Federal University of Paraná
Palotina – PR – Brazil

Embrapa Dairy Cattle

Validation of sensor on rumination and feeding behavior of dairy heifers in two feedlot systems

R.D. Kliemann, E.M. Nascimento, S.R. Fernandes, M.M. Campos, T.R. Tomich, L.G.R. Pereira, Américo F. Garcez Neto

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Introduction

Agricultural Revolution

20s: Mechanized agriculture

60s: Green revolution

80s**:** **Precision Farming……….!**

Introduction

Agricultural Revolutions

20s: Mechanized agriculture

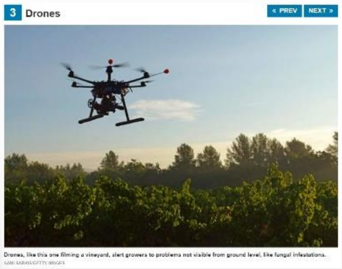
60s: Green revolution

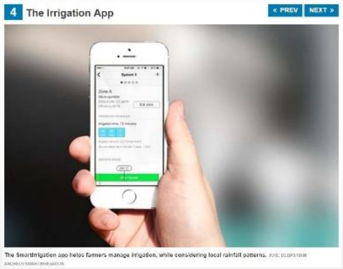
80s: Precision Farming………!

Precision Livestock Farming (PLF)

Introduction

- 10 High-tech Tools on the Typical Farm





https://electronics.howstuffworks.com/everyday-tech/10-high-tech-tools-farm.htm

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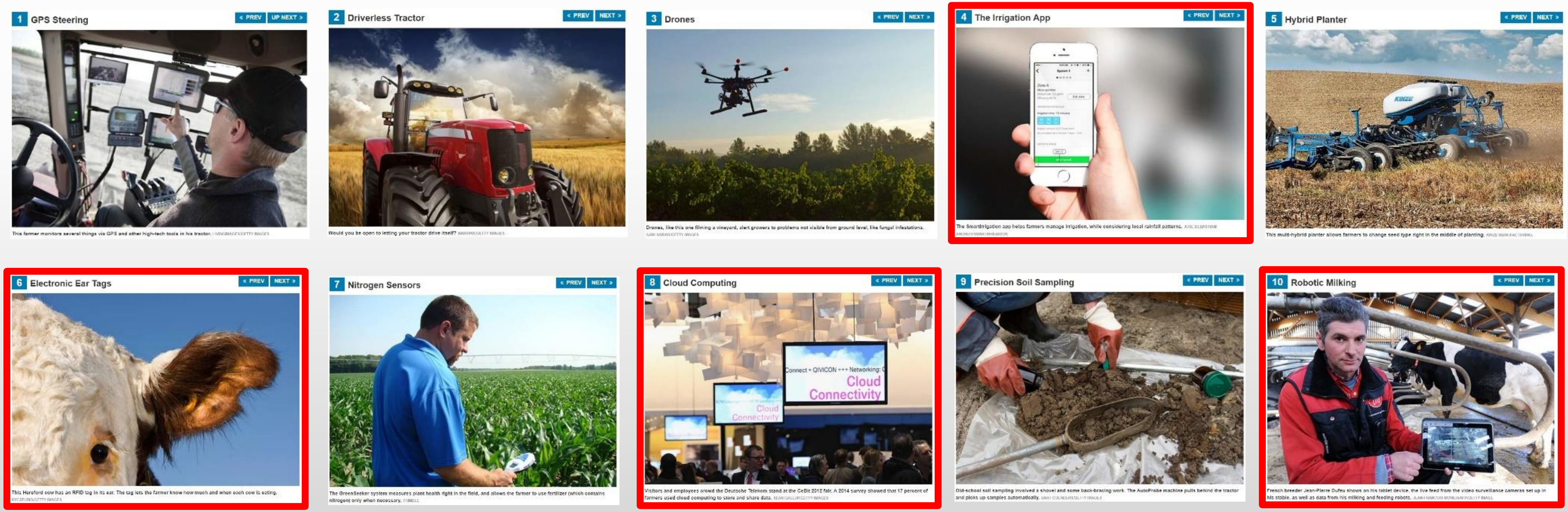

