GEORG-AUGUST-UNIVERSITÄT GÖTTINGEN

systemanalyse milch

Department for Animal Sciences
Division of Livestock Systems

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Does season alter dairy cows' preference for pasture and their behavioural pattern?

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Introduction

- ⇗ Consumers‘ interest in livestock production
  - ➥ Dairy cows: pasture access ⇒ „freedom of movement“ (De Graaf et al. 2016)
- ⇗ (Free choice) studies comparing in- and outdoor dairy housing systems
  - Favourable & infavourable effects of pasture access (Arnott et al. 2016)
  - Basal research on pasture behaviour & preference

➥ Focus on

- Single influencing parameters (Lee et al. 2013)
- Independent of seasonal influences (Herbut and Angrecka 2017)
- Recording of behaviour mainly during daytime (Clark et al. 2014)

Which seasonal and diurnal differences can be noticed in the cows‘ behaviour if cows have a free choice between stable and pasture?

Animals, Materials and Methods

- Data collection 2016
- Conventional farm (Northern Germany)
- Loose-housing stable with raised boxes
- Pasture gate
  - ➥ Free Choice Time (FCT) between service times
- 3 pastures close to the stable (4 ha each)
- 305 day performance: 8.700 kg milk

Pasture gate

Animals

- 12 cows
  - Milk yield above herd‘s average milk performance
  - Same animals throughout grazing season
- 86 days in milk
- daily milk yield 36.9 kg
- Fitted with
  - Noseband sensor (RumiWatch, ITIN+HOCH, Switzerland)
  - Pedometer at hind leg (RumiWatch, ITIN+HOCH, Switzerland)

Noseband Sensor

Pedometer

Periods & parameters

Beginning of grazing season
(29.5. + 17 days)

Mid of grazing season
(21.7. + 17 days)

End of grazing season
(8.9. + 17 days)

Experim. day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Pasture day	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
Pasture	**A**						**B**						**C**					

Pasture Change *Pasture Change*

Animal related parameters

- Transits
- Locomotive behaviour
- Ingestive behaviour

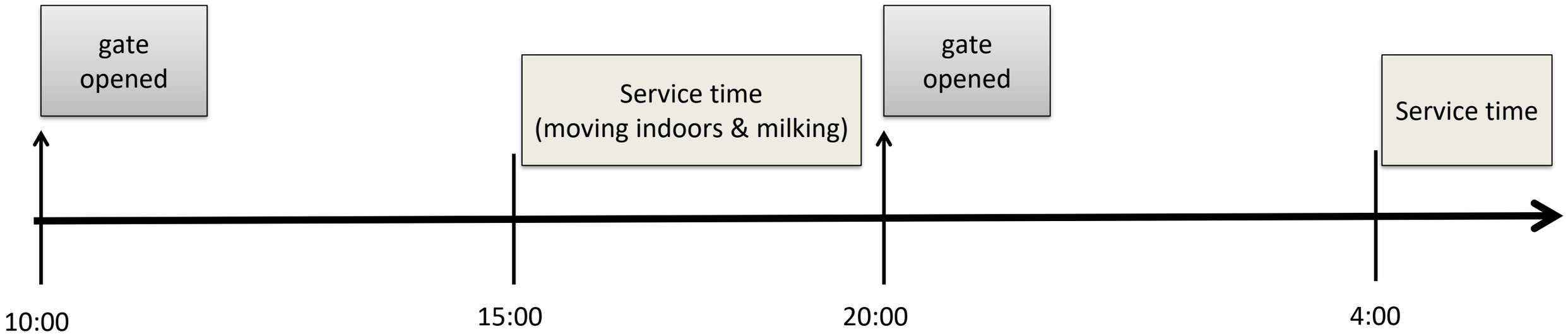
Feed related parameters

- Indoor
  Mixed ration samples
  → Weender analysis
- Outdoor
  Sward height measurements
  Gras samples
  → NIRS

Heat stress related parameters

- Indoor
  Temperature, relative humidity
  → Temperature Humidity Index
  (THI, NRC 1971)
- Outdoor
  T, RH + wind speed, solar radiation
  →THI & Heat Load Index
  (HLI, Petrov et al. 2003)

