Using modelling to assess the sensitivity of sheep farming systems to hazards

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Introduction - Context

- High price of concentrates
  → Matching lambing period with grass growth
  → 2 lambing periods: March and September
- => High sensitivity to hazards: technical, economic and climate
- How to make farming systems safer?

Hypothesis

- Aiming at a larger distribution of lambing during the year → duplication of the lambing periods → dilution of the risks

Objectives

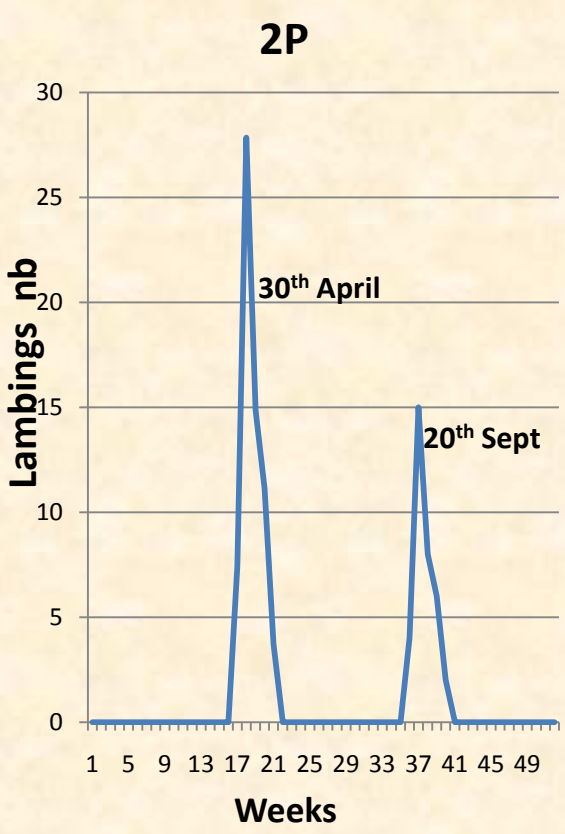
- Assess the impact of technical and economic uncertainties on stability of economic results, after a doubling of lambing periods.

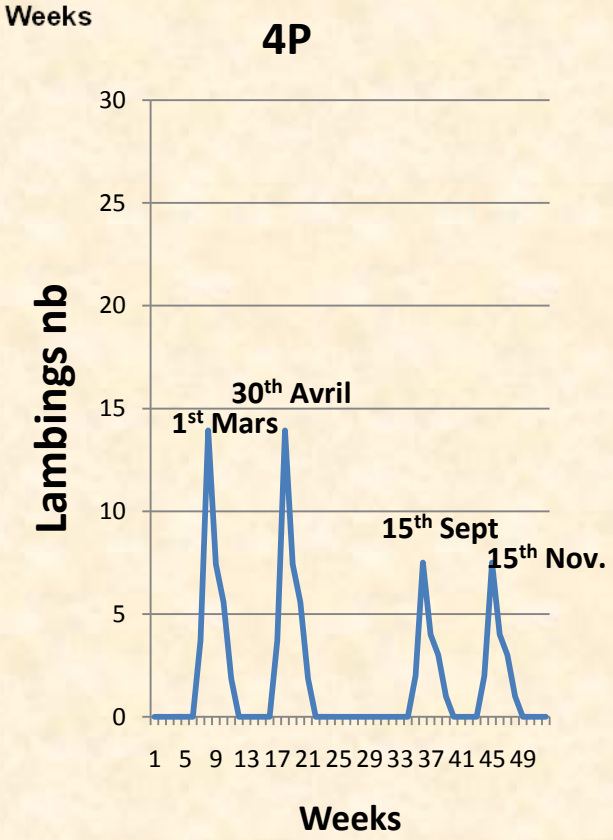
This is done prior to a trial size (2 flocks of 120 ewes)

Method

- We use OSTRAL model (deterministic); parameters came from experiments made about comparable systems tested on previous years.
- Comparison between 2 farming systems: control system (2 lambing periods) and system with duplication of lambing periods (4 lambing periods).

