Evolution in performances of French dairy cattle herds transitioning towards 3-breed crossbreeding

Julien Quenon, Stéphane Ingrand, Marie-Angélina Magne

Analysis of the explanatory factors of performance trends in French dairy herds transitioning towards rotational crossbreeding

Farmers' crossbreeding practices matter as much as changes in general farming management and initial situation of performances

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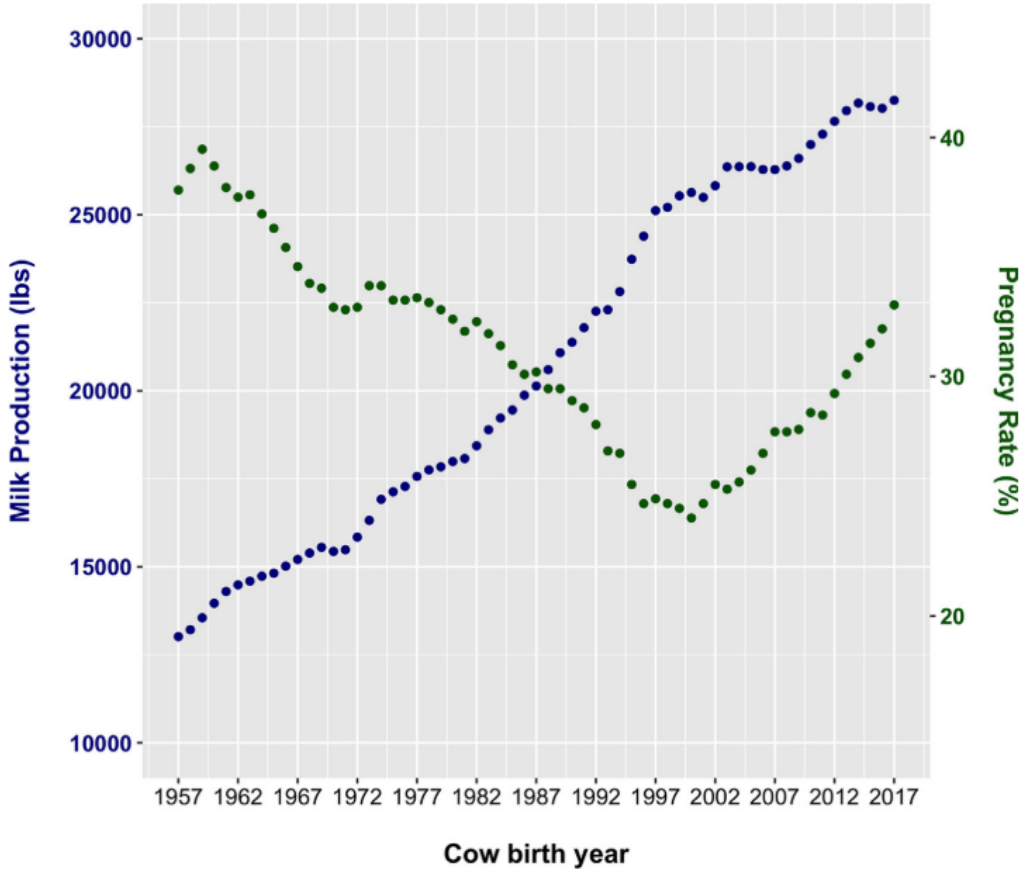
[3] Université de Toulouse, ENSFEA, INRAE, UMR AGIR, F-31320 Castanet-Tolosan, France

Introduction

- **Decrease in functional performances** (i.e. fertility, health, longevity) in purebred Holstein dairy cattle herds *(Kerslake et al. 2018; Brito et al., 2021; Hu et al., 2021)*

- Functional performances are **main determinants of the profitability of dairy cattle systems** *(Buckley et al., 2014; De Vries, 2017; Dezetter et al., 2017)*

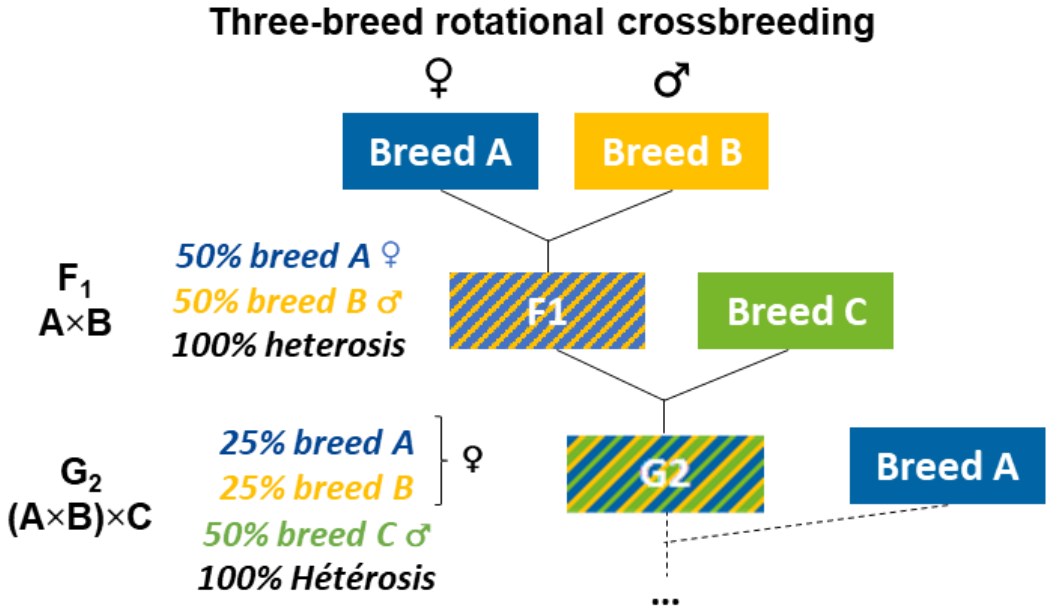


Brito et al. (2021)

Introduction

Rotational crossbreeding?

- Crossbreeding to benefit from heterosis effect *(Penasa, 2010)* and complementarity of dairy cattle breeds *(Magne et al., 2016)*
- Three-breed rotational crossbreeding (3BC) : compromise to ensure high heterosis (83% in 3rd generation) while keeping management of crossbreeding programme simple
- Uncommon in Western countries *(Dezetter et al., 2015; Clasen et al., 2017; Magne and Quénon, 2021)*



Introduction

- Few studies assessing performances of rotational crossbreeding:
  - At the herd level
  - In the long run (post-F_1 generations)
- Mostly based on modelling *(Dezetter et al., 2017; Clasen et al., 2020)*

Modelling hypotheses ≠ Actual technical pathways to introduce and manage rotational crossbreeding *(Quénon et al., 2020)*

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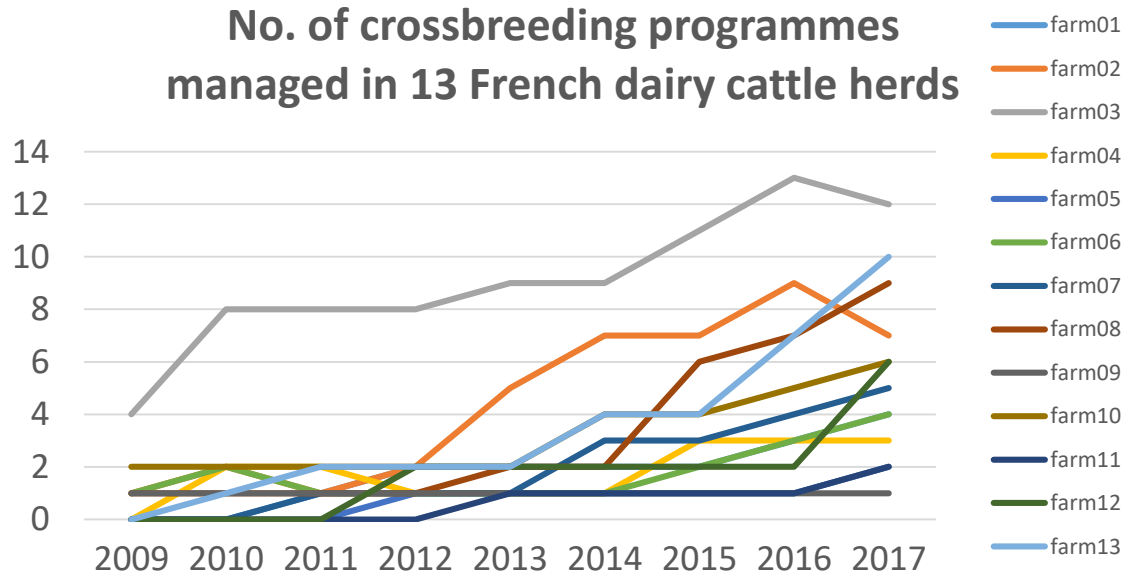
Modelling hypotheses

