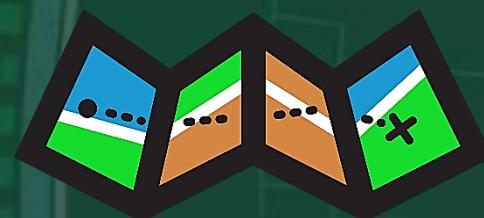


Indoor animal movement data from the CSI:DT project

Hector Marina



CSI:DT - Cow Social Interaction and Disease Transmission



Anna Skarin



Keni Ren



Lars Rönnegård



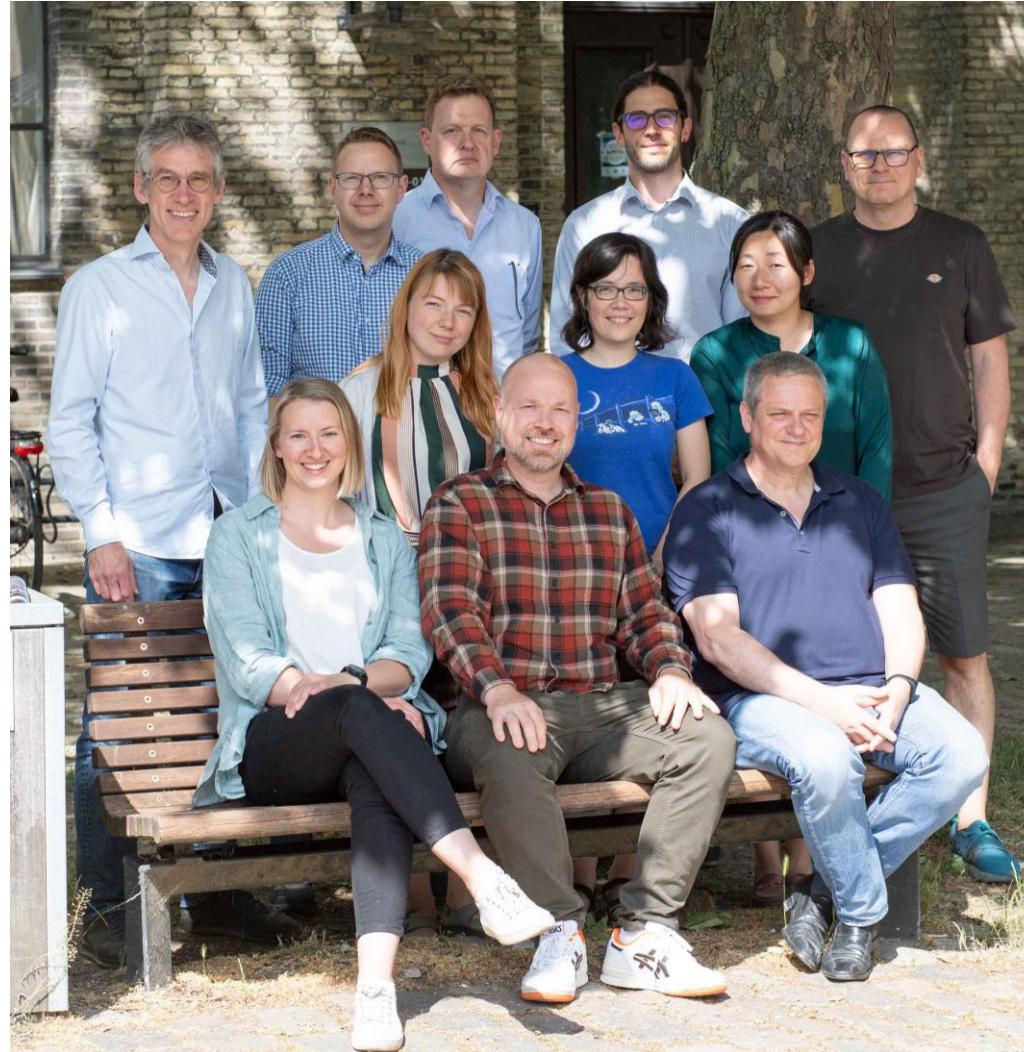
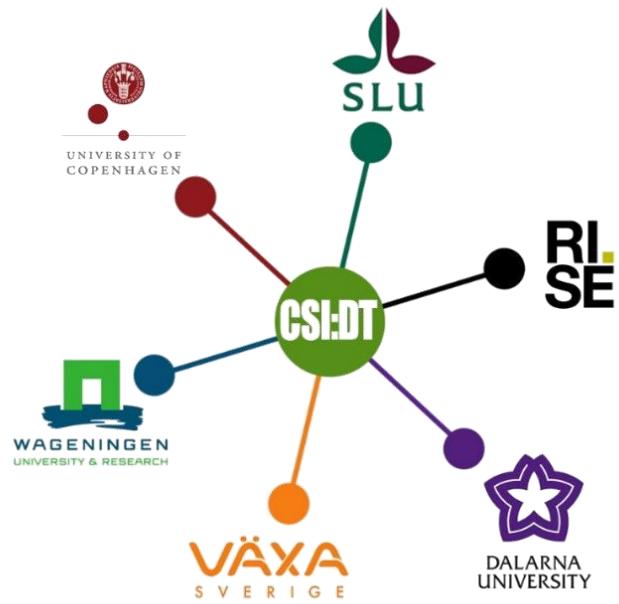
Hector Marina

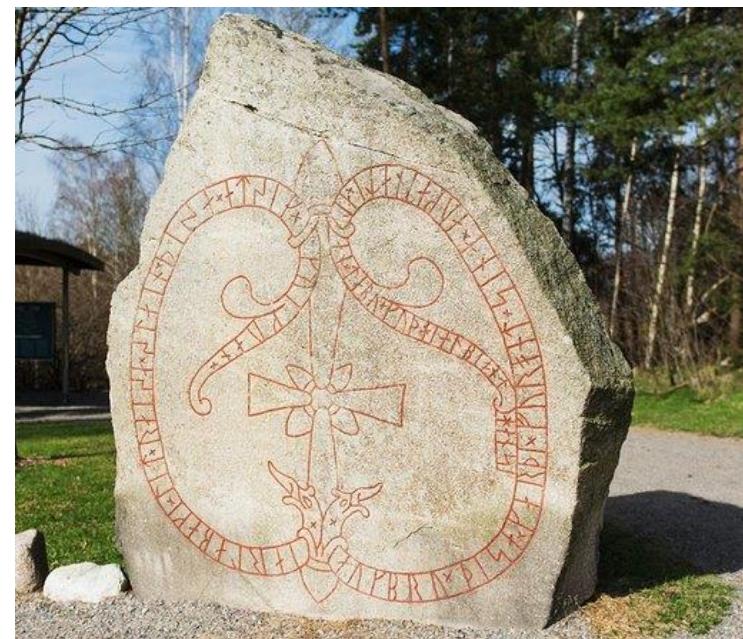
CSI:DT - Cow Social Interaction and Disease Transmission



FORMAS

KJELL OCH MÄRTA BEIJERS STIFTELSE
Främjar vetenskap och kultur



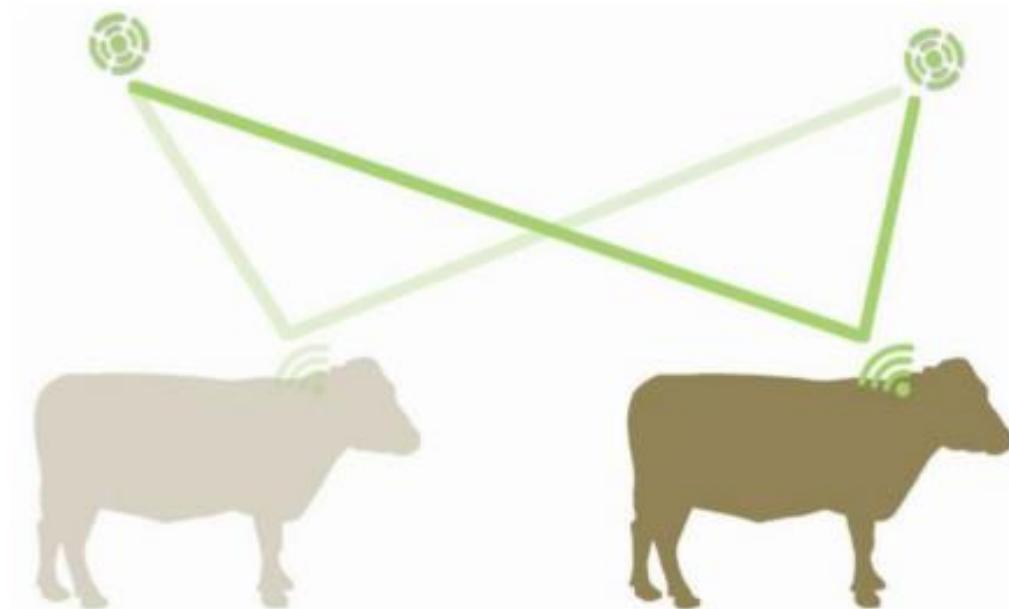
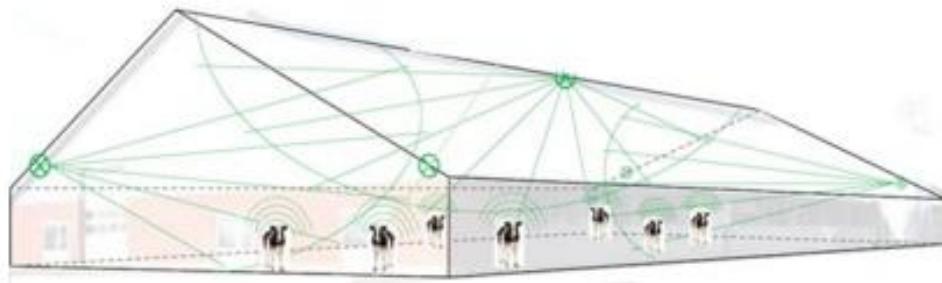




Focus on the social environment of cows in free-stall dairy farms:



- to **improve animal welfare and production**
- to **reduce transmission of diseases** (mastitis) using monitored movement and interactions between cow



