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

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CENTRO DE INVESTIGACIÓN Y TECNOLOGÍA AGROALIMENTARIA DE ARAGÓN

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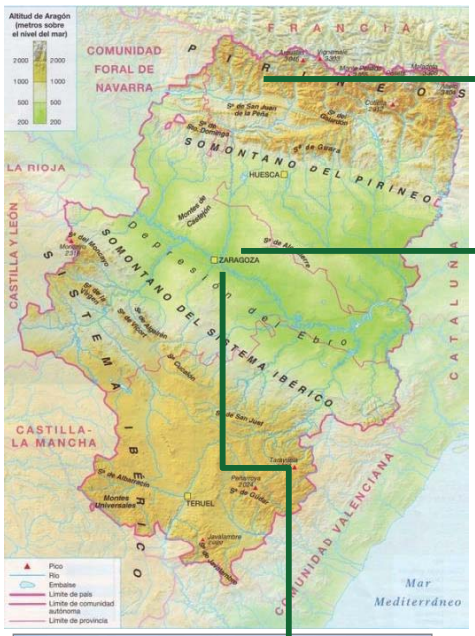
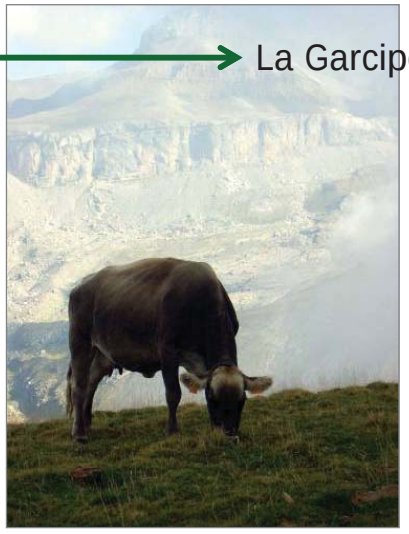
Public Research Institute for R&D in the Agri-Food sector in Aragón

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 Facilities





La Garcipollera

Vedado de Zuera

Soto Lezcano

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

Livestock production

Environment

Socio - Economic context

How can we increase calf crop?

Optimising reproductive performance

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

Age at 1st calving
- Precocity-development

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

Conception & Pregnancy
- Fertility
- Heat detection
- AI protocols

Reproducibility
- Lifespan

Sanz et al. (2004)

Reproductive diseases

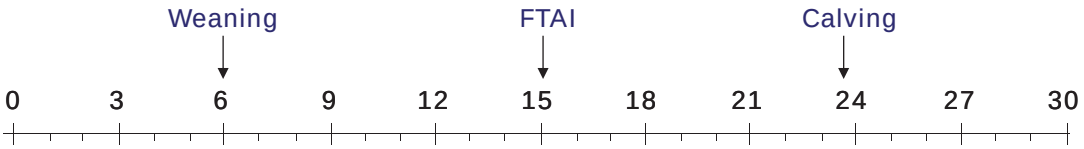
Trichomonas, Besnoitia, Campylobacter, Neospora, BVD, IBR

(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)



Lactation	Rear	Pregnancy	1st Lactation
0-6 m	6-15 m		

Target ADG	Target ADG		
LOW 700 g/d	**LOW** 700 g/d	100%	100%
	HIGH 1000 g/d		
HIGH 1000 g/d	**LOW** 700 g/d		
	HIGH 1000 g/d		

2 feeding levels LACTATION (0-6 m)
x 2 feeding levels REAR (6-15 m)

