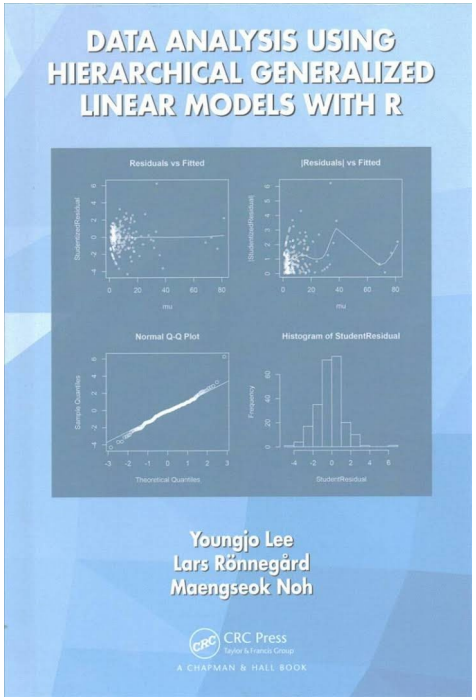
Animal Movement Course at Ekenäs

Indoor animal movement data
from the CSI:DT project

Lars Rönnegård

- PhD thesis on reindeer in 2003
- linear mixed models, generalized linear models, ….
- hglm package on CRAN since 2010
- Co-authored a book on hierarchical generalized linear models
- Started CSI:DT in 2020

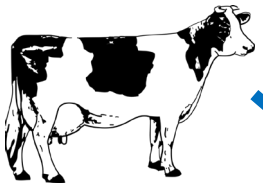
www.larsronnegard.se

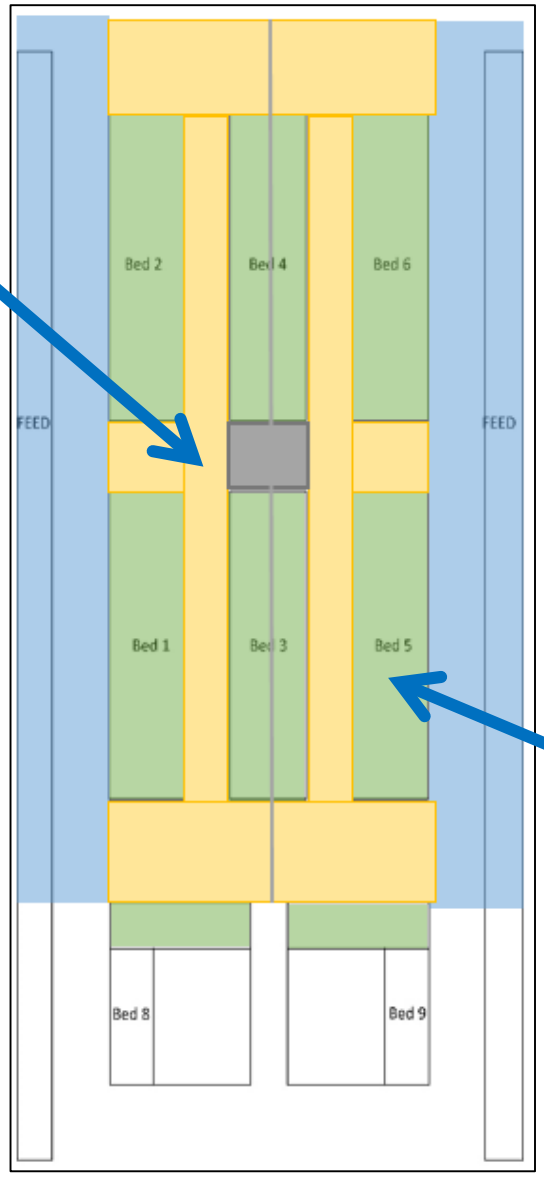


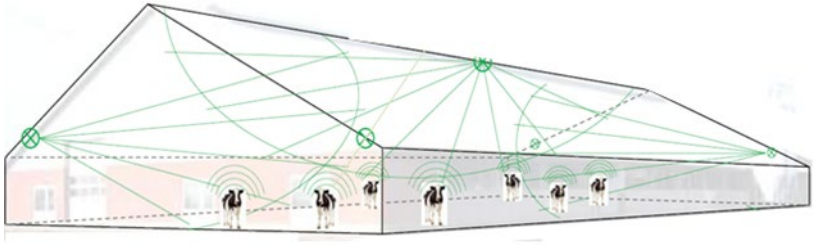
CSI:DT - Cow Social Interaction and Disease Transmission