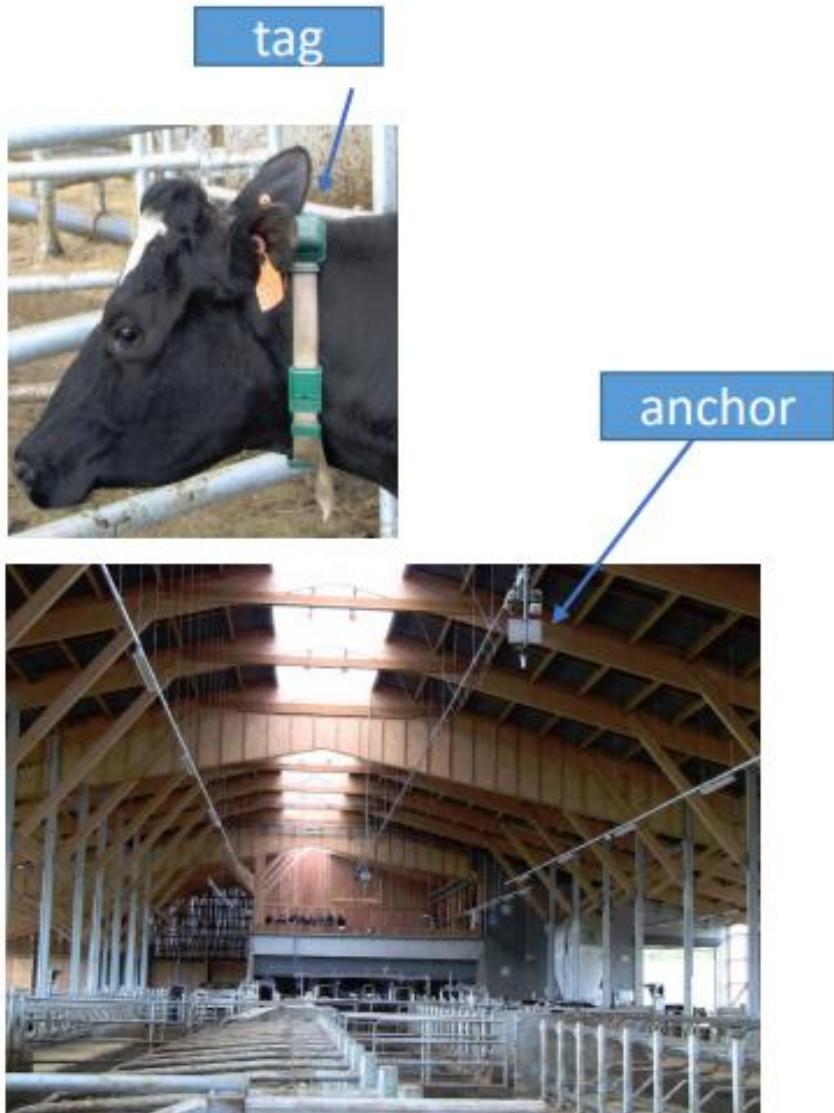
GEA - CowView



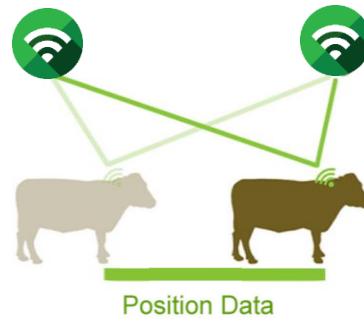
GEA-CowView

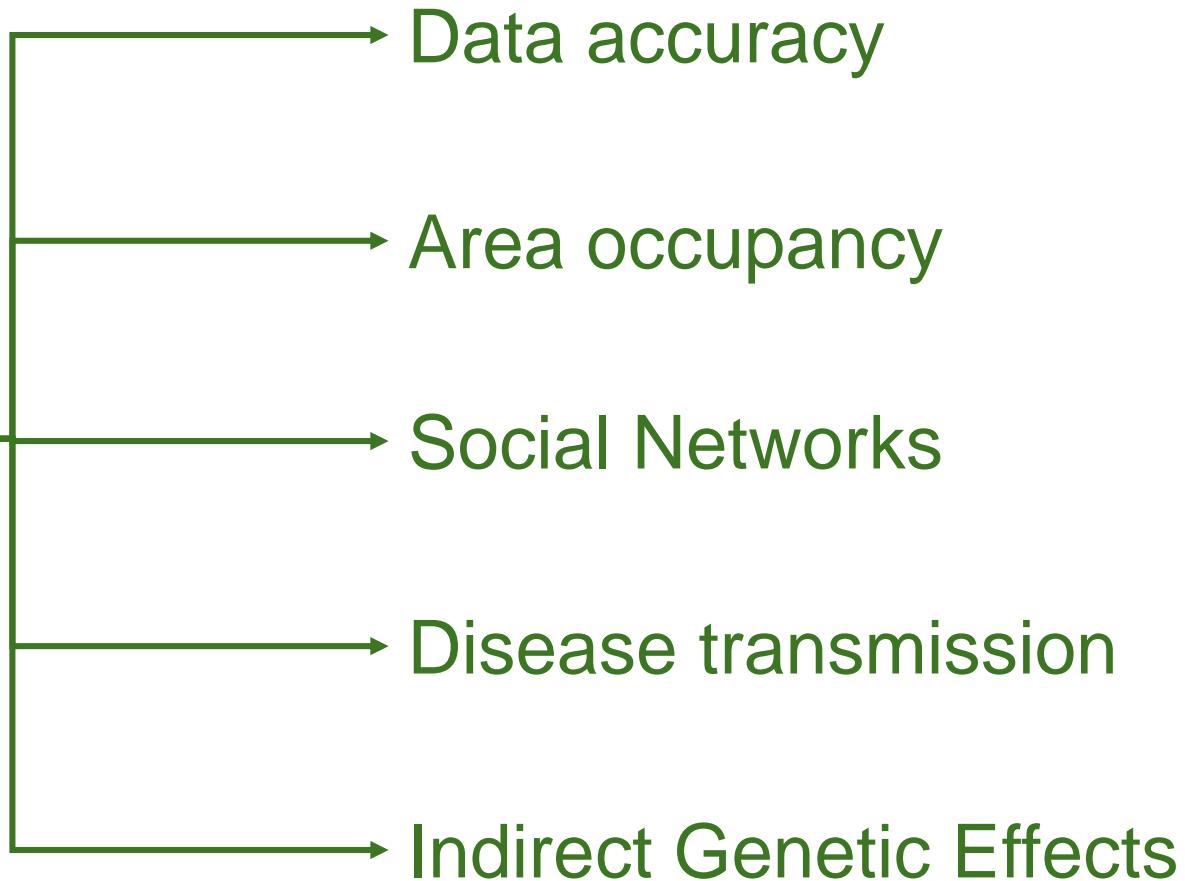


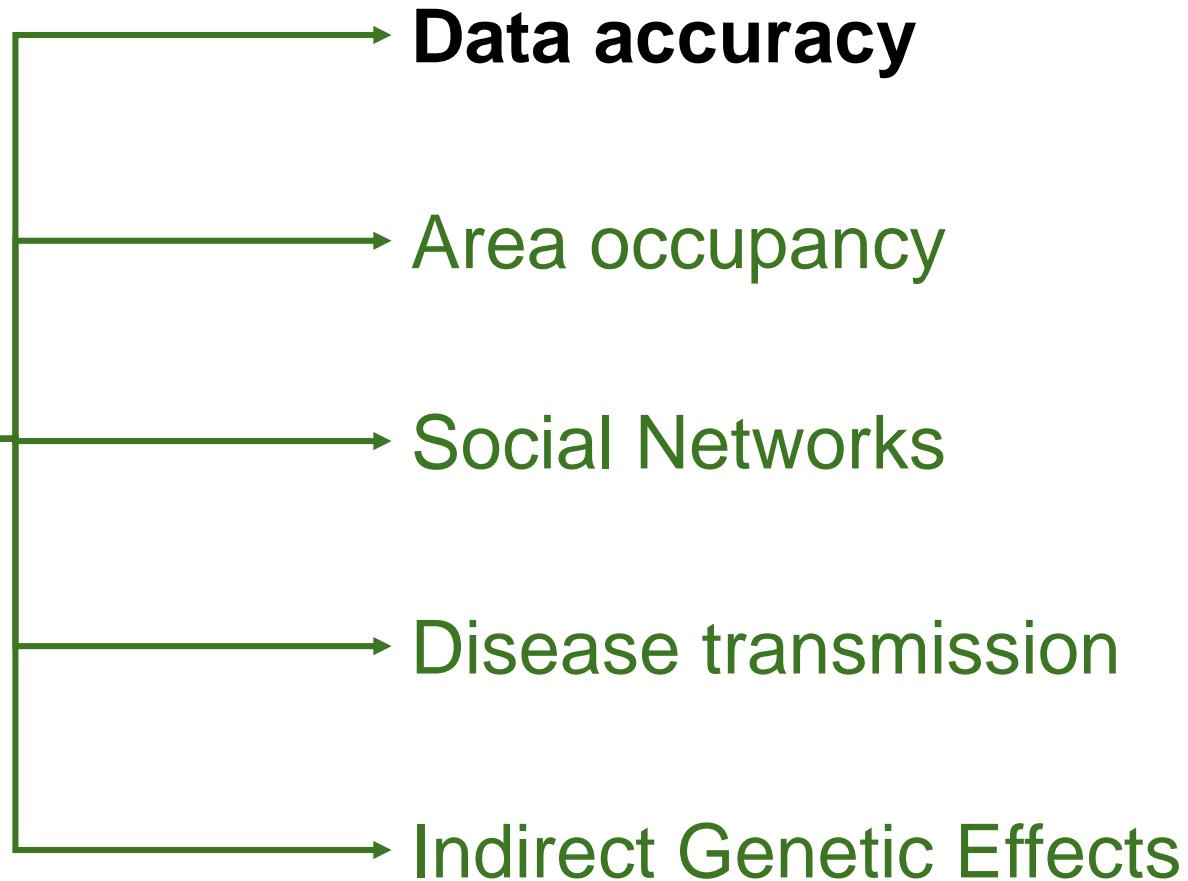
A real-time positioning system



Anchor









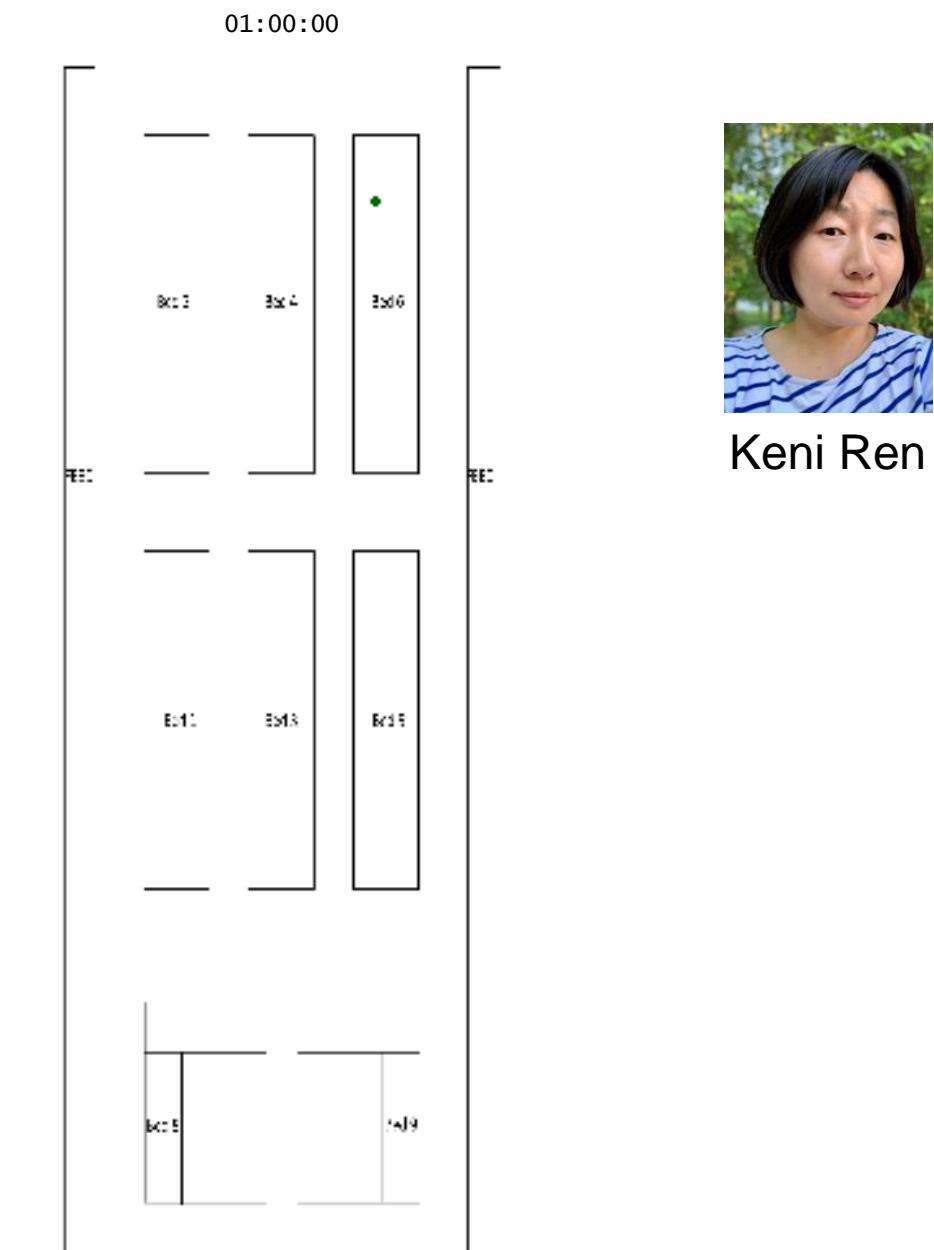
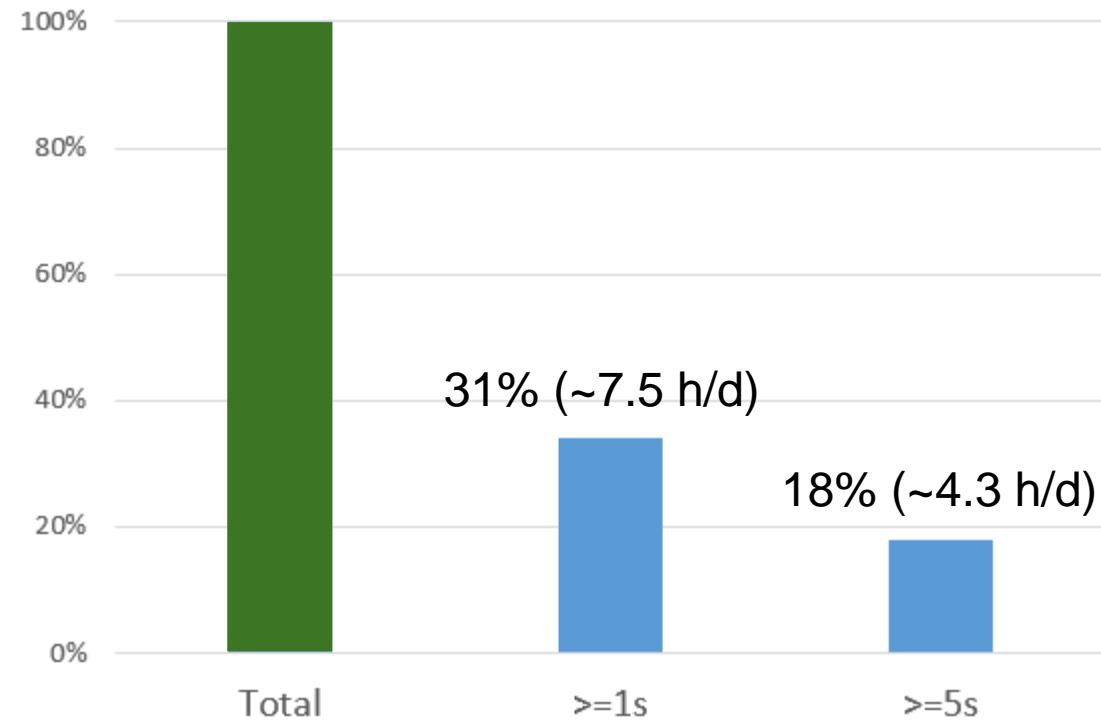
Data accuracy

- Ren, K., Nielsen, P. P., Alam, M., & Rønnegård, L. (2021). Where do we find missing data in a commercial real-time location system? Evidence from 2 dairy farms. *JDS Communications*, 2(6):345-350.
- Ren, K., Alam, M., Nielsen, P. P., Gussmann, M. K., & Rønnegård, L. (2022). Interpolation methods to improve data quality of indoor positioning data for dairy cattle. *Frontiers in Animal Science*, 53.

