Challenges and Opportunities for Beef Production in Developing Countries of the Southern Hemisphere

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OUTLINE

INTRODUCTION
Challenges:
• Low production levels
• Global warming
• Adaptation
• Enteric methane production

Opportunities:
• Increase in demand
• Description of production environments
• Recording and improvement
• Genomics
INTRODUCTION

• Currently cattle are the most important livestock species in Africa & Latin America

• Africa is one of the centres of domestication – large numbers of adapted indigenous breeds.

• Latin America: only camelids (lamas, Alpacas) & guinea pigs are indigenous.
  – All other livestock were imported, & underwent 500 years of natural selection
INTRODUCTION

• Currently Latin America (Brazil, Argentina & Uruguay) are large exporters of beef.
• Southern hemisphere African countries – only Botswana & Namibia net exporters;
• all others are net importers of beef, despite huge potential of good indigenous beef cattle breeds.
What are the challenges and opportunities for beef production in the Southern Hemisphere?
CHALLENGES
LOW PRODUCTION LEVELS

Cattle sector is highly dualistic:
– communal, subsistence & small scale farmers co-existing with
– large commercial farmers.

Off-take from the commercial sector is high, while it is still low in other sectors as a result of low fertility, high mortality, etc.
Production in the different beef sectors in South Africa

- Calving %: 62% (Commercial), 35% (Communal)
- Pre-wean mortality: 3% (Commercial), 31% (Communal)
- % Off-take: 32% (Commercial), 6% (Communal)
Beef cattle production in the Brazilian Pantanal following 4 yrs of monitoring

<table>
<thead>
<tr>
<th>Trait</th>
<th>Start of monitoring</th>
<th>After 4 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calving %</td>
<td>45-56%</td>
<td>65-70%</td>
</tr>
<tr>
<td>Pre-wean mortality</td>
<td>18-25%</td>
<td>5-10%</td>
</tr>
<tr>
<td>Post wean mortality</td>
<td>5%</td>
<td>3%</td>
</tr>
</tbody>
</table>
Comparison of off-takes

- USA, 37%
- Uruguay, 30%
- Argentina, 26%
- Brazil, 22%
- Commercial South Africa, 32%
- Communal South Africa, 6%
GLOBAL WARMING

Prediction is that climate change will have a more extreme effect on southern than on northern hemisphere.
## GLOBAL WARMING

<table>
<thead>
<tr>
<th></th>
<th>↑ Temp</th>
<th>↓ Grazing Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Africa</td>
<td>2.5° C</td>
<td>30%</td>
</tr>
<tr>
<td>Brazil</td>
<td>5° C</td>
<td>50%</td>
</tr>
</tbody>
</table>
Effect of global warming on livestock production: Ambient Temperature

Largest direct effect
If livestock is not adapted to high temps:
- reduce feed intake in order to reduce digestive heat production
- reduce grazing time as animals do not graze in hot midday
- increase sweating and water intake
Effect of global warming on livestock production: Nutrition stress

• **Largest indirect effect**
  - natural pasture has lower nutritional value and lower tiller density (Tropically adapted C\textsubscript{4} grasses)
  - in comparison to C\textsubscript{3} grasses, C\textsubscript{4} has high fibre content, reduced digestibility & higher methane production
Effect of global warming on livestock production: Diseases

- Altered disease patterns that will put even more pressure on production
- Recent outbreaks of Rift Valley Fever in Southern Africa
- Climate determines distribution of ticks & vectors (Red water, Gall sickness, Heart water, Corridor disease, East Coast Fever)
ADAPTATION

• Due to global warming, animals will have to adapt to:
  – higher temperature,
  – lower nutritional value of grasses,
  – expansion of diseases

• Balancing genotype with the production environment is crucial
ADAPTATION

• The question is how to measure adaptation and how to select for it

• Adaptability – ability to survive and reproduce within a given environment
Research on adaptation

Direct measurements:
• rectal body temperature,
• respiration rate,
• heart (pulse) rate,
• sweating rate (water loss),
• skin thickness,
• hair per cm²,
• heat tolerance test,
• temperature change with exercise
Research on adaptation

Several proxy-indicators:

• reproductive traits:
  – fertility & survival,
  – birth rate,
  – peri-natal mortality,

