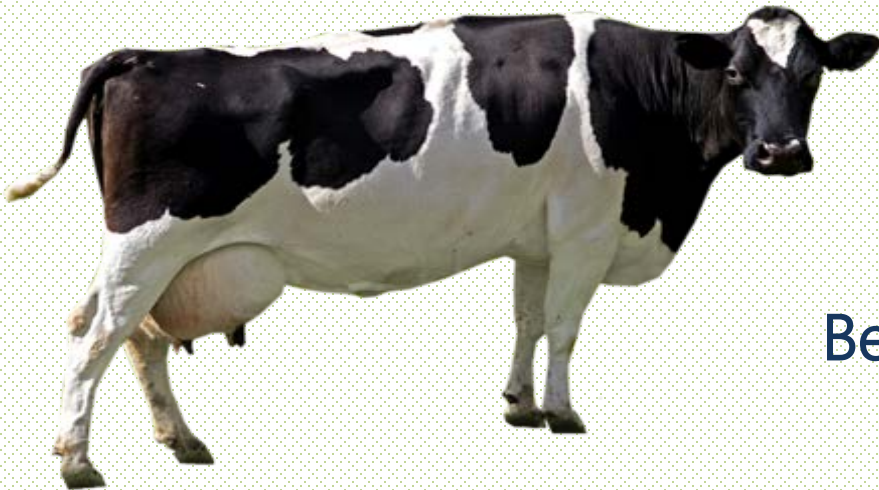


Individual Feed Intake Model of a Dairy Cow Based on Feeding Behavior

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Ben-Gurion University



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Data on dairy farms in Israel

The annual income of dairy industry is more than **2** billion euro

About 900 cooperative and family owned dairy farms

Almost 13,500 people work in the dairy industry

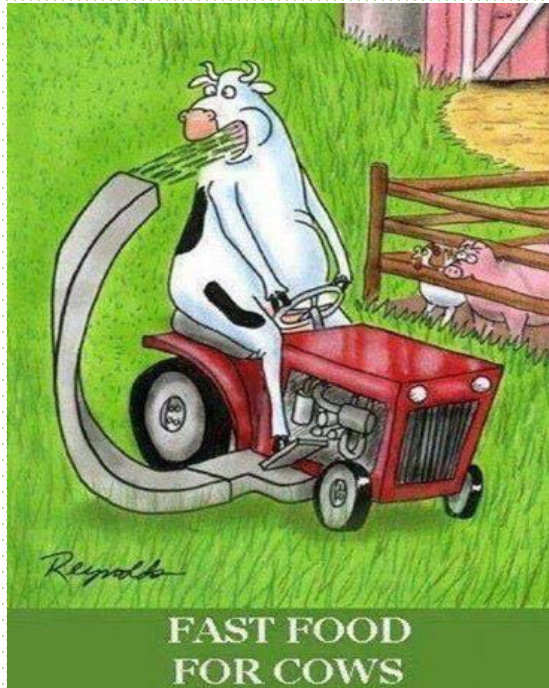
About **70%** of the expenses are on food for the cows



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The aim

To develop a feed intake model for the individual dairy cow using variables that are being measured in commercial farms



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Measured in commercial farms

- Body weight
- Activity
- Milk indicators
 - Milk yield
 - Milk components
 - Electrical conductivity
- Feeding behavior
 - Feeding time
 - Number of meals



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Dry Matter Intake (DMI) measured in research farms



ARO's research farm



A commercial farm

Individual DMI measurements are possible in tie-stall barns, small-scale operations, or research centers



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Motivation

- 1 Assess the cow individual feed efficiency
- 2 Breed improvement / Replacement policy
- 3 Detect health problems
- 4 Nutrition calculation



Referred DMI models

1 NRC Model (NRC 2001)

$$DMI_{NRC} = [(0.372 \times FCM) + (0.0968 \times BW^{0.75})] \times (1 - e^{-0.192 \times (wol + 3.67)})$$