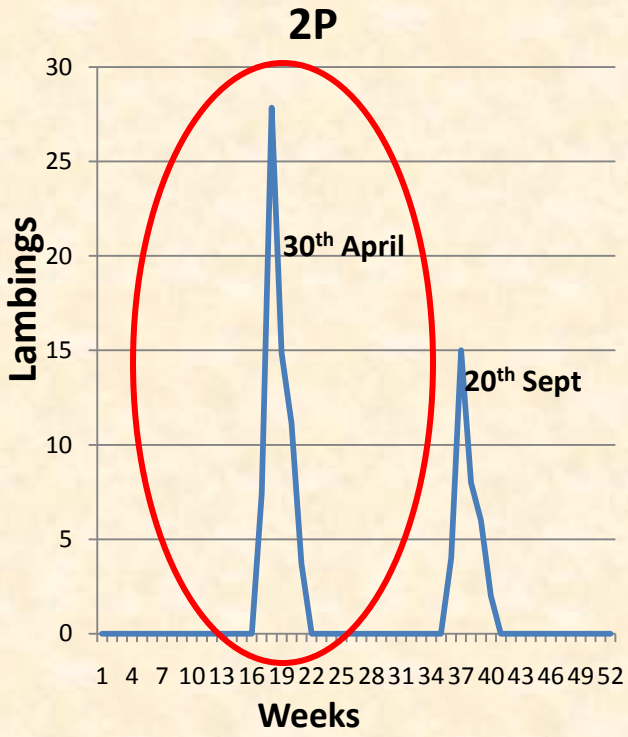
Compared systems:
Lambing calendar

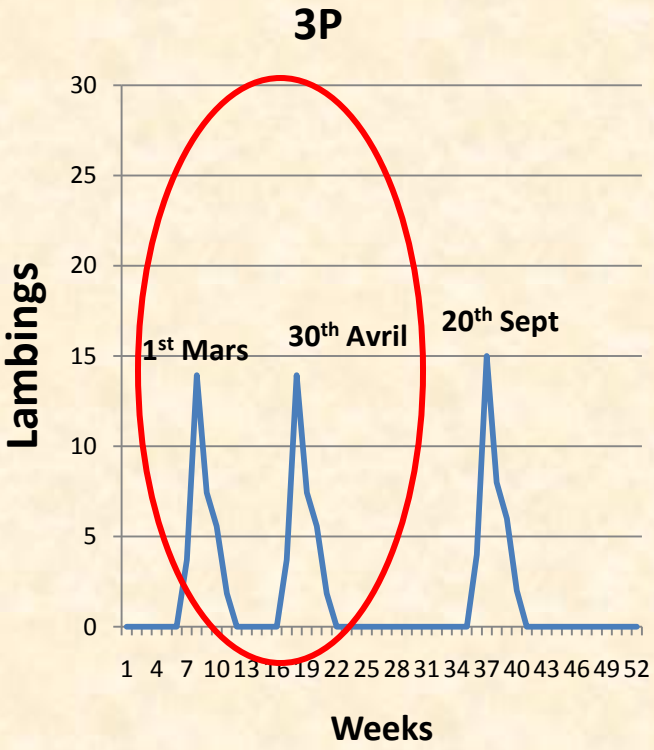




Simplification of the study

- Only spring duplication of lambing -> 2P *versus* 3P





- The impact of hazards on fertility rate (for spring matting) is not presented here (it modifies the functioning of the systems ; different type of analysis)

Types of hazards

- Technical
  - (Fertility)
  - Prolificacy +/- 15%
  - Lambs Mortality +/-50%
- Economic
  - Meat price +/-15%
  - Grain price +/- 20%

Implementation of simulations and analysis of results 1

- Drawing value (same probability between bounds) for each of the 4 criteria

  - Prolificacy +-15%
  - Lambs Mortality +-50%
  - Meat Price +-15%
  - Grain Price +-20%

1 criteria studied → 1 draw
or 4 criteria together → 4 draws

= 1 iteration
= 1 calculation of the economic result:
Gross Margin per Ewe

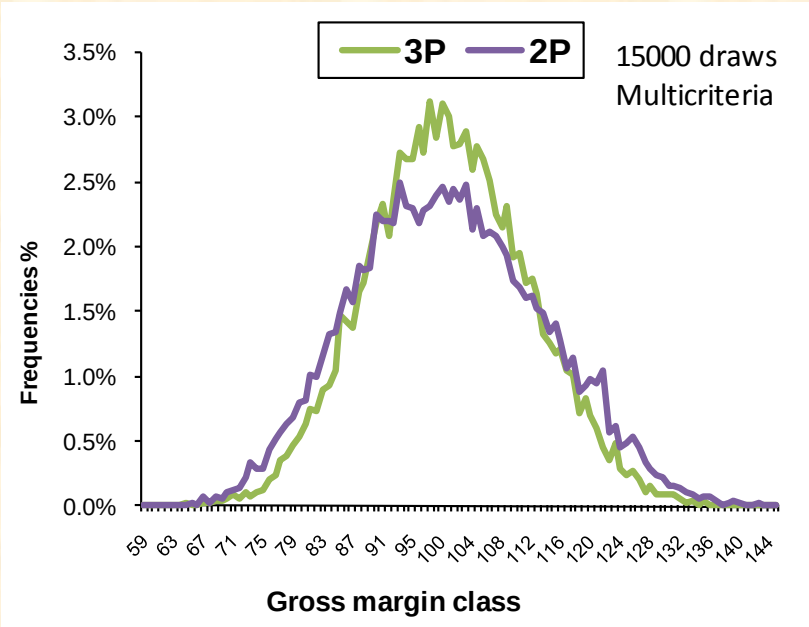
For one study (1 criteria or 4 together) = from 10 to 15000 iterations → storage of 10 to 15000 values of gross margin per situation (and some other variables)

