

Session 04

Adaptation of breeding strategies and genetics to climate change, right animal for right environment

➤ **Ewe-lamb allocation trade-offs shape ewe lifetime production depending on dietary energy scarcity**

Maya Hiltbold, Ronan Trépos, Frédéric Douhard

> Searching the super ewe

Which ewe performs best in which environment?

- Valorisation of available feed
- Good number of lambs the ewe is able to rise (prolificity)
- Lambs born alive and vigorous
- Good growth of lambs (milk production)
- Survival / longevity
- Repeated reproduction

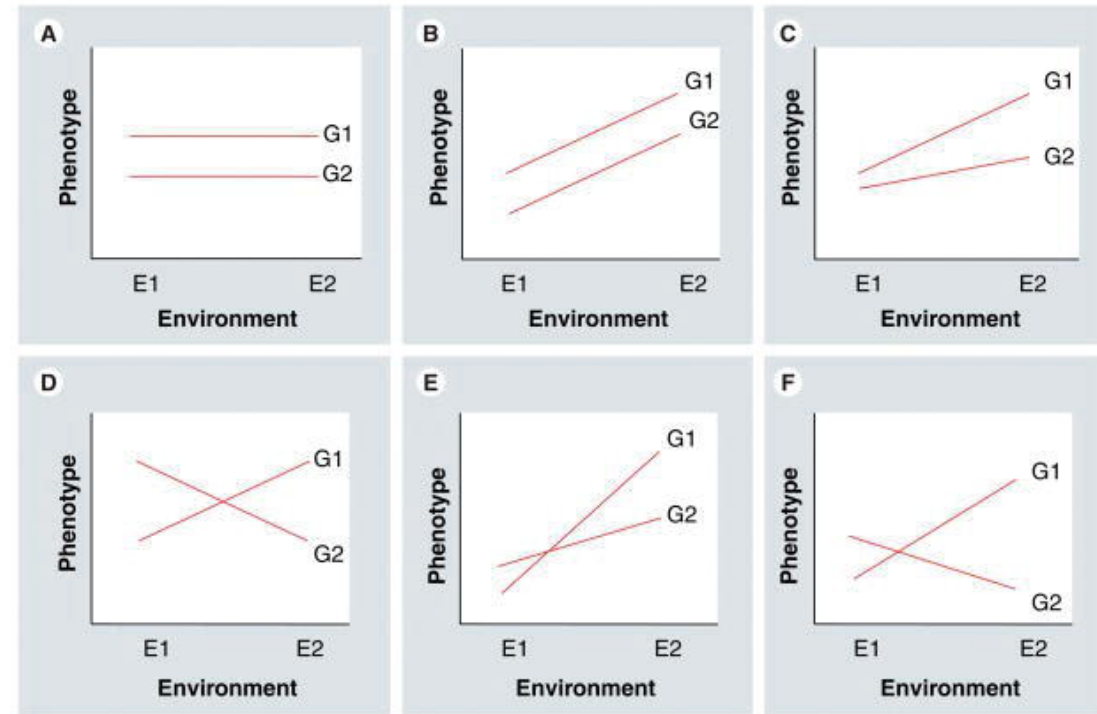
Life performance = genotype + environment + management + interaction



➤ Genotype x environment interactions

- Selection often in good environments
 - ...to express the genetic potential
- BUT: G x E interaction can change ranking
- Difficult to measure the performance in multiple environments
- Future environments might not exist yet

=> Model the performance in multiple environments

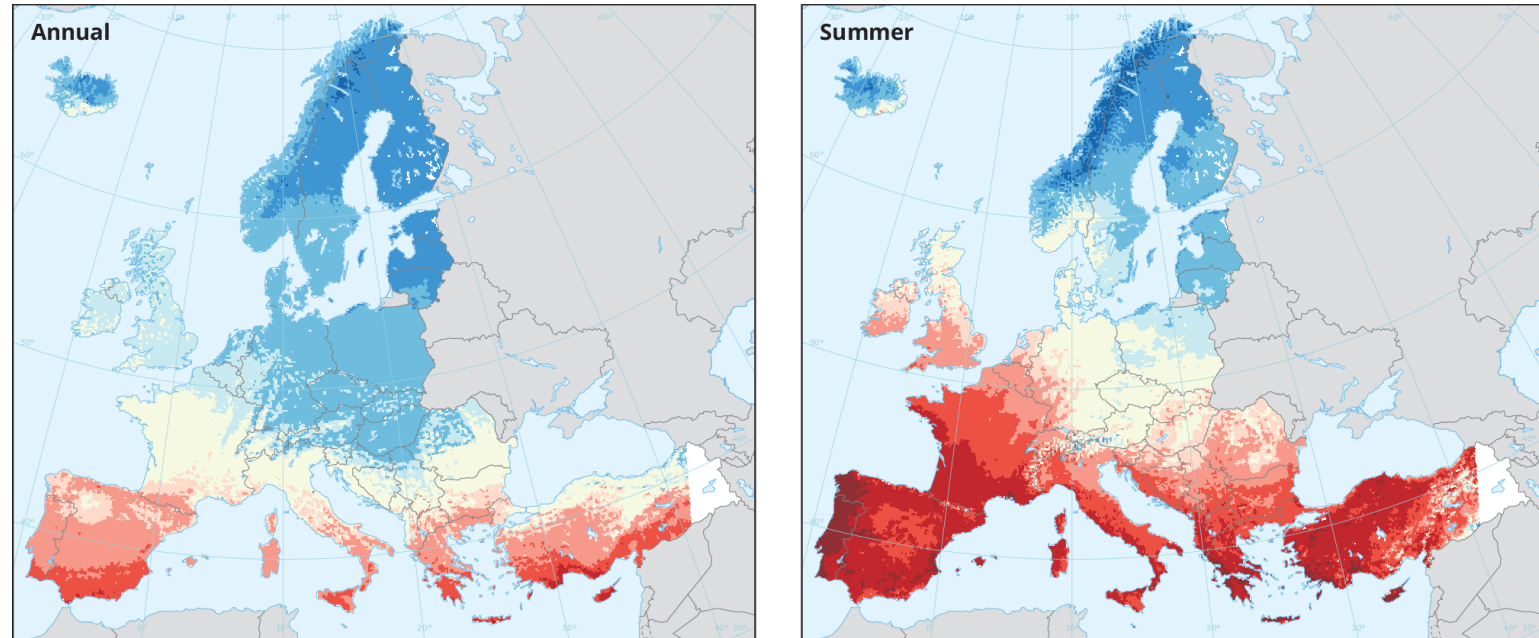


https://bookdown.org/emma_strand/comps-study-guide/genotype-x-environment-interactions.html