Determination of free choice time



Free choice time day (5 h)

Indoors & outdoors

- **Standing**, Lying, Walking
- **Eating**, Ruminating
- THI_{ID}, THI_{OD}, HLI_{OD}

Free choice time night (8 h)

Indoors & outdoors

- **Standing**, Lying, Walking
- **Eating**, Ruminating
- THI_{ID}, THI_{OD}, HLI_{OD}

Data analysis

- Descriptive Statistics
  - Feed quality related parameters of each period
  - Share of free choice time spent in- and outdoors during day and night
- Mixed model (PROC MIXED)
  - **Fixed effects:**

    period (Beginning, Mid, End), pasture (A, B, C),

    pasture day (1-6), heat stress indices classes
  - **Interactions:**

    period*pasture, pasture*pasture day
  - **Random effect:** individual animal
  - SAS 9.4, Bonferroni corrected

	Free choice time day (5 h) Standing, Eating	**Free choice time night (8 h)** Standing, Eating
Indoor	THI_{ID} (<60; 60-67, >67)	THI_{ID}
Outdoor	THI_{OD} HLI (≤70; >70)	THI_{OD}

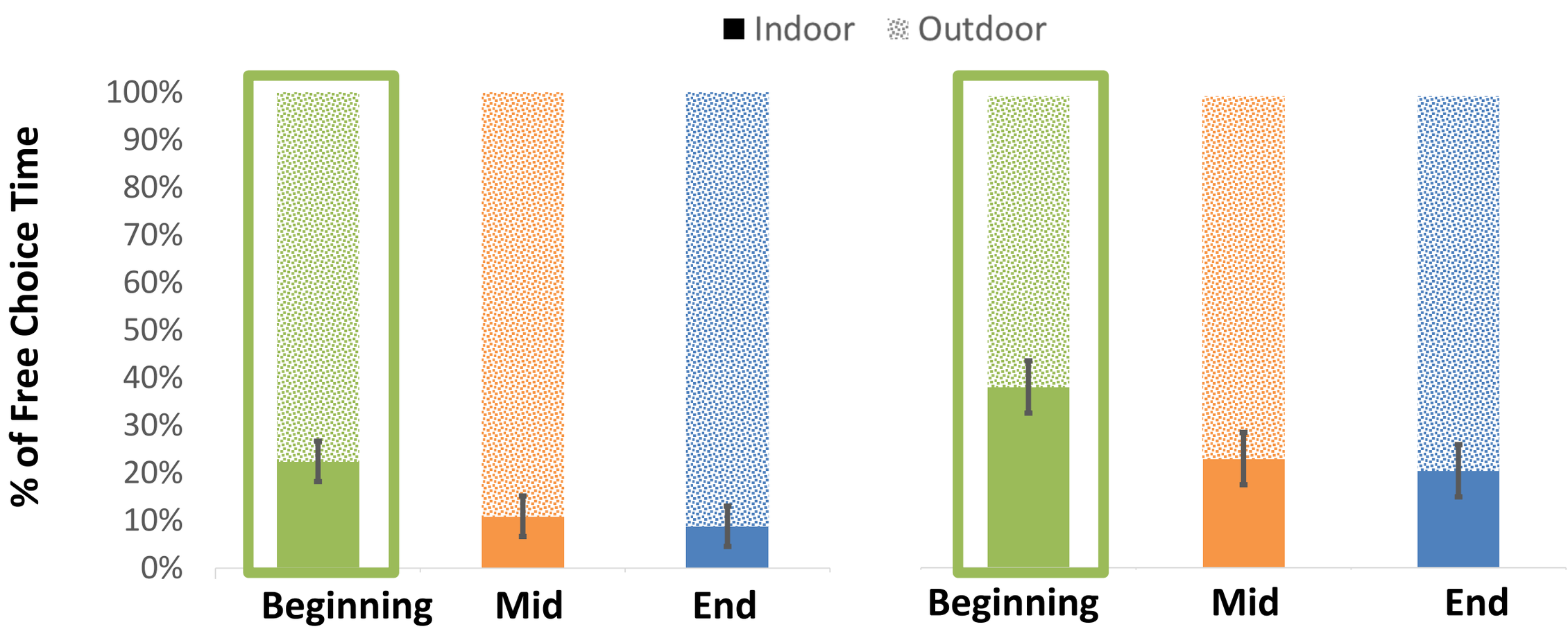
Feed quality related parameters of each period