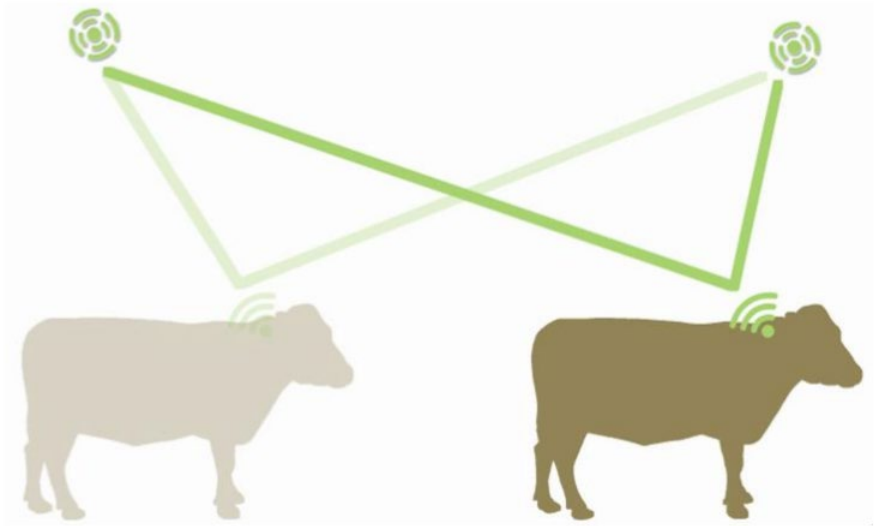
FORMAS

KJELL OCH MÄRTA BEIJERS STIFTELSE
Främjar vetenskap och kultur




Bed 2
Bed 4
Bed 6
FEED
FEED
Bed 1
Bed 3
Bed 5
Bed 8
Bed 9





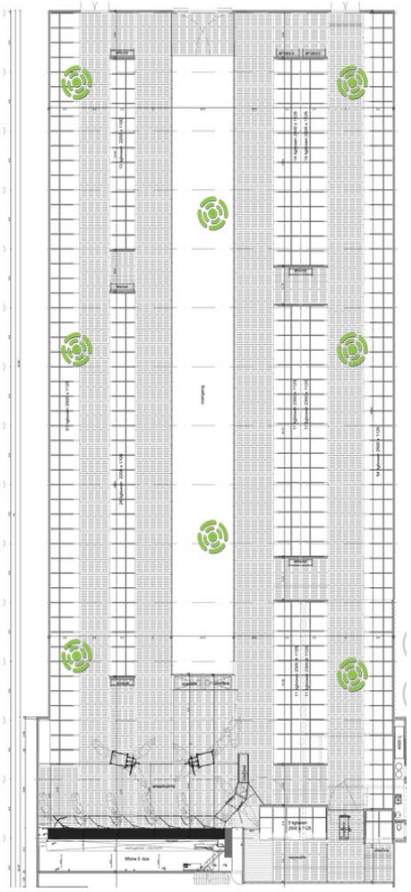
https://app.gea-cowview.com

GEA-CowView

A real-time positioning system

tag

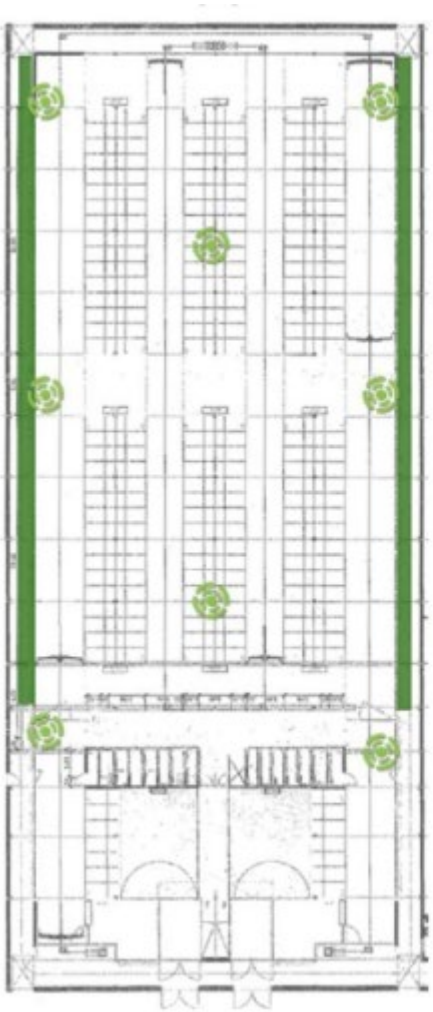
anchor



Anchor

10 m

Swedish farm



Dutch farm

Anchor

Feeding Area

Data

Illustration: Fredrik Saarkoppel

Swedish Farm	Dutch Farm
~200 cows (2 groups)	~200 cows (1 group)
Milking system: Milking Parlour	Milking system: Milking Robots
Breeds: Holstein, RDC, Cross	Breeds: Holstein