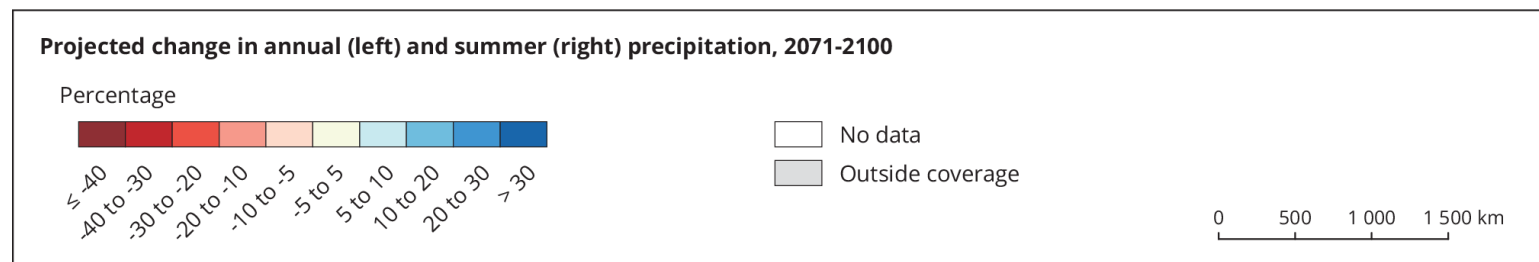
➤ Future environments: climate change (middle and southern Europe)

- Average temperature increases
- Changed precipitation patterns
 - Increased drought frequency
 - Less rain in summer
 - More heavy rain

-> summer with no pasture regrowth



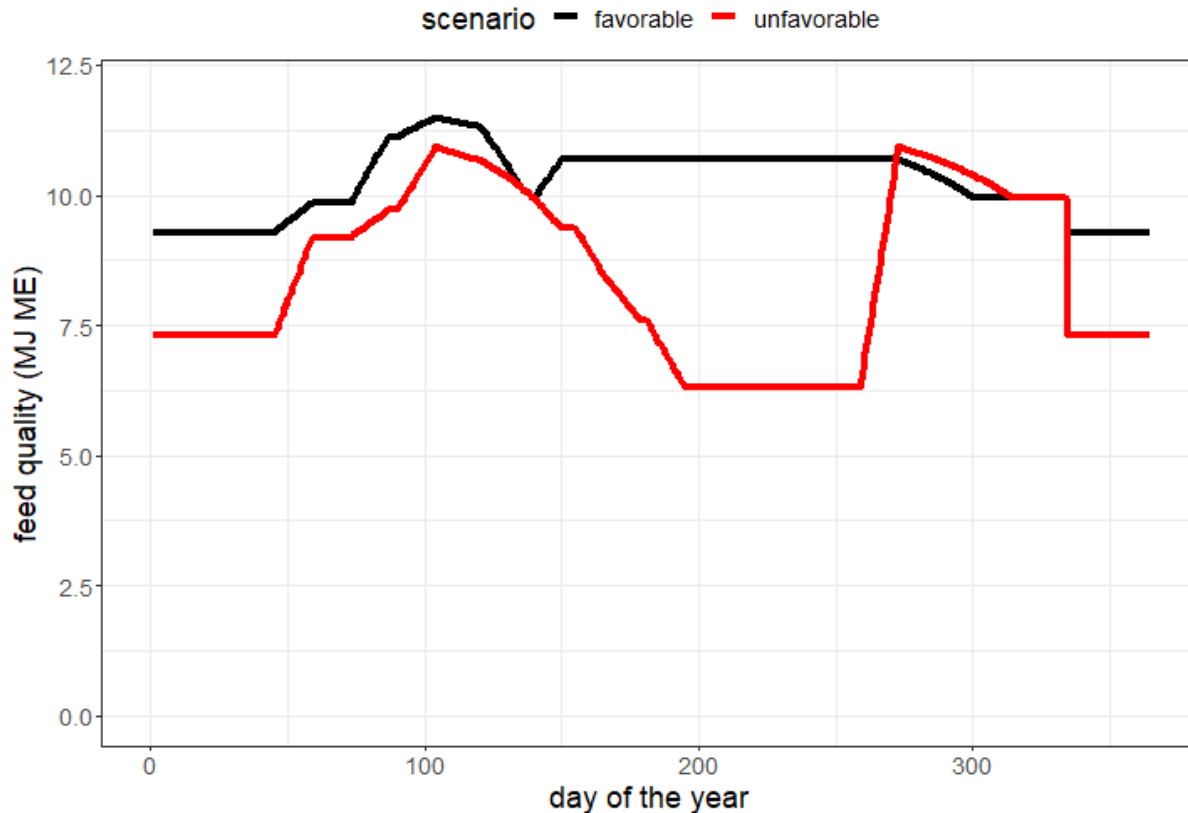
Reference data: ©ESRI



<https://www.eea.europa.eu/data-and-maps/figures/projected-change-in-meteorological-drought>



➤ Environment scenarios: favorable & unfavorable



Favorable (+):

- Good pasture and forage
- Favorable grass growth
- Intensive grassland management (conservation and regrowth: «young» feed)
- Complementation with cereals around lambing

Unfavorable (-):

- Good spring pasture, then medium to low quality pasture and forage
- No regrowth during summer, regrowth in autumn
- Extensive grassland management (conservation: «old» feed)
- No complementation with cereals around lambing

