iSAGE Training Course and Workshop

INNOVATIONS TO IMPROVE SUSTAINABILITY IN THE SHEEP AND GOAT SECTOR
(Zaragoza, Spain, from 10 to 13 December 2019)

Genetic approaches to improve sustainability and adapting to climate change (WP5)

→ novel phenotypes for improving animal resilience/adaptability :

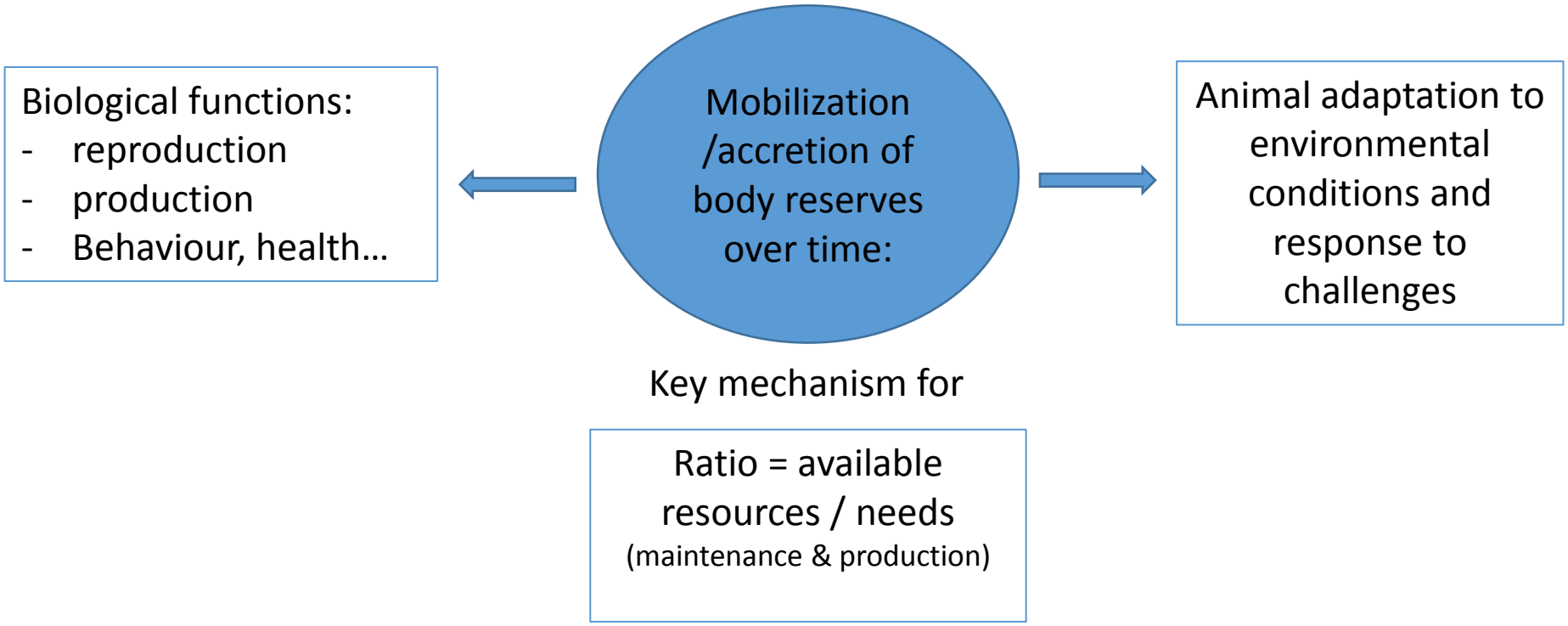
The body reserves mobilization-accretion process

Dominique Hazard et al. (dominique.hazard@inra.fr)

Innovation for Sustainable Sheep and Goat Production in Europe

iSAGE project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 679302.

Body reserves dynamics – Why ?



Hypothesis = Animals better adapted or more resilient may show a better management of body reserves

Objective in farms : ↑ **Contribution of animals to managing the ratio** ↓ **Contribution of farmers to managing the ratio**

Experimental facilities:

INRA experimental farm La Sapinière
(Bourges, centre of France)

Meat sheep : Romane

intensives conditions

N=65
N=63

- Exclusively indoor
- high inputs system

INRA experimental farm La Fage
(Roquefort sur Soulzon, south of France)

Meat sheep : Romane

extensive conditions

Primiparous ewes: N=180
Multiparous ewes: N=220

- Exclusively outdoor
- Harsh environment: high seasonal variations (feed quality and quantity)
- Low inputs system (1 ewe/ha)
- One lambing /year (in April)

