

GENETIC IMPROVEMENT OF PIG WELFARE

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Sanco Training, 27-30 September 2011



OUTLINE

- ✓ (Ethical) Background
- ✓ Genetic Improvement Strategies
- ✓ Review of SOME studies on Genetic Improvement of pig welfare
- ✓ Further "complications"
- ✓ General recommendations

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ETHICAL BACKGROUND

- ✓ Welfare policies, legislation and discussions are often based on **environment and management**

- ✓ BUT, "**genetic suitability**" is receiving more attention

FAWC is aware that selection for temperament is becoming increasingly important in breeding programmes. This is particularly the case for species such as pigs..." (FAWC, 2004)

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ETHICAL BACKGROUND



QUESTION 1

DO WE HAVE TO ADAPT ENVIRONMENTS TO ANIMALS OR ANIMALS TO ENVIRONMENTS?



BOTH



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ETHICAL BACKGROUND



QUESTION 2

ARE THERE ANIMALS **BETTER ADAPTED** TO "COPE" WITH CERTAIN ENVIRONMENTS?



YES (UP TO A CERTAIN DEGREE)



IS IT ACCEPTED FROM AN ETHICAL POINT OF VIEW?



YES (MAINLY)



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ETHICAL BACKGROUND



QUESTION 3

CAN WE BREED OR SELECT FOR TRAITS TO IMPROVE PIG WELFARE?



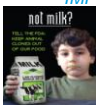
YES (UP TO A CERTAIN DEGREE)



IS IT ACCEPTED FROM AN ETHICAL POINT OF VIEW?



????????????????????



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ETHICAL BACKGROUND

Ethical issues

- ✓ Can we change "the intrinsic characteristics" of pigs?
- ✓ Can we select for "easy care animals"? → we don't have to care
- ✓ Can we alter "animal integrity"?
- ✓ Do we want to transform pigs into "uniform beings"?



"Staying good while playing God" (Sandó et al, 1999)

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GENETIC IMPROVEMENT STRATEGIES

✓ SELECTION BETWEEN BREEDS



✓ CROSSBREEDING → "HYBRID VIGOUR"



✓ SELECTION WITHIN BREEDS



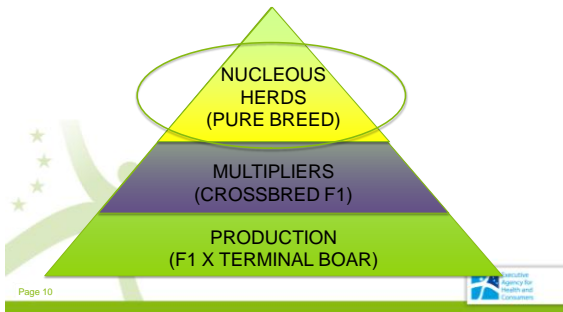
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GENETIC IMPROVEMENT STRATEGIES



PYRAMID FOR GENETIC PROGRESS



GENETIC IMPROVEMENT STRATEGIES



SELECTION WITHIN BREED

- (1) Deciding **BREEDING GOAL**
- (2) Deciding **SELECTION CRITERION**
- (3) Deciding **BREEDING PROGRAMME**
- (4) Implementing the programme
- (5) Monitoring progress and redesigning the programme



GENETIC IMPROVEMENT STRATEGIES



BREEDING GOALS TO IMPROVE ANIMAL WELFARE

- (1) PHYSICAL ADAPTATION
- (2) BEHAVIOURAL ADAPTATION
- (3) DISEASE RESISTANCE





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REVIEW STUDIES

THE FIVE FREEDOMS (FAWC)

- FREEDOM FROM HUNGER AND THIRST
- FREEDOM FROM THERMAL AND PHYSICAL DISCOMFORT
- FREEDOM FROM PAIN, INJURY OR DISEASE
- FREEDOM TO EXPRESS NORMAL BEHAVIOUR
- FREEDOM FROM FEAR AND DISTRESS



REVIEW STUDIES

WELFARE QUALITY PRINCIPLES®

- GOOD FEEDING
- GOOD HOUSING
- GOOD HEALTH
- APPROPRIATE BEHAVIOUR



REVIEW STUDIES: GOOD FEEDING



DIFFERENCES IN FEEDING STRATEGIES BETWEEN PURE BREEDS (MEAL EATERS VS. NIBBLERS)