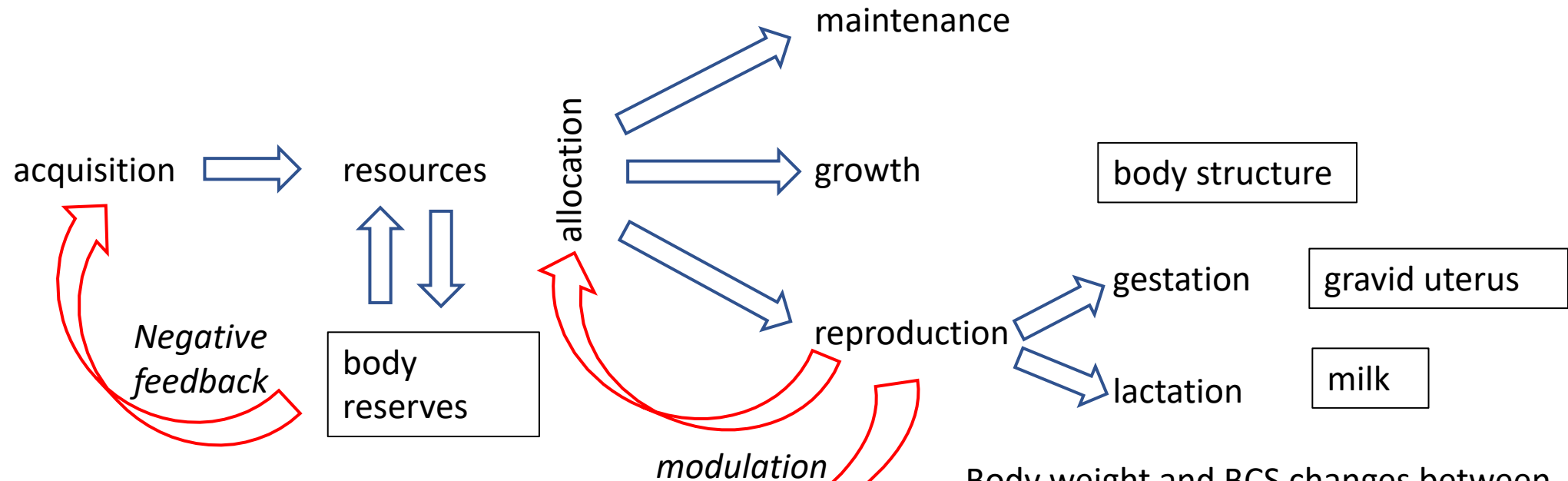
> Allocation problem

Limited energy resources -> compromise between functions

- How much do I eat (can I eat)?
- How do I split what I have eaten between functions?

Acquisition

Allocation



Body weight and BCS changes between reproductive stages are heritable

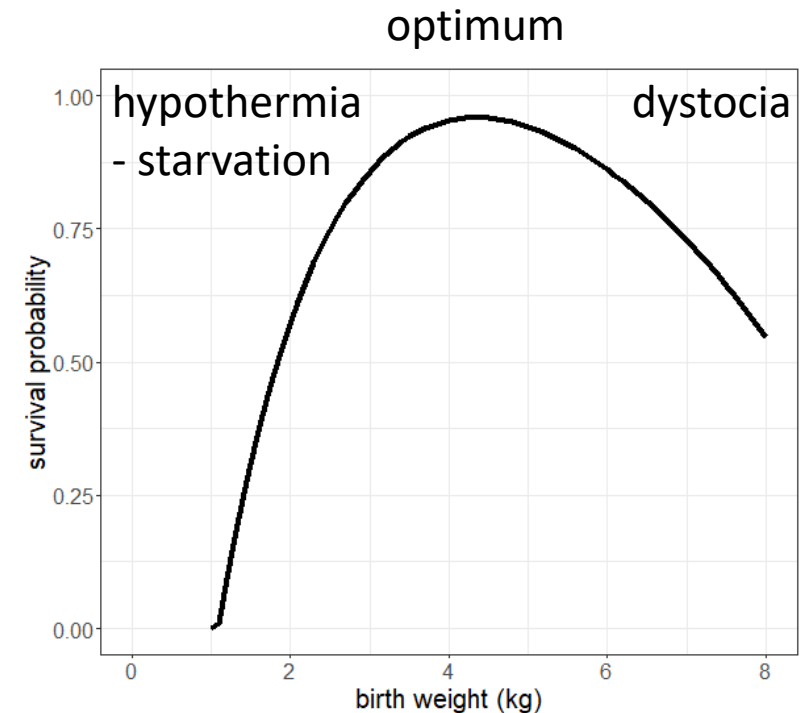
e.g. Romane ewes $\Delta BW h^2 = 0.13-0.17$

$\Delta BCS h^2 = 0.04-0.16$

(Macé et al 2018 doi: 10.1093/jas/sky318)

➤ Sheep acquisition and allocation model

- Body compartments result from acquisition and allocation (daily update)
- Body reserves modulate acquisition and allocation
- Reproduction is modulated by ewe's condition (body reserves, body reserve change, maturity)
- Lamb is linked to the mother (birth weight, available milk)
- Perinatal and daily survival is sampled from modulated probabilities