(means, std. deviation)

		Gras		Mixed Ration	
	Sward Height (cm)	% XF	% XP	g XF/kg DM	g XP/kg DM
Beginning	**15.7** ± 7.0	**30.5** ± 1.4	**12.8** ± 1.0	**191.2** ± 14.6	**157.6** ± 8.4
Mid	**12.3** ± 2.6	**26.4** ± 1.5	**19.0** ± 1.8	**194.5** ± 12.8	**159.3** ± 6.9
End	**11.5** ± 1.7	**26.6** ± 1.9	**20.6** ± 2.0	**222.7** ± 19.7	**137.7** ± 10.2

Free choice time spent in- and outdoors depending on season and daytime *(means, std. deviation)*

☀ Free choice time day (5 h) **☾ Free choice time night (8 h)**



Min/h standing and eating depending on daytime and place over the season

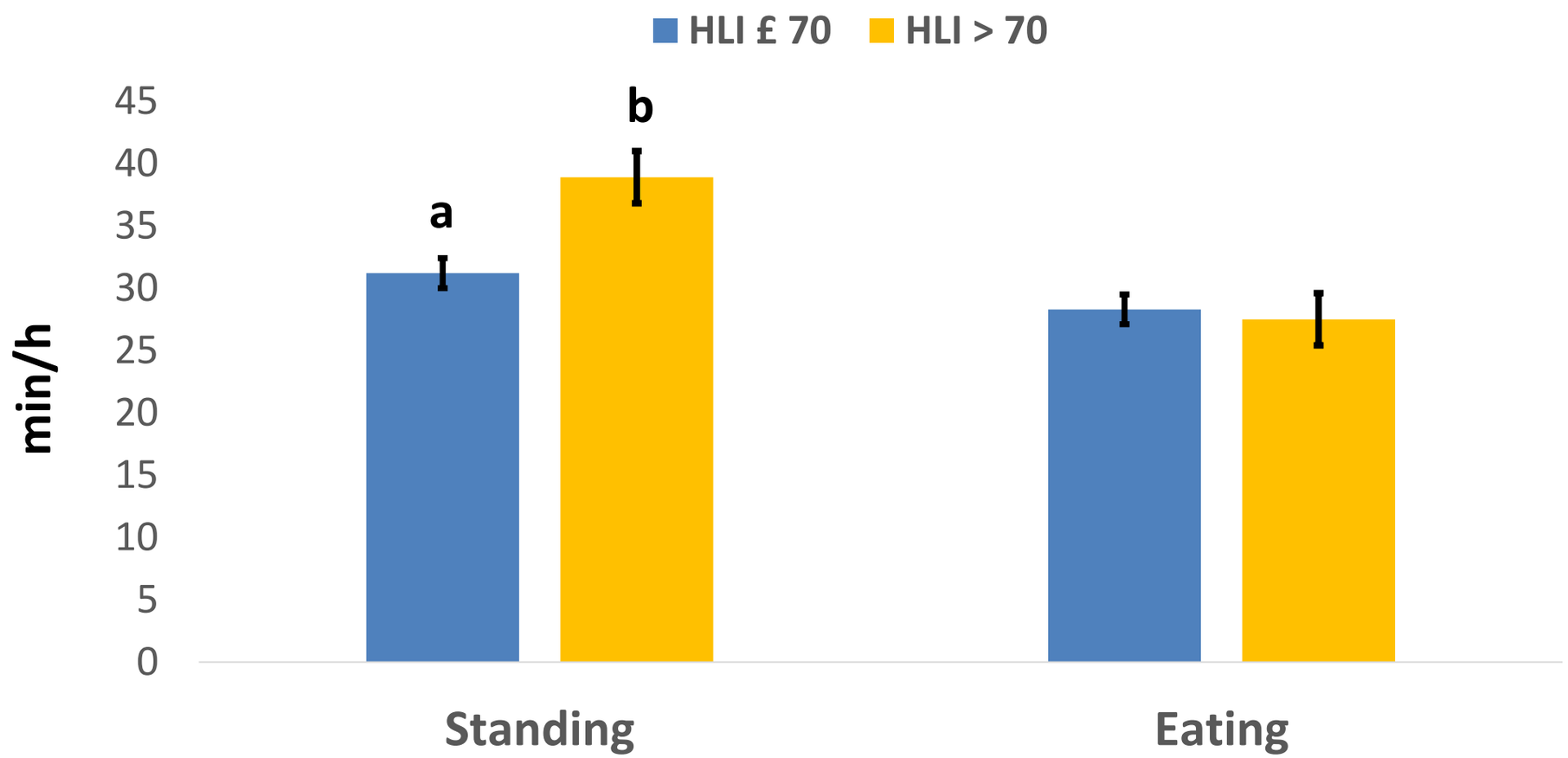
(LS means & std. error)

