Beef cattle growth and performance: Modulating effects of nutrition in different phases of the life cycle

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http://www.cita-aragon.es/

Public Research Institute for R&D in the Agri-Food sector in Aragón

Animal Production and Health Unit

- Optimisation of sustainable livestock systems
- Land and resources use by extensive livestock
- Profitability in livestock production
- Cattle and lamb meat quality
- Preservation of endangered breeds and species
- Epidemiology and sustainable fight against livestock disease
Research Stations

- Experiments under controlled conditions

Research

Associated farms

- Breeders associations
- Cooperatives, ...

Extension & other studies
**Competitive beef cattle production systems**

To produce more and better calves while reducing the input/output ratio

1. Increase calf crop *fertility* & *lifespan*
2. Increase calf growth *lactation* + fattening
3. Reduce production costs *feeding the suckler herd and fattening animals*
4. Increase added value *product quality*

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**How can we increase calf crop?**

Optimising reproductive performance

- **Age at puberty**
  - Genetics
  - Pre- and Post-weaning management

- **Age at 1st calving**
  - Genetics
  - Precocity-development

- **Postpartum anoestrous**
  - Precalving nutrition
  - Suckling freq
  - Postcalving nutrition

- **Conception & Pregnancy**
  - Fertility
  - Heat detection
  - AI protocols

- **Reproductibility**
  - Lifespan

Sanz et al. (2004)

Reproductive diseases

- Trichomonas, Besnoitia, Campylobacter, Neospora, BVD, IBR

(adapted from ANEMBE 2014; Diskin & Kenny, 2014)
Rearing the beef heifer

TARGET: first calving around two years without compromising lifetime performance? *(Wathes et al., 2014)*

![Diagram showing stages of heifer rearing: Weaning, FTAI, Calving, Lactation, Rear, Pregnancy, 1st Lactation]

<table>
<thead>
<tr>
<th>Lactation</th>
<th>Rear</th>
<th>Pregnancy</th>
<th>1st Lactation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-6 m</td>
<td>6-15 m</td>
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<tr>
<td>Target ADG</td>
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<tr>
<td>LOW 700 g/d</td>
<td>LOW 700 g/d</td>
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<td>100%</td>
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<tr>
<td>HIGH 1000 g/d</td>
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<td>100%</td>
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2 feeding levels LACTATION (0-6 m) x 2 feeding levels REAR (6-15 m)

- Growth & development
- Reproduction
- Performance 1st lactation

![Image of beef heifers]

- Liveweight, fat depth
- Body measurements
- Feed intake and efficiency (milk, concentrate, forage)
- Metabolic profiles:
  - plasma
  - rumen
- Endocrine profiles
- Reproduction: puberty, fertility at FTAI, PPA
- Performance 1st lactation: dam & calf growth, milk yield *gene expression*

*Mechanisms of Action*
### Growth patterns

**LW kg**

**First Calving**

**FTAI**

**PUBERTY**

- Low-Low
- Low-High
- High-Low
- High-High

<table>
<thead>
<tr>
<th>Age, m</th>
<th>0</th>
<th>3</th>
<th>6</th>
<th>9</th>
<th>12</th>
<th>15</th>
<th>18</th>
<th>21</th>
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<tr>
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<thead>
<tr>
<th></th>
<th>Low</th>
<th>High</th>
<th>Low</th>
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<th>LACT</th>
<th>REAR</th>
<th>LxR</th>
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<tbody>
<tr>
<td>ADG Lact</td>
<td>0.643&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.699&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.046&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1.080&lt;sup&gt;a&lt;/sup&gt;</td>
<td>***</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>ADG Rear</td>
<td>0.744&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.998&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.593&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.925&lt;sup&gt;b&lt;/sup&gt;</td>
<td>***</td>
<td>***</td>
<td>NS</td>
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**Puberty**

**LW kg**

**First Calving**

**FTAI**

- Low-Low
- Low-High
- High-Low
- High-High

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- **Similar BW** at onset of **puberty** (~327kg - 55% adult weight) but **different age**, depending on ADG
- **Similar fertility rate** (86% 3m)
- **Age at conception greater** in heifers **with high ADG in REAR** more AI needed to conceive (1.96 vs. 1.27, P<0.05)

### First lactation

#### Growth and Calving ease

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<tr>
<td>REAR (6–15 mo)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Age 1st calving, mo</td>
<td>25.6	extsuperscript{b}</td>
<td>26.6	extsuperscript{a}</td>
<td>25.7	extsuperscript{b}</td>
<td>26.2	extsuperscript{ab}</td>
<td>NS</td>
</tr>
<tr>
<td>BW at calving, kg</td>
<td>436	extsuperscript{b}</td>
<td>487	extsuperscript{a}</td>
<td>474	extsuperscript{a}</td>
<td>500	extsuperscript{a}</td>
<td>*</td>
</tr>
<tr>
<td>BW at weaning, kg</td>
<td>425	extsuperscript{b}</td>
<td>482	extsuperscript{a}</td>
<td>469	extsuperscript{a}</td>
<td>479	extsuperscript{a}</td>
<td>0.06</td>
</tr>
<tr>
<td>ADG first lactation, kg</td>
<td>-0.07</td>
<td>-0.05</td>
<td>0.015</td>
<td>-0.12</td>
<td>NS</td>
</tr>
<tr>
<td>Dystocia, %</td>
<td>80</td>
<td>37.5</td>
<td>0</td>
<td>16.7</td>
<td>*</td>
</tr>
<tr>
<td>Calf/Cow BW ratio, %</td>
<td>8.4	extsuperscript{a}</td>
<td>8.5	extsuperscript{a}</td>
<td>7.3	extsuperscript{b}</td>
<td>7.3	extsuperscript{b}</td>
<td>**</td>
</tr>
</tbody>
</table>

