# Redesigning selection objectives to improve animal welfare

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*Leading the way in Agriculture and Rural Research, Education and Consulting*

# Introduction

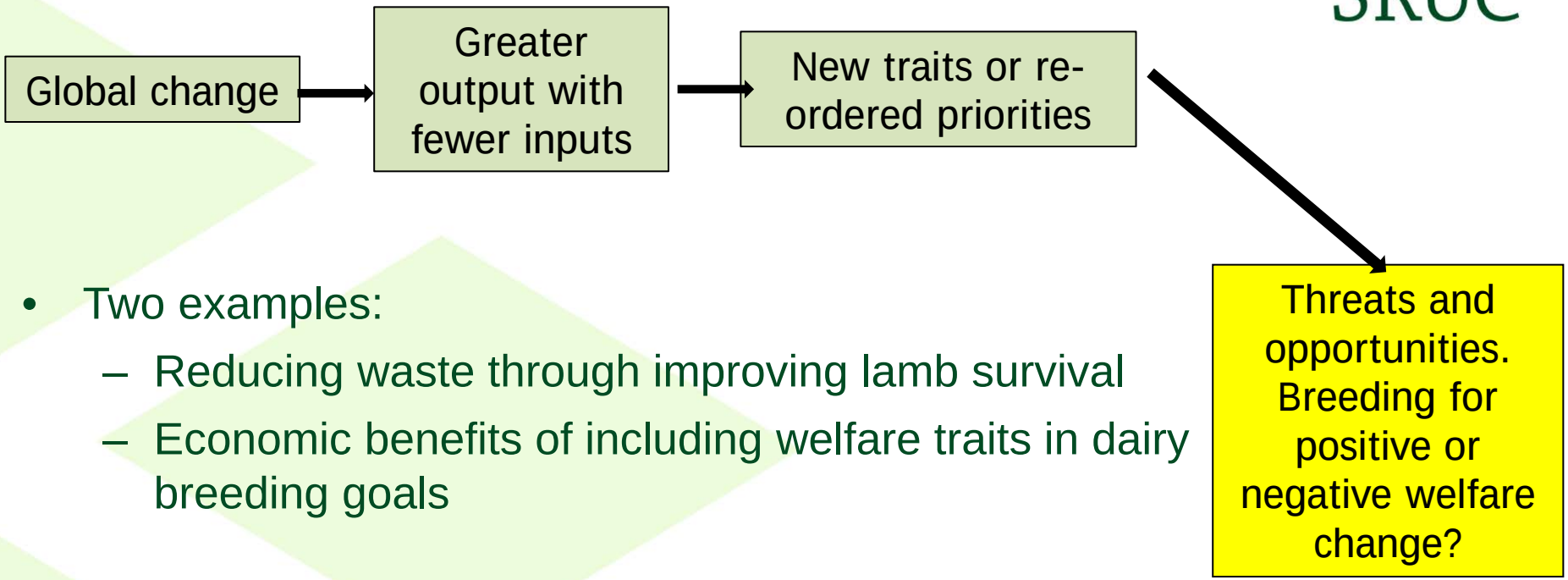
Why redesign selection objectives to improve animal welfare?

Possibilities and consequences

Next steps: What do we still need to know?

How do we practically improve animal welfare through breeding?

# Why redesign selection objectives to improve animal welfare?




- Two examples:
  - Reducing waste through improving lamb survival
  - Economic benefits of including welfare traits in dairy breeding goals

# Improving lamb survival

- Average pre-weaning lamb mortality at least 15%
  - As high as 40% on some farms
  - More ewes required to produce same number of lambs at weaning (environmental issues)
  - Significant welfare and economic challenge
- Lamb survival is a multifactorial issue
  - Heritability generally low (<0.05-0.2, Safari et al., 2005; Sawalha et al., 2007)
- Selection for indicator traits might be an alternative e.g.:
  - Lamb behaviours related to survival (Dwyer et al.,2003; Cloete et al 2005)
  - Thermoregulatory ability (Dwyer & Morgan, 2006, Dwyer & Nath, in prep; Slee et al., 1991)

# Genetic Parameters for lamb behaviours

Matheson et al., 2012

| | Birth Assistance | Vigour | Sucking Assistance |
|---|---|---|---|
| Birth Assistance | **0.26 ± 0.033** | | |
| Vigour | | **0.39 ± 0.037** | |
| Sucking Assistance | | | **0.31 ± 0.034** |

# Genetic Parameters for lamb behaviours

Matheson et al., 2012

| | Birth Assistance | Vigour | Sucking Assistance |
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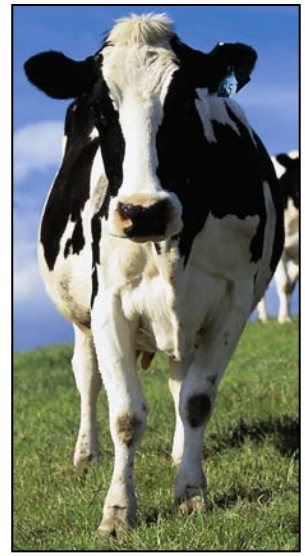
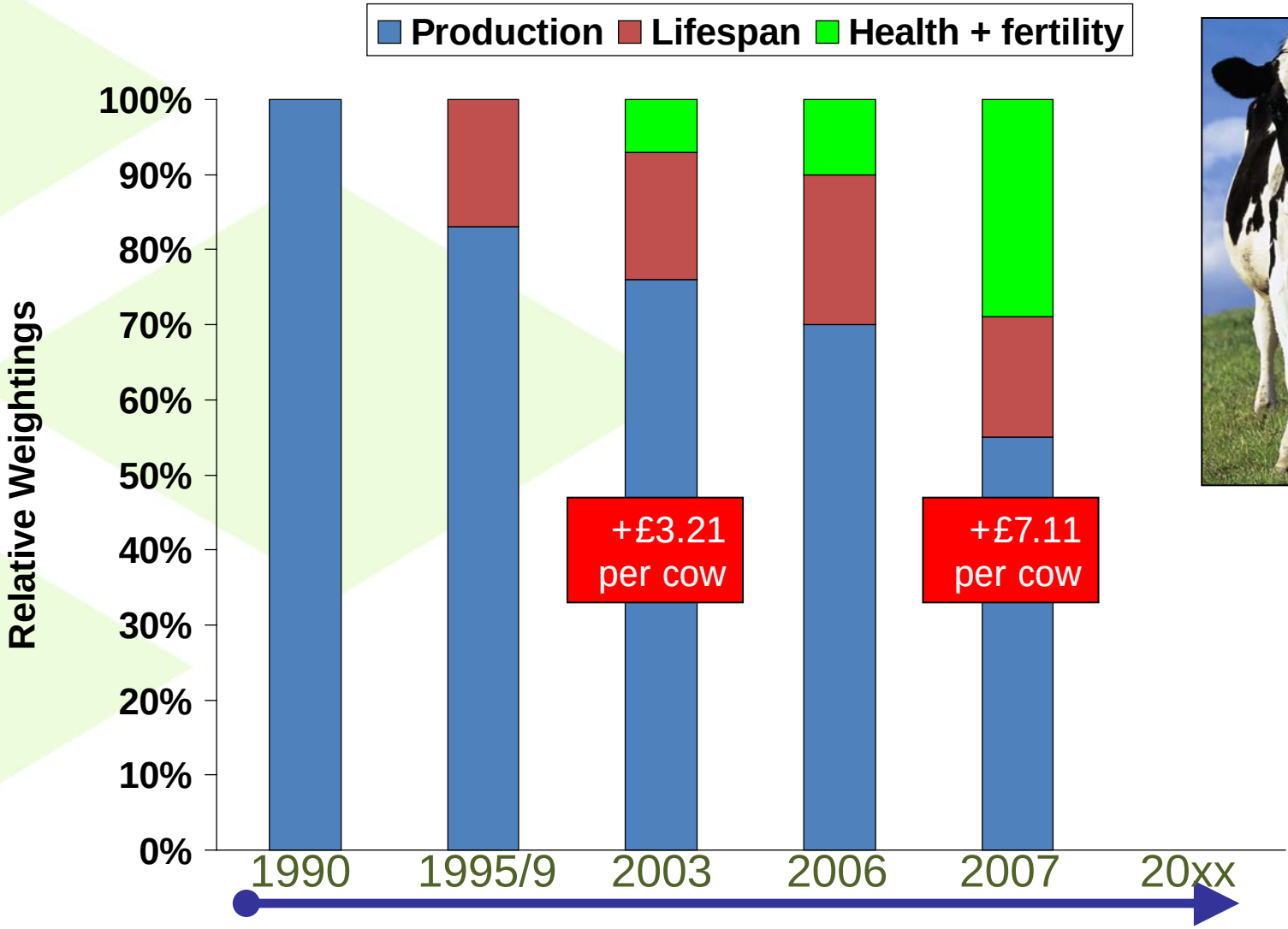
| Birth Assistance | **0.26 ± 0.033** | | |
| Vigour | 0.68 œ0.059 | **0.39 ± 0.037** | |
| Sucking Assistance | 0.54 œ0.074 | 0.80 œ0.038 | **0.31 ± 0.034** |

