Can animal breeding improve domestic animals’ experiences?

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Animal Welfare

Defines physical and mental state of animals
A remarkable woman

Ruth Harrison, 1920 – 2000
Photo from FACT (www.fact.uk.com)
‘Animal Machines’ alerted the public and government to the fact that many in the industry regarded farm animals merely as production objects. It also described the continuous effort to obtain ever-greater production at whatever cost to the animals. The book revealed farm practices such as castration, tail-docking, beak-trimming, de-horning, adding antibiotics to feed, battery cages for laying hens and veal calf crates to the general public, who were largely ignorant of such routines.

• 1964: Animal machines was published
• 1965: UK government initiated investigation
  – The Brambell Committee
• 1967: Farm Animal Welfare Advisory Committee
• 1979: Farm Animal Welfare Committee

Five Freedoms

“These freedoms define ideal states rather than standards for acceptable welfare.”

Farm Animal Welfare Committee
Note: Ruth Harrison was very much part of the solution

- Ruth Harrison was part of
  - Brambell committee
  - Farm Animal Welfare Advisory Committee
  - Farm Animal Welfare Committee

- Ruth Harrison founded Farm Animal Care Trust (FACT) in 1967
Five freedoms

1. **Freedom from Hunger and Thirst** – by ready access to fresh water and a diet to maintain full health and vigour.

2. **Freedom from Discomfort** – by providing an appropriate environment including shelter and a comfortable resting area.

3. **Freedom from Pain, Injury or Disease** – by prevention or rapid diagnosis and treatment.

4. **Freedom to Express Normal Behaviour** - by providing sufficient space, proper facilities and company of the animal’s own kind.

5. **Freedom from Fear and Distress** – by ensuring conditions and treatment which avoid mental suffering.
Animal breeding has made significant improvements in numerous animal welfare traits.

- Examples from the Armidale genetics group:
  - Breech strike resistance in sheep
  - Calving or lambing ease to prevent distocia
  - Disease resistance/resilience in pigs and sheep
  - Heat tolerance of cattle and pigs
  - Longevity in cows, sows and ewes
  - Polled cattle
  - Sociable sows and pigs
  - Structural soundness in sows and cows
  - Survival of lambs, cattle and pigs
  - Temperament of sheep, cattle and pigs
Examples of breeding for animal welfare

- Breeding sheep resistant to breech strike
- Breeding polled cattle
- Breeding sociable sows and pigs
Breeding sheep resistant to breech strike

• Welfare issue:
  – Mulesing, the removal of strips of wool-bearing skin from around the breech, is painful

• Why are sheep mulesed?
  – Prevent flystrike which causes pain and can lead to the death of sheep
Breeding sheep resistant to breech strike

Project leader in Armidale: Jen Smith

• Comparison of selection lines at CSIRO
  – Selective breeding of Merinos for resistance to breech strike (Resistant line)
  – Susceptible control line
  – Two locations
    • Armidale (summer rainfall)
    • Mt Barker, WA (winter rainfall)
  – Two treatments
    • Mulesed sheep
    • Unmulesed sheep
Objective: develop selection criteria for breech strike resistance

What gets measured and recorded

Breech strike resistance indicators (at birth, marking, post-weaning, yearling and adult)
- Breech & crutch (inguinal) bare area
- Neck, body and breech wrinkle
- Dags & urine stain
- Tail length (pre-marking)

Lambing and pedigree information

Disease traits
- Body strike
- Fleece rot
- Dermatitis
- Worm egg count

Fleece traits (yearling & adult)
- Mean fibre diameter & variation
- Greasy & clean fleece weight
- Yield
- Staple length & strength
- Style characteristics

Bodyweight (at birth, post-weaning, yearling & adult)

Fertility traits
- Ewes mated
- Lambs born, marked & weaned

Source: Breech Strike Genetics, Issue 1, November 2007.
Wanted: Bare breech sires from industry for 2008 mating