→ Study of the gross margin distribution (centered Gross Margin: average value = 100)

Implementation of simulations and analysis of results 2

Analysis of the difference of distribution of the gross margin per ewe between the 2 systems: 2P and 3P

1/ Comparison of distribution curves



2/ Calculation of the standard deviation of GM/ewe

3/ Levene's Test for Homogeneity of Variance

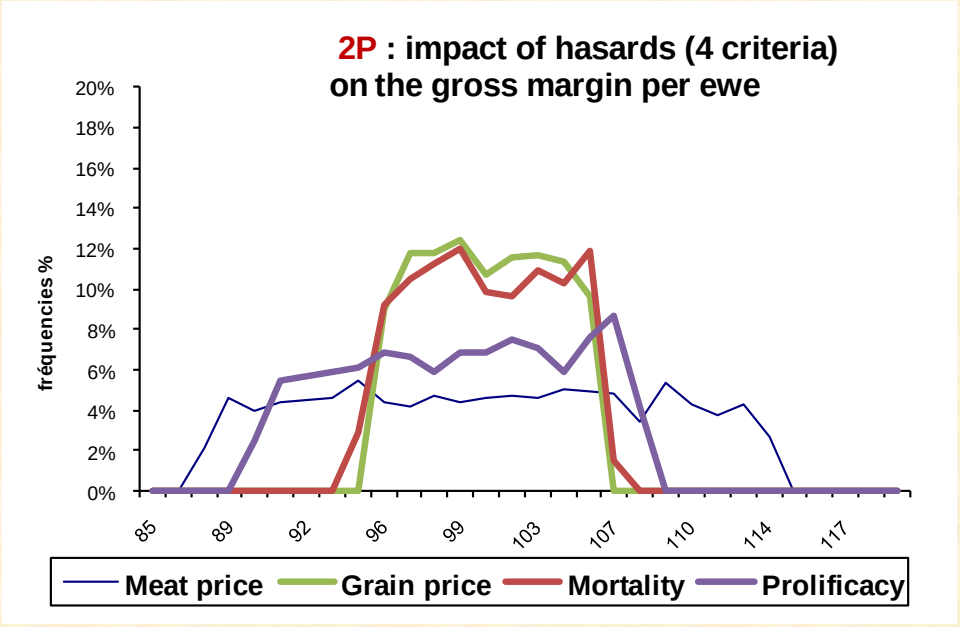
Results 1

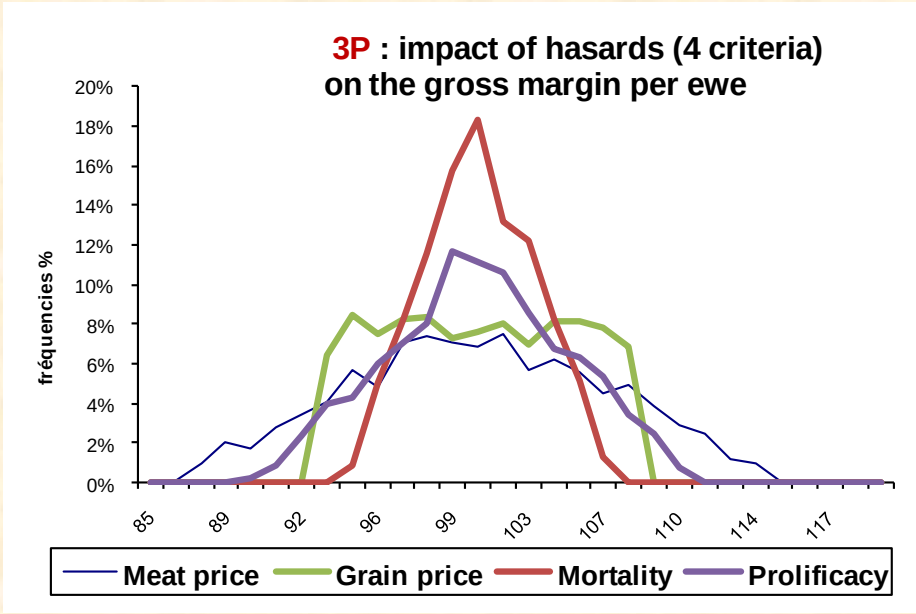
Which factor has the strongest impact on Gross margin per ewe?