No genetic correlation with birth weight or growth/back fat parameters

# Development of UK dairy breeding goal





# Why redesign selection objectives to improve animal welfare?

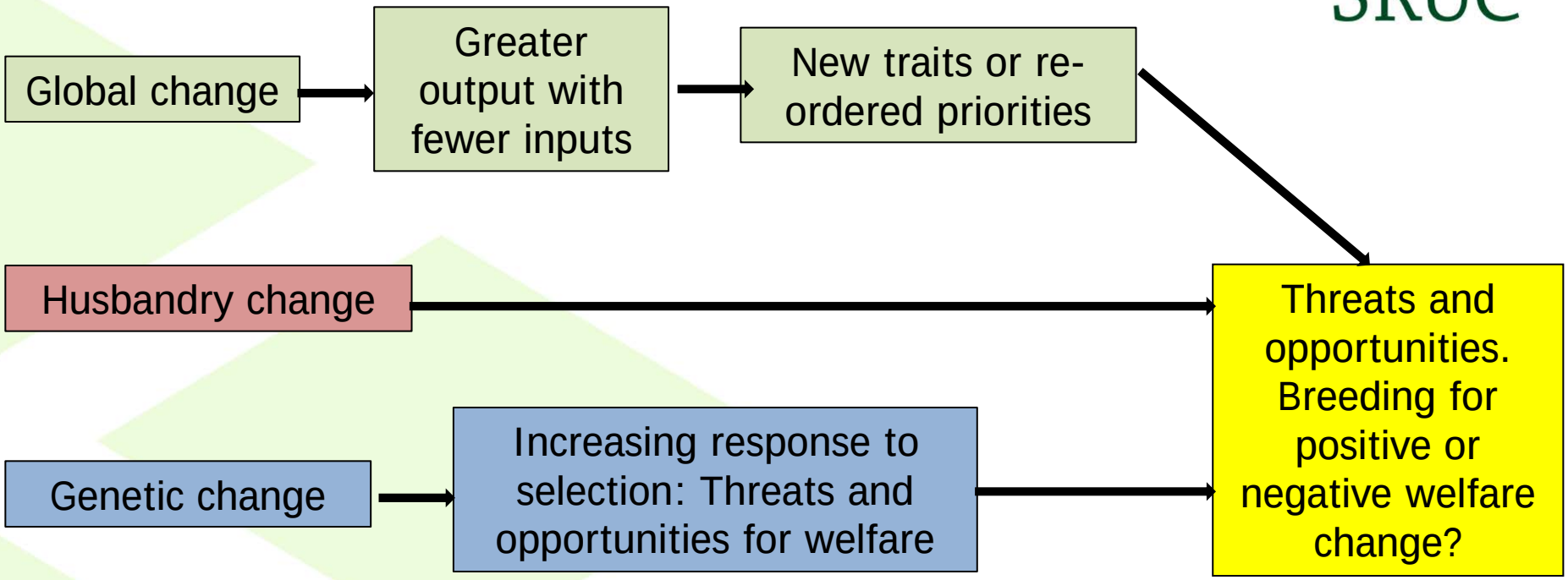
Global change → Greater output with fewer inputs → New traits or re-ordered priorities

Husbandry change

Threats and opportunities. Breeding for positive or negative welfare change?




# Why redesign selection objectives to improve animal welfare?




Lean tissue growth rate

Back fat
(Breuer et al. 2005)

WATTAgNet.com

Early sexual maturation
(Jensen et al. 2005)

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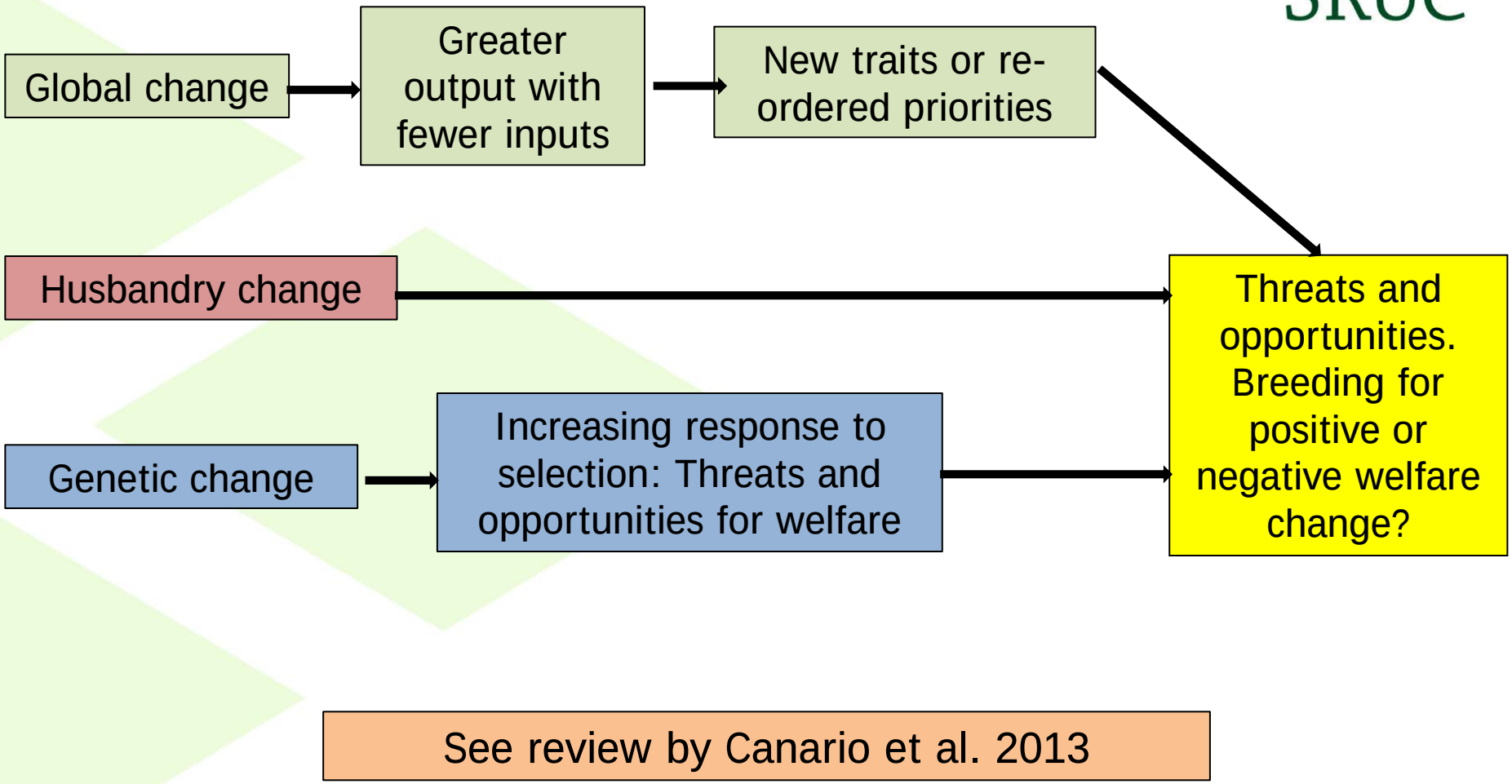