Cow traits: Parity, DIM, etc	Cow traits: Parity, DIM, etc
Positions: November 2019-	Positions: February 2020-

Data

Illustration: Fredrik Saarkoppel

Swedish Farm	Dutch Farm
~200 cows (2 groups)	~200 cows (1 group)
Milking system: Milking Parlour	Milking system: Milking Robots
Breeds: Holstein, RDC, Cross	Breeds: Holstein
Cow traits: Parity, DIM, etc	Cow traits: Parity, DIM, etc
Positions: November 2019-	Positions: February 2020-

Parity = no. of calves a cow has given birth to

DIM = how many days has the cow been milked since its latest calf was born

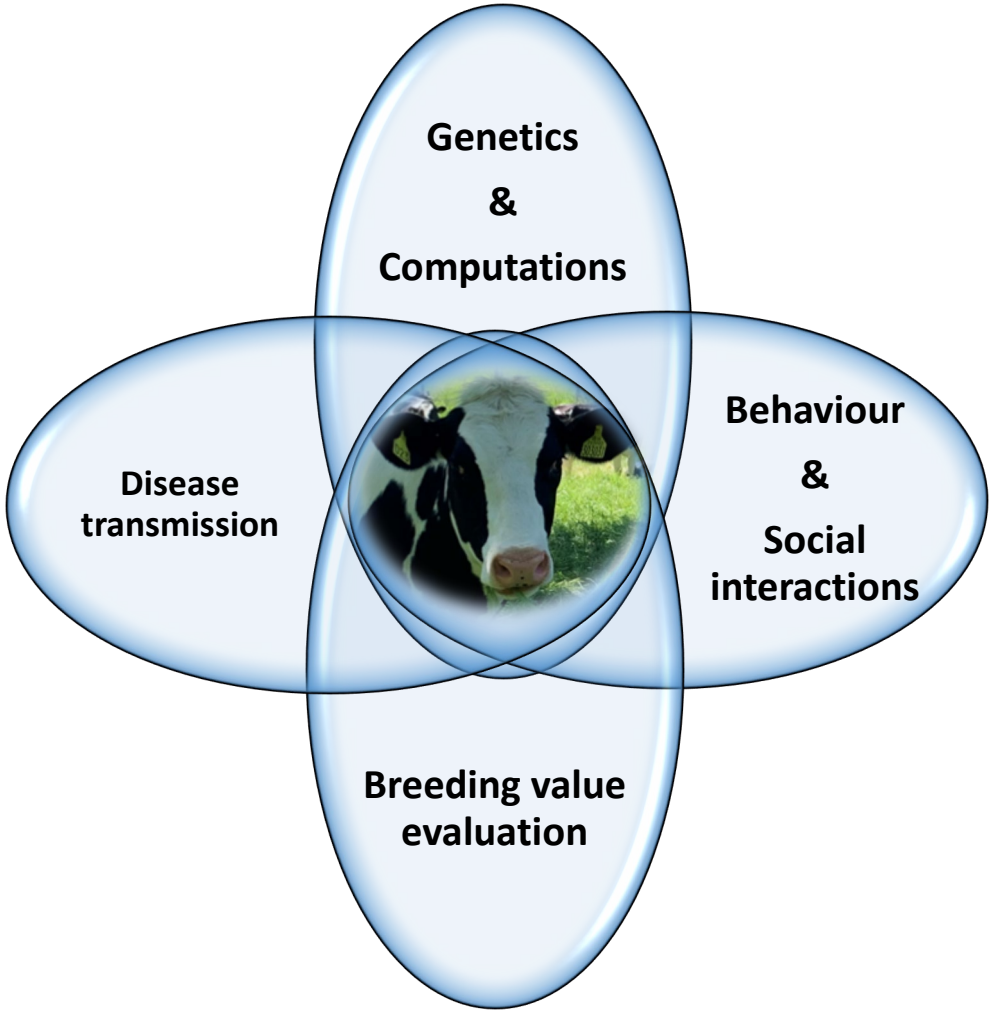
… and transmission of bacteria associated with mastitis