• production traits:
  – growth rate,
  – milk production,
  – mortality,
  – longevity and

• health traits:
  – faecal egg counts,
  – external parasites
ENTERIC METHANE (CH$_4$) PRODUCTION

• Methane facts:
  – makes up 16% of total world gas emissions,
  – 2nd most important greenhouse gas (GHG)
  – atmospheric warming activity 23 times higher than CO$_2$

• Animal digestive tract is main source of methane (28% of global CH$_4$ emissions)

• GHG emission from livestock measured as:
  – kg CO$_2$ equivalent per kg product (Intensive grain-fed systems best) or
  – per area of land used (Extensive systems best)
Can GHG emissions from cattle be reduced? 1: Diet

- Most research is focusing on manipulating the diet to combat $\text{CH}_4$ emission:
  - Use of feed additives
  - Genetic engineering of rumen flora
Can GHG emissions from cattle be reduced? 2: Genetics

- Genetic improvement results in permanent and cumulative changes in performance

- Selection will mitigate GHG in two ways:
  - higher productivity leads to higher gross efficiency as a result of diluting maintenance cost
  - a given level of production can be achieved with fewer higher yielding animals.
Can GHG emissions from cattle be reduced? 3: Residual Feed Intake

• RFI = Actual FI$_{Production}$ - Expected FI$_{Maintenance}$
• Cattle with low RFI produce up to 28% less methane
• Attributed to different rumen microbial populations
• May be heritable
OPPORTUNITIES
INCREASE IN DEMAND

• Increasing population, urbanization & economic development in developing countries - significant rise in demand for livestock products (Livestock Revolution)

• World demand for meat expected to rise by more than 200%

• Much bigger market opportunities for livestock producers in developing countries.
DESCRIPTION OF PRODUCTION ENVIRONMENT

• By describing production environments in more detail it would be possible to identify breeds or genotypes that may be adapted to specific environments
DESCRIPTION OF PRODUCTION ENVIRONMENT

• Necessary to link animal performance with the production environment
• Such information can be used in genetic evaluations either as part of the predictive model or as a “post breeding value prediction” calculation
Environmental data

• Good quality environmental data describing production environments already exist

• Variables on
  – temperature,
  – relative humidity,
  – precipitation (including variation in rainfall),
  – day length and
  – radiation

are available through Geo-referenced Information Systems (GIS) layers

• Important to record GPS waypoints
RECORDING AND IMPROVEMENT

- Animal recording forms the backbone of any improvement programme
- If traits are not measured and recorded improvement is not possible
- Argentina, Brazil, Namibia and South Africa have very well organized recording and improvement programmes in place
RECORDING AND IMPROVEMENT

• South Africa:
  – National Beef Recording and Improvement Scheme supported by government and managed by the ARC

• Brazil:
  – successful beef breeding schemes are run by private companies, universities and EMBRAPA (Brazilian Corporation for Agricultural Research).
Measurement & science

• Statistical science continues to support animal breeding and improvement - very sophisticated, high-dimensional models are applied

• Challenge - to identify fixed and random effects, that account for variation in production environments for use in genetic evaluations
Proxy-indicators for adaptation

- Traits linked to fertility and/or survival (days to calving, calving interval, stayability, calving tempo) all influenced significantly by management or arbitrary decisions taken by breeders or scientists.
• Inclusion of DNA information in the estimation of EBVs may result in substantial increases in genetic gain at reduced cost

• Genomic EBVs (EBVs derived from DNA information combined with conventional EBVs), may speed up the process of breeding animals that are adapted to results of climate change
Genomics

• May enhance the detection of genes and QTLs that affect tick resistance or methane production

• Marker assisted selection will assist in:
  - selection for disease and parasite resistance/ tolerance
  - traits linked to adaptation (high levels of blood urea to digest low quality C4 grasses)
CONCLUSION

• Challenges facing beef production in the developing countries of the southern hemisphere include
  – variable and low production levels,
  – the effect of climate change,
  – enteric methane production and
  – low levels of animal recording.
CONCLUSION

• Several new technologies offer opportunities for beef production in developing countries in next few years. These include
  – recording and improvement,
  – genomic evaluation methods, together with
  – the development of statistical,
  – bio-informatics,
  – computational and
  – geographical information system technologies.
Thank you