Dataset on productive functional traits at first lactation and productive longevity from a herd of 185 Montbéliarde and Holstein cows managed on a low-input mountain-area grassland farm

Luciano Barreto Mendes, Mauro Coppa, Bruno Martin, Anne Ferlay, Matthieu Bouchon, Fabienne Blanc

Data in Brief 53 (2024) 110205

Contents lists available at ScienceDirect

Data in Brief

journal homepage: www.elsevier.com/locate/dib

Data Article

Dataset on productive functional traits at first lactation and productive longevity from a herd of 185 Montbéliarde and Holstein cows managed on a low-input mountain-area grassland farm

Luciano Barreto-Mendes[a,*], Mauro Coppa[b], Bruno Martin[a], Anne Ferlay[a], Matthieu Bouchon[c], Fabienne Blanc[a]

[a] INRAE, Université Clermont Auvergne, VetAgro Sup, UMR 1213 Herbivores, Saint-Genès-Champanelle 63122, France
[b] Department of Agricultural, Forest and Food Sciences, University of Turin, Largo P. Braccini 2, Grugliasco, TO 10095, Italy
[c] INRAE, UE Herbipôle, Saint-Genès-Champanelle 63122, France

ARTICLE INFO

Article history:
Received 16 October 2023
Revised 17 January 2024
Accepted 12 February 2024
Available online 17 February 2024

Dataset link: table (Original data)

Keywords:
Dairy herd
Grass-based system
Productive lifespan
Functional traits

ABSTRACT

The dataset available here comes from an experimental dairy cattle farm located in a mountain region in Central France, where the feeding systems are mostly pasture grazing combined with a period of indoor overwintering during the colder months. The dataset comprises individual productive and functional traits covering over 36 different variables in 185 primiparous Montbéliarde and Holstein cows, followed by data on productive longevity and reason for culling. The data was collected over a 20-year period during which animal husbandry and data collection protocols remained consistent. Potential re-users of the data are private-sector professionals, farmer associations, and researchers interested in developing statistical and mechanistic models and simulations of individual dairy cows under low-input grassland-based systems.

* Corresponding author.
E-mail address: luciano.mendes@inrae.fr (L. Barreto-Mendes).
Social media: @MendesLuciano6 (L. Barreto-Mendes), @BMartinInrae (B. Martin), @BouchonMatthieu (M. Bouchon)

https://doi.org/10.1016/j.dib.2024.110205

Specifications Table

Subject	Agricultural Sciences, Animal Science
Specific subject area	Husbandry and management of dairy cows in low-input pasture systems
Data format	Filtered
Type of data	Table
Data collection	Data storage: MS Access data collection and management software for data on milk production and composition, body weight (BW), body condition score (BCS), fertility, and health events. Production performance: milk recording jars (DeLaval®, Ghent, Belgium) set on loading cells. Measurement time-step: daily. Milk composition: Infrared method (Milkoscan 4000, Foss System, Hillerod, Denmark). Measurement time-step: twice a week. Body weight: Electronic scale (Mettler-Toledo SAS, Mettler Spider 2 model, Viroflay, France). Measurement time-step: monthly (average of measurements taken during milkings). BCS: suitably-trained staff using the method described in Bazin et al. [1]. Measurement time-step: monthly (average taken from measurements from three trained staff members). Fertility & reproduction: suitably-trained staff & veterinarian. Health status: suitably-trained staff & veterinarian. Feeding: rations were calculated according to the INRA Feeding System [2]. Individual forage and concentrate intakes when cows were confined indoors were calculated as weight offered minus weight of refusals three/four days per week. Reason for culling: completed by suitably-trained staff.
Data source location	Institution: INRAE UE 1414 Herbipôle - Systèmes d'Elevage de Ruminants de Moyenne Montagne City/Town/Region: Marcenat / Auvergne Country: France Latitude and longitude for collected samples/data: 45°18'21"N, 2°50'13"E; average altitude: 1075 m DOI: https://doi.org/10.15454/1.5572318050509348E12
Data accessibility	Repository name: DataINRAE Data identification number: doi:10.15454/MEN81R Direct URL to data: https://entrepot.recherche.data.gouv.fr/dataset.xhtml?persistentId=doi:10.15454/MEN81R
Related research article	L.Barreto-Mendes, M. Coppa, J. Rouel, B. Martin, B. Dumont, A. Ferlay, C. Espinasse, F. Blanc. Profiles of dairy cows with different productive lifespan emerge from multiple traits assessed at first lactation: the case of a grassland-based dairy system. Livest. Sci. 246 (2021) 104443. https://doi.org/10.1016/j.livsci.2021.104443. [3]