Industry provided sires for the AI program at CSIRO

Source: Breech Strike Genetics, Issue 1, November 2007.
Selection will make the need for mulesing sheep redundant

Unmulesed selected sheep had breech strike rates comparable to mulesed controls


Figure 3. Breech strike rates in mulesed (M) and unmulesed (UN) weaners in the Intense selection (Resistant) and Unselected Control (Susceptible) selection lines.
Industry has the tools to select for breech strike resistance

There is genetic variation between sires in breech wrinkle ASBV

Breech wrinkle ASBVs predict differences in phenotypes

Source: www.flyboss.com.au
Selective breeding can improve both:
Productivity & Resistance to breech strike
Breeding polled cattle

• Welfare issue
  – Dehorning is associated with calf mortality (Bunter et al., 2014)
  – Dehorning procedure is painful for cattle
    • In particular in older animals of 3 to 10 months of age
    • Wound takes longer to heal and is prone to secondary infections

• Why are cattle dehorned?
  – Prevent injuries in cattle and humans caused by cattle horns
    • Damage to hide
    • Bruising of animals during transport
Inheritance of horns – from single to multiple-gene hypothesis

- Single gene hypothesis (1900 to 1930s)
  - Homozygous dominant (PP) – polled in both sexes
  - Heterozygous (Pp) – horned in males and polled in females
  - Homozygous recessive (pp) – horned in both sexes

Example: polled Hereford

- Other genes
  - Ha: African horn gene epistatic to P in males; not certain in females
    - Low frequency in *Bos taurus*, higher frequency in *Bos indicus*
  - Sc: Gene for scurs. Expression is sex influenced
    - Heterozygote is scurred in males, but only homozygote is scurred in females.

Source: Prayaga, 2005. MLA final report
Breeding polled cattle
Project leader: John Henshall

Need:
Gene marker tests for beef cattle used in northern Australia
  – Commercial tests were available for *Bos taurus*
    • Expensive
    • Test had not been validated for *Bos indicus* cattle

2010: “A marker was found excellent potential for use as a test for polled in northern Australian beef herds.”
  – Association between marker and polled/horned status in Brahman and other breeds
  – In Brahman there was no evidence for another gene
  – Tropical composite cattle contained Sanga (African) genetics
    • Some PP animals were actually horned – African gene or other genes?

Source: Henshall, 2010. MLA final report summary; AHW.144
Proportion (%) of horned (H), polled (P) and scurred (S) bulls for individual cattle breeds in Australia

<table>
<thead>
<tr>
<th>Breed</th>
<th>2005 Breed society records</th>
<th>2012 30 to 60 bulls/breed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H</td>
<td>P</td>
</tr>
<tr>
<td>Angus</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Brahman</td>
<td>70</td>
<td>10</td>
</tr>
<tr>
<td>Charolais</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td>Droughtmaster</td>
<td>26</td>
<td>67</td>
</tr>
<tr>
<td>Hereford</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Limousin</td>
<td>42</td>
<td>12</td>
</tr>
<tr>
<td>Santa Gertrudis</td>
<td>92</td>
<td>1</td>
</tr>
<tr>
<td>Shorthorn</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Simmental</td>
<td>0</td>
<td>8</td>
</tr>
</tbody>
</table>

Table 1. Number of polled animals tested and proportion of genotypes assigned with confidence (% non-ambiguous) for 10 breeds assessed during polled marker field testing.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Number Tested</th>
<th>% Non Ambiguous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brahman</td>
<td>207</td>
<td>89%</td>
</tr>
<tr>
<td>Brangus</td>
<td>36</td>
<td>38%</td>
</tr>
<tr>
<td>Charolais</td>
<td>36</td>
<td>72%</td>
</tr>
<tr>
<td>Droughtmaster</td>
<td>99</td>
<td>73%</td>
</tr>
<tr>
<td>Hereford</td>
<td>205</td>
<td>72%</td>
</tr>
<tr>
<td>Limousin</td>
<td>250</td>
<td>39%</td>
</tr>
<tr>
<td>Santa Gertrudis</td>
<td>99</td>
<td>77%</td>
</tr>
<tr>
<td>Shorthorn</td>
<td>105</td>
<td>34%</td>
</tr>
<tr>
<td>Simmental</td>
<td>36</td>
<td>56%</td>
</tr>
<tr>
<td>Tropical Composite</td>
<td>84</td>
<td>74%</td>
</tr>
</tbody>
</table>

