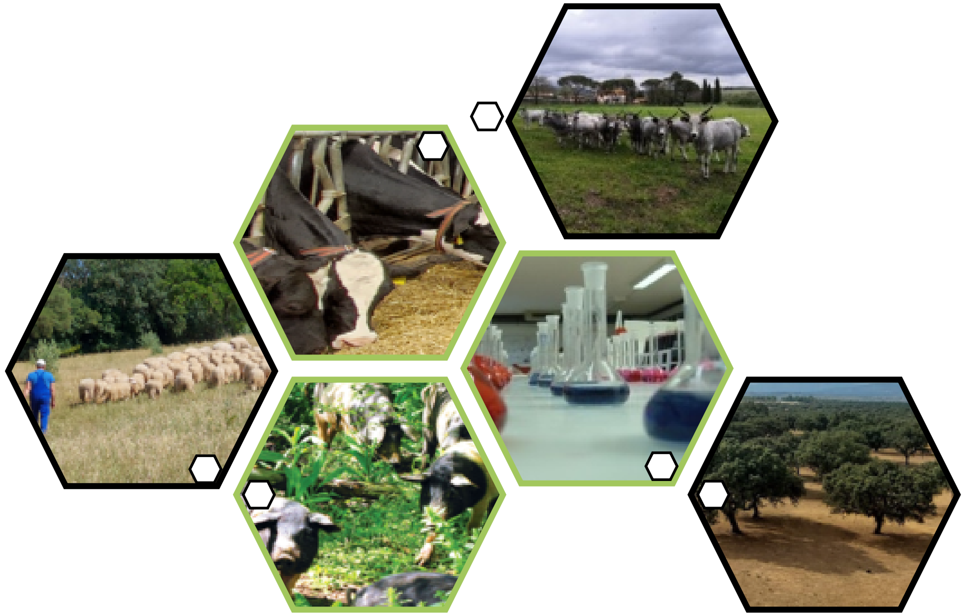
EAAP - WAAP - Interbull Congress 2023

Lyon, France - August 26th / September 1st, 2023



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Pisa Livestock farming, Animal food quality, and Sustainability

A thirty-year assessment of interactions between weather conditions and sheep milk yield and quality

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The Mediterranean is a climate change hot spot