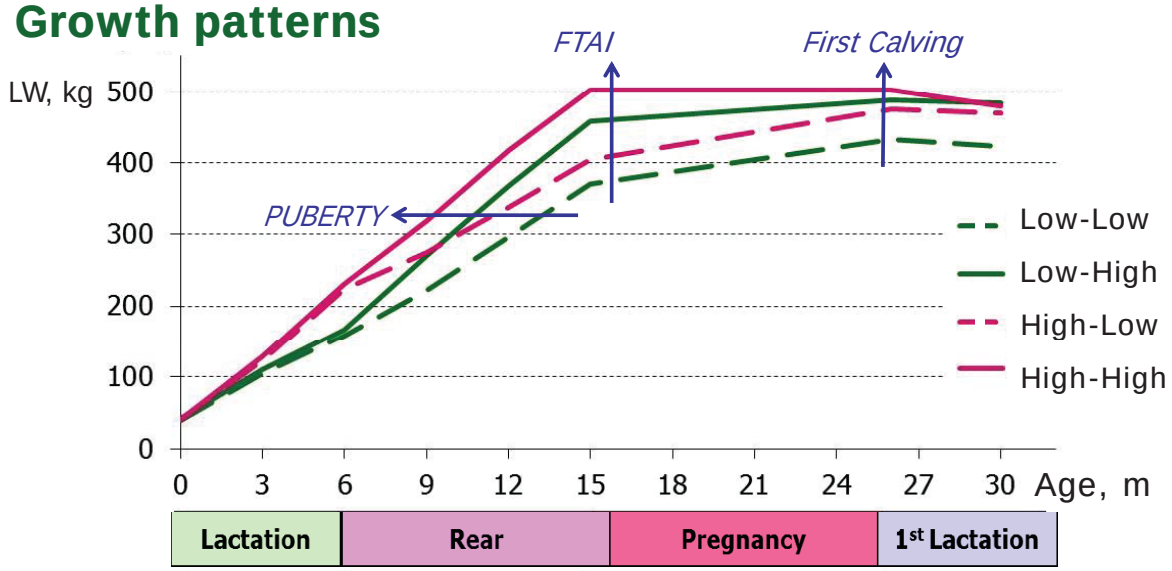
- Growth & development
- Reproduction
- Performance 1st lactation

- 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)

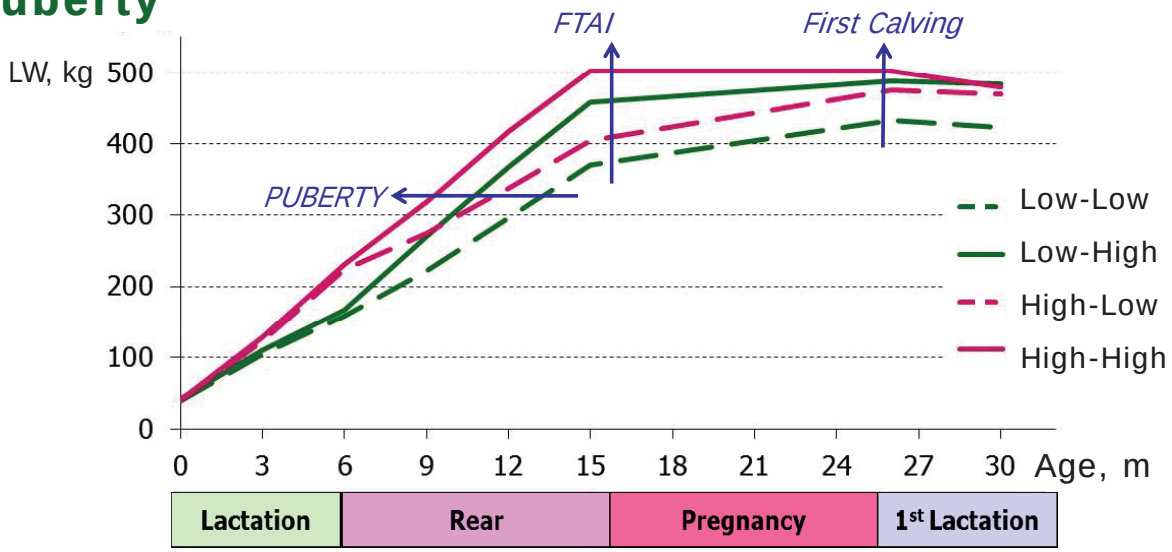
Mechanisms of Action

≠ Growth patterns



LACT (0–6 mo)	Low		High				
REAR (6–15 mo)	**Low**	**High**	**Low**	**High**	LACT	REAR	LxR
ADG Lact	0.643^{b}	0.699^{b}	1.046^{a}	1.080^{a}	***	NS	NS
ADG Rear	0.744^{c}	0.998^{a}	0.593^{d}	0.925^{b}	***	***	NS