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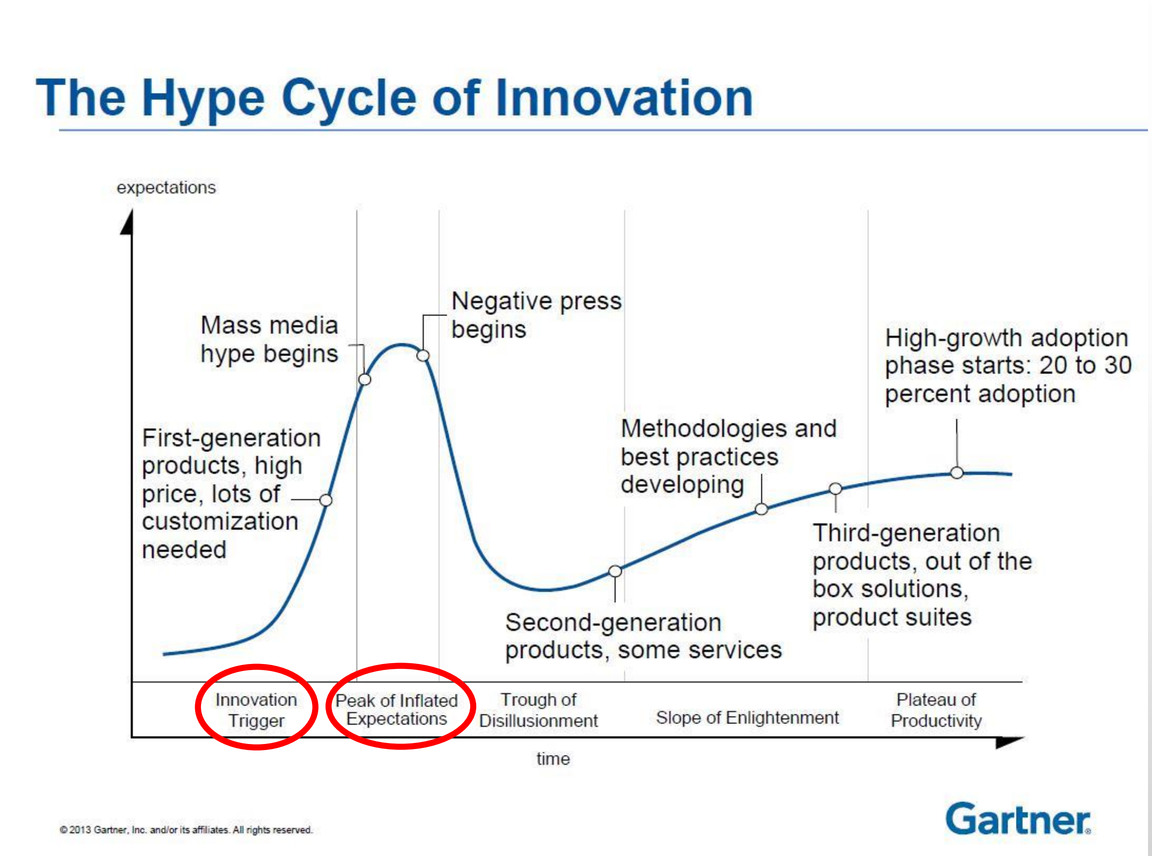

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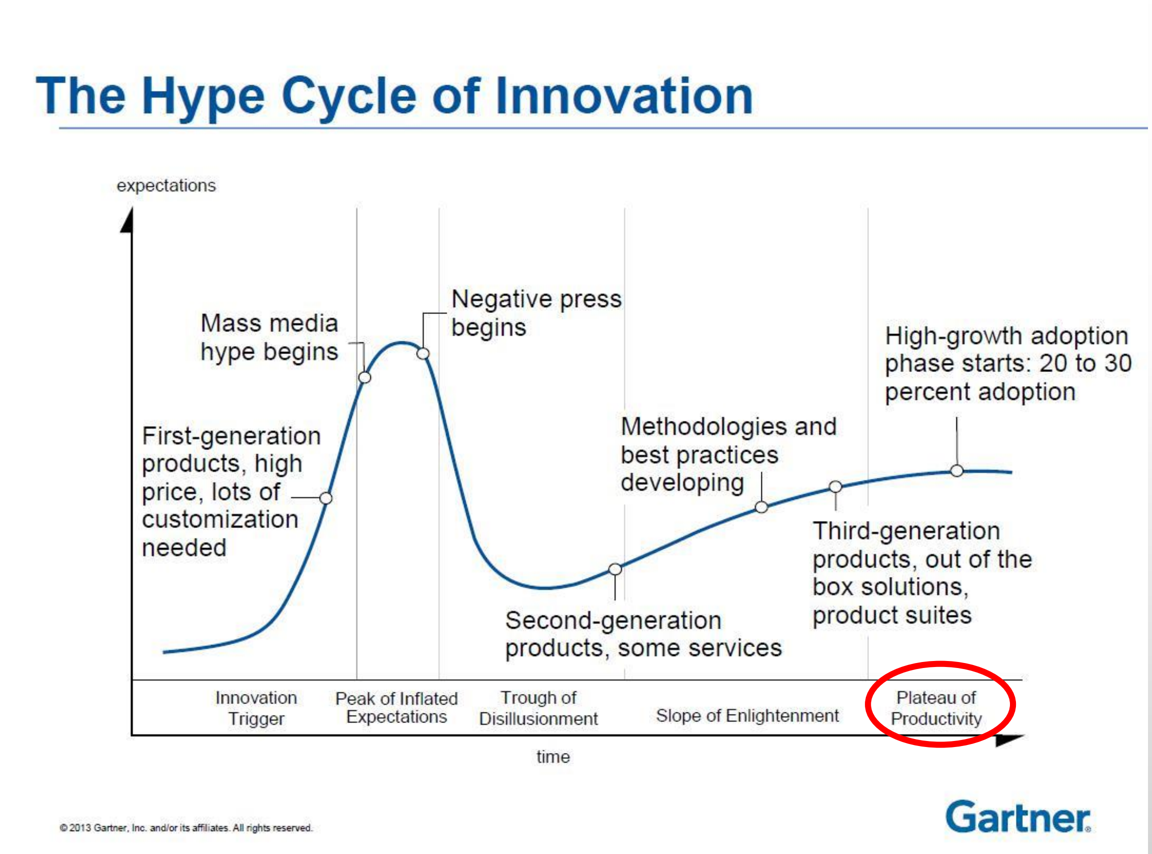