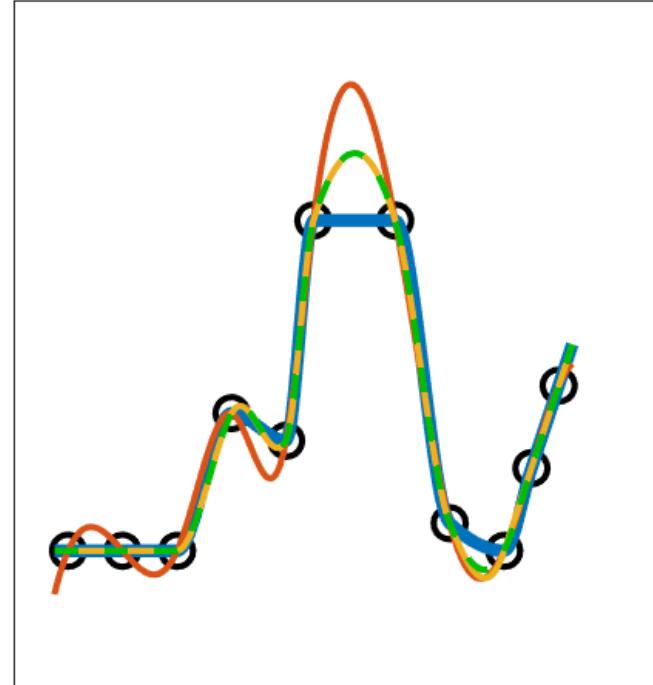
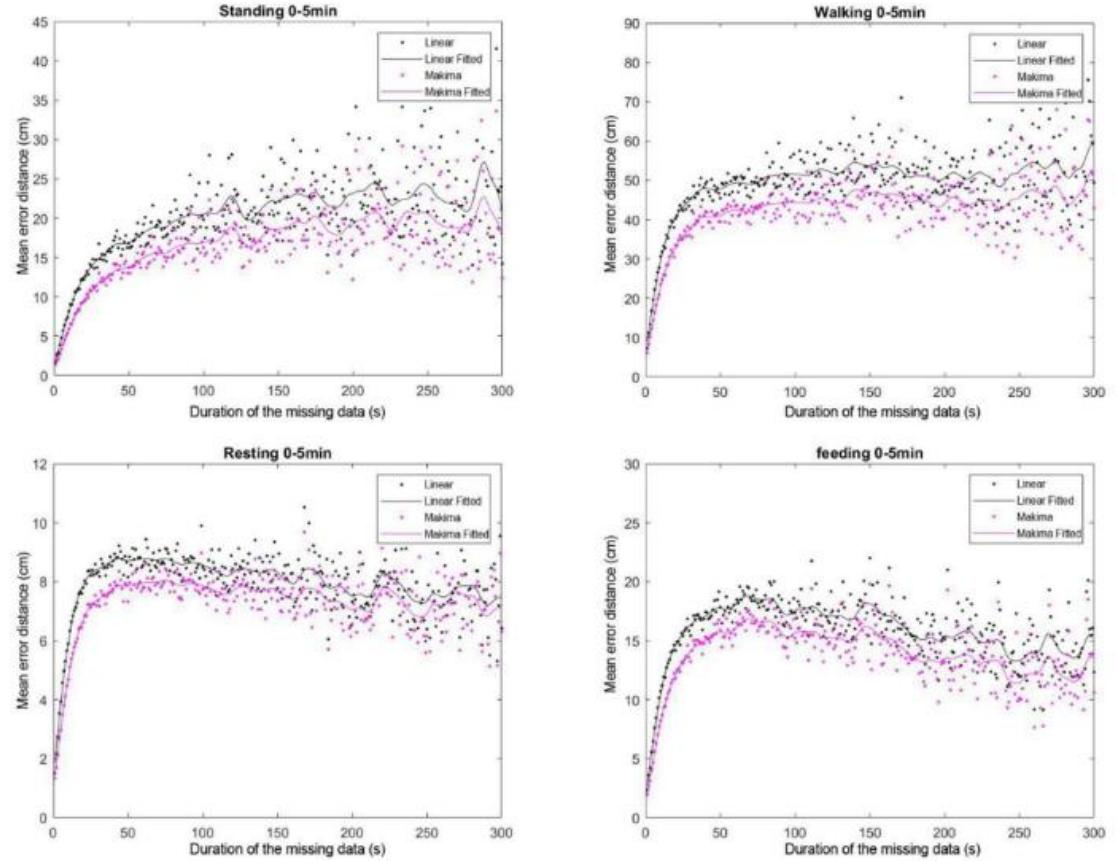
Data accuracy



Interpolation methods



Data accuracy



Keni Ren

LINEAR
CUBICAL
AKIMA

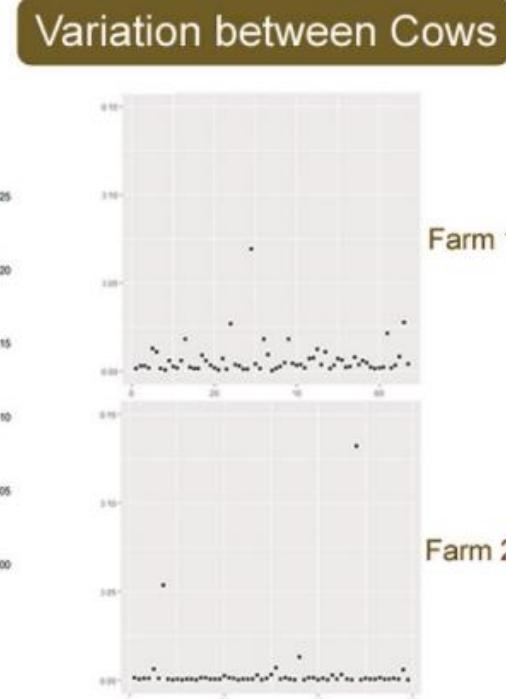
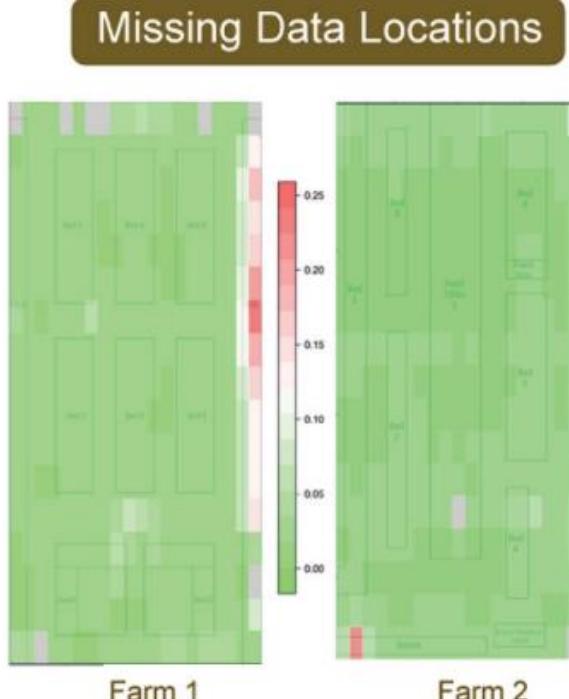
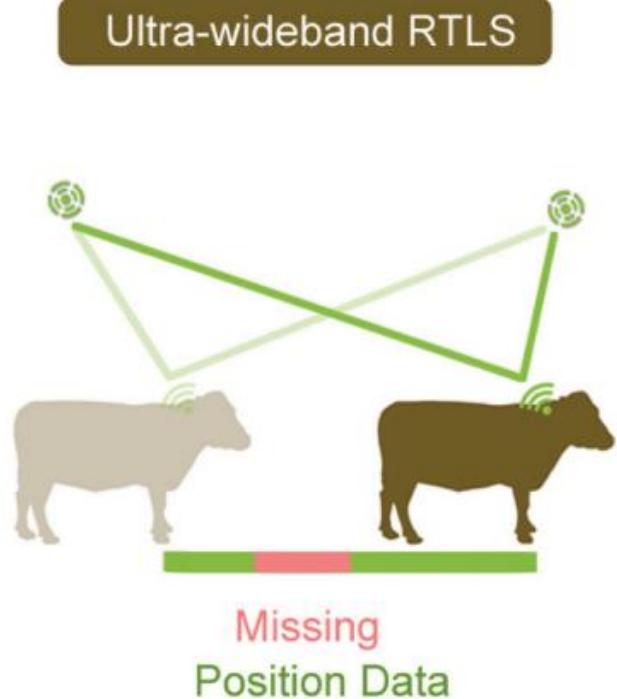
Accuracy: 17 cm

Ren, K., Alam, M., Nielsen, P. P., Gussmann, M. K., & Rønnegård, L. (2022). Interpolation methods to improve data quality of indoor positioning data for dairy cattle. *Frontiers in Animal Science*, 53.

Data accuracy

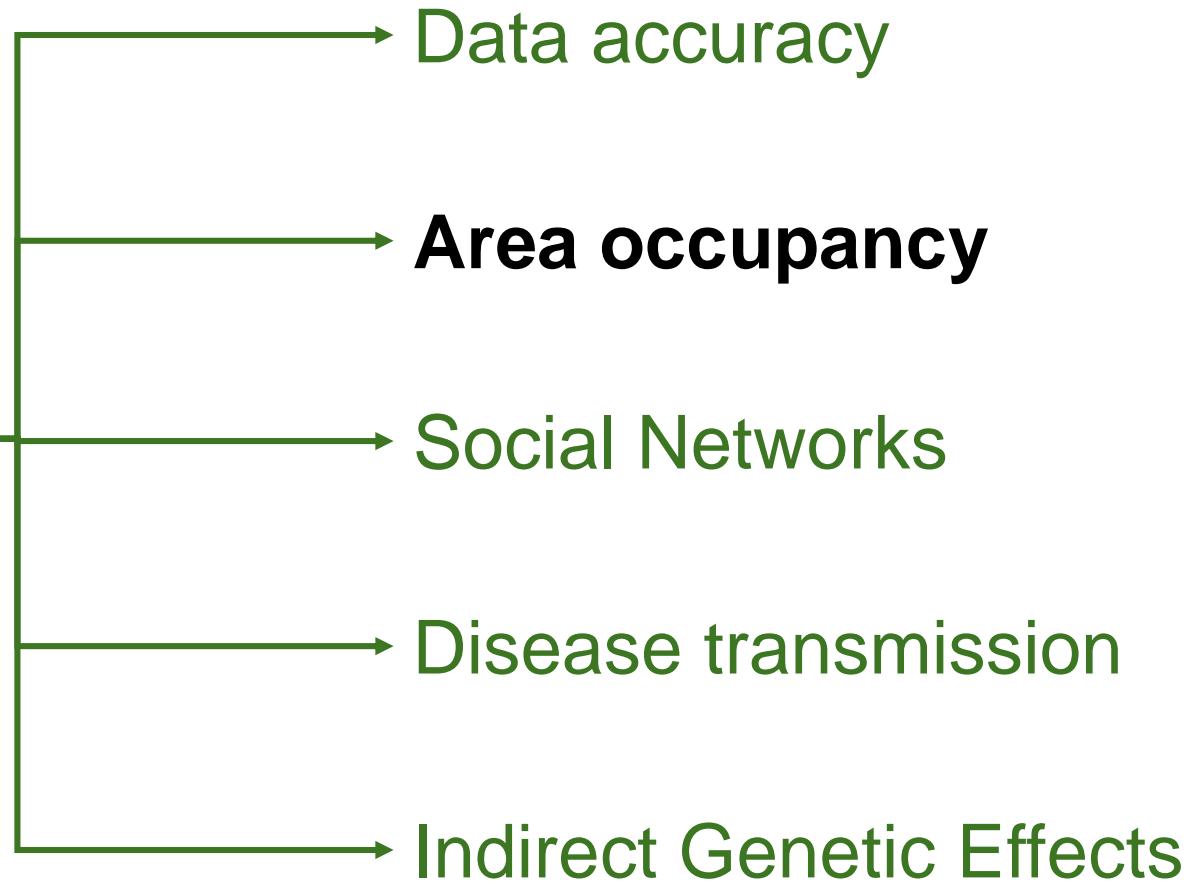


Graphical Abstract



Keni Ren

Ren, K., Nielsen, P. P., Alam, M., & Rønnegård, L. (2021). Where do we find missing data in a commercial real-time location system? Evidence from 2 dairy farms. *JDS Communications*, 2(6):345-350.

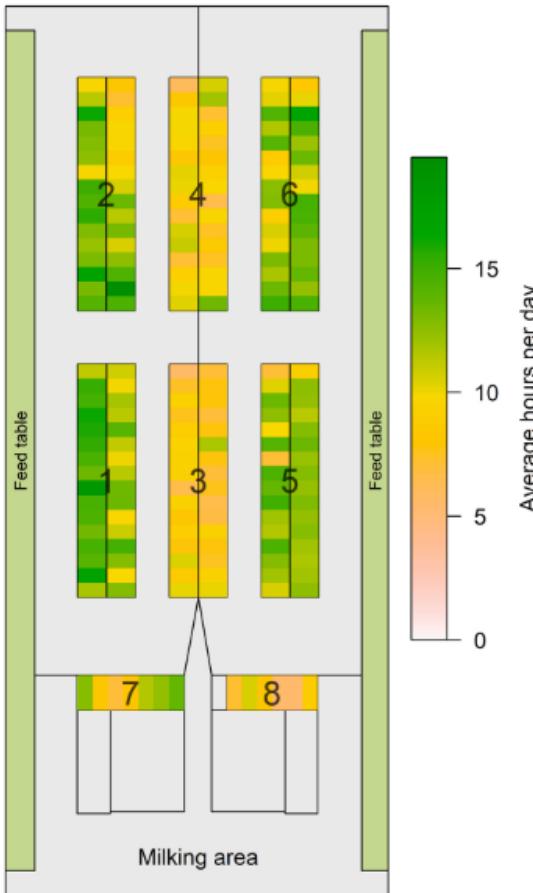


Area occupancy



- **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*, 105494.
- **Gussmann, M.**, Marina, H., Ren, K., Rønnegård, L., Nielsen, P. P. (2025). Variations in cow behaviour after regrouping in a conventional Swedish dairy herd. *Submitted for publication.*
- **Marina, H.**, Nielsen, P. P., Fikse, W. F., & Rønnegård, L. (2024). Multiple factors shape social contacts in dairy cows. *Applied Animal Behaviour Science.*