See review by Canario et al. 2013

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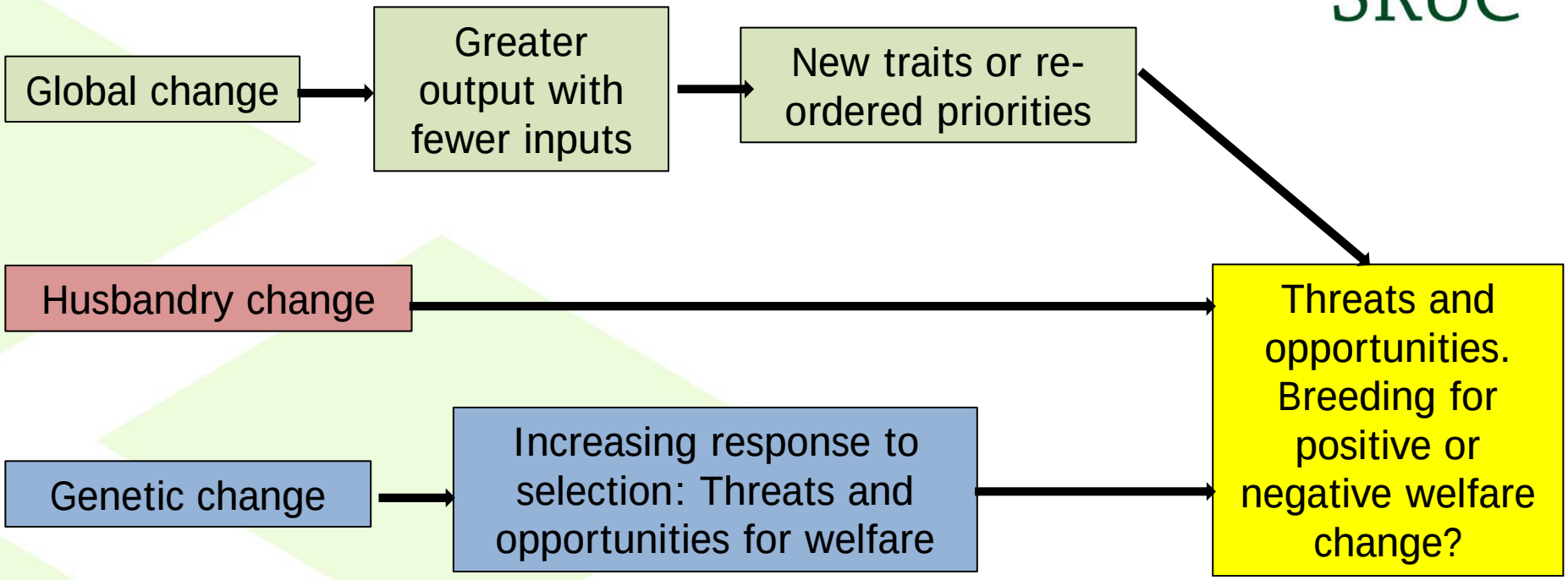



Intractable welfare problems

- Tail biting
- Ear biting
- Savaging
- Aggression
- Feather pecking
- Cannibalism
- Fin chewing

# Why redesign selection objectives to improve animal welfare?

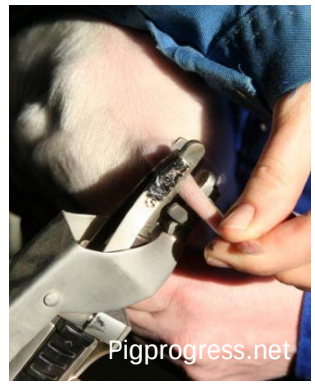
Global change → Greater output with fewer inputs → New traits or re-ordered priorities

Husbandry change

Genetic change → Increasing response to selection: Threats and opportunities for welfare

Threats and opportunities. Breeding for positive or negative welfare change?

Intractable welfare problems → Current solutions are problematic or minimally effective



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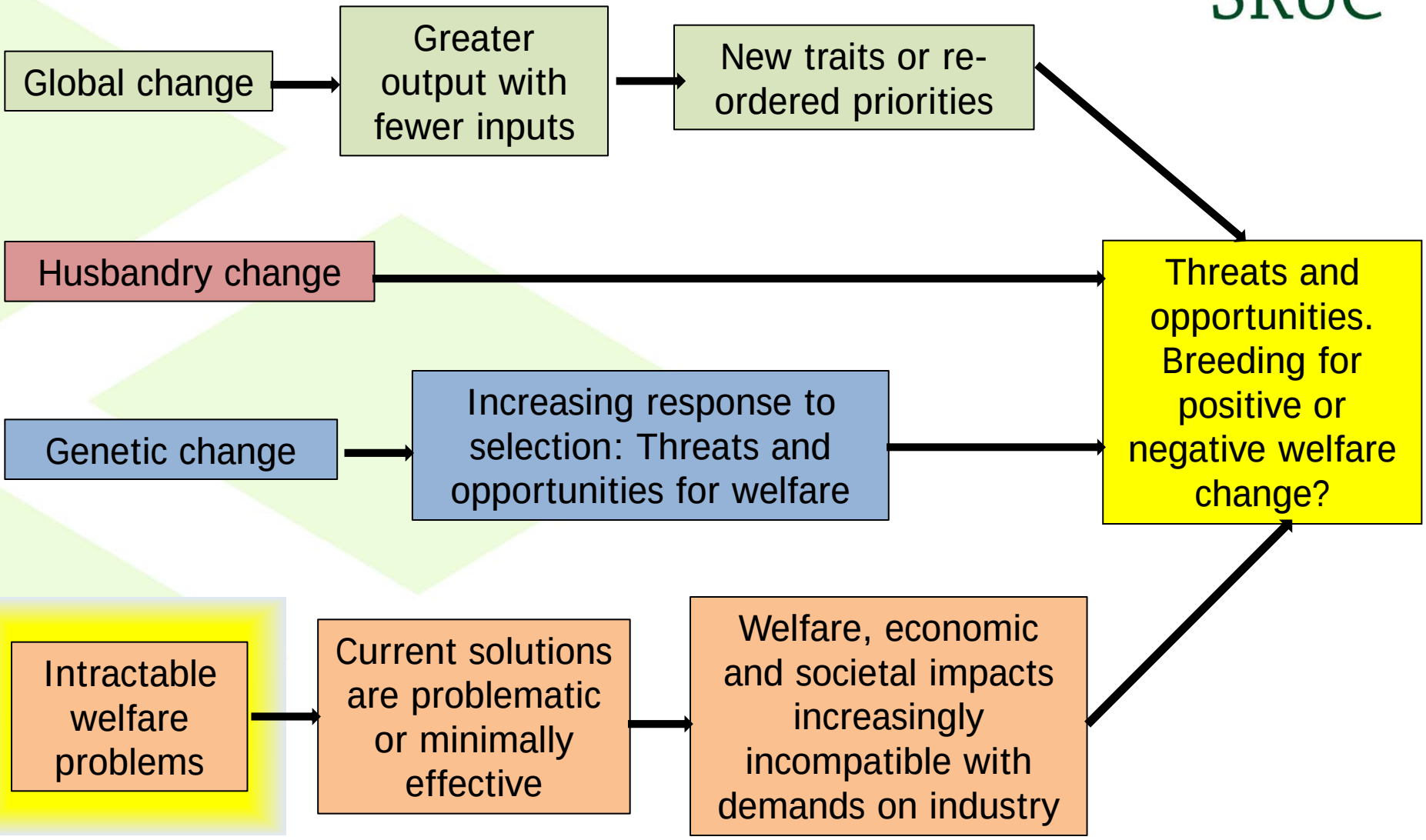
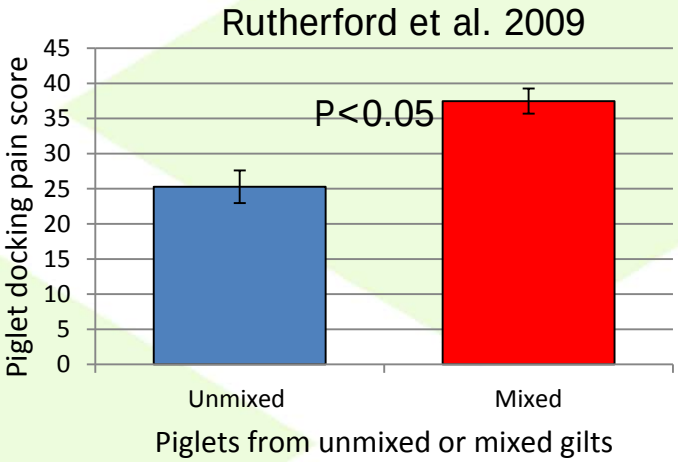


