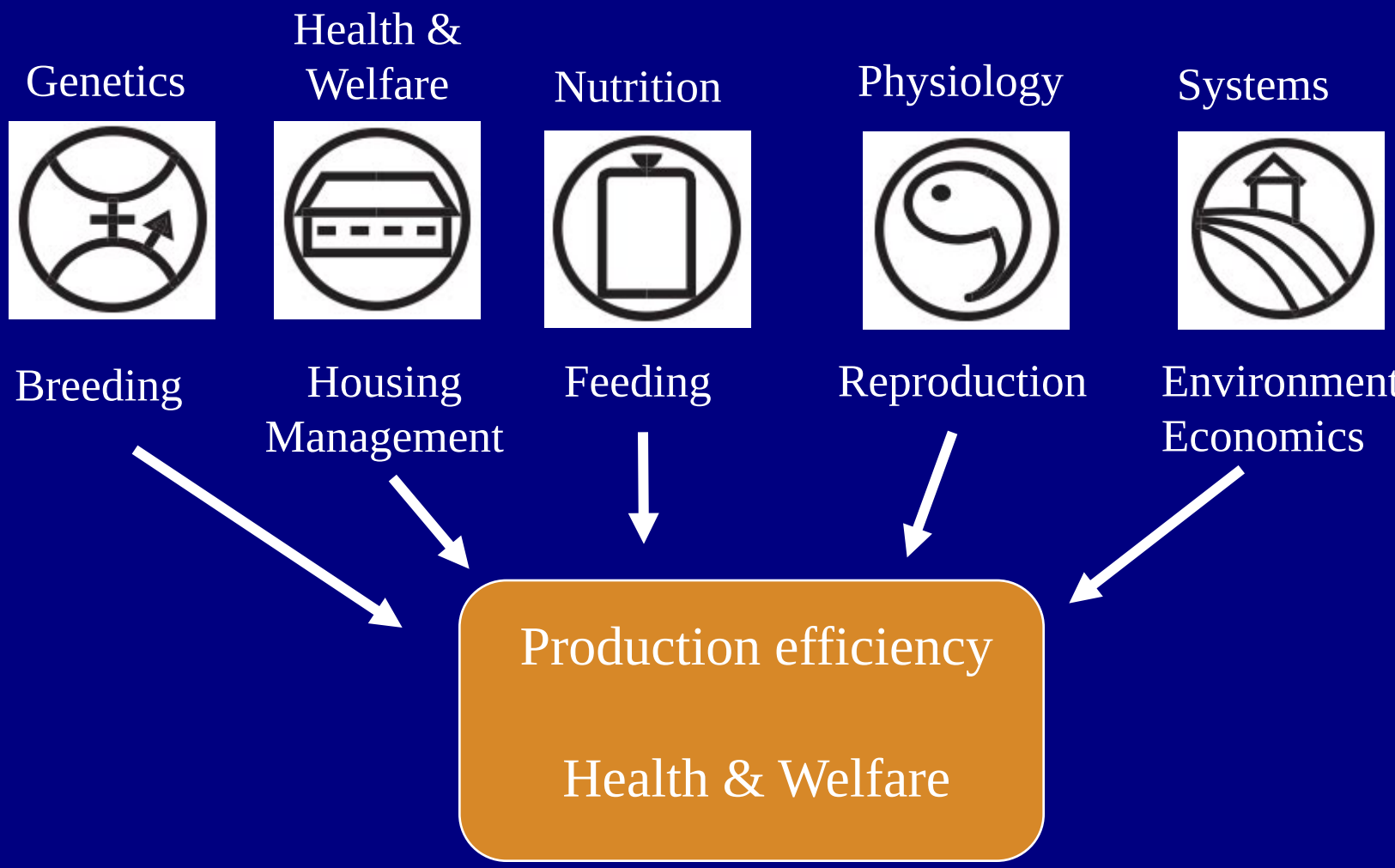
EAAP 2016

ANIMAL BEHAVIOUR AND ANIMAL NUTRITION SCIENCE

WORKING TOGETHER TO SUPPORT LIVESTOCK PRODUCTION

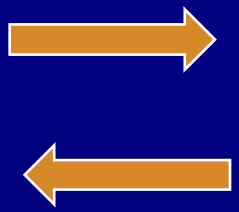
Sandra Edwards & Hans Spoolder

Bridging disciplines



Two-way influences

Animal nutrition

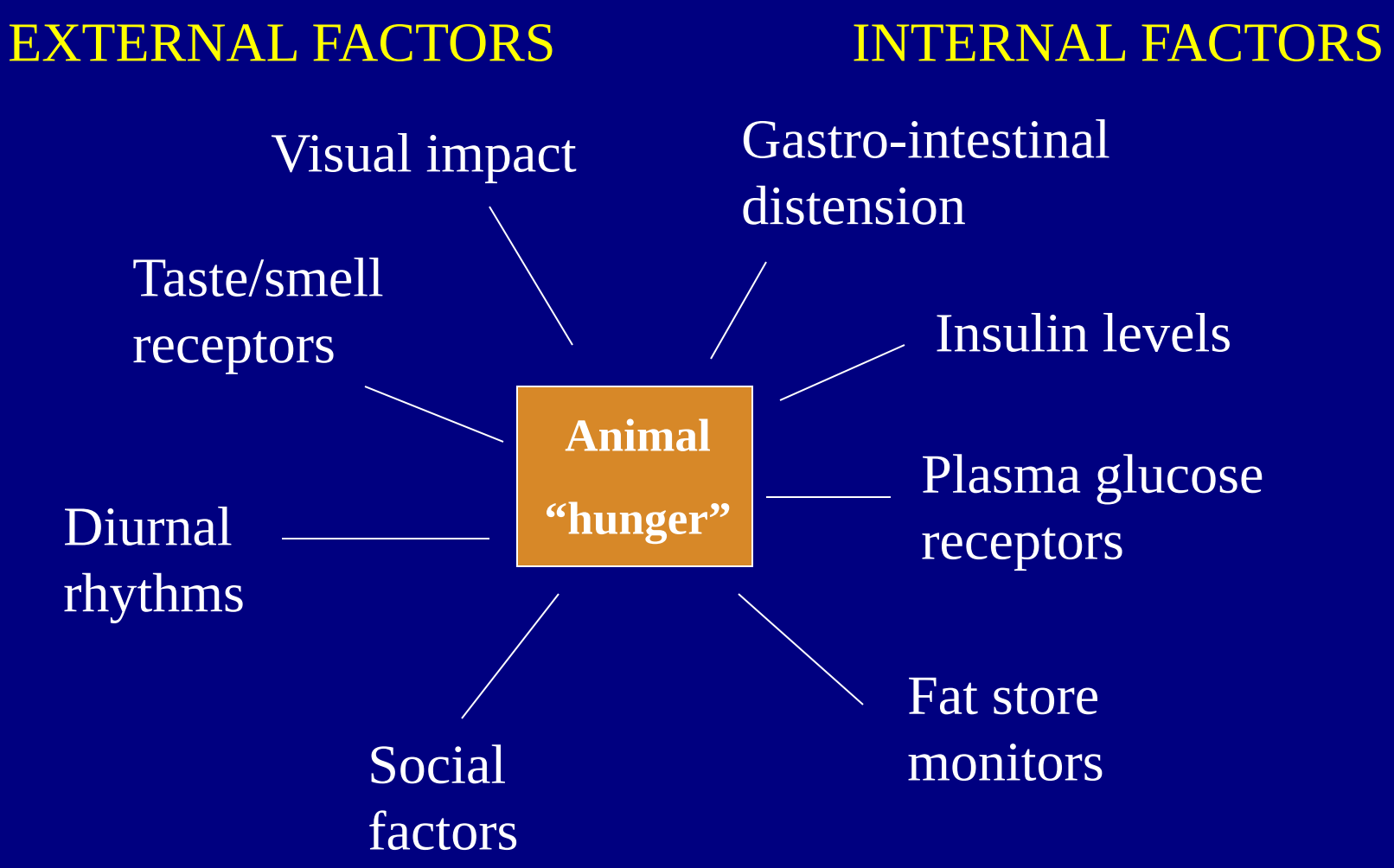


Animal behaviour

DIRECTIVE 91/630/EEC:

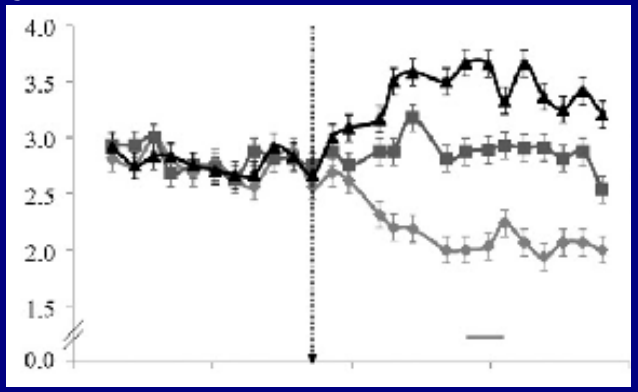
“All pigs must be provided with a diet appropriate to their age, weight and behavioural and physiological needs, to promote a positive state of health and well-being”

Control of feeding behaviour



Level of hunger affects strength of appetitive behavioural response

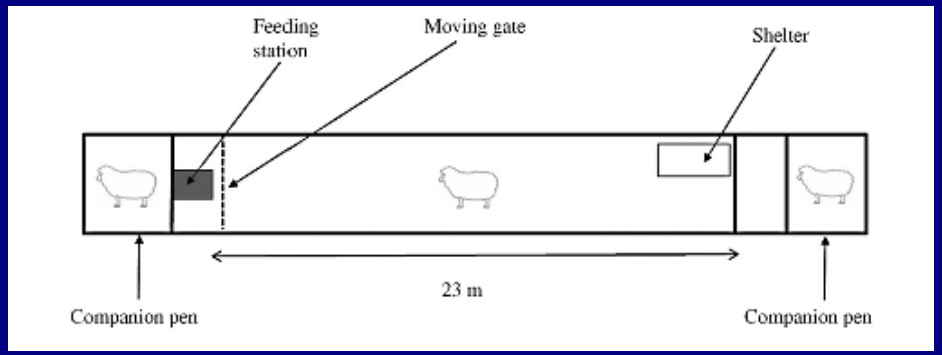
Body Condition Score

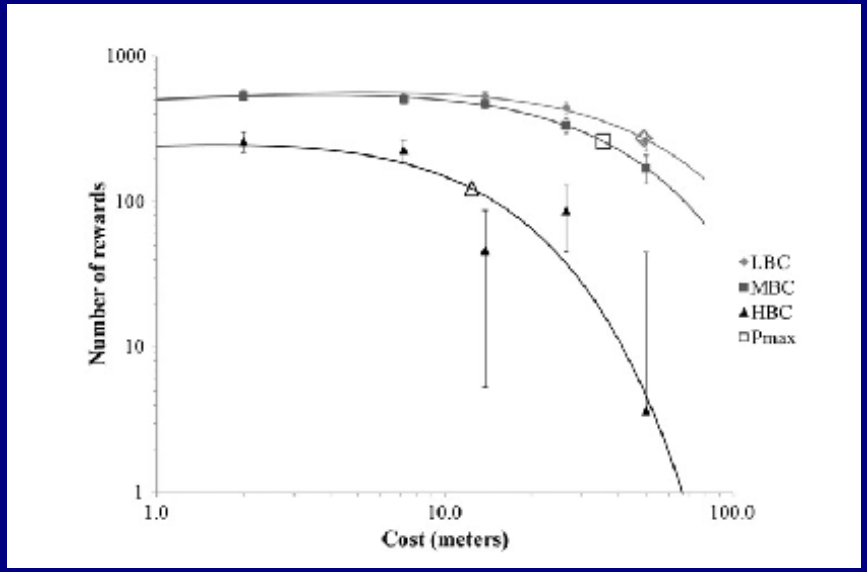


High
Medium
Low

Days of gestation

Feeding motivation in sheep

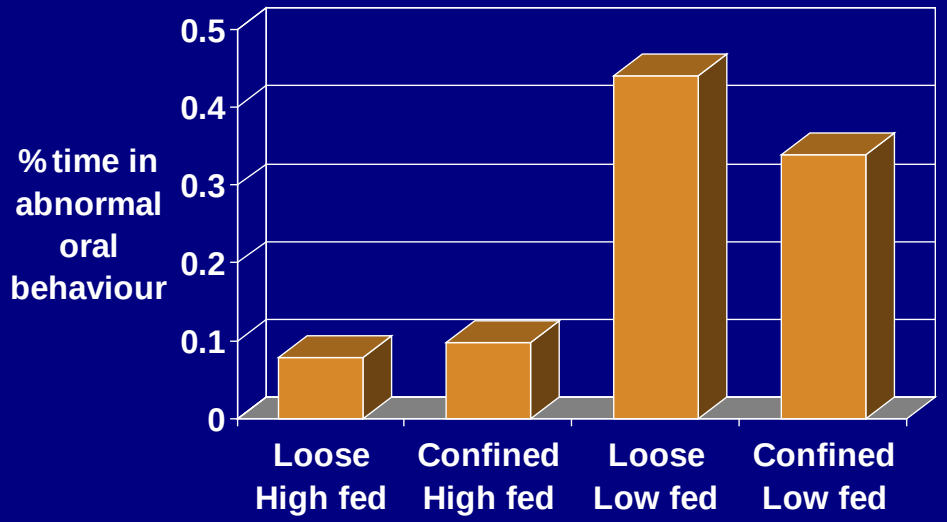




(Verbeek et al. 2012)

What happens if appetitive behaviour cannot deliver?

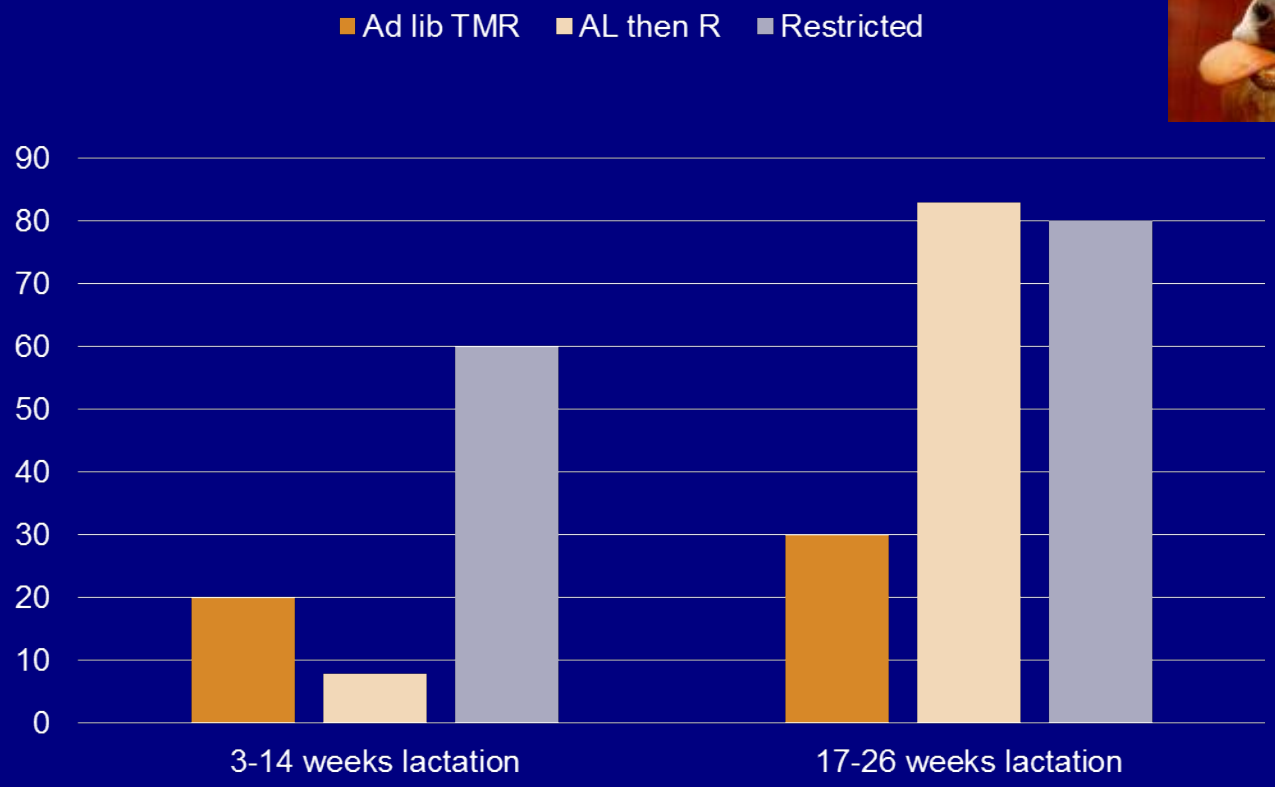
- Stereotyped oral behaviour arises because of chronic hunger in an environment where foraging behaviour cannot be functionally expressed



(Terlouw et al, 1991)

Frustrated feeding motivation in cattle

% of housed dairy cattle showing oral stereotypies



(Redbo et al, 1996)

Behavioural or nutritional causation?