FREQUENCY OF FEEDER VISITS	RATE OF FEED INTAKE
CIRCADIAN RHYTHM	AVERAGE DAILY GROWTH
MEAL CRITERION	PRANDIAL CORRELATIONS



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(Fernández et al., 2011)



REVIEW STUDIES: GOOD FEEDING



DIFFERENCES IN FEEDING STRATEGIES BETWEEN PURE BREEDS (MEAL EATERS VS. NIBBLERS)



FREQUENCY OF FEEDER VISITS	RATE OF FEED INTAKE
MEAL EATERS (few long visits every day)	FAST EATER
NIBBLERS (many short visits every day)	SLOW EATER



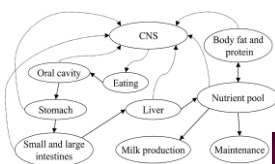
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REVIEW STUDIES: GOOD FEEDING



SOWS IN LACTATION: SELECTION FOR INCREASED FEED INTAKE TO INCREASE MILK YIELD



Regulation of feed intake in lactating sows (from Eissen et al., 2000)

✓ SELECTION FOR ↑ FEED INTAKE IN LACTATING SOWS
POSSIBLE (MODERATE h^2 0.19-0.42)

✓ DIRECT SELECTION OR INDIRECT (PRODUCTION TRAITS)

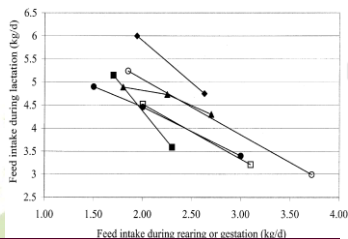
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REVIEW STUDIES: GOOD FEEDING



WHAT HAPPENS THEN FOR SOWS IN GESTATION??



FEED
RESTRICTION

HUNGER AND
STEREOTYPES



Results from different studies (from Eissen et al., 2000)

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REVIEW STUDIES: GOOD FEEDING



WHAT HAPPENS IN SOWS IN GESTATION?? INCREASE FEED EFFICIENCY??

RESIDUAL FEED INTAKE = OBSERVED - EXPECTED
FEED INTAKE

(Based on average requirements for maintenance of body weight and gain,
Koch et al. 1967)

FEED
EFFICIENCY



RFI h^2 0,15-0,40

Selection for \downarrow RFI \rightarrow \downarrow DFI

(Cai et al., 2008; Gilbert et al., 2008)

(Saintilan et al., 2011)

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REVIEW STUDIES: GOOD HOUSING



LEANER LACTATING SOWS: MORE DISCOMFORT??



SELECTION
FOR LEANESS

SOW
DISCOMFORT

POSTURE
CHANGES

PIGLET
CRUSHING

(McPhee et al., 2001; Menieur-Salaün et al., 1991; Shi-quan et al., 2011...)

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REVIEW STUDIES:
GOOD HEALTH



SOW ROBUSTNESS AND LONGEVITY

AGRESSIVE BEHAVIOUR IN GROWING PIGS AND SOWS

TAIL BITING

DISEASE RESISTANCE

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REVIEW STUDIES:
GOOD HEALTH



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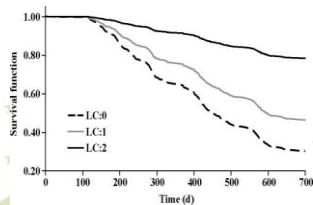
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REVIEW STUDIES:
GOOD HEALTH



SOW ROBUSTNESS AND LONGEVITY



MODERATE
ESTIMATES OF h^2 ,
BUT SURVIVABILITY
GENETICALLY
IMPROVED BY
DIRECT SELECTION
FOR LEG
CONFORMATION

Survival probability of Duroc sows depending on overall leg score

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(Fernández de Sevilla et al., 2008)