Dairy sheep : Lacaune

Semi-intensive conditions

N=220
N=250

- Indoor and outdoor
- Grazing (6 months : April to October)
- One lambing /year (in December or January)

Phenotypes:

❖ **Body Condition Score:**

→ from the original grid described by Russel et al. (1969)

→ A scale from 1 to 5 (0.25 or 0.1 increments)

❖ **Key metabolites and hormones** associated with lipids metabolism :

→ Blood sampling (plasma)

- Non Esterified Fatty Acids (NEFA) : produced by adipose tissue during BR mobilization
- Beta-hydroxybutyrate (BOHB) : produced by liver tissue during use of fatty acids to produce energy
- Triiodothyronine (T3) : thyroid hormone produced to activate lipolysis

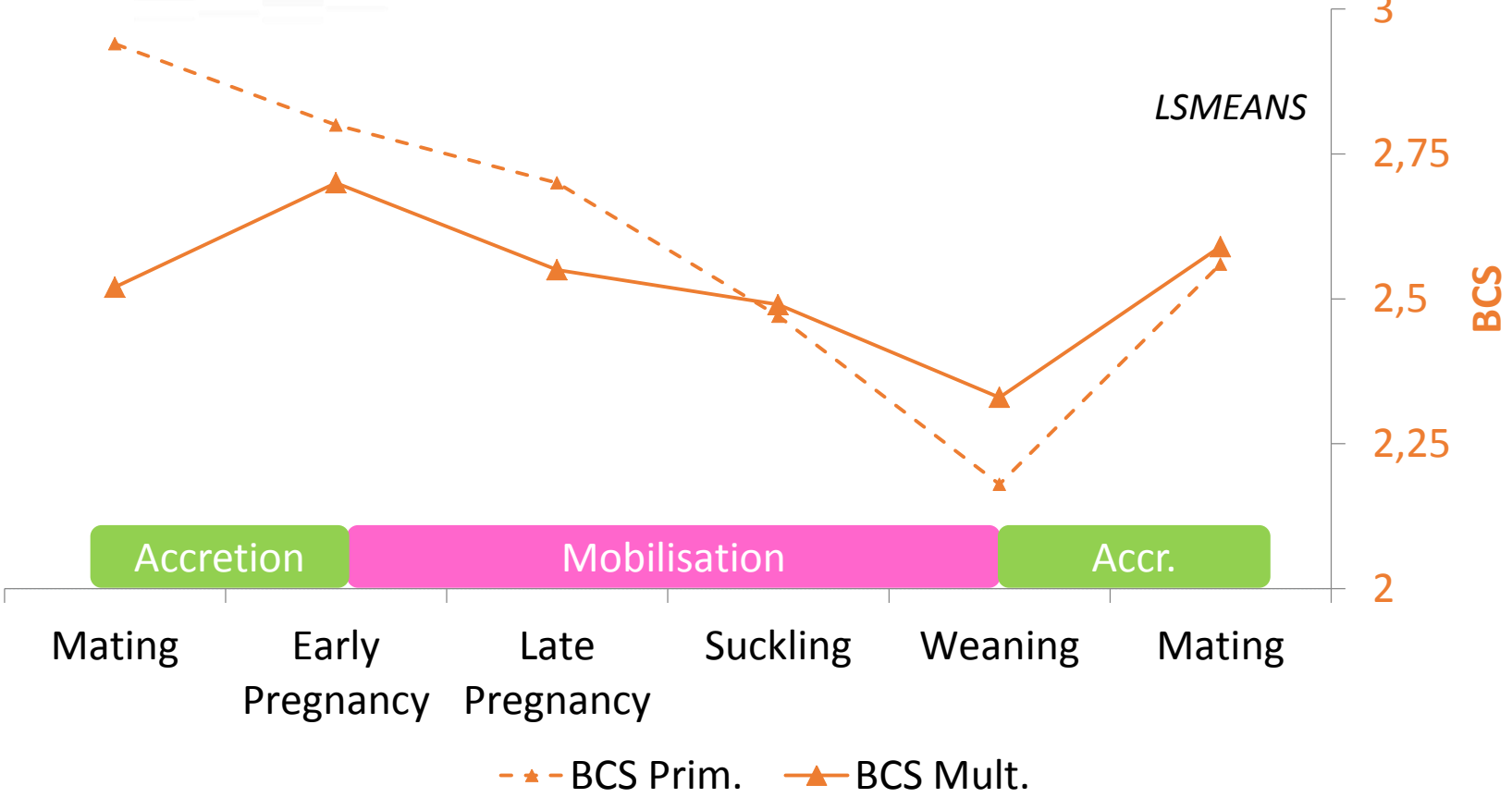
❖ Longitudinal phenotyping (3 to 6 points / 1 to 2 productive cycles): mating, early pregnancy (2months), late pregnancy (2weeks before lambing), suckling (3 weeks after lambing), weaning

