

➤ Milk metabolite profiles in goats selected for longevity support link between resource allocation and resilience

M. Ithurbide ¹, H. Wang ², C. Huau ¹, I. Palhière ¹, T. Fassier ¹, J. Pires ¹, T. Larsen ¹, J. Cao ², N.C. Friggens ¹ and R. Rupp ¹

¹ INRAE, France

² Simon Fraser University, Canada

What is resilience?



A goat's ability to handle environmental disturbances

Relating to short-term disturbances

Good longevity can result, all other things being equal, from the cumulative consequences of good resilience



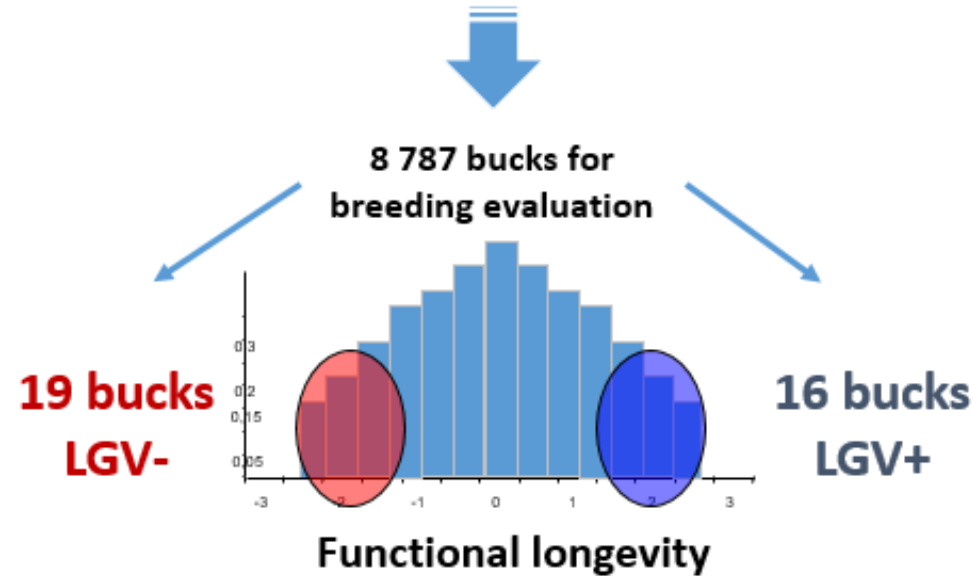
INRAE

WCGALP 2022

Marie Ithurbide PHD

The divergent lines of goats for functional longevity

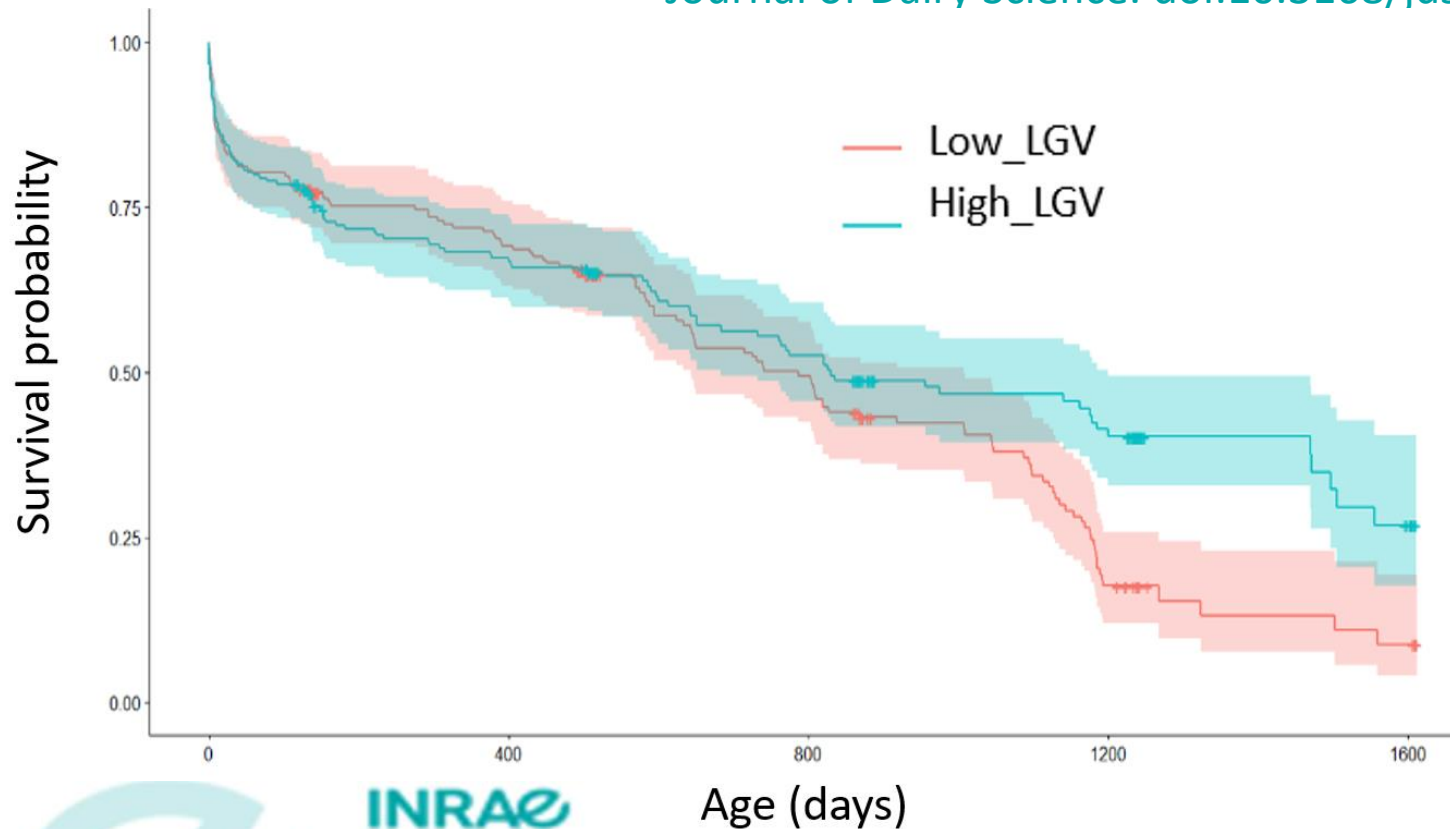
Palhiere, Oget, et Rupp 2018



	2017	2018	2019	2020	2021	Total
Low_LGV	48	46	39	40	39	212
High_LGV	45	45	42	68	28	228
Total	93	91	81	108	67	440

Comparison of the two longevity goat lines

Ithurbide, M., C. Huau, I. Palhière, T. Fassier, N.C. Friggens, and R. Rupp. 2022. Selection on functional longevity in a commercial population of dairy goats translates into significant differences in longevity in a common farm environment. *Journal of Dairy Science*. doi:10.3168/jds.2021-21222