Illustration: Fredrik Saarkoppel

mastitis = udder infection

Swedish Farm	Dutch Farm
Bacterial samples taken every second week for 5 months (June-October 2020) -Milk samples from all cows -Environmental samples from different parts of the barn -Strain typing of bacteria	

SLU



KØBENHAVNS
UNIVERSITET

RI.
SE

VÄXA
SVERIGE

Anna Skarin professor, SLU

Keni Ren postdoc, SLU

Hector Marina postdoc, SLU

Ida Hansson PhD student, SLU

Freddy Fikse Växa Sverige

Svenja Woudstra PhD student, University of Copenhagen

Per Peetz Nielsen senior researcher, RISE

Carsten Kirkeby senior researcher, University of Copenhagen

Volker Krömker professor, University of Copenhagen

Maya Gussmann assistant professor, University of Copenhagen

Moudud Alam associate professor, Dalarna University

Lisa Beste communication officer, SLU

What do we want to achieve?

Focus on the social environment of cows in free-stall dairy farms

- to improve animal welfare and production
- to predict transmission of diseases (mastitis) using monitored movement and interactions between cows

Deliverables

To develop

- tools for summarizing animal movement and social interactions in dairy farms.

- decision-support tools for minimizing disease transmission within dairy farms.

- methodology for breeding on indirect genetic effects.

Published papers on real-time location data and social interactions

Marina, Ren, Hansson, Fikse, Nielsen, Rönnegård (2023) **New insight into social relationships in dairy cows, and how time of birth, parity and relatedness affect spatial interactions later in life**. Journal of Dairy Science (accepted)

Hansson, I., Silvera, A., Ren, K., Woudstra, S., Skarin, A., Fikse, W. F., Nielsen, P. P., & Rönnegård, L. (2023). **Cow characteristics associated with the variation in number of contacts between dairy cows.** Journal of Dairy Science.

Ren, K., Alam, M., Nielsen, P. P., Gussmann, M. K., & Rönnegård, L. (2022). **Interpolation methods to improve data quality of indoor positioning data for dairy cattle.** Frontiers in Animal Science

Ren, K., Nielsen, P. P., Alam, M., & Rönnegård, L. (2021). **Where do we find missing data in a commercial real-time location system? Evidence from 2 dairy farms.** JDS Communications.

Churakov, M., Silvera, A. M., Gussmann, M., & Nielsen, P. P. (2021). **Parity and days in milk affect cubicle occupancy in dairy cows.** Applied Animal Behaviour Science

Applied Animal Behaviour Science 244 (2021) 105494

Contents lists available at ScienceDirect

Applied Animal Behaviour Science

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

Parity and days in milk affect cubicle occupancy in dairy cows

Mikhail Churakov [a,1], Anna Maria Silvera [b,1], Maya Gussmann [c], Per Peetz Nielsen [d,*]