		☀ Free choice time day (5 h)				☾ Free choice time night (8 h)			
		Standing		Eating		Standing		Eating	
Indoor	Beginning	20.7	*2.7*	18.1	*1.6*	25.6	*1.1*	14.6	*0.8*
	Mid	22.3	*2.9*	15.5	*2.0*	20.7	*1.1*	12.9_{a}	*0.8*
	End	26.1	*3.0*	23.0	*2.0*	23.9	*1.5*	17.9_{b}	*1.1*
Outdoor	Beginning	36.5	*1.5*	28.8	*1.5*	31.8_{ac}	*1.1*	24.5_{a}	*1.0*
	Mid	35.7	*1.6*	28.1	*1.7*	28.3_{be}	*1.1*	24.5_{c}	*1.0*
	End	33.1	*1.5*	26.9	*1.5*	23.0_{df}	*1.0*	19.2_{bd}	*0.9*

Subscript letters depict significances between periods within locations, $p < 0.05$

Influence of HLI values on min/h standing and eating during free choice time day over the season

(LS means & std. error)



Letters above bars depicts significances within model, p< 0.05

Conclusion

Which seasonal and diurnal differences can be noticed in the cows' behaviour if cows have a free choice between stable and pasture?

- Increasing preference for being outdoors throughout season

  ➥ especially during ☀ free choice time day

- Time (min/h) spent …

  … standing and eating lower during ☾ free choice time night ⇒ **Resting behaviour**

  … standing and eating higher if cows are outdoors ⇒ **Grazing behaviour**

  … standing decrease and eating increase significantly with season during ☾ free choice time night ⇒ **highest XF content of fodder**

  … standing increase with HLI values > 70 during ☀ free choice time day ⇒ **Heat avoidance behaviour**

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funded by Niedersächsisches Ministerium für Wissenschaft und Kultur

supported by Landwirtschaftskammer Niedersachsen

Thank you.