High_LGV

- Better survival
- Heavier during early lactation
- Lower milk fat-to-protein ratio
- Lower Somatic Cell Score

INRAE

WCGALP 2022

Marie Ithurbide PHD

Comparison of the two longevity goat lines

Validation of an experimental model :
goats with different resilience



INRAE

WCGALP 2022

Marie Ithurbide PHD

Resilience = longevity?

Not exactly...

Resilience is an underlying character of the animal

Longevity also depends on the choices of the breeder, breeding practices, etc...

... it would be more efficient to select directly on resilience than on longevity

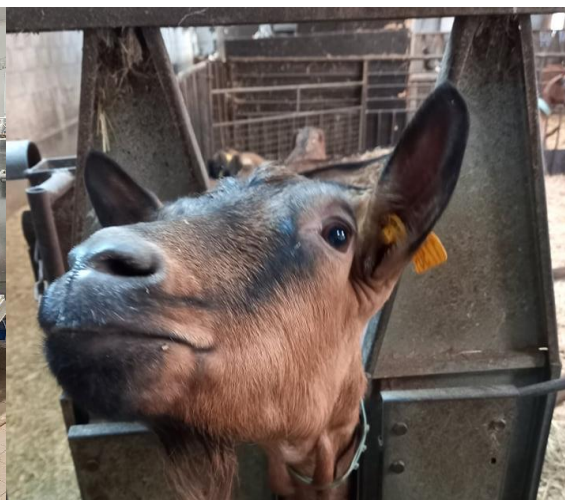


INRAE

WCGALP 2022

Marie Ithurbide PHD

Description of the underfeeding challenges



INRAE experimental facility of Bourges



INRAE

WCGALP 2022

Marie Ithurbide PHD

Description of the underfeeding challenges

	Year of the underfeeding challenge		Total
	2020	2021	
Low_LGV	15	14	29
High_LGV	18	22	40
Total	33	36	69