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ARTICLE INFO

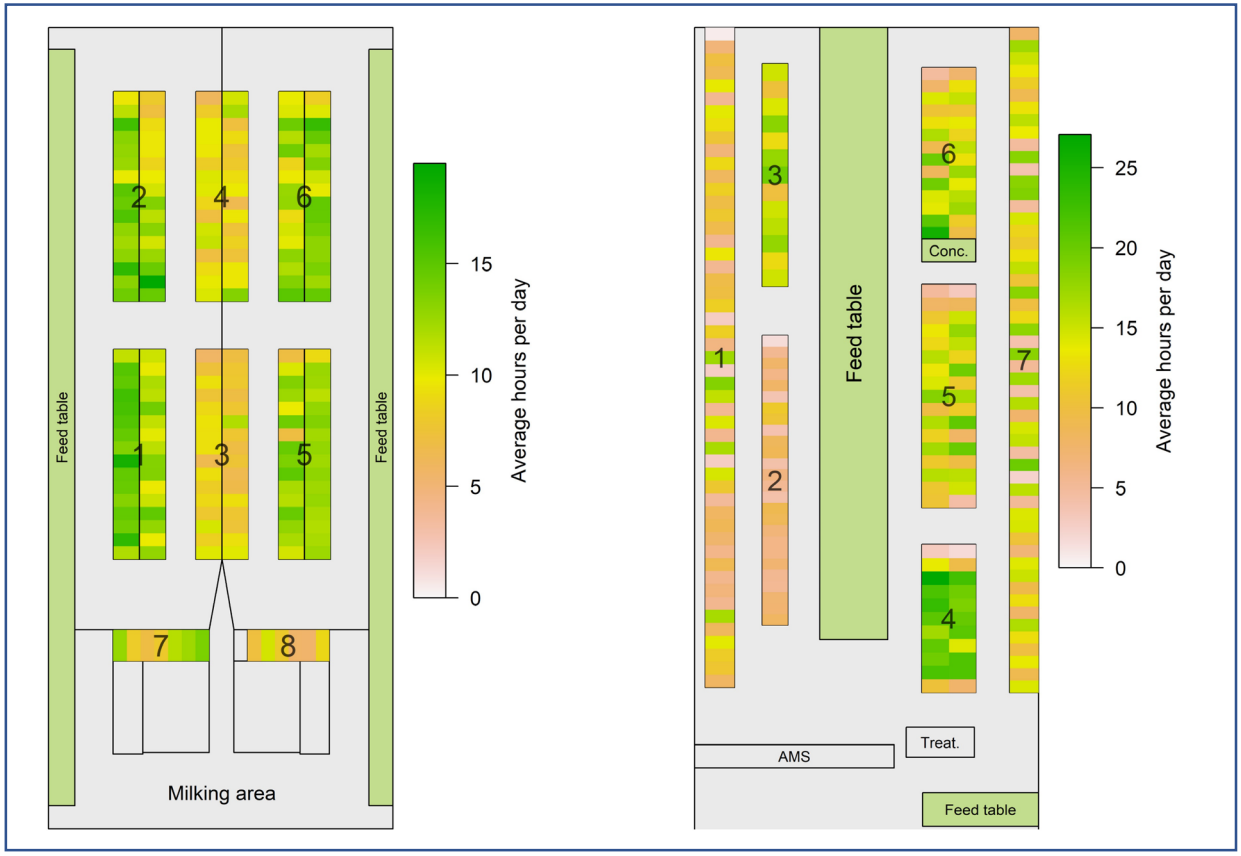
Keywords:
Real-time location system
Lying time
Dairy cattle

ABSTRACT

Modern dairy cattle farms are usually equipped with cubicle systems to provide cows with comfortable conditions for lying down and resting. Cows are free to choose any cubicle they want, but in reality, they do not distribute themselves uniformly throughout the barn. There are many factors that affect where a cow lies down, such as hierarchy of a cow, access to resources, cow traffic nearby, etc. In this study, we used real-time location system data from two commercial farms to examine patterns of cubicle occupancy in relation to parity and lactation stage. We summarized cubicle occupancy over several days and compared different areas of the barn. Our findings suggest that, in general, there was a higher occupancy of cubicles close to the feeding areas. High parity cows lay down more frequently in cubicles close to the milking area as opposed to first lactation cows that tend to occupy less busy areas of the barn. The overall conclusion is that cubicle occupancy is not uniform throughout the barn, and patterns related to parity and DIM are seen. This information can be important for future studies on spread of diseases and for management purposes.

Swedish farm

Dutch farm



JDS Communications
2021; 2:345–350

https://doi.org/10.3168/jdsc.2020-0064
Technical Note
Animal Nutrition and Farm Systems

Where do we find missing data in a commercial real-time location system? Evidence from 2 dairy farms

Keni Ren,[1]* Per Peetz Nielsen,[2] Moudud Alam,[3] and Lars Rönnegård[1,3]