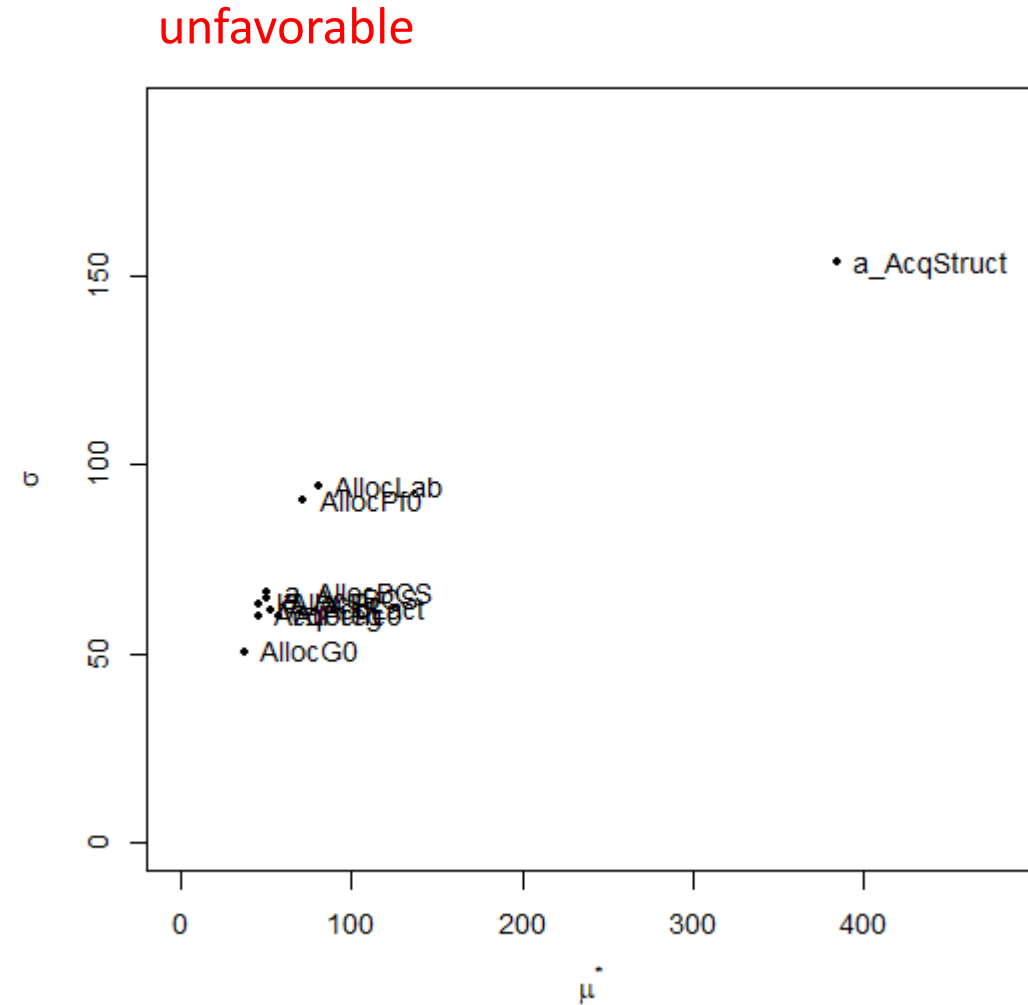
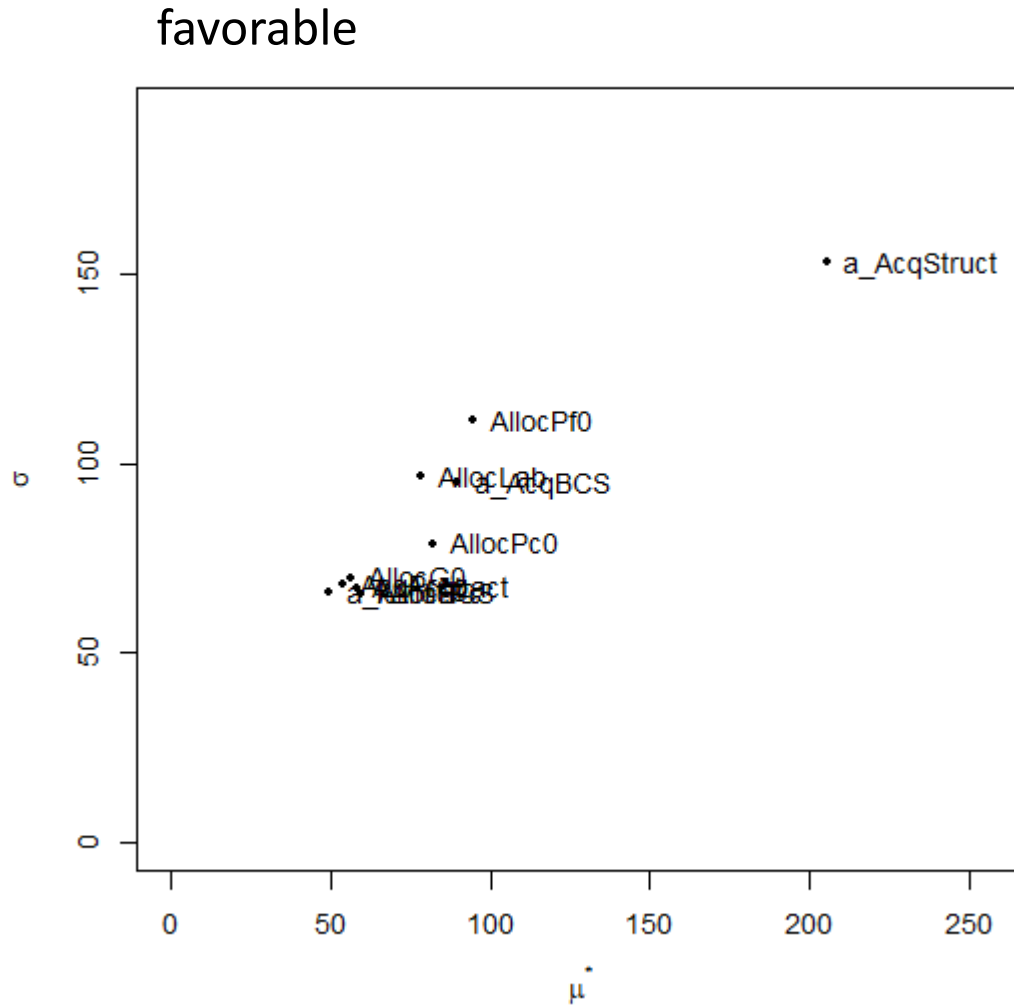
➤ Which acquisition and allocation parameters have strongest impact?

- Sensitivity analysis (Morris method) in both environments on some parameters
- 4 acquisition parameters
 - a_AcqStruct basal acquisition rate
 - AcqPreg gestation effect on acquisition rate
 - A_AcqLact lactation effect on acquisition rate
 - a_AcqBCS BCS effect on acquisition
- 6 allocation parameters
 - AllocG0 basal allocation to growth
 - AllocPf0 basal allocation to gestation
 - AllocPc0 basal allocation to lactation
 - kAllocPc days post partum effect on allocation to lactation
 - a_AllocBCS BCS effect on allocation
 - AllocLab allocation to labile protein (= reduction allocation to fat reserves)