Underfeeding challenges

- Early lactation primiparous goats
- Two days on straw

Measures

- 14 milk metabolites
- Production, Fat content, Protein content, SCS
- From day -7 to day +9 (day +6 in 2020 COVID)



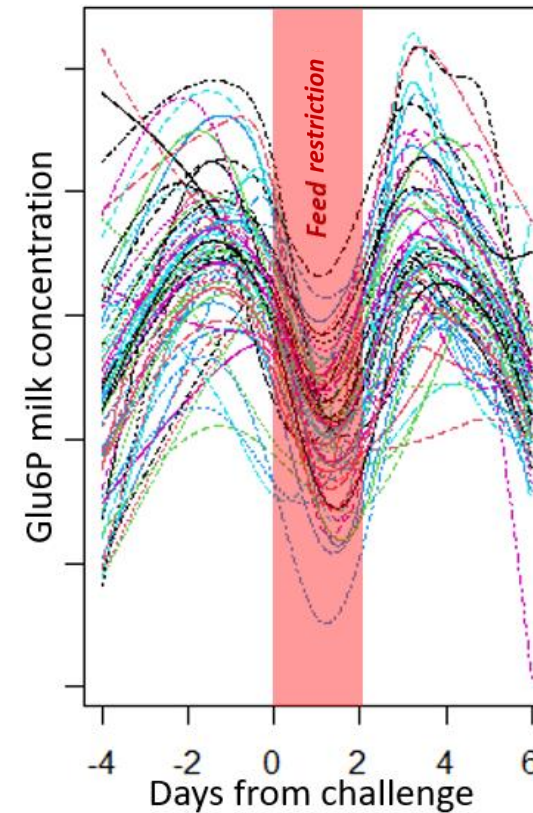
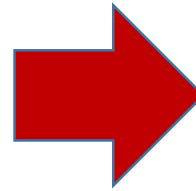
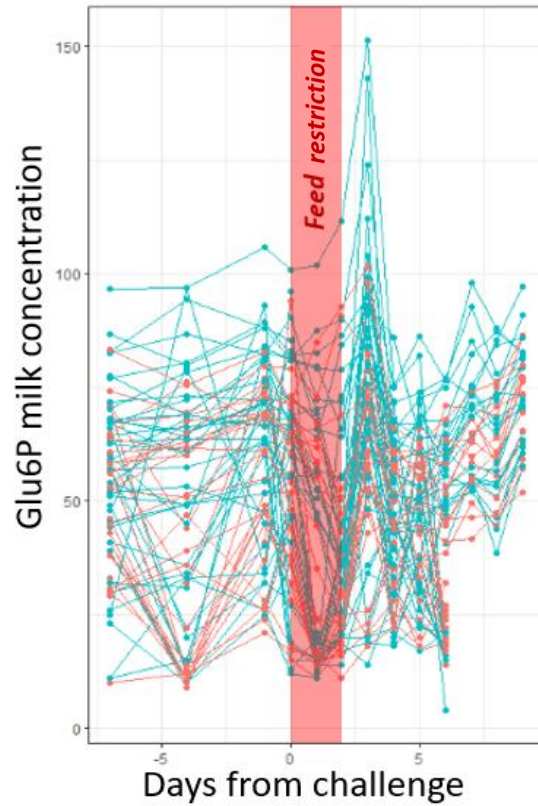
INRAE

WCGALP 2022

Marie Ithurbide PHD

Profiling of milk metabolites upon challenge

Step 1: Model milk metabolites curves with few hypothesis concerning the shape of the curves