Abstract: Real-time indoor positioning using ultra-wideband devices provides an opportunity for modern dairy farms to monitor the behavior of individual cows; however, missing data from these devices hinders reliable continuous monitoring and analysis of animal movement and social behavior. The objective of this study was to examine the data quality, in terms of missing data, in one commercially available ultra-wideband–based real-time location system for dairy cows. The focus was on detecting major obstacles, or sections, inside open freestall barns that resulted in increased levels of missing data. The study was conducted on 2 dairy farms with an existing commercial real-time location system. Position data were recorded for 6 full days from 69 cows on farm 1 and from 59 cows on farm 2. These data were used in subsequent analyses to determine the locations within the dairy barns where position data were missing for individual cows. The proportions of missing data were found to be evenly distributed within the 2 barns after fitting a linear mixed model with spatial smoothing to logit-transformed proportions (mean = 18% vs. 4% missing data for farm 1 and farm 2, respectively), with the exception of larger proportions of missing data along one of the walls on both farms. On farm 1, the variation between individual tags was large (range: 9–49%) compared with farm 2 (range: 12–38%). This greater individual variation of proportions of missing data indicates a potential problem with the individual tag, such as a battery malfunction or tag placement issue. Further research is needed to guide researchers in identifying problems relating to data capture problems in real-time monitoring systems on dairy farms. This is especially important when undertaking detailed analyses of animal movement and social interactions between animals.

