Improving resilience by support and facilitation of adaptation.

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Department of Animal Sciences

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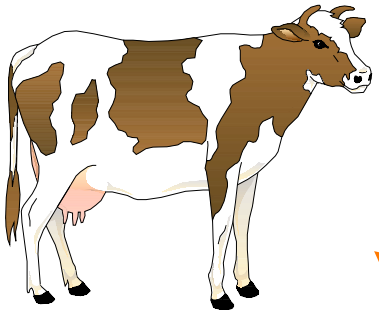
Environmental challenges to adapt to



- Climate
- Housing system
- Pathogens
- Interactions with other animals and man

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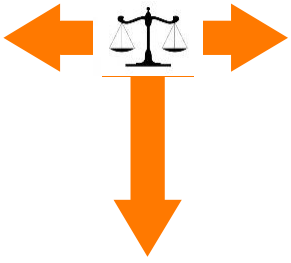
Adaptive capacity (Resilience):

The ability of an animal to adapt to a changing environment with minimum loss of function (adapted from Brooks and Adger, 2005)

Challenges



Adaptive capacity
'coping resources'

- genetic predisposition
- early life experiences
- current environment

health
welfare
performance

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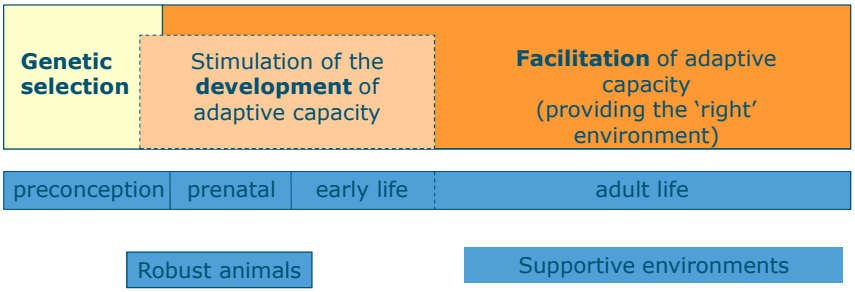
Determinants of Resilience

Overview of different methods (**selection, development, facilitation**) to improve adaptive capacity of animals



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Examples of shaping resilience

- Genetics
  - Natural selection
  - Genetic traits selection
- Prenatally
  - Incubation temperature in broilers
  - Flavour learning in pigs
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Genetic variation allows adaptation of a population

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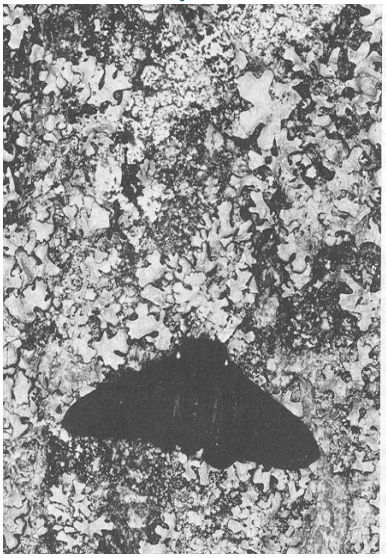
Genetic adaptation Birch Moth (berkenmot)



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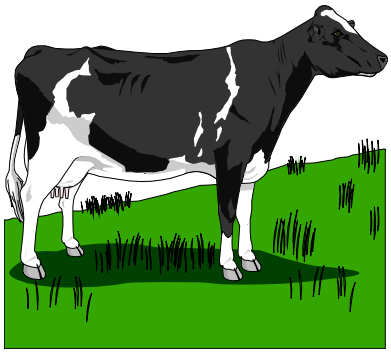
Kettlewell, 1956

Genetic predisposition



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Genetic selection for robustness

Natural antibodies are antibodies that are found in plasma that are not a result of specific antigen exposure