1. Value of the Data

- The utility of this original data is that it exhaustively characterizes productive and functional traits at first lactation along with productive longevity in a population of 71 individual Holstein and 114 Montbéliarde cows reared in an experimental grass-based system located in a mountain area, in central France (Massif Central). Although this livestock farming system is designed to mimic commercial farms, the substantial amount of individual-based information obtained for each cow presented in the available datasets is not usually collected in commercial practice.
- The available dataset could be used by all kinds of researchers (experimental, statistical or mechanistic modeling), students, breeder associations, and any other stakeholders.

- It comprises in a quantitative account of the most relevant productive and functional traits of dairy cows assessed at first lactation together with traits that synthesize the lifespan career of these individuals, such as productive longevity and reasons for culling.
- We anticipate multiple possibilities for use/reuse of the provided data. For instance, modelers interested in setting ranges of variability for the traits considered here could use the data to produce individual-based simulations of dairy cows under grassland-based systems. This data can equally be used to calibrate and/or validate individual-centered mechanistic models.

2. Objective

As the farm where the data was collected is an experimental station, the dataset provides a detailed account of key productive, reproductive and physiological variables in dairy cows managed in a low-input grass-based system, along with information on health, fertility, and reproductive performance. The frequency of data collection and rigorous protocols applied to ensure data quality were originally meant to serve for the experiments performed on-site over a period of years. In the periods between experiments, cows were often kept on-site and managed by trained staff until the next trial was started or until culling. Technical measurements and recording of data continued during these 'inter-experiment' phases.

A recent need to investigate newly-identified associations among the variables described above during the first lactation [3] led to a broader compilation of key data in order to better characterize the animals over their entire career.

3. Data Description

3.1. Data on Productive and Functional Traits

This section concerns the data provided under doi.org/10.15454/1.5572318050509348E12, in .csv format. Each line in the data file starts with a unique individual identification number, followed by a breed identifier ('MO' for Montbéliarde or 'HO' for Holstein) and a column stating whether a specific cow had been exposed to an experimental trial during its first lactation. The following columns contain the variables that describe the first lactation, and were defined and determined as described in Tables 1–5. For simplicity, in the data file, names of the variables have been replaced by the number of the equation corresponding to that variable. For instance, Var1 refers to $\overline{\text{concentrate}}_{10\ \text{wk}}$, and so on.

Table 1
Definition of variables related to feeding and herd management, with their equations and units.

Variable and equation	Definition and units	
$\overline{\text{concentrate}}_{10\ \text{wk}} = (1/10)\ \sum_{i=1}^{10}(\text{concentrate}_i)$	Average concentrate consumption ($kg_{DM}\cdot d^{-1}$) up to 10 weeks after calving; concentrate_i is average concentrate intake ($kg_{DM}\cdot d^{-1}$) at week i after calving	(1)
$\overline{\text{forage}}_{10\ \text{wk}} = (1/10)\ \sum_{i=1}^{10}(\text{forage}_i)$	Average forage consumption ($kg_{DM}\cdot d^{-1}$) up to 10 weeks after calving; forage_i is average forage intake ($kg_{DM}\cdot d^{-1}$) at week i after calving	(2)
$\overline{\text{feed intake}}_{10\ \text{wk}} = (1/10)\ \sum_{i=1}^{i=10}(\text{forage}_i + \text{concentrate}_i)$	Average feed intake ($kgDM\cdot d^{-1}$) up to 10 weeks after calving	(3)
$\overline{\text{corrected feed intake}}_{10\ \text{wk}} = (1/10)\ \sum_{i=1}^{i=10}(\text{forage}_i + 0.5\cdot\text{concentrate}_i)$	Corrected feed intake ($kgDM\cdot d^{-1}$), taking into account the different encumbrances of forage_i and concentrate_i [2], also in $kgDM\cdot d^{-1}$, calculated up to the 10^{th} week of lactation	(4)
$\%T_{indoors} = (100/n)\sum_{i=1}^{i=n} i$	Percentage of time spent indoors (%), where n is lactation length in weeks	(5)

Table 2
Definition of variables related to milk production and composition at first lactation, with their equations and units.