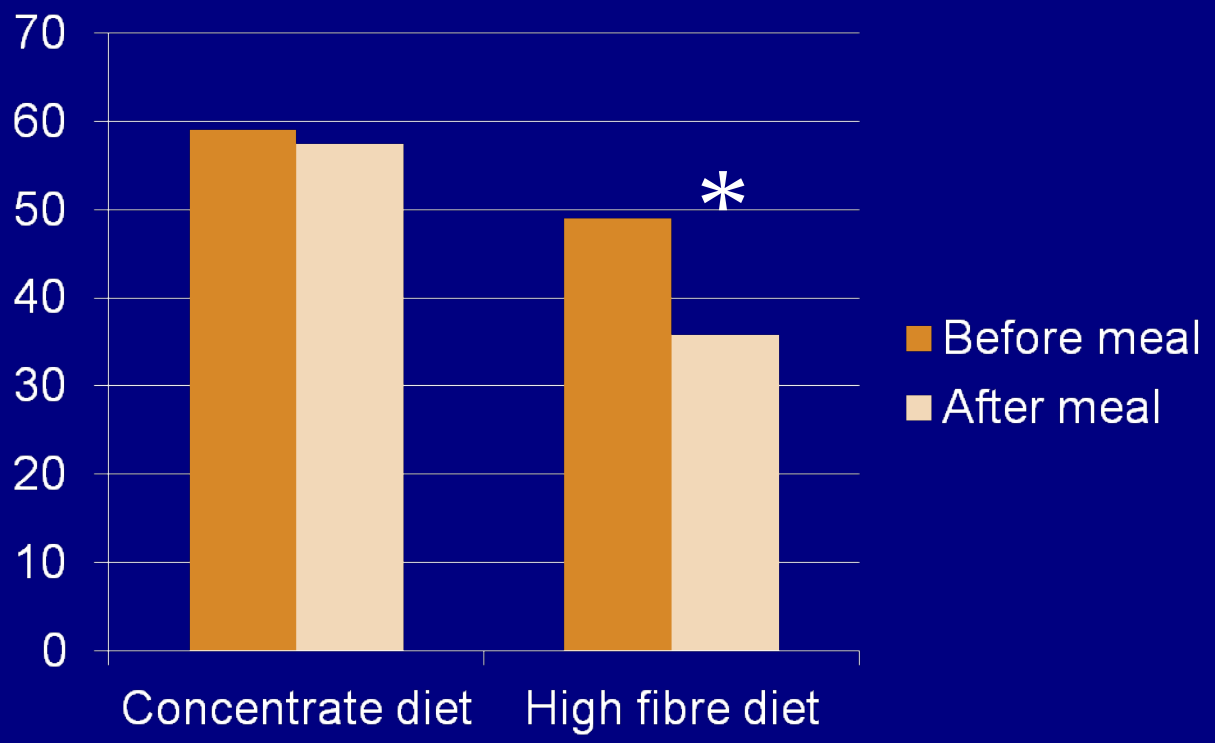
Independently varied meal size and rumen contents (fistula)

% time	H-L	L-H	H-H	L-L
Eating	61	5	22	15
Ruminating	11	20	25	12
Stereotypies	11	14	4	35

(Lindstrom & Redbo, 2000)

Can we reduce hunger without increasing calorie intake? [obesity is undesirable]

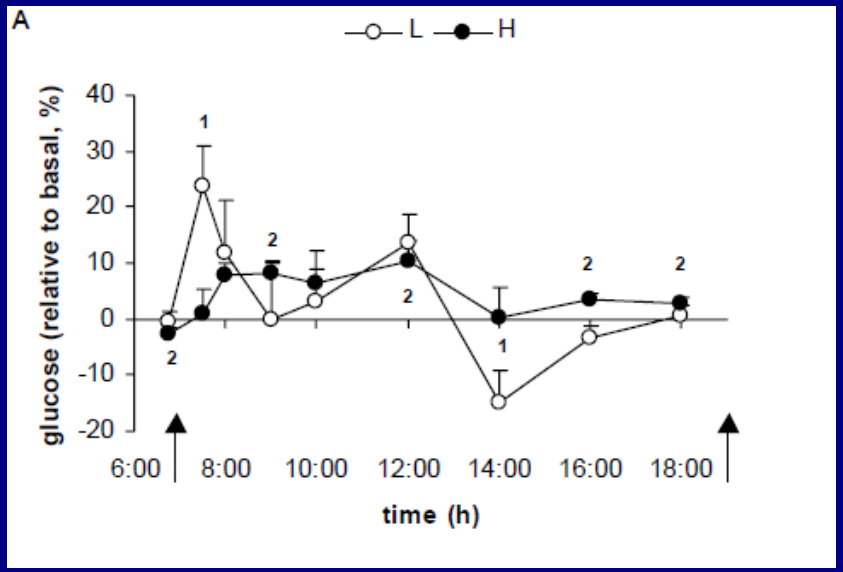
No of rewards in operant test

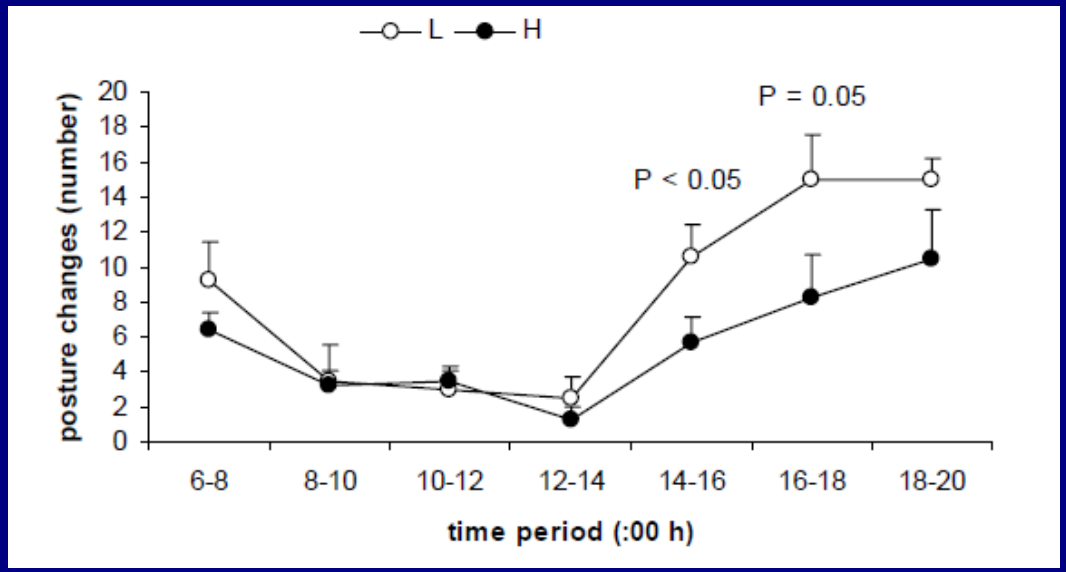


(Robert et al, 1997)

Post ingestive metabolism with HF diet

- HF diet (45% sugar beet pulp) increased glucose stability and reduced afternoon activity





(de Leeuw et al, 2004)

