Voorspellen, meten en beïnvloeden van Veerkracht

19 januari 2017, Ingrid van Dixhoorn

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Resilience - Veerkracht

Resilience is the capacity of a complex system to adapt to changes and continue to function and develop (Holling, 1973)

- Learning to live with *change* and *uncertainty*
- Nurturing *diversity* for *reorganization* and *renewal*
- Creating opportunity for *self-organization*

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Waarom?

COSUST 624 1–11 ARTICLE IN PRESS

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ScienceDirect

Current Opinion in Environmental Sustainability

Why we need resilience thinking to meet societal challenges in bio-based production systems

Lan Ge[1], Niels PR Anten[2], Ingrid van Dixhoorn[3], Peter H Feindt[4], Koen Kramer[5], Rik Leemans[6], Miranda PM Meuwissen[7], Hans Spoolder[3] and Wijnand Sukkel[8]

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Abstract message, Lan et al. 2016

Many of the bio-based production systems have been designed to maximize productivity and efficiency under standard conditions, increasing their vulnerability to changes and their surrounding natural, technological and social systems.

The dominant attempts to increase production focus on maximizing control, while insufficient attention has been paid to system resilience, adaptability and transformability. These three core aspects of resilience thinking aim to reduce system vulnerability. We therefore argue for stronger adoption of resilience thinking into research on bio-based productions systems.

We show how applying resilience thinking helps to address both the production and the vulnerability challenges through interdisciplinary collaboration and cross-fertilization.

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Veel bio-based productie systemen zijn ontworpen om de productiviteit en de efficiëntie te maximaliseren onder gestandaardiseerde omstandigheden, met een verhoogde kwetsbaarheid om te kunnen gaan met veranderingen tot gevolg (van de omringende natuurlijke, technologische en sociale systemen).

Door dit dominante streven naar productie verhoging, welke zich richt op het maximaliseren van de controle, wordt onvoldoende aandacht besteed aan veerkracht, aanpassingsvermogen en transformabiliteit. Deze drie belangrijkste aspecten van resilience thinking die zich richten op het verminderen van kwetsbaarheid.

Wij pleiten dan ook voor het toepassen van het veerkracht denken in het onderzoek van bio-based productie systemen.

Met het artikel willen we laten zien dat toepassing van resilience thinking helpt bij de uitdagingen die er liggen voor zowel de productie als de kwetsbaarheid van BBPS door middel van interdisciplinaire samenwerking en kruisbestuiving.

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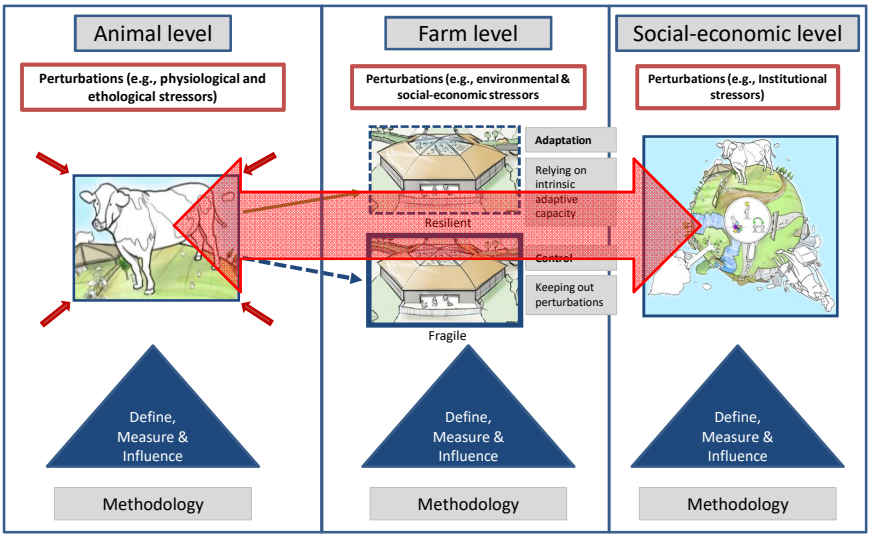
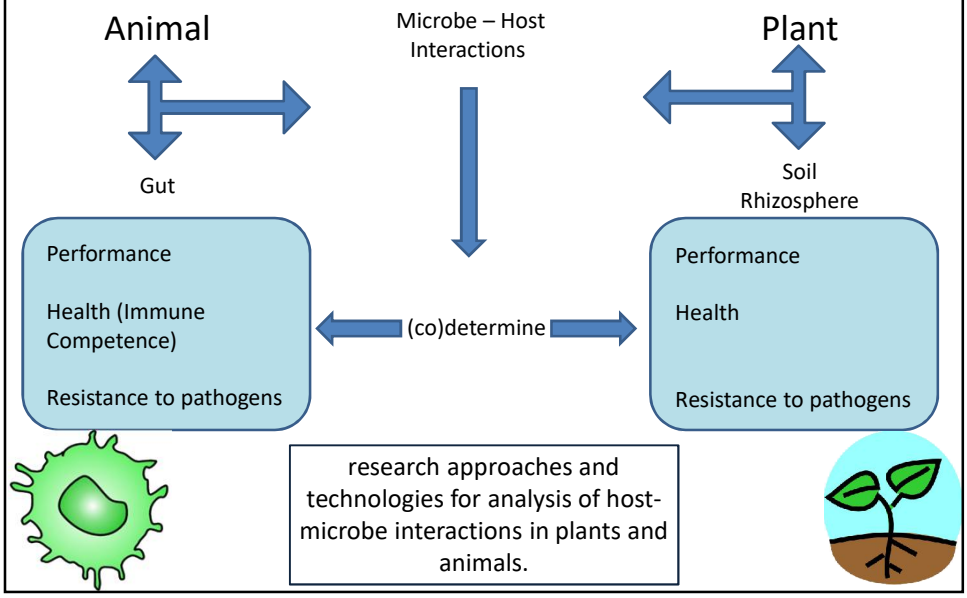
Applying Resilience Thinking to Livestock Production Systems