REVIEW STUDIES: GOOD HEALTH



SOW ROBUSTNESS AND LONGEVITY

AGGRESSIVE BEHAVIOUR IN GROWING PIGS AND SOWS

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REVIEW STUDIES: GOOD HEALTH



AGGRESSIVE BEHAVIOUR IN GESTATING SOWS IN LOOSE HOUSED GROUS

- ✓ Aggressive behaviour recorded in field study
- ✓ Sows mixed in a "test arena" during pregnancy
- ✓ Groups of 8 sows studied for 30 min. (800 sows)

- ✓ Individual records
- attacks given
- attacks received

ANIMAL MODEL WITH 2 GENETIC EFFECTS:

Give attack $h^2 = 0.09$
Receive attack $h^2 = 0.02$

ANIMAL MODEL WITH 1 GENETIC EFFECT:

Record only sum of given attacks $h^2 = 0.22$



(Lövendahl et al, 2005)

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REVIEW STUDIES: GOOD HEALTH



AGGRESSIVE BEHAVIOUR IN GESTATING SOWS IN LOOSE HOUSED GROUS

- ✓ Helbrügge et al (2008) recorded aggressiveness in groups of pregnant sows during washing before farrowing

18 % OF SOWS AGGRESSIVE
 $h^2 = 0.3$



- ✓ Helbrügge et al (2008) and Lövendahl et al (2005) found favourable genetic correlations:

LESS AGGRESSION-BETTER MATERNAL BEHAVIOUR



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REVIEW STUDIES: GOOD HEALTH



AGGRESSIVE BEHAVIOUR IN GROWING PIGS

✓ 24 h video recording after mixing

(Turner et al (2009))

Fighting (reciprocal) $h^2 = 0.4$

Bullies, deliver $h^2 = 0.3$

Bullies, receive $h^2 = 0.1$

Fighting and deliver bullies $r_g = 0.8$

Fighting and receive bullies $r_g = 0.0$

Deliver and receive bullies $r_g = -0.4$



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REVIEW STUDIES: GOOD HEALTH



AGGRESSIVE BEHAVIOUR IN GROWING PIGS

✓ Pigs selected for high lean tissue growth rate are more aggressive during transport

(Busse & Shea-Moore (1999))

✓ Social rank during feeding ($h^2 = 0.5$) is genetically correlated to growth rate

(Jonsson & Jørgensen (1989))

✓ Schinkel et al (2003) propose: Selection for growth results in increased aggressiveness

✓ Canario et al (2008): High breeding values for growth rate initiate more fights and bullies



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REVIEW STUDIES: GOOD HEALTH



AGGRESSIVE BEHAVIOUR IN GROWING PIGS : THE GROUP MODEL

✓ To estimate breeding values for unfavourable behaviours without recording behaviour:

(Muir (2005))

THE GROUP MODEL

✓ TWO GENETIC EFFECTS:

• direct (own growth)

• associative (influence on pen mates growth)

Correlation between direct and associative effects



ARE PIGS COOPERATIVE OR COMPETITIVE ?



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REVIEW STUDIES: GOOD HEALTH



AGGRESSIVE BEHAVIOUR IN GROWING PIGS :THE GROUP MODEL

ARE PIGS COOPERATIVE OR COMPETITIVE ?

Pigs staying calm, eating without disturbing group members

↓
High EBV for direct and associative effects

→ aggressive behaviour at mixing (ability to quickly establish rank order)

- is not necessarily a "bad behaviour"
- is probably not correlated to aggressive behaviour once rank order is established

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(Canario et al., 2010)



REVIEW STUDIES: GOOD HEALTH



SOW ROBUSTNESS AND LONGEVITY

AGGRESSIVE BEHAVIOUR IN GROWING PIGS AND SOWS

TAIL BITING

DISEASE RESISTANCE

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REVIEW STUDIES: GOOD HEALTH



TAIL BITING

✓Difficult to record the biter!