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Introduction

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World Development Vol. 87, pp. 16–29, 2016

http://dx.doi.org/10.1016/j.worlddev.2015.10.041

The Number, Size, and Distribution of Farms, Smallholder Farms, and Family Farms Worldwide☆

SARAH K. LOWDER, JAKOB SKOET and TERRI RANEY*

Food and Agriculture Organization of the United Nations, Rome, Italy

Table 3. *Number of countries exhibiting a decrease or increase in the average size of agricultural holdings, 1960–2000*

	Decrease	Increase	Neither clear increase nor decrease
High-income countries	7	26	4
Low- and middle-income countries, by income group			
Low-income countries	12	2	1
Lower-middle-income countries	24	2	0
Upper-middle-income countries	19	5	1
Low- and middle-income countries, by regional grouping			
East Asia and the Pacific	8	2	0
Latin America and the Caribbean	18	7	2
Middle East and North Africa	10	0	0
South Asia	5	0	0
Sub-Saharan Africa	15	3	1

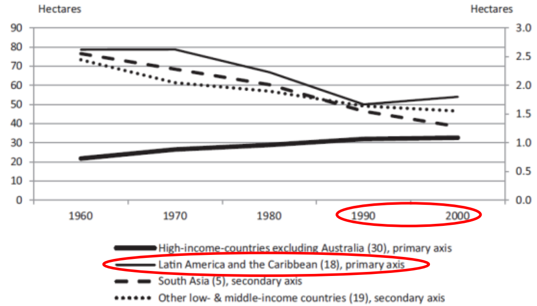

Figure 2. *Average farm size, 1960–2000. Sources: Authors' calculations using (FAO, 2013) for average farm size together with the most recent observation for the number of farms. See Web Appendix Table 2. Notes: Total country coverage is indicated in parentheses.*

Introduction

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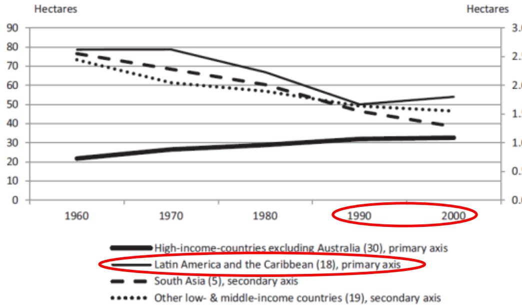

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FAO

http://www.fao.org/faostat/en/#data

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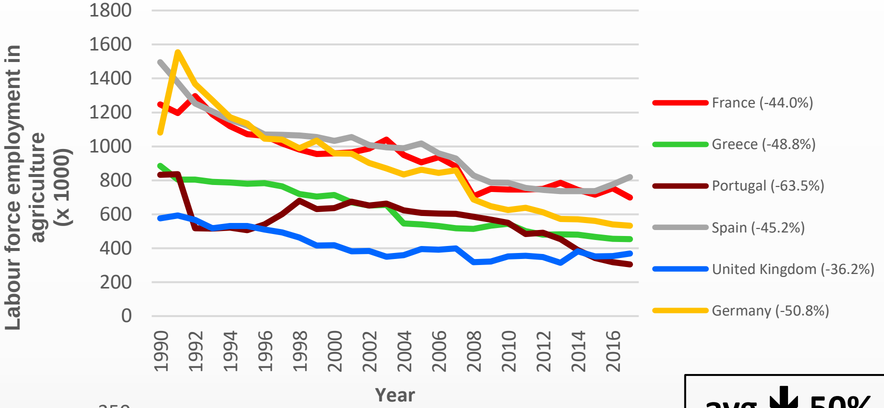
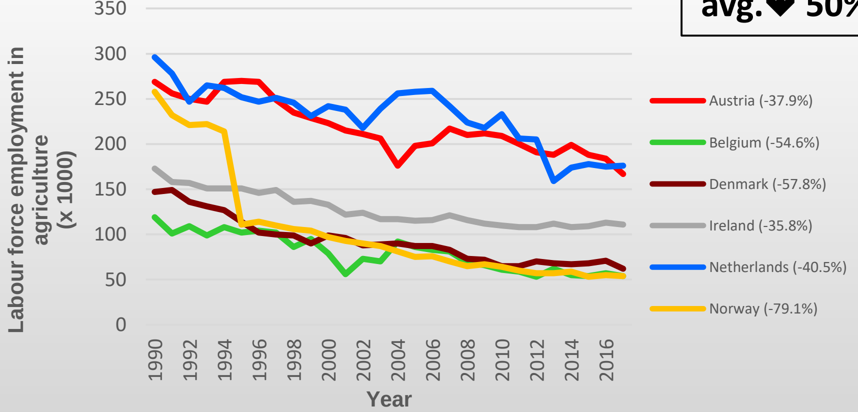