Lan *et al.* 2016

Exchange of concepts Immunology & microbes



Shift in strategie

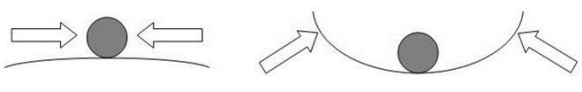
Van:

Verminderen van risico's en maximeren van productie

Naar:

Reduceren van de impact van verstoringen, ondersteunen en faciliteren van adaptatie kracht

Control Model: richt zich op de oorzaken
Adaptation Model: richt zich op consequenties



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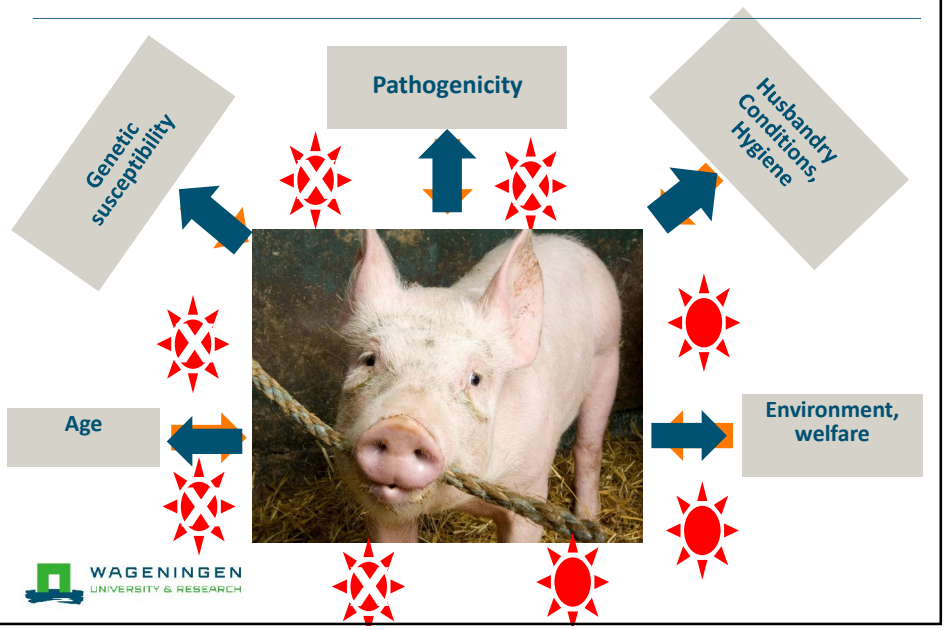
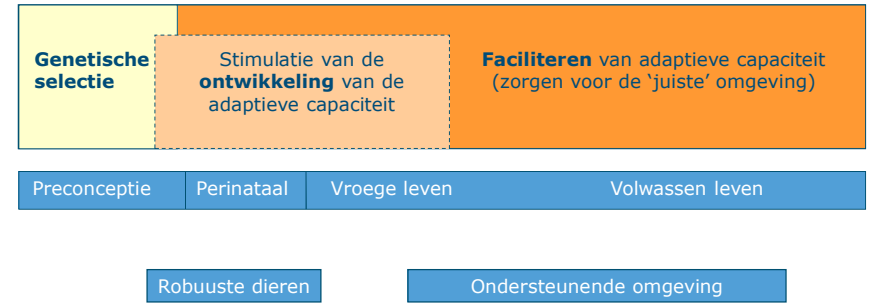
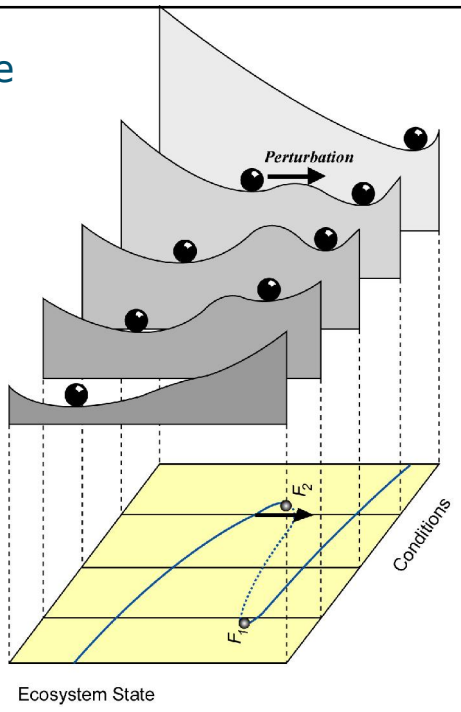
Shift in strategie