* **1rst factor for 2P et 3P:** price of the meat

* **then 2P:** Prolificacy

3P: Prolificacy and price of grain





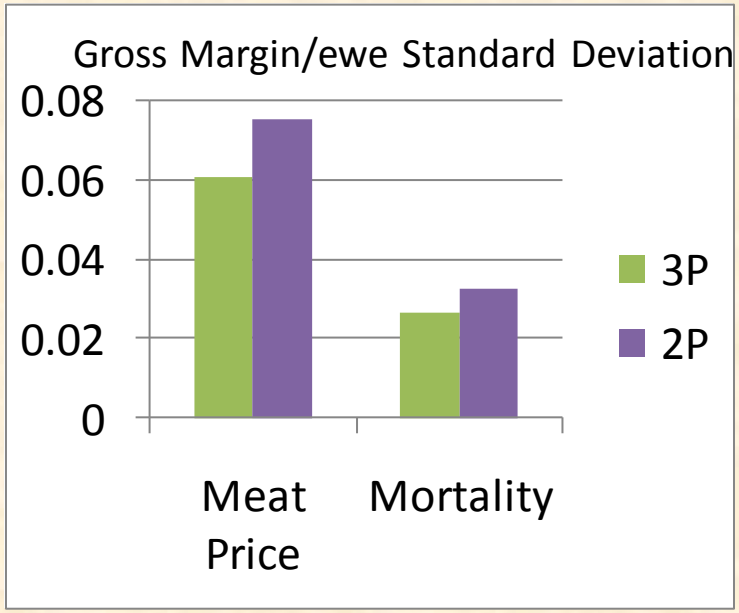
Results 2

Comparison 2P / 3P:

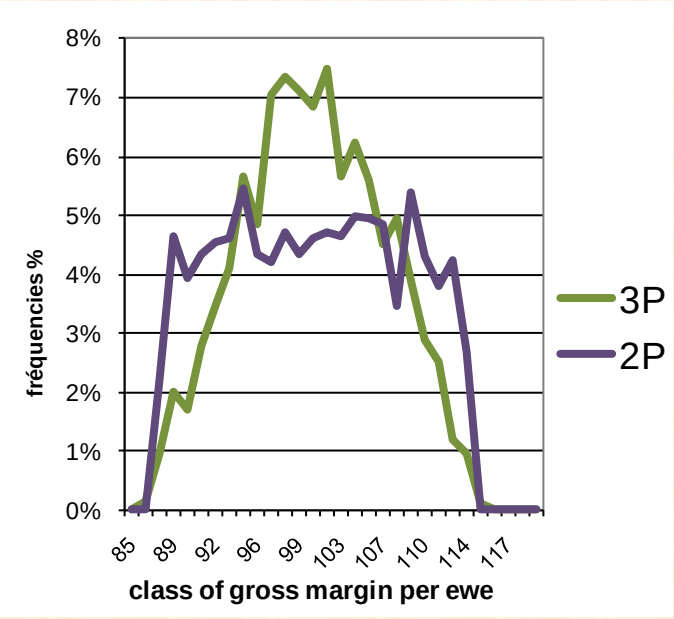
In 3P: stabilization of the gross margin:

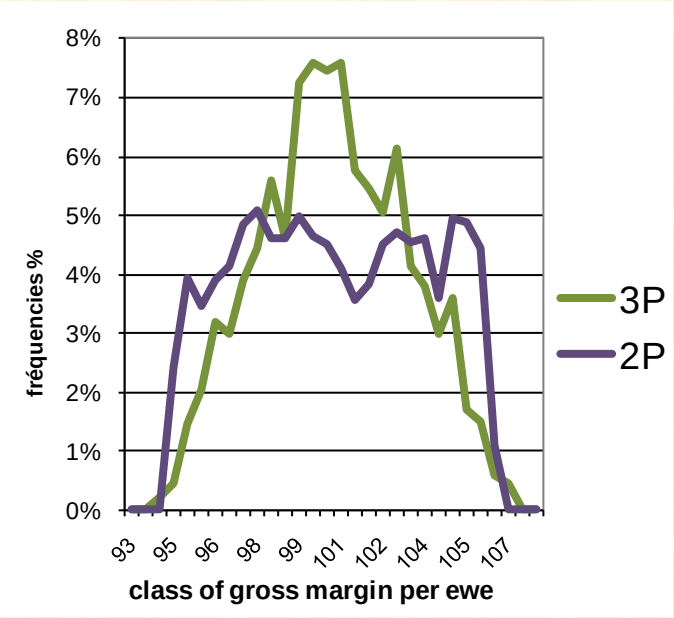
higher probability to have a gross margin near the mean value (compensation between the 2 sub-periods)

- Ex 1: Price of the meat (in spring)
- Ex 2: Lamb mortality



Distribution of gross margin per ewe
(centered, 2000 iter.)