2 2004 Model (Halachmi et al. 2004)

$$DMI (\%)_{0,i} = (b_{0,i} + b_{1,i} \frac{MY_0}{BW_0} + b_{2,i} \frac{MY_{-1}}{BW_{-1}} + b_{3,i} \frac{MY_{-2}}{BW_{-2}} + b_{4,i} BW_0 + b_{5,i} \frac{MY_{-1}}{BW_0} + b_{6,i} \text{fat} + e)$$

3 Covariate Model

4 Simple Linear Regression Model

$$5 \quad DMI = .008037 \times \text{kg BW} + .3134 \times \text{kg } 4\% \text{ FCM} + .2286 \times \text{DIM} - .002176 \times (\text{DIM})^2 + .00000705 \times (\text{DIM})^3$$

National Research Council (NRC), 2001. Nutrient Requirements of Dairy Cattle. 7th rev. ed. National Academy Press, Washington, DC.

Halachmi, I. et al., 2004. Predicting feed intake of the individual dairy cow. Journal of dairy science, 87(7).

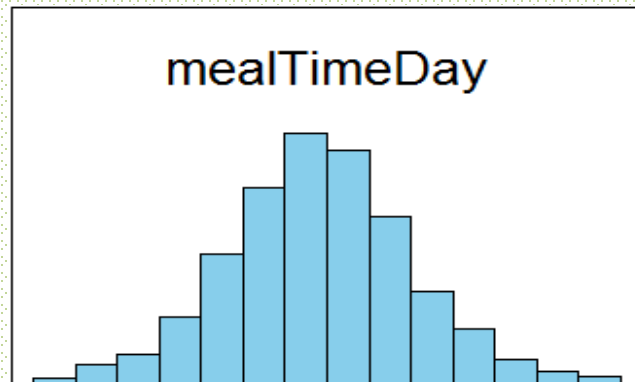
Halachmi, I. et al., 2015. Feeding behavior improves prediction of dairy cow voluntary feed intake but cannot serve as the sole indicator.

Referred DMI models results

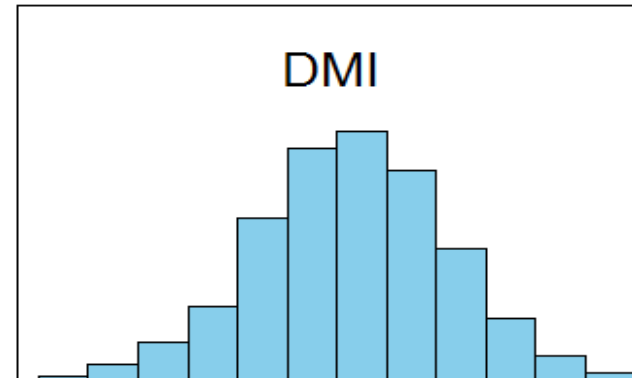
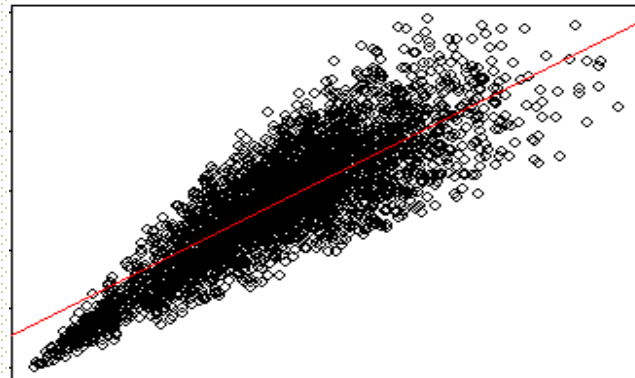
Model	R ²
1	0.79
2	0.73
3	0.64
4	0.36
5	0.65

The Data

- Dataset of 120 cows during 117 days
- Interesting findings:

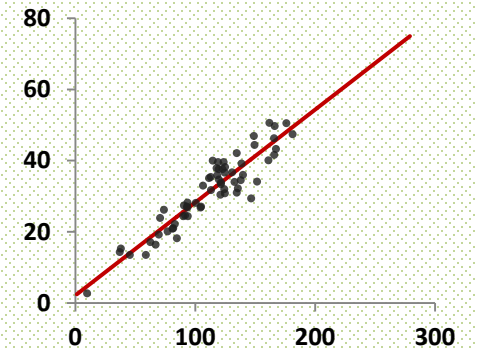
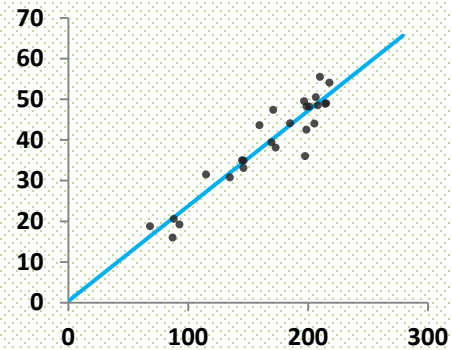
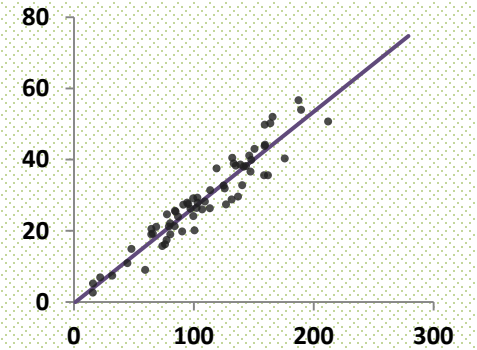
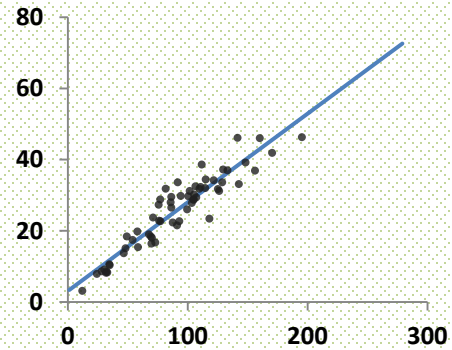
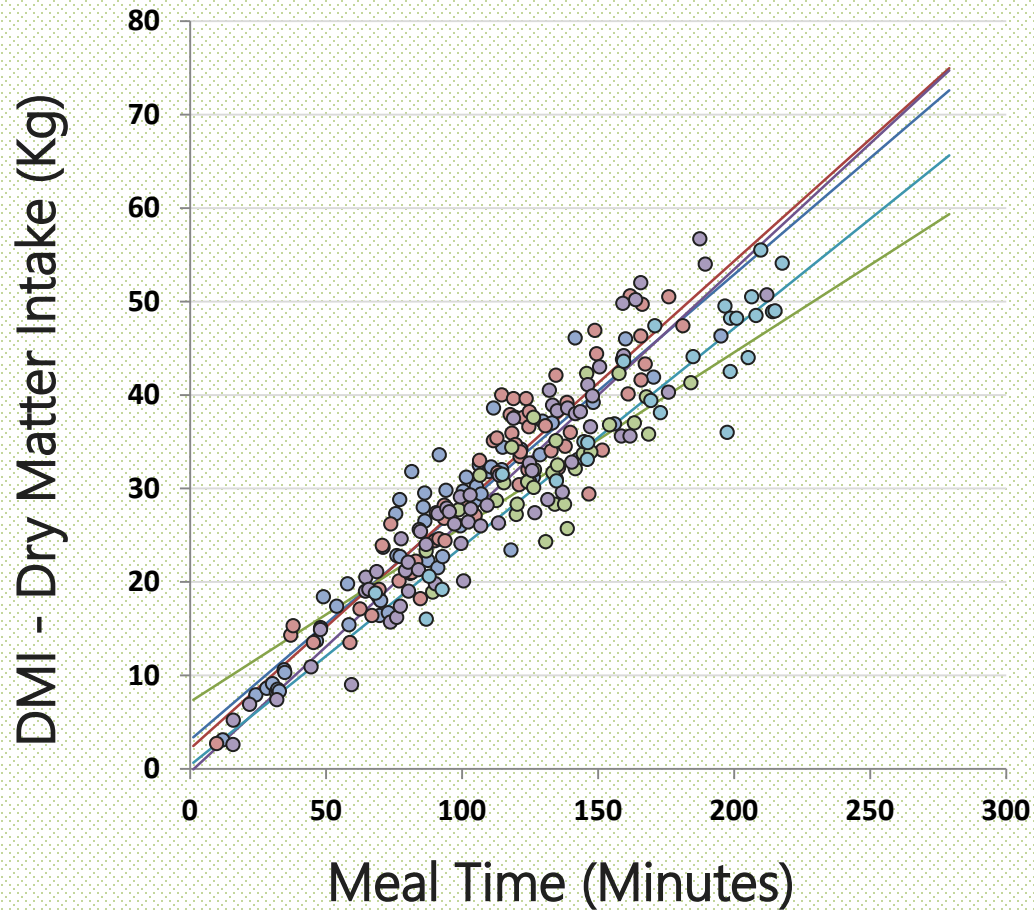