- One crossbreeding programme

≠



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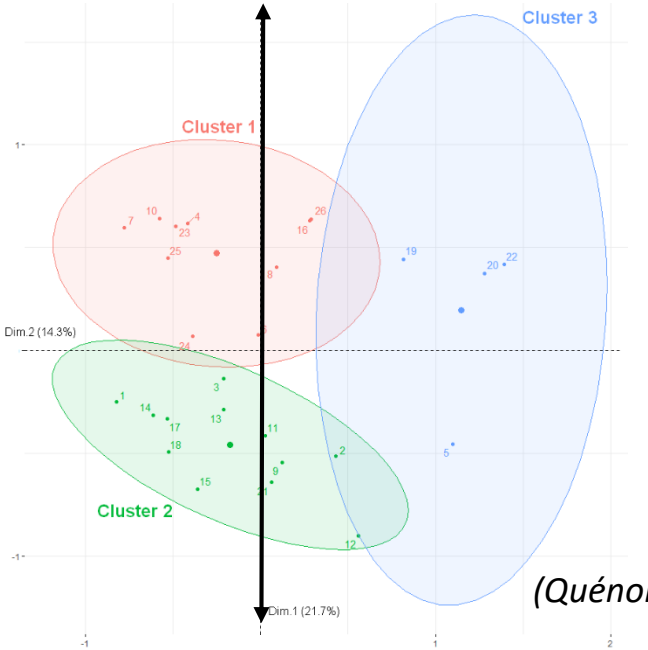
Modelling hypotheses

- *One crossbreeding programme*
- Introduced and managed on the entire dairy herd
- At a regular and/or linear pace

≠

Stable crossbred mating ≥ 90%
Crossbred mating peaked ≥ 90% then decrease ≥ 50%



(Quénon et al., 2020)

Crossbreeding managed on < 50% of the herd

Introduction

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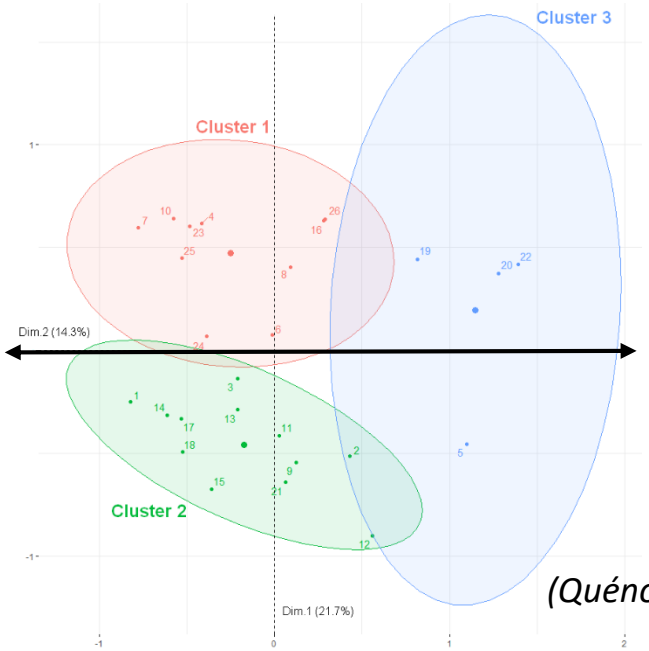
Modelling hypotheses

- *One crossbreeding programme*
- *Introduced and managed on the entire dairy herd*
- *At a regular and/or linear pace*
- Without considering other farm-level changes

≠

Crossbreeding fit farm-scale changes



Crossbreeding introduced without other changes

(Quénon et al., 2020)

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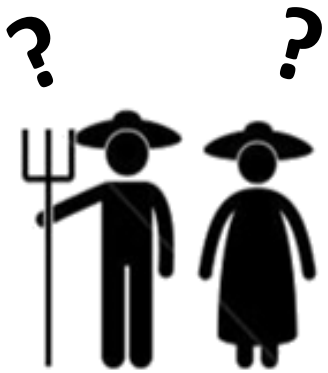
➡ *What are the empirical **trends in the performances of herds** in which rotational crossbreeding is introduced?*



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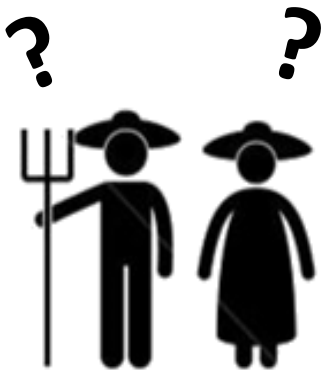

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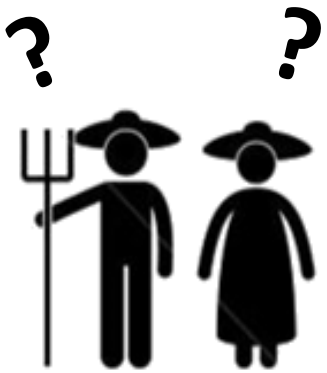
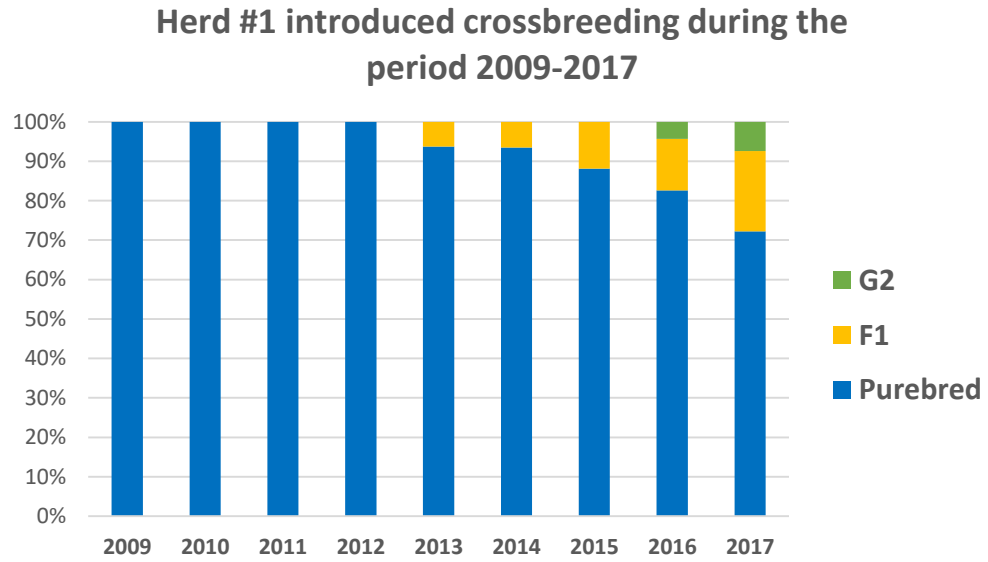