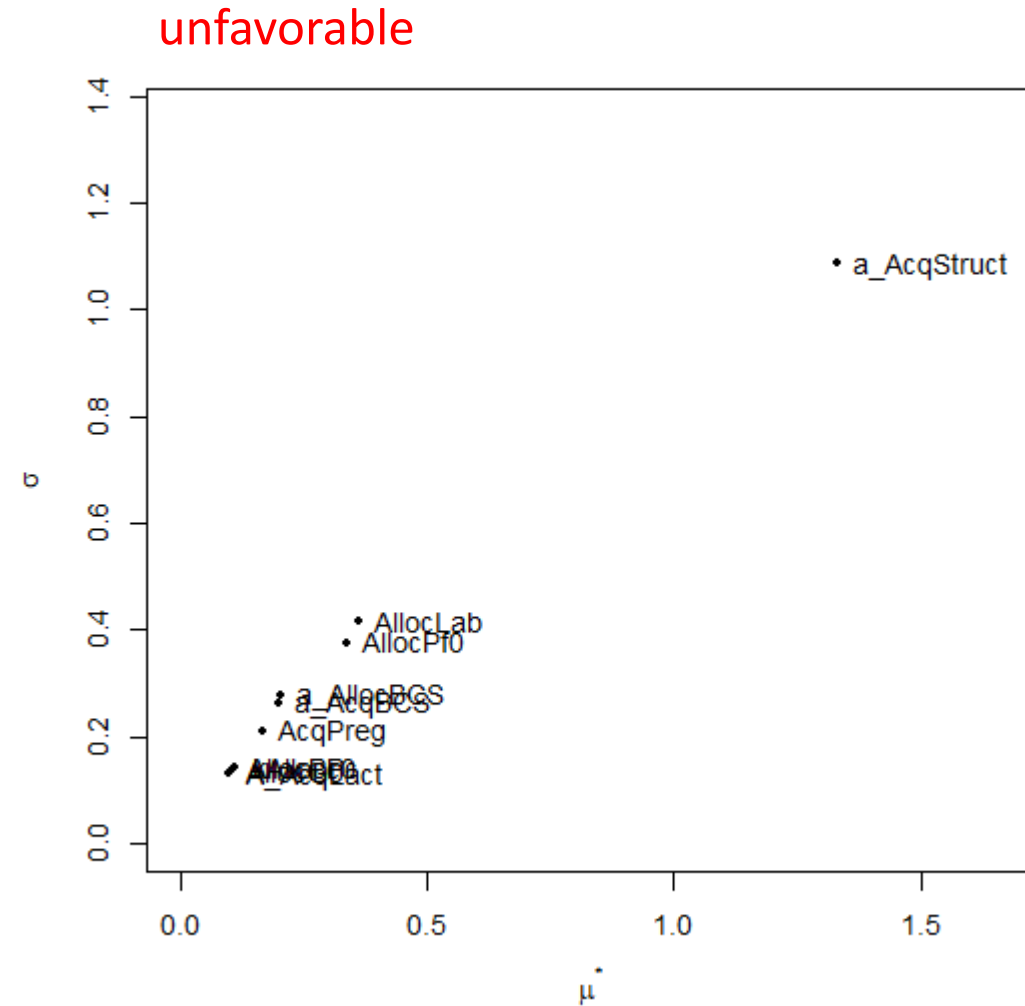
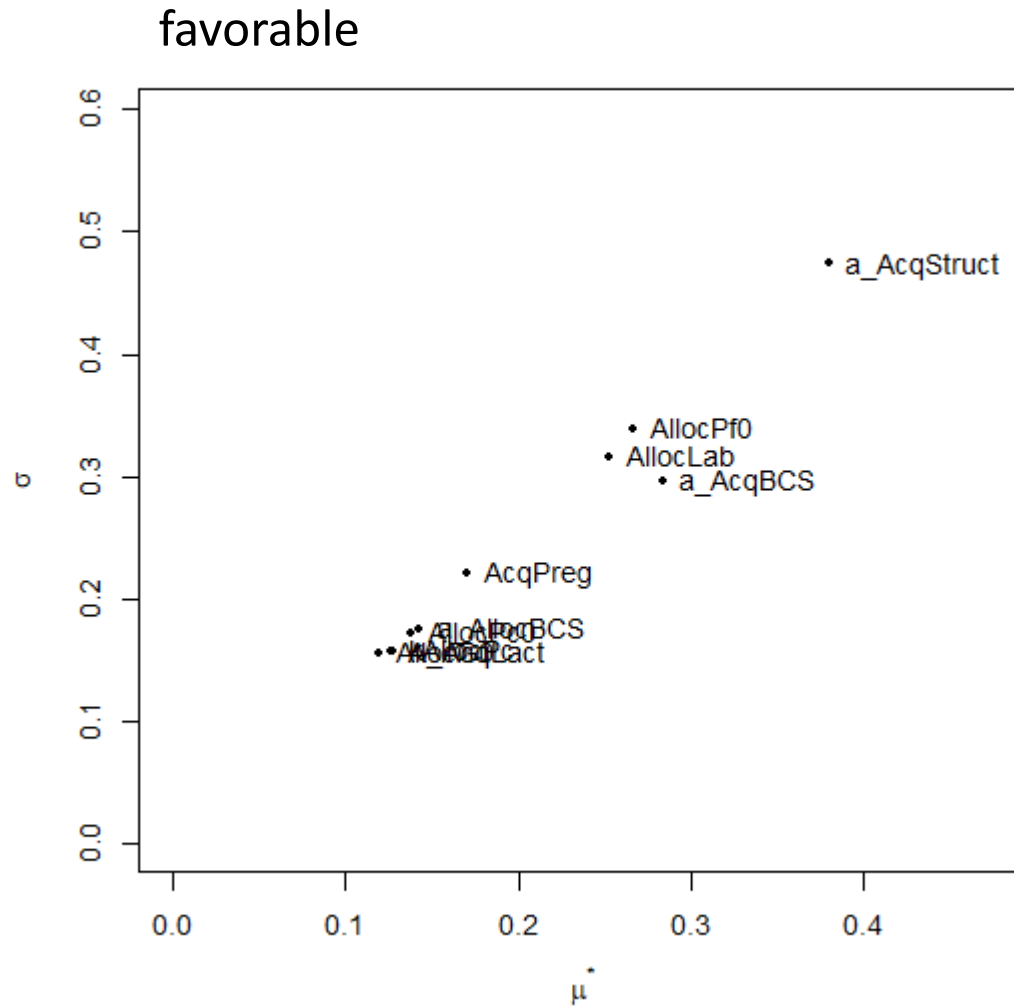
➤ Importance of parameters between environments (2)