Puberty



- **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)

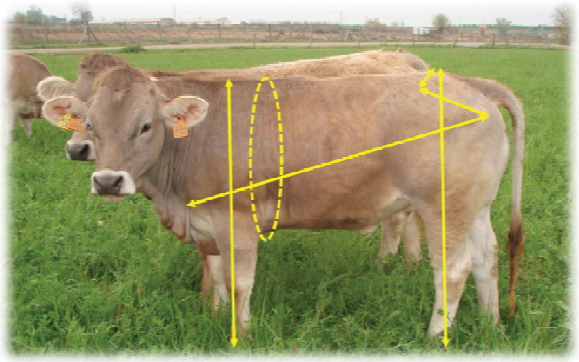
glucose, NEFA, urea, B-OH-B, leptin, IGF-1

Rodríguez-Sánchez et al., 2015. Journal of Animal Science 93: 3871-3885.

First lactation

Growth and Calving ease

LACT (0–6 mo)	Low		High				
REAR (6–15 mo)	**Low**	**High**	**Low**	**High**	LACT	REAR	LxR
Age 1st calving, mo	25.6[b]	26.6[a]	25.7[b]	26.2[ab]	NS	*	NS
BW at calving, kg	436[b]	487[a]	474[a]	500[a]	*	**	NS
BW at weaning, kg	425[b]	482[a]	469[a]	479[a]	0.06	**	*
ADG first lactation, kg	-0.07	-0.05	0.015	-0.12	NS	NS	NS
Dystocia, %	80	37.5	0	16.7	*	NS	
Calf/Cow BW ratio, %	8.4[a]	8.5[a]	7.3[b]	7.3[b]	**	NS	NS



LACT (0–6 mo)	Low		High				
REAR (6–15 mo)	**Low**	**High**	**Low**	**High**	LACT	REAR	LxR
Dam performance							
Milk yield, kg ECM/d	5.73	6.60	5.95	6.58	NS	NS	NS
Postpartum anoestrus, d	112	79	101	84	NS	0.06	NS ??

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

Calf performance							
BW at birth, kg	36.6	41.5	38.3	36.3	NS	NS	NS
BW at weaning 4m, kg	130	128	127	146	NS	NS	NS
ADG, kg	0.779	0.718	0.737	0.910	NS	NS	NS

Rodríguez-Sánchez et al., submitted

Main conclusions

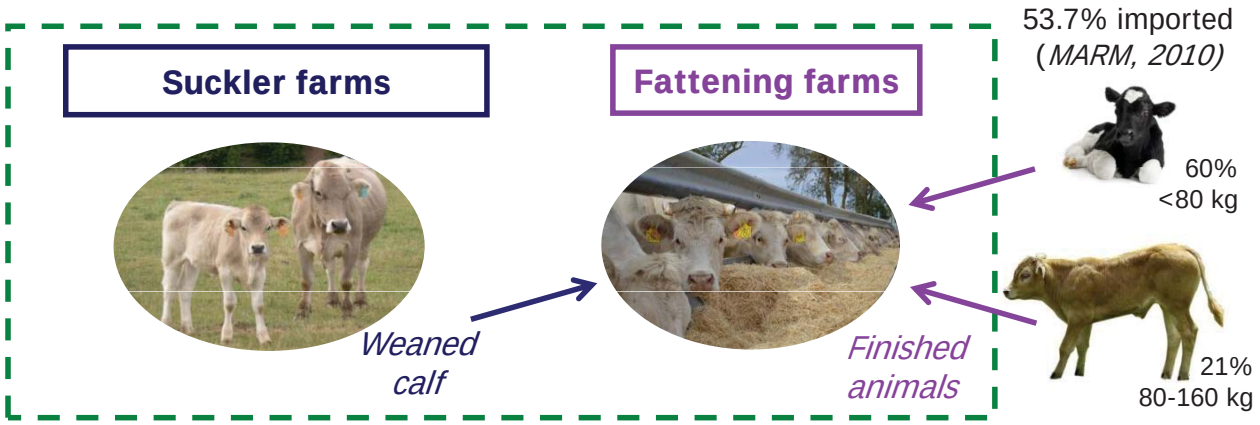
Beef heifers can calve for the first time around 2 years