Selectie, ontwikkeling en **faciliteren** ter bevordering van het (intrinsiek aanwezige) aanpassingsvermogen



Grenzen aan adaptatie vermogen?



Critical transitions - Resilience

Scheffer, 2009

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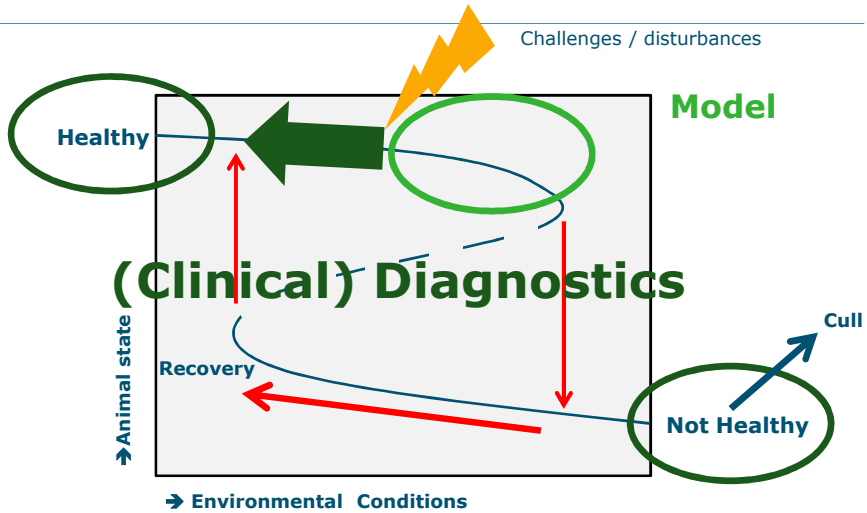
Conceptuele denkraam