Nutritional characteristics promoting behavioural effects

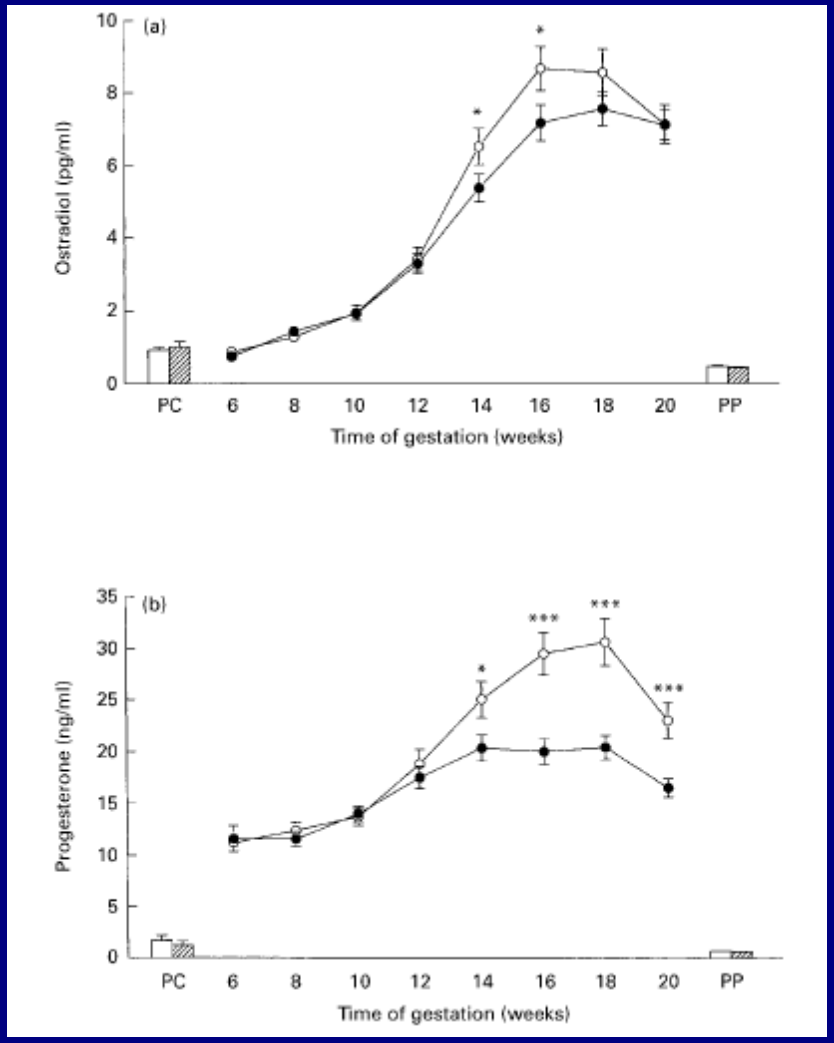
- Short term effect = physical
  - Increased chewing, gut distention (Brouns et al., 1991)
- Long term effect = metabolic
  - Reduced initial postprandial rise in glucose and insulin
  - Longer persistence of VFA & insulin

(Danielsen & Vestergaard 2001; de Leeuw et al 2004)

Most effective fibres: (Souza da Silva et al, 2013)

- High water holding capacity
- Delayed gastric emptying
- High and prolonged fermentation

Nutritional status affects other behavioural control systems



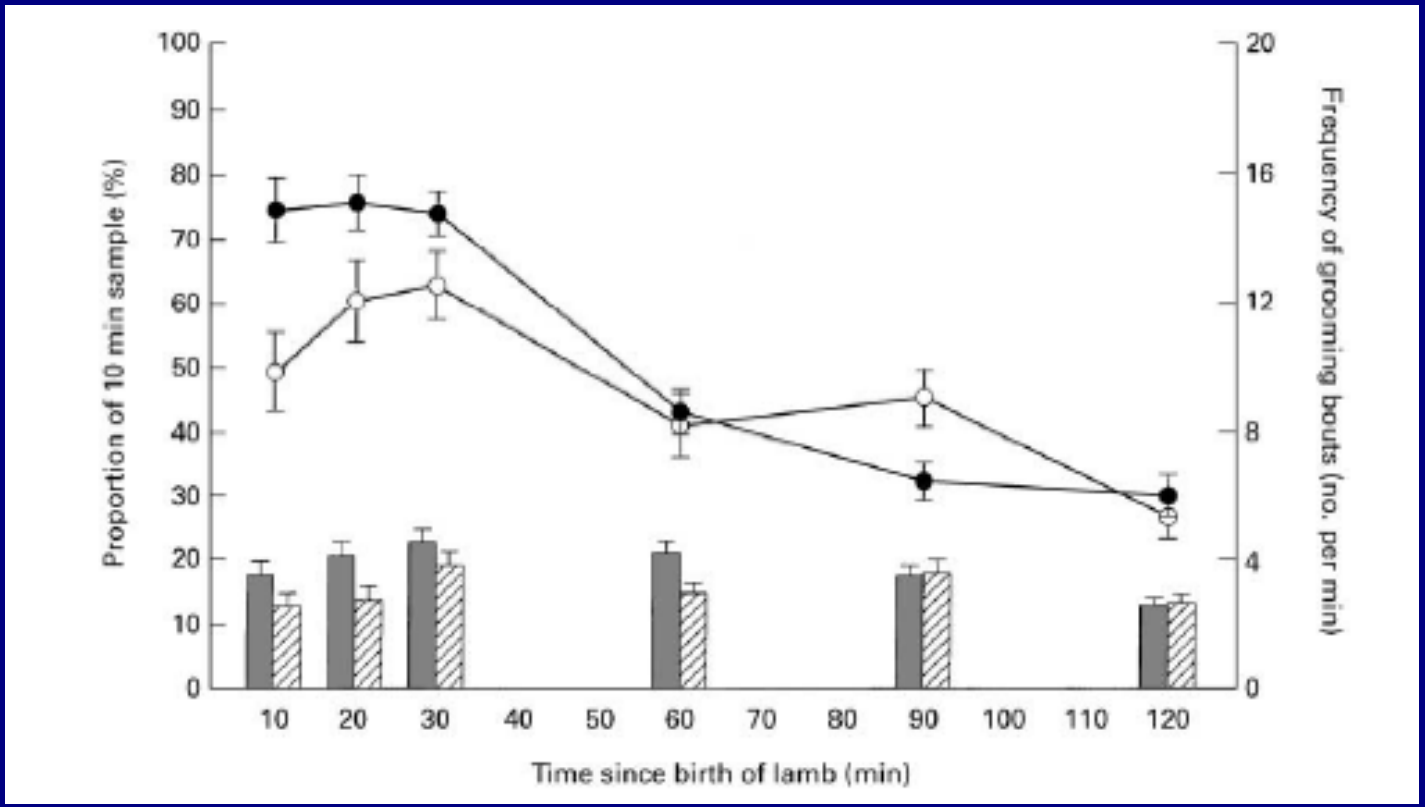
- High plane nutrition
- Low plane nutrition (35% reduction)

Reproductive steroid concentrations affected by undernutrition

(e.g. pregnant ewe)

(Dwyer et al., 2003)

Ewe nutrition and maternal behaviour



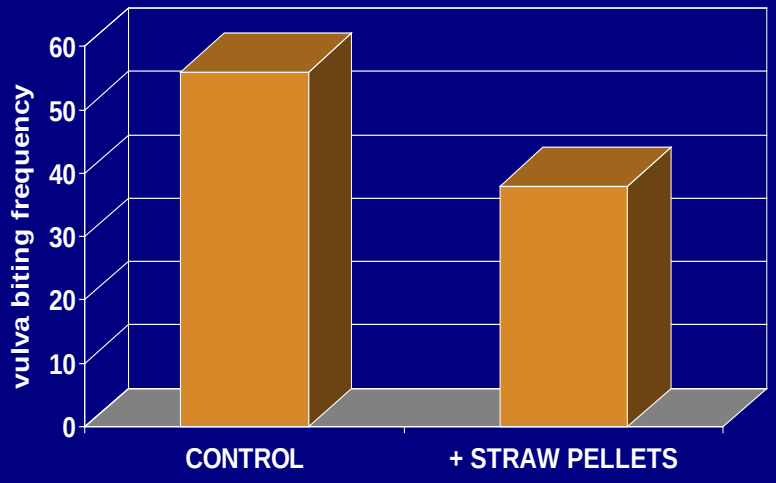
Lamb grooming reduced by undernutrition in gestation