#### Dam performance

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<th>High</th>
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<th>REAR</th>
<th>LxR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milk yield, kg ECM/d</td>
<td>5.73</td>
<td>6.60</td>
<td>5.95</td>
<td>6.58</td>
<td>NS</td>
</tr>
<tr>
<td>Postpartum anoestrus, d</td>
<td>112</td>
<td>79</td>
<td>101</td>
<td>84</td>
<td>NS</td>
</tr>
</tbody>
</table>

~ pre- and post-partum feeding level, suckling frequency, calving difficulty, metabolic profiles

#### Calf performance

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<thead>
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<th></th>
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<th>LACT</th>
<th>REAR</th>
<th>LxR</th>
</tr>
</thead>
<tbody>
<tr>
<td>BW at birth, kg</td>
<td>36.6</td>
<td>41.5</td>
<td>38.3</td>
<td>36.3</td>
<td>NS</td>
</tr>
<tr>
<td>BW at weaning 4m, kg</td>
<td>130</td>
<td>128</td>
<td>127</td>
<td>146</td>
<td>NS</td>
</tr>
<tr>
<td>ADG, kg</td>
<td>0.779</td>
<td>0.718</td>
<td>0.737</td>
<td>0.910</td>
<td>NS</td>
</tr>
</tbody>
</table>

Rodríguez-Sánchez et al., submitted
Main conclusions

Beef heifers can calve for the first time around 2 years
- if **ADG ~ 1 kg/d** during either LACT or REAR (...$)
- growth rate affects **age at puberty** (not weight), but not fertility at 15 m.
- low weight at first calving can impair **calving ease**
- similar **first lactation performance**, although low growth rates during REAR can increase **PPA (~ 1m)**

... long term effects?

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**How can we optimize calf growth?**

**Beef production in Spain**

- **Suckler farms**
- **Fattening farms**

Whole cycle farms

**Intensive**
- housing + forage crops

**Extensive**
- dry / humid / mountain areas

**Feedlots**
- concentrates vs. other diets

**Pasture + supplements**

53.7% imported (MARM, 2010)

60% < 80 kg

21% 80-160 kg
Feed supplements: for the cow or for the calf?  
Age at weaning: early (3 m) vs. traditional (6 m)

Cow-Calf mgt during LACTATION

Effects on performance:  
- offspring: lactation/finishing replacement heifers  
- dams: reproduction

Economic interest:  
Suckler / finishing / whole cycle farms

≠ Growth patterns

Effect of dam feeding level (High vs. Low) and calf supplementation (C vs. NoC) during lactation

Casasús et al. (2001)

Effect of age at weaning (EARLY vs. TRAD) and calf supplementation (C vs. NoC) during lactation

Blanco et al. (2008)
Serum IGF-1 concentration (ng/mL)

Physiological stress response, feed and efficiency

... but similar carcass and meat quality after long finishing periods on similar concentrate-based diets

Animal type: Breed, sex, final weight

Grazing & finishing: pasture (type, period, stocking rate...) supplements (phase, level, type...)

Fattening on forages: silage, TMR, by-products...

Feed mgt during FATTENING

Concentrates: raw materials, additives
Comparisons of Forage-based diets vs. Conventional fattening

- **Technical performance**: different forages & supplements
- **Economic performance**: feed costs vs. product price
- **Carcass quality**: weight, conformation & fattening score, saleable meat
- **Meat quality**: color & stability, toughness, nutritive quality (composition, FA profiles), consumer tests

*use of local resources - opportunity costs - differentiation - organic production – market segmentation*

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**Main Conclusions**

- Technical performance of animals finished on pasture/forages can be similar to those fed with concentrate-based diets if adequate *supplementation* is timely provided.
- **Fattening score** depends on type and level of supplementation
- **Organic production** requires special supplementation patterns.
- Meat and carcass quality may differ: basis for system *traceability*

**BUT... uncertainty**

- Performance is more *aleatory* (weather, feed quality ...)
- More *flexibility* in management and technical knowledge for *sound decisions*
Effects of maternal nutrition on embryo growth and offspring: implications for beef productive efficiency

INIA 2013

Under nutrition in early pregnancy (1st third)

Cow (short term)
- Oocyte quality
- Luteal function
- Plasmatic P4
- Embryo survival
- Fertility

Embryo (mid term)
- Nutrient allocation
- Fetal programming (organic function)
- DNA changes (epigenetics)

Fetal dvpt. (long term)
- Fetal germ cells
- Epigenetics

100 vs. 60% feeding
3 m post AI

Dams: E balance, maternal recognition of pregnancy

Offspring: performance, immune function
- Female replacements
- Finishing calves
Effect of pea inclusion as alternative protein and energy level of the diet on the efficiency of ruminant fattening diets

- High dependence of EU intensive fattening on imported protein
- Environmental impacts of low efficiency of use of N

Substitution of soya by field pea in isoN isoE concentrates

Diets differing in E content and presentation

- ruminal fermentation
- diet digestibility
- efficiency of use of N
- animal performance
- carcass & meat quality
- economic interest
- carbon footprint LCA

Sheep and Cattle

Strategies to mitigate the impact of changing from a forage diet to others rich in concentrate for intensive rearing of beef cattle

TRANSITION from Lactation to Fattening

Abrupt change of feeding
- alterations in rumen environment
- health status & performance

- Concentrate ingredients
  - sources of carbohydrates
  - inclusion of additives
- Pattern of administration

- Calf management before weaning
  - milk
  - milk + hay
  - milk + concentrate

Ruminal conditions, animal welfare and productivity