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Dynamiek van variabelen

- Koolhaas *et al.* 2011

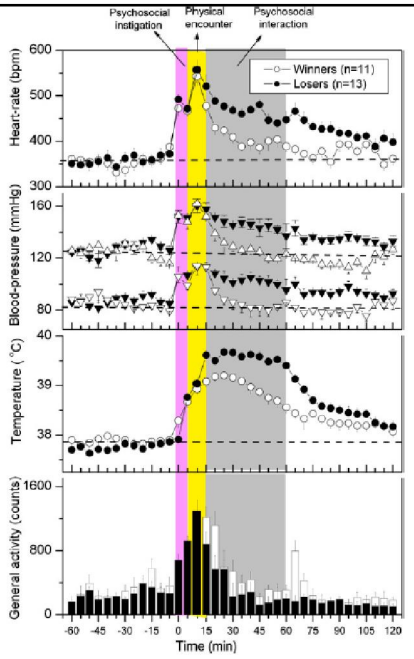

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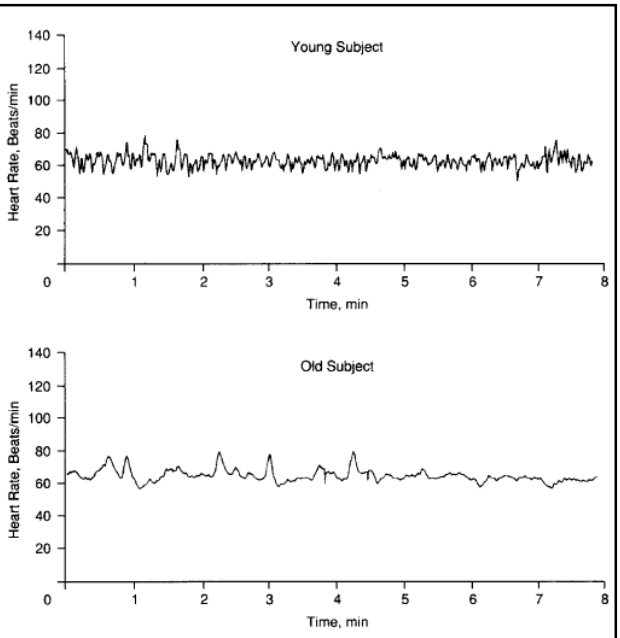
Fig. 4. Changes in heart rate, blood pressure and core body temperature in male rats during winning or losing a social interaction in a resident intruder paradigm. The animals were provided with permanently implanted radiotelemetry transmitters.

Dynamics of variables reveal more information

Average Heartbeat/min
young person 64.7; SD 3.9
old person 64.5; SD 3.8

Lipsitz & Goldberger, 1992



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Veerkracht van melkvee

Animals **2015**, *5*(4), 978-1020; doi:10.3390/ani5040395

Open Access

Review

Metabolic Disorders in the Transition Period Indicate that the Dairy Cows' Ability to Adapt is Overstressed

Albert Sundrum

Any attempt to reduce prevalences of metabolic disorders and associated production diseases should rely on continuous and comprehensive monitoring of appropriate living conditions

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Both farm management and agricultural science should support animals in their ability to cope with nutritional and metabolic challenges by employing a functional and result driven approach.

Any attempt to reduce prevalences of metabolic disorders and associated production diseases should rely on continuous and comprehensive monitoring of appropriate living conditions

Zowel bedrijfsmanagement als agrarische wetenschap moeten zich richten op het ondersteunen van dieren in hun vermogen om te kunnen gaan met voedings- en metabole problemen door gebruik te maken van een functionele en resultaatgerichte aanpak. Elke poging om de prevalentie van metabole aandoeningen en bijbehorende productie ziekten te verminderen moet gericht zijn op een continue en uitgebreide controle van de juiste leefomstandigheden

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Selectie, ontwikkeling en **faciliteren** ter bevordering van het (intrinsiek aanwezige) aanpassingsvermogen

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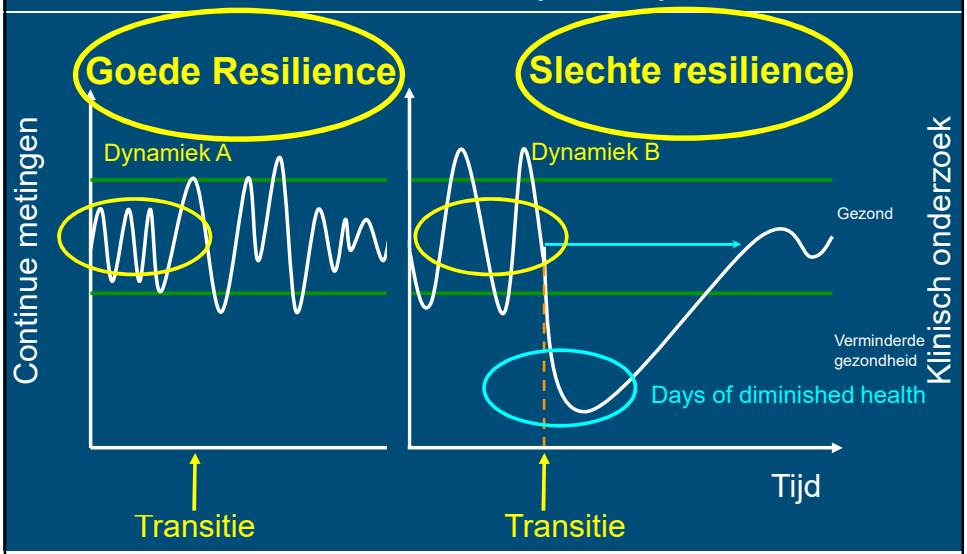
Veerkracht van Melkvee, proefopzet