Variable and equation	Definition and units	
$\overline{MY} = \frac{1}{n}\sum_{i=1}^{n} MY_i$	Average daily milk yield (MY) for the entire lactation cycle ($kg{\cdot}d^{-1}$); n is duration of the lactation, in weeks	(6)
$\overline{MY_{305d}} = \frac{1}{44}\sum_{i=1}^{i=44} MY_{305d,i}$	MY for a cycle of 305d ($kg{\cdot}d^{-1}$); 44 is the number of weeks considered as a 'standard' lactation. If the cow lactated less than 44 weeks then the missing weeks were at 0.	(7)
$lactation_{length} =$ drying up $date_{1st\ lact} -$ calving $date_{1st\ lact}$	Lactation length (d); difference between drying up and calving dates	(8)
$MY_{peak} = \max(MY_i)\|_{i=1}^{n}$	MY at lactation peak ($kg{\cdot}d^{-1}$), defined as maximum weekly MY in a lactation cycle of n weeks. n is duration of the lactation, in weeks	(9)
$T_{peak} = i_{MY_{peak}}$	Time of peak (wk) is week in the lactation cycle when the MY peak occurs	(10)
$int_{dry} =$ $Int_{calving\ to\ calving} - lactation_{length}$	Time interval (d) between first and second calvings when the cow was no longer being milked	(11)
$sumMY_{305\ d} = \sum_{i=1}^{44} MY_i$	Cumulative MY (kg) during a reference lactation cycle of 305 d	(12)
$sumMY_{peak} = \sum_{i=1}^{T_{peak}} MY_i$	Cumulative MY (kg) up to the lactation peak at T_{peak}	(13)
$sumMY_{4wk} = \sum_{i=1}^{4} MY_i$	Cumulative MY (kg) up to the 4th week	(14)
$sumMY_{24wk} = \sum_{i=1}^{24} MY_i$	Cumulative MY (kg) up to the 24th week	(15)
$P =$ $\|(MY_{peak} - MY_{36th\ wk})/(T_{peak} - 36)\|$	Persistence of the lactation curve ($kg{\cdot}d^{-1}$), taking the 36th week of the lactation cycle as the reference	(16)
$R = (MY_{peak} - MY_{1st\ wk})/T_{peak}$	MY rise rate ($kg{\cdot}d^{-1}$) is the rate of rise in MY between the 1st week of lactation and the lactation peak	(17)
$\overline{MP} = \frac{1}{n}\sum_{i=1}^{n} MP_i$	Average milk protein (MP) content for the entire lactation cycle ($g{\cdot}kg^{-1}$)	(18)
$\overline{MF} = \frac{1}{n}\sum_{i=1}^{n} MF_i$	Average milk fat (MF) content for the entire lactation cycle ($g{\cdot}kg^{-1}$)	(19)

Table 3
Definition of variables related to body weight (BW) and body condition score (BCS) at first lactation, with their equations and units.

Variable and equation	Definition and units	
$BW_{calving} = BW_{i=T_{calving}}$	BW (kg) at week of calving	(20)
$BW_{min} = \min(BW_i)\|_{i=1}^{i=n}$	Minimum body weight (kg)	(21)
$BW_{loss} = BW_{calving}$ - BW_{min}	Loss of BW (kg) between $BW_{calving}$ and BW_{min}	(22)
$BCS_{calving} = BCS_{i=T_{calving}}$	Average weekly BCS (dimensionless) at calving	(23)
$BCS_{loss} = BCS_{calving}$ - BCS_{min}	Loss of BCS (dimensionless) between calving and minimum	(24)

Table 4
Definition of variables related to health at first lactation, with their equations and units.