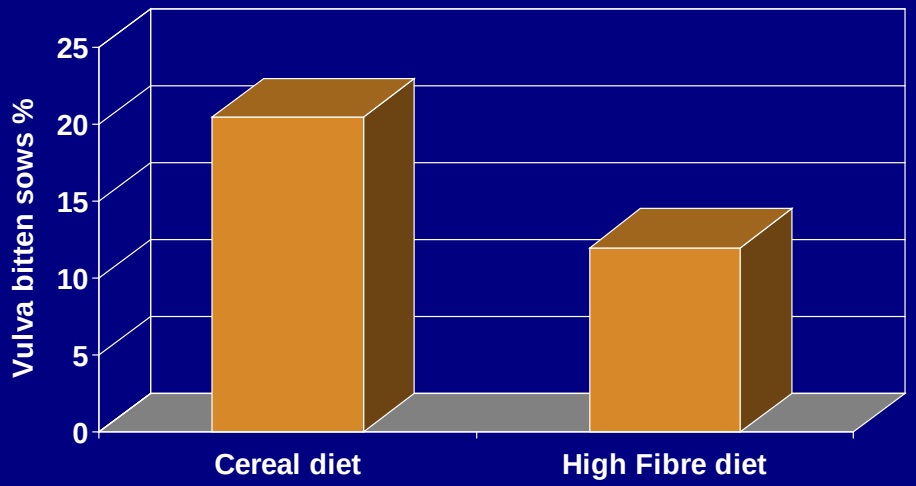
(Dwyer et al., 2003)

High plane nutrition

Low plane nutrition (35% reduction)

Nutrition affects aggressive behaviour





ESF system
(Bure 1991)

Floor feeding
(Whittaker et al 1995)

High Fibre diets reduce vulva biting in sows

Its not just about energy

Animals can select amongst feeds to balance their diet: therefore have nutrient specific hunger

Protein content of offered foods (g/kg)

Food 1	Food 2	Protein Intake of selected mix (g/kg)
125	213	208
125	267	204
174	213	202
174	267	205

(Kyriazakis et al, 1993)

Its not just about energy

Foraging behaviour increased with imbalanced diets even when fed ad libitum

Cr. protein in diet	**12**	**20**	**24**
% time:			
Standing	37	28	24
Rooting straw	8	5	5

(Jensen et al., 1993)

Nutritional deficiencies can contribute to other undesirable behaviours

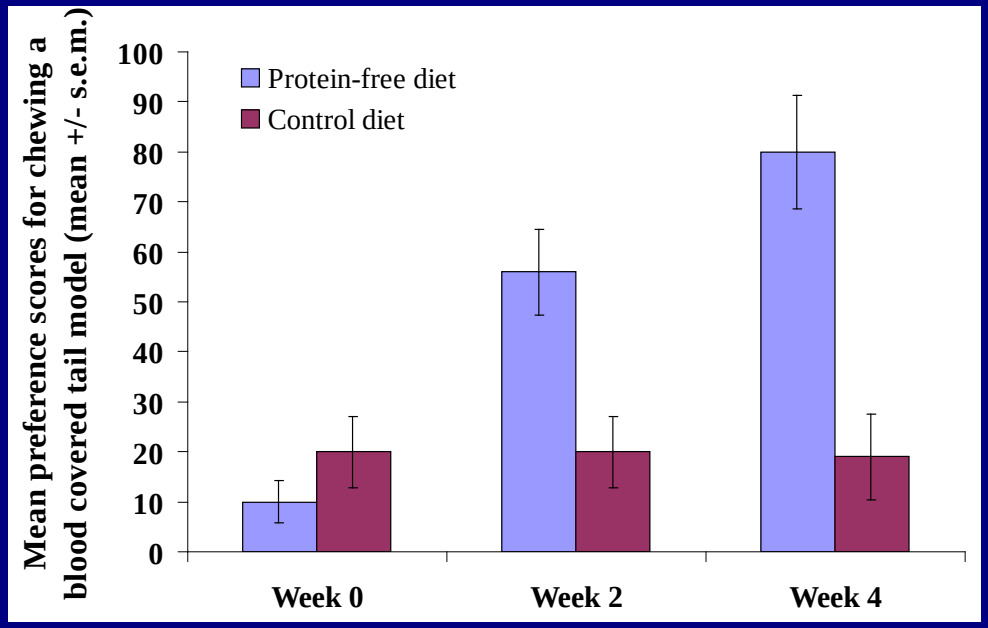
Still not known what predisposes individual pigs to start tail biting

Abnormal behaviour linked to:

- nutritional deficiencies
- (incl. protein imbalances)
- poor growth rate
- exploratory motivation

Effect of protein deficiency on scores for chewing a blood saturated tail model

(Fraser *et al.*, 1991)



low / imbalanced protein diets increase tail biting

predisposition genetically linked to high lean tissue growth

tryptophan supplementation reduces biting

(BPEX 2004, 2005; Breuer et al 2005; McIntyre & Edwards 2002)

How might protein deficit/imbalance affect tail biting ?

- Amino acids = substrates for key neurotransmitters associated in aggression, exploratory and foraging behaviour

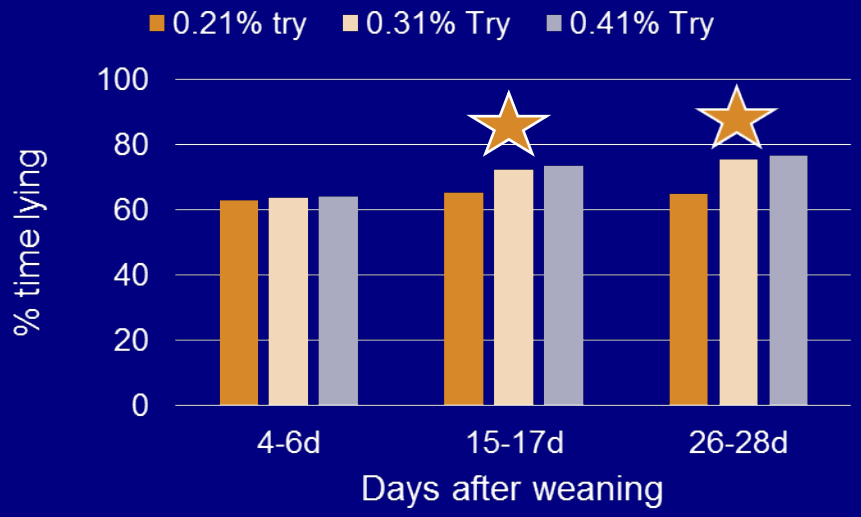
  - Tyrosine ⇒Dopamine

  - Tryptophan ⇒ Serotonin

Known mood-modifiers in many species

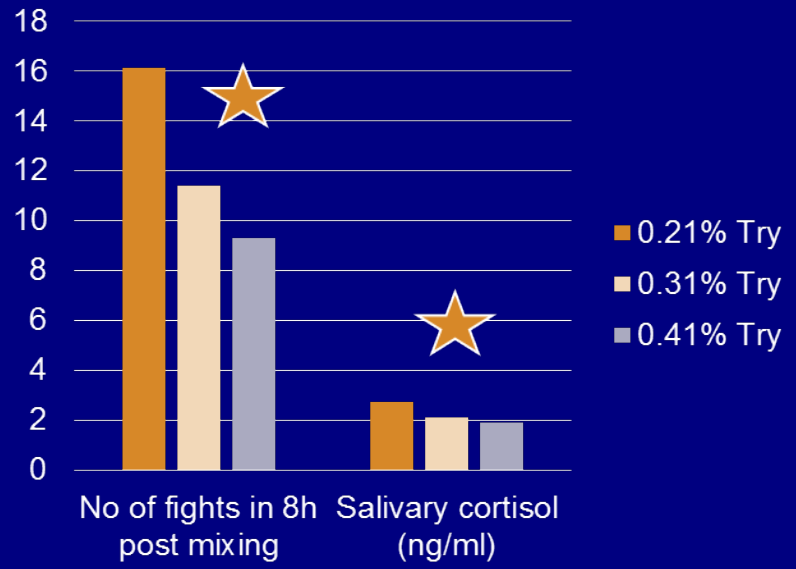
Tail biting pigs have changed brain serotonin metabolism

Amino acid intake and behavioural modification



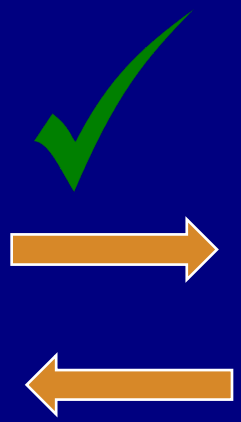
(Liu et al, 2013)

After remixing on d29



Two-way influences

Animal nutrition



Animal behaviour

SO: Animal [science] can help Animal Beha[viour] to understand and deal w[ith behavi]oural problems

What about the effects of behaviour on nutrition?