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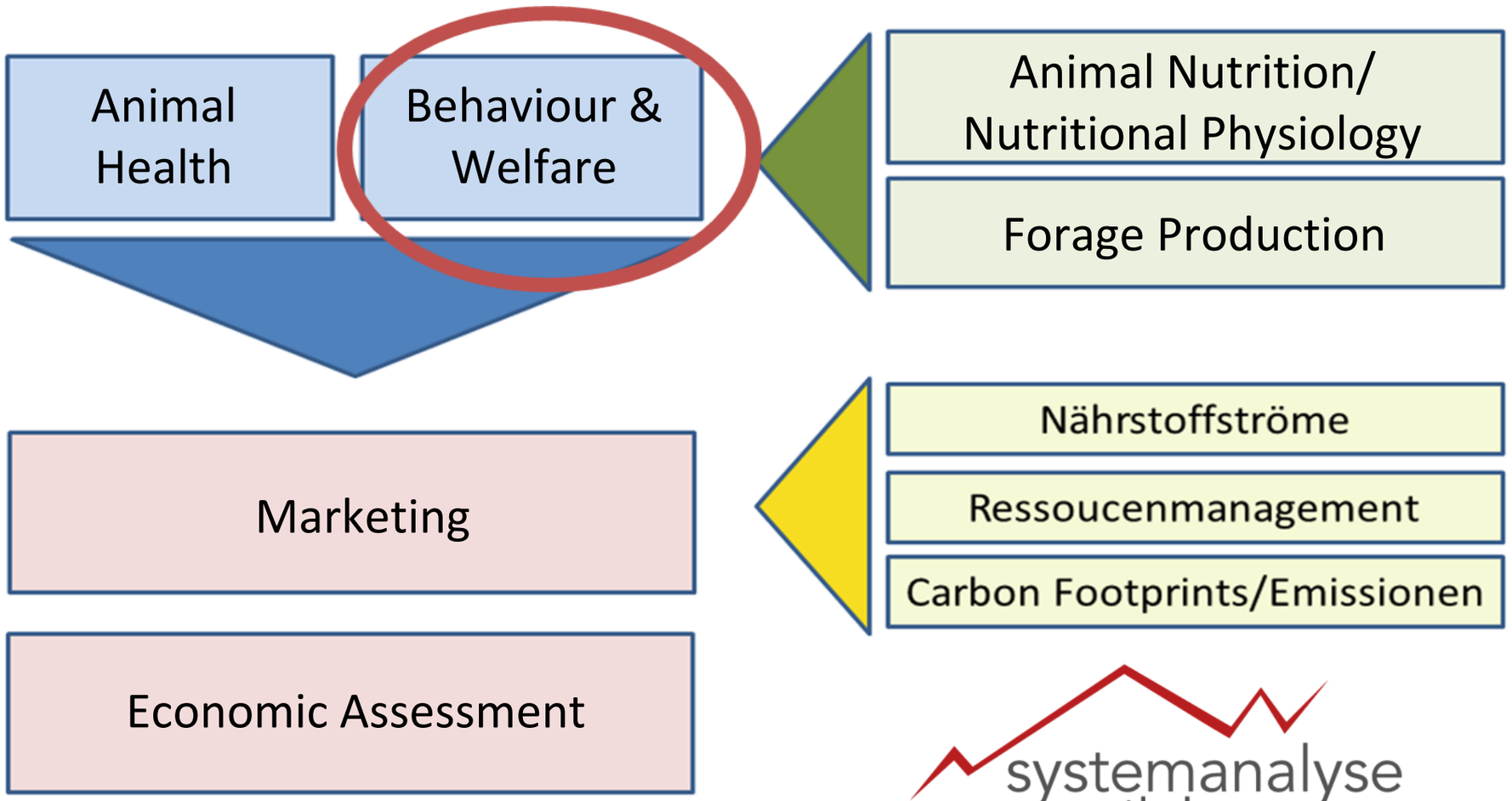
For more references, please contact the speaker

The Project: Systemanalyse Milch



Experimental Design

Beginning of grazing period (29.5.-17.6.2016)

Mid of grazing period (21.7.-9.8.2016)