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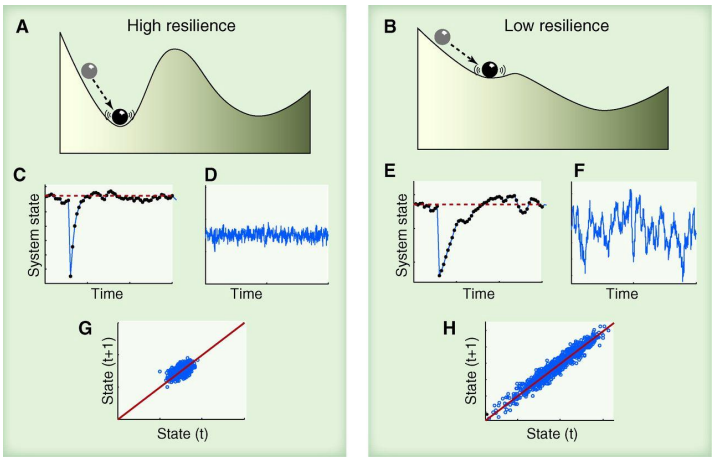

Critical slowing down as an indicator that the system has lost resilience and may therefore be tipped more easily into an alternative state. Recovery rates upon small perturbations (C and E) are slower if the basin of attraction is small (B) than when the attraction basin is larger (A). The effect of this slowing down may be measured in stochastically induced fluctuations in the state of the system (D and F) as increased variance and "memory" as reflected by lag-1 autocorrelation (G and H). Scheffer *et al,* Science 19 October 2012

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Veerkracht van Melkvee, Fase I

- Samenwerking
- VKON / Dierenkliniek Den Ham
- De boerenveearts (Gerrit Hegen)
- Cowsultancy (Joost de Veer)
- Veterinaire kenniscoöperatie 'Veerkracht'
- Koekompas
- Agrovision
- WUR



Figure 1. Sensors: IceQube (left), SensOor (middle), Bella Ag (right)

Veerkracht melkvee I, experiment : april-juni 2014

- Gezondheidsstatus:
  - Dagelijks uitgebreid klinisch onderzoek van 20 koeien gedurende 8 weken (VKON)
  - Om de dag bloedmonster (GD)
  - Mestonderzoek (BLGG)
- Continu waarneembare variabelen:
  - Productie (robotgegevens)
  - Temperatuur (pensbolus BellaAg, oortemperatuur Sensoor)
  - Activiteit – staan, liggen, lopen, eten, kauwen (IceQube / Sensoor)
  - Melkbestandelen herd navigator (DeLaval)
- Toestand van het gehele bedrijf
  - 6x koekompas

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Veerkracht melkvee I, experiment : april-juni 2014

- Doel: Voorspellen van risico-koeien voor de transitie periode
- Relatie days of diminished health (DDH) met sensordata
- Critical slowing down?
  - Marten Scheffer / Egbert van Nes


LIVESTOCK RESEARCH
WAGENINGEN UR

Identifying cows at risk

Ingrid van Dixhoorn[a], Rudi de Mol, Joop van der Werf, Kees van Reenen

Background

The transition period is a critical phase in the life of dairy cows. Early identification of cows at risk for disease would allow for early intervention and optimization of the transition period. Based on the theory of resilience of biological systems [1,2] we hypothesize that the level of vulnerability of an individual cow can be quantified by describing dynamical aspects of continuously measured physiological and behavioural variables.

Objective

To examine the relationship between the risk to develop diseases early in lactation and dynamic patterns of high-resolution, continuous physiological and behavioural data, recorded in individual cows before calving.