Variable and equation	Definition and units	
$\%T_{MF/MP<1.0} = \begin{cases} if\ MF_i/MP_i < 1.0,\ (100/n)\sum_{i=1}^{n} i \\ if\ MF_i/MP_i \geq 1.0,\ 0 \end{cases}$	Percentage of time during the total lactation period when MF/MP ratio was lower than 1.0 (higher risk of acidosis); n is the count of days when the 1st condition was true	(25)
$\%T_{MF/MP>1.4} = \begin{cases} if\ MF_i/MP_i > 1.4,\ (100/n)\sum_{i=1}^{n} i \\ if\ MF_i/MP_i \leq 1.4,\ 0 \end{cases}$	Percentage of time during the total lactation period when MF/MP ratio was higher than 1.4 (risk of ketosis); n is the count of days when the 1st condition was true	(26)
$mastitis_{count} = \sum_{i=1}^{n} mastitis_{count,i}$	Total count of mastitis episodes that occurred during lactation	(27)
$lameness_{count} = \sum_{i=1}^{n} lameness_{count,i}$	Total count of lameness episodes that occurred during lactation	(28)
$med.int_{count} = \sum_{i=1}^{n} med.int_{count,i}$	Total count of medical interventions that occurred during lactation	(29)

Table 5
Definition of variables related to fertility and reproduction at first lactation, with their equations and units.

Variable and equation	Definition and units	
$heat_{count} = \sum_{i=1}^{n} heat_{count,i}$	Total count of observed heat events	(30)
$(AI+NI)_{count} = \sum_{i=1}^{n} AI_i + \sum_{i=1}^{n} NI_i$	Total count of artificial and/or natural inseminations	(31)
$int_{calving\ to\ calving} = T_{2nd\ calving} - T_{1st\ calving}$	Time interval (d) between first and second calvings	(32)
$int_{calving-1^{st}\ heat} = T_{calving} - T_{1^{st}\ heat}$	Time interval (d) between calving and first heat	(33)
$int_{calving-1^{st}\ insemination} = T_{calving} - T_{1^{st}\ insemination}$	Time interval (d) between calving and first insemination	(34)
$int_{calving-conception} = T_{calving} - T_{conception}$	Time interval (d) between calving and conception	(35)
$int_{1^{st}heat\ -conception} = T_{1^{st}heat} - T_{conception}$	Time interval (d) between first heat and conception	(36)

Data on longevity and reason for culling

$$lifespan_{productive} = \left(T_{culling} - T_{birth}\right) - age_{1st\ calving} \quad (37)$$

where: $lifespan_{productive}$ is measured in d; T_{birth} and $T_{culling}$ are birth date and culling date, respectively; $age_{1st\ calving}$ is measured in d.

The reason(s) why an individual cow was culled from the herd is represented in the dataset via three different qualitative variables. The “reason for culling” variable indicates the primary reason for making the decision to cull, i.e. reproductive, health, or economic. Next to that, the “primary reason for culling” variable provides deeper detail on the decision to cull, such as an abortion diagnostic, a high incidence of mastitis, or herd renewal. When there was more than one reason for culling, this information is provided under “secondary reason for culling”. Finally, the last column of the dataset indicates the destination of the cow after being culled, including but not limited to “sold to another farm”, “sold to slaughter”, or “death on-farm”.

4. Animal Husbandry, Materials and Methods

The information provided in this paper was gathered between 1996 and 2016 at the INRAE experimental farm of Marcenat (INRAE, UE 1414 Herbipôle, France; coordinates 45°18’21”N, 2°50’13”E; average altitude 1075 m, DOI: https://doi.org/10.15454/1.5572318050509348E12) located in the Massif Central mountain region in central France. Annual average air temperature is 11 °C. Average annual precipitation is 725 mm, with peak precipitations occurring in autumn and moderate summer droughts. The feeding regimen for dairy cows comprised hay from mountain grasslands, haylage (grass silage), and concentrate during the indoor overwintering season (from

November to mid-April, with concentrate ranging between 1.0 and 1.5 tDMI·animal^{-1}·year^{-1}). The cows grazed on permanent pastures for the remainder of the year.

The calving strategy primarily followed a seasonal pattern, with cows conceiving naturally or through artificial insemination during the winter months. After a voluntary wait period of at least two months, visual detection of heat was performed by trained staff. Cases of anestrus were only addressed for heifers, who received hormonal treatment. An artificial insemination campaign took place on the farm from November to February. If a cow was not confirmed pregnant by the end of the grazing/reproductive period, it was culled.