Objective: characterize novel phenotypes for BR and investigate genetic determinism

Body reserves at physiological stages

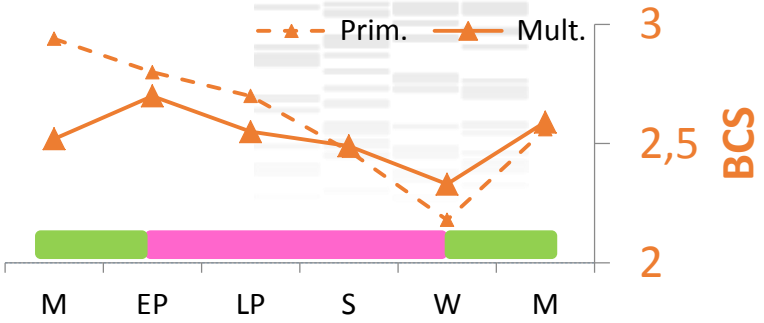
in Romane

extensive conditions



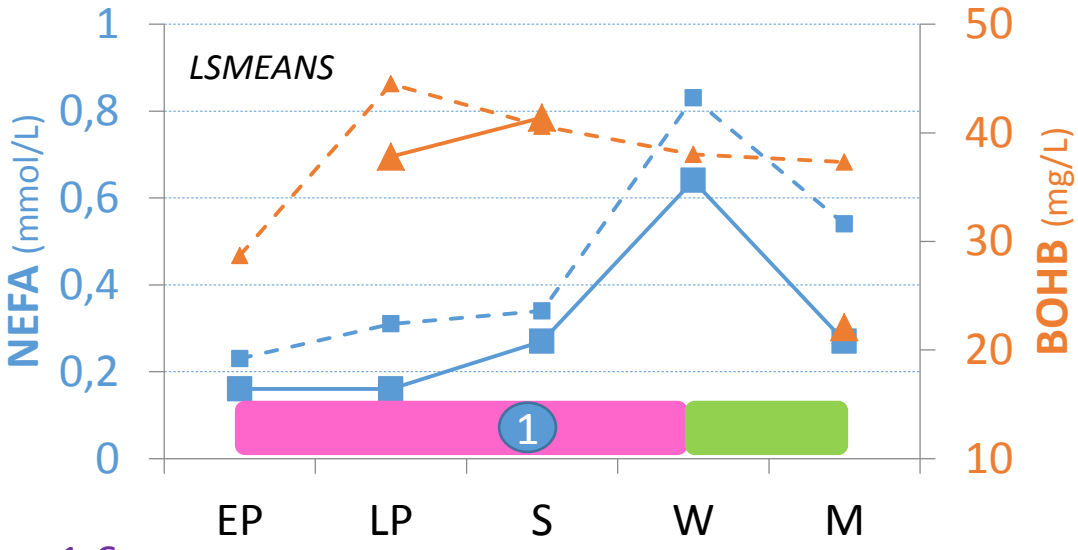
➔ Alternation of BR accretion and mobilization throughout a productive cycle