They have a broad affinity to bind antigens and act as first line defence

They are part of the innate immune system

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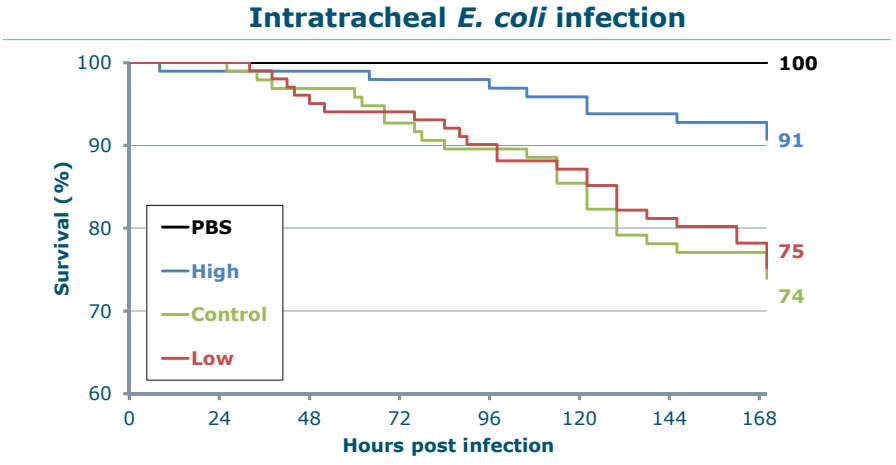
Selection for NAB against KLH: results of an Infection experiment



Tom Berghof

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Genetic selection and resilience

Selection for Natural Antibodies against a model antigen (KLH) makes animals more resilient against a disease challenge

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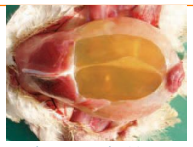
High temperature during late incubation

	37.8°C	38.9°C
Yolk Free Body Mass (g)	36.9[a]	33.9[b]
Heart (%, YFBM)	0.38[a]	0.28[b]
Total mortality (%)	8.4[a]	12.5[b]
Ascites related mortality (%)	2.8[a]	6.6[b]



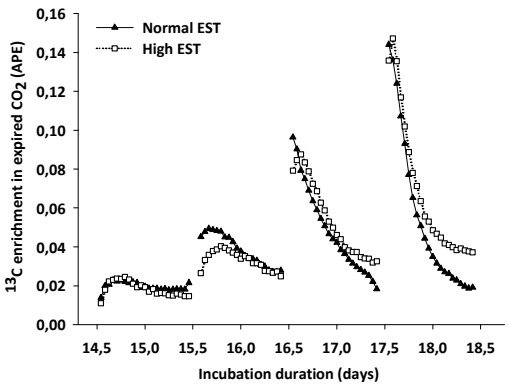
Molenaar et al., 2011, Poultry Science

High temperature during late incubation I

Incubation temperature ↑

Heat production ↑

Glucose requirements ↑

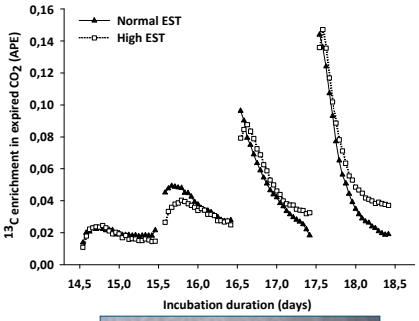


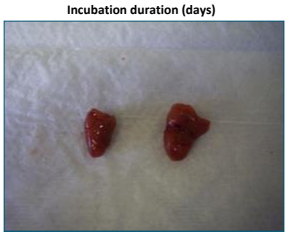
(37.8 vs 38.9 ^{0}C from days 7-19 of incubation)

Molenaar et al., 2013, PloS One

High temperature during incubation

Incubation temperature ↑
Metabolic rate ↑
Glucose needs ↑
Glycogen reserves ↓
Protein ret. efficiency ↓
Urid acid levels ↑
Heart size ↓
Mortality due to ascites ↑





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Incubation temperature and resilience

High incubation temperatures result in an lower resilience against metabolic stress later in life in fast growing broilers.

