



University of Natural Resources
and Life Sciences, Vienna



**FORUM
MORGEN**



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Einsatz von Sensortechnologien in Rinderbeständen

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Dissertationsprojekt



„Sensor-basiertes Monitoring der Weidehaltung von Milchkühen“

Validierung

- Hobo Logger
 - Stehen/Liegen
- Smartbow System
 - Wiederkauen
 - Stehen/Liegen
- RumiWatch System
 - Wiederkauen
 - Stehen/Liegen

Validierung – Ergebnisse

➤ Übereinstimmung zwischen visueller Beobachtung und Sensordaten

Verhalten	WIEDERKAUEN		LIEGEN	
	Smartbow	Smartbow	Hobo	Hobo
Sensitivität	0.84	0.40	0.96	0.96
Spezifität	0.99	0.99	0.99	0.99
Spearman's r	0.86	0.55	0.95	0.95
CCC	0.85	0.48	0.95	0.95

Smartbow

- Performance im Stall
r > 0,99 (Reiter et al., 2018)

Hobo

- Performance im Stall
➤ **Se = 99,7 %; Sp = 99,9 %**
(Ledgerwood et al., 2010)

Stall vs. Weide – Weideversuch #1

- 10 laktierende Kühe
- Weideaustrieb: stundenweise
- Referenzzeitraum Stallhaltung

- Sensordaten
 - Liegezeit: Hobo-Logger
 - Wiederkauzeit: Smartbow System
- Kotproben
 - Fäkale Cortisol-Metaboliten

Weideversuch #1 – Ergebnisse

➤ Tägliche Liege- und Wiederkauzeiten

	Referenz (Jun/Jul)	Weide (Jul)	Weide (Sep)
Liegen (min/Tag)	619 ± 99 ^a	548 ± 101 ^b	605 ± 97 ^a
Wiederkauen (min/Tag)	545 ± 64 ^a	494 ± 66 ^b	496 ± 72 ^b