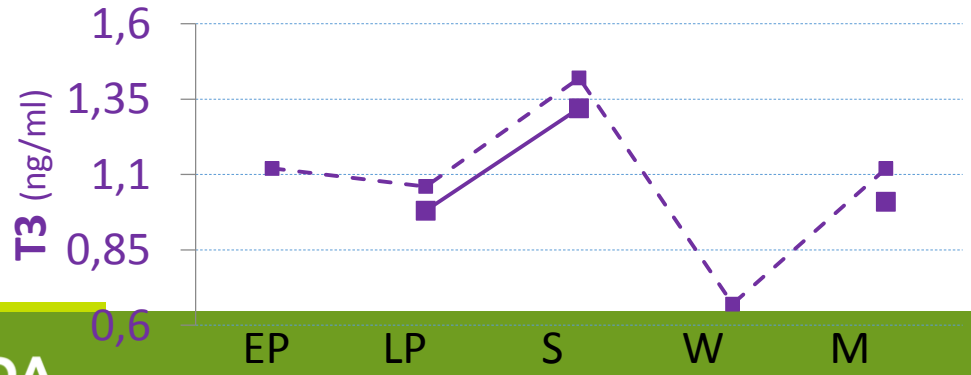
Biomarkers of Body Reserves



in Romane

extensive conditions



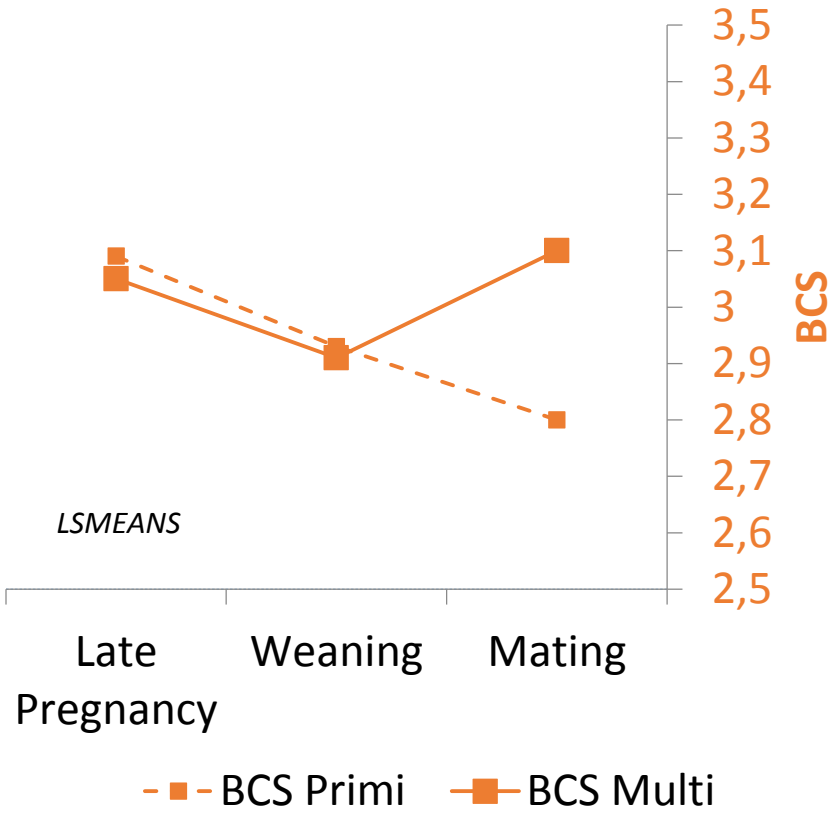


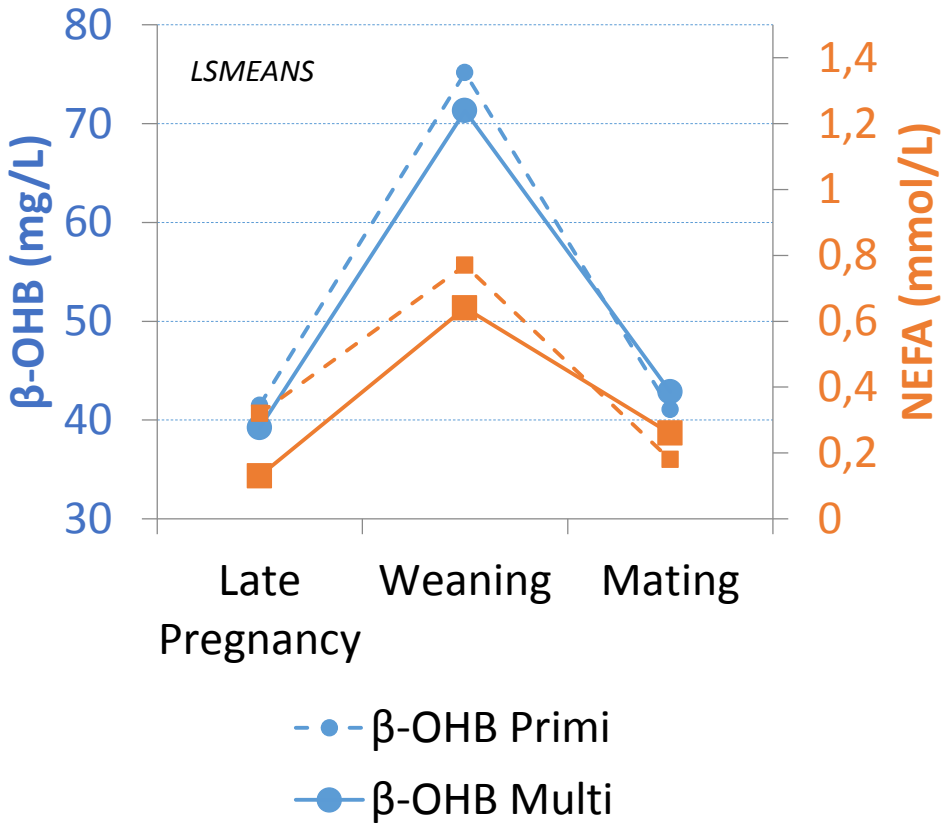
1 Increase of lipolysis

Body reserves at physiological stages

in Lacaune

Semi-intensive conditions