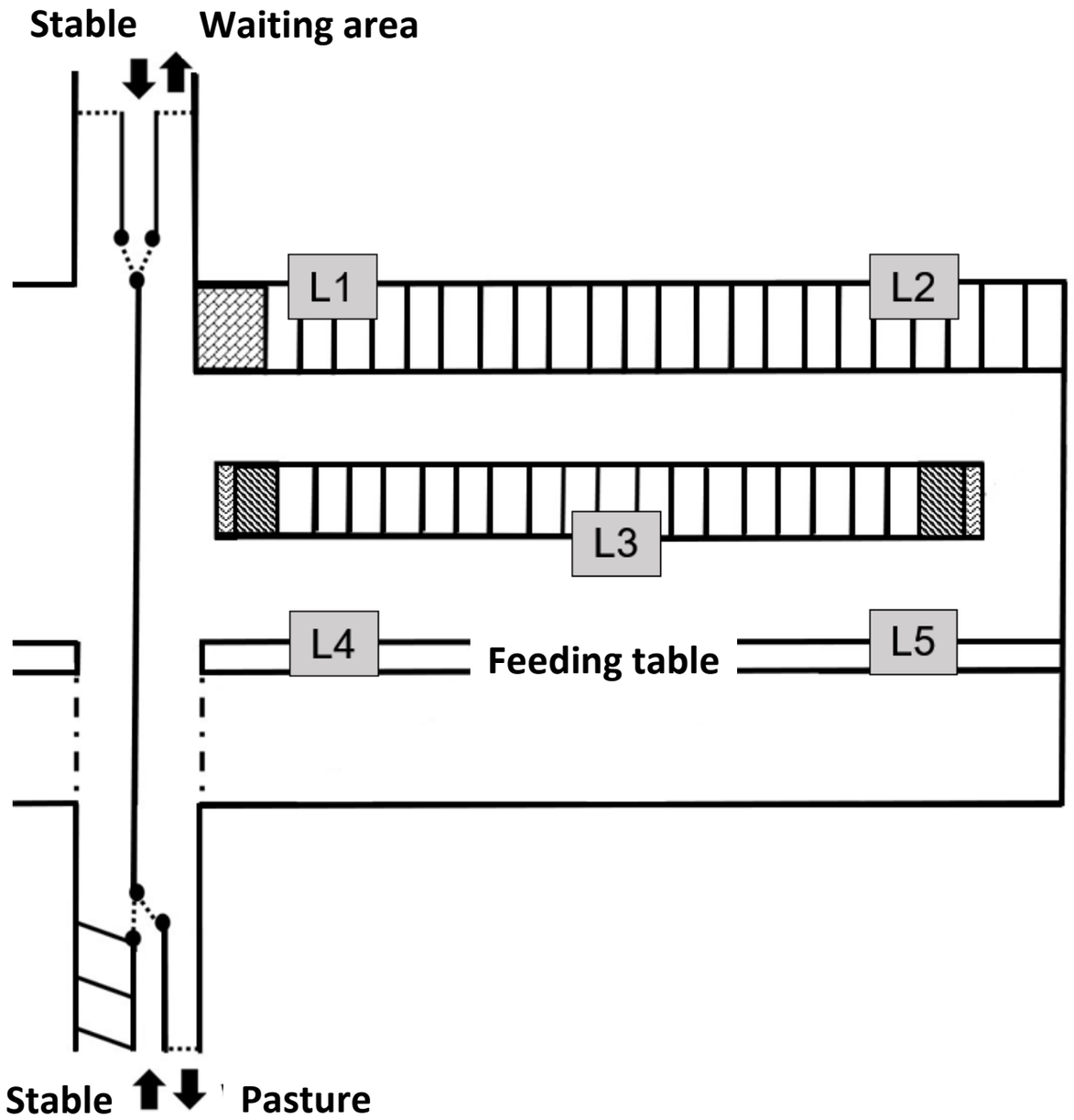
End of grazing period (8.9.-29.9.2016)

Device	Producer	Factor	Parameter
Pasture gate	GEA (Westfalia)	Transits	Pasture/Stable - transits
Data logger	TinyTag2	Climate ID	- Temperature - Relative humidity
Weather station	AWEKAS	Climate OD	- Temperature - Relative humidity - Wind speed - Solar radiation - Precipitation
Milking parlour	GEA (Westfalia)	Milk yield (MY)	- MY morning - MY evening
Nose band sensor	RumiWatch	Ingestive behaviour (IB)	- Eating (head up/down) - Ruminating
Pedometer	RumiWatch	Locomotive behaviour (LB)	- Standing - Lying - Walking