- 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?

How can we optimize calf growth?

Beef production in Spain



Intensive
housing + forage crops

Extensive
dry / humid / mountain areas

Feedlots
concentrates vs. other diets

***Pasture** + supplements*

Feed supplements:
for the cow or for the calf?

Age at weaning:
early (3 m) vs. traditional (6m)

Cow-Calf mgt during LACTATION

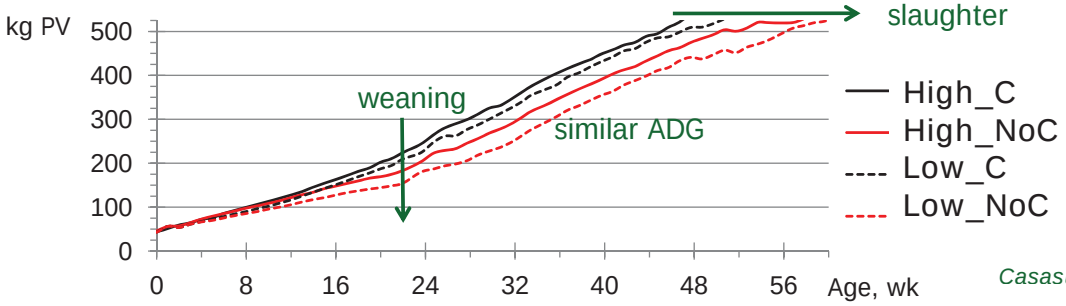
Effects on performance:
- offspring: lactation/finishing replacement heifers
- dams: reproduction

Economic interest:
Suckler / finishing / whole cycle farms



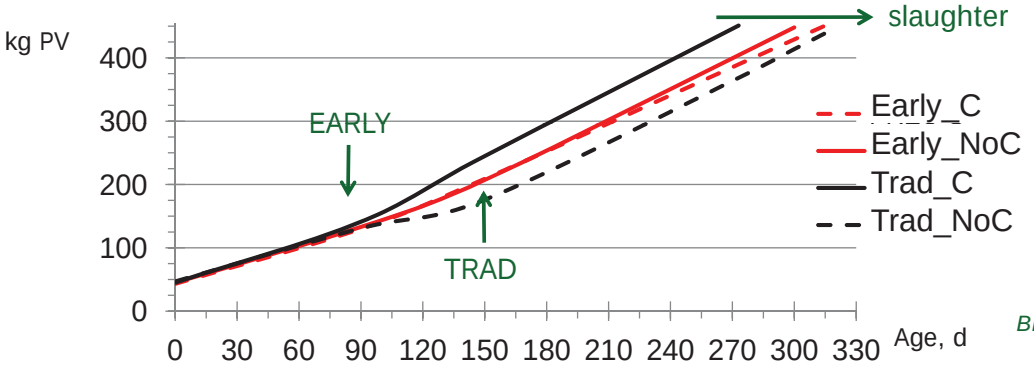

≠ Growth patterns

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



Casasús et al. (2001)