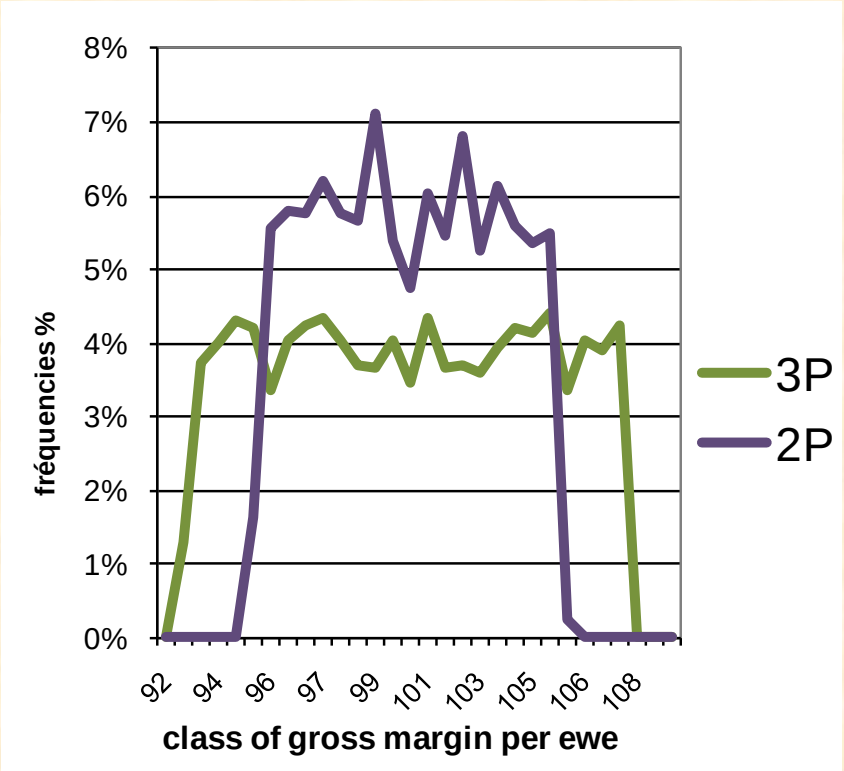


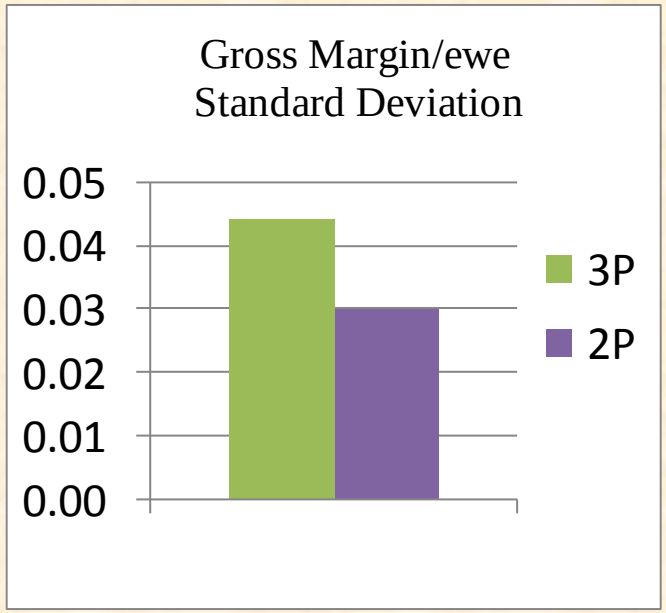


Results 3

In 3P: a greater sensitivity to grain price variation, in relation with a higher consumption of concentrates for March lambing.

Distribution of gross margin per ewe
(centered, 2000 iter.)
when hazard on grain price

