UNIVERSITY OF COPENHAGEN

Faculty of Health and Medical Sciences

Relationship between intake of metabolizable energy and chewing index of diets fed to pregnant ewes

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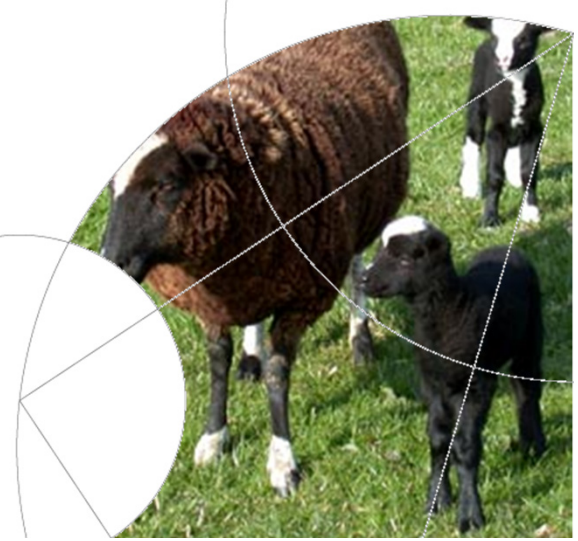


Introduction

- Feed intake, especially the last 4-6 weeks of pregnancy, are important for ewe and lambs

- Nutrition during late pregnancy affects
  - ewe colostrum production and BCS (Robinson et al. 1999)
  - lamb birth weight (Dwyer et al 2003)
  - lamb survival (Holst et al. 1986)
  - lamb carcass composition (Daniel et al 2007)

- Feed intake models can help predict feed requirements and intake

Introduction

- Nørgaard and Mølbak (2001) linear model describing net energy intake as a function of the ration chewing index (CI) in Scandinavian cattle

- The model was valid for very different types of production, and could possibly be modified to fit ewes in the last 4 weeks before parturition

Nørgaard and Mølbak 2001

- NEI= intercept –slope·CI
- The model is empirical based on a meta-analysis
- The intercept was interpreted as the theoretical maximum intake capacity for cattle
- The slope represents decrease in energy intake with increasing CI of the ration
- There was direct proportionality between slope and squared intercept slope=k*Intercept^2

Objective

- To study the relationship between metabolizable energy (ME) intake and the chewing index (CI) of the rations for pregnant ewes

- To study proportionality between the slopes and squared intercepts

Data

- Feeding experiments: 4 from Skara, Sweden, 1 from Ås, Norway.
- 107 ewes, the last 4 weeks before parturition
- A total of 14 dietary treatments
- Restricted concentrate allocation (0-0.8 kg), and *ad lib* silage
    - 2 experiments included 1 treatment with TMR

Estimation of CI and ME

- Estimation of CI according to the NorFor method (Nørgaard et al. 2011)

- The NorFor CI corrected (Nørgaard et al. 2011)
  - For BW: 625/BW
  - Intake of forage NDF: deviations from 0.7 kg NDF in % of BW

- Estimation of ME content of the feeds
  - Forage: *in vitro* digestibility (VOS) (Lindgren 1979, 1983, 1988).
  - Concentrates: according to Axelsson (1941)
  - 1 experiment: *in vivo* digestibility, for concentrate and forage (Van Es 1978)

Data collected

- Mean DMI, BW and MEI of the ewes

DMI (kg DM/day)		MEI (MJ/day)		BW (kg)	
mean	SD	mean	SD	mean	SD
2.5	0.41	29	5.3	100	11.0

- Mean forage characteristics and chewing index of the rations

	Forage characteristics per kg DM						Ration CI_{cor}	
	ME_f , MJ		NDF_f , g		CP_f , g		CI_{cor} (min/MJ ME)	
Rations	mean	SD	mean	SD	mean	SD	mean	SD
	11.3	1.01	500	57.6	159	27.4	27.2	5.10

Mathematical method

$$MEI_{i(,j)} = \textbf{intercept}_j + \textbf{b}_j * CI_{i(,j)} + \varepsilon_{i(,j)} \quad \text{(Equation 1)}$$

Where $MEI_{i(,j)}$ is the metabolizable energy intake (MJ ME/day) of the individual ewe (*i*) in week within experiment *(j)*, $\textbf{intercept}_j$ is the intercept (MJ ME/day) of week within experiment (*j*), $\textbf{b}_j$ is the slope ((MJ ME/day)^2/(min/day)) of week within experiment (*j*), $CI_{i(,j)}$ is the chewing index (min/MJ ME) from the individual ewe (*i*) in week within experiment (*j*), and $\varepsilon_{i,(j)}$ is the error of the regression of the individual ewe (*i*) in week within experiment (*j*).