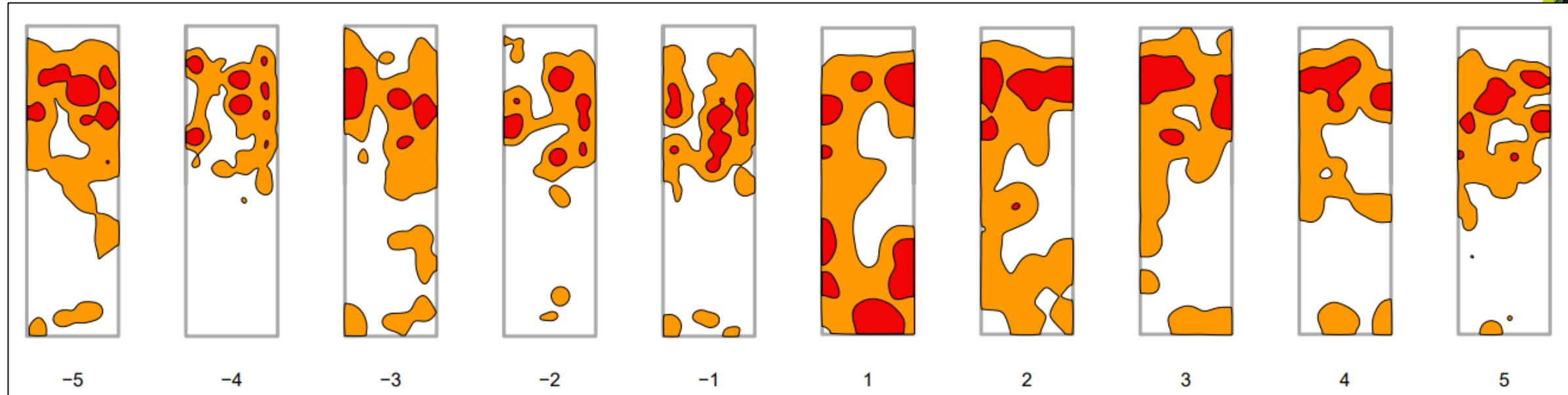
Area occupancy



Mikhail Churakov

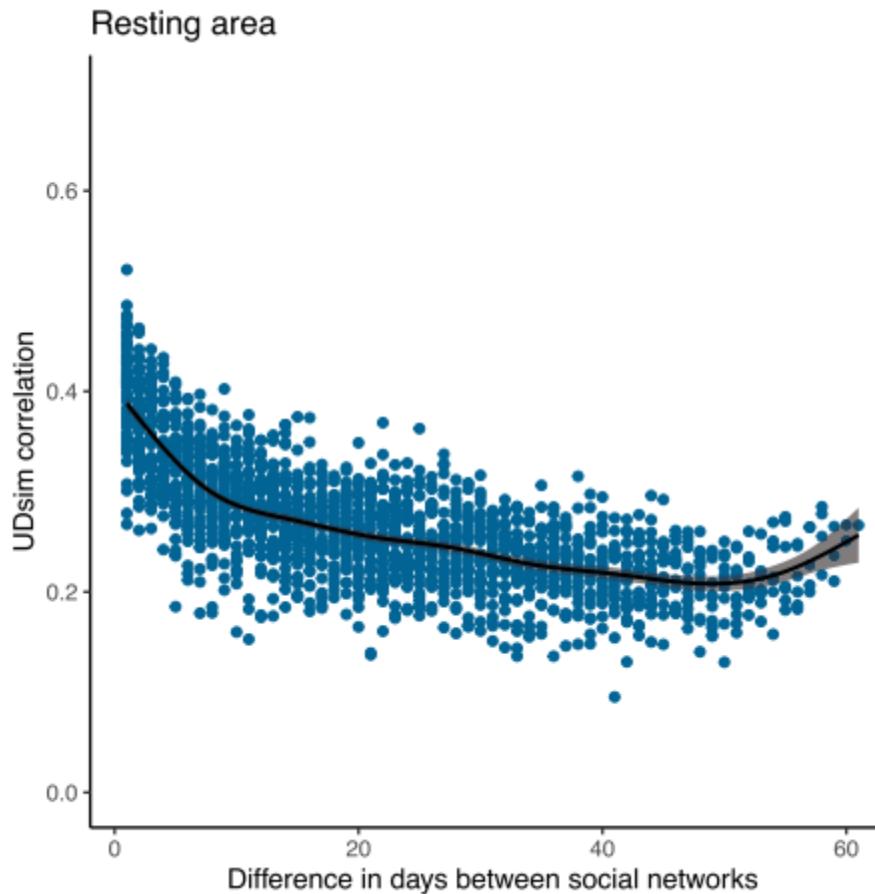
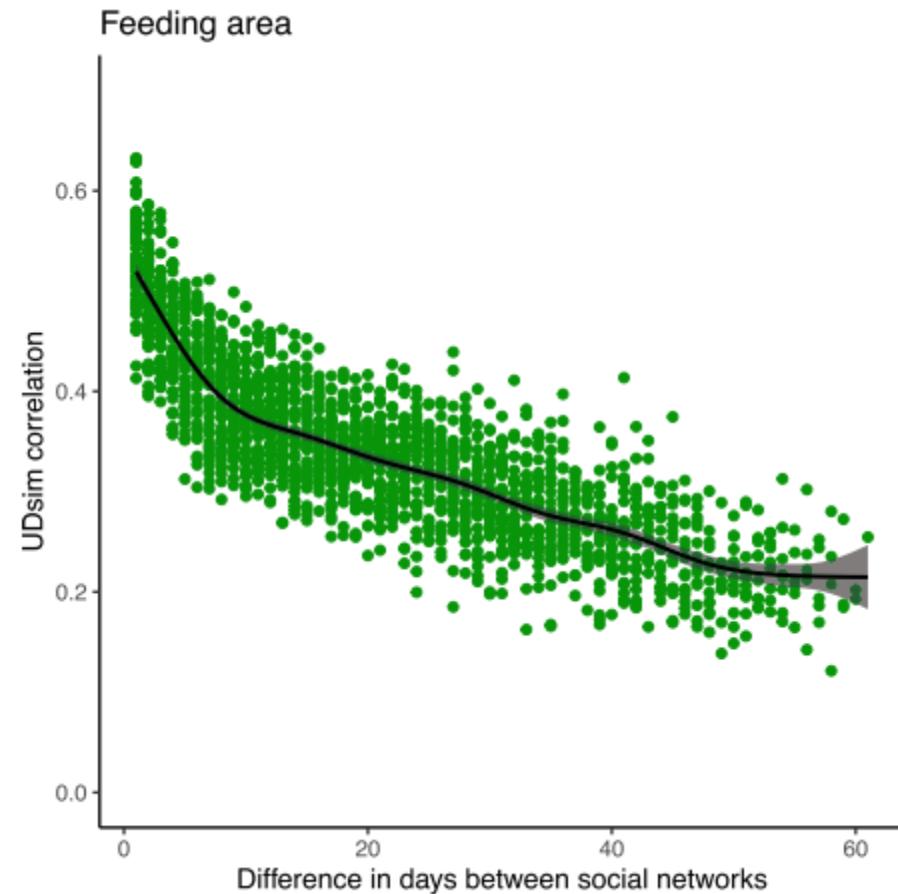
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Area occupancy

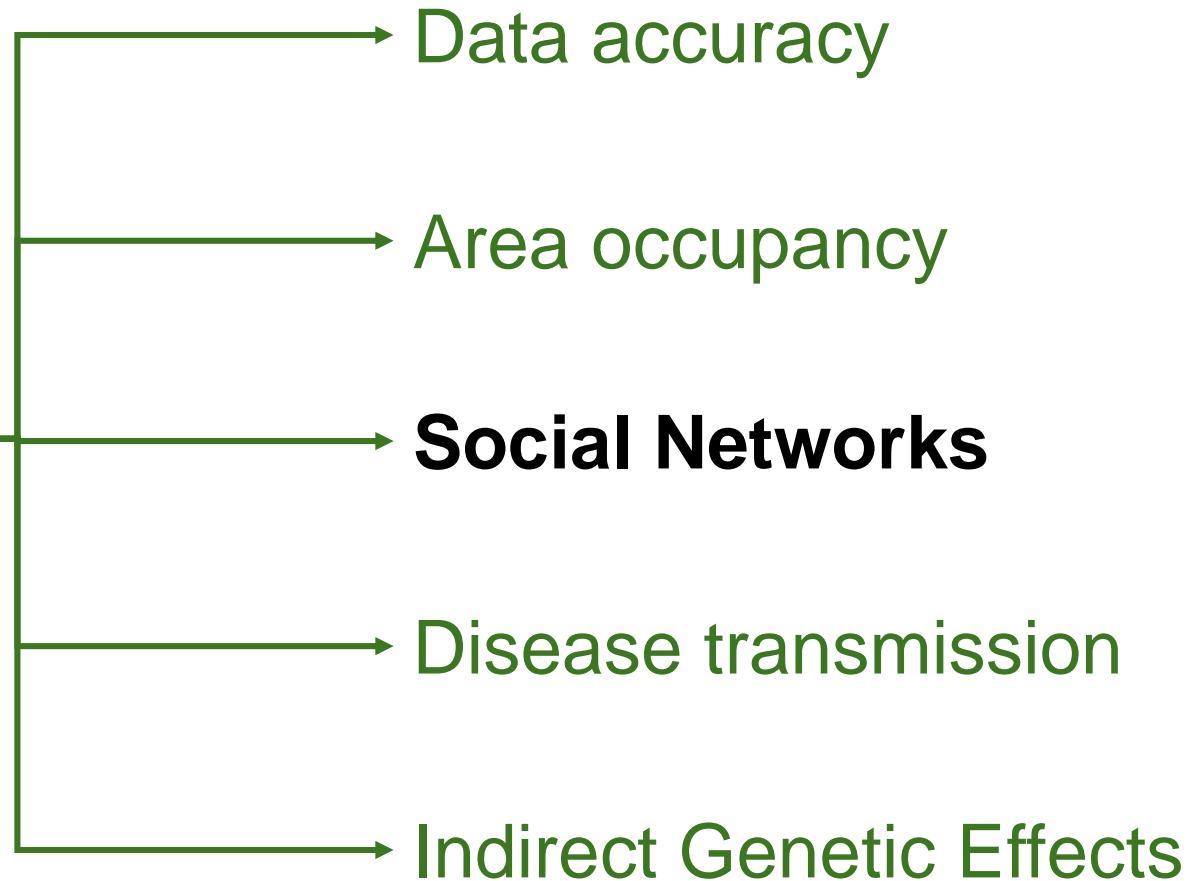


Gussmann, M., Marina, H., Ren, K., Rönnegård, L., Nielsen, P. P. (2025). Variations in cow behaviour after regrouping in a conventional Swedish dairy herd. *Submitted for publication.*

Area occupancy



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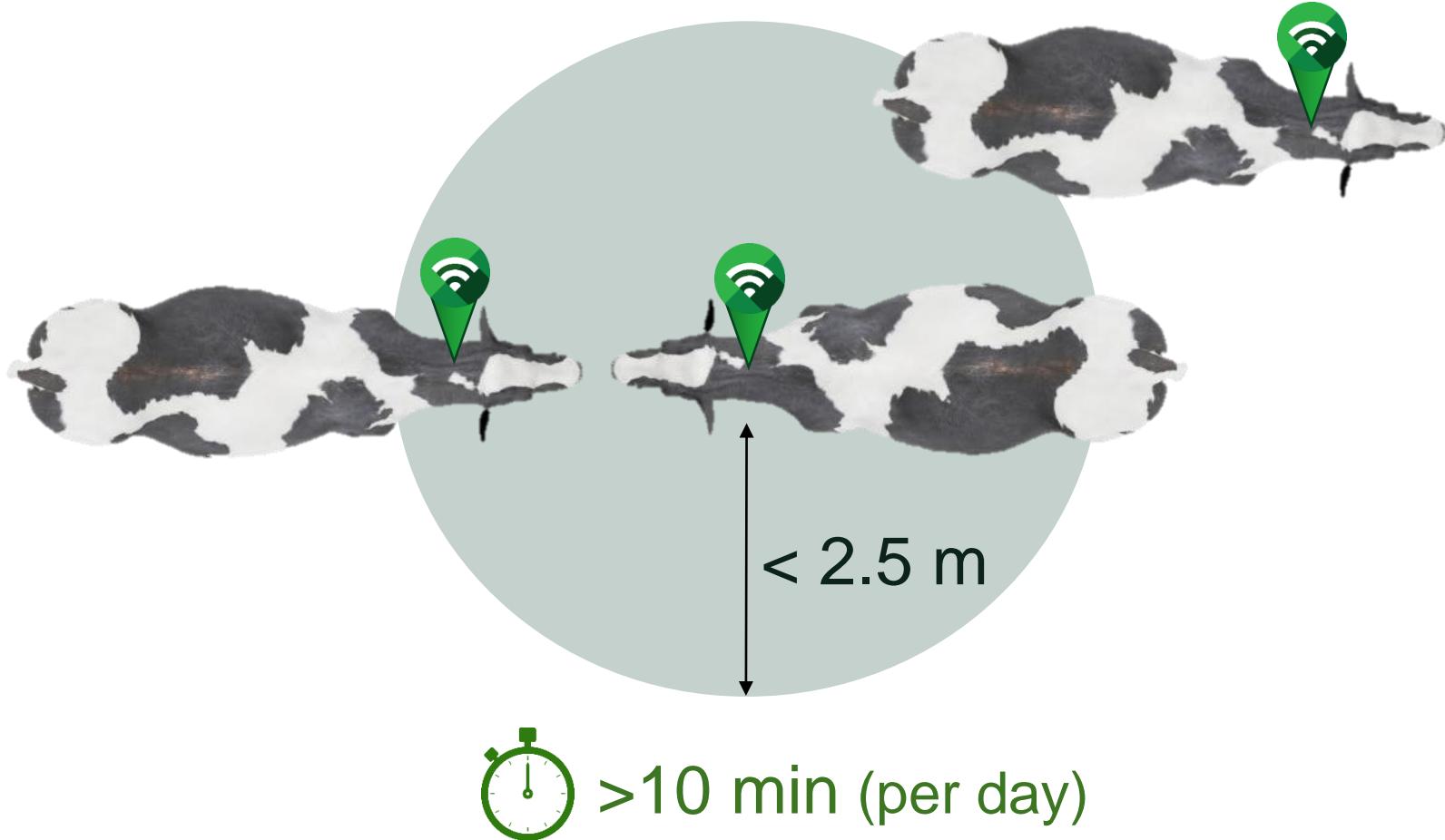


Social Networks



- **Hansson, I.**, Silvera, A., Ren, K., Woudstra, S., Skarin, A., Fikse, W. F., Nielsen, P. P., & Rønnegård, L. (2023). Cow characteristics associated with the variation in number of contacts between dairy cows. *Journal of Dairy Science*.
- **Marina, H.**, Ren, K., Hansson, I., Fikse, F., Nielsen, P. P., & Rønnegård, L. (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*.
- **Marina, H.**, Nielsen, P. P., Fikse, W. F., & Rønnegård, L. (2024). Multiple factors shape social contacts in dairy cows. *Applied Animal Behaviour Science*.
- **Marina, H.**, Fikse, W.F. & Rønnegård, L. (2024). Social network analysis to predict social behavior in dairy cattle. *JDS Communications*.