- Social facilitation:

"Behaviour that is initiated or increased in rate or frequency by the presence of another animal doing that behaviour"

- Social competition:

Will both affect feed intake

Behavioural programming of feed choice

Learning is affected both by social model and participation

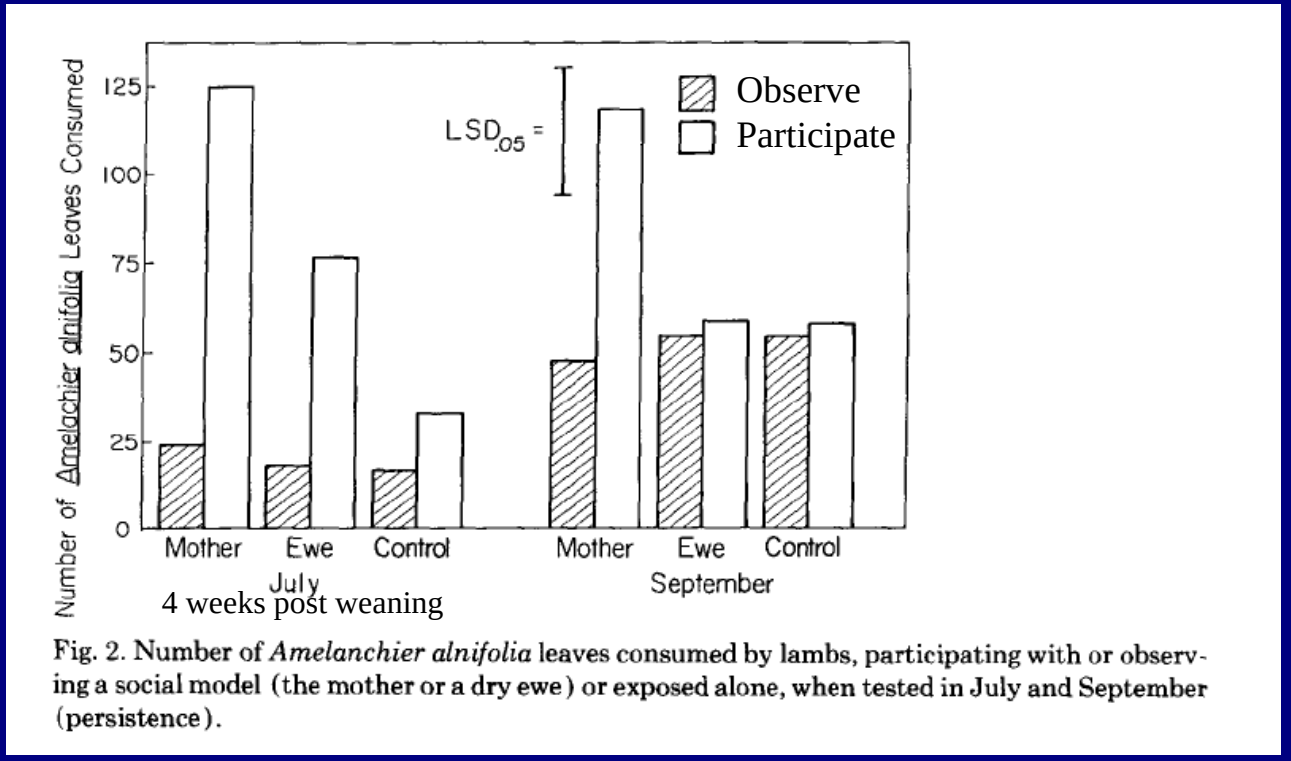
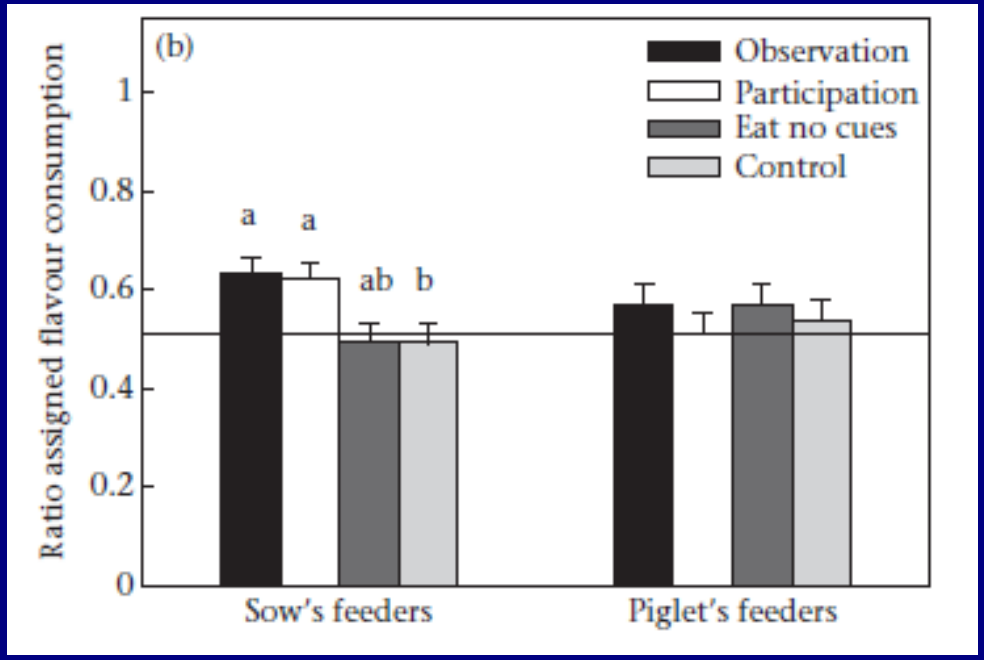


Fig. 2. Number of *Amelanchier alnifolia* leaves consumed by lambs, participating with or observing a social model (the mother or a dry ewe) or exposed alone, when tested in July and September (persistence).

(Thorhallsdottir et al., 1990)

Behavioural modification of feed intake

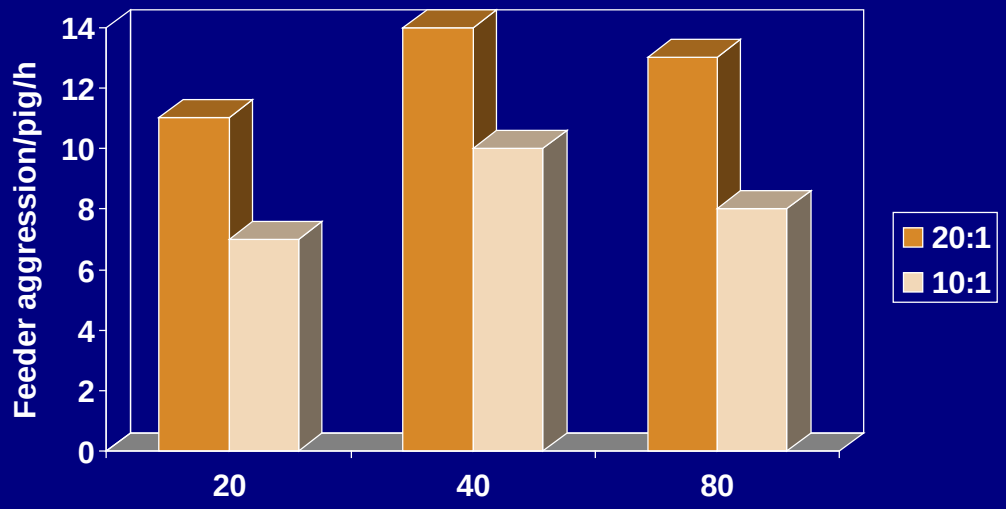
Piglets learn food flavour choice from observing or participating in maternal feeding