✓Test: Biting behaviour towards a rope

✓Duroc showed more rope biting (and ear-biting) than Landrace and Large White



(Breuer et al., 2003)

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REVIEW STUDIES: GOOD HEALTH



TAIL BITING



INJURED
 $h^2 = 0.0$



(Breuer et al., 2003)

3 % classified as
"biters"

BITING
Large White $h^2 = 0.0$
Landrace $h^2 = 0.3$

UNFAVOURABLE GENETIC CORRELATIONS

TAIL BITING	HIGH LEAN TISSUE GROWTH RATE
TAIL BITING	LOW BACKFAT THICKNESS



REVIEW STUDIES: APPROPRIATE BEHAVIOUR



MATERNAL BEHAVIOUR AND PIGLET SURVIVAL

FEAR TO HUMANS

STRESS SUSCEPTIBILITY

EXPLORATIVE BEHAVIOUR

BEHAVIOURAL STRATEGIES

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REVIEW STUDIES: APPROPRIATE BEHAVIOUR



**WHAT IS "NATURAL"
BEHAVIOUR ?**



**WHAT IS "NATURAL"
BEHAVIOUR IN CONFINED
ENVIRONMENTS?**

**DOMESTICATION HAS NOT MODIFIED TO A GREAT
EXTENT THE "NEED" TO PERFORM CERTAIN
BEHAVIOURS (NESTING BEHAVIOUR, FORAGING...)**

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REVIEW STUDIES: APPROPRIATE BEHAVIOUR



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REVIEW STUDIES: APPROPRIATE BEHAVIOUR



SELECTION FOR GOOD MATERNAL BEHAVIOUR: SAVAGING BEHAVIOUR/INFANTICIDE

✓ Infanticide is heritable: **0.4- 0.9**

Knap & Merks, 1987

✓ Several QTL found

Quilter et al, 2007

BUT: UNDERLYING CAUSES STILL NOT TOTALLY CLEAR...

↑ Restlessness before farrowing (Jarvis et al., 2004)

↑ Excitability not piglet directed (Chen et al., 2008)

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REVIEW STUDIES: APPROPRIATE BEHAVIOUR



SELECTION FOR GOOD MATERNAL BEHAVIOUR: CAREFULNESS

✓ Crushing and sows' reaction to screaming piglets are heritable traits

✓ Genetic correlation:
stronger reaction - lower mortality

(Grandinson et al, 2003; Helbrügge et al, 2008)



BUT...

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REVIEW STUDIES: APPROPRIATE BEHAVIOUR



SELECTION FOR MATERNAL BEHAVIOUR: DIRECT OR INDIRECT SELECTION? WHICH TRAITS TO CHOOSE?

	h^2
Group Behaviour	0.07
Maternal Ability	0.06
Crushing of piglets	0.03
Savaging of piglets	0.02

**IS IT BETTER TO SELECT FOR
PIGLET SURVIVAL?**

(Gäde et al., 2008)

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REVIEW STUDIES: APPROPRIATE BEHAVIOUR



SELECTION FOR PIGLET VITALITY



	Crossbred	Purebred
Birth weight (kg)	1.29	1.21
Reactivity score	1.38	1.03



	Crossbred	Purebred
Birth weight (kg)	1.08	0.86
Reactivity score	1.03	1.00

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(Dauberlieu et al., 2011, EAAP congress)



REVIEW STUDIES: APPROPRIATE BEHAVIOUR



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REVIEW STUDIES: APPROPRIATE BEHAVIOUR



h² OF FEAR TO HUMANS OR ATTITUDE TO HUMANS

	h ²	Reference
Gilts	0.4	Hemsworth, 1990
Gilts	0.1	Helbrügge et al, 2007
Sows	0.1	Grandinson et al, 2003
Sows	0.1	Vangen et al, 2005
Sows	0.1	Gäde et al, 2008
Minipigs	0.1	Köhn et al, 2009

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REVIEW STUDIES: APPROPRIATE BEHAVIOUR



MATERNAL BEHAVIOUR AND PIGLET SURVIVAL

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EXPLORATIVE BEHAVIOUR

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REVIEW STUDIES: APPROPRIATE BEHAVIOUR



RYR(1)- GENE SUSCEPTIBILITY TO STRESS



**MUTATION RYANODINE
RECEPTOR**

	NN	Nn
Number of grid lines crossed	18.6	12.4
Number of defecations	16.3	14.7

Ryr(1) carriers less active in an open field test

(Fàbrega et al., 2004)

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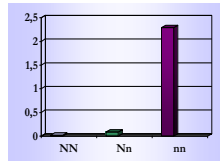
REVIEW STUDIES: APPROPRIATE BEHAVIOUR