Social Networks



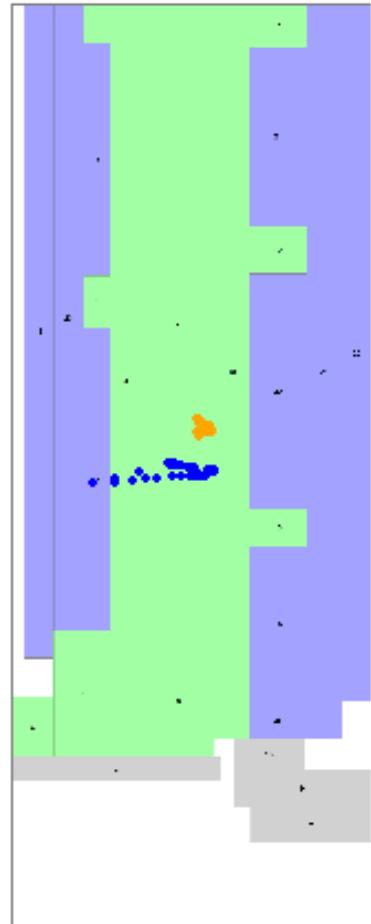
Ida Hansson



Social Networks



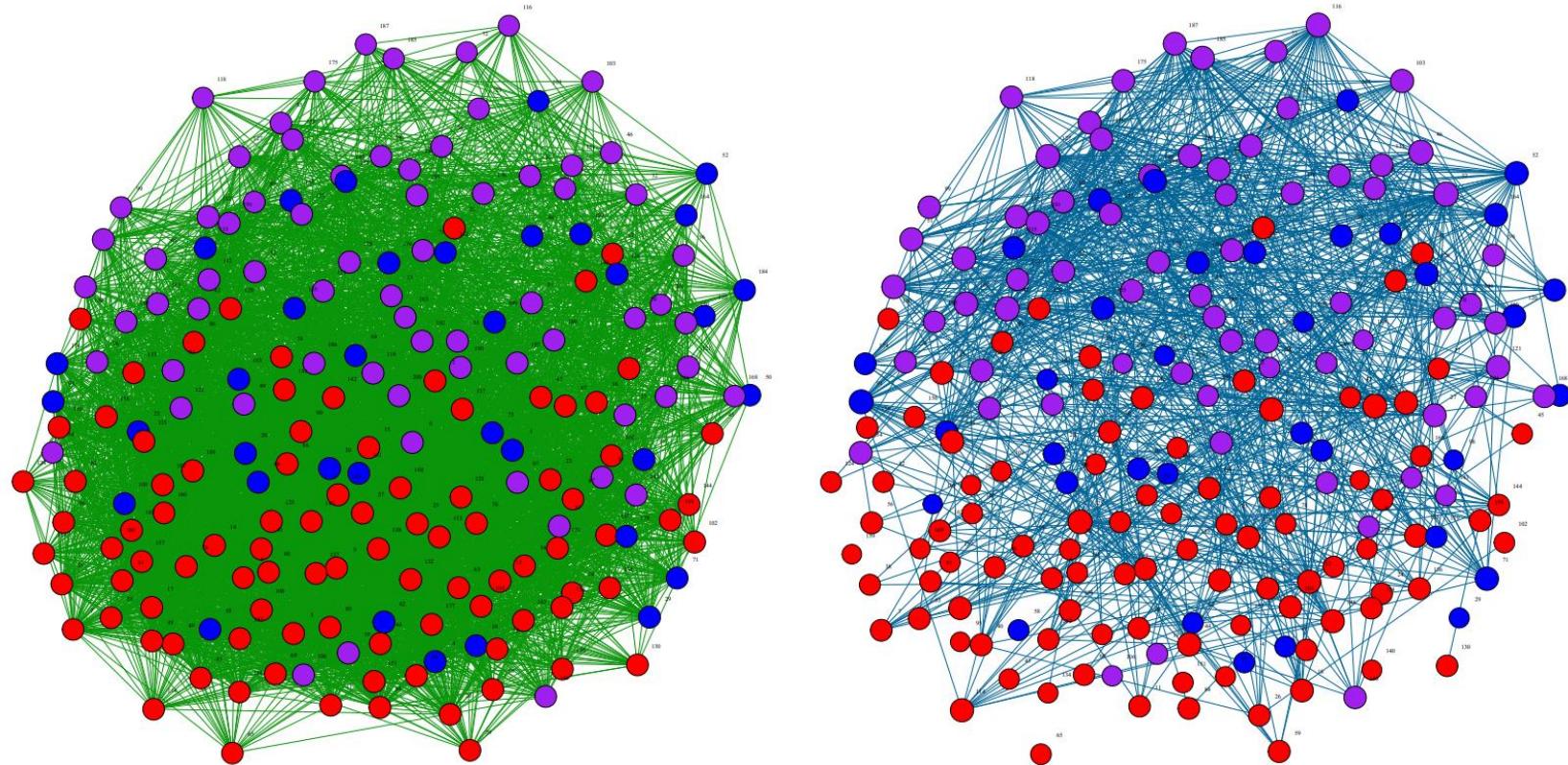
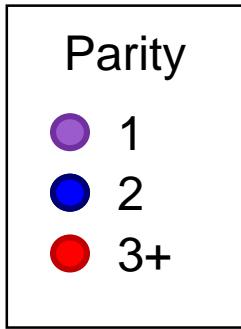
- Cow: 1
- Cow: 2
- Social contact



Ida Hansson

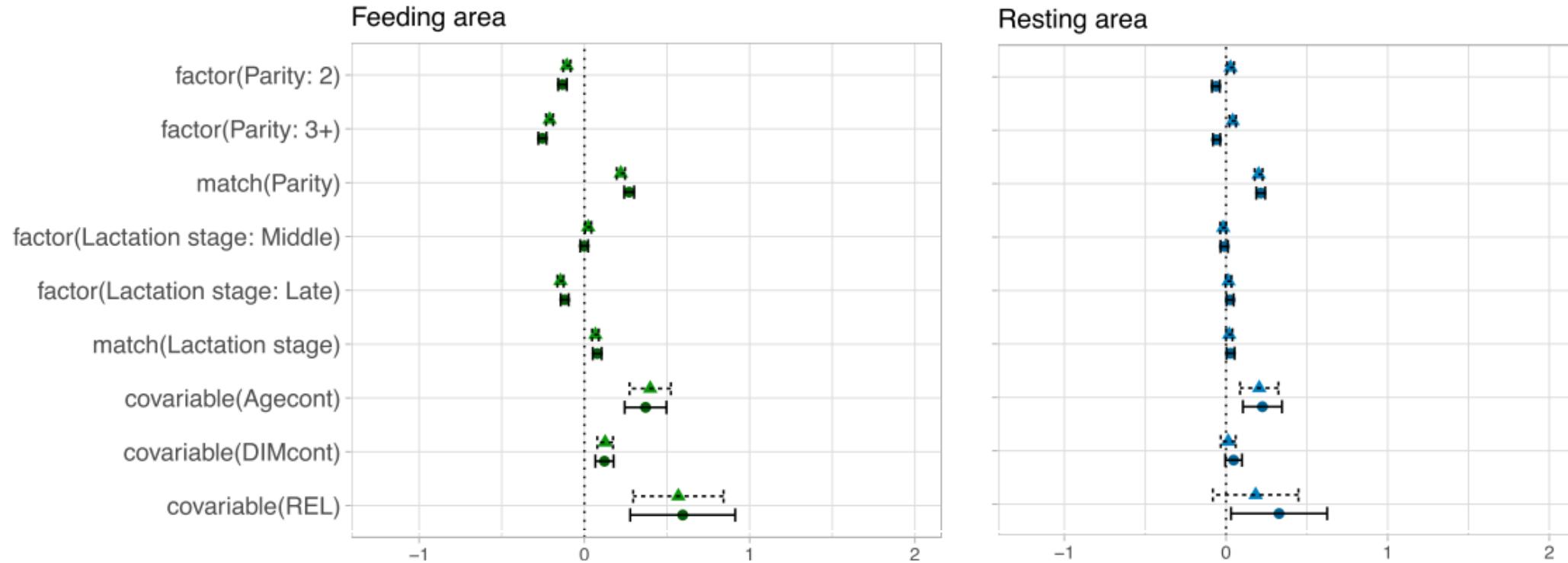


Social Networks

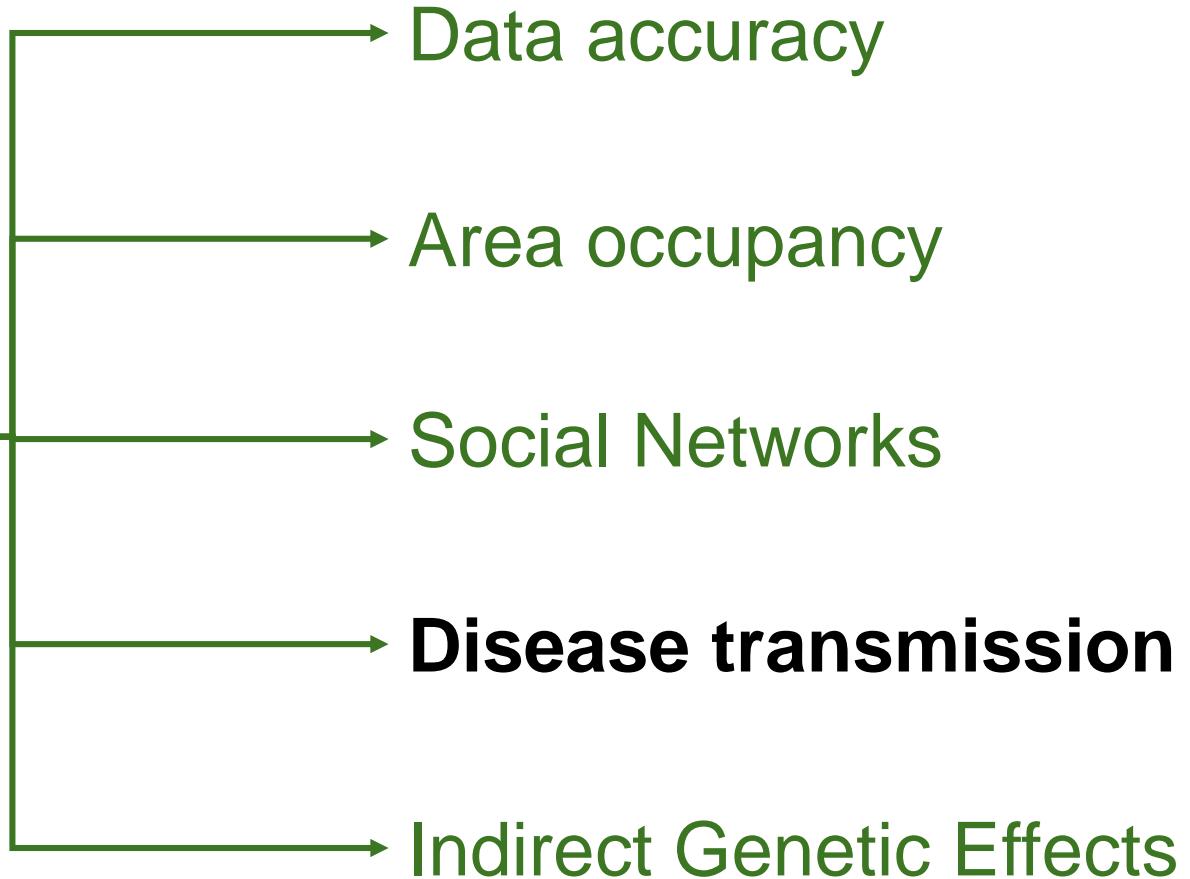


Ida Hansson





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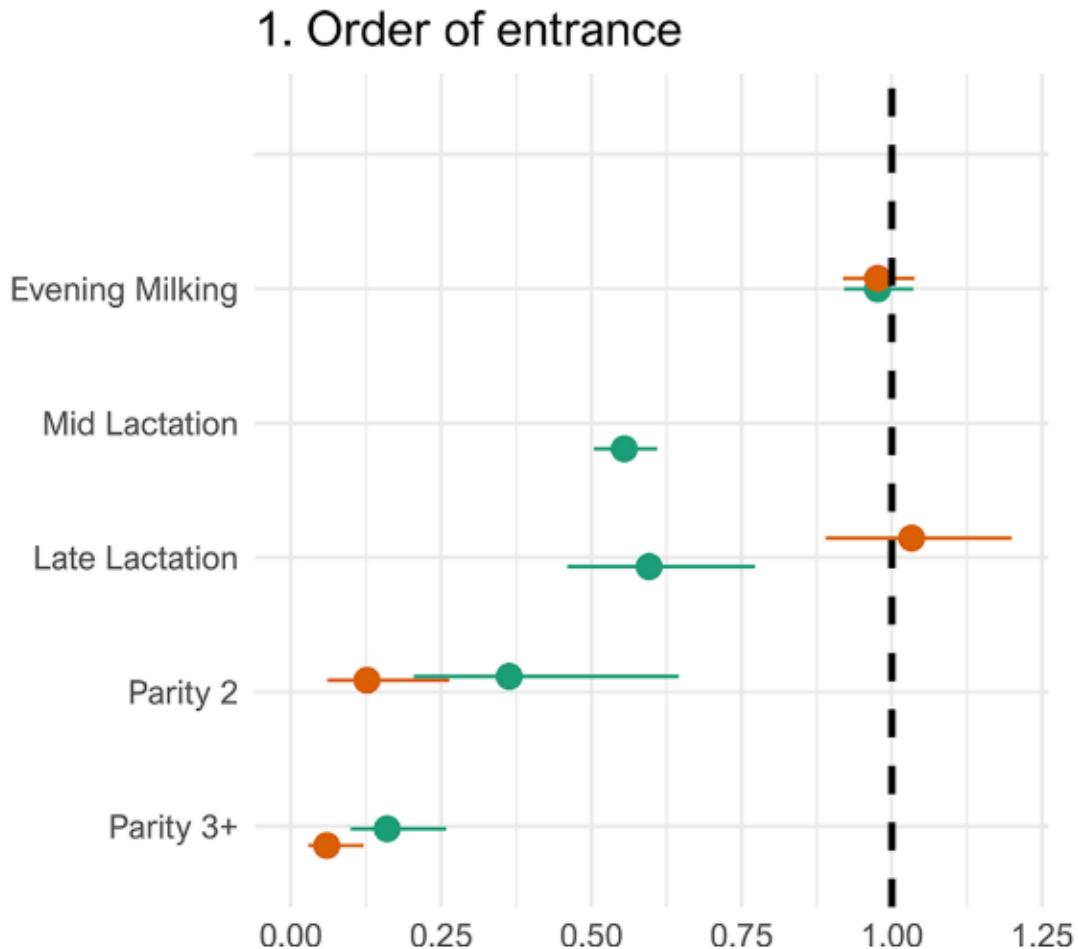
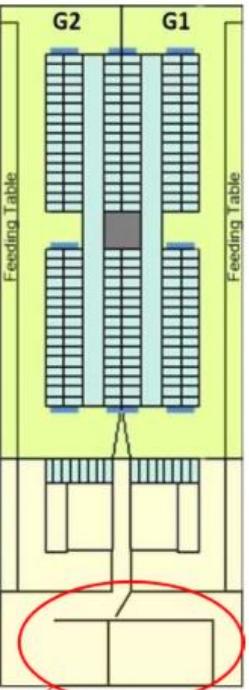
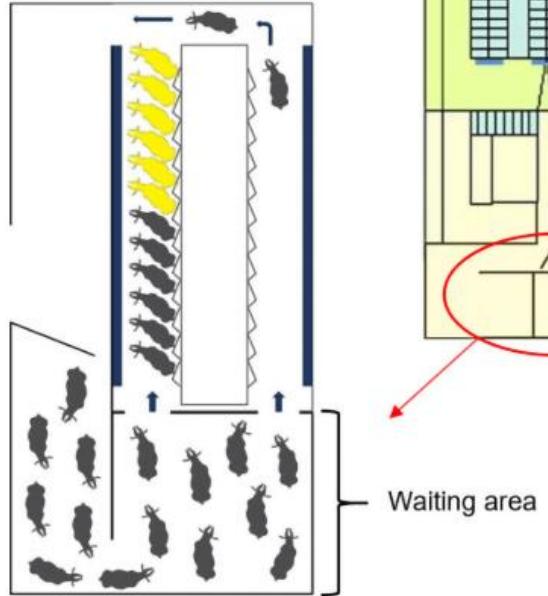