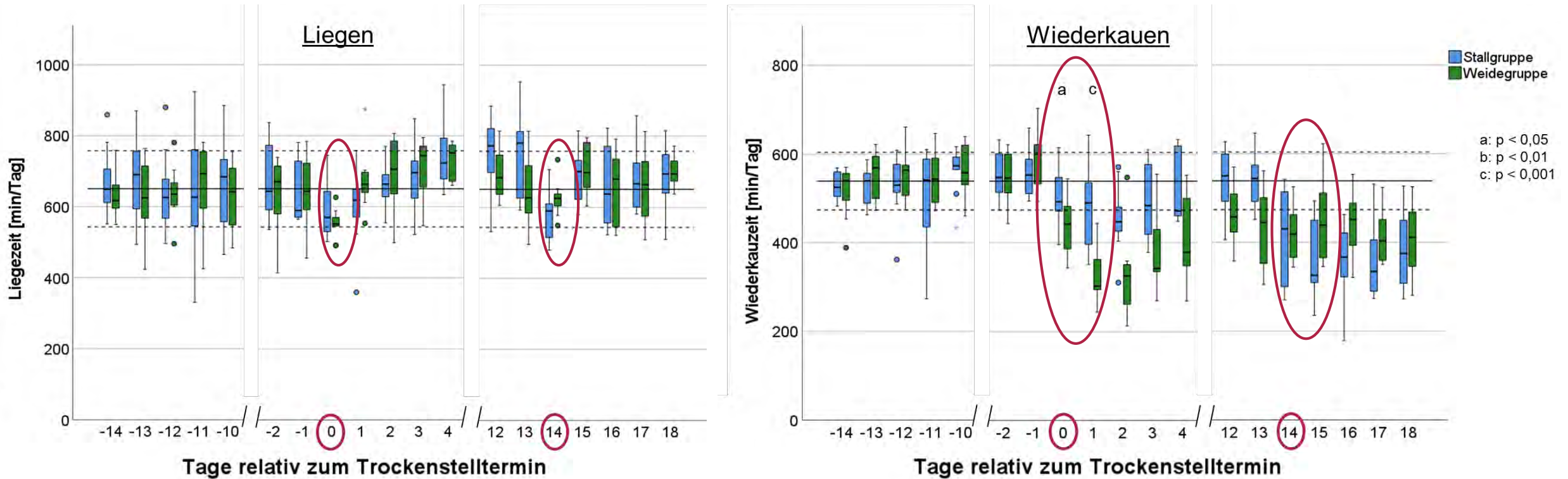
a,b p < 0.01

➤ Fäkale Cortisol Metaboliten: keine signifikanten Unterschiede

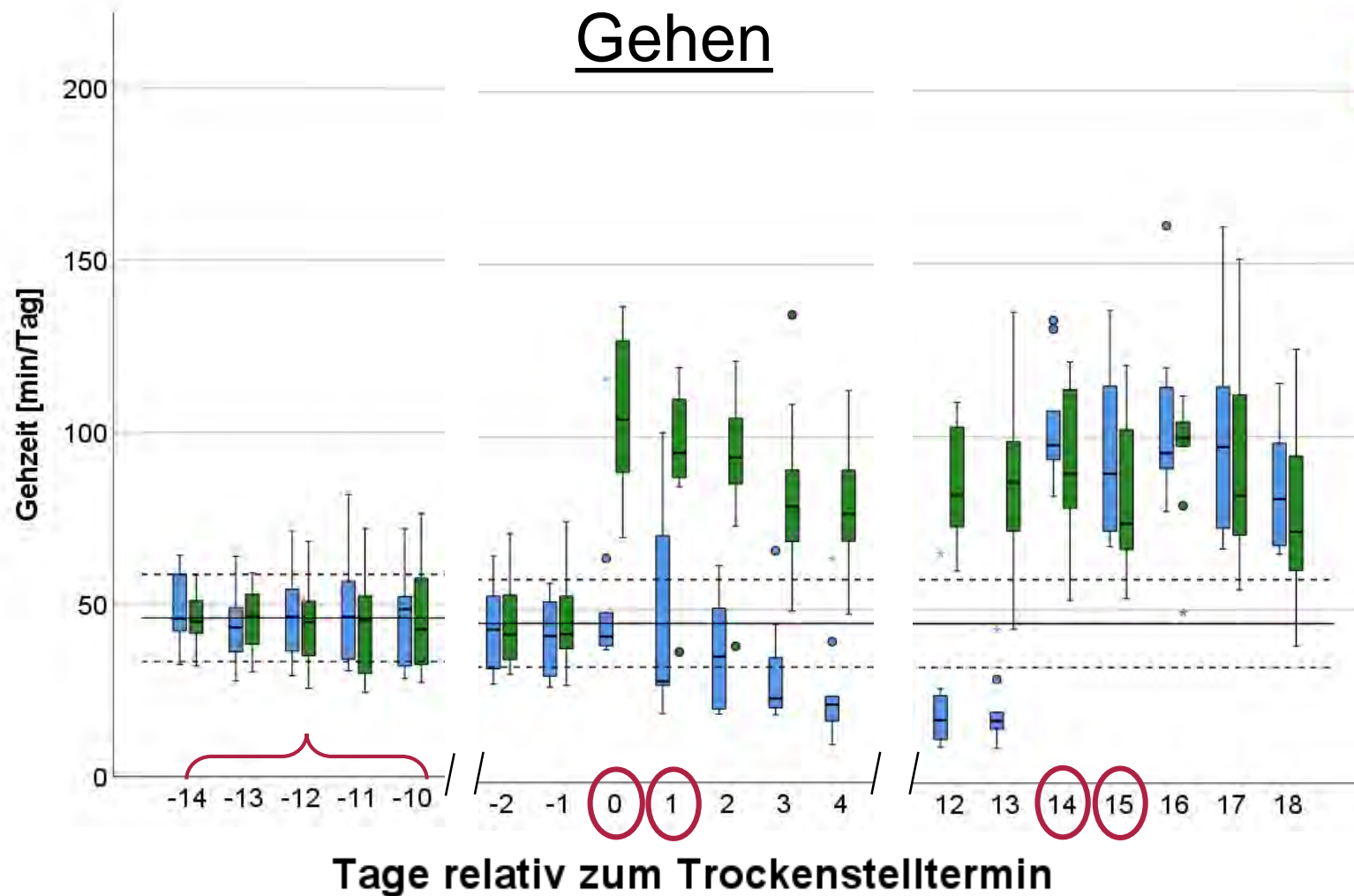
Stall vs. Weide – Weideversuch #2

- 20 Kühe, Trockenstellen
- Stall- und Weidegruppe (SG und WG)
- **Tag 0**
 - Trockenstellen SG und WG
 - Weideaustrieb WG
- **Tag 14**
 - Weideaustrieb SG
- Sensordaten – RumiWatch System
 - Wiederkauen, Liegen
 - Futteraufnahme, Gehen