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Weaning 'in nature'

- Weaning between 10 -16 wk of age
- Learning from mother
- Gradual transition from milk to dry feed
- Gradual decrease in maternal care
- Adaptation and maturation of the gastrointestinal tract (variety of feed sources)

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Weaning: a critical transition period in pig husbandry

usually at 3- 4 wks of age

usually a combination of (stress) factors:

- Away from sow
- Different housing
- Mixing of litters
- Abrupt change from milk to dry feed

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Problems associated with weaning of pigs

- Health and performance
  - Low nutrient intake
  - Poor growth rate or even weight loss
  - Impaired intestinal functioning, diarrhoea
- Welfare
  - Stress responses
  - Maladaptive behaviours

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Prenatal flavour learning to reduce weaning problems in piglets

flavours maternal diet

amniotic fluid, milk

↓

exposure piglets *in utero*

↓

flavour recognition

↓

preference flavour ↑

↓

food neophobia ↓ ← stress ↓

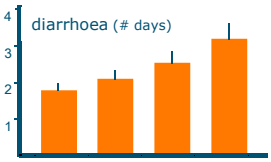
↓

feed intake at weaning ↑

↓

growth ↑, diarrhoea ↓

damaging behaviours ↓



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PhD Marije Oostindjer

Prenatal flavour learning...

Can it be used as a tool to improve piglet performance, health and welfare at weaning?

→ Flavour preference

→ Reduction of stress

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Flavour learning & performance post-weaning

- Piglets prenatally exposed to flavour sow's feed
  - → lower cortisol response and less vocalisations
  - → higher feed intake and higher growth
  - → less diarrhoea and less damaging behaviours

  … if flavour was present in post-weaning environment



Bolhuis et al. 2009 VFI in Pigs; Oostindjer et al. 2009 Chem Sens; 2010 Physiol Behav; 2011 PLoS ONE

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Flavour learning and resilience

Prenatal exposure to a favour combined with re-exposure around weaning makes piglets more robust against weaning stress

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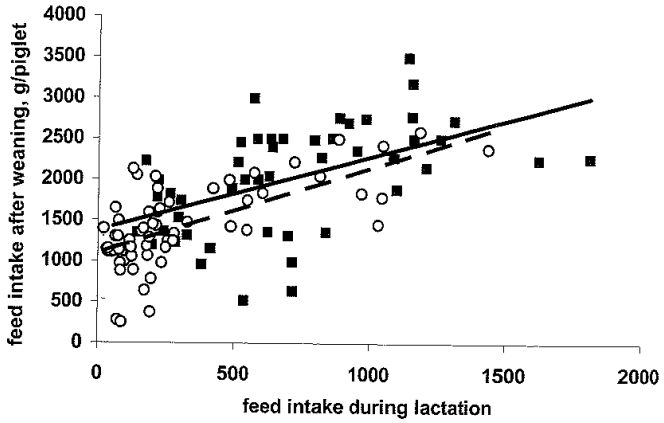
The importance of early feeding for resilience

Feed intake before and after weaning

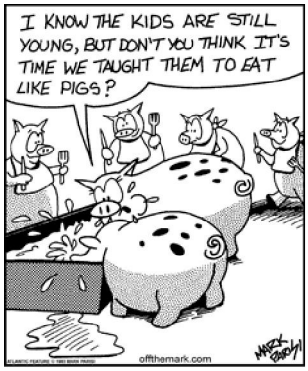


27 days lactation, creep feed from 7 days, feed intake after weaning first 7 days (g/piglet)

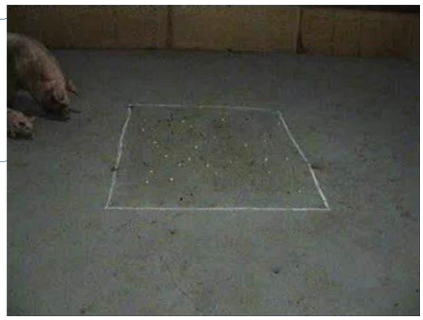
Kuller et al., 2004, JAS

Learning how to eat like a pig

Do piglets learn for mom what & where to eat



More interactions with the sow



- In the presence of the sow
  - → Reduced food neophobia
  - faster to touch the food (19 vs. 111 s)
  - consumed more food items (6.3 vs. 4.6)
- Loose-housed sow
  - → Higher preweaning growth
  - → Less damaging behaviours & more play behaviour after weaning

Oostindjer et al, 2010 Biol Lett; 2010 J Anim Sci

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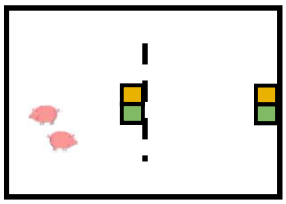
Social learning: processes and cues

- Observing sow and participating with sow both effective
  - Higher feed intake than controls, start to eat sooner
  - Preference for sow's feed and feeder
  - Observing sow more effective than own exposure to food!