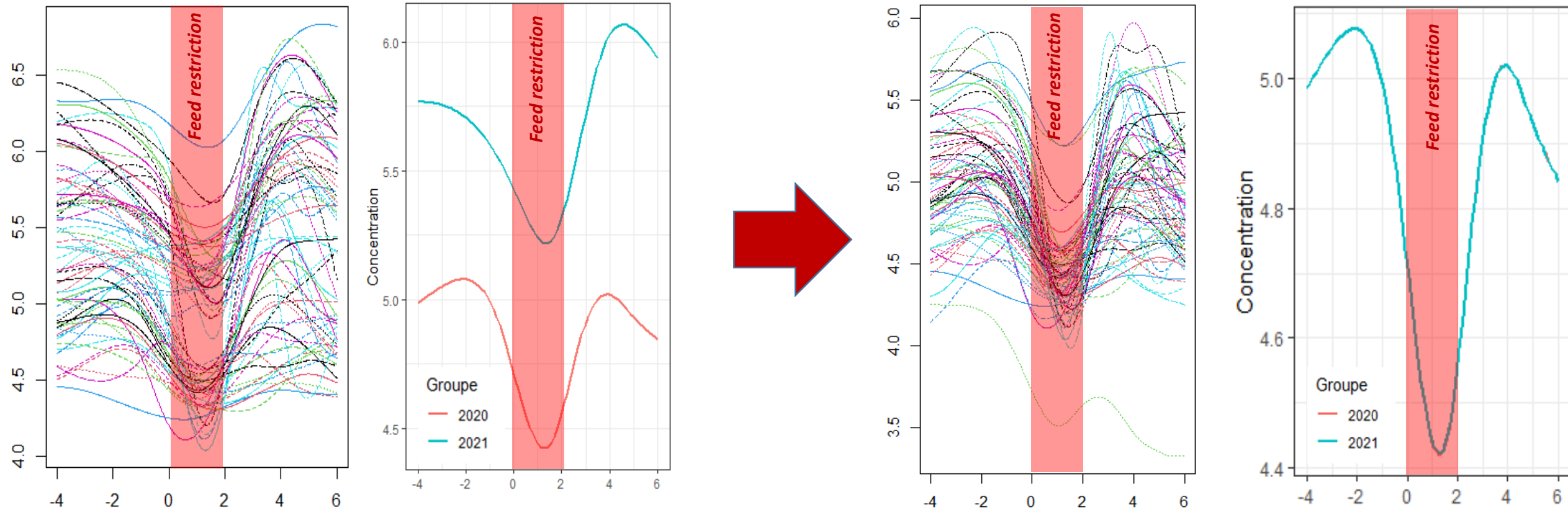
INRAE

SMARTER annual meeting 2022

Marie Ithurbide PHD

Profiling of milk metabolites upon challenge

Step 2: Correct the year effect with a functional linear regression



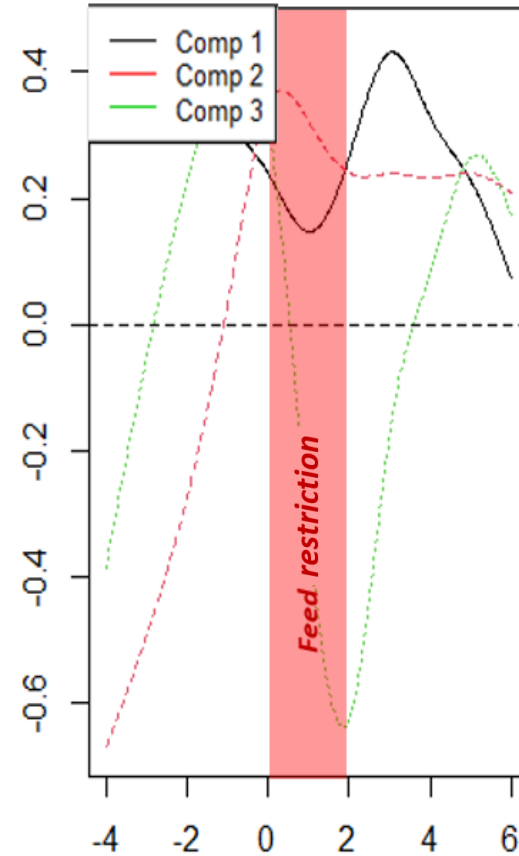
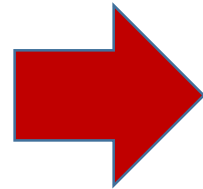
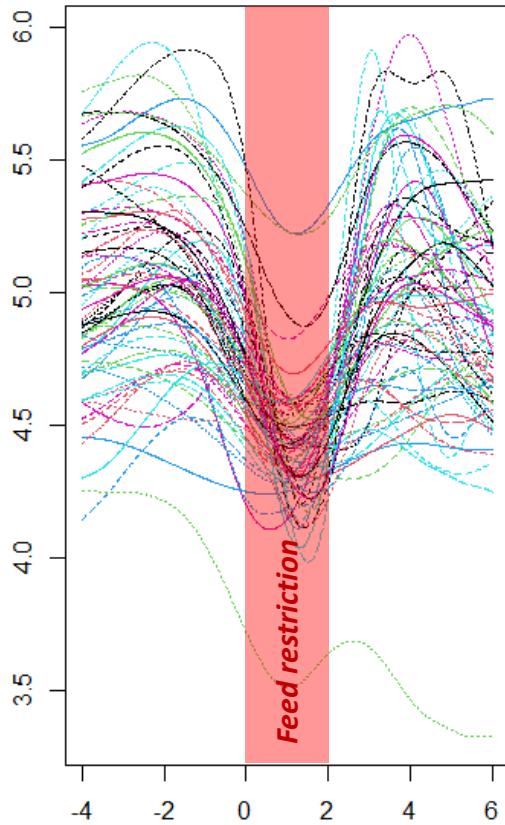
INRAE