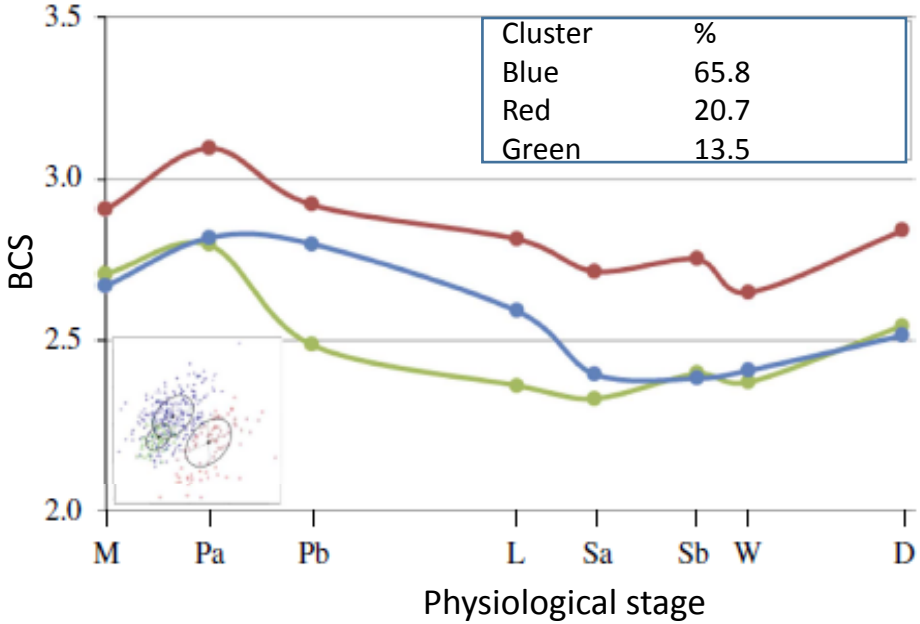


Body reserves trajectories

in Romane

extensive conditions

- Multiparous ewes (n~500, *background data*)
  - 2nd lambing
  - age = 2-3 years (2.5 in avg. in each cluster)
  - Litter size = 2 lambs (pregnancy and suckling)