Total lamb weight weaned per ewe



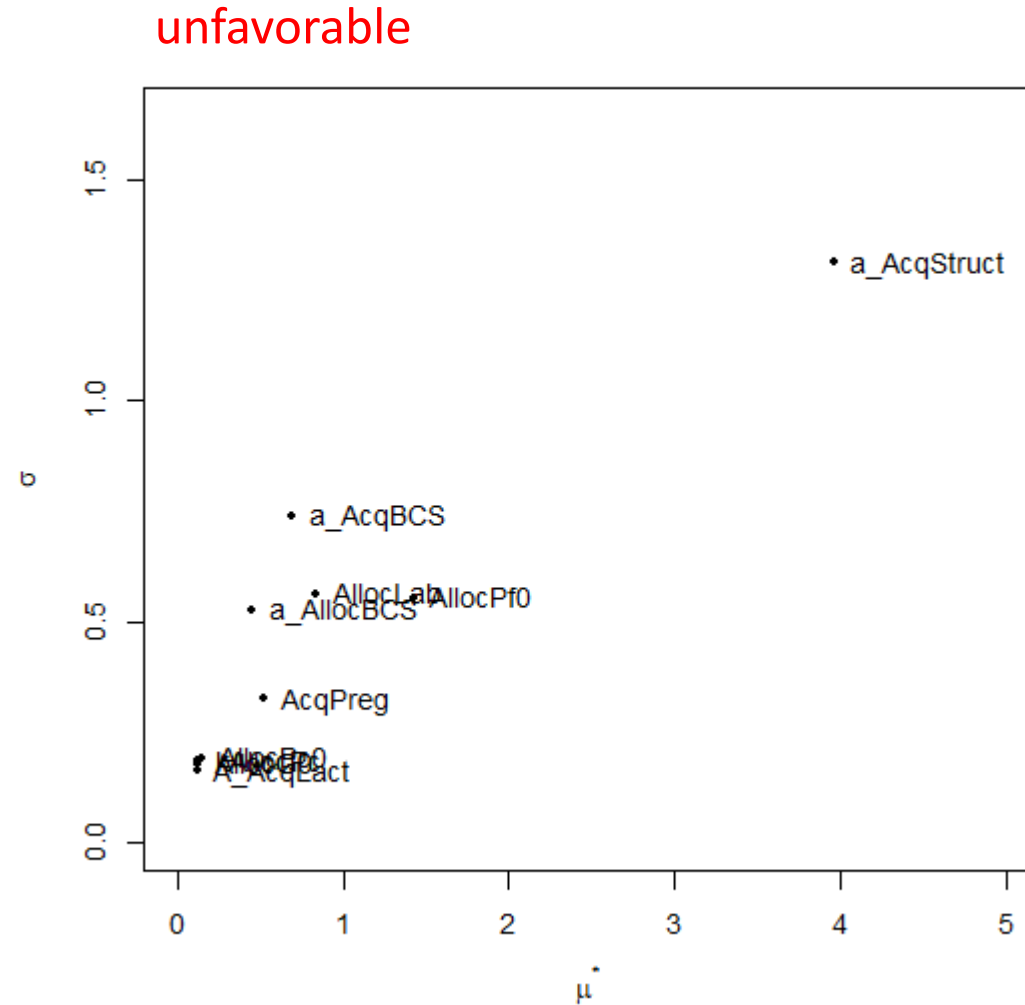
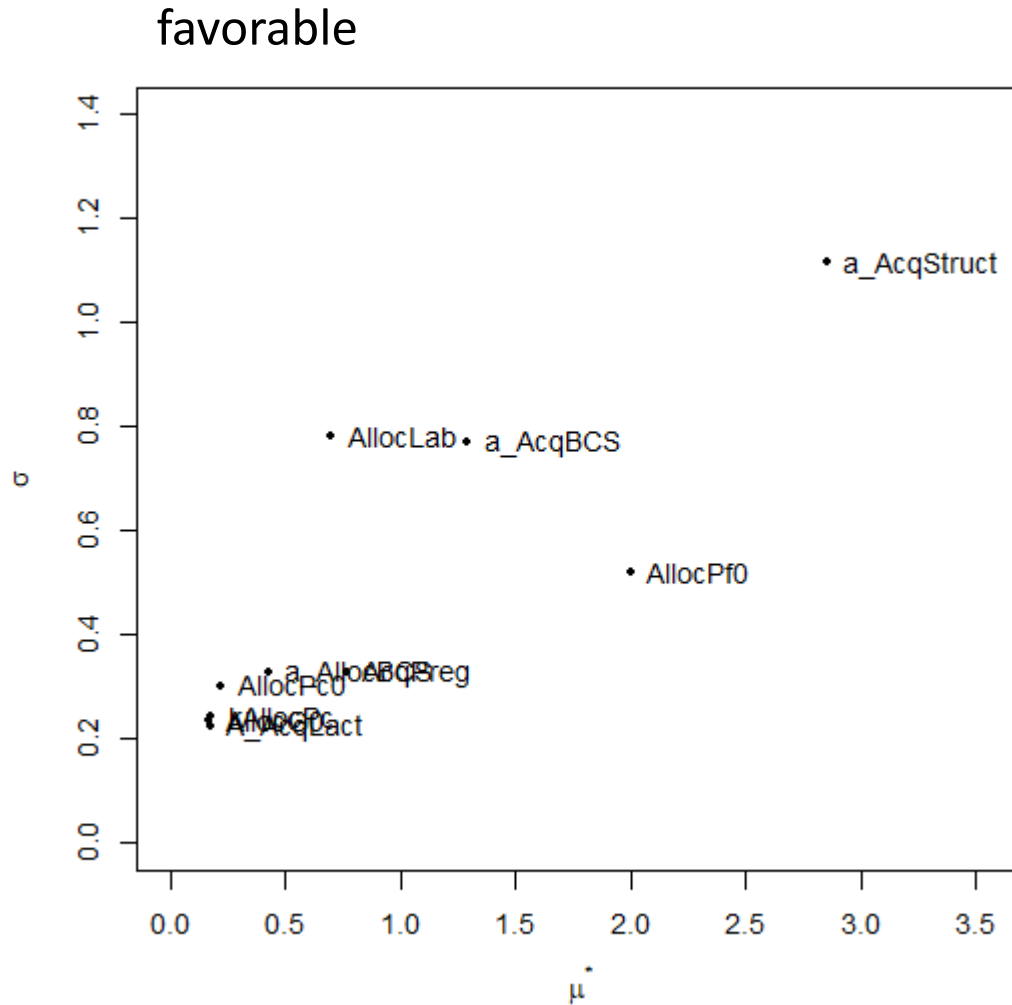
➤ Importance of parameters between environments (3)

Litter size born alive per ewe (parity 3ff)