Weideversuch #2 – Ergebnisse



Ergebnisse



Tag 0: Trockenstellen (SG + WG)
Weideaustrieb WG

Tag 14: Weideaustrieb SG

Neue Methode zur Anbringung von Hobo-Loggern



Konventionelle Methode mit Verbandsmaterial

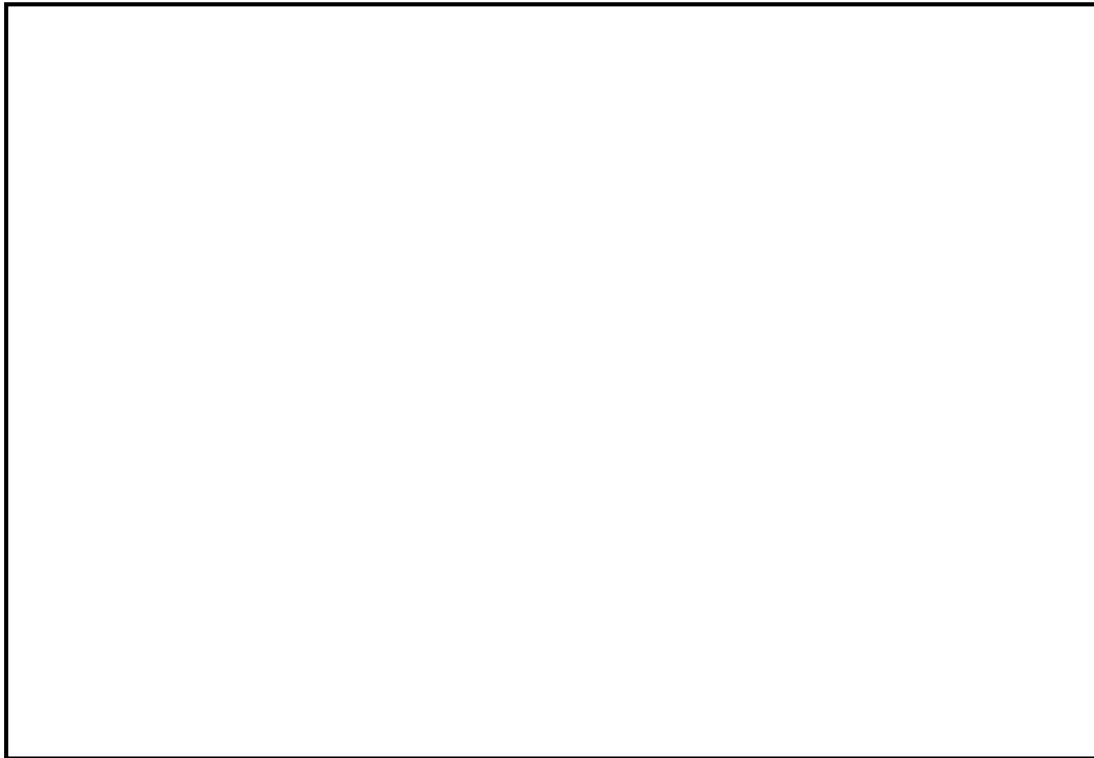
- Hoher Materialverbrauch!
- Neue Methode
 - wiederverwendbar
 - günstig
 - einfache Handhabung
 - stabile Position