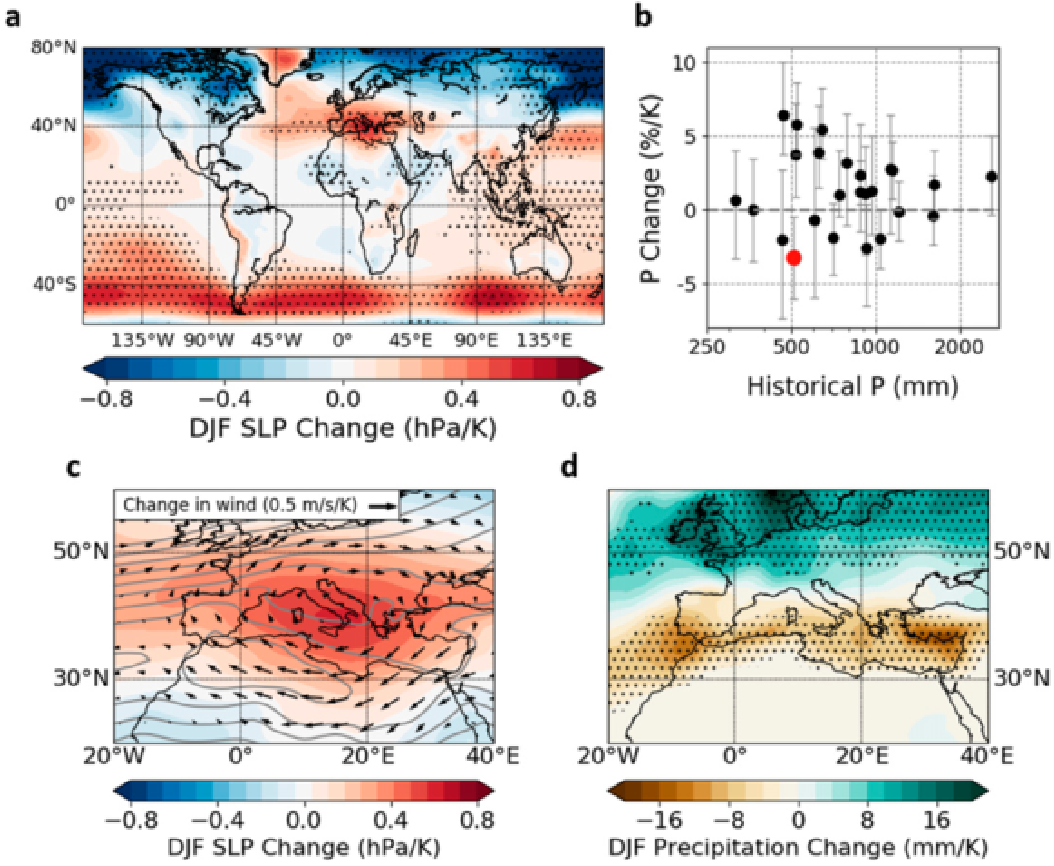


FIG. 1. CMIP5 winter (DJF) multimodel mean projected change in (a) worldwide SLP, (c) Mediterranean SLP and 850-hPa winds, and (d) Mediterranean precipitation under RCP8.5 (2071–2100 minus 1976–2005). Historical DJF SLP contours are also shown in (c) (from 1010 to 1024 hPa every 2 hPa; the closed contour over North Africa is 1024 hPa). Dots in (a) and (d) indicate that more than 80% of models agree on the sign of the change. Also shown is (b) median (black dots) and 90% intermodel spread (gray whiskers) of relative change in annual precipitation in CMIP5 models under RCP8.5 (2071–2100 minus 1976–2005), against annual mean historical (1976–2005) precipitation, for 25 land regions covering the whole globe (Giorgi and Bi 2005). The Mediterranean is highlighted with a red dot. In (a)–(d), projections have been renormalized by each model's global projected temperature change.

A large part of rainfall decline occurs during winter, south of 40°N (Fig. 1d), with enhanced drying over northwestern Africa [from -30% to -40% in December–February (DJF) precipitation] and the eastern Mediterranean (from -20% to -25%).

In summer, significant warming and drying is also projected for the northern Mediterranean (Brogli et al. 2019)

Source: **Tuel and Eltahir, 2020 - JOURNAL OF CLIMATE - Why Is the Mediterranean a Climate Change Hot Spot?**
Brogli et al., 2019: Causes of future Mediterranean precipitation decline depend on the season. Environ. Res. Lett.

Are semi-intensive livestock systems resilient?

- Less labour per unit area
- Animal welfare is generally improved
- Grazing reduces feed costs
- Reduced impacts to the local environment and soils
- Maintenance of local knowledge and landscapes

But climate-resilient?

General aim

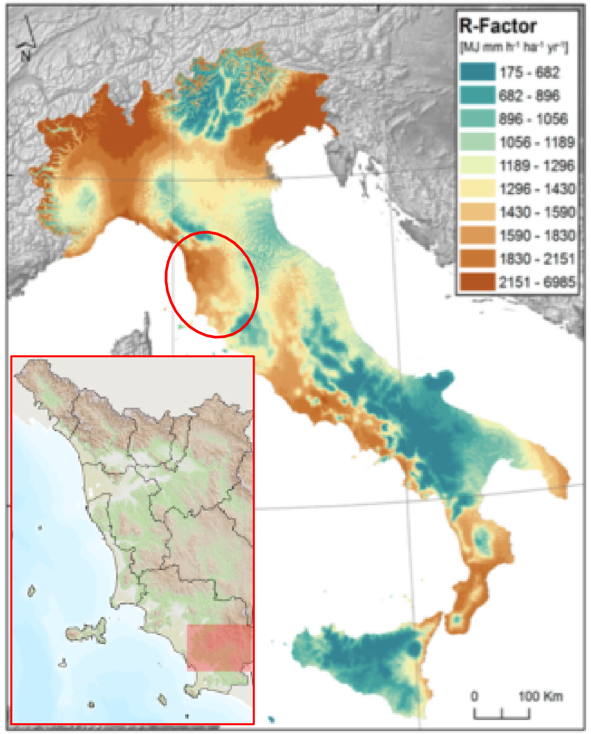
Increase the knowledge of **scientists and practitioners** about the **effect of weather conditions** **on milk** yield and quality **to cope (**as better as we can**)** with a **changing climate**