avg. ↓ 50%



Introduction

- **Intensive Management**
  - Grazing
  - Feedlot

+ Efficiency

Introduction

- **Intensive Management**
  - Grazing
  - Feedlot

+ Efficiency

Feeding Behaviour !

(Daily Intake)

Intense feeding behavior results in maximum dry matter intake, optimal milk production and reproduction, and improved herd health (Grant and Albright, 1997)

Introduction

- **Intensive Management**
  - Grazing
  - Feedlot

Feeding Behaviour

- Bite mass
- Bite rate
- Eating time
- Ruminating time

Introduction

- **Intensive Management**
  - Grazing
  - Feedlot

Grazing / Feedlot — Feeding Behaviour — Bite mass; Bite rate; Feeding time; Ruminating time

Individual Parameters !

- **PLF Goals**

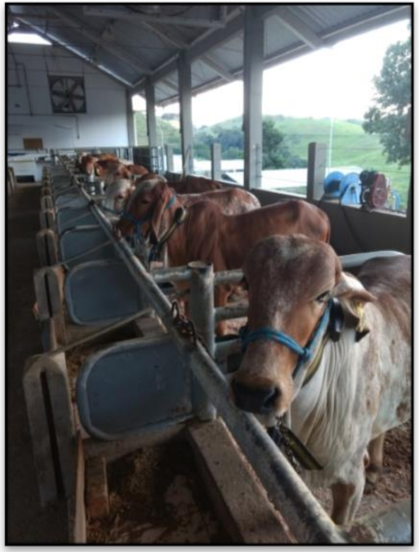
- **Herd to individual level**
- Trade-offs between **data acquisition at high frequency**, while preserving battery life and considering memory limits, **and output accuracy** obtained using adequate data treatment methods (Andriamandroso et at., 2016)

Aims

- **Validate a sensor developed to cows on rumination activity of dairy heifers at tie-stall and loose-housing facilities**

- **Evaluate the feeding behaviour of dairy heifers at tie-stall and loose-housing facilities**

Material and Methods



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Dairy Cattle

➢ Local of study

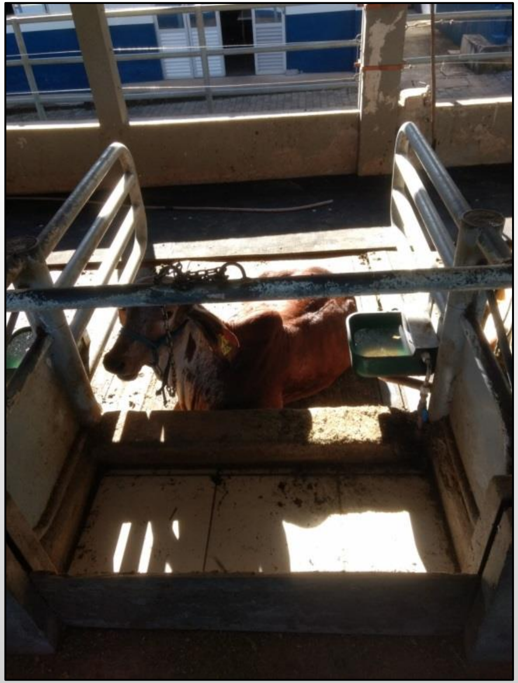
- Experimental station José Henrique Bruschi – EMBRAPA Dairy Cattle, Minas Gerais State, Brazil

➢ Animals

- 11 Gir Heifers
- Body Weight: 179 ± 26 kg
- Feeding Behaviour: 10 days (2x5)
- 8h per day (morning/afternoon)

Material and Methods

- **Local of study**
  - **Tie-Stall**



- Bed: 1.3 x 1.8 m
- Automatic drinker
- Trough: 1.3 x 0.6m
- Rubber floor

Material and Methods

- **Local of study**
  - **Loose-Housing**

- Paddock: 27 x 16 m
- Automatic feeder and drinker (Intergado ®) (Three units of 0.7 x 0.3 m)