Neue Methode zur Anbringung von Hobo-Loggern

Entwicklung einer neuen Methode

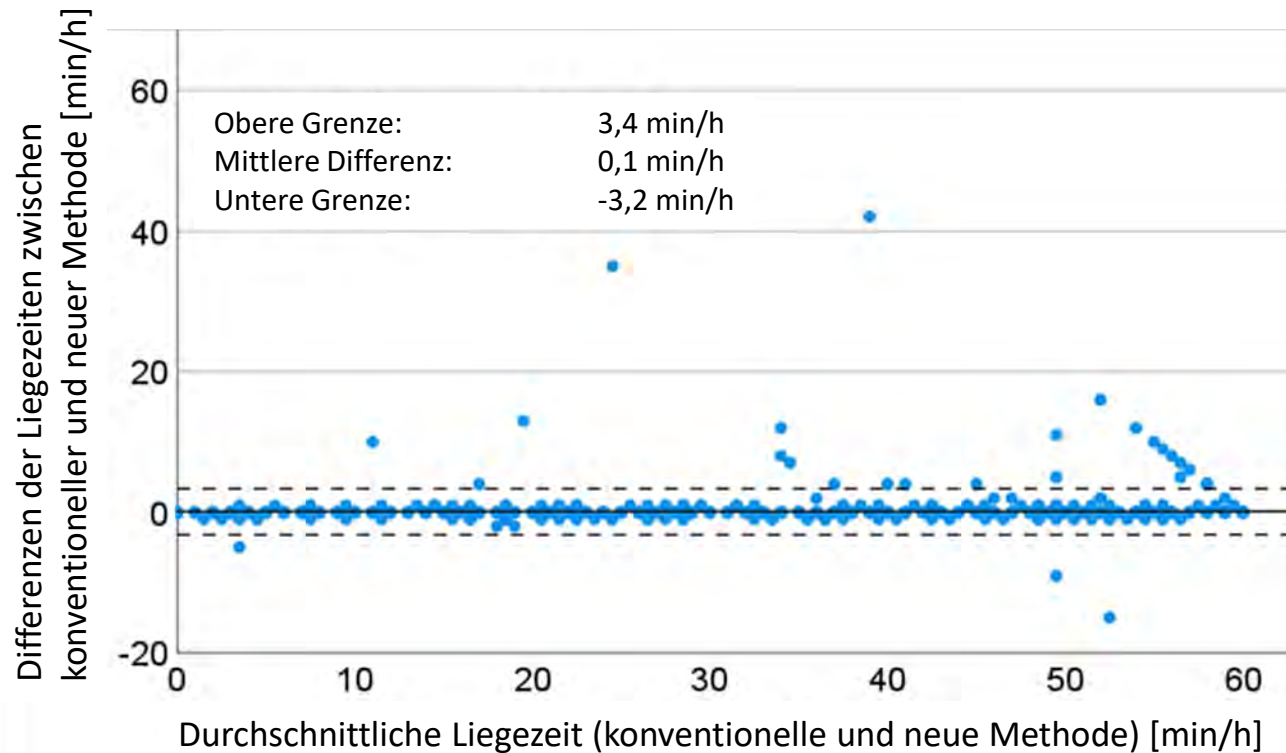
Validierung des finalen Prototyps

- 10 Kühe
- 7 Tage am Stück
- Tasche am linken Bein
- Verband am rechten Bein
- Direkter Vergleich der Daten



Hobo-Logger – Ergebnisse

Bland-Altman Diagramm: Neue vs. konventionelle Methode



Development and validation of a new method to attach Hobo loggers to cows' legs

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Introduction

- Continuous monitoring of behaviour
- insights into animal health and welfare
- Hobo loggers (HBL) used for research on lying behaviour
- attaching them to cows' legs using bandage material
- conventional method (Figure 1)
- Objective:** Development and validation of a new attachment method
 - reusable, cheap and easy to handle
 - robust and well tolerated by cows
 - ensure a stable position of the logger

Materials and Methods

1. Designing and sewing the prototype → 2. Testing the prototype and further development → 3. Validation against the conventional method

Original prototype: Bag with hook-and-loop closure fixed on a common arable strap. Adaptions and further development: 14 days in total (breaks for adjustments in between). Final version of the prototype: Left leg, Right leg. Conventional method: 7 consecutive days.

Results

Table 1: Test characteristics based on minute data (n = 215 516) from Hobo loggers attached with the new method against the conventional method.

Parameters	%
Sensitivity	99.4
Specificity	99.8
Positive predictive value	99.8
Accuracy	99.6

The comparison of hourly data (n = 1800 hours) is presented as a Bland-Altman plot in Figure 2.

Figure 2: Bland-Altman plot of hourly lying times. Differences between the new (NM) and the conventional (CM) method against their means.

Conclusion
These results show an almost perfect agreement between the two methods. Consequently, the new attachment method can be considered as suitable for research projects on lying behaviour using HBL. Especially in longitudinal studies, where HBL have to be removed and reattached repeatedly to the same cows, it can be beneficial and helpful to save resources. Therefore, this can be seen as a small contribution to more sustainability in research.