WCGALP 2022

Marie Ithurbide PHD

Profiling of milk metabolites upon challenge

Step 3: Run a functional PCA to describe each curve with few fPC scores that are scalars



Like classical PCA, the linear decomposition basis explains more variation than any other basis expansion



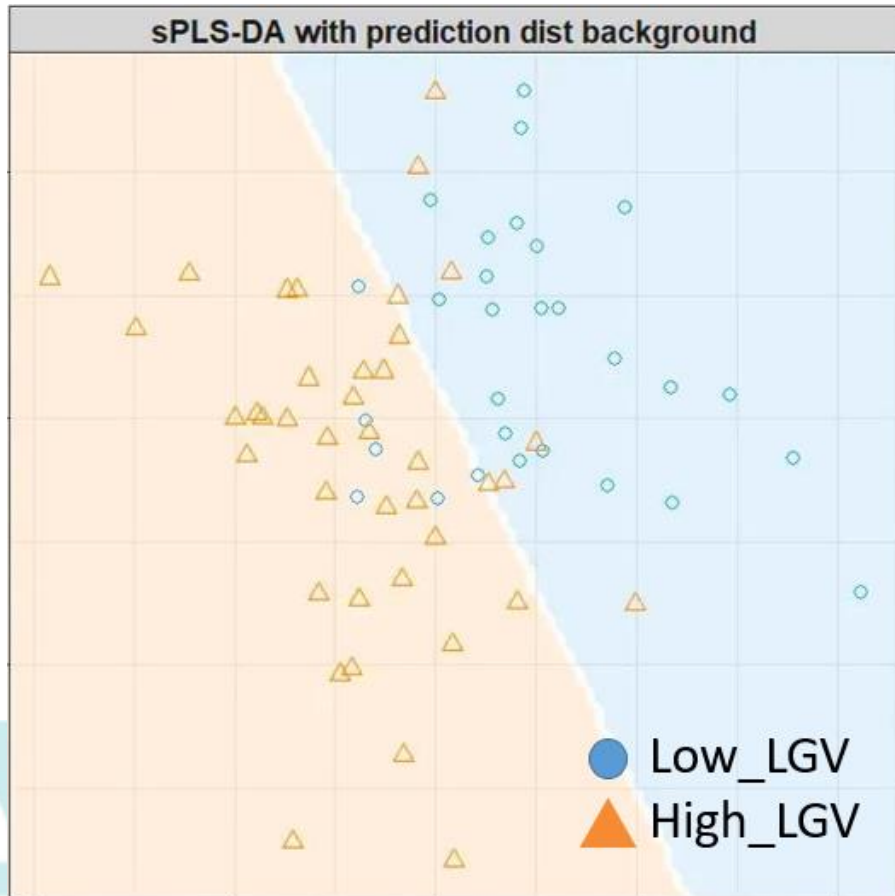
INRAE

WCGALP 2022

Marie Ithurbide PHD

Discriminating longevity goat lines with milk metabolites

Prediction of the longevity line based of the fPC scores of all the 14 metabolites with sPLS DA