➡ *What are **the main factors that explain** such trends?*

➡ *To what extent **do crossbreeding practices explain** such trends?*

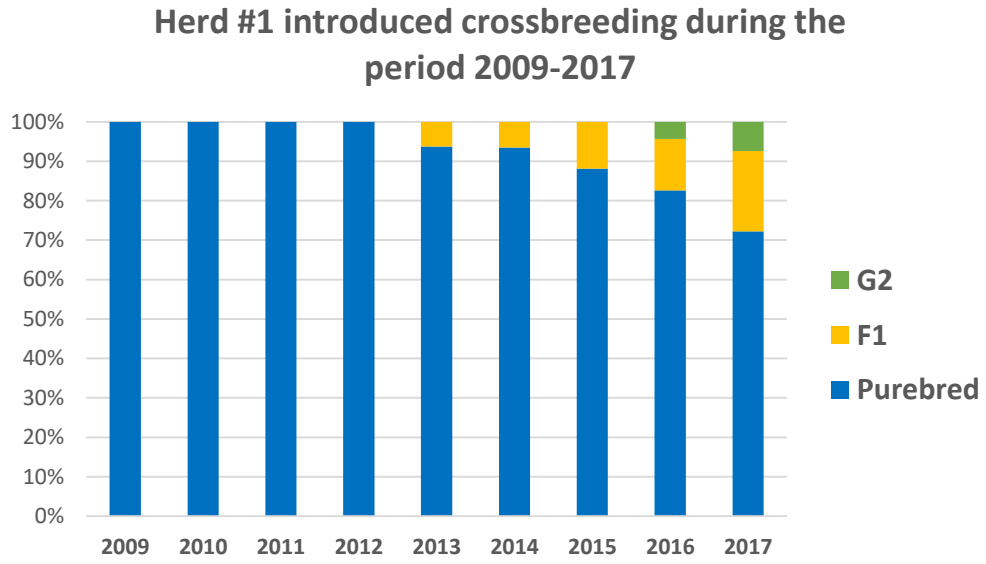
Material and methods

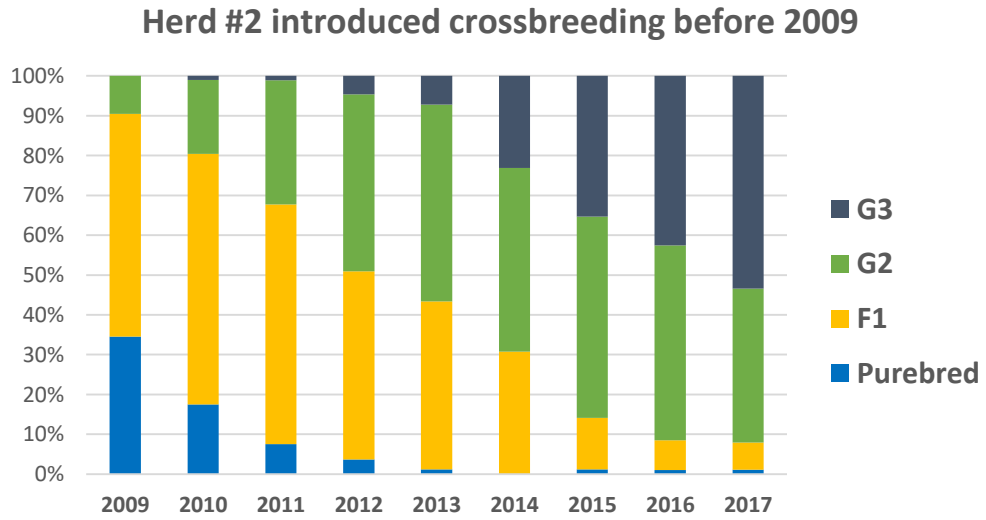
- 13 French dairy farms
- Study period: 2009-2017
- Introduction of crossbreeding varied among sampled farms
  - Some introduced it **during the study period 2009-2017**



Material and methods

- 13 French dairy farms
- Study period: 2009-2017
- Introduction of crossbreeding varied among sampled farms
  - Some introduced it **during the study period 2009-2017**
  - Some introduced crossbreeding **before 2009**





Material and methods

1. DATA COLLECTION & EDITING

Milk Record Organisation

5 Herds' performances
2009-2017

- **Milk productivity** (kg/cow)
- **Milk solids content** (g/kg/cow)
- **Fertility** (% of high fertile cows in the herd: Days Open < 117 days)
- **Somatic cell score** (% of low-SCS cows)
- **Longevity** (% of cows in 4th lactation)

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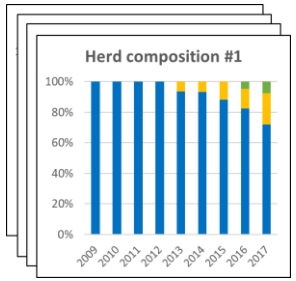
French National System of Genetic Information

→ **Herds' compositions in purebred, F_1, G_2, etc.**
2009-2017



→ **Crossbreeding practices**

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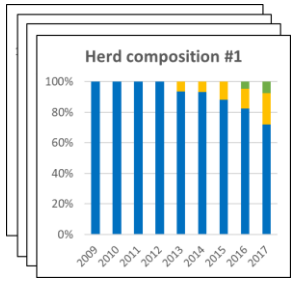

→ **Crossbreeding practices**

Semi-directive interviews

→ **Farming practices & structure**
2009-2017

- Herd size, total agricultural area, etc.
- Crop rotation: % of grassland in main fodder area, etc.
- Conversion to organic farming vs. stable conventional/organic farming sytem
- Technical pathway to manage crossbreeding *(Quénon et al., 2020)*

Material and methods

1. DATA COLLECTION & EDITING → **2. LINEAR REGRESSIONS**

Milk Record Organisation
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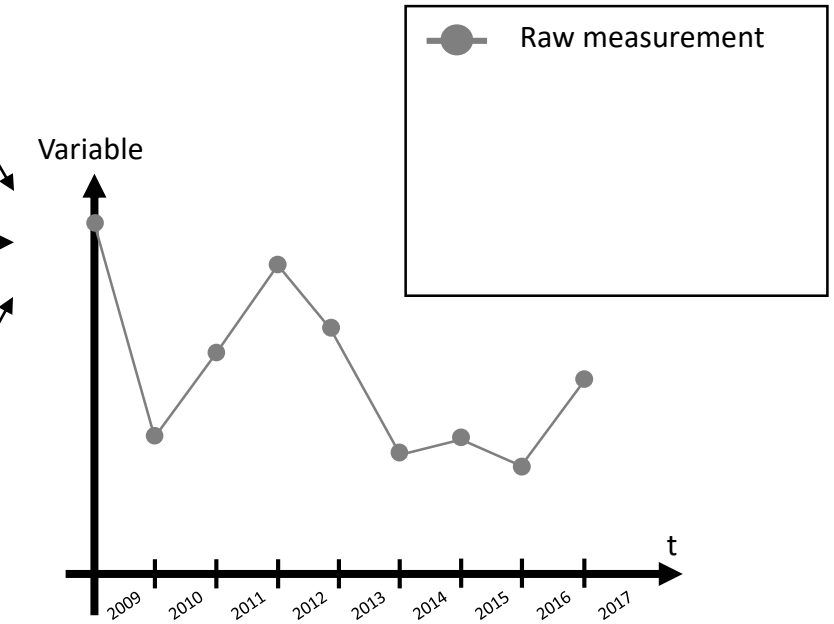

Method from Martin et al. (2017)

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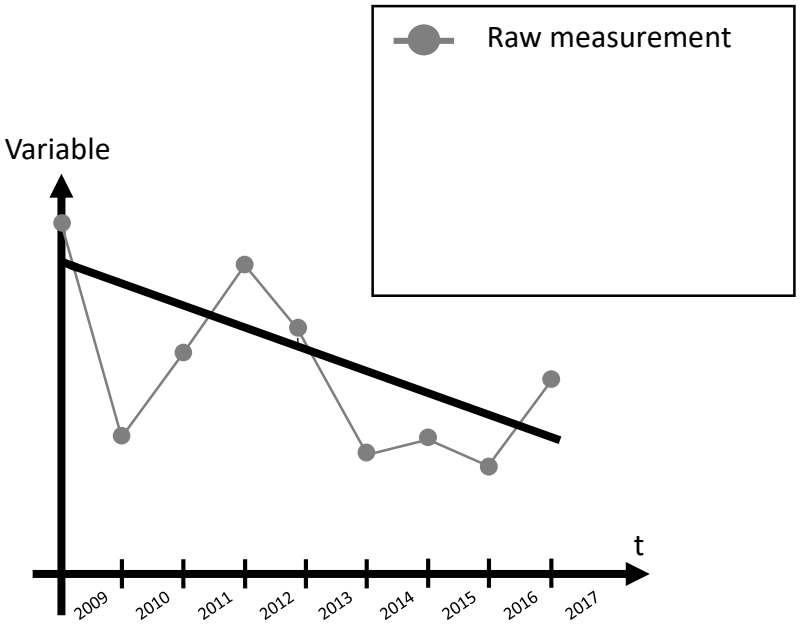
$$Variable \sim t = slope \times t + intercept$$



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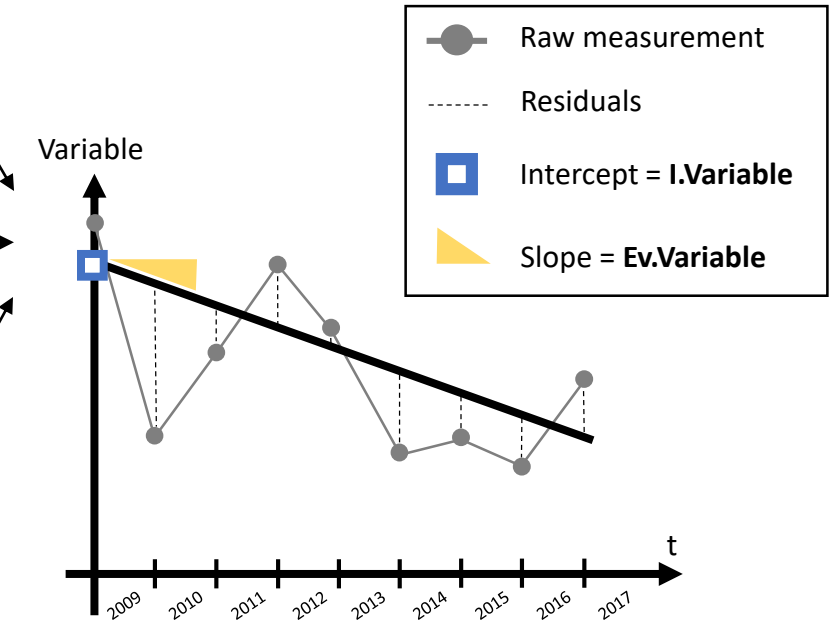