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ECPLF 2022, Wien

Evaluierung des Vienna Surface Testers (VST)

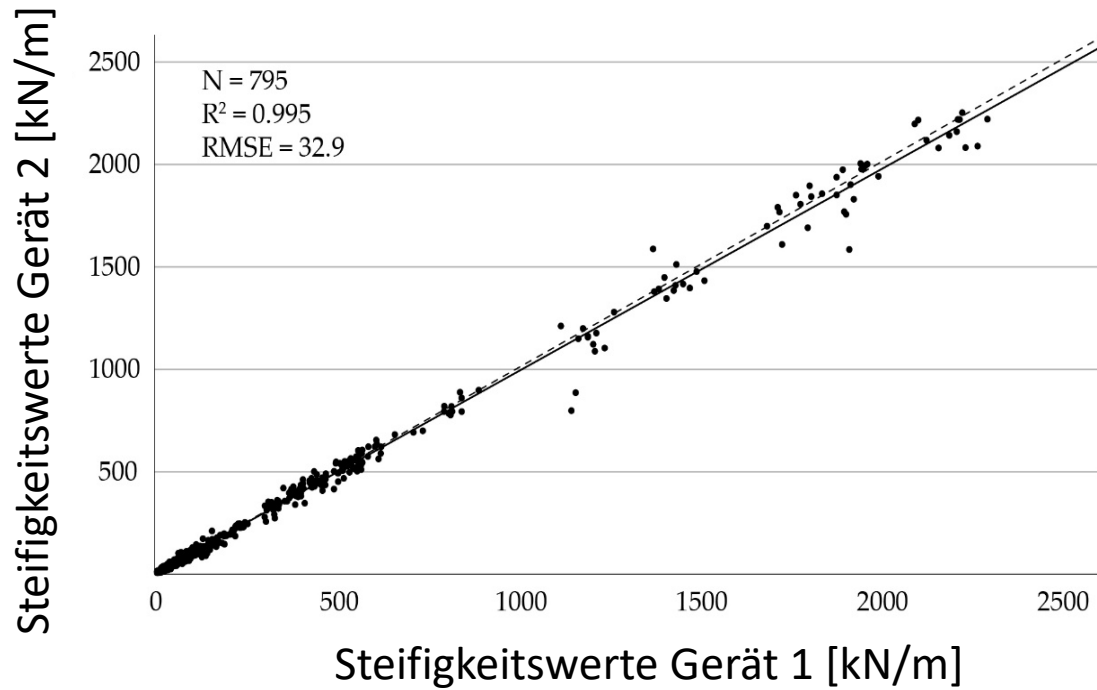


- Messung der elastischen Bodeneigenschaften
- 2 Geräte
- 2 Personen
- verschiedene Einstreumaterialien bzw. Böden