Method

From 1 day until 6 weeks after calving, 20 cows were clinically examined daily. During the 2-week period before calving, continuous and high-frequent (average or single values every 10 -15 - 60 min) behavioural and body temperature data were obtained with the use of 3 sensors:

- IceQube: number of steps and overall activity (Motion Index)
- SensOor: eating, and level of activity (high, low, inactive)
- Ag Bolus: rumen temperature

Total number of days of diminished health (DDH) post partum was calculated based on clinical findings. Three (dynamical) quantitative parameters per sensor variable were calculated: average, variance and autocorrelation. These parameters were correlated with DDH (Spearman rank correlations).

Results

Table 1: Significant correlations between days of diminished health (DDH) after calving and sensor variables, recorded before calving.

Quantitative parameter sensor variable	Correlation with DDH	P-value
High activity, variance	-0.75	<0.05
Eating time, average	-0.70	<0.05
Inactive time, average	>0.40	<0.1
Number of steps, average	-0.43	<0.1
Number of steps, variance	-0.48	<0.01
Motion Index, average	-0.62	<0.05
Motion Index, variance	-0.74	<0.001
Rumen temperature, autocorrelation	>0.27	<0.1

Conclusions

Dynamic, quantitative parameters for high-resolution physiological and behavioural measures, continuously acquired during the dry period have predictive value for the risk of cows to develop diseases during the early lactation period. Our results suggest that quantitative parameters derived from sensor data may reflect the level of resilience of individual cows.

References

[1] Walker B, Holling CS, Carpenter SR, Kinzig A (2004) Resilience, adaptability and transformability in social-ecological systems. Ecology and Society 9.
[2] Scheffer M, Bascompte J, Brock WA, Brovkin V, Carpenter SR, et al. (2009) Early-warning signals for critical transitions. Nature 461: 53-59.

Figure 1. Sensors: IceQube (left), SensOor (middle), Bella Ag (right).

Partners

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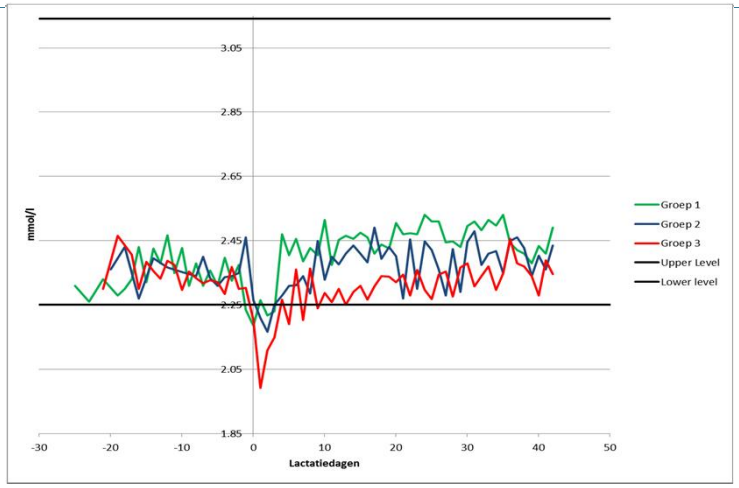
Calcium Recovery Rates



Verloop van Ca niveau gedurende het transitie moment
Groene lijn <7 DDH, rode lijn >20 DDH, blauwe lijn 7-14 DDH.

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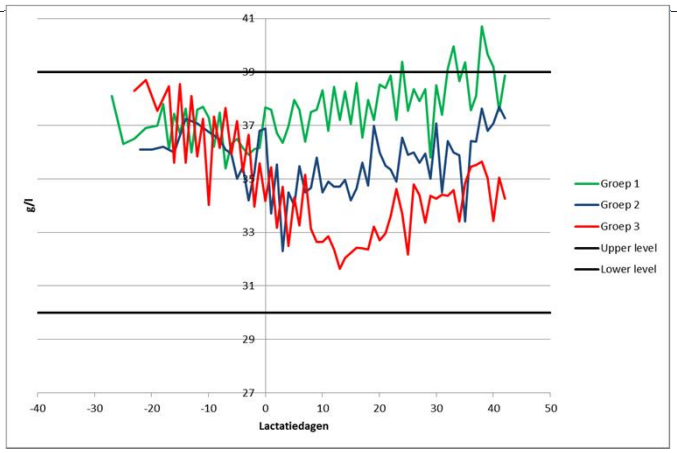
Eindrapportage Veerkracht van Melkvee I, 2016

Albumine in bloed



Verloop van Albumine niveau gedurende het transitie moment. Groene lijn <7 DDH, rode lijn >20 DDH, blauwe lijn 7-14 DDH.