AIM

Case study

Caseificio Sociale Manciano

A cooperative of 150 farmers (year 2022), about 14.000 ha of UAA, one cheese factory, about 56.000 ewes and more than 6 millions litre of milk



Maremma (Tuscany)

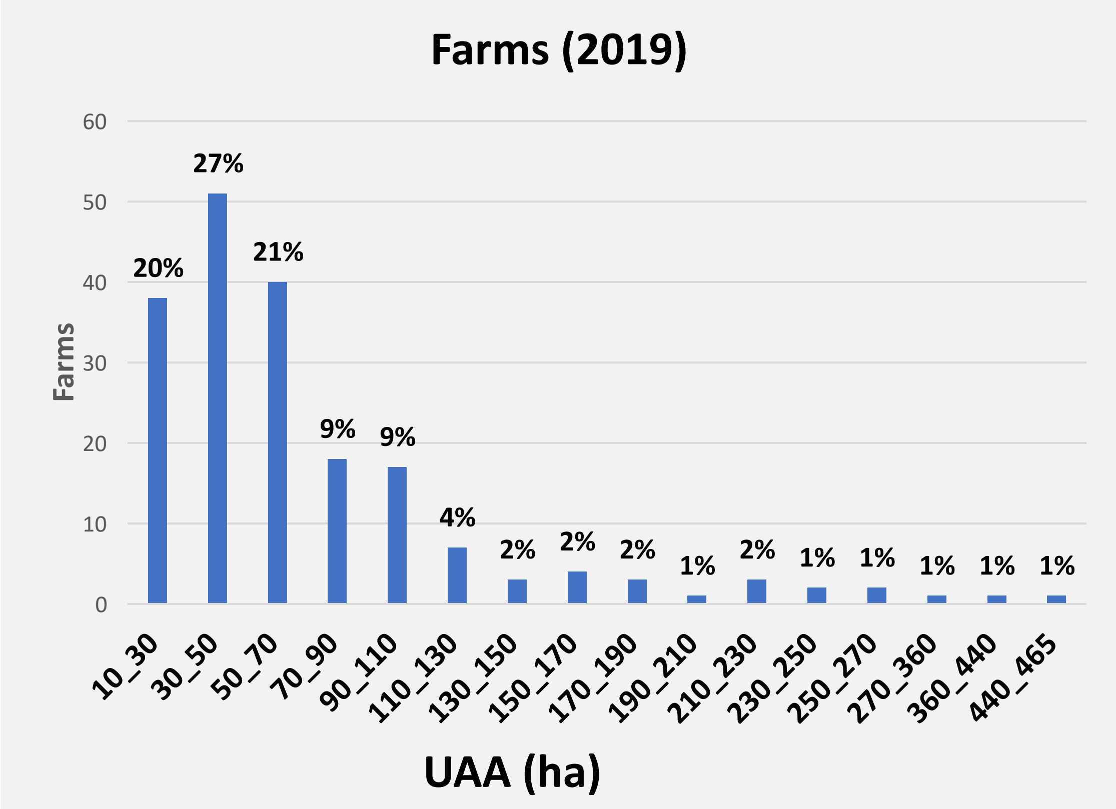
90% Sarda breed

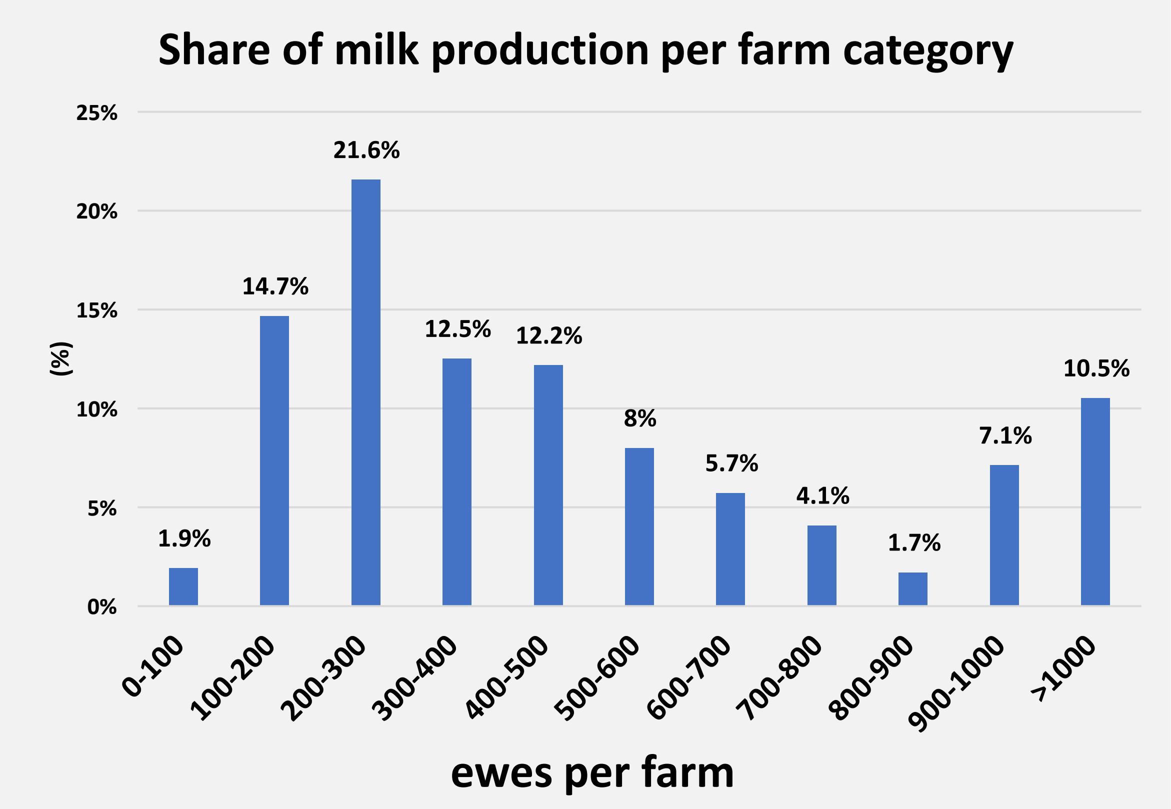
Pecorino Toscano PDO

Case study

A cooperative of 150 farmers (year 2022), about 14.000 ha of UAA, one cheese factory, about 56.000 ewes and more than 6 millions litre of milk

Caseificio Sociale Manciano





Data (21 years of merged dataset)