Material and Methods

- **TMR:**
  - Maize silage (75% DM)
  - Concentrate (25% DM)
    - Corn grain, soybean meal and minerals
  - *Ad Libitum*

Material and Methods

- **Behaviour evaluation**
  - Two trained observers: Visual evaluation (3min/interval)
  - Collar sensor: Digital recorder (2h/interval)

Technology supported by Bioacoustic/Accelerometer

Material and Methods

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Dairy Cattle

➢ Animal evaluation

Validation

- **Rumination**

Feeding

- **Rumination** (Standing/Lying)
- **Rest** (Standing/Lying)
- **Intake**
- **Drinking**
- **Activity**

Material and Methods

➢ Crossover Design

- 11 Gir Heifers
- Two periods of five consecutive days
- 8h per day

➢ Analysis of Variance and Regression (Proc Mixed)

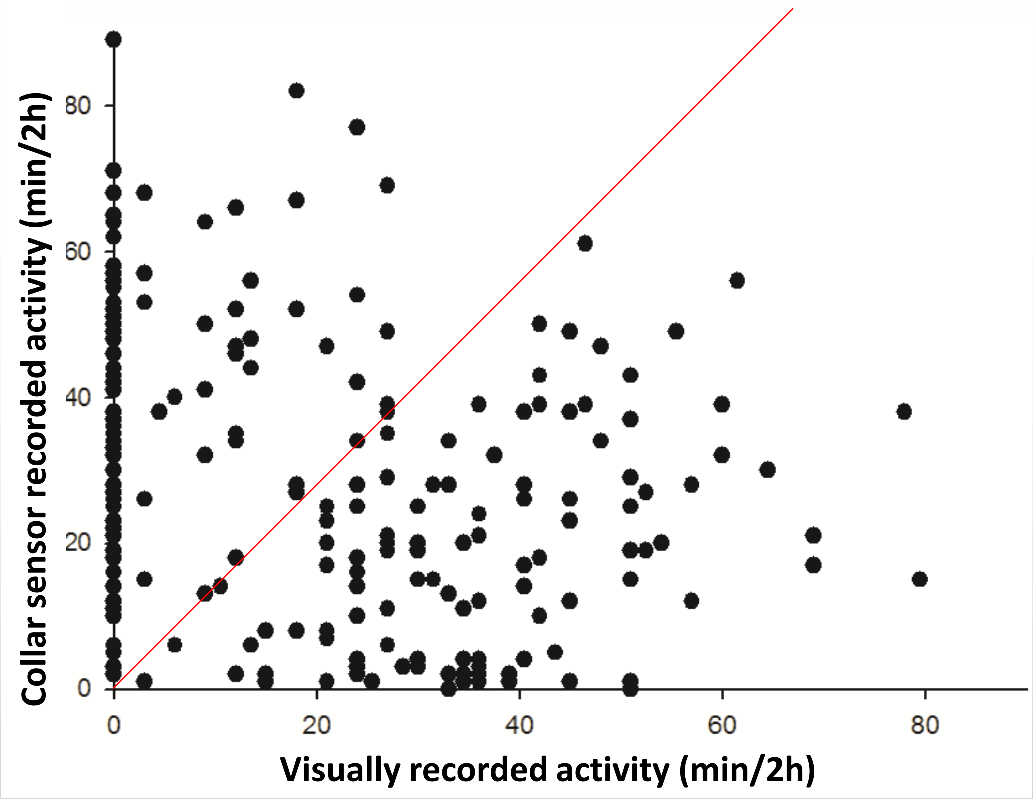
- Validation (Collar Sensor *vs.* Visual Observation)
- Comparison of Systems (Tie-Stall *vs.* Loose-Housing)