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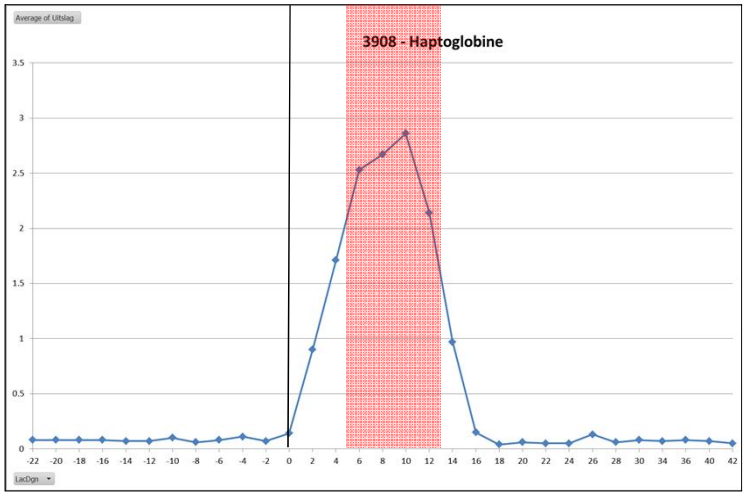
Eindrapportage Veerkracht van Melkvee I, 2016

Verhoogd haptoglobine vóór klinisch ziek



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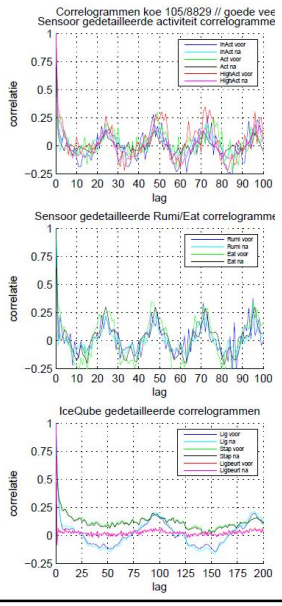
Eindrapportage Veerkracht van Melkvee I, 2016

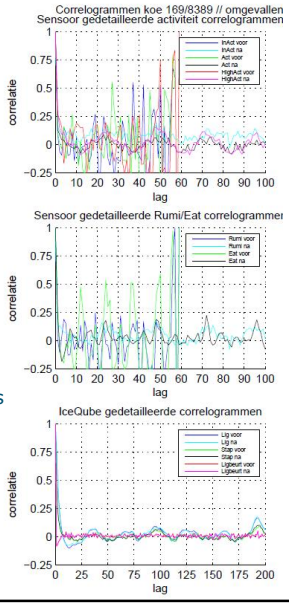
Circadian Rhythm - periodiciteit



Strong circadian rhythm (left) before calving related to less days of diminished health post partum

Weak circadian rhythm (right) with more days of diminished health post partum

Van Dixhoorn *et al*, in progress



Correlaties tussen DDH en kwantitatieve waarden van sensor data tijdens droogstand

Sensor measurement	Value	Correlation with log(1+DDH)	P-value
Inactive time	average	0.67	<0.05
Eating time	average	-0.76	<0.05
Ear temperature	variance	0.67	<0.05
Number of steps	variance	-0.51	<0.05
Eating time	nonperiodicity	0.78	<0.05
Lying time	nonperiodicity	0.79	<0.001
number of steps	nonperiodicity	0.63	<0.01
motion index	nonperiodicity	0.62	<0.01

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Van Dixhoorn *et al*, in progress

Next: Veerkracht Melkvee II

EFRO – Zuivel NL – Innovatiefonds

- VKON
- WUR
- Nedap
- Relitech
- Farm Result
- De boerenveearts
- Cowsultancy
- Crumelhaeve

- 4-5 melkveebedrijven,
- ca 250 koeien
- Transitieperiode
- Klinisch onderzoek
- Sensor data
- duur: 1,5 jaar
- Koekompas
- Managementsysteem

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Beïnvloeden – sturen op resilience

- Combinatie met KoeKompas KoeKompas
- Bedrijfsspecifiek
- Verbetering na management-, voeraanpassing etc?
- Plan – Do – Check – Act cyclus

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Breeding for resilience?