Milk production

- 2002-2022
- Daily production per farm

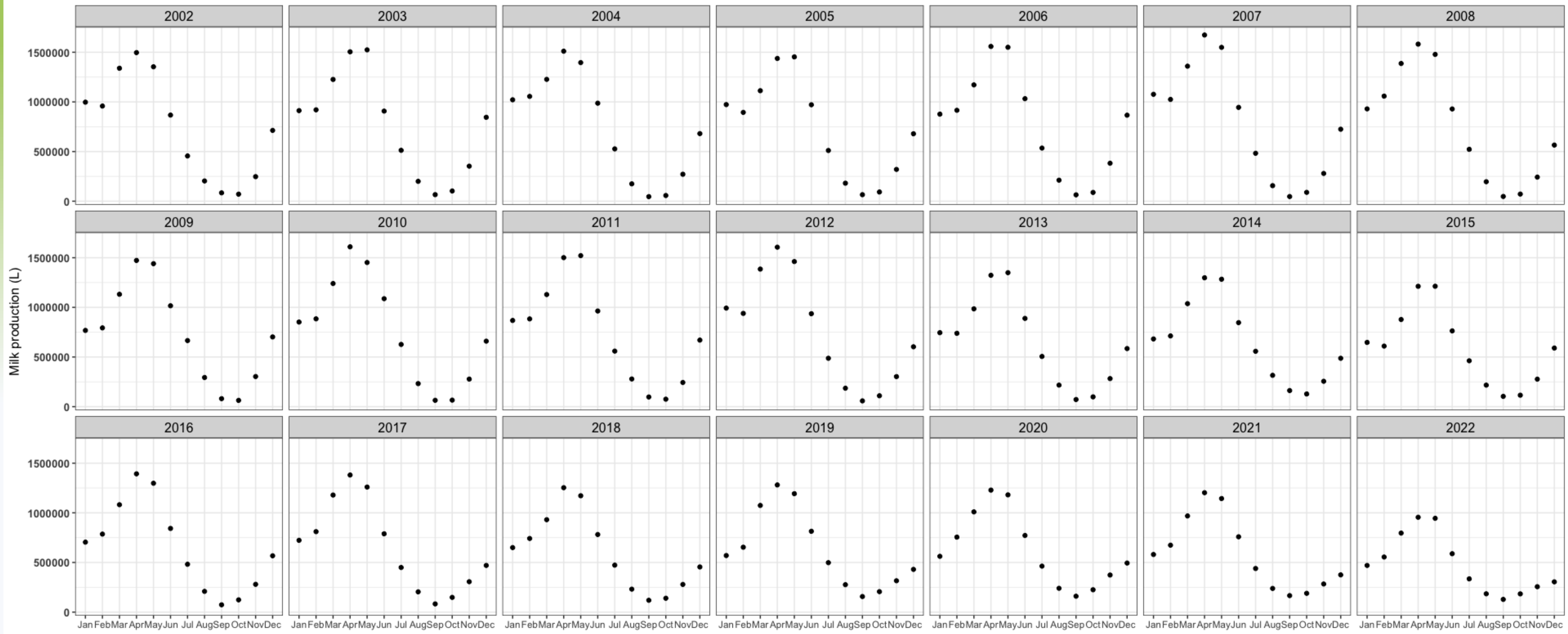
Milk Quality

- 2002-2022
- Milk quality (twice a month)