Disease transmission



- **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.**, Lücke, 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*, 12(1):139.
- **Hansson, I.** & Woudstra, S. (2023). Associations of parity and lactation stage with the order cows enter the milking parlor. *JDS Communications*.
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Disease transmission



Ida Hansson



Svenja Woudstra

Hansson, I. & Woudstra, S. (2023). Associations of parity and lactation stage with the order cows enter the milking parlor. *JDS Communications*.

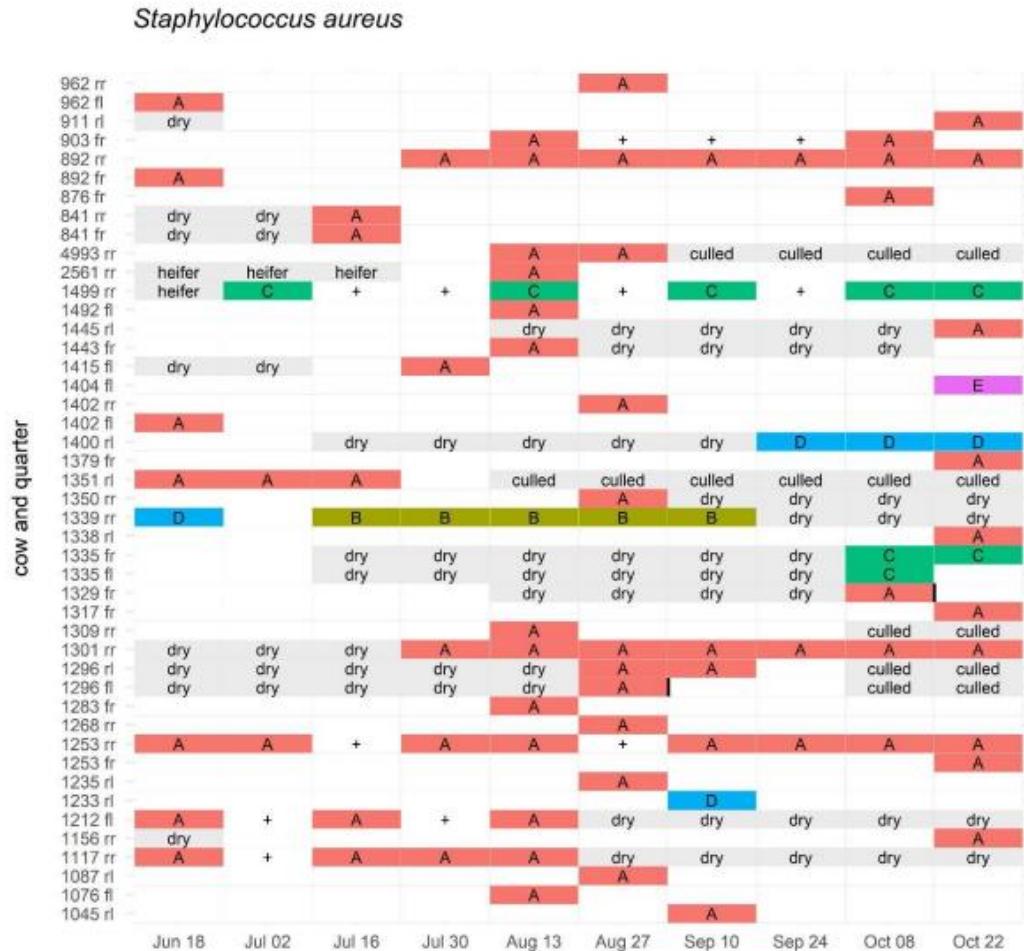
Disease transmission



Svenja Woudstra

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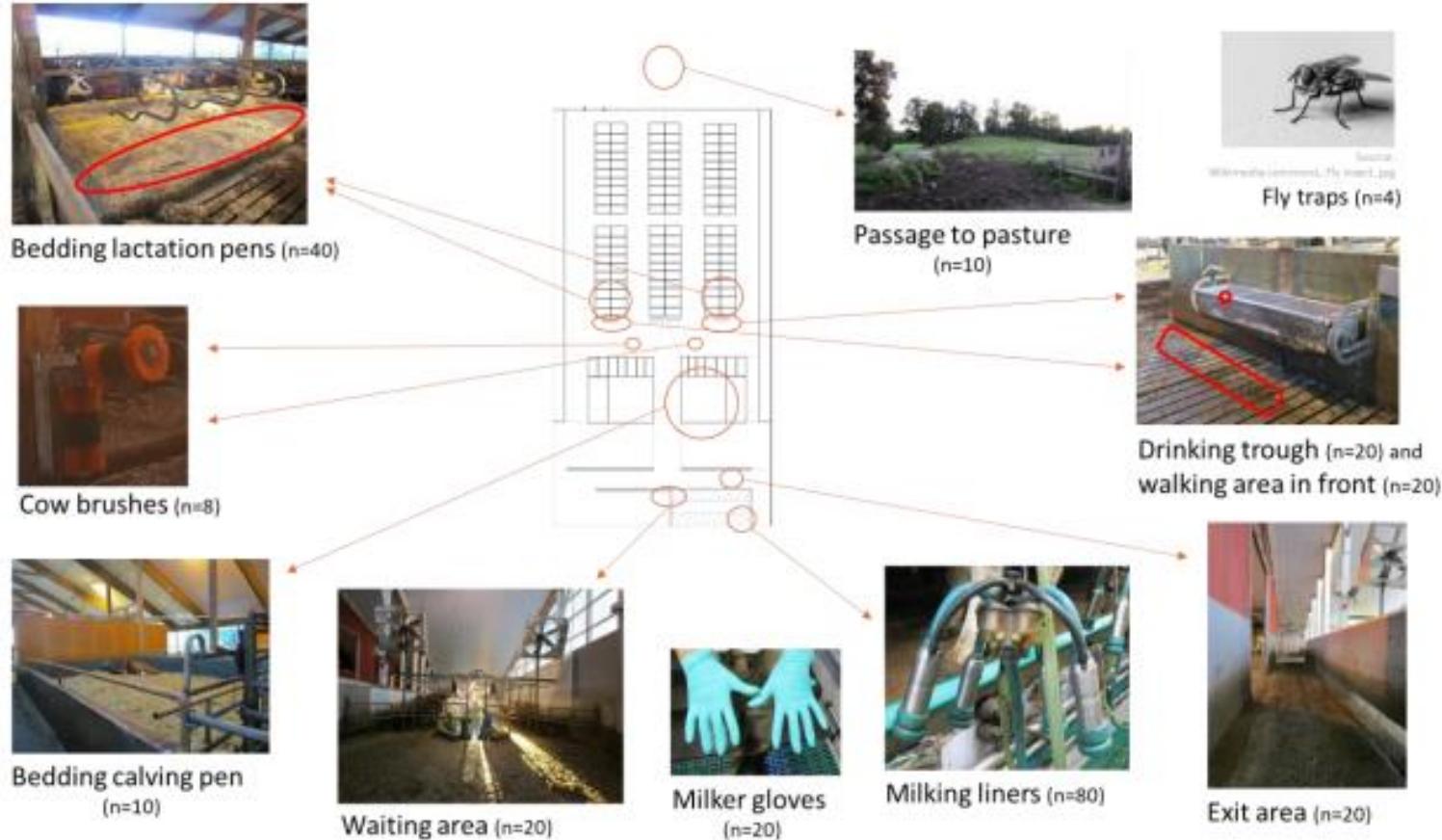
Disease transmission



Svenja Woudstra

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Disease transmission



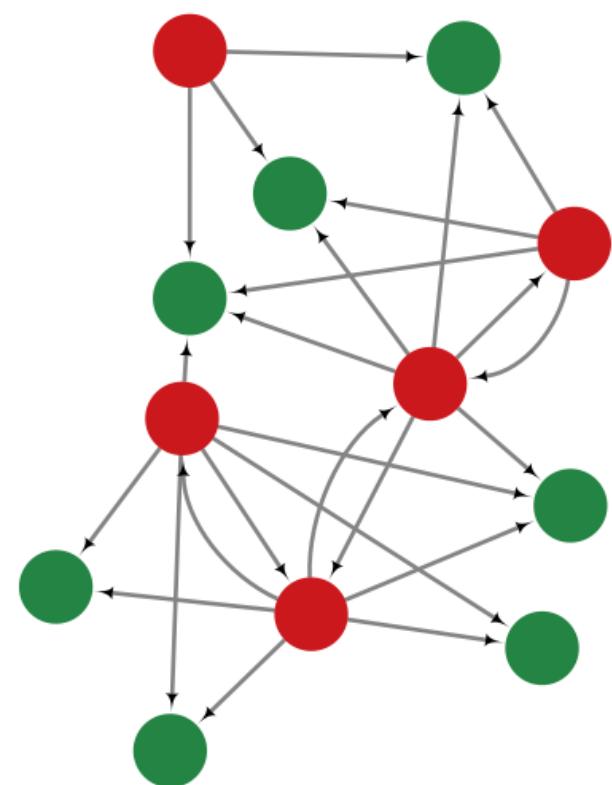
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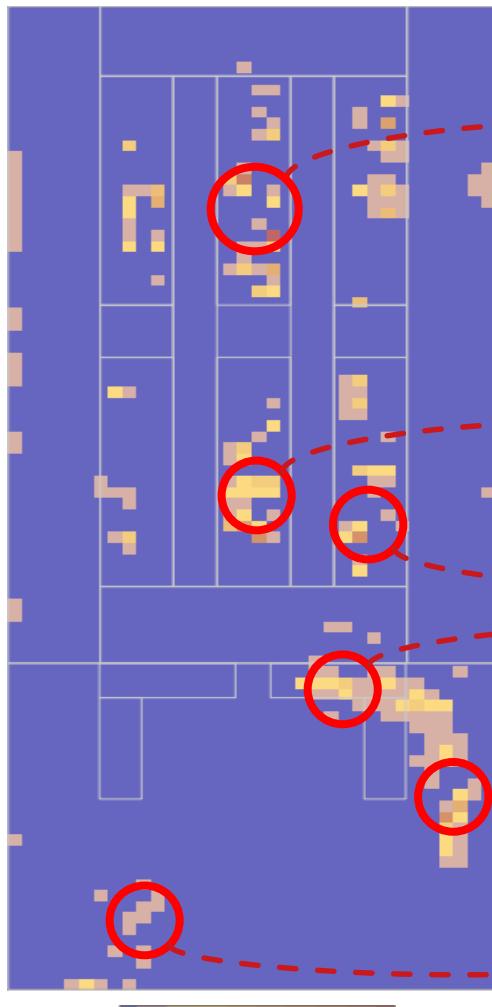
Disease transmission