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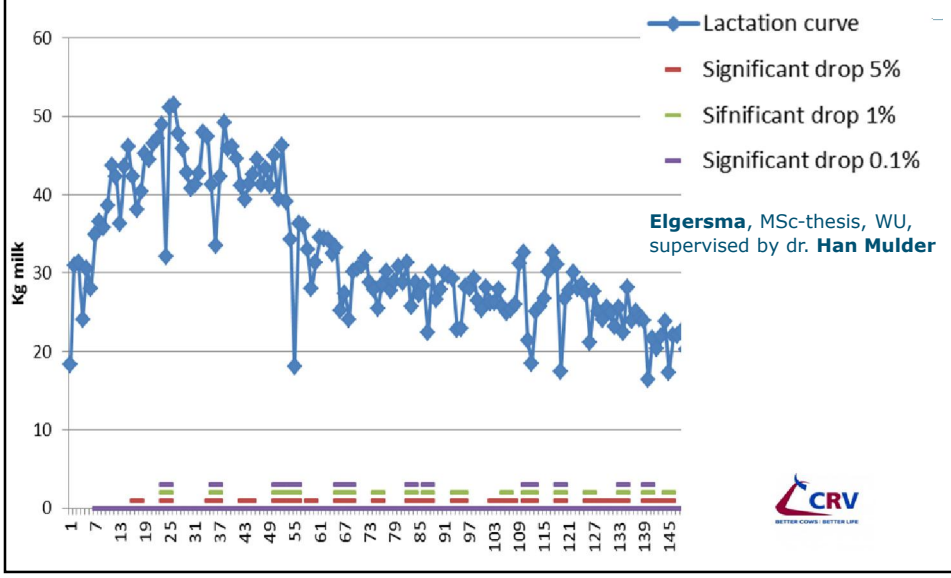
Fluctuations of milk production as predictor for health and longevity



Elgersma, MSc-thesis, WU, supervised by dr. **Han Mulder**

Fluctuations of milk production as predictor for health and longevity

- 20 sires with highest/lowest EBV
- Average EBV of health traits

	fertility		viability		udder health	claw health	ketosis
Parity 1	CI1	FL1	DS1	MS1	UDH	CLW	KET1
20 sires highest EBV	103	101	100	101	105	101	105
20 sires lowest EBV	99	99	99	100	98	100	97

Less fluctuations in milk production =
- less mastitis
- less ketosis
- better fertility
- stay 150 days longer in the farm!

Elgersma, MSc-thesis, WU, supervised by dr. **Han Mulder**

Rearing for resilience?

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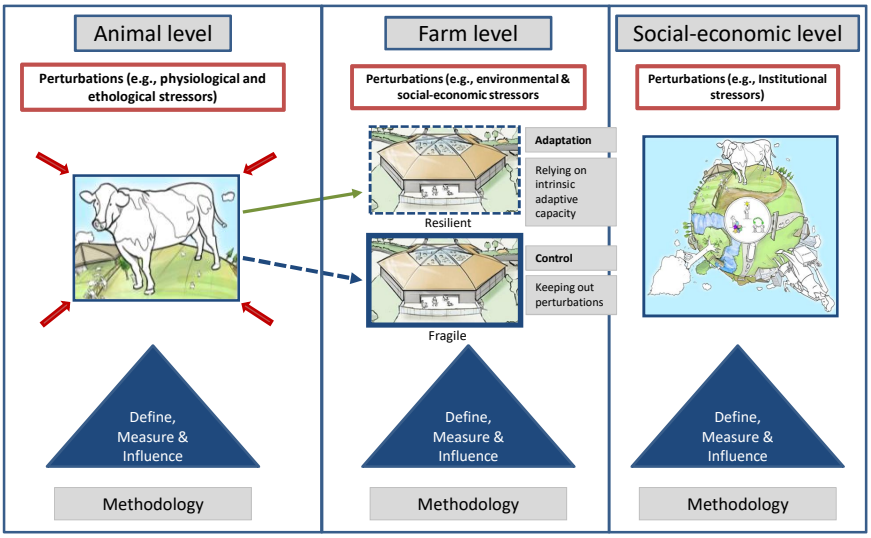
Applying Resilience Thinking to Livestock Production Systems



Lan *et al.* 2016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