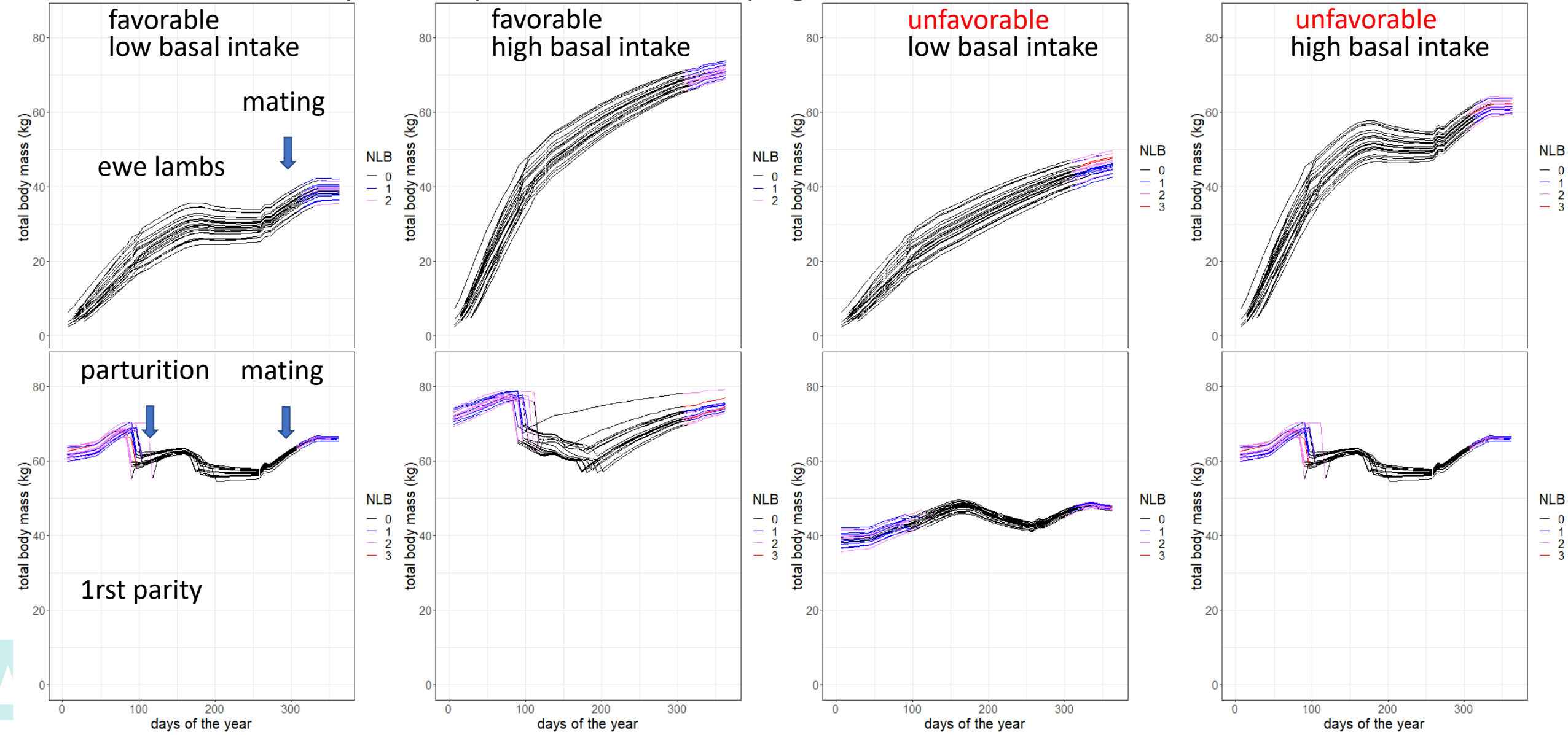
➤ Importance of parameters between environments (4)

Mean lamb birth weight (parity 3ff)



➤ Dynamic model output (1)

Total ewe body mass dependent on n lambs pregnant with

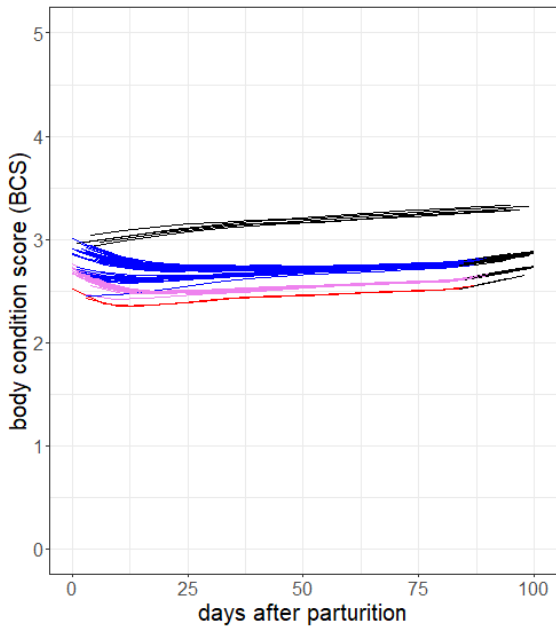


➤ Dynamic model output (2)

Ewe BCS after parturition dependent on n lambs suckled

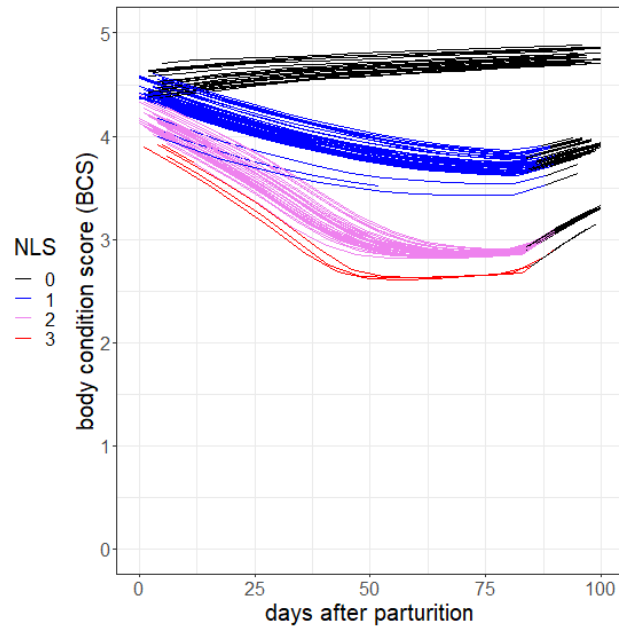
favorable

low basal intake



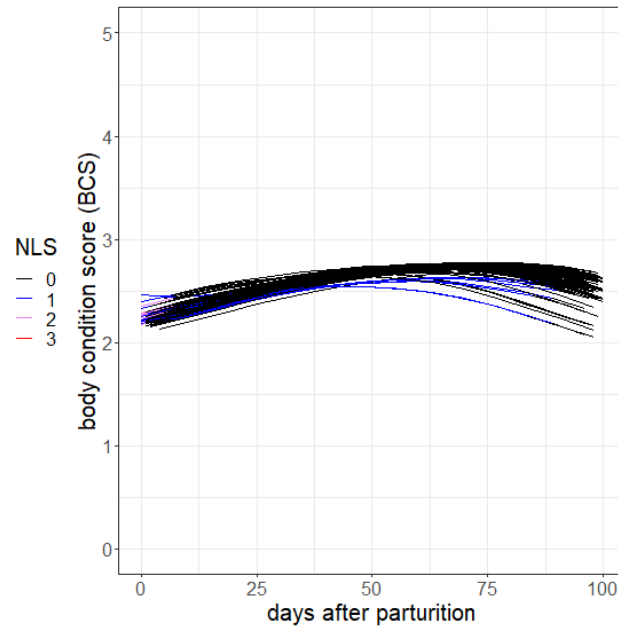
favorable

high basal intake



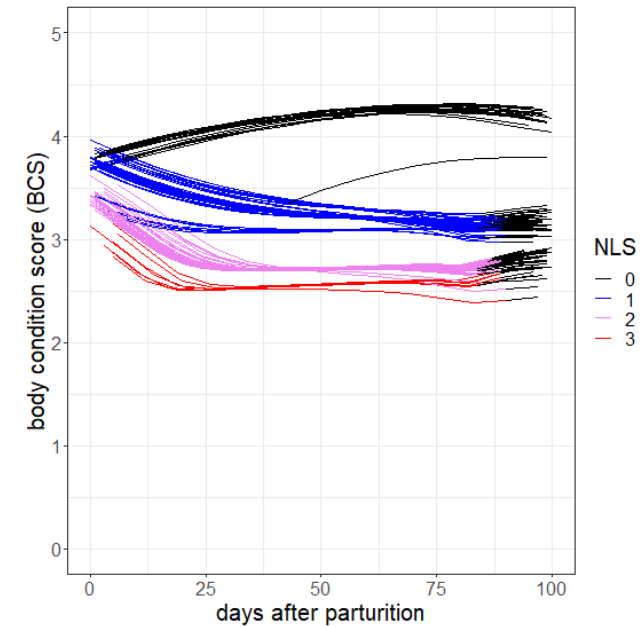
unfavorable

low basal intake



unfavorable

high basal intake



➤ Dynamic model output (3)