# Possibilities and consequences of breeding for improved welfare

- Some of the most intractable welfare problems involve complex social behaviour
  - Traits examined so far are heritable
- Proved resilient to low-cost management change without incurring other welfare costs
- Economically, environmentally and socially unacceptable
  - The status quo is highly costly to all

# Example 1: Pig aggression
## The problem

- Mixing is routine
- Post-mixing aggression:
  - ↑ injury, disease, activity
  - ↓ food intake, FCE, growth rate, reproductive success
- A source of pre-natal stress

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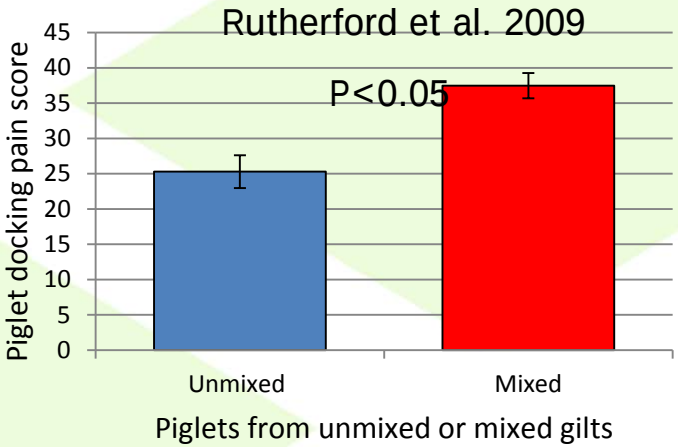
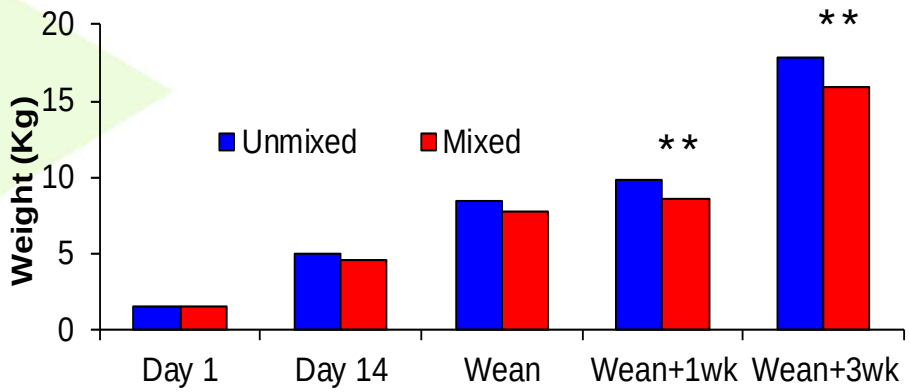


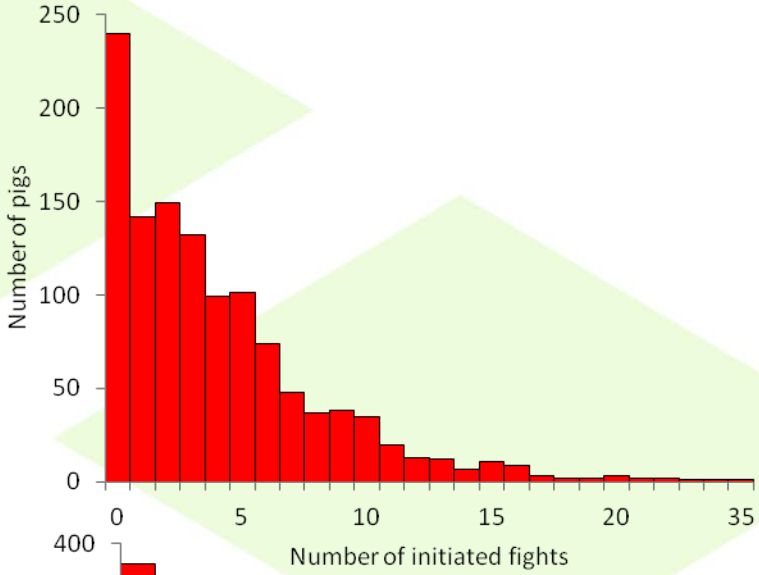

Jarvis et al. 2006

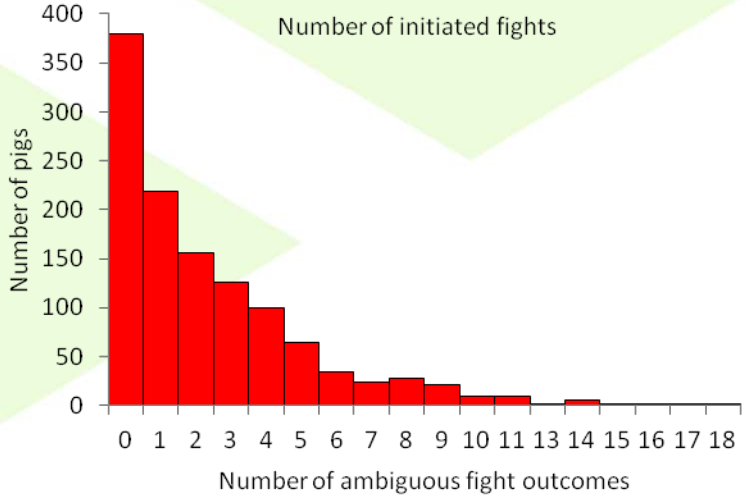


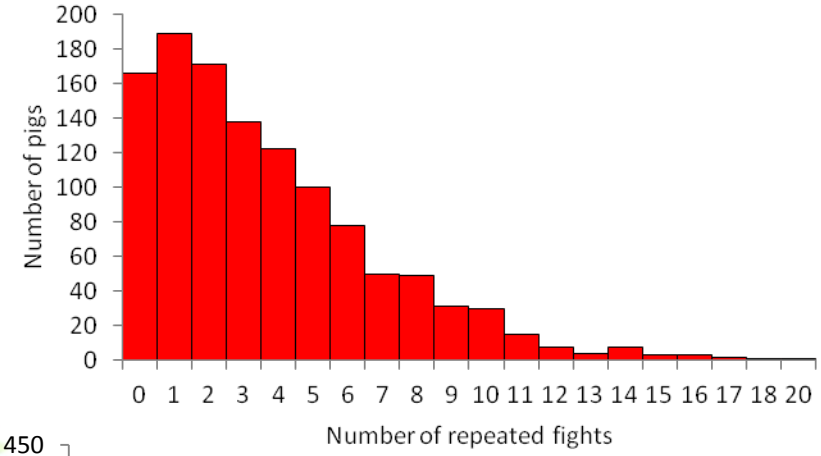

- A significant and routine challenge to welfare, economic performance and environmental sustainability