Oostindjer et al. 2011, Anim. Beh.

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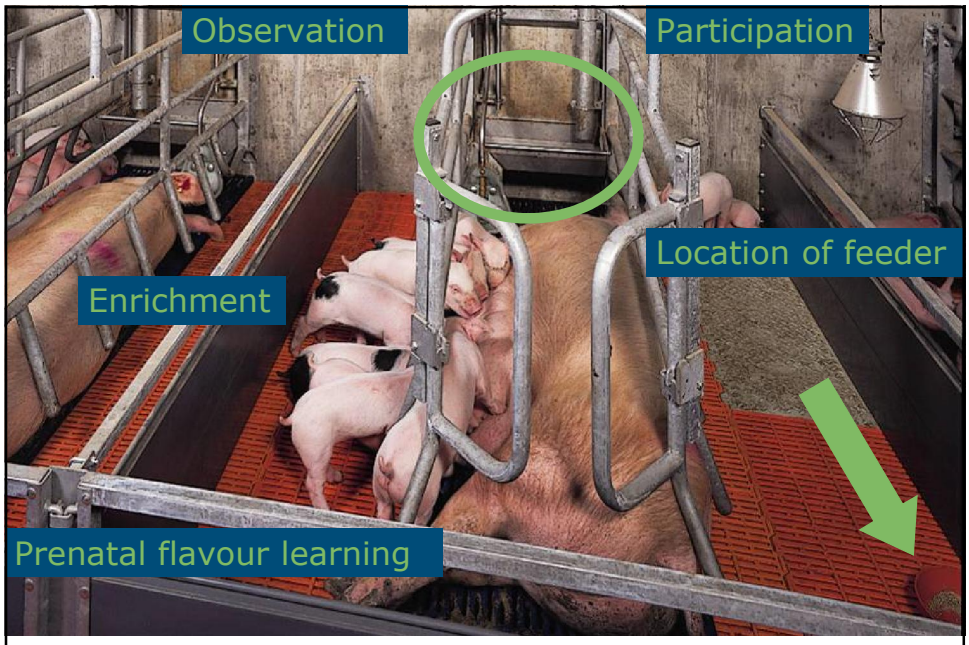
Conclusions on processes and cues in social learning

- Piglets should be able to participate in or at least to observe the sow eating
- Piglets prefer a similar flavoured sow feed
- Piglets prefer to eat at the same feeder as the sow



Early feed intake and resilience to weaning

Learning piglets what, how and where to eat improves resilience to weaning

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Effects of the current environment on resilience: environmental enrichment

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Foraging behaviour of pigs

- Opportunistic, omnivorous animals
  - Flexible in food choice (large range of potential food items)[1]
  - Flexible in circadian pattern (depending on e.g. predators or temperature)
- Exploration & foraging behaviour
  - Large part of active hours

[1] Schley & Rober, 2003

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Is foraging and exploration a behavioural need?

Pigs also show the behaviour when fed ad lib!

- Pigs are willing to work for enrichment materials[1]
- Working for food: positive effects on health and welfare[2]
- When enrichment material is absent[3]
  - Stress related differences in HPA-axis; stomach wall lesions; less play behaviour; more pessimistic ('the glass is half empty')
- Redirected foraging and exploration behaviour[4]
  - Use of pen fixtures or pen mates as alternative rooting 'material'
  - More tail and ear biting and other manipulative behaviour directed at pen mates

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[1] Ladewig & Matthews 1996; [2] Ernst et al. 2006; Zebunke et al. 2013; [3] Douglas et al. 2012; [4] Bolhuis et al. 2005

Redirected behaviours on pen mates

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Maladaptive behaviour can start early in life

- This manipulative behaviour can start early
- At weaning (4 wks) ~5-10% piglets (small) tail wound
- Pigs can also damage sow (tail, vulva, ears)

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Ursinus et al. 2014

Enrichment and health

Enrichment:

- Reduces tail and ear biting (wounds and infections, culling, carcass condemnation)
- Reducing tail and ear biting and other manipulative behaviour positively affects growth (victims grow 43 g/day less)[1]
- Makes animals more robust against disease challenges

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[1]Camerlink et al. 2012

Enriched housing before and after weaning

Versus a barren environment

Dixhoorn et al. 2016

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Enriched vs barren: effects on a challenge