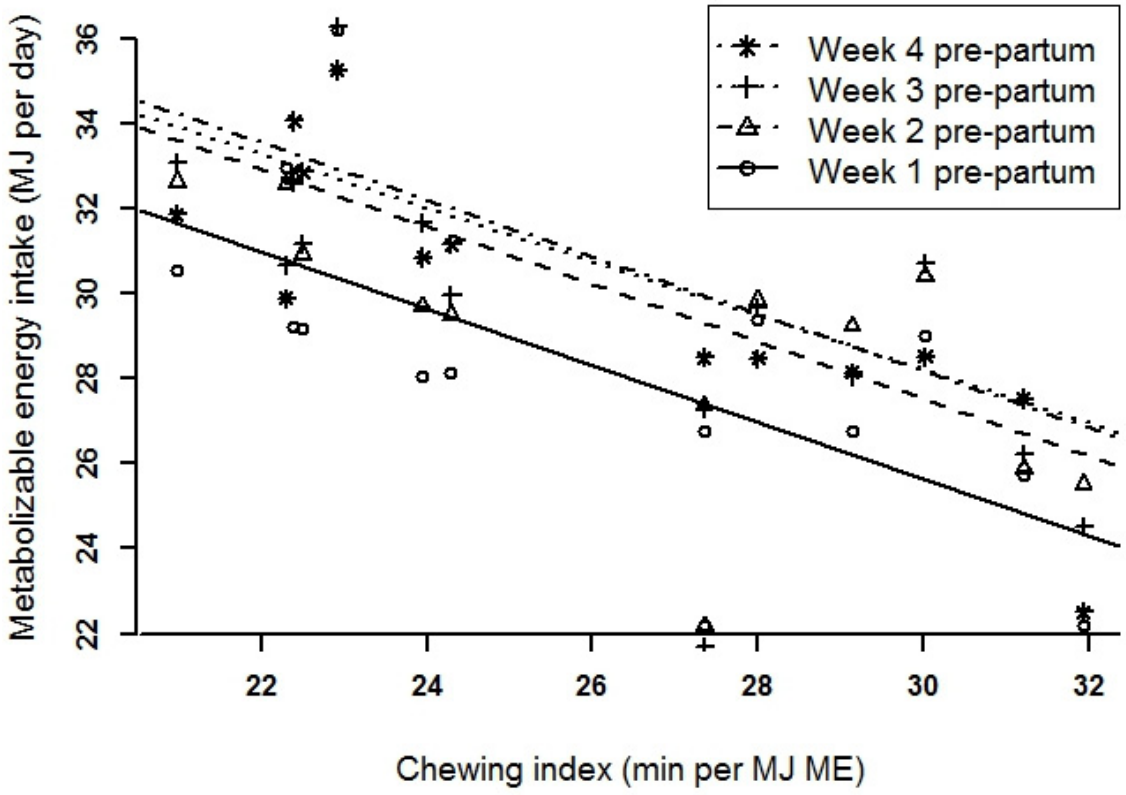
$$\textbf{b}_j = q + k * \textbf{intercept}_j^{\,2} + \varepsilon_j \quad \text{(Equation 2)}$$

Where $\textbf{b}_j$ is the slope of week within experiment *(j)*, $\textbf{intercept}_j^{\,2}$ is the squared intercept of week within experiment (*j*), and ε_j is the error of the regression in week within experiment *j*, q is the possible intercept and k is the slope of the linear function.