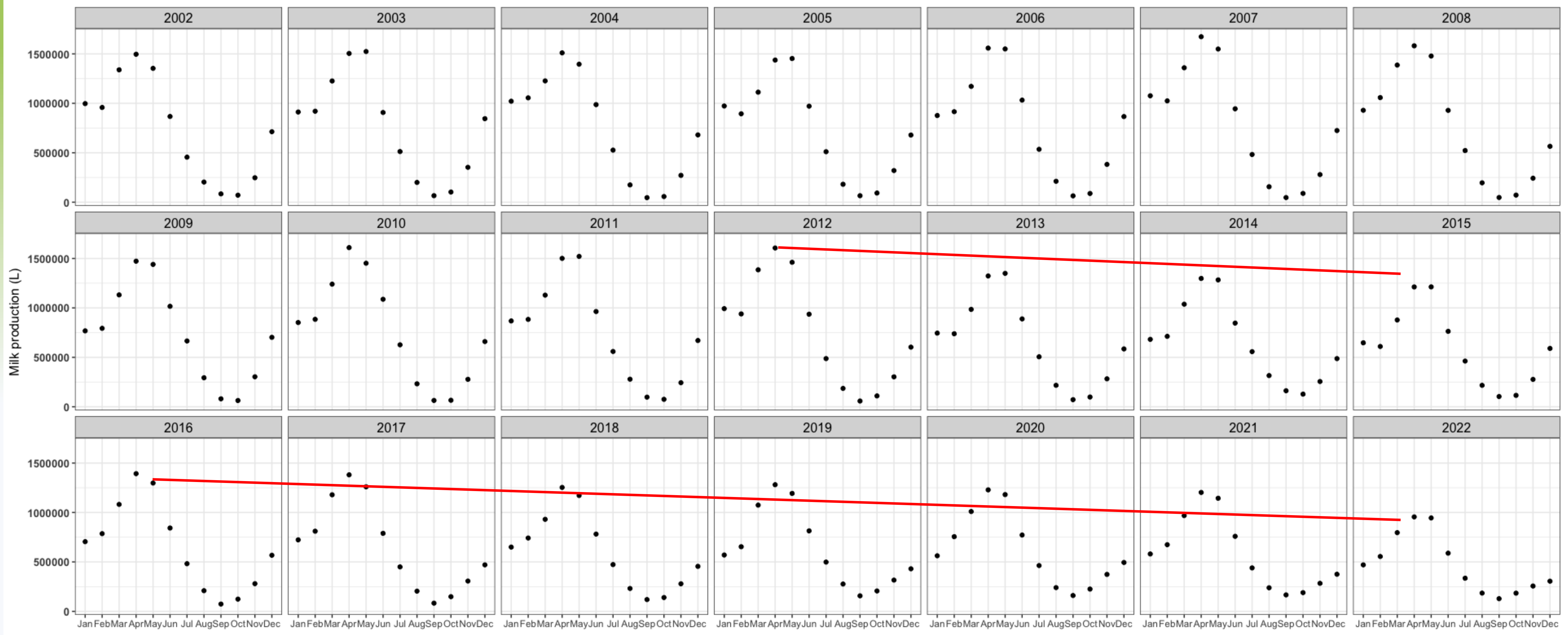
Historical weather data

- 2002-2022
- Daily