# Possibilities for a breeding solution

- Considerable variation in aggressiveness



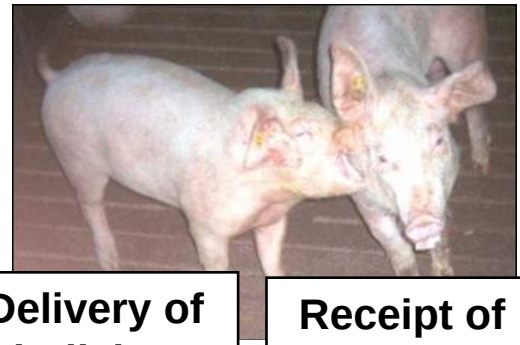




Desire et al In prep

**Reciprocal fighting**

$h^2$=0.43
(se 0.04)

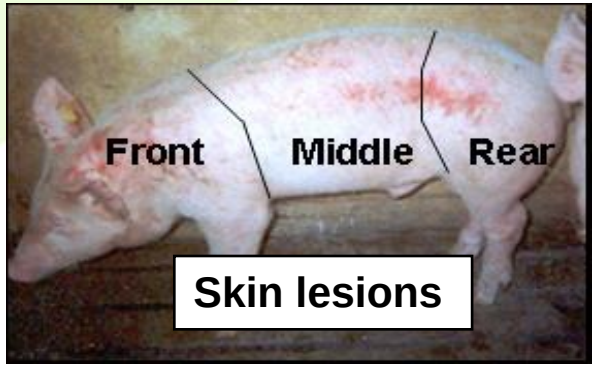


**Delivery of bullying**

$h^2$=0.31
(se 0.04)

**Receipt of bullying**

$h^2$=0.08
(se 0.03)



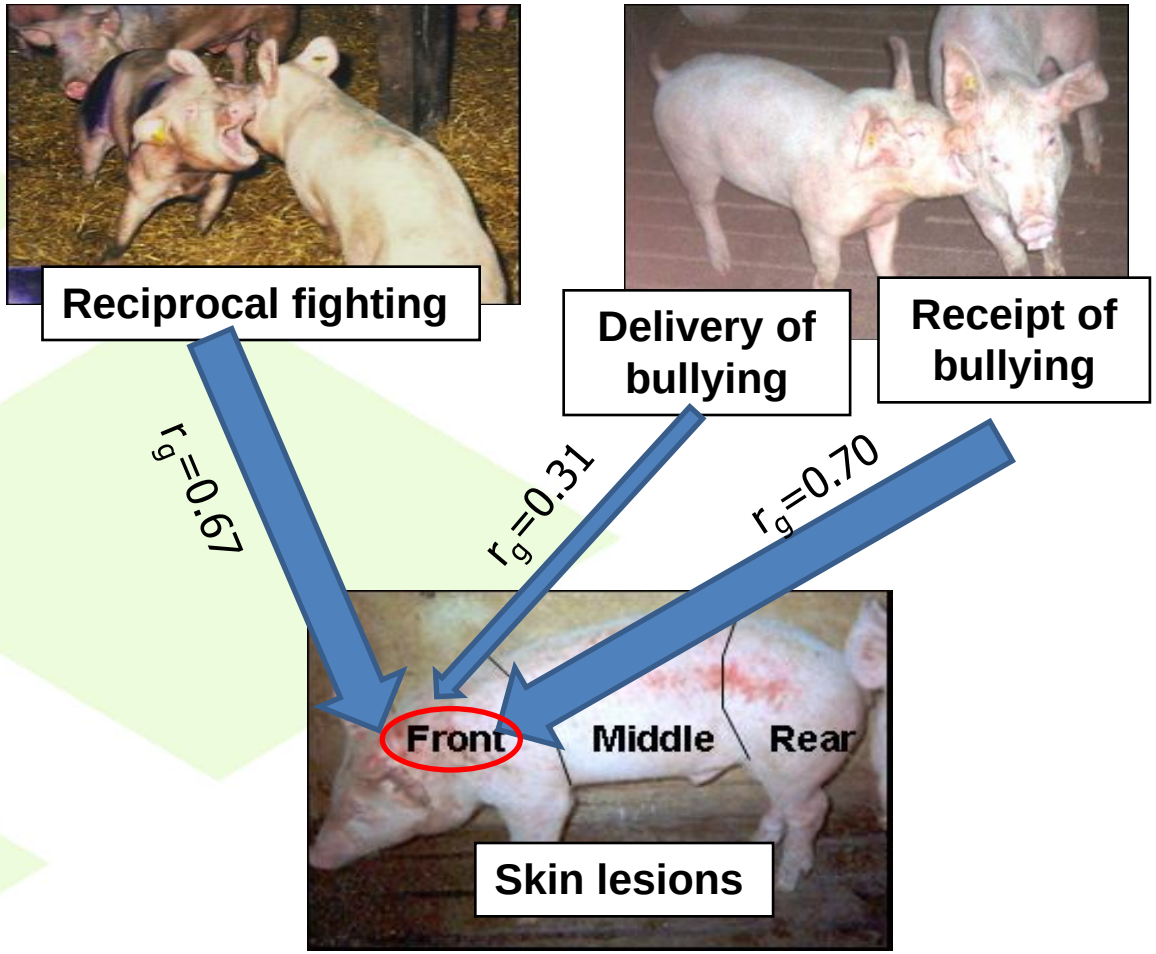

**Skin lesions**

**Front**
$h^2$=0.26
(se 0.02)

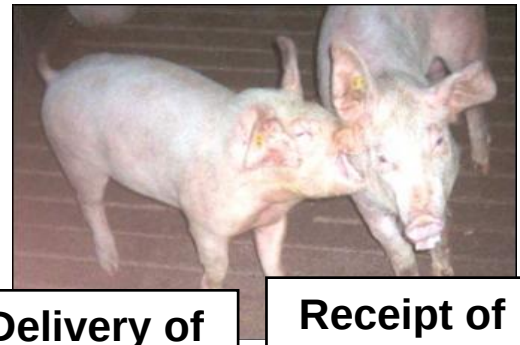
**Middle**
$h^2$=0.25
(se 0.03)

**Rear**
$h^2$=0.21
(se 0.02)

Turner et al
2006, 2009


Reciprocal fighting
Delivery of bullying
Receipt of bullying
$r_g$=0.67
$r_g$=0.31
$r_g$=0.70
Front
Middle
Rear
Skin lesions

Reciprocal fighting

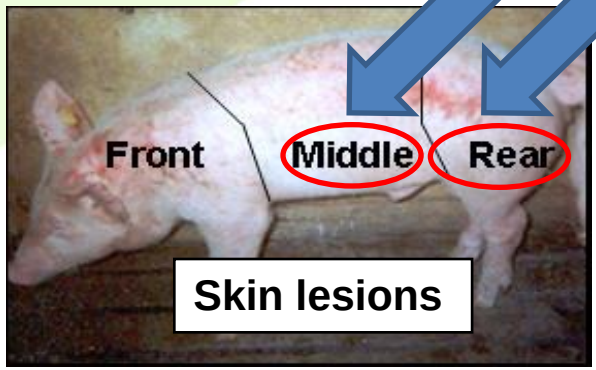


Delivery of bullying

Receipt of bullying

$r_g$=0.80

$r_g$=0.79




Skin lesions

30 seconds per pig

# Consequences of a breeding solution

- SNP associations between aggressiveness and HPA function (Murani et al. 2010)
- Altered mRNA expression in serotonin and vasopressin systems (D'Eath et al. 2005)
- Examining role of genetic variation in oxytocin system in aggressiveness

- No impact on activity levels
- Some impact on response to handling (D'Eath et al. 2009)
  - Being investigated further
- Long-term benefit on aggression in stable social groups (Turner et al. 2009)
- Potential benefits for maternal behaviour (reviewed by Canario et al. 2013)

# Next steps

- Assessing genomic basis to aggression
- Estimating associations with routinely recorded or economically important traits
- Investigating how dynamic aggressive strategies of pigs differ
  - how do they use information during fights
  - how do they choose who to fight, when and in what way
  - how do they choose when to give up
- Do unaggressive pigs show greater evidence of positive welfare?
  - Play and gentle social interactions