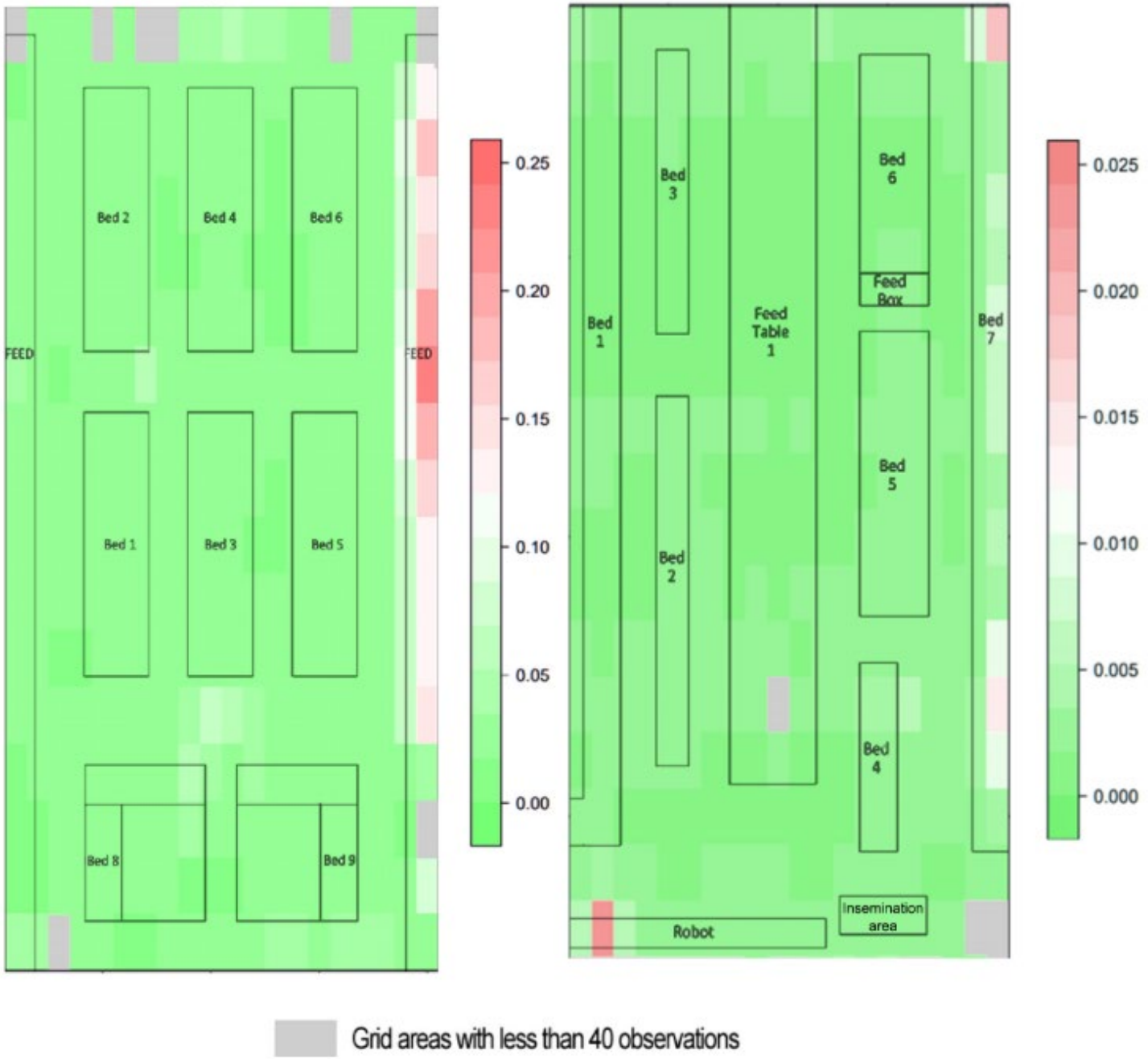


Figure 2. Fitted proportion of lost positions (>5 s) from the ultra-wideband system within grid squares (approximate size 4 m × 1.6 m), on (a) farm 1 and (b) farm 2. Grid squares with too few observations (gray) were excluded from the analysis. The insemination area is a closed bed area for inseminating the cows.

frontiers | Frontiers in Animal Science

ORIGINAL RESEARCH
published: 24 May 2022
doi: 10.3389/fanim.2022.896666

Interpolation Methods to Improve Data Quality of Indoor Positioning Data for Dairy Cattle

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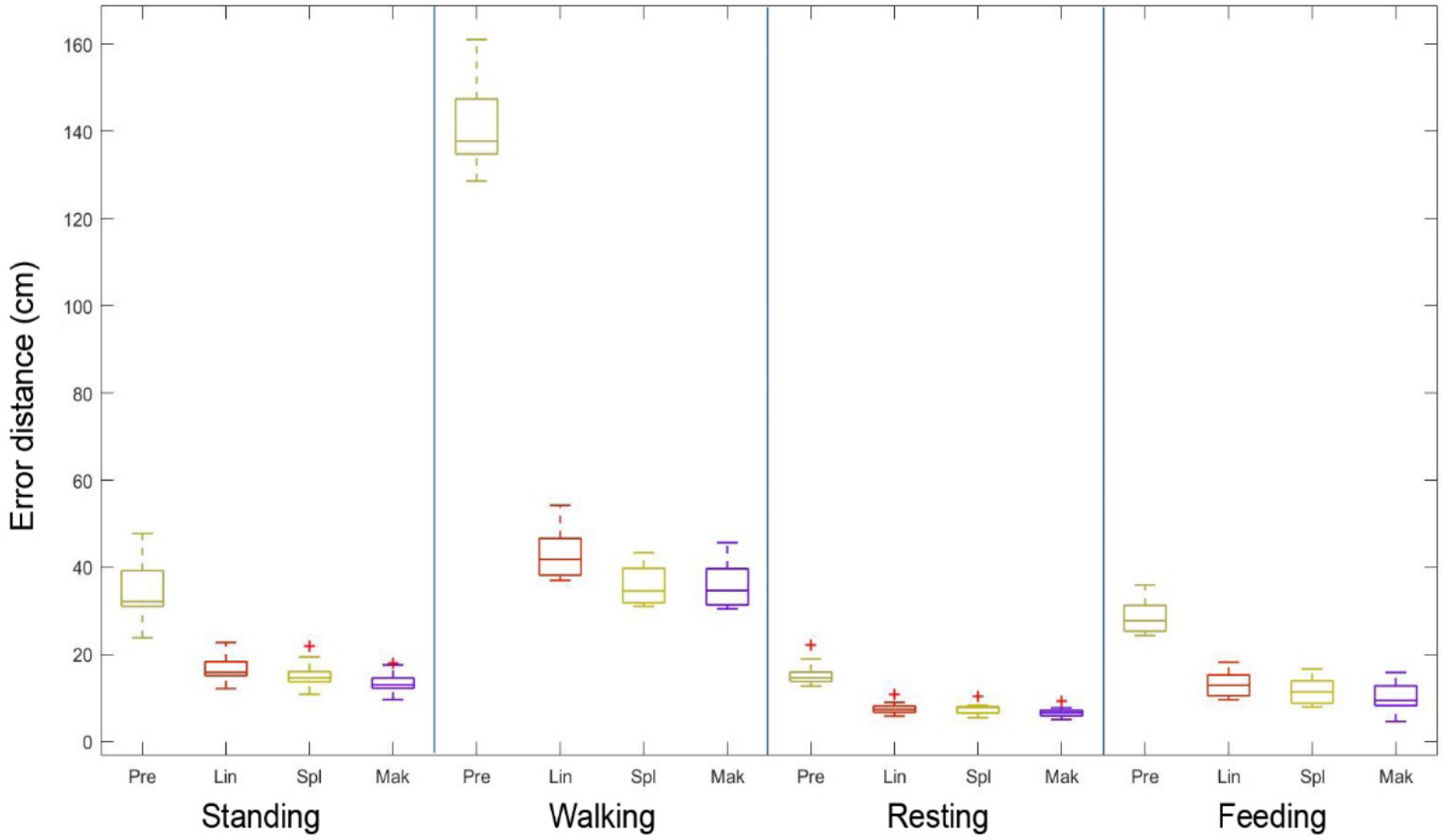
[1] *Department of Animal Breeding and Genetics, Swedish University of Agricultural Sciences, Uppsala, Sweden,* [2] *School of Information and Engineering, Statistics, Dalarna University, Falun, Sweden,* [3] *Department of Agriculture and Food, RISE Research Institutes of Sweden (RISE), Lund, Sweden,* [4] *Department of Veterinary and Animal Sciences, University of Copenhagen, Frederiksberg, Denmark*