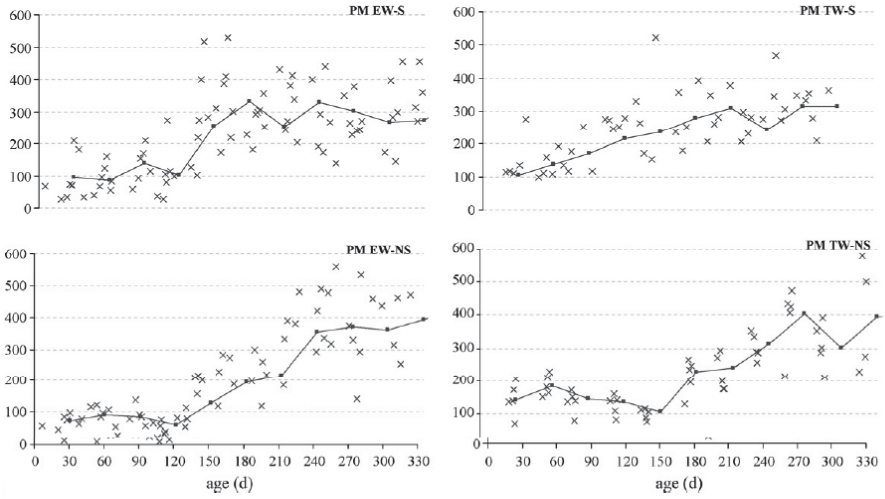
Effect of **age at weaning** (EARLY vs. TRAD) and **calf supplementation** (C vs. NoC) during lactation



Blanco et al. (2008)

≠ endocrine & metabolic profiles

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

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

Feed mgt during FATTENING

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

Concentrates:
raw materials, additives

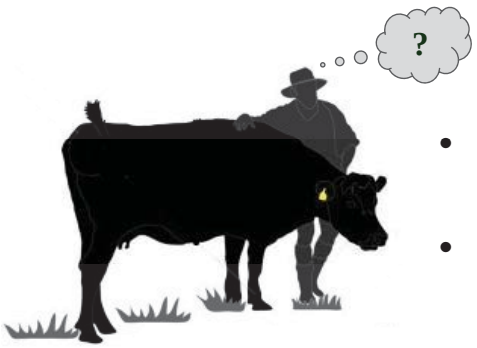
Comparisons of Forage-based diets vs. Conventional fattening

- Technical performance: different forages & supplements
- Economic performance: feed costs  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

Main Conclusions

- Tecnhical 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**



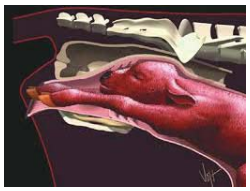
BUT… uncertainty

- Performance is more **aleatory** (weather, feed quality …)
- More **flexibility** in management and technical knowledge for **sound decissions**

Current specific research topics

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)*	**Embryo** *(mid term)*	**Fetal dvpt.** *(long term)*
Oocyte quality	*Nutrient allocation*	*Fetal germ cells*
Luteal function	*Fetal programming (organic function)*	*Epigenetics*
Plasmatic P4		
Embryo survival	*DNA changes (epigenetics)*	
Fertility		

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

INIA 2014

- 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

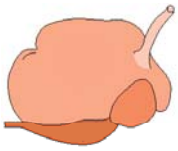
Sheep and Cattle

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

MINECO 2013

TRANSITION from Lactation to Fattening

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

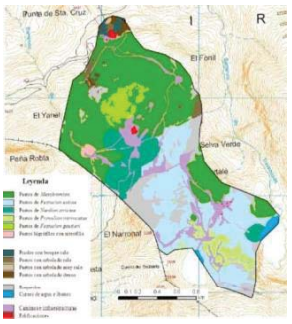


- Concentrate ingredients
  - sources of carbohydrates
  - inclusion of additives
- Pattern of administration

- **Calf management before weaning**

Ruminal conditions, animal welfare and productivity

milk | milk + hay | milk + concentrate


Punta de Sta. Cruz
El Yanel
Peña Robla
El Fonil
Selva Verde
El Narronal
Leyenda