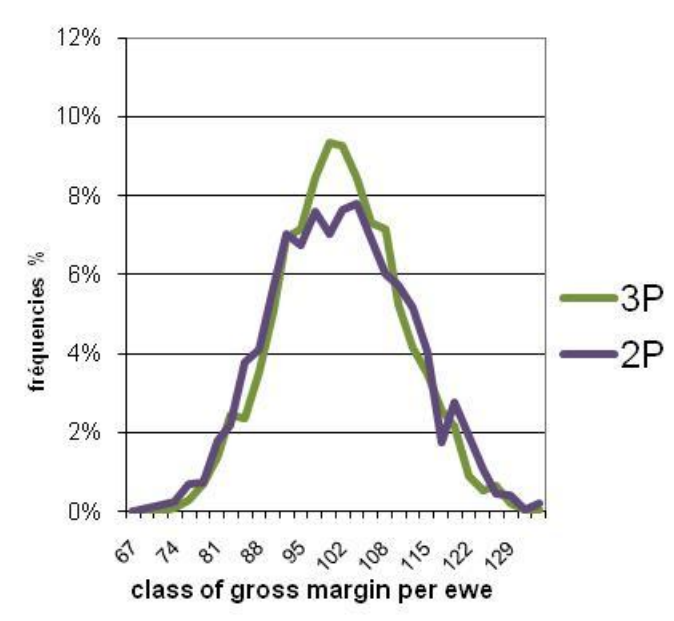


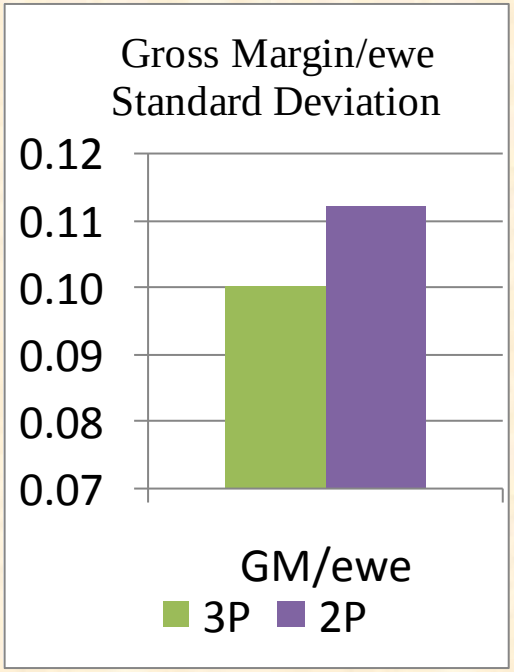


Results 4

In 3P, a better stability (gross margin per ewe) when hazards on 4 criteria combined (Prolif., Mortal., Meat and Grain prices).

Distribution of gross margin per ewe
(centered, 2000 iter.)
when hazard on 4 criteria



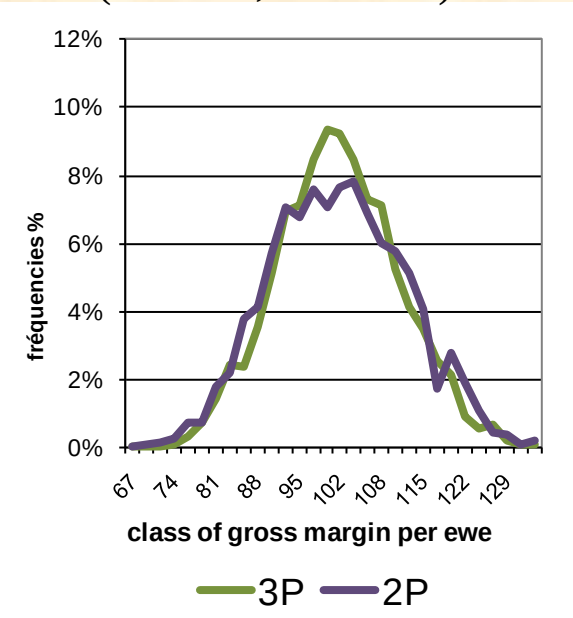


Results 5

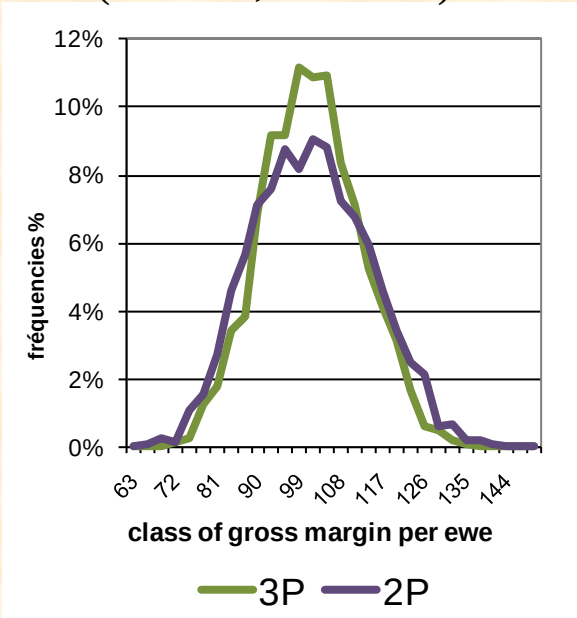
At farm scale, in 3P, a better stability (gross margin of the farm) as the self-produced grain is then not taken into account.