# Example 2: feather pecking
## The problem

- 2012 EU ban on conventional battery cages
  - Beak trimming prohibited or regulated in many countries
  - In large groups with intact beaks: increased risk of feather pecking and cannibalism

- Traditional selection methods focused on individual performance
  - Potentially selecting cannibals

# Possibilities for a breeding solution

Kin selection on low mortality

White leghorn line

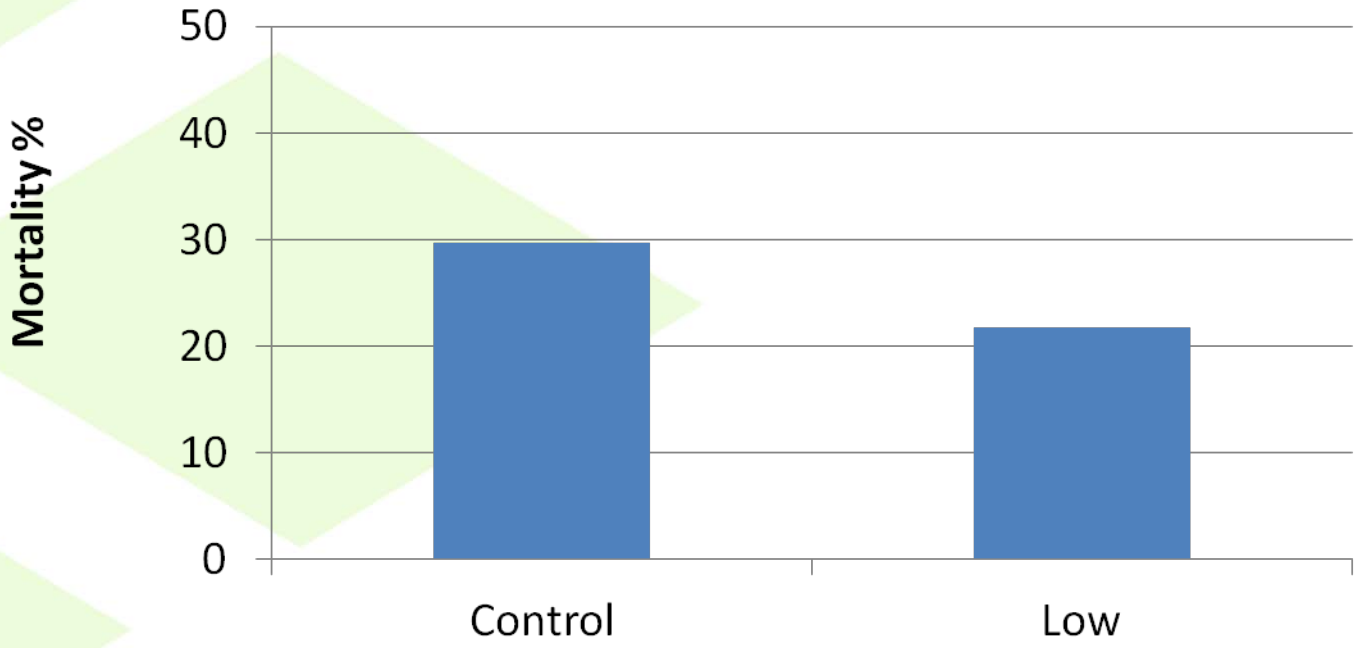
Control line:
- Selection candidate individual
- Selection on production

Non-beak trimmed in cages:
mortality due to cannibalism

Low mortality line
- Selection candidate individual
- Selection on production
- Full sisters in group (4)
- Selection on low mortality

Ellen et al., 2007

# Results after one generation



# Consequences of a breeding solution

**Birds selected on low mortality:**

- Less fearful
  - Young age
  - Adult age
- Reduced stress response
- Less cannibalistic pecking
- Changes in the serotonergic system

Bolhuis et al., 2009; Rodenburg et al, 2009ab; Flisikowski et al., 2009; Biscarini et al., 2010 Nordquist et al., 2011

# Next steps

- Investigate:
  - whether effects also hold for large groups
  - whether effects translate to commercial crossbreds: reciprocal crosses perform differently (Peeters et al., 2012)

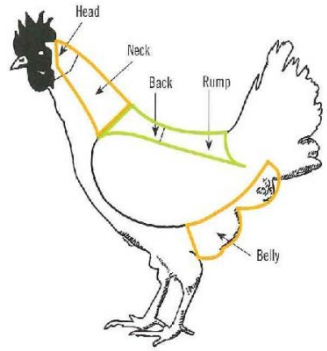
- Explore potential of genomic markers associated with feather damage and mortality

# How do we practically improve animal welfare through breeding?

**Phenotype with maximum efficiency**

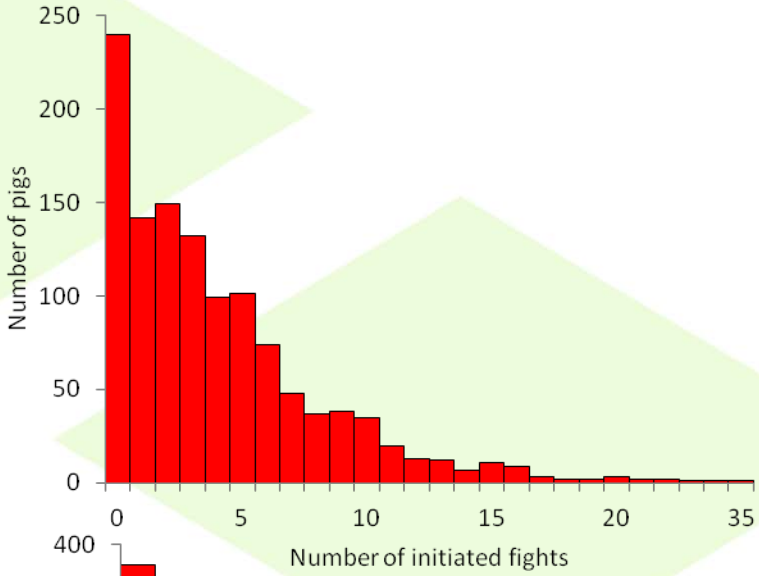
- **Lamb survival**
- Lamb behaviour score

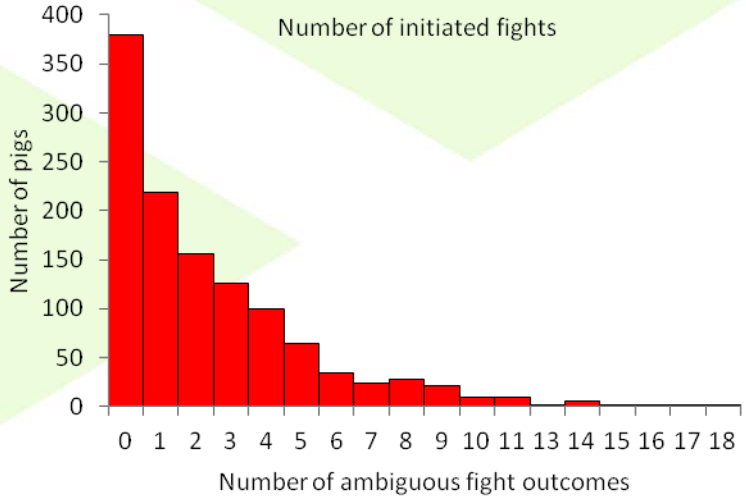
- **Feather pecking**
- Record feather damage rather than pecking
  - Simple scale (0, 1, 2)
  - Focus on areas unaffected by abrasion: neck, back rump and belly
  - Less than 1 minute per bird
  - Could be automated: infra-red pictures (Zhao et al., 2013)