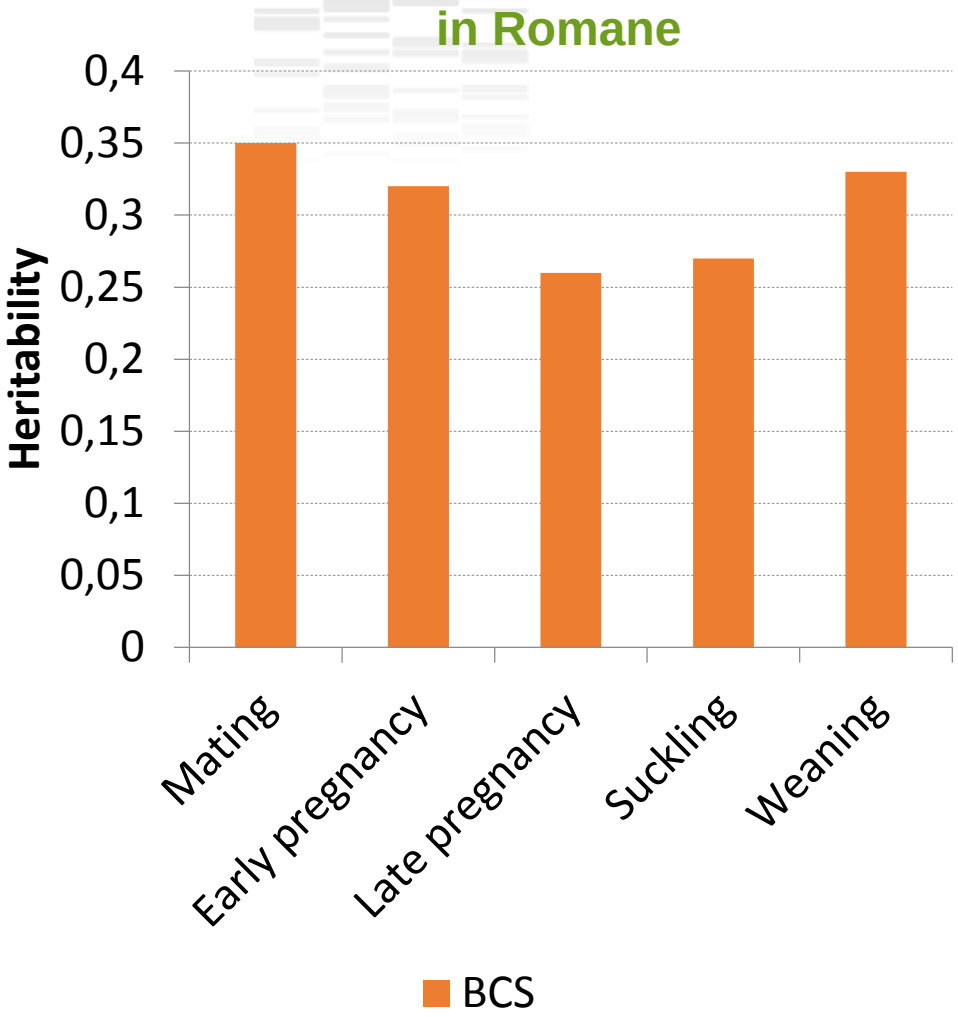


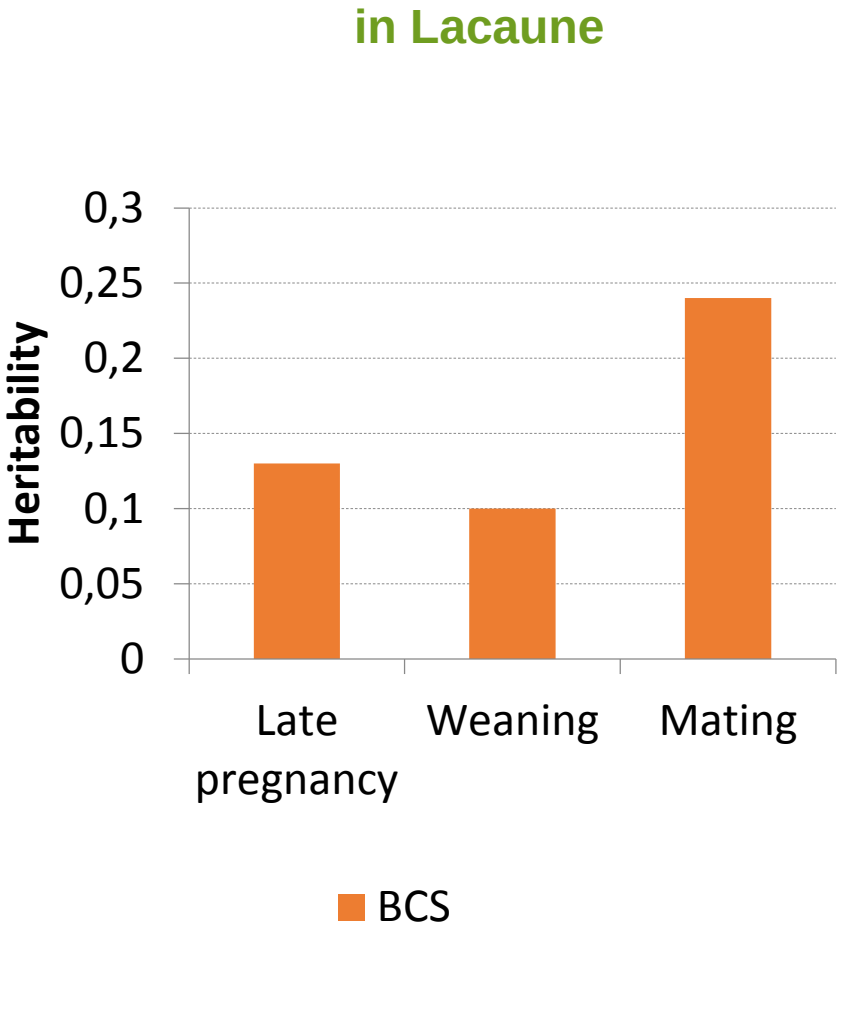
→ Three main groups of ewes differing by their BR trajectories.