Statistical Method

- Linear mixed effects modelling with random effect of week within experiment
    - Effect of model variables: Wald test
    - Random variation effect on slope and intercept: Likelihood ratio test
    - Linearity of the model: standardized residual-plot, qq-plot
- How well the models fit to data: R^2
- Direct proportionality using linear regression: Wald test

Visualization



Results

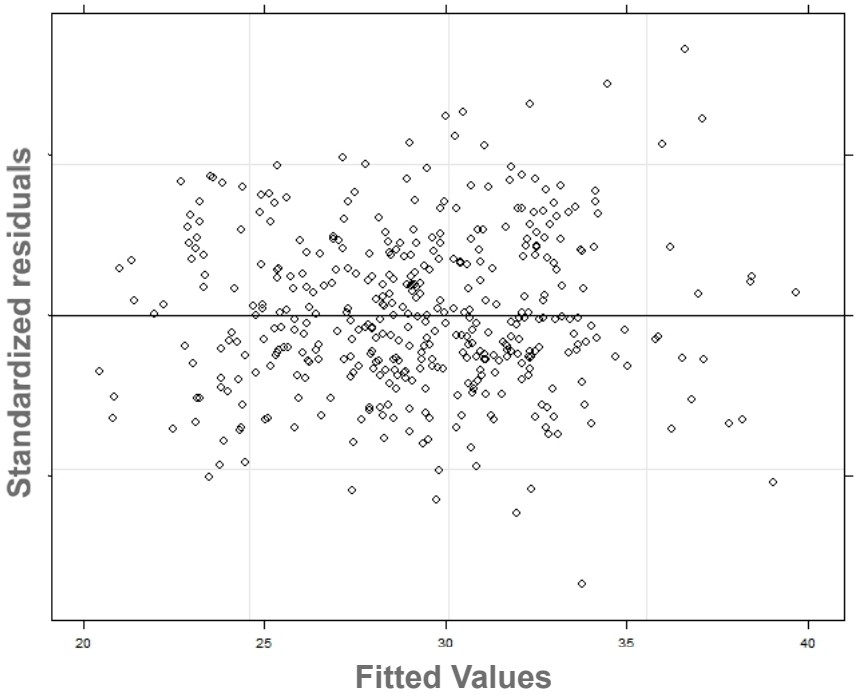
- Intercept and slope of the linear regression MEI= Intercept +b*CI for pregnant ewes.

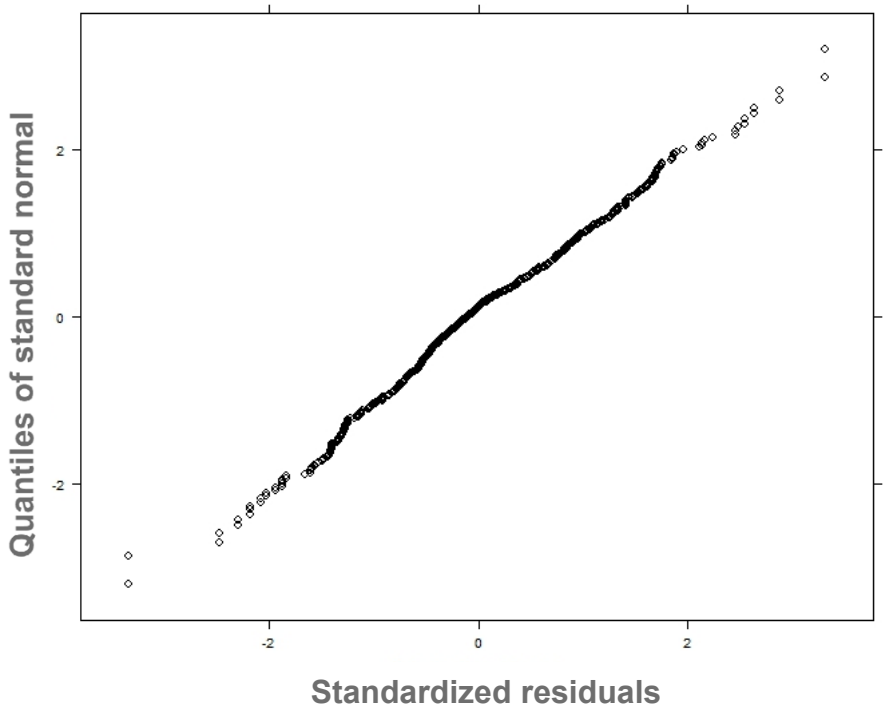
Parameters	Estimates	SE	P-value
Intercept (MJ ME/day)	**43**	**3.99**	**<0.001**
b ((MJ ME/day)^2/(min/day))	**-0.52**	**0.12**	**<0.001**

- There were significant effects of **week** before parturition and **experiment** on both intercept and slope

Results

- Evaluation plots of MEI=Intercept+b*CI pregnant ewes.