Experimental Design

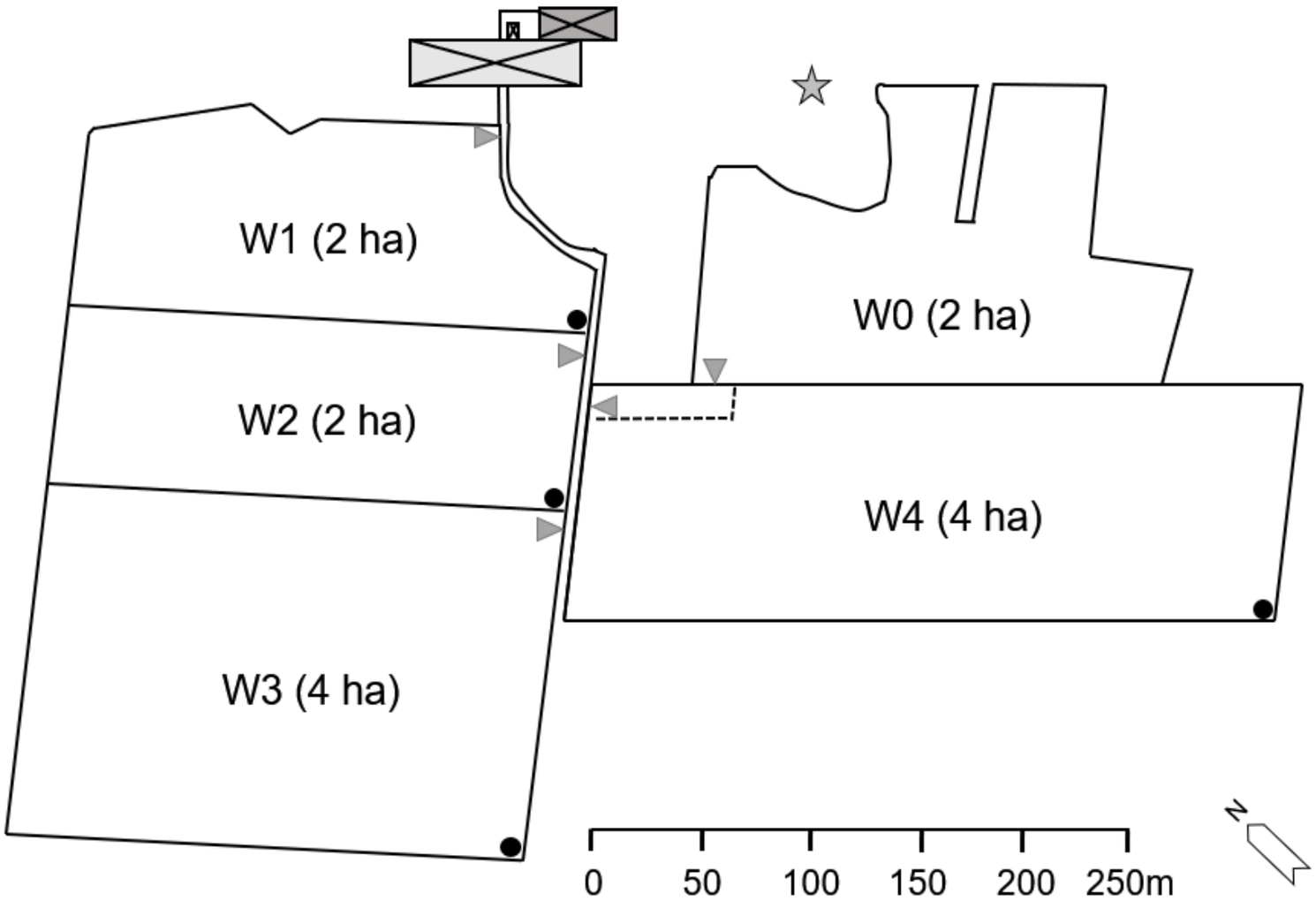
Locomotive Behaviour	
Standing	Cow is in an upright position but not walking (incl. temporary changes of the pedometer to vertical angle for less than 50s)
Lying	Pedometer in a horizontal position >50 s.
Walking	at least 3 consecutive strides in the same direction (forward or backward). The period between 2 strides must not exceed 4 s. Walking bouts are rated as separate if the time between 2 strides exceeds 10 s
Ingestive Behaviour	
Eating	Feeding time with head position down and up > 30 jaw movements/min, unsteady frequency
Rumination	> 30 jaw movements/min, min. 3 minutes duration, steady frequency

Experimental Design - Stable



- Swivel gate
- Gate
- Pasture gate
- Drinking trough
- Concentrate station
- Cubicle
- Utility room
- L Data logger

Experimental Design - Pastures



- **Drinking trough**
- **Pasture entrance**
- **Weather station**
- **Loose-housing barn**
- **Milking parlour**

Pasture use 2016

- **P1**: W0, W1, W2
- **P2**: W4, W1+2, W3
- **P3**: W4, W1+2, W3

Heat stress indices – **T**emperature **H**umidity **I**ndex & **H**eat **L**oad **I**ndex