Macé et al, Animal, 2018

➔ Inter-individual variability in the level and the form of BR trajectories.

Body reserves levels: heritability

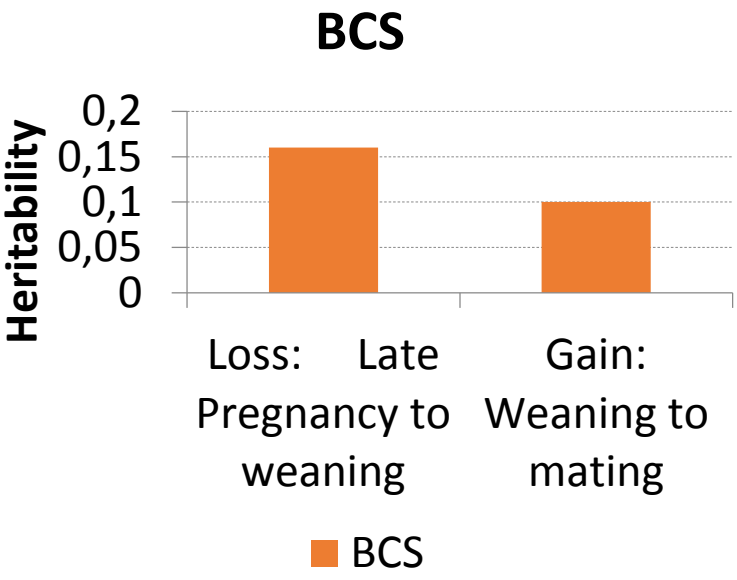




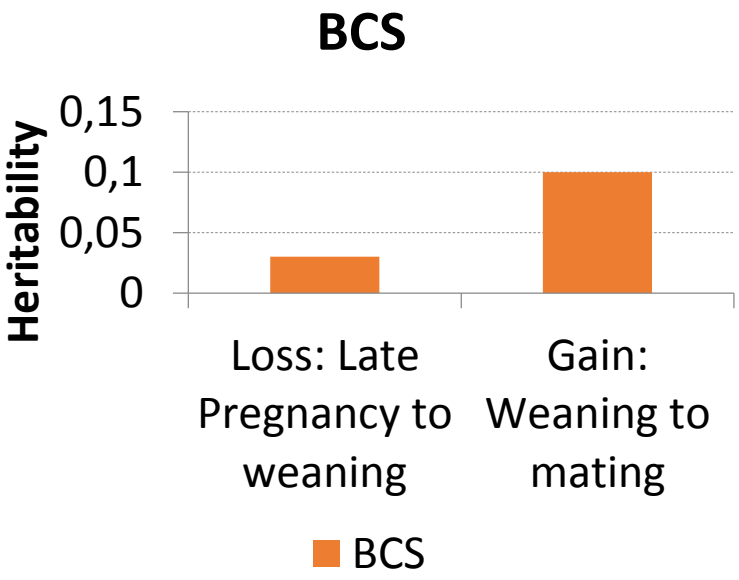
➔ BR levels are heritable traits.

Body reserves changes over time: genetic parameters

in Romane



in Lacaune



➔ BR mobilization and accretion processes are heritable traits.

Body reserves changes over time:
genetic correlation between loss and gain

in Romane

➔ BR mobilization (loss) and accretion (gain) processes are genetically linked.

	BCS gain
BCS loss	**-0.75** (±0.31)

in Lacaune

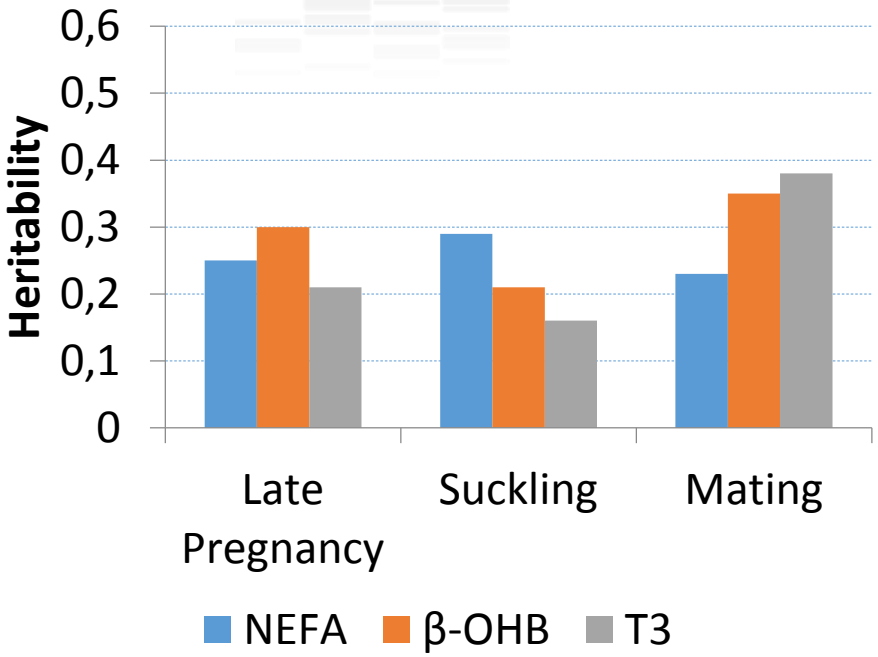
➔ No significant correlation between mobilization and accretion