Lamb milk intake dependent on litter size at birth

favorable

low basal intake

favorable

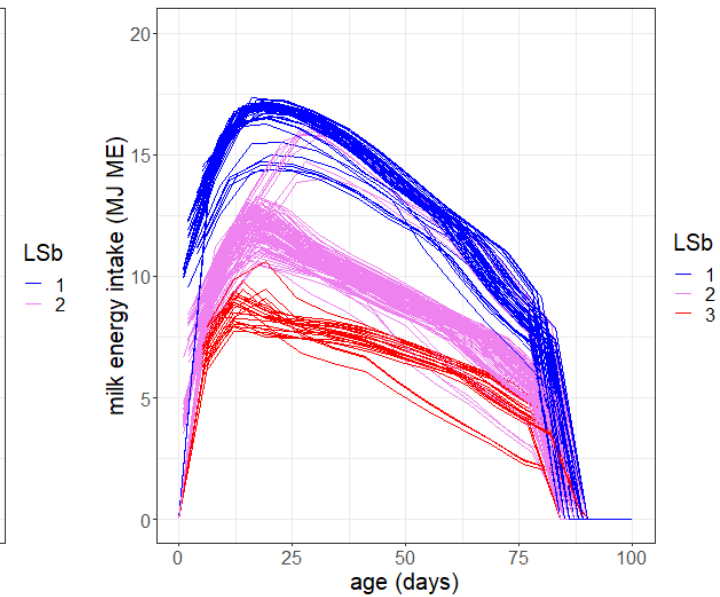
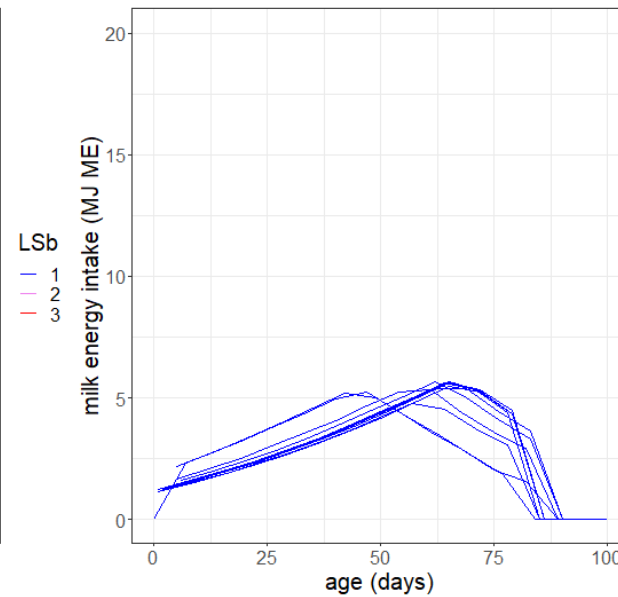
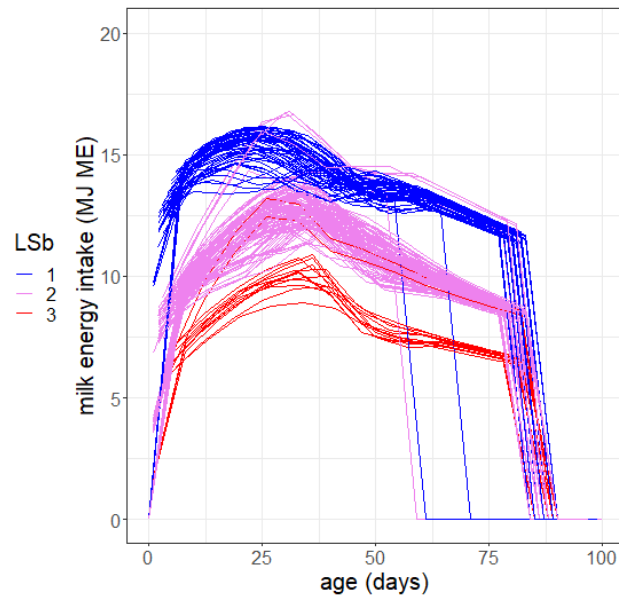
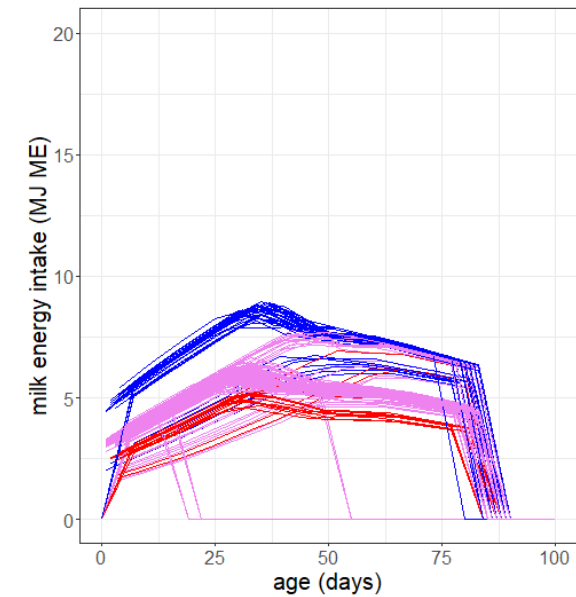
high basal intake

unfavorable

low basal intake

unfavorable

high basal intake



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28-08-2023 / EAAP / Hiltpold et al.

➤ Conclusion and outlook

- In favorable environment more parameters have stronger effect the ewe's lifetime performance
- ... giving more possibilities to express a phenotype
- Lambs need to be born alive to grow (fast)
- Perinatal survival and birth weight depend on energy ewe allocates to gestation
- Which ewes can cope best with an unfavorable environment?
- Variance component estimation of acquisition and allocation factors using real life data



Thank you for your attention

Thanks to Adapt-Herd partners



maya.hiltpold@inrae.fr