Polled cattle in Australia

- The initial marker test has been refined
  - 10 additional markers have been evaluated

- Test should be validated on a larger population

- Develop software to maximise the information obtained from the marker test
  - Analysis is more complicated than for a single marker
  - Database to manage genotype data has been developed

Source: Henshall, 2012. MLA final report; B.AWW.0209
Figure 4.1.1. Screen shot of interface to the database (animal names are pseudonyms).

Source: Henshall, 2012. MLA final report; B.AWW.0209
Genetics can work fast
Commercial herds can choose polled sires now to increase polledness in their progeny

Breeders can increase frequency of polled allele
Accuracy of test has been improved further
A new version of the test will be launched in November this year
Breeding sociable sows

• Welfare issue
  – Sows are kept in stalls during gestation which significantly limits their ability to move

• Australian pork producers decided in 2010 to voluntarily phase out of gestation stalls by 2017
  – Sows are able to move more freely in groups
  – However, sows may also exhibit aggressive behaviour towards each other
Program 1 – Reduced confinement of sows and piglets

Large R&D investment to improve welfare and performance of group-housed sows
Breeding strategies for sociable sows
Project leader: Kim Bunter

• Proximity loggers
  – New technology used in other species

• Target traits to describe behaviour and injuries
  – Skin lesions post mixing
  – Flight time
  – Hoof lesions

• Social genetic effects
  – Makes use of existing data from groups

Proximity loggers

• Collaboration with Central Queensland University

• Loggers have been used to determine
  – Maternal behaviour in cattle and sheep
  – Wildlife disease transmission routes
  – Relationship development in cattle
  – Inter-species interactions (e.g. badger and cattle)

• Initial trial on farm has been completed and data analysis is underway

Heritabilities have been demonstrated for target traits

- **Aggression**
  - Scoring lesions in pigs post mixing is a good proxy for aggression

- **Flight time**
  - Better-performing groups of pigs have slower average flight time

- **Locomotion scores**
  - Sow locomotion affects performance of nurse sows

- **Hoof lesions are heritable in dairy cattle**
  - Association between hoof lesions and lameness in pigs?

Social genetic effects – the basic idea

Each animal has:
- Direct effect on self ($P_D$)
- Social effect on others ($P_S$)

\[
P_1 = P_{D,1} + P_{S,2} + P_{S,3} \\
P_2 = P_{D,2} + P_{S,1} + P_{S,3} \\
P_3 = P_{D,3} + P_{S,1} + P_{S,2}
\]
Selection for social effects reduced incidence of tail biting

Divergent selection based on social genetic effects for growth

- High Social Genetic Effects  
  ![Happy pigs](image)

- Low Social Genetic Effects  
  ![Sad pigs](image)

- F1 population with 240 pigs in each selection group
- Pigs were raised in conventional or enriched environments
- A range of behavioural traits were investigated

Conclusion: Selection on social genetic effects targets a behavioural strategy rather than a single behavioural trait

Source: Camerlink et al. (2013), PLoS ONE
Tailbiting consequences

Concrete environment

High line probably underestimated because of interventions

Straw environment

Days in finishing

Thanks to Egbert Knol, TOPIGS Research Centre IPG
Can animal breeding improve domestic animals’ experiences?

Yes, animal breeding can, and should, improve welfare of animals.
Animal breeding should improve welfare of animals further

• Five freedoms provide the framework to define animal welfare

• Welfare measures and protocols for data collection on farm or at slaughter have been developed (Veissier et al., 2013)

• It is possible to improve both, productivity and welfare of animals