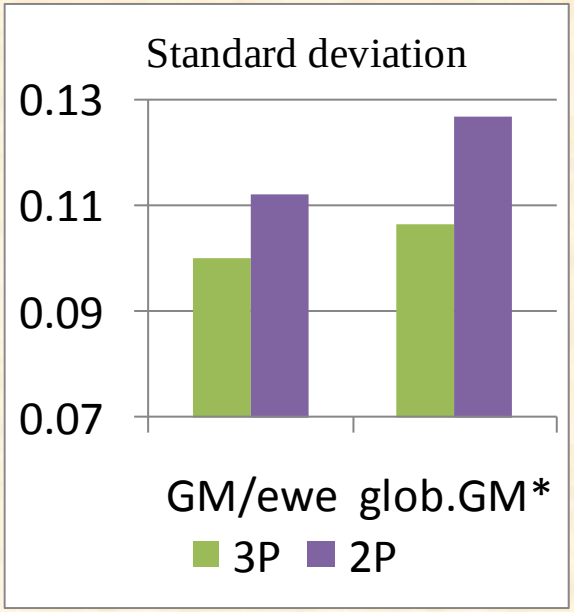
Distribution when hazard on 4 criteria:

Gross margin per ewe
(centered, 2000 iter.)



Global gross margin*
(centered, 2000 iter.)



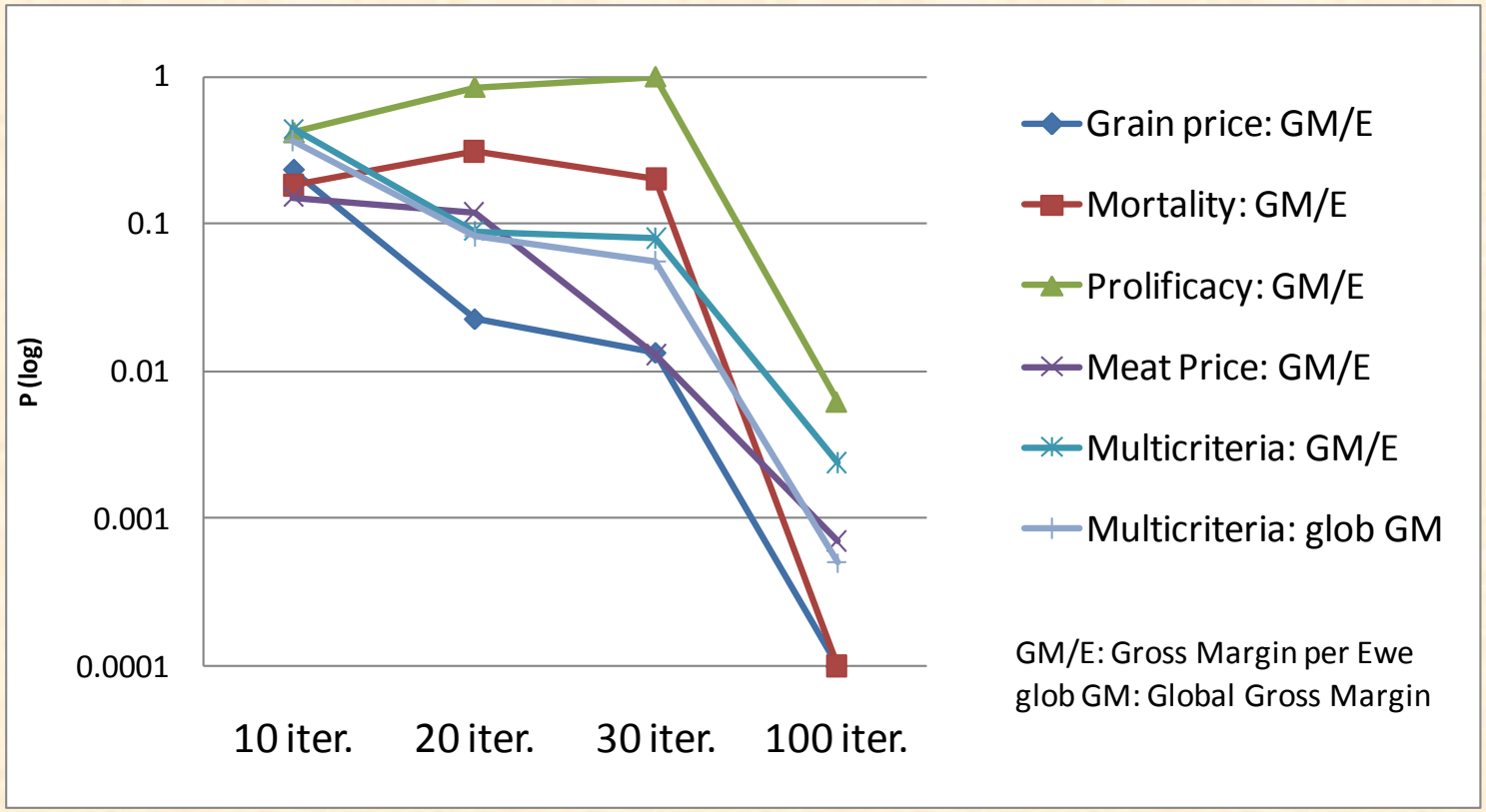


* Without subsidies

Discussion 1

All results (comparison of distributions) are significant for n > 100 iterations (P<0.01)

