste sono le informazioni cxhe sono riuscito ad ottenere:

33% melasso di canna da zucchero
33% melasso di barbabietola da zucchero
33% glicerolo
1% additivi

Feed C