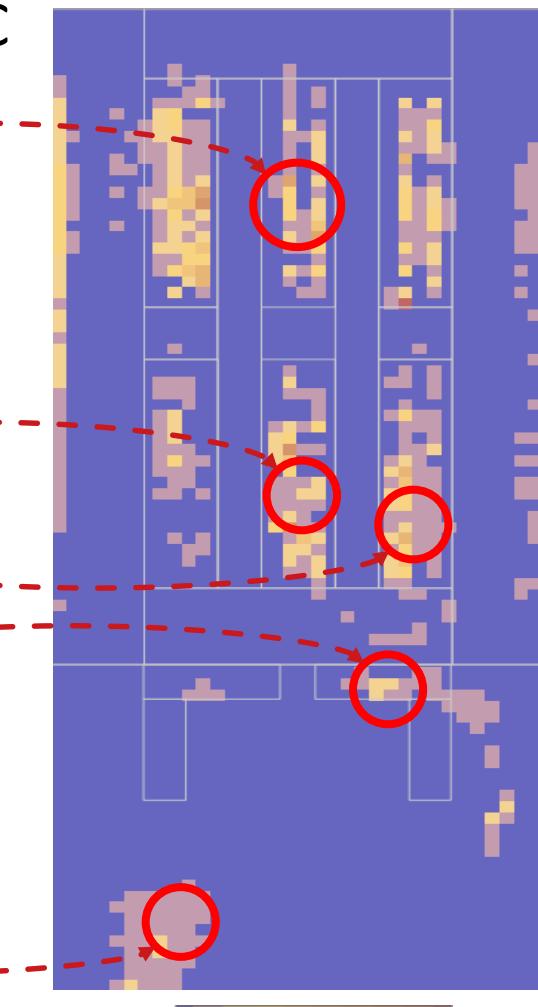
A



B

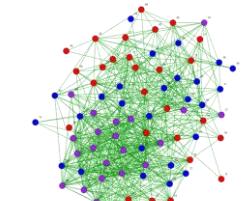


C

 Infected Non-infected

Infected cows area utilization

Non-infected cows area utilization

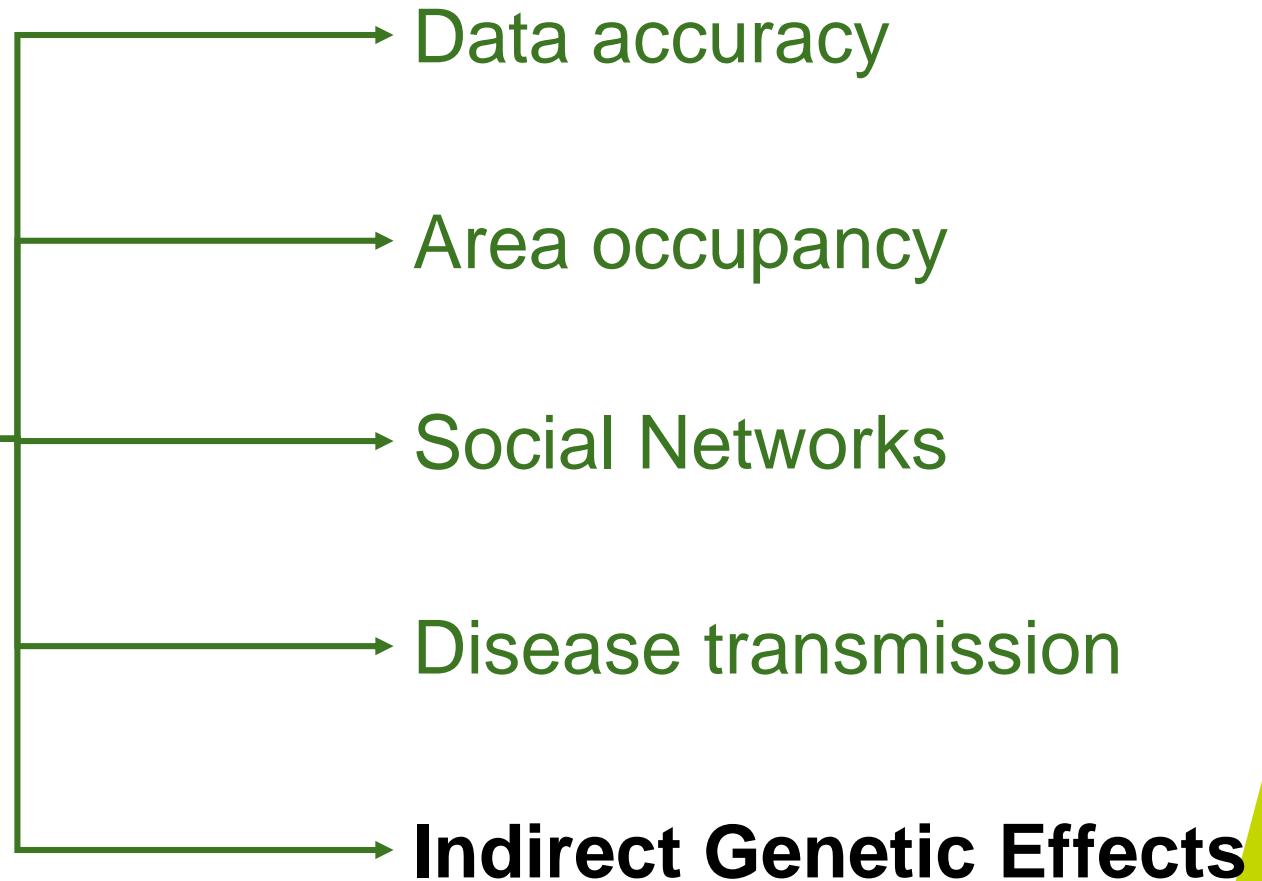


Social networks



Area usage



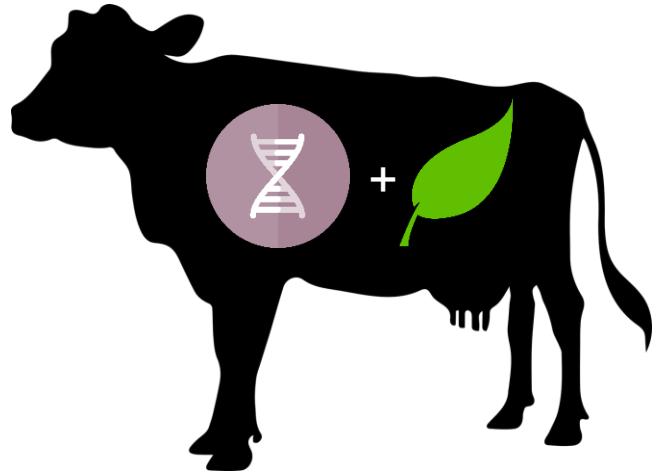


Indirect Genetic Effects



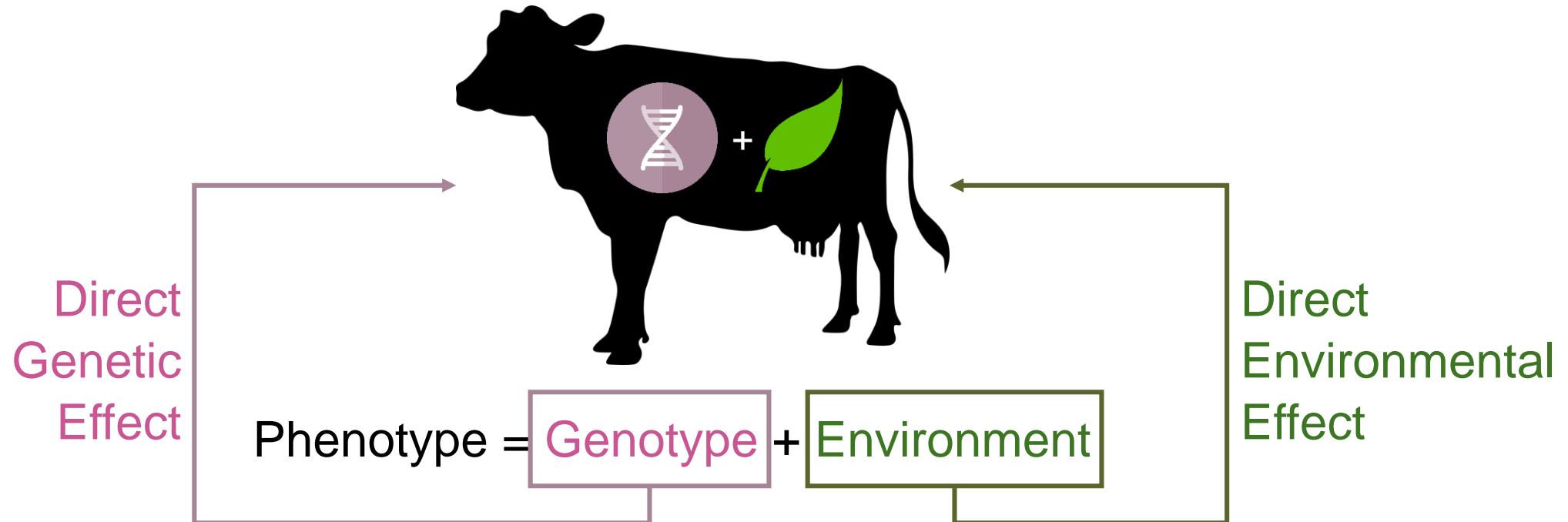
- **Hansson, I.**, Marina, H., Fikse, F., Nielsen, P.P. & Rønnegård, L. (2025). The effect of neighbouring cows within the milking parlour on a cow's daily milk yield. *Livestock Science*.
- **Hansson, I.**, Bijma, P., Fikse, W.F., Rønnegård, L. (2024). Towards assessing indirect genetic effects in dairy cattle. *Accepted*.
- **Marina, H.** Anglart, D. Rønnegård, L. (2024). Investigating the relationship between social behaviour and milk production in dairy cattle. *Unpublished*.