RYR(1)- GENE SUSCEPTIBILITY TO STRESS: MORTALITY DURING TRANSPORT



Frequencies of death:
0.02 % NN
0.09 % Nn
2.29 % nn



SIGNIFICANT REDUCTION OF TRANSPORT MORTALITY

(Fàbrega et al., 2003)



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REVIEW STUDIES: APPROPRIATE BEHAVIOUR



MATERNAL BEHAVIOUR AND PIGLET SURVIVAL

FEAR TO HUMANS

STRESS SUSCEPTIBILITY

BEHAVIOURAL STRATEGIES

EXPLORATIVE BEHAVIOUR

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REVIEW STUDIES: APPROPRIATE BEHAVIOUR



BEHAVIOURAL STRATEGY AND TONIC IMMOBILITY TEST



Large White Landrace

% TI pigs

69.09

45.31

Duration TI (s)

15.05

7.18

(Fernández de Sevilla et al., 2009)

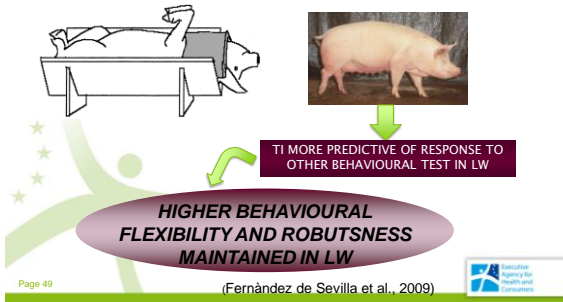


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REVIEW STUDIES: APPROPRIATE BEHAVIOUR



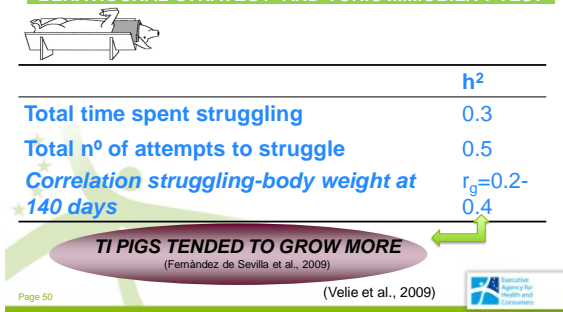
BEHAVIOURAL STRATEGY AND TONIC IMMOBILITY TEST



REVIEW STUDIES: APPROPRIATE BEHAVIOUR



BEHAVIOURAL STRATEGY AND TONIC IMMOBILITY TEST



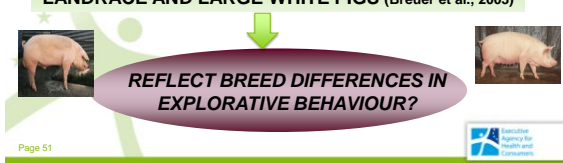
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BREED DIFFERENCES IN EXPLORATIVE BEHAVIOUR

The pig is an omnivorous, opportunistic generalist

BREED DIFFERENCES IN TAIL BITING BETWEEN LANDRACE AND LARGE WHITE PIGS (Breuer et al., 2003)





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FURTHER COMPLICATIONS

TAKE INTO ACCOUNT...

- ✓ **Epigenetic** effects on behavioural (ie welfare traits)
(Jensen, 2009)
- ✓ **Behavioural variation** within clone of pigs, even when born and raised in the same litter (Archer et al, 2003)
- ✓ **Foetal preprogramming** and **Neonatal handling** effects
- ✓ **Genetic X Environment** interactions (ie behaviour is shaped by experience and learning, which in turn is a heritable trait!!)

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SOME RECOMMENDATIONS



TAKE HOME MESSAGES ?

- ✓ SELECTION FOR LOW AGRESSIVITY IN GROUPS
- ✓ SELECTION AGAINST FEAR TO HUMANS. BUT UP TO WHAT EXTENT??
- ✓ SELECTION FOR PIGLET SURVIVAL AND GROWTH (DIRECT AND MATERNAL EFFECTS) PROBABLY EASIER THAN SELECTION FOR MATERNAL BEHAVIOUR



MANY THANKS FOR YOUR ATTENTION!!!



MANY THANKS TO LOTTA RYDHMER FOR SUPPORT, IDEAS AND INFORMATION!!