(Oostindjer et al, 2011)

The effects of feed competition

Pigs per feeding place	20:1	10:1	
DLWG:			
30-65kg	0.72	0.76	***
30-90 kg	0.75	0.77	*



(Spoolder et al., 1999)

The effects of feed competition

Feed space/cow	0.5m	1.0m	
Inter-cow distance (m)	0.49	0.80	**
Total daily mealtime (min)	279	308	***
Aggressive displacements (/cow/90 min post feed)	1.5	0.7	*

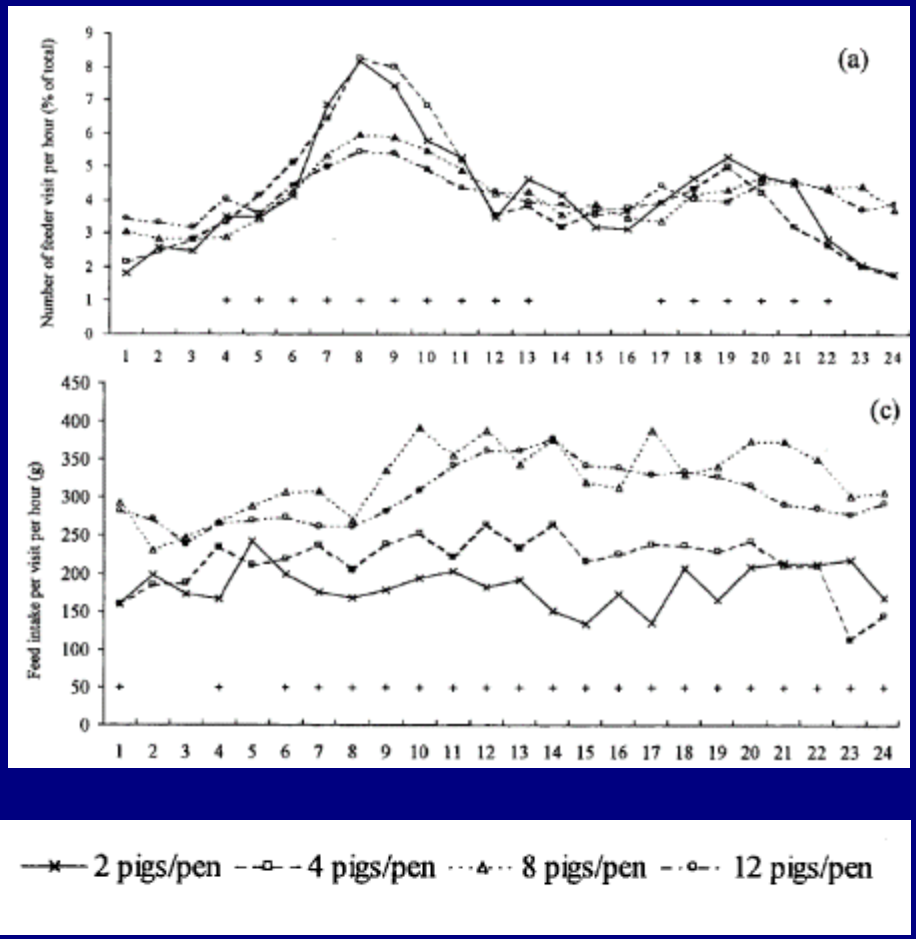
(De Vries et al, 2004)

Social competition and feeding patterns

Increased competition:

- Reduces feeding bouts
- Increases intake per bout
- Reduces diurnal variation in feeding

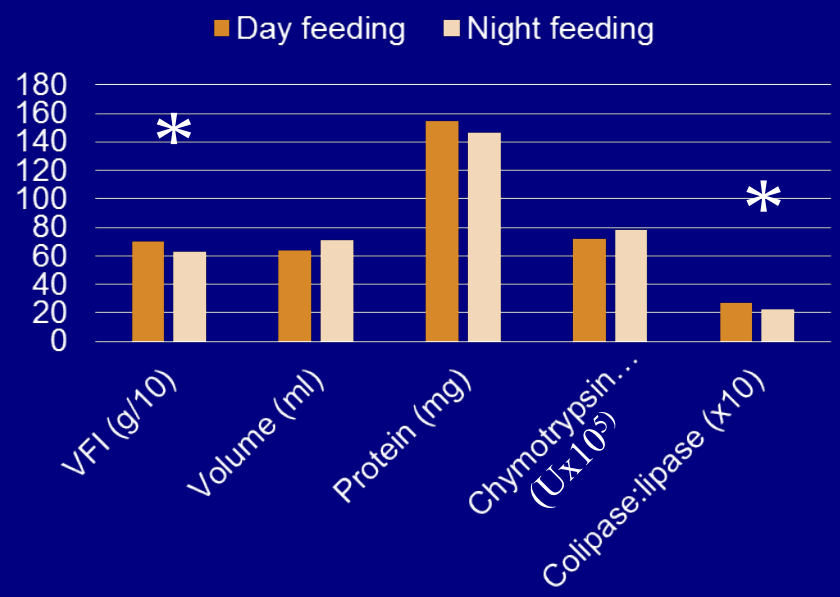
Feed intake per visit negatively correlated with gain:feed ratio ($r = -0.38$; $P < 0.01$)

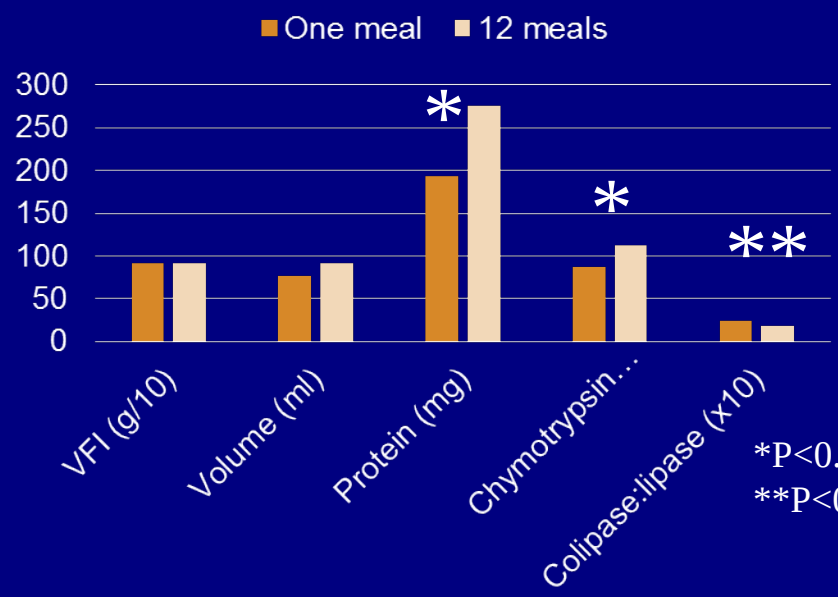


(Hyun & Ellis 2002)