- 14 days after weaning PRRSv challenge
- 22 days after weaning APP challenge

- PRRSv: Porcine Reproductive and Respiratory Syndrome virus
- APP: Actinobacillus Pleuropneumoniae
- Model for multifactorial lung challenge

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	Barren	Enriched	
	BHI pigs (%)	EHI pigs (%)	p- value [1]
Pigs with lung lesions	57.1	7.1	<0.05
re-isolated A. pp	35.7	7.1	NS

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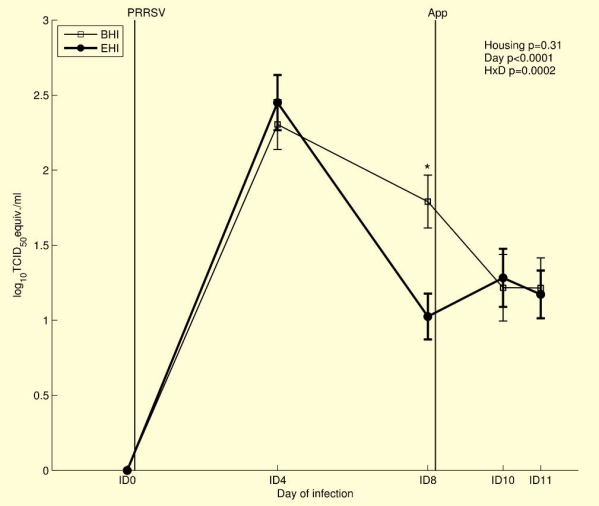
Results Virology ('Viral clearance')



PRRSV qRT-PCR serum in BHI and EHI pigs (Averages ± SEM). Moments of infections PRRSV at ID0 and A. *pleuropneumoniae* at ID8. *(P<0.05)

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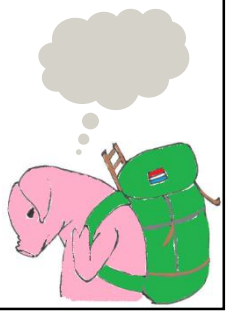
Environmental enrichment and resilience

- Providing in a behavioural need like the need to forage and explore does not only effect welfare but also the resilience against disease
- There is cross talk between the physiological systems
- Is it a matter of allostatic load or frailty, stress?
- How can we measure this?



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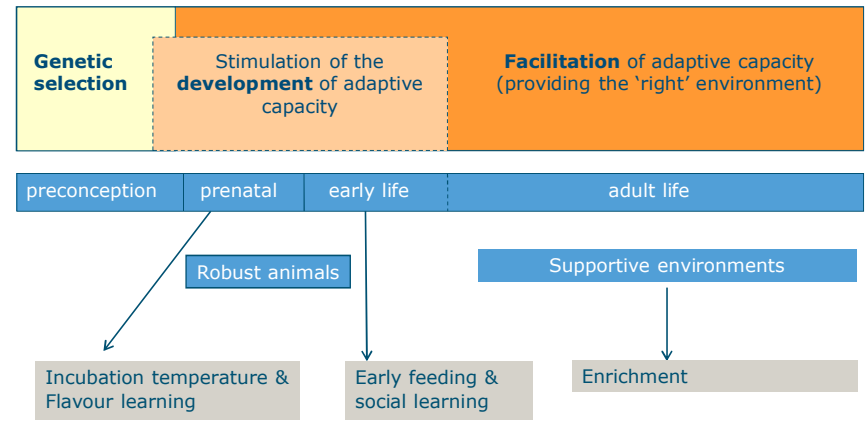
A flavour of our efforts to shape health and welfare by supporting the ability to adapt



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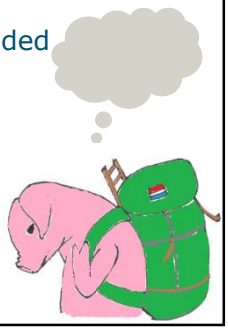
Take home messages

- The perinatal environment has substantial effects on later life resilience
- In housing and management of animals in early stages of life effects on later resilience need to be considered
- The current housing affect resilience and there is cross talk between different regulatory systems
- Parameters for allostatic load or frailty are needed



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Thank you

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Questions?

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