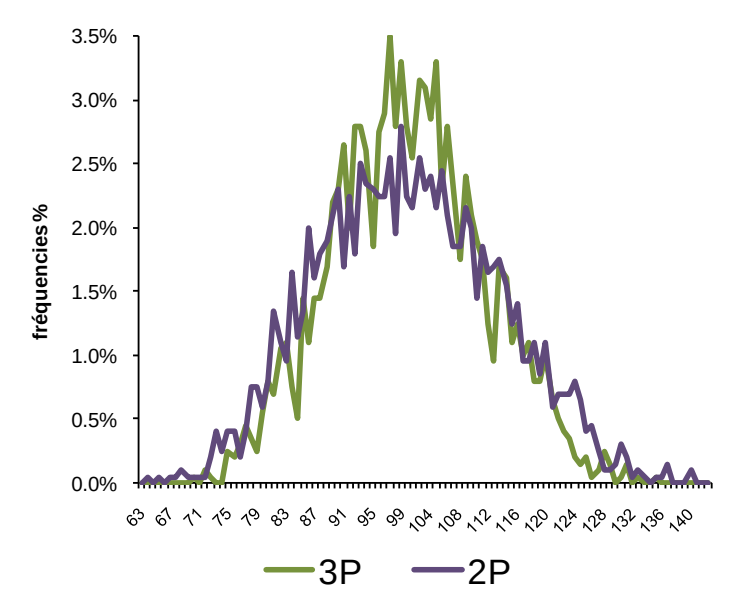
Levene's Test for Homogeneity of Variance between 2P and 3P



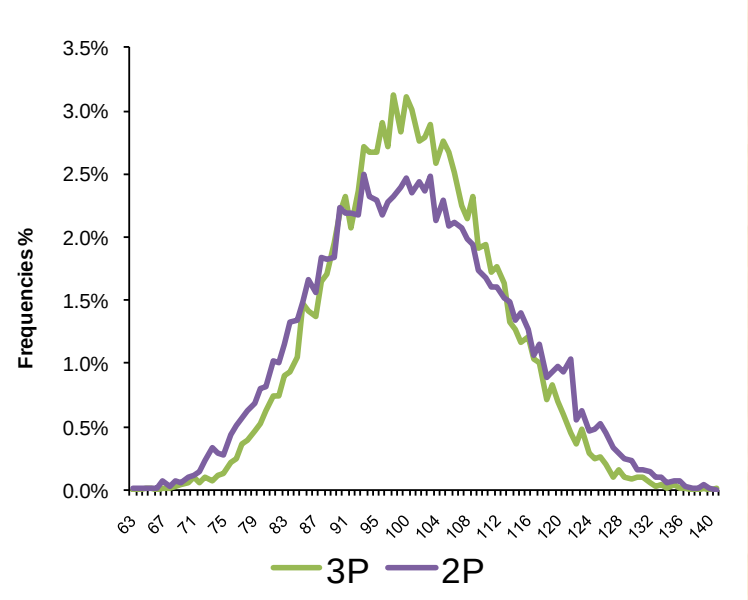
Discussion 2

The only interest of more iterations is to smooth curves:

2000 iterations



15000 iterations



(Hazards on 4 criteria; distribution of the Global gross margin without subsidies)

Discussion 3

- If autumn is considered → more significant difference.
- If hazards on fertility: great advantage for 4P system ("catching up" ewes with 2nd period of matting)
  → stabilization of technical and economic result
- If significant difference for 10 iterations → probability to have a significant difference in the real results after 10 years in situ.
- Some hazards (climatic) are not taken into account as there can be various possible adaptations and aspects difficult to take into account: quantity of forages, compensation between seasons, impact on zootechnical performances or not…: a priori, 3P and 4P are better than 2P (at each season there is a diversity of batches of animals in terms of forage needs)

Conclusion

- Despite a stronger dependency towards the concentrates bought, P3 is globally less sensitive to the hazards studied.
- A wider distribution of the lambing during the year reduces the sensitivity to hazards: one of the most important factor is a broad distribution of sales over the year
- A doubled matting period stabilizes the zootechnical results through fertility.
- …but this kind of adaptation leads to a more complex system in term of organization and is certainly much more time consuming

Thank you for your attention