RH (%) / T (°C)	40	50	60	70	80	90
0	41	39	38	36	35	33
4	45	44	43	42	41	40
8	50	50	49	48	48	47
12	55	55	55	54	54	54
16	60	60	60	60	60	61
20	65	65	66	66	67	67
24	70	70	71	72	73	74
28	74	76	77	78	80	81
32	79	81	83	84	86	88

No stress
Mild stress
Moderate stress
Severe stress

THI = (1.8*Temperature (T)+32)-(0.55-0.0055*Relative Humidity (RH)*(1.8*T-26)

(National Research Council 1971)

HLI values

<70.0 thermoneutral conditions
70.1 – 77.0 warm conditions
77.1 – 86.0 hot conditions
>86.0 very hot conditions

HLITemp > 25°C = 8.62+0.38*RH+(1.55*Black Globe Temperature (TBG)+EXP(-Windspeed (WS)+2.4)-0.5*WS;
HLITemp < 25°C = 10.66+0.28*RL+(1.3*TBG-WS)

(Petrov et al. 2003)

Temperature Humitidy Index & Heat Load Index of all seasons (means, min, max, std. dev.)

Parameter	Beginning	Mid	End
THI_ID	64.6 ± 5.7	66.1 ± 4.8	64.5 ± 6.2
min	*50.3*	*53.7*	*49.3*
max	*78.7*	*78.7*	*79.9*
THI_OD	62.1 ± 6.1	64.5 ± 4.7	63.1 ± 6.6
min	*48.7*	*52.3*	*46.9*
max	*76.3*	*76.0*	*80.1*
HLI_OD	50.9 ± 8.5	47.5 ± 9.5	50.3 ± 7.4
min	*32.2*	*23.5*	*35.7*
max	*75.1*	*77.9*	*74.7*

Temperature **H**umitidy **I**ndex & **H**eat **L**oad **I**ndex depending on place and free choice time

(means & std. deviation)

		☀ Free choice time day (5 h)		☾ Free choice time night (8 h)	
		THI	**HLI**	**THI**	**HLI**
Indoor (ID)	**Beginning**	66.7 ± 5.0	-	61.1 ± 4.4	-
	Mid	68.2 ± 4.7	-	63.7 ± 4.5	-
	End	69.3 ± 4.8	-	60.8 ± 4.3	-
Outdoor (OD)	**Beginning**	65.7 ± 5.0	53.2 ± 9.1	59.5 ± 5.2	49.0 ± 6.0
	Mid	67.1 ± 2.9	45.3 ± 11.0	61.1 ± 3.9	48.7 ± 5.8
	End	67.2 ± 4.5	51.1 ± 9.9	60.1 ± 5.0	49.0 ± 4.0

Time lying (min/h), walking^{T} and ruminating^{T} depending on daytime and place over the season

(LS means)

		☀ Free choice time day (5 h)			☾ Free choice time night (8 h)		
		Lying	Walking^{T}	Ruminate^{T}	Lying	Walking^{T}	Ruminate^{T}
Indoor	Beginning	34.6	14.3	35.1	31.7	9.5	48.2
	Mid	33.6	12.8	39.2	37.7	6.4	47.5
	End	28.1	16.6	30.5	33.9	8.4	45
Outdoor	Beginning	18.9	14.9	29.3	23.7	14.0	41.4
	Mid	20.6	12.6	29.8	28.1	11.4	39.9
	End	23.8	11.5	30.6	34.5	9.0	45.9

Subscript letters depict significances between periods within locations, $p < 0.05$

Claw health parameters

(n=36)

	Pre Grazing Period	Post Grazing Period
% healthy cows	48 %	70 %
Claw diseases (% of all prevalent diseases)	1. Laminitis (50 %) 2. WLF (11 %) 3. DD (11 %)	1. Laminitis (47 %) 2. DD (17 %) 3. WLF (13 %)

Mean milk yield and body weight

(n=12)

Parameter	Beginning	Mid	End
Daily milk yield (kg)	36.2 ± 5.2	32.4 ± 5.3	24.3 ± 5.5
Weight (kg)	613.7 ± 39.3	624.3 ± 38.5	628.1 ± 35.2
Body **C**ondition **S**core	-	2,7 ± 0,4	2,7 ± 0,3
Lamenes**s**score	-	2,3 ± 1,4	2,4 ± 1,4