Indirect Genetic Effects



Phenotype = Genotype + Environment

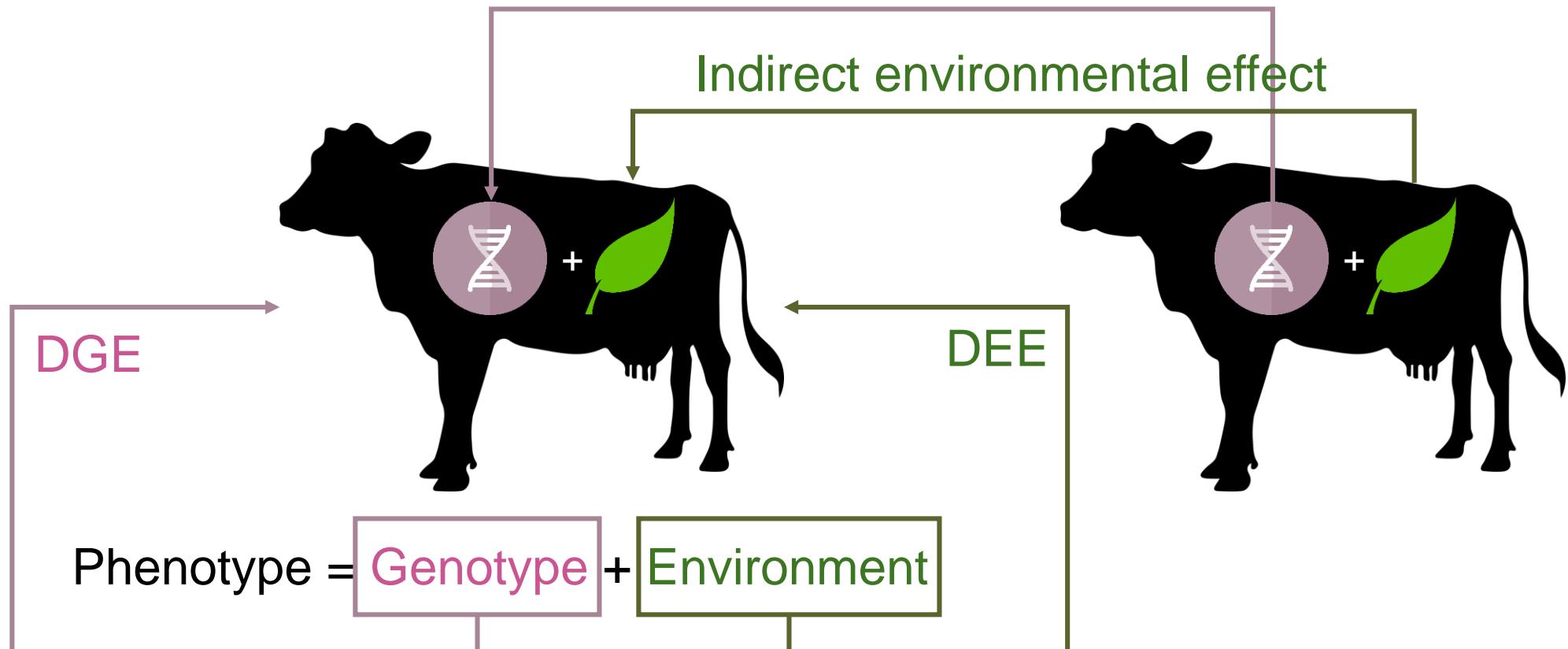
Indirect Genetic Effects



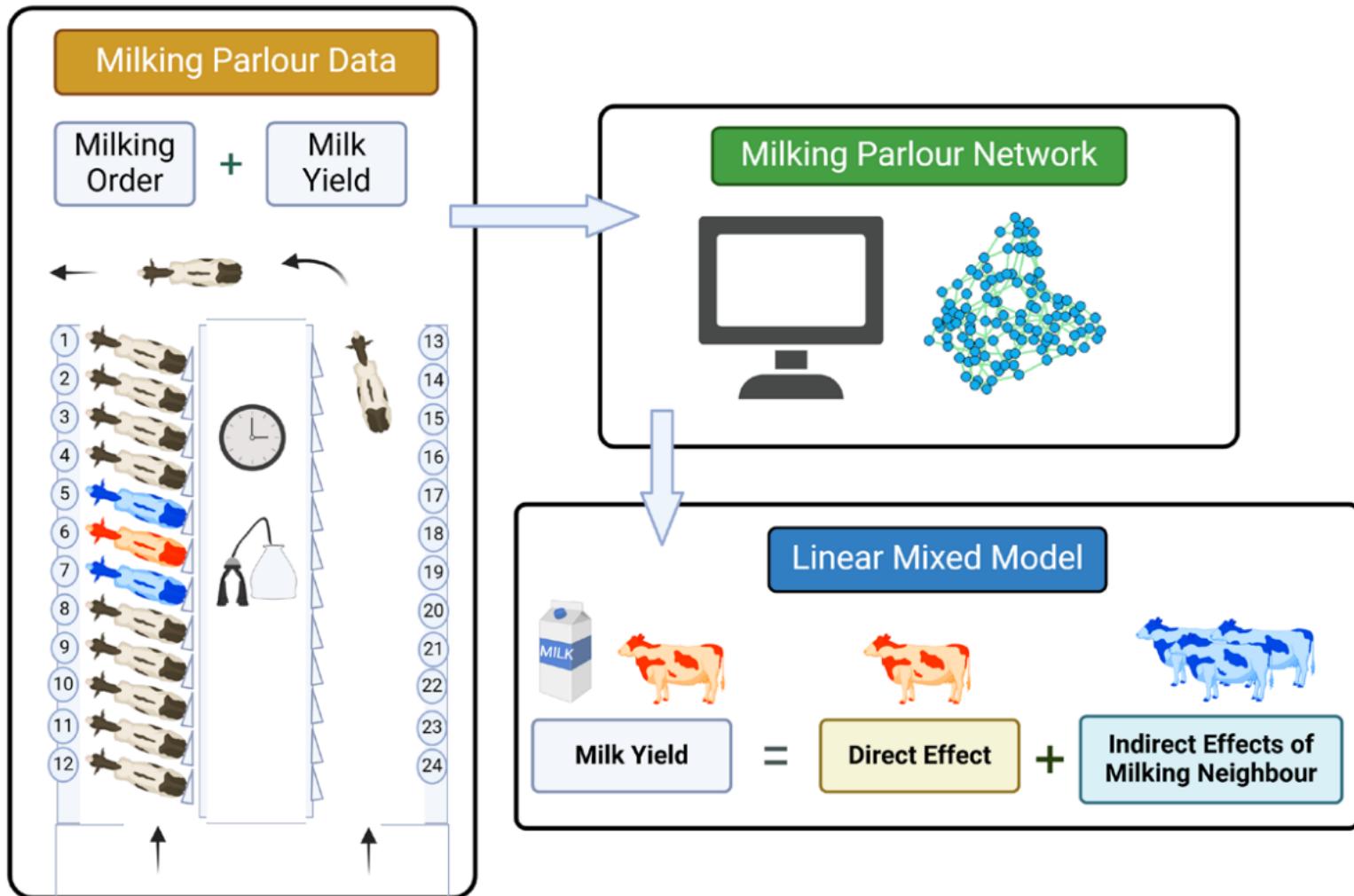
Indirect Genetic Effects



Indirect Genetic Effects



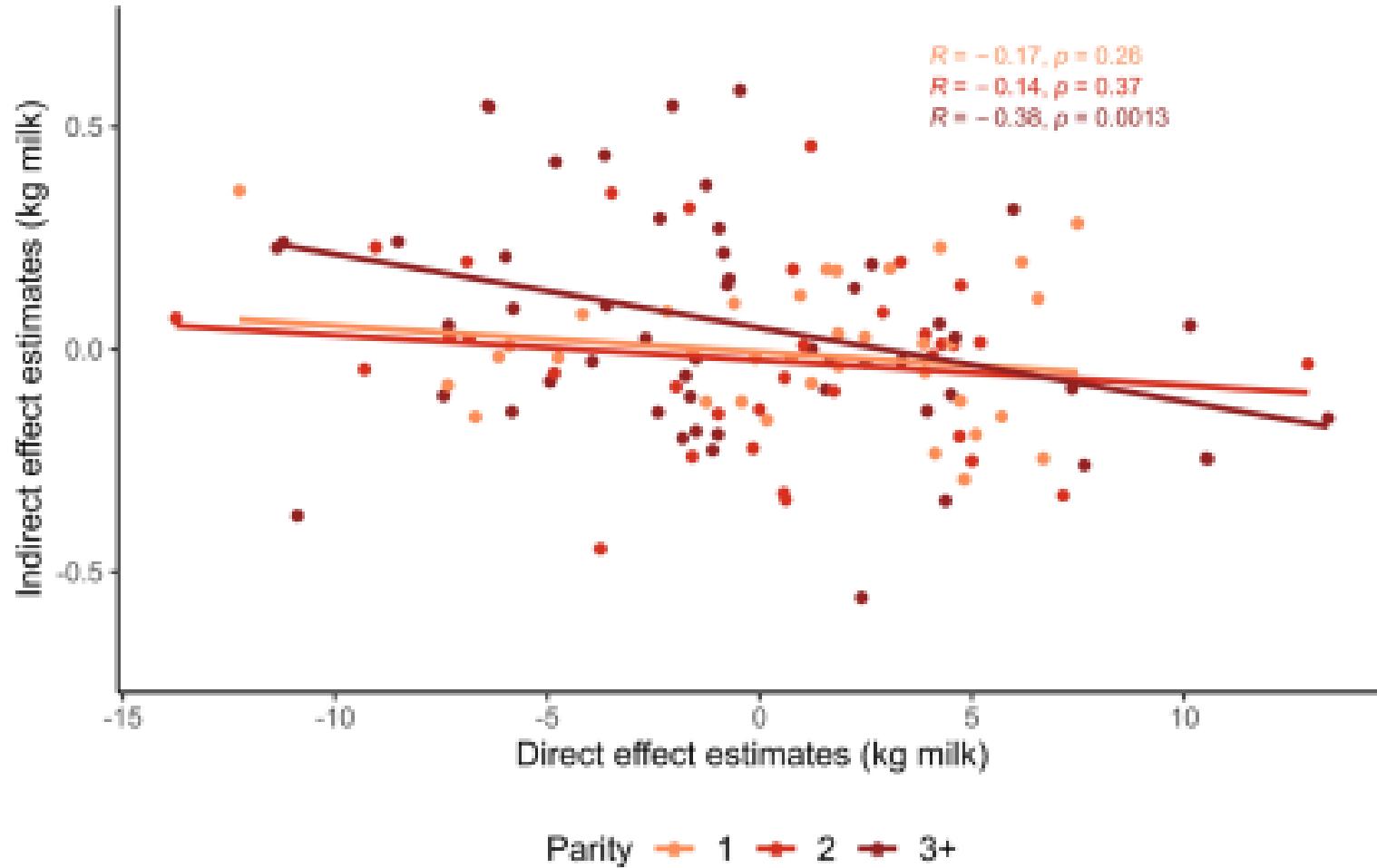
Indirect Genetic Effects



Ida Hansson

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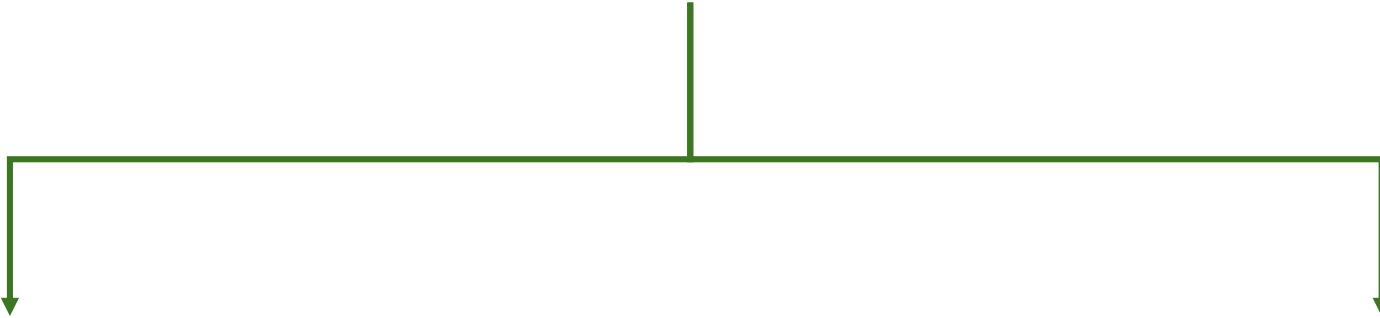
Indirect Genetic Effects



Ida Hansson

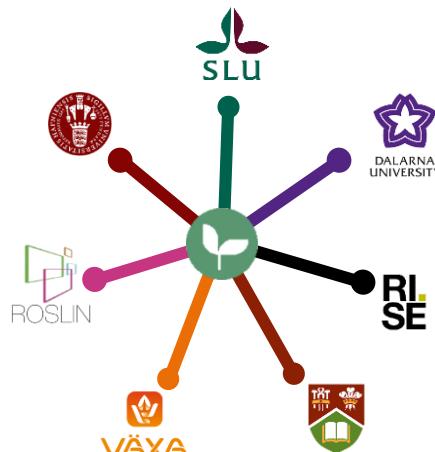
Hansson, I., Bijma, P., Fikse, W.F., Rönnegård, L. (2024). Towards assessing indirect genetic effects in dairy cattle. Accepted.

CSI:DT programme

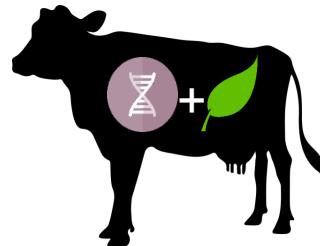


Disease transmission

Indirect Genetic Effects



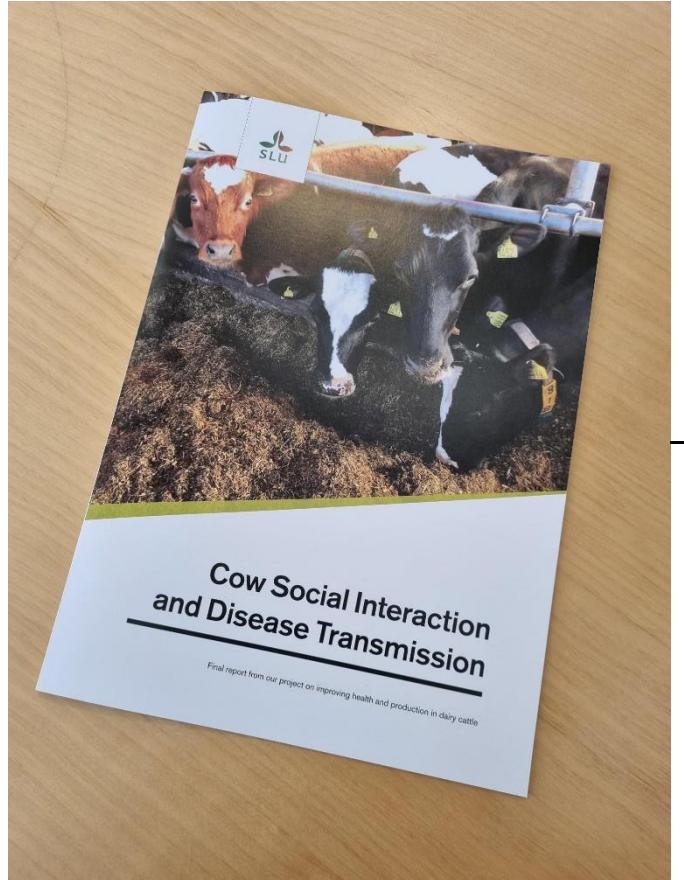
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Lantbruksforskning



Erik Philip-Sörensens stiftelse
FÖR FRÄMJANDET AV GENETISK OCH HUMANISTISK VETENSKAPLIG FORSKNING

 GENETISK
VETENSKAPLIG FORSKNING

Popular science report



CSI:DT website

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CITATION
Marina H. Hanson¹, Ben K. Fiske², Gemma J. Williams³, John S. Thompson⁴, Svenja Woudstra⁵ and Rönneqvist L. (2025) How and why to monitor social networks in dairy cows. *Front. Anim. Sci.* 3:505612. doi: 10.3389/fans.2025.505612

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Abstract
One of the most important environmental influences on a cow is the social environment it lives in. Cows have the ability to affiliate and interact with other cows and their interactions can have both positive and negative effects. Affiliative interactions, such as allogrooming and proximity, contribute to forming and maintaining positive social relationships within the herd (Van Laerhoven et al., 2009). In contrast, negative interactions such as aggression, competition, or avoidance, can be triggered by access to resources and housing conditions, among other factors, contribute to establishing dominance relationships between the individuals (Forte et al., 2021).

These relationships can be affected by dairy husbandry procedures on dairy farms, such as re-grouping of animals according to age or production stage or insufficient space allowances (Thompson et al., 2022; Van Laerhoven et al., 2023). Frequent negative changes in dominance relationships and social perturbations, which increase levels of aggression within the herd (Fausey et al., 2006; Schramann et al., 2011). Thus, daily husbandry practices on dairy farms can unintentionally disrupt these social interactions, impacting animal welfare and production (Bousman et al., 2001; Thompson et al., 2022; von Keyserlingk et al., 2023). Moreover, social interactions play a role in the transmission of contagious diseases (Bousman et al., 2001; Thompson et al., 2022). These studies described the relationship between social network structure and the incidence of respiratory and reproductive diseases in cattle.

Due to the importance of social behavior in cattle's daily activities, scientific research has focused on understanding their social interactions. Visual observations have been the main tool to study social interactions in cattle (Vahia et al., 2023). Visual observations are a robust

Keywords
dairy cows, social network, ultra-wideband, real-time location systems, indirect genetic effects

How and why to monitor social networks in dairy cows

Hector Marina¹, Ida Hansson², Keni Ren³, Freddy Fiske³, Maya Katrin Gusmann⁴, Per Peetz Nielsen⁵, Anna Skarin⁶, Svenja Woudstra⁷ and Lars Rönneqvist^{8,9}

Front. Opin. Published: 07 April 2025
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CITATION
Woudstra S., Gusmann M., Marra H., Nielsen P.A., Ben K. Rönneqvist L. (2025) Lessons learnt from strain types, milking order, and mastitis pathogen transmision. *Front. Anim. Sci.* 3:615681. doi: 10.3389/fans.2025.615681

Abstract
Mastitis is the inflammation of mammary glands (and one of) the most costly diseases in dairy cattle herds is developed countries (Halasa et al., 2007). The majority of antibiotics in dairy herds are used in the context of treating intramammary infections, which are the major cause of mastitis. However, antibiotic resistance is a growing concern. The antibiotic resistance model used in the context of mastitis control generally assume that mastitis occurrence and pathogen transmission is a homogeneous process that may either originate from the environment (environmental) or the milking process (cow-associated transmission; e.g. Gusmann et al., 2018). However, research has shown that these assumptions are often wrong and unrealistic, as presumably purely cow-associated pathogens can also have reservoirs in the environment and the pathogen categories as environmental can behave in a different way than expected. The milking process (Ingvartsen et al., 2016; Zadoks et al., 2023). In addition, exposure to pathogens may not be random but governed by social interactions within the herd and the milking order of the cows. These assumptions may substantially impact the assessment of the cost-effectiveness of mastitis prevention and control strategies. This points out the need for data to properly parametrize these tools for accurate and economic assessment of mastitis prevention and control, to ensure sustainable dairy production.

The milking order can affect social interactions between animals and the milking order of cows may allow parametrization of decision support tools more realistically, providing farmers with a valuable and accurate tool for decision support making. Precision livestock farming (PLF) opened a myriad of possibilities to monitor disease transmission patterns through cattle positioning systems, computer vision, and data collected via milking machines and robots. With a real-time location system (RTLS), cows

Keywords
dairy cows, strain typing, milking order, simulation model, mastitis prevention

Lessons learnt from strain types, milking order, and mastitis pathogen transmision

Svenja Woudstra¹, Maya Katrin Gusmann², Hector Marra³, Ida Hansson⁴, Carsten Thurn Kirkeby⁵, Volker Krömer⁶, Per Peetz Nielsen⁷, Keni Ren⁸ and Lars Rönneqvist^{9,8}

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doi: 10.3389/fans.2025.615681



GitHub



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