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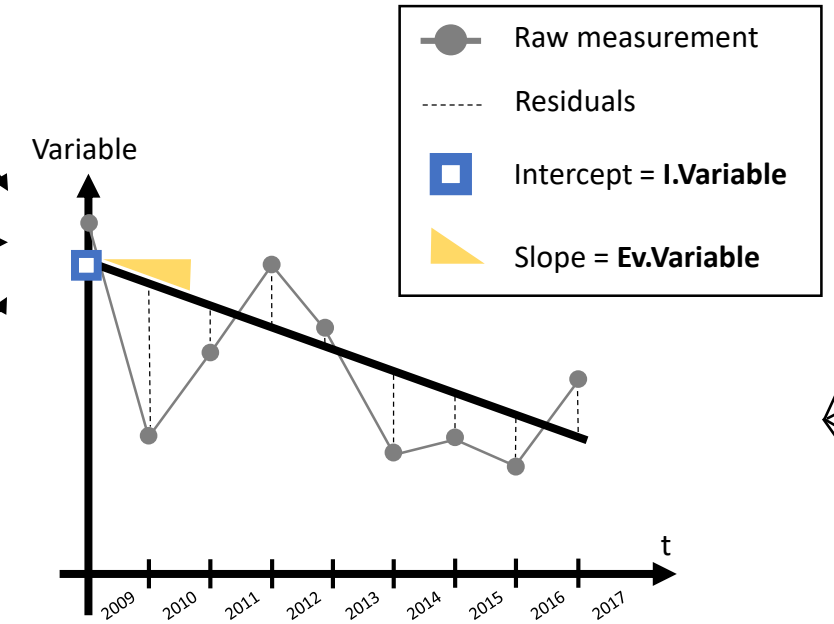

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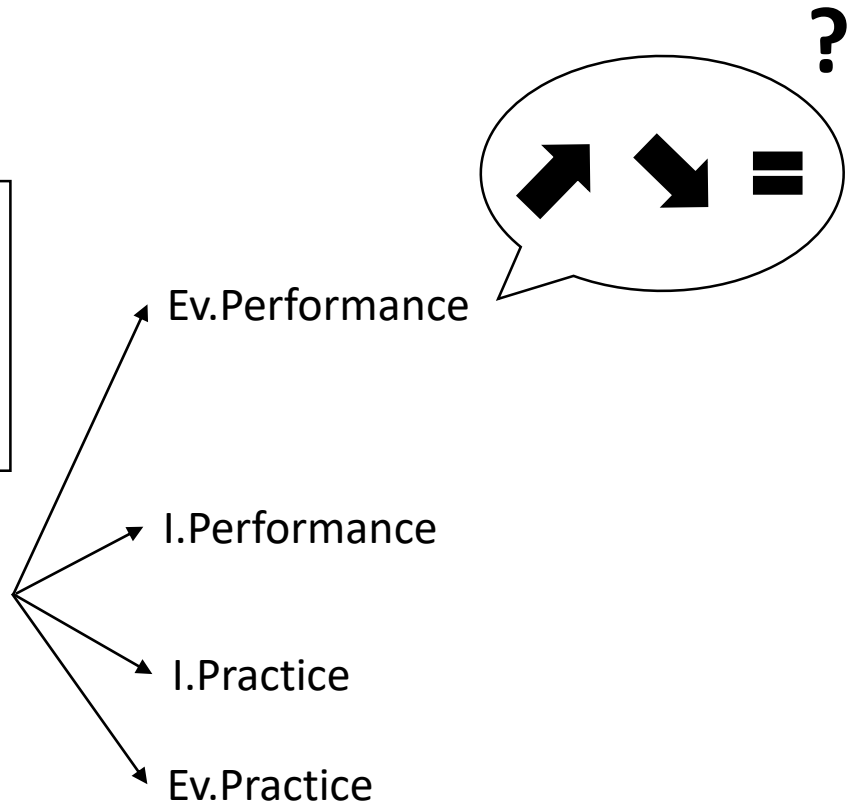
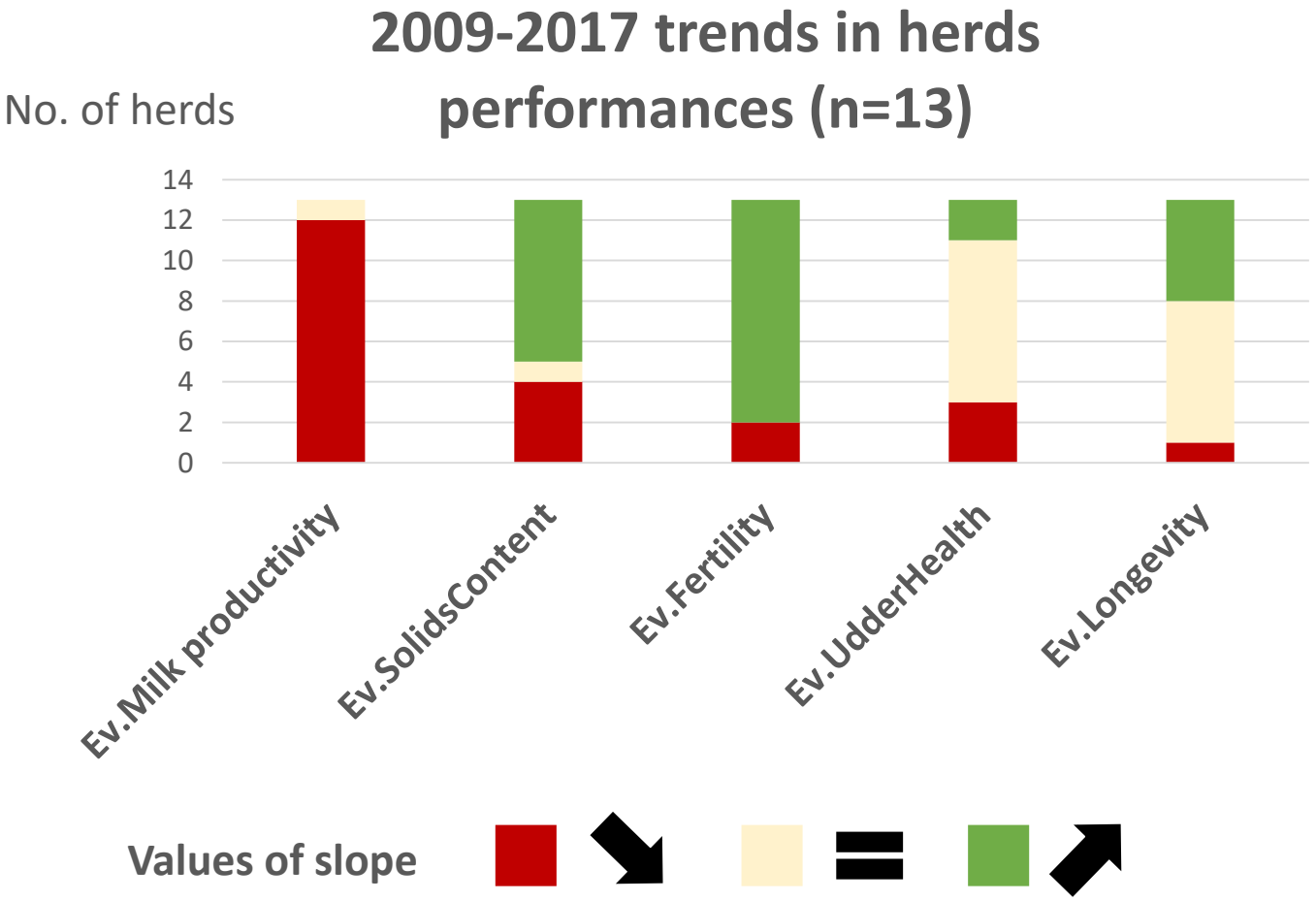


Results



- **Unequivocal trends:**
  - Decrease in milk productivity (12/13)
  - Increase in fertility (11/13)
  - Increase in solids contents (8/13)

➡ consistent with:

  - Crossbreeding performances at animal level *(Dezetter et al., 2015, 2017; Clasen et al., 2020)*
  - Farmers' drivers to introduce dairy crossbreeding *(Buckley et al., 2014; Magne and Quénon, 2021)*

- **More unclear trends** for udder health and longevity

Material and methods

1. DATA COLLECTION & EDITING
2. LINEAR REGRESSIONS
3. PARTIAL LEAST SQUARES REGRESSION

Milk Record Organisation
→ Herds' performances 2009-2017

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$$Variable \sim t = slope \times t + intercept$$