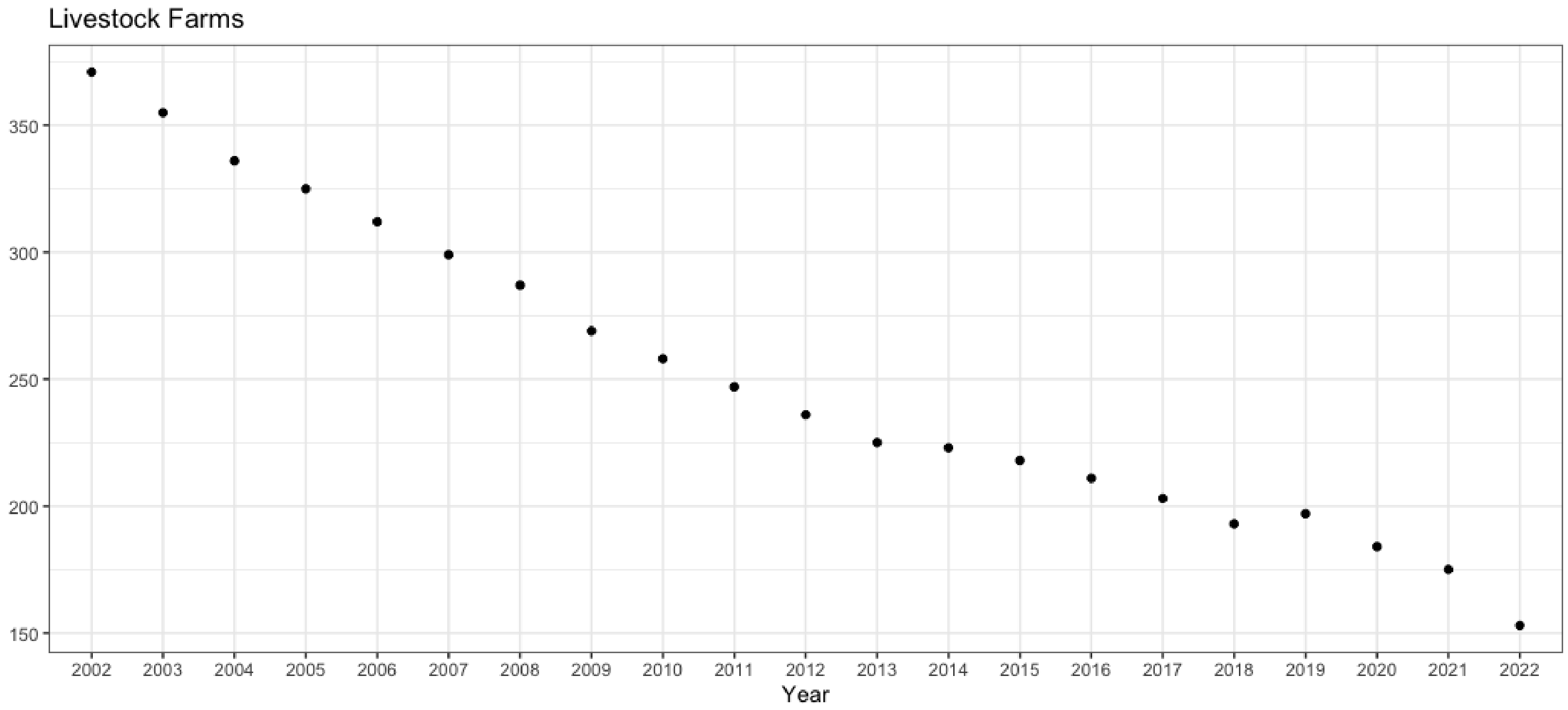
Milk production over the years (2002-2022)