Results

Loose-Housing

Pearson

- P = 0.0002
- r = -0.25



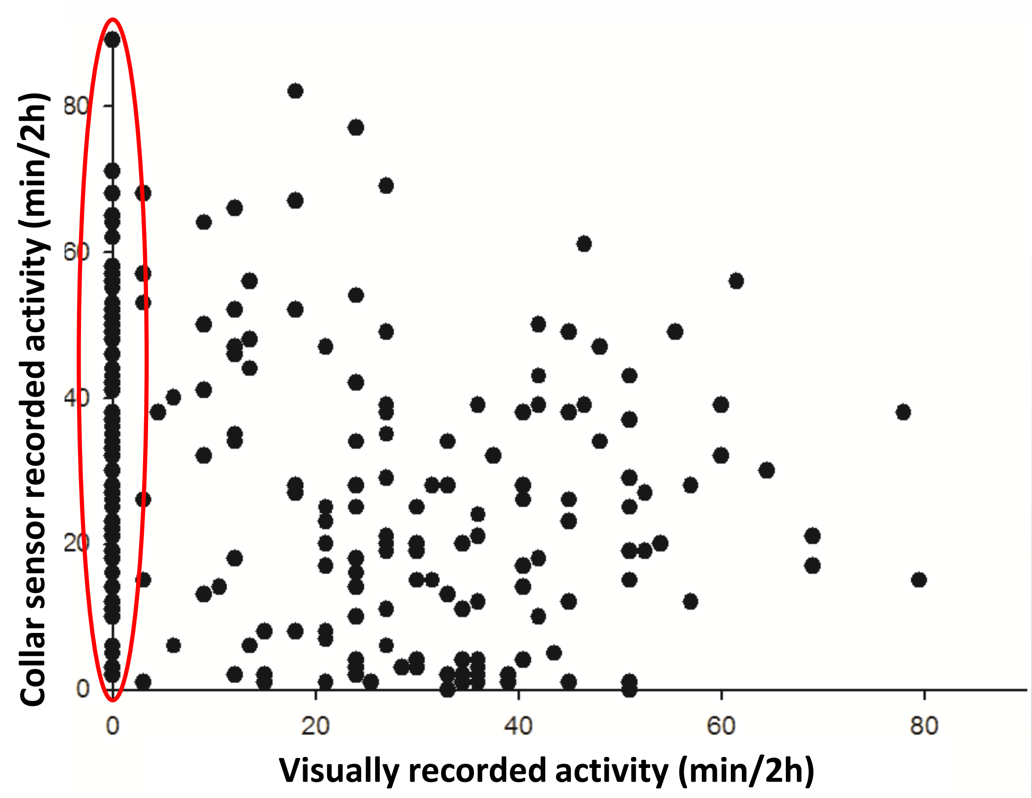
Results

Loose-Housing

Pearson

- P = 0.0002
- r = -0.25

- + 27.3%
- 28 *vs.* 22 min/2h



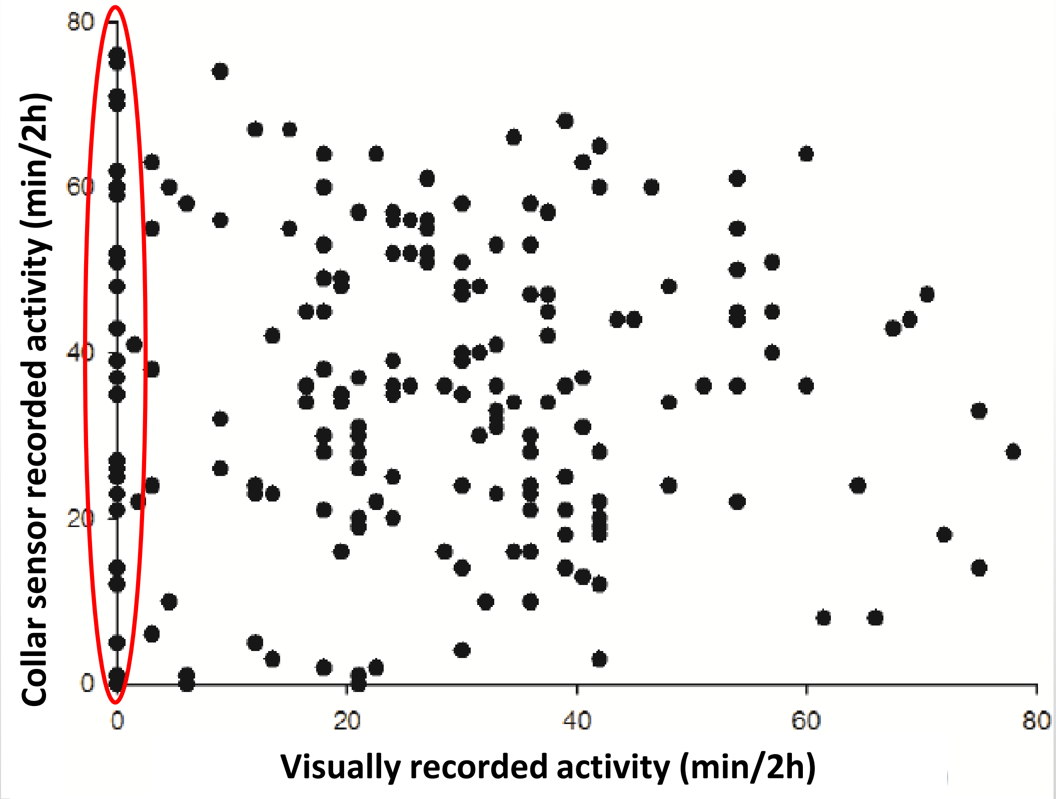
Results

Tie-Stall

Pearson

- P > 0.05

- + 38.5%
- 36 *vs*. 26 min/2h



Results

Goldhawk et al. (2013)