0.80



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The Data



The Model

Two DMI models were assessed: 'daily' and 'single meals'

$$\begin{aligned} Y = & (\beta_0 + \gamma_{0,k} + \delta_{0,j}) + (\beta_1 + \delta_{1,j}) \text{mealTime}_{i,j,k} \\ & + \beta_2 \text{numOfMeals}_{i,j,k} + (\beta_3 + \delta_{3,j}) \text{daysInMilking}_{i,j,k} \\ & + \beta_4 \text{fatPercent}_{i,j,k} + \beta_5 \text{proteinPercent}_{i,j,k} + \beta_6 \text{lactation}_{i,j,k} \\ & + \beta_7 \text{BW}_{i,j,k} + \beta_8 \text{activity}_{i,j,k} + \varepsilon_{i,j,k} \end{aligned}$$

Results: Model vs. Reality

R ²		
	Daily	Single Meal
Precision Livestock Farming (PLF)	0.93	0.88
Not PLF	0.74	0.78



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Conclusion

1. This feasibility study suggests that our model is accurate
2. When using our model attitude results with about 20% improvement



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Future plan



- Model validation (different cows\farms\countries)
- Model improvement – use of other sensors
- Applications
 - Economic decisions based on individual cows value
 - Control-charts and other modelling tools



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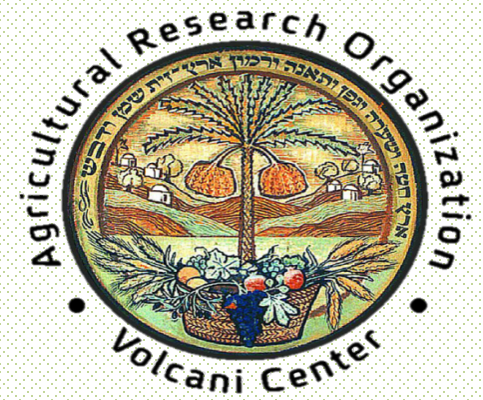
Thank you for listening!

Are there any questions?