Milk production over the years (2002-2022)



Farms over the years (2002-2022)



Analysis of weather conditions (2002-2022)

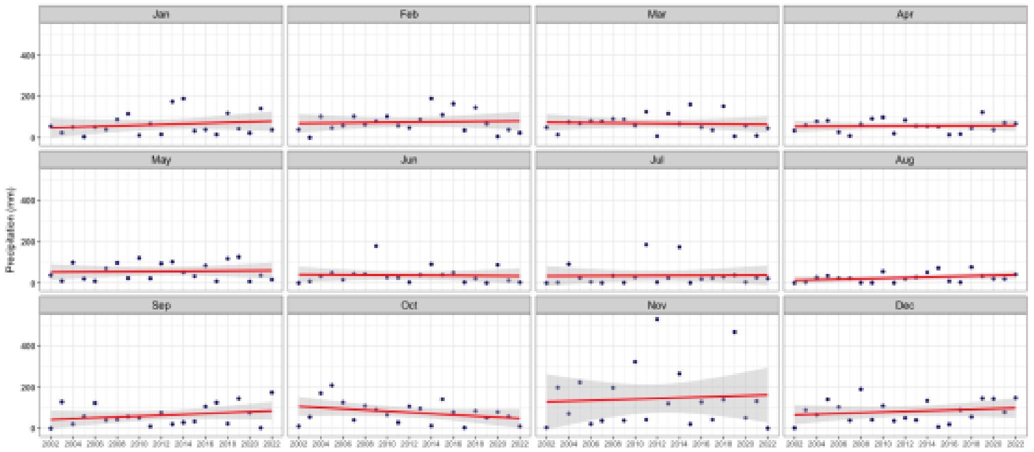
In a nutshell

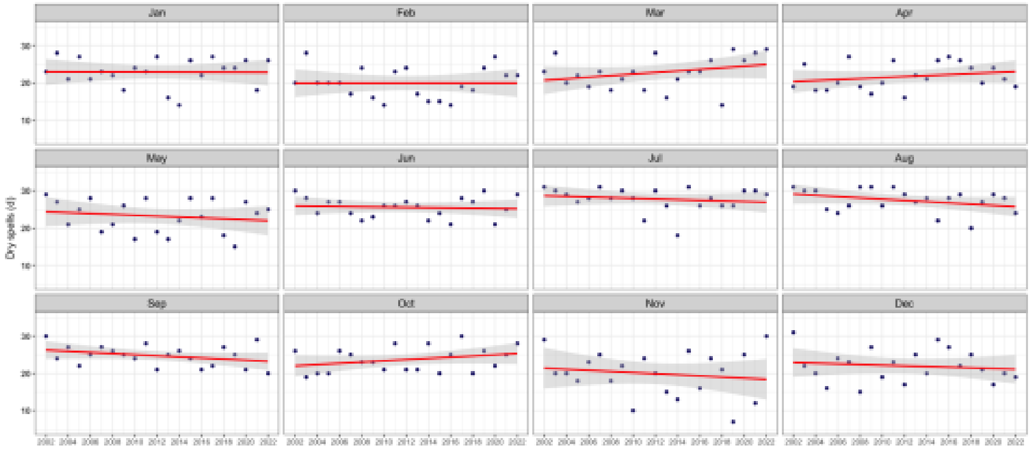
Higher variability of precipitation during autumn

High variability of dry spells over the year

Stability of maximum temperature

Increasing of minimum temperature





Analysis of effects of climate on