Beef
Heifers

Validation of rumination collars for beef cattle 2861

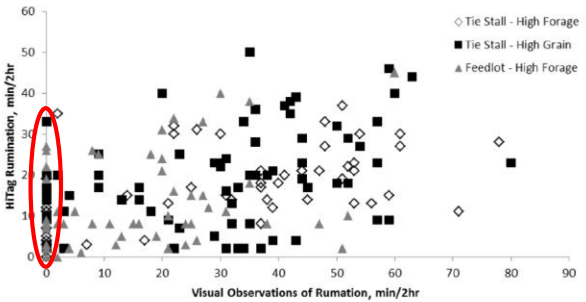


Figure 1. Number of minutes that beef cattle spent ruminating during a 2 h period estimated by visual observation vs. Hi-Tag rumination collars for tie-stall and feedlot housing and high forage and high grain diets.

Table 2. Pearson's correlation coefficient, concordance correlation coefficient, location, and scale shift between Hi-Tag[1] rumination collar and visual observations of rumination by beef cattle as affected by housing system and diet

Housing	Diet	r	P-value[2]	CCC[3]	P-value[4]	Location shift	Scale shift
Tie-stall	High forage	0.46	0.001	0.24 ± 0.07	0.001	1.02	2.35
	High grain	0.39	<0.001	0.29 ± 0.08	<0.001	0.67	1.63
Feedlot	High forage	0.08	0.595	0.07 ± 0.14	0.280	0.33	1.45
Overall		0.41	<0.001	0.30 ± 0.05	<0.001	0.65	1.82

[1]SCR Engineers Ltd., Netanya, Israel.
[2]P-value for Pearson's correlation coefficient.
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[4]P-value for concordance correlation coefficient.

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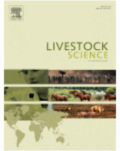

Rodrigues et al. (2019)

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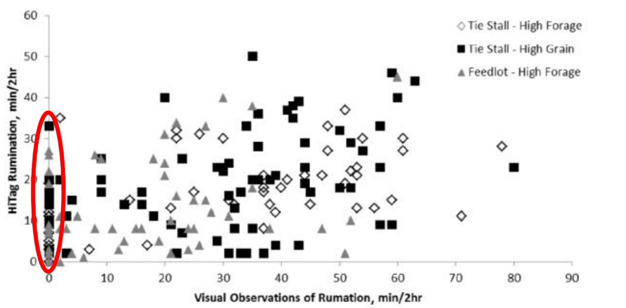

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Dairy
Calves

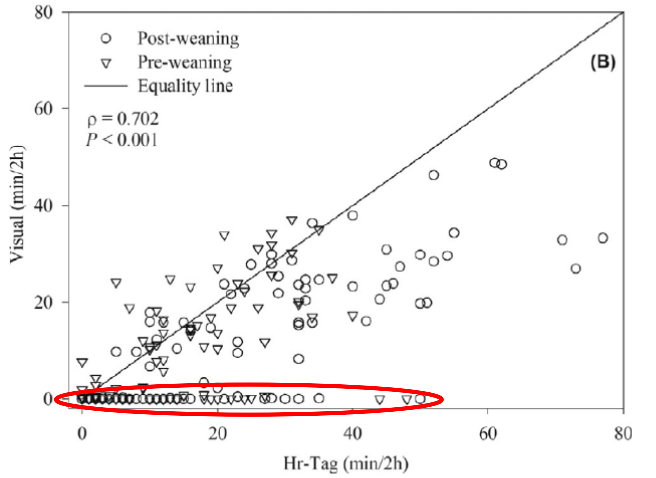
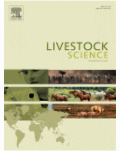


Fig. 1. Cumulative distribution analysis (A) and Spearman correlation (ρ) between rumination time obtained by visual observations or Hr-Tag system (B) in calves (n = 242).

then the pre-weaning period (P < 0.05; Fig. 3).

Results

Goldhawk et al. (2013)



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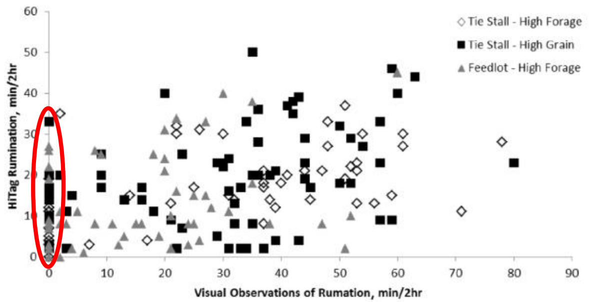