Pre = Previous last observed position
Lin = Linear interpolation
Spl = Spline interpolation
Mak = Modified Akima interpolation

J. Dairy Sci. 106:2685–2699
https://doi.org/10.3168/jds.2022-21915

Cow characteristics associated with the variation in number of contacts between dairy cows

I. Hansson,[1] A. Silvera,[1] K. Ren,[1] S. Woudstra,[2] A. Skarin,[3] W. F. Fikse,[4] P. P. Nielsen,[5] and L. Rönnegård[1,6,7]*

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Definition of contact used in the paper

- Less than 2.5 m (one body length) apart
- Duration >10 minutes in total during a day, otherwise removed to reduce noise.

Response variable studied

The average number of contacts for each cow was calculated as the **instantaneous number of individuals within proximity of a cow** at any time during the day.

Traits affecting the number of contacts a cow has during a day

	Feeding Area			Resting Area		
	Farm A		Farm B	Farm A		Farm B
Trait	G1 (n= 83)	G2 (n = 80)	(n = 201)	G1 (n = 83)	G2 (n = 80)	(n = 201)
Date	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Parity	< 0.001	0.685	0.009	0.773	0.999	< 0.001
Lactation stage	0.013	0.029	< 0.001	0.089	0.646	0.366
Breed	0.468	0.008		0.513	0.815	
Pregnancy status	0.319	0.266	0.688	< 0.001	0.583	0.725
Estrus	0.002		0.069	0.002		0.240
Udder Health	0.967	0.264		0.017	0.936	
Claw Health	0.109	0.327		0.454	0.008	

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SOCIAL NETWORK ANALYSIS OF DAIRY COW INTERACTIONS

New insight into social relationships in dairy cows, and how time of birth, parity and relatedness affect spatial interactions later in life.

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Interpretive summary

Understanding social interactions between cows is crucial to improving animal welfare and production. Real-time location systems provide an opportunity to study dyadic social contacts inside dairy free-stall barns. We investigated the impact of different cow characteristics on the likelihood of the formation and persistence of social contacts in dairy cattle. **Our main finding was that cows born within seven days of each other had more consistent interactions, a kind of "kindergarten effect", as well as cows of the same parity or related by pedigree.**

Published papers on disease transmission

Woudstra, S., Wente, N., Zhang, Y., Leimbach, S., Gussmann, M. K., Kirkeby, C., & Krömker, V. (2023). **Strain diversity and infection durations of Staphylococcus spp. and Streptococcus spp. causing intramammary infections in dairy cows.** Journal of Dairy Science.

Woudstra, S., Lücken, A., Wente, N., Zhang, Y., Leimbach, S., Gussmann, M. K., Kirkeby, C., & Krömker, V. (2023). **Reservoirs of Corynebacterium spp. in the environment of dairy Cows.** Pathogens

Lücken, A., Woudstra, S., Wente, N., Zhang, Y., & Krömker, V. (2022). **Intramammary infections with Corynebacterium spp. in bovine lactating udder quarters.** Plos One.

… and transmission of bacteria associated with mastitis

Illustration: Fredrik Saarkoppel

mastitis = udder infection

Swedish Farm	Dutch Farm
Bacterial samples taken every second week for 5 months (June-October 2020) -Milk samples from all cows -Environmental samples from different parts of the barn -Strain typing of bacteria	

QR to our project web page

We also put our code on GitHub
https://github.com/CSI-DT