Housing facilities consisted of a naturally-ventilated barn accommodating up to 110 cows in cubicles. Raw data, including milk production and composition, body weight (BW), body condition score (BCS), fertility, and health events, were stored using the Datalogic Aladdin^{TM} data collection and management software (Datalogic S.p.A, Bologna, Italy). Milking occurred year-round inside the barn's automatic milking parlor twice a day (at 06:00 and 16:00). Forage was individually provided twice a day during the indoor season, and forage intake records were collected on an individual basis three/four days a week.

In winter, the amount of concentrate offered to cows each week was determined based on their nutritional requirements as per the INRA feeding system [2], factoring in their milk production in the previous week. Concentrate intake was monitored individually using an automatic feeder (Feeding Station FSC-40 DeLaval, Elancourt, France). During the outdoor grazing period, the group of cows was offered concentrate, thus ruling out individual intake records.

These feeding and management practices were consistently applied whenever the cows were not part of experiments, but adjusted during the experimental periods.

Limitations

The dataset may contain bias introduced by the fact that the farm where the cows were kept is an experimental station. The majority of cows kept on this farm have been exposed to experimental procedures at least once in their lifetime, which might have temporarily or permanently influenced their performance and/or functional traits. However, as the experiments performed across the years were hugely diverse in terms of duration (weeks to months), form (invasive, non-invasive, individual, group), and purpose (diet, management, health, welfare, etc.), we consider this bias to be homogeneously spread across all the data, and so the data provided does not specify details on the specific experiments. However, we advise potential users of the dataset to keep this bias in mind, especially when making comparisons to other similar systems.

Concerning the feeding variables, individual feed intakes were only calculated at the beginning of lactation (<10 weeks), because after this period the cows were often turned back out to pasture, where an accurate measure of intake is not practicably possible.

We also want to inform the reader that some variables related to BCS could not be calculated up to the first lactation in all cows, which is why the dataset has some missing data.

Ethics Statement

The data described in this paper stems from multiple protocols performed at an experimental farm, where each experiment required ethics-committee approval. Each individual experimental protocol applied to animals was submitted to and secured approval from the Auvergne-Rhône-Alpes region and French Ministry of Higher Education, Research and Innovation ethical review boards.

Data Availability

table (Original data) (DataINRAE).

CRediT Author Statement

Luciano Barreto-Mendes: Formal analysis, Data curation, Writing – original draft; **Mauro Coppa:** Methodology, Data curation, Writing – review & editing; **Bruno Martin:** Supervision, Conceptualization, Methodology, Resources, Writing – review & editing; **Anne Ferlay:** Supervision, Conceptualization, Resources, Writing – review & editing; **Matthieu Bouchon:** Resources, Writing – review & editing; **Fabienne Blanc:** Funding acquisition, Conceptualization, Methodology, Writing – review & editing.

Acknowledgments

The work to prepare, filter and pre-process the data published with this article was partially funded by GenTORE Project, a European Union H2020 Research and Innovation Program under agreement No. 727213, and falls within the thematic area of the French government IDEX-ISITE initiative 16-IDEX-0001 (CAP 20-25). The authors thank Philippe Pradel for providing valuable help retrieving some of the data made available here. We express our appreciation to Metaform Langues for providing their professional proof-reading services of the final version of the manuscript, and are grateful to the anonymous reviewer for providing valuable feedback to the improvement of the scientific and technical quality of this paper.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] S. Bazin, P. Augeard, M. Carteau, H. Champion, Y. Chilliard, G. Cuylle, C. Dissenhaus, G. Durand, R. Espinasse, A. Gascoin, M. Godineau, D. Jouanne, O. Olivier, B. Remond, Grille de Notation de l'etat d'Engraissement des Vaches Pie Noires, Inst. Tech. l'Elevage Bovin, Paris, France, 1984.

[2] P. Nozière, D. Sauvant, L. Delaby, Alimentation des Ruminants: Apports Nutritionels - Besions et Réponses Des Animaux - Rationement - Tables De Valeurs Des Aliments, Editions Quae, Versailles, France, 2018.

[3] L. Barreto-Mendes, M. Coppa, J. Rouel, B. Martin, B. Dumont, A. Ferlay, C. Espinasse, F. Blanc, Profiles of dairy cows with different productive lifespan emerge from multiple traits assessed at first lactation: the case of a grassland-based dairy system, Livest. Sci. 246 (2021) 104443, doi:10.1016/j.livsci.2021.104443.