E-mails for questions: ilanarichter@gmail.com
halachmi@volcani.agri.gov.il

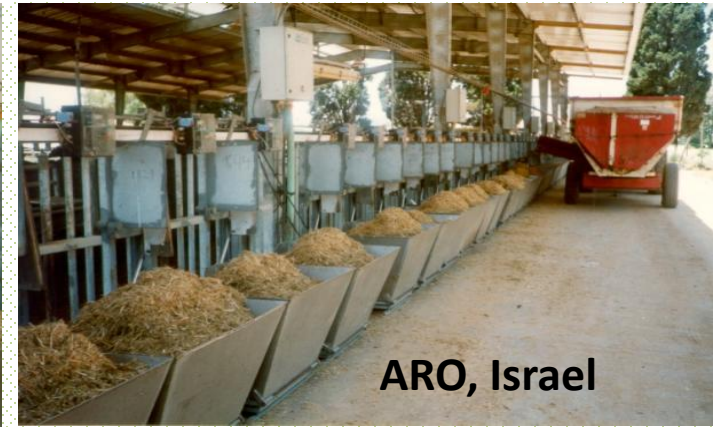


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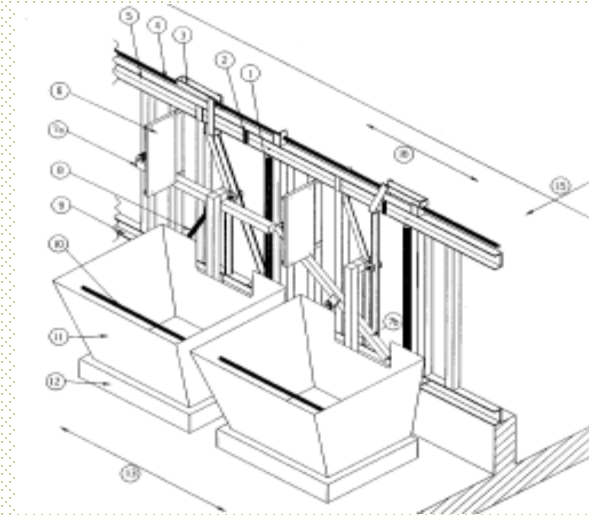


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Direct monitoring of feed intake



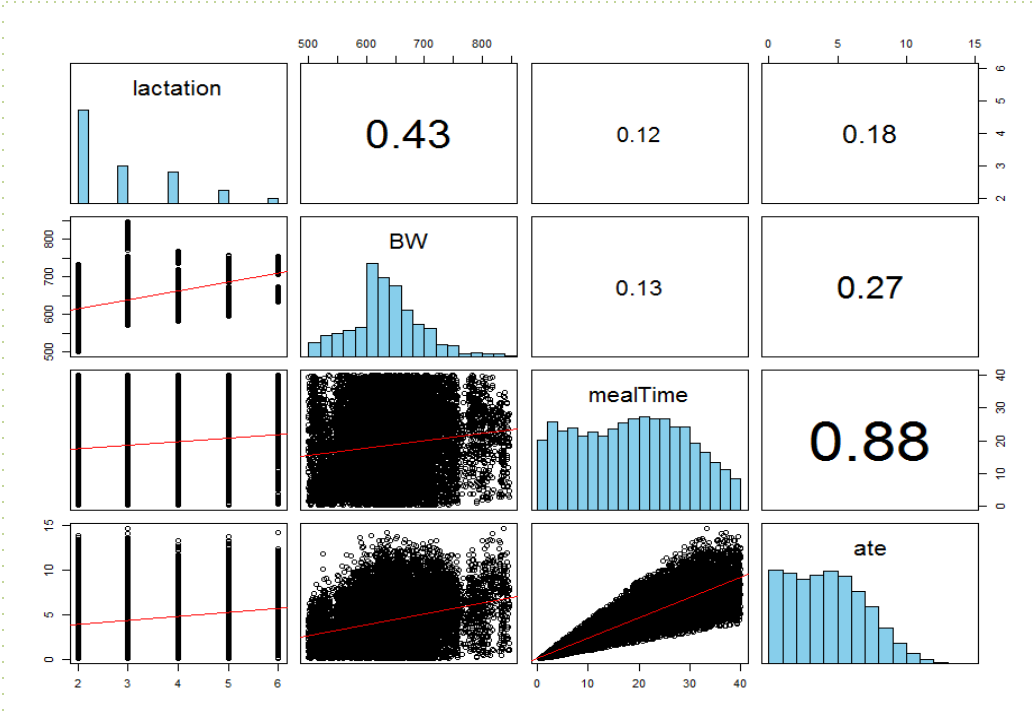
Pictures borrowed from Ilan Halachmi's lab



Halachmi I., et al., *Animal individual Feed intake monitoring*. *Computers and Electronics in Agriculture*, 1998. 20: p. 131-144.

Halachmi , Børsting, M.R. Weisbjerg et al. *Livestock Science* 138 (2011) 56–61

Single Meal Model



Daily Model