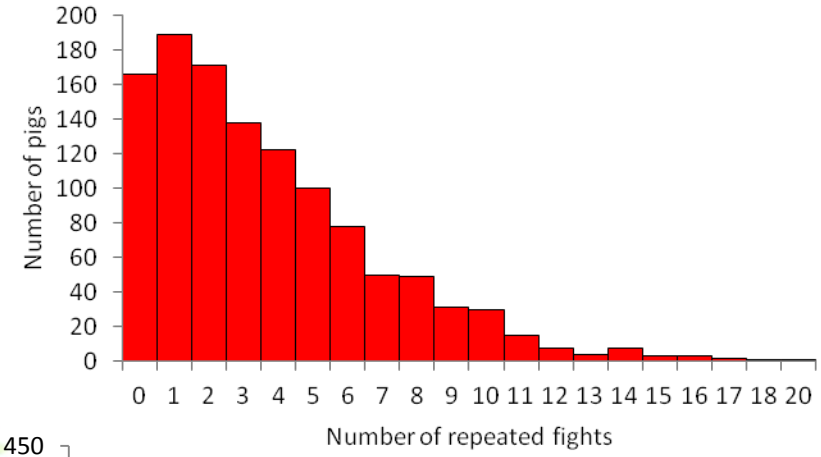


- **Pig aggression:**
- Record lesions rather than behaviour
  - Can this be automated?
  - Record only one side of the body?
  - Categorical scoring system?
  - Quantify correlations with e.g. aspects of feeding behaviour

- Tension between simplicity of recording and complexity of traits



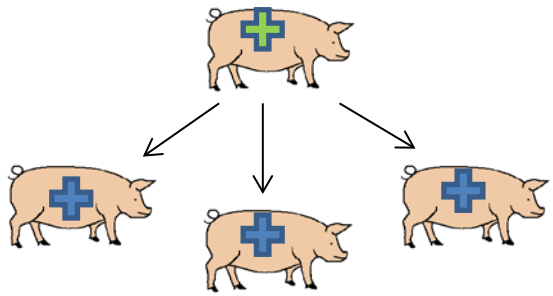




Desire et al In prep

## Avoid routine phenotyping

- Genome wide selection
- Kin selection method
- Selection on social breeding values
  - Heritable impact of an individual on productivity of group members (Bijma et al., 2007)
  - Selection would favour pigs that show reduced bullying, chronic aggression and tail-biting (Canario et al. 2012; Camerlink et al. 2013; Ursinus et al., 2013)
    - But independent of dominance (Turner et al In prep)
  - Requires no new phenotyping
  - Phenotype favoured likely to depend strongly on degree of social competition (Canario et al. 2012)



# Conclusions

- Welfare impacts on economic, environmental and societal outcomes of farming
  - Central, rather than an adjunct to sustainability
- It is technically possible to select for improvements in animal welfare AND benefit profitability
- Breeding may offer a solution to intractable welfare problems

- Breeding for positive welfare change requires:
  - Knowledge of impacts on basic biology
  - Knowledge of correlated impacts on other traits
  - Assessment of the likely impacts on individual experiences
  - Solutions to maximise the efficiency of phenotyping, to better exploit routinely collected data and to avoid phenotyping costs altogether
- Progress is being made in all of these areas for some welfare-relevant traits
  - For other traits with major welfare and economic impacts, we`ve hardly left the starting line

# Acknowledgements


- Funders:
  - EU
  - Defra
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  - BBSRC
  - Biosciences KTN

- Industry collaborators:
  - PIC
  - Quality Genetics
  - JSR
  - Suffolk Sheep Society
  - ISA BV
  - Hendrix Genetics
  - TOPIGS Research Centre IPG

- Academic collaborators:
  - Swedish University of Agricultural Sciences
  - University of Dummerstorf
  - BioSS

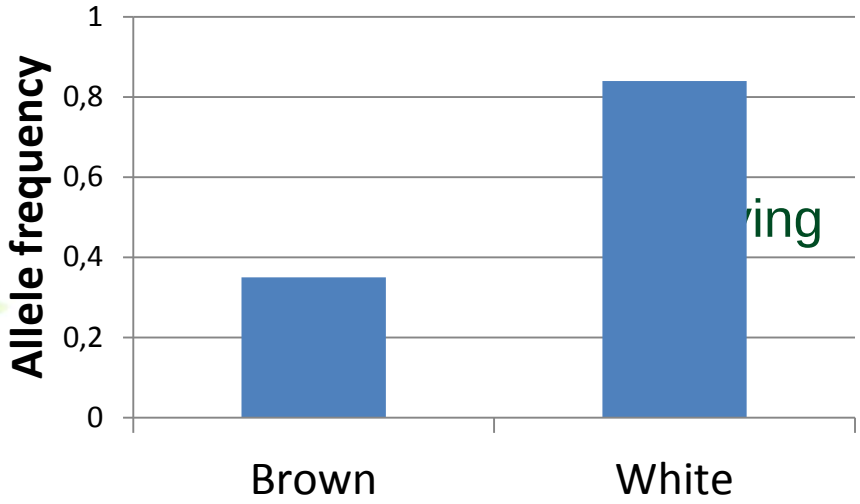
SRUC

# Role of the serotonergic system

- Feather pecking is redirected foraging
  - In response to fear and stress inducing stimuli
- The serotonergic (5-HT) system central role:
  - Involved in coping with fear and stress,
  - Involved in foraging and in feather pecking (van Hierden et al., 2004)
- Selection for low mortality: changes in the peripheral serotonergic (5-HT) system (Bolhuis et al., 2009)