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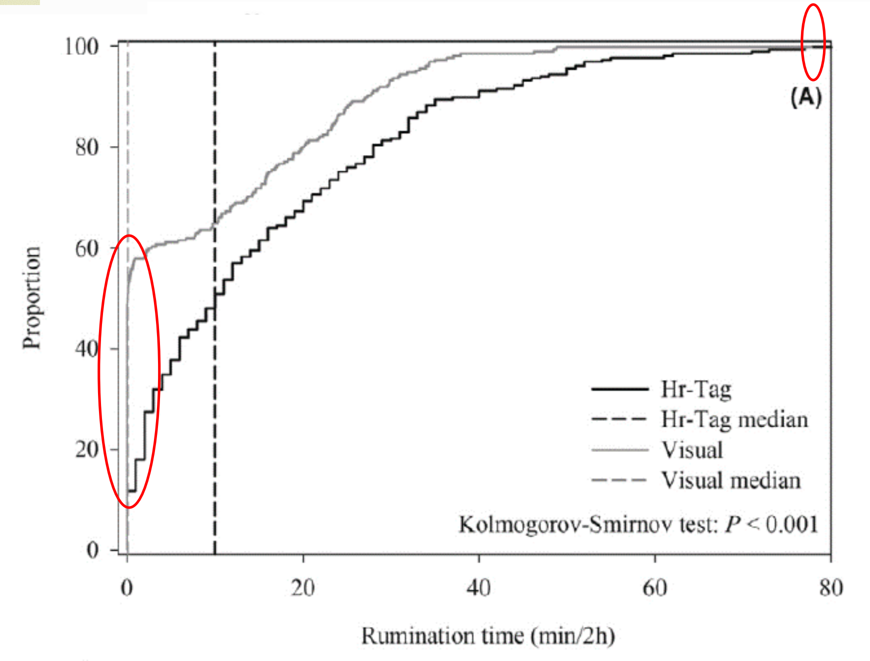

Results

Means of time on the behaviours between feedlot systems (*Tie-stall* and Loose-house) to 120min interval to data record from 8 to 12 am and 2 to 6 pm.

Parameter	Tie-stall (min)	Loose-house (min)	P Value
Activity	30 (13)	50 (20)	<0.0001
Rest$_S$	2 (2)	2 (2)	0.4413
Rest$_L$	19 (13)	15 (11)	0.0344
Rest$_T$	22 (12)	17 (11)	0.0426
Rumination$_S$	3 (3)	1 (2)	0.1112
Rumination$_L$	22 (15)	19 (14)	0.3424
Rumination$_T$	25 (14)	21 (14)	0.1392
Intake	41 (16)	29 (12)	<0.0001
Drink	1 (0)	1 (0)	0.4433

S: standing; L: lying; T: total; Standard deviation between brackets

OBS: Animals between systems presented the same level of intake (DM/day)($P>0.05$)

Results

Means of time on the behaviours between feedlot systems (Tie-stall and Loose-house) to 120min interval to data record from 8 to 12 am and 2 to 6 pm.

Time		am		pm	
Parameters (min)		**8 – 10**	**10 – 12**	**2 – 4**	**4 – 6**
Activity	Tie-stall	41 (8)	19 (7)	27 (10)	33 (14)
	Loose-house	46 (19)	36 (10)	46 (16) +43%	71 (16)
Rest$_S$	Tie-stall	4 (3)	1 (1)	1 (1)	2 (2)
	Loose-house	3 (2)	1 (0)	3 (3)	1 (2)
Rest$_L$	Tie-stall	6 (6)	31 (9)	20 (10)	20 (13)
	Loose-house	15 (8) +221%	30 (4)	11 (5)	3 (2)
Rumination$_S$	Tie-stall	6 (4)	3 (3)	1 (1)	1 (1)
	Loose-house	1 (1)	1 (0)	1 (2)	3 (4)
Rumination$_L$ +859%	Tie-stall	9 (8) +42%	42 (10)	18 (8)	18 (7)
	Loose-house	26 (15) +162%	29 (8)	20 (10)	1 (2)
Intake	Tie-stall	51 (12)	21 (7)	50 (13) +29%	43 (12)
	Loose-house	15 (7)	19 (6)	34 (10) +109%	37 (13)
Drink	Tie-stall	1 (1)	0 (0)	1 (1)	1 (0)
	Loose-house	1 (0)	0 (0)	1 (0)	0 (0)

S: standing; L: lying; Standard deviation between brackets.

Conclusion

Heifers can have the rumination overestimated from 27 to 38% with the collars. Collar sensors, based on bioacoustics/accelerometer, require more developments to have their use extended on dairy heifers to measure with high accuracy their rumination.

Tie-stall makes heifers spend less time in activities not related to feeding, allowing them make a better balance between their time to rest and use effectively more meals during the day.

Acknowledgments

CNPq

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Ciência Animal

P P G C A

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Federal University of Paraná

Embrapa

Dairy Cattle

GENFOR

Study Group on Ruminant Nutrition and Forage Crops

Federal University of Paraná

Thank you !

americo.garcez@ufpr.br

*Laboratory of Animal Nutrition - UF**PR***