➔

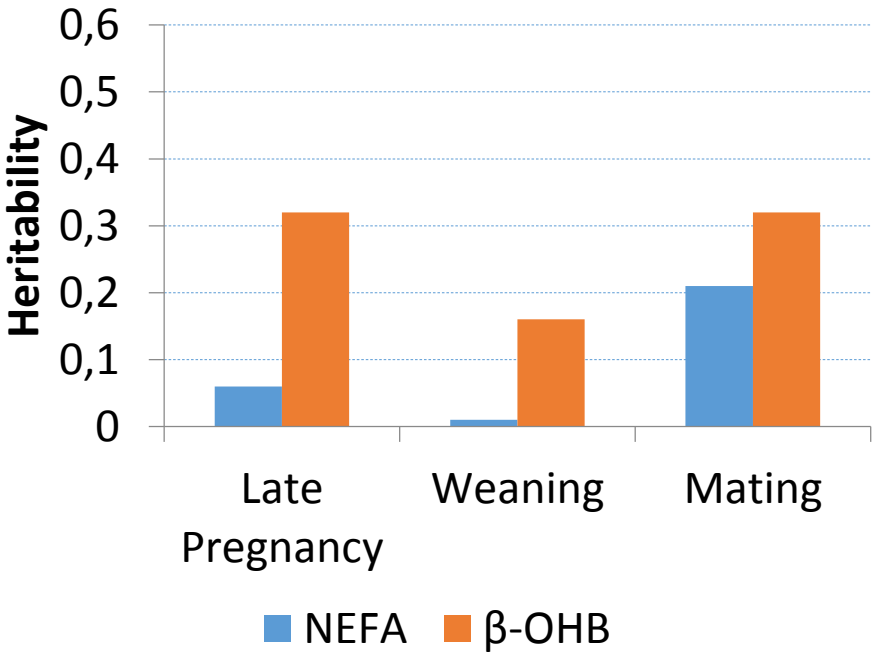
	BW loss	BW gain
BCS loss	**0.9** (±0.31)	
BCS gain		**0.65** (±0.14)

Biomarkers for body reserves: genetic parameters

in Romane



in Lacaune



➔ Levels in biomarkers of BR metabolism are heritable traits.

➔ Changes over time (ie loss or gain) in biomarkers are lowly heritable (h2 ~0.10, dairy and meat sheep).

Take Home Message :

- Body reserves successfully assessed with:
  - body condition score (and body weight)
  - metabolic biomarkers

- Body reserves dynamics:
  - alternation of mobilization and accretion processes throughout productive cycles
  - linked to physiological and environmental factors

- Levels and variations in body reserves:
  - are heritable traits (low to moderate heritabilities)
  - are associated with genomic regions

➔ **Genetic selection of sheep that better manage BR can be envisaged in future breeding programs to improve their resilience.**

Acknowledgments

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Thanks for your attention

Photo : INRA C. Maître

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Body reserves and production :

in Romane

Genetic correlations:

	Birth weight (litter or lamb)	Lamb growth or weaning weight
BCS	**NS to -0.3** (±0,10)	**NS to -0.35** (±0,10)
BCS loss	**-0.40** (±0,10)	NS
BCS gain (Early Pregnancy)	**0.34** (±0,16)	NS

➔ Higher level of production associated with lower BR level at mating and higher BCS loss during pregnancy and suckling in meat sheep.

in Lacaune

Genetic correlations:

	Milk	
BCS at mating	**-0.4 to -0.6** (±0,13)	
BCS loss	*-0.45 (±0,30)*	
BCS gain	**-0.6** (±0,13)	

➔ Higher level of production associated with lower BR level at mating and lower BCS gain before mating in dairy sheep.