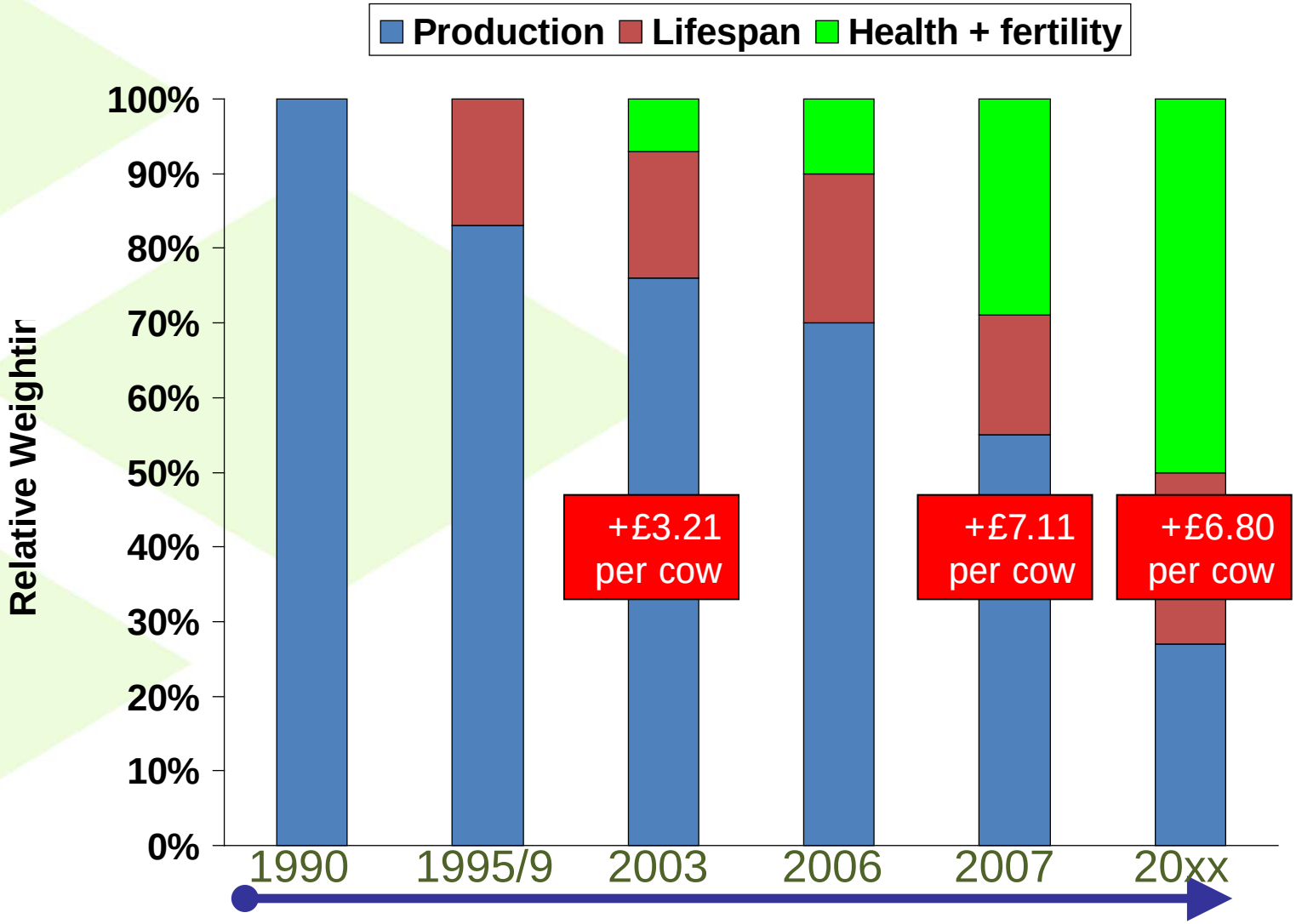
# FP and the serotonergic system

- Association study on feather damage
  - Nine different lines hens
  - Brown and white lines




(after Biscarini et al., 2010)

# Development of UK dairy breeding goal



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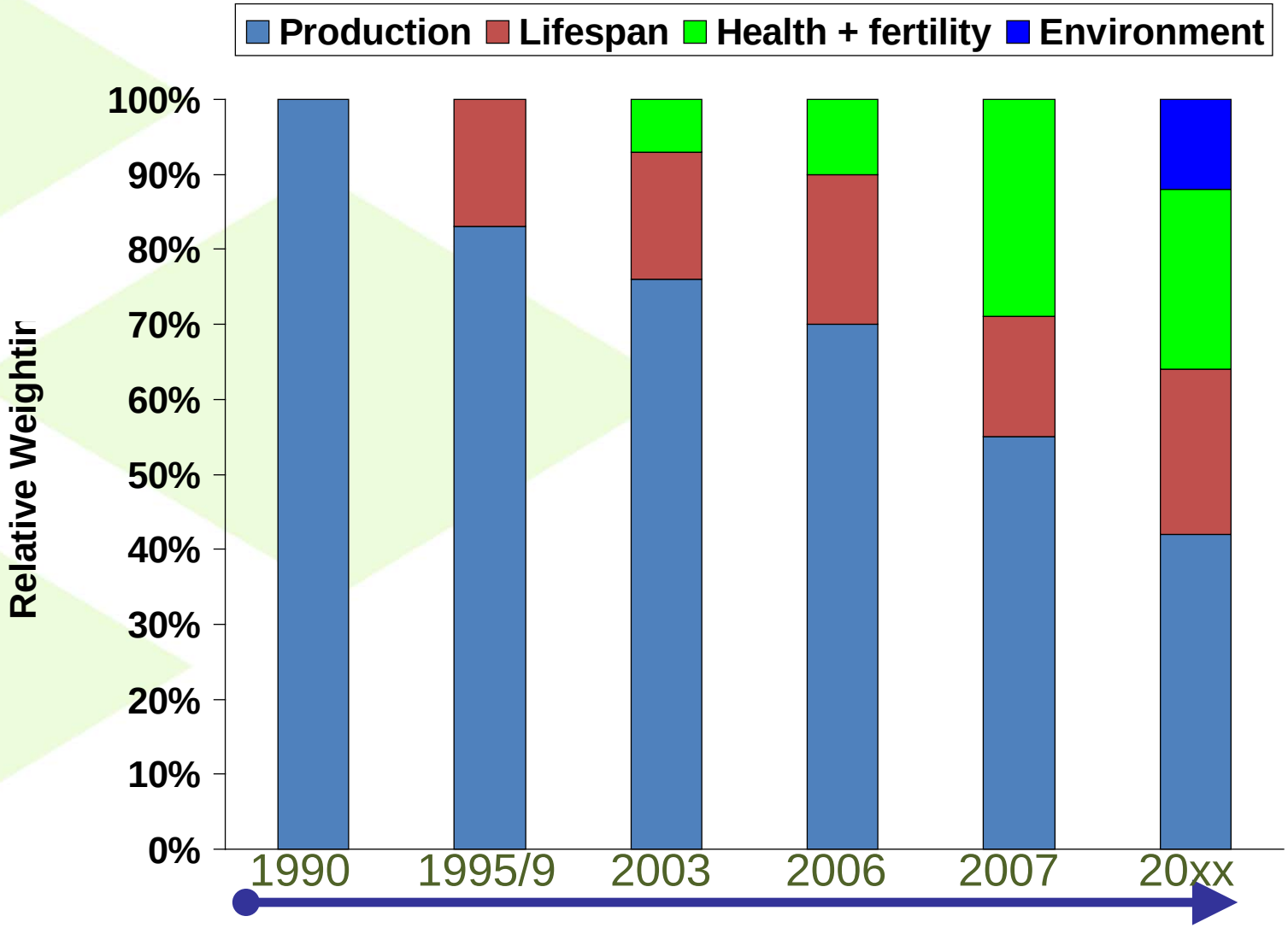

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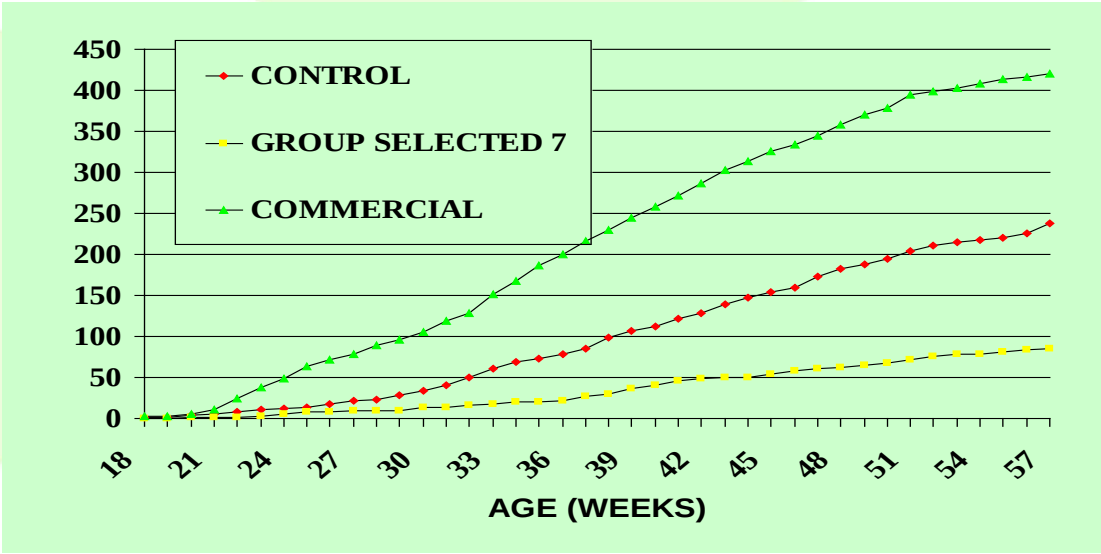
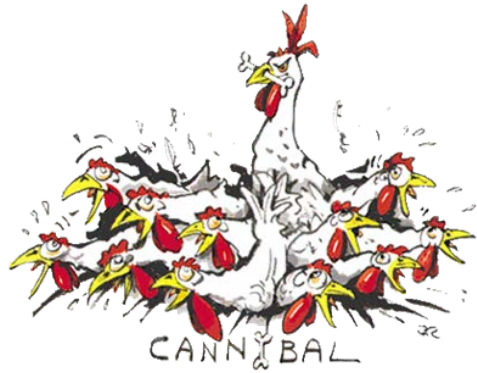



Individually selected

Control

Group selected




Muir 1996