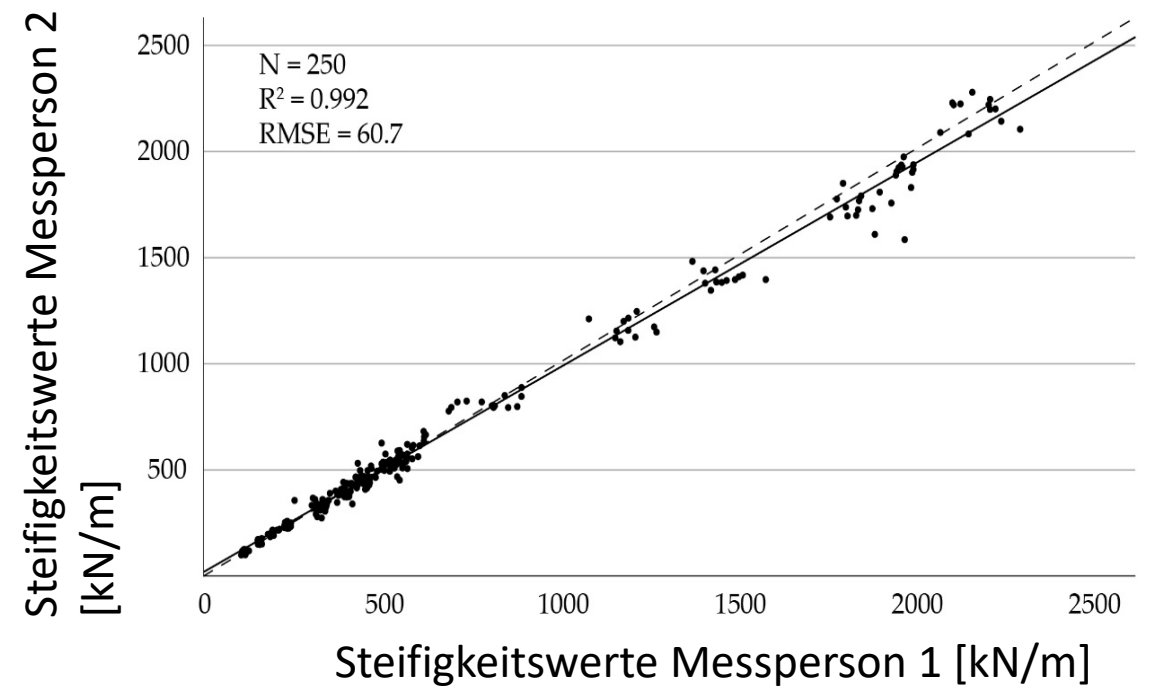
VST – Ergebnisse

➤ Übereinstimmung

Geräte



Messpersonen



VST – Ergebnisse

Steifigkeitswerte verschiedener Böden

Einstreumaterial	MW ± SD [kN/m]	R ²
Weideboden	252.3 ± 46.0 ^a	0.5
Rindenmulch	106.4 ± 13.6 ^b	0.7
Pferdemist	57.7 ± 9.7 ^c	0.3
Separierte Gülle	36.7 ± 2.6 ^{c,d}	0.4
Sand	21.8 ± 5.4 ^d	0.1
Sägespäne	12.6 ± 0.7 ^d	0.7

Sensor-based comparison of bedding materials for cattle

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Introduction

- Resting and rumination are high priority behaviors for dairy cows
- Quality of cubicles can influence the lying time of cows
- Objective: Comparing different bedding materials using an electronic device for assessing mechanical properties of floors

Materials & Methods

Bedding materials

- Pasture
- Dark mulch
- Horse manure
- Recycled manure solid
- Sand
- Sawdust




Figure 1: Test cubicle filled with different materials about 20 cm high. (a) Sand, (b) Horse manure, (c) Bark mulch




Figure 2: One drop of the Vienna Surface Tester (VST) from a particular height creates the stiffness value for that specific spot

→ 12 repeated measurements (each 14 drops) per bedding material

Results

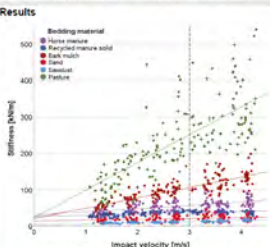


Figure 3: Stiffness of bedding materials across impact velocity

Figure 3 shows the stiffness values across the different impact velocities and the linear regression line for each bedding material, respectively. The dashed line at an impact velocity of 3 m/s indicates at which level the bedding materials were compared to each other (Table 1).

Bedding material	Mean ± SD [N/m]	R ²
Pasture	252.3 ± 46.0 ^a	0.5
Dark mulch	106.4 ± 13.6 ^b	0.7
Horse manure	57.7 ± 9.7 ^c	0.3
Recycled manure solid	36.7 ± 2.6 ^{c,d}	0.4
Sand	21.8 ± 5.4 ^d	0.1
Sawdust	12.6 ± 0.7 ^d	0.7

Conclusion

- Differences in the stiffness of bedding materials for cattle can be measured objectively by using the Vienna Surface Tester
- Sawdust was the softest material, followed by sand and recycled manure solid
- All tested materials were softer than the ground on pasture
- Further studies: Changes of mechanical properties over time and their influence on lying times under practical conditions

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Zusammenfassung

- Valide und verlässliche Systeme
 - Voraussetzung für Sensor-basiertes Monitoring
- Unterschiede zwischen Stall- und Weidehaltung darstellbar
- Managementmaßnahmen anhand von Sensordaten nachvollziehbar

- Neue Methode geeignet zur Anbringung von Hobo-Loggern an Kühen
- Vienna Surface Tester: objektive Einschätzung von Einstreumaterialien

Vielen Dank!



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