N=69 one year old goats

- Variable selection with lasso penalty
- Evaluation of the Error rate with a five fold crossed validation

**Balanced error
rate = 38%**

Running an unsupervised clustering on fPC scores

The selection increased diversity of resilience levels and resilience related mechanisms



We can explore the diversity of response to the challenge, without previous assumption on the individual resilience level of the goats

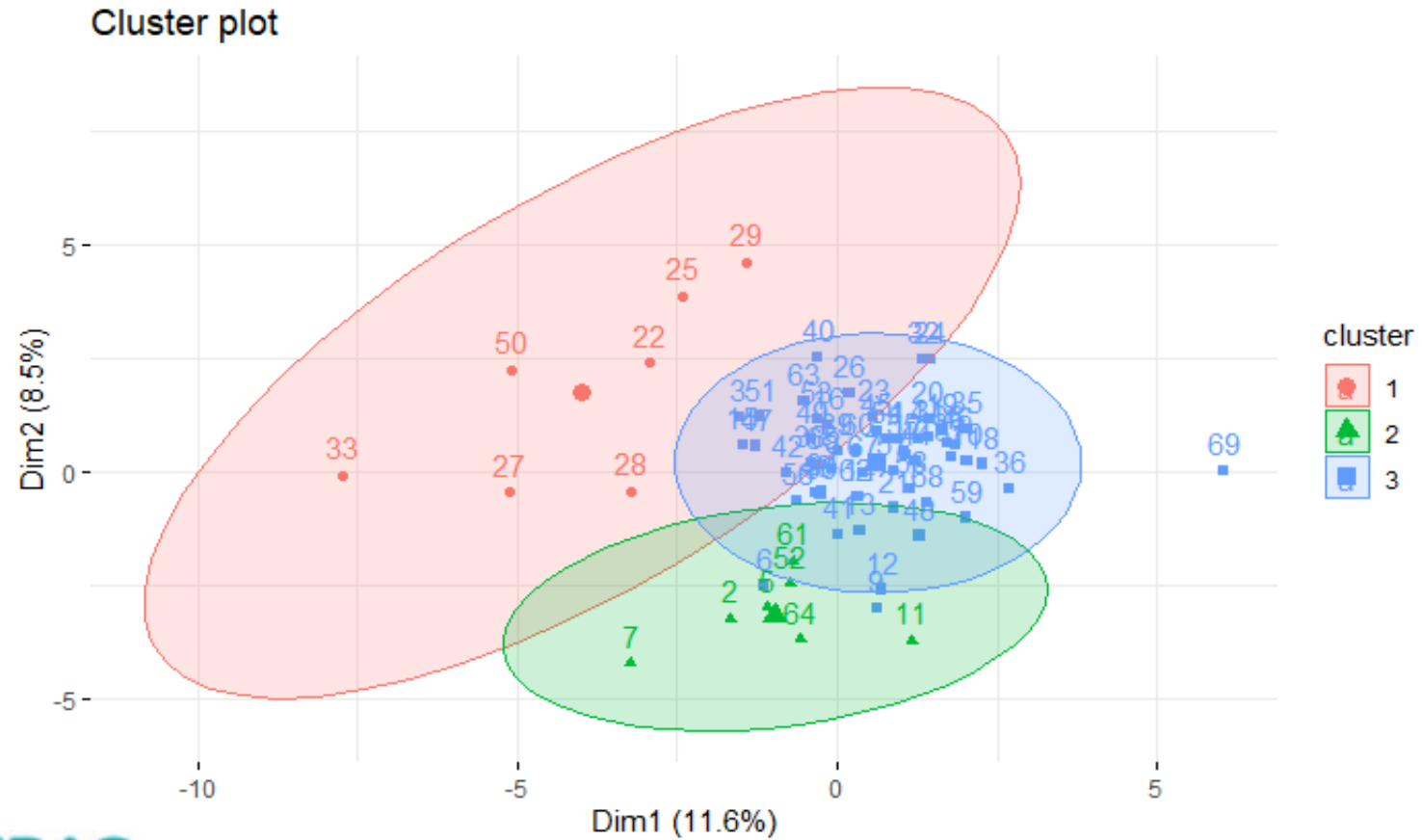


INRAE

WCGALP 2022

Marie Ithurbide PHD

Running an unsupervised clustering on fPC scores

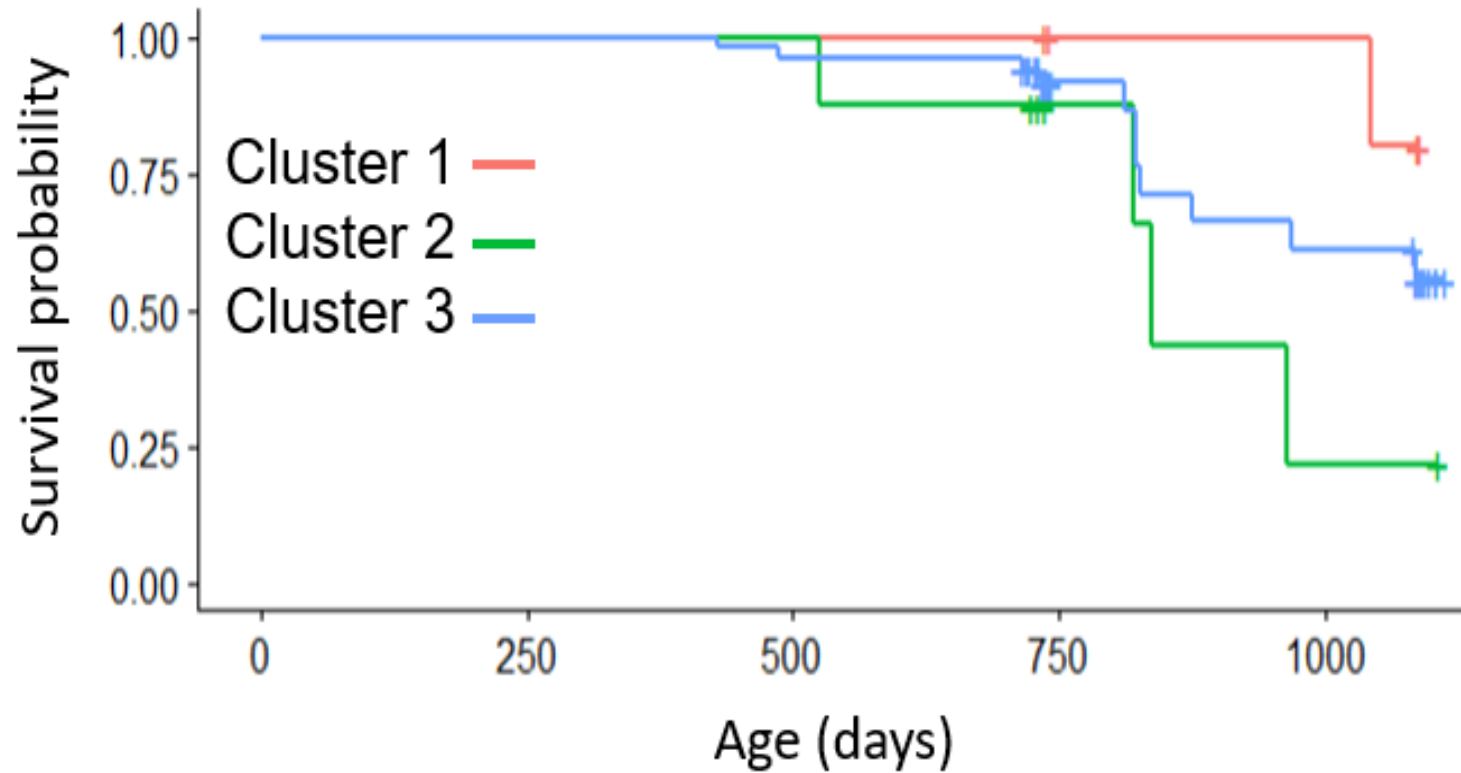


INRAE

WCGALP 2022

Marie Ithurbide PHD

Compare resilience indicators between the clusters



INRAE

WCGALP 2022

Marie Ithurbide PHD

Conclusion

- Selection for functional longevity results in significant difference in survival
- The milk metabolites profiles partly discriminate lines
- Large variability of metabolic responses within line
 - Unsupervised clustering suggests that extreme metabolic responses are linked with survival



Multivariate analysis of non-invasive milk measures shows potential for deriving new resilience phenotypes



INRAE

WCGALP 2022

Marie Ithurbide PHD