Feeding pattern and digestive activity

Hourly exocrine pancreatic secretion





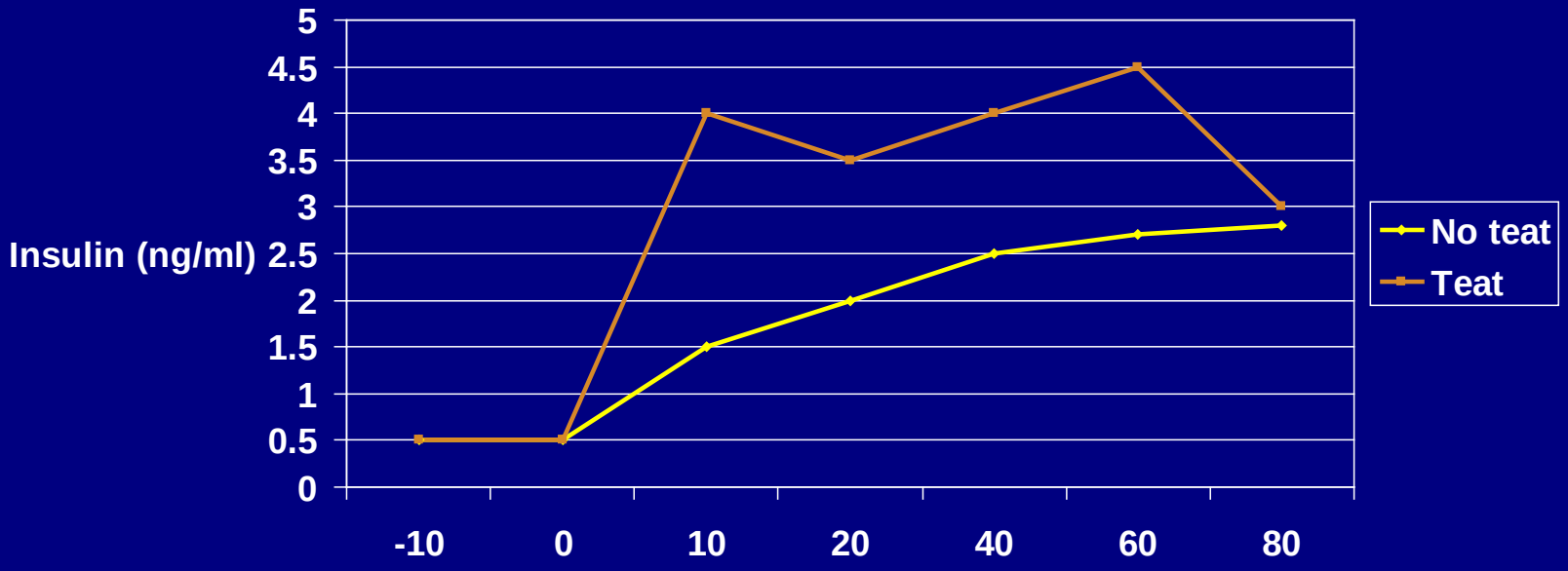
*P<0.10
**P<0.05

Feeding pattern changed pancreatic enzyme output

(Botemans et al, 2000)

Feeding behaviour can also affect digestive physiology

Non-nutritive sucking enhances secretion of insulin and CCK in calves

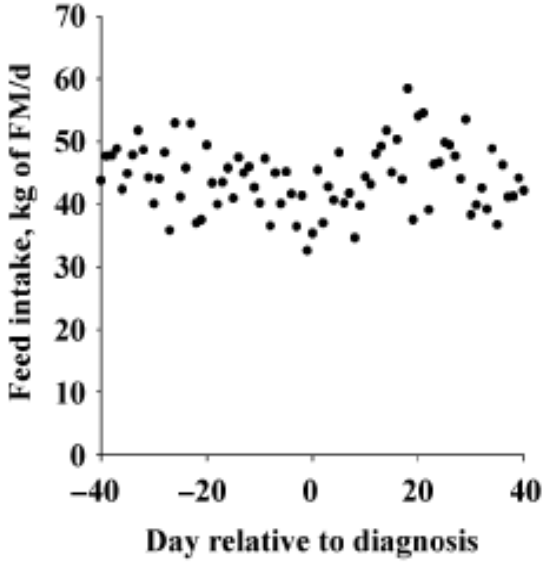


(de Passille et al, 1993)

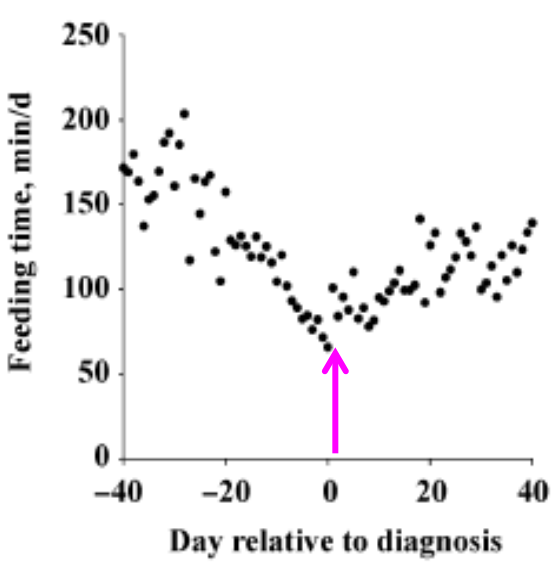
Feeding behaviour as a diagnostic tool

Early diagnosis of lameness in dairy cows by change in feeding behaviour more sensitive than feed intake

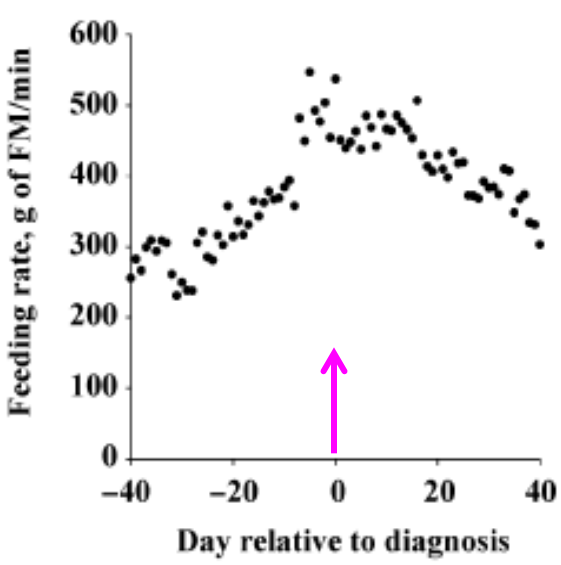
Feed intake



Feeding time

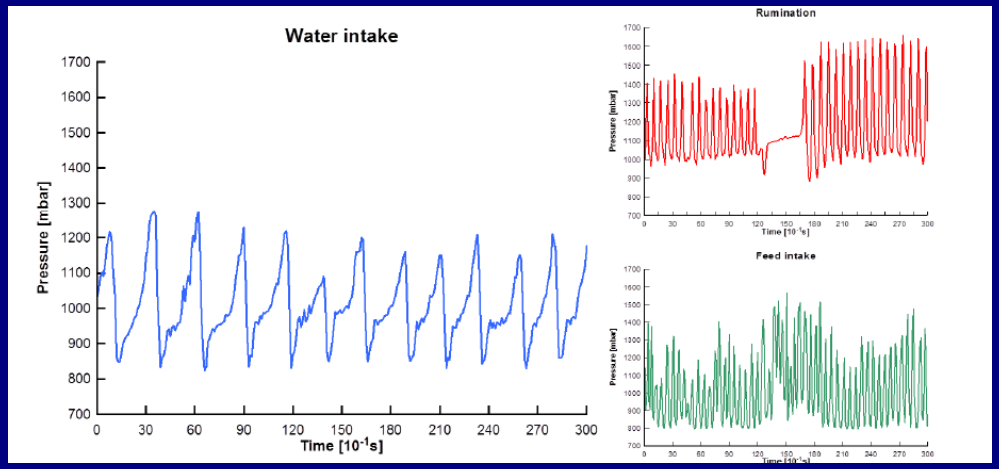


Feeding rate

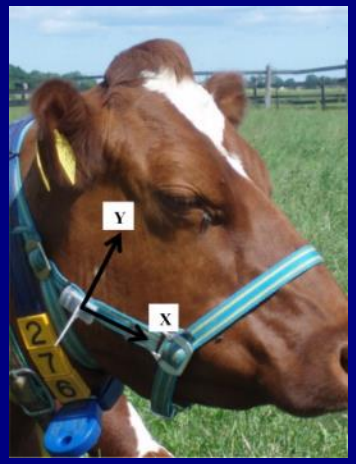


(González et al. 2008)

Monitoring feeding behaviour in free-ranging animals



"RumiWatch"
(Zehner et al, 2012)



Grazing behaviour	Frequency of logging		
	5 s	5 min	10 min
Sensitivity %	83.63	85.47	58.55
Specificity %	79.89	82.08	92.17
Precision %	74.57	77.63	83.70

3-D accelerometer
(Nielsen, 2013)

Conclusions

- There are many interactive effects of animal behaviour and animal nutrition in livestock production systems
- Collaborations between ethologists and nutritionists will continue to be important for future improvements in both efficiency and animal welfare
- New tools to facilitate such collaborations are increasingly sophisticated and affordable