Ev.Performance

Response Variable

Material and methods

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Response Variable
- Ev.Performance
- I.Performance
- I.Practice
- Ev.Practice

Explanatory Variable #1
Explanatory Variable #2
Explanatory Variable #3

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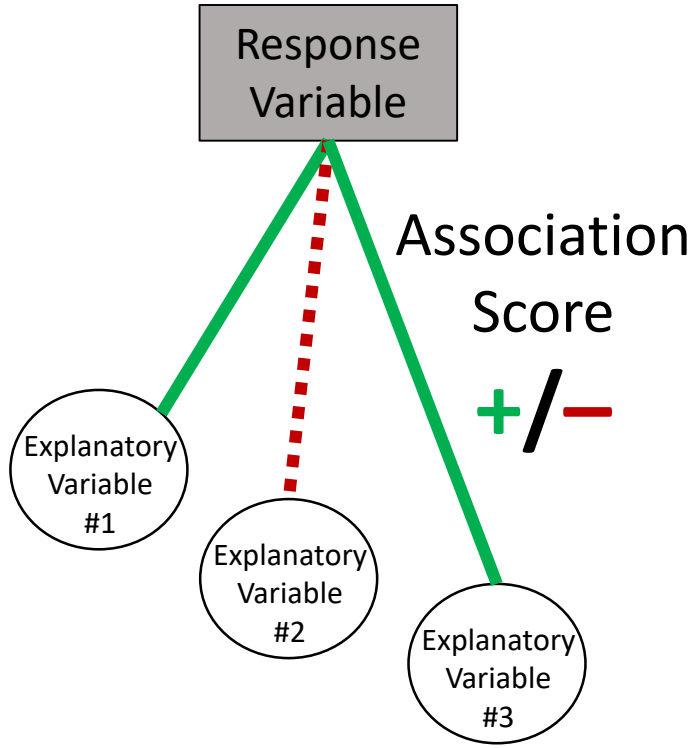
- Ev.Performance
- I.Performance
- I.Practice
- Ev.Practice



Results

Component 1

Explanatory variables	Herd performance (response variable)		
	Ev. Milk productivity	Ev. Udder health	Ev. Longevity
I. F1	+0.58	+0.45	–0.53
Ev. G3_3b	+0.52	/	–0.47
TPG3	+0.44	/	/
Converting to OF	–0.50	/	+0.45
Ev. F1	–0.58	–0.44	+0.52
I. PB	–0.59	–0.45	+0.54

Results

Component 1

Explanatory variables	*Ev. Milk productivity*
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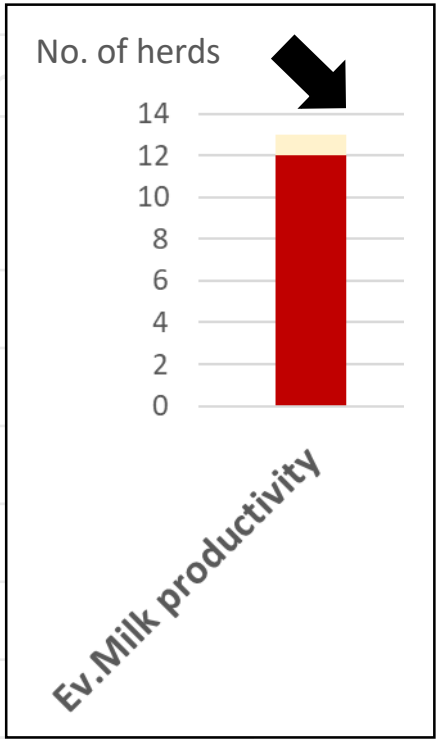

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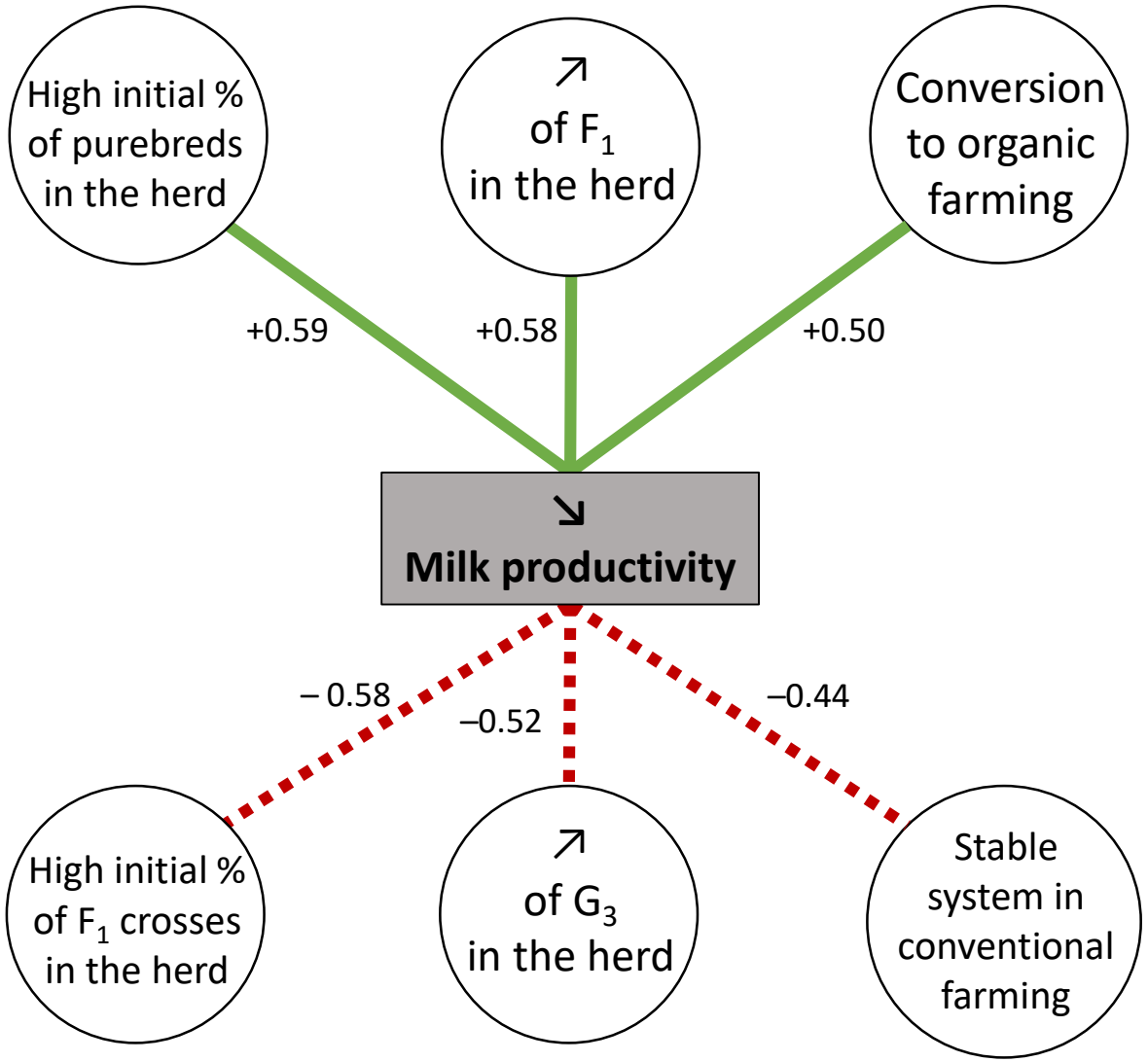
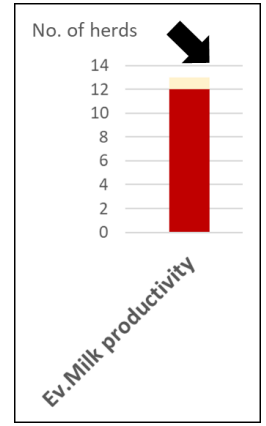
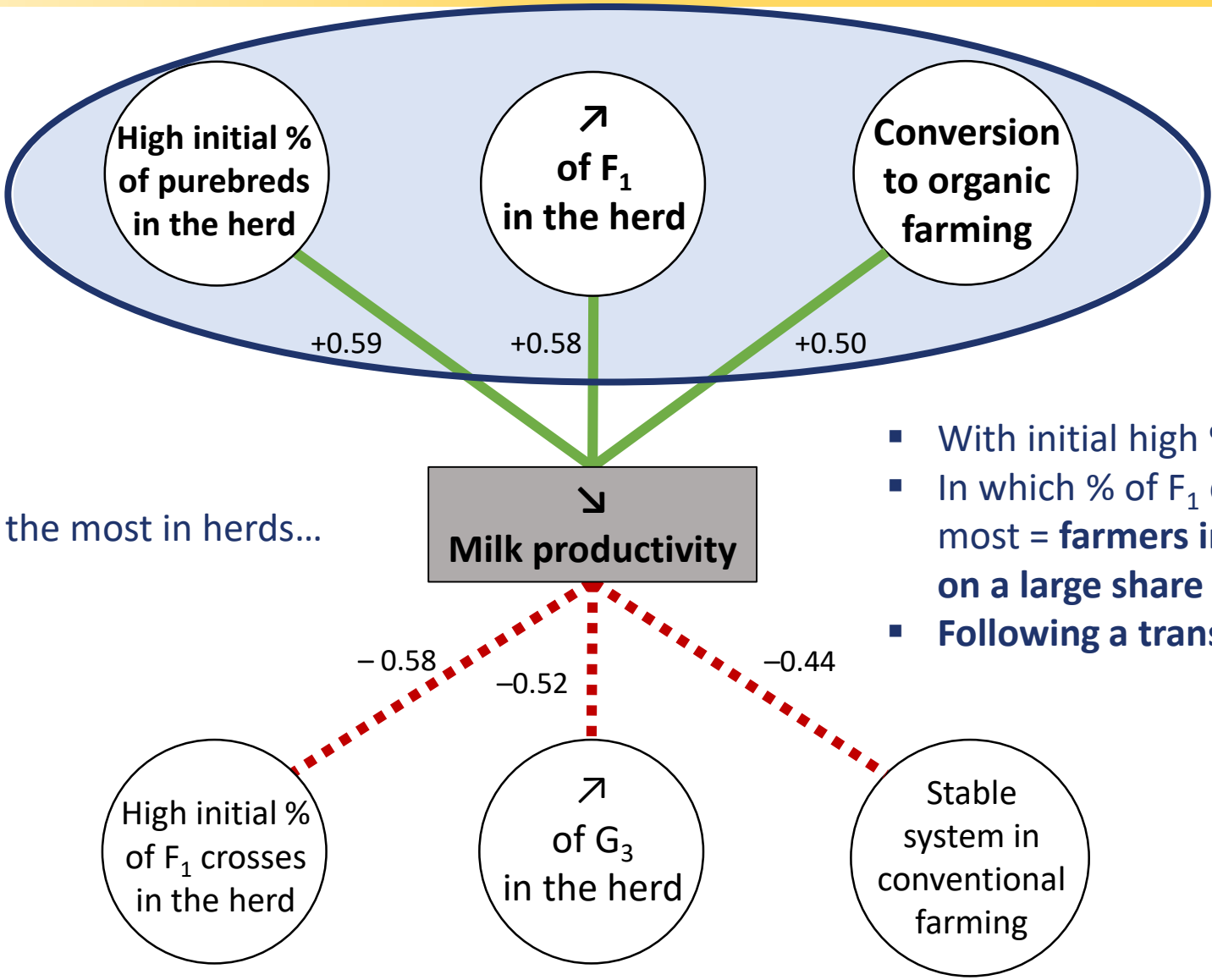
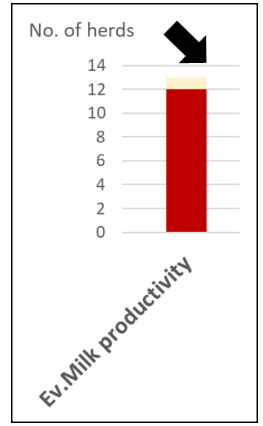