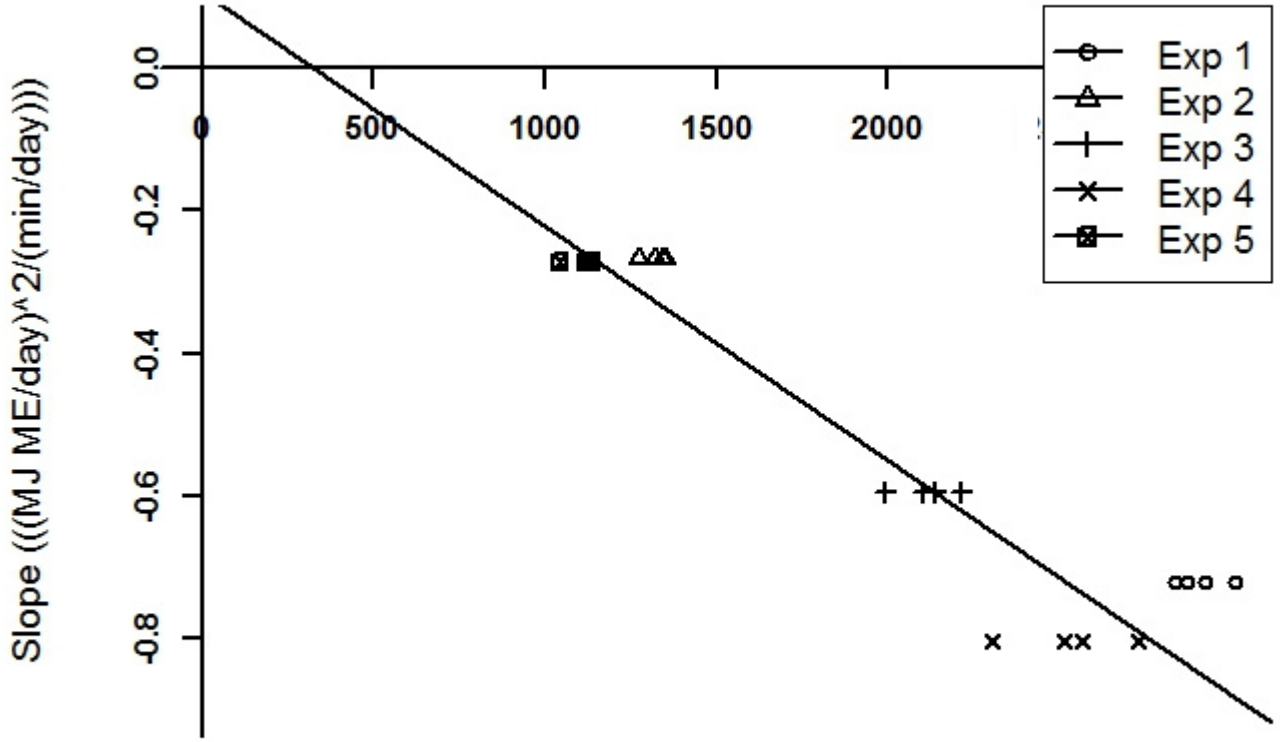




- R^2: 0.51

Results

- Direct proportionality using linear regression
- P-value for this intercept: 0.17



Conclusion

- ME intake of pregnant ewes during the last four weeks of pregnancy decreases linearly at increasing dietary chewing index.
- The slope values appear proportional with the squared intercepts values.
- The model proposed could be relevant also for pregnant sheep.
- However, the potential prediction power of the model was low and the model needs further improvements.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Research questions

- Can ME intake of similar groups of nursing ewe fed different types of forage be described as a linear function of the CI of the ration?
- Does the estimated slope from different experiments vary from each other?
- Do the estimated intercept from different experiments vary from each other?
- Is there a pattern in the distribution of residuals so the model has to be rejected?
- Can the estimated slope values from different experiments be related to the squared intercept as negatively proportional?
- Is the intake most likely regulated by metabolically and physical constrain EN9 most only likely only physical constraint? Try to estimate if the maximal CI<2*CTmax/NE0, and if the NE>½NE0
- How well does the model fit the data (r^2)?

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EN9 ....constraints or most likely only by physical constraint?

How are you going to use these questions?
Elisabet Nadeau, 08/06/2014