High initial % of purebreds in the herd
↗ of F_1 in the herd
Conversion to organic farming
+0.59
+0.58
+0.50
↘ Milk productivity
– 0.58
–0.52
–0.44
High initial % of F_1 crosses in the herd
↗ of G_3 in the herd
Stable system in conventional farming


No. of herds
14
12
10
8
6
4
2
0
Ev.Milk productivity

Results

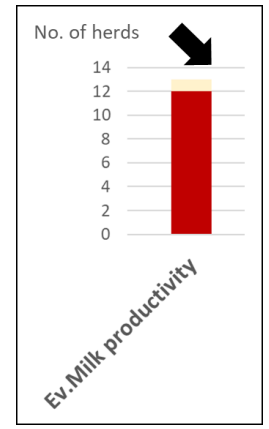


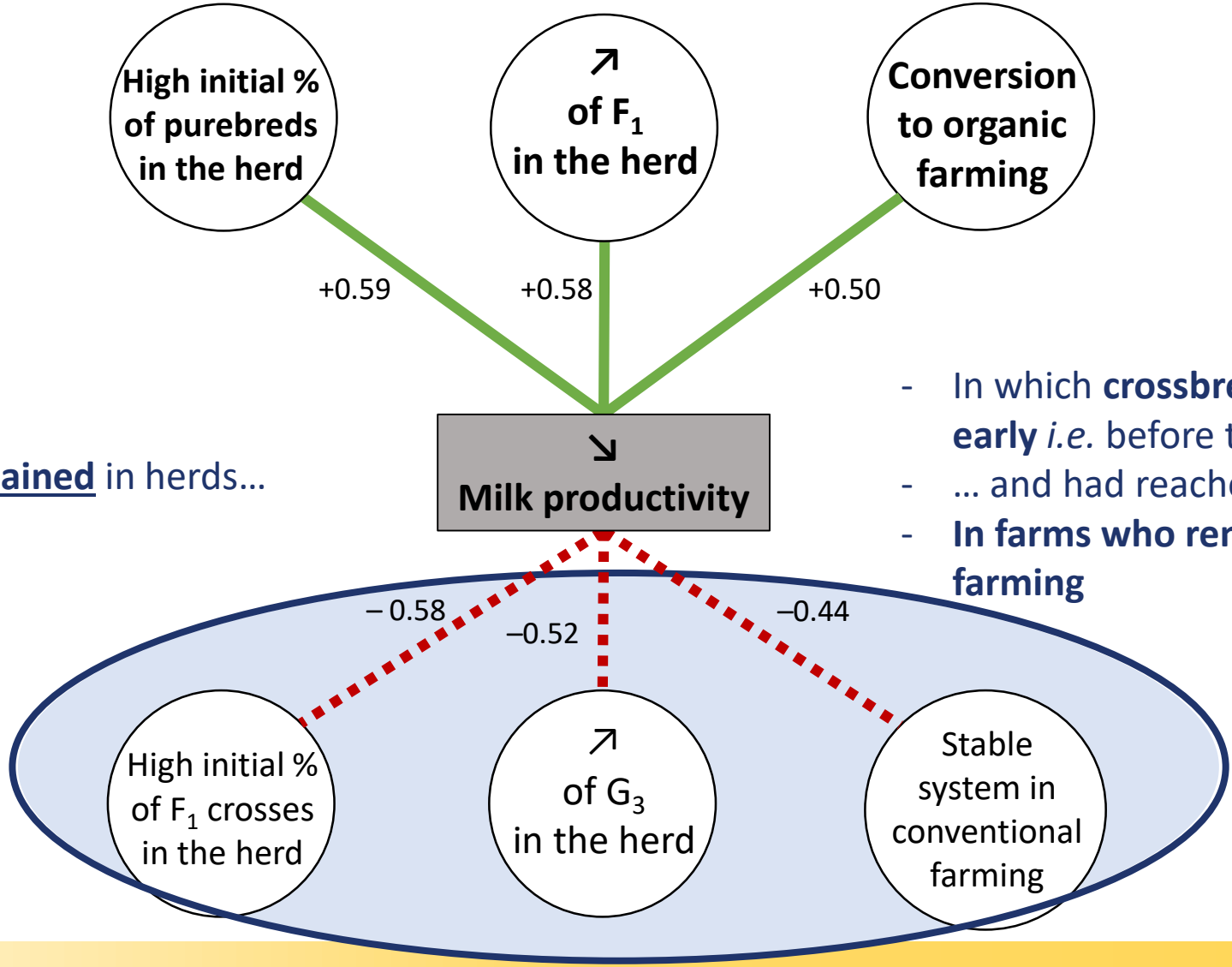


Milk productivity **<u>decreased</u>** the most in herds…

- With initial high % of purebred cows
- In which % of F_1 crosses increased the most = **farmers introduced crossbreeding on a large share of the herd**
- **Following a transition to organic farming**

Results





Milk productivity was **<u>maintained</u>** in herds…

- In which **crossbreeding was introduced early** *i.e.* before the study period…
- … and had reached the G_3 backcross-stage
- **In farms who remained in conventional farming**

Results

Component 1

Explanatory variables	Herd performance (response variable)		
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Component 2

Explanatory Variables	**Herd performance (response variable)**	
	Ev. Milk solids content	Ev. Fertility
Ev. All crosses	+0.45	–0.31
I. Fertility	+0.45	–0.30
TPG1	+0.35	–0.24
Ev. G2_3b	+0.28	/
I. Milk solids content	–0.32	/
I. Milk productivity	–0.40	+0,27

Results

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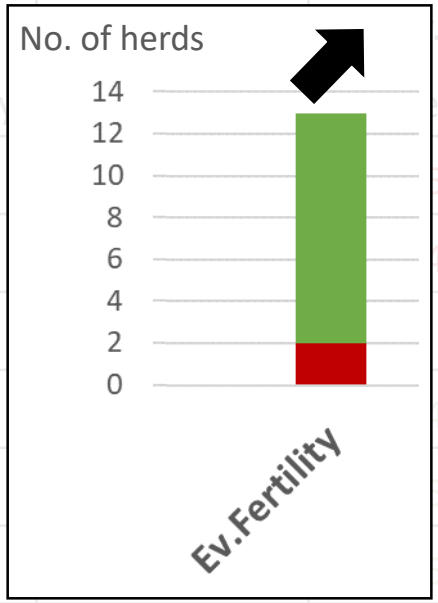

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Ev. G2_3b	+0.28	/
I. Milk solids content	–0.32	/
I. Milk productivity	–0.40	***+0,27***

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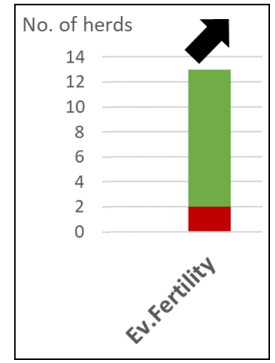
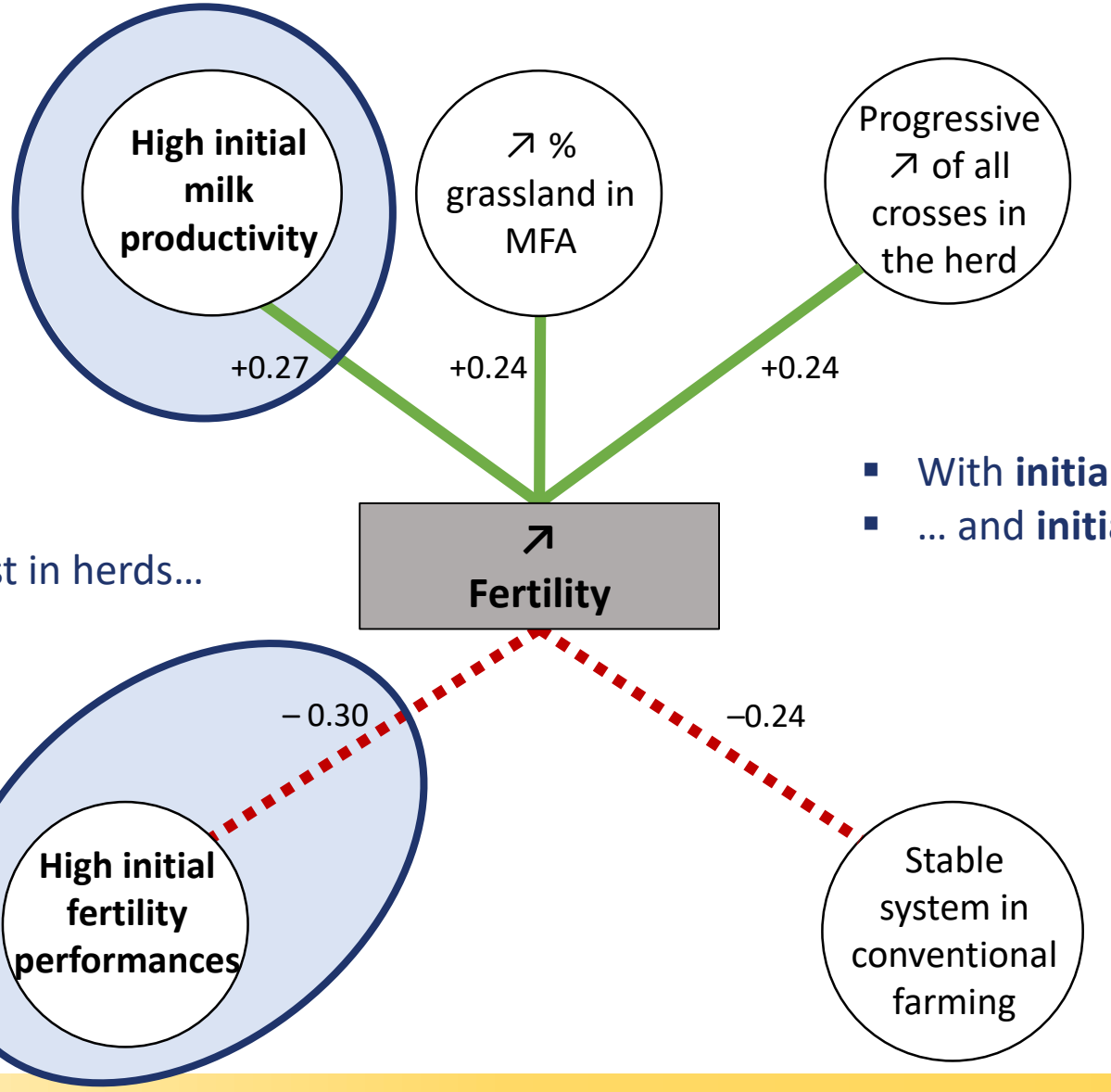
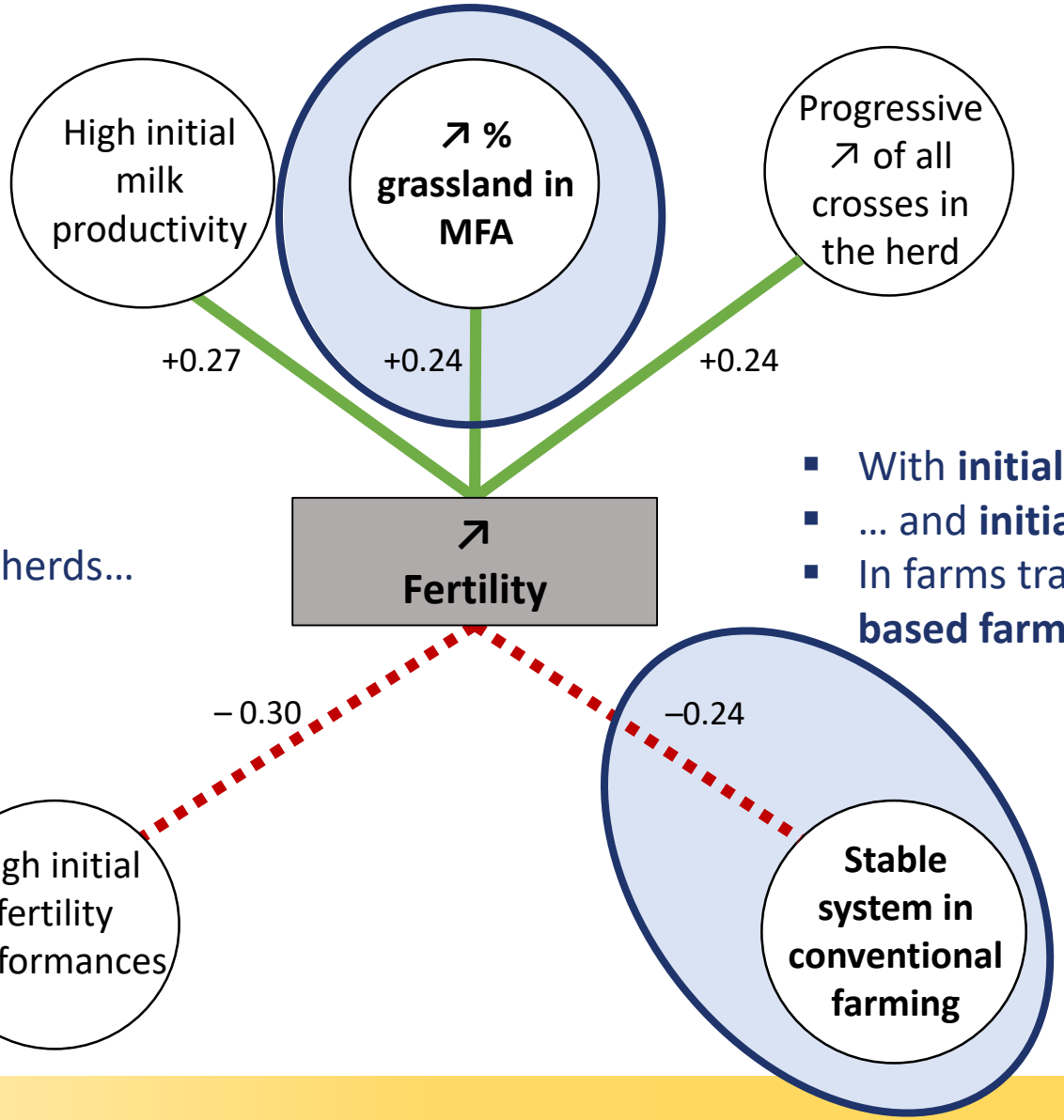


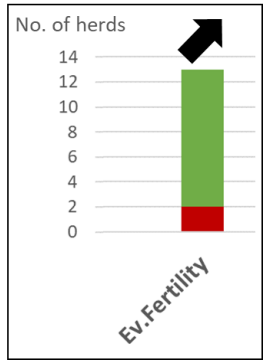


Fertility **increased** the most in herds…

- With **initial high milk** performances…
- … and **initial low fertility** performances

Results





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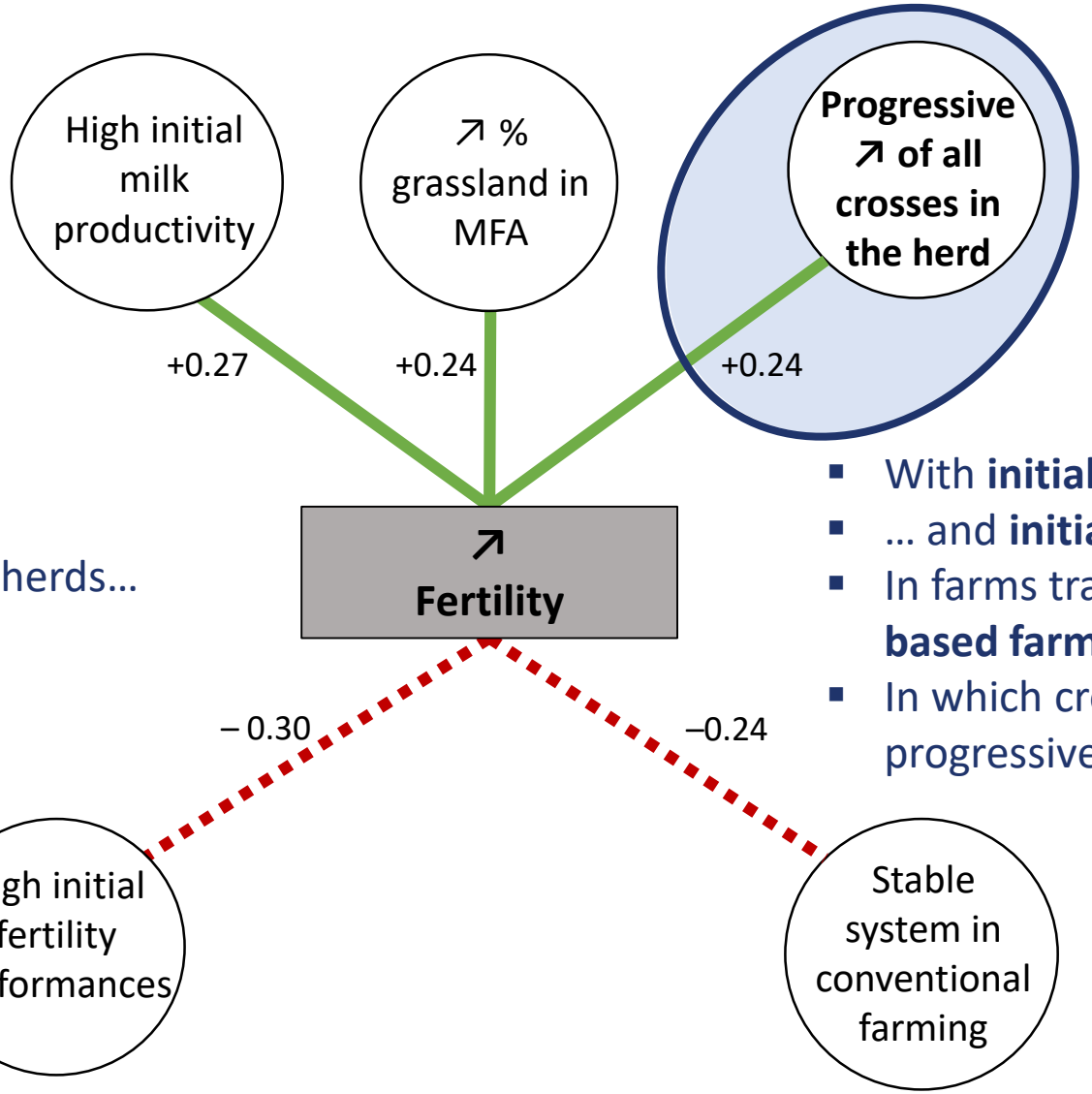
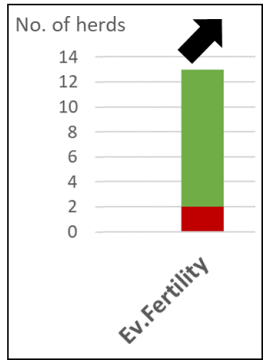
- With **initial high milk** performances…
- … and **initial low fertility** performances
- In farms transitioning **towards grassland-based farming systems**…

Results





Fertility **increased** the most in herds…

- With **initial high milk** performances…
- … and **initial low fertility** performances
- In farms transitioning **towards grassland-based farming systems**…
- In which crossbreeding was introduced progressively

Conclusion

- Crossbreeding practices are a major factor on trends in herds performance but as much as :
  - Farm-scale changes (e.g. conversion to organic farming)
  - The initial performance situation: "margin for improvement" (e.g. fertility)

➡ Crossbreeding is one explanatory factor among others: specific management of dairy crossbreeding required to be consistent with general farm management practices

Conclusion

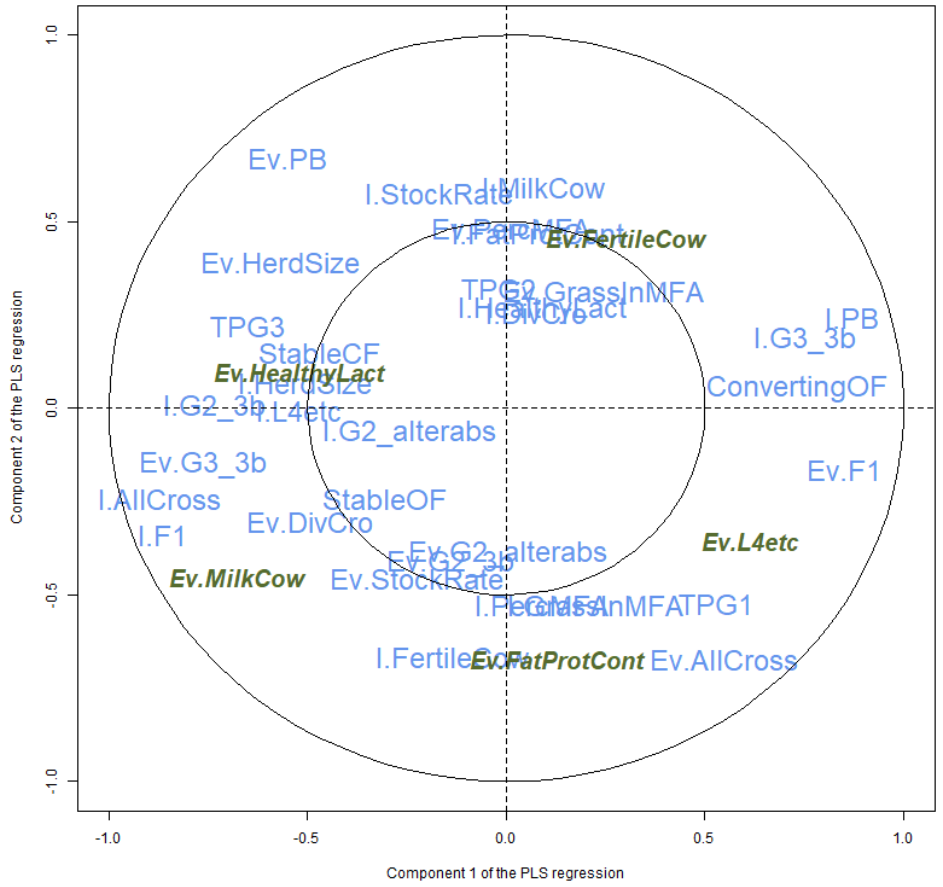
- The different generation of crosses (F_1, G_2, G_3, *etc.*) have different performances: their relative % in the herd and the evolution of herd composition while managing crossbreeding induces contrasting trends in performance on the long run

➡ Need to assess empirical trends in herd performances on longer period of time and on larger sample

Thank you for your attention

Any questions ?

Results (2/x)



- **2 first components** ($Q^2 > 0.0975$)
- **5 herd performances' variables projected on the 2 components**
  - Component 1:
    - Milk productivity & Udder health
    - Longevity
  - Component 2:
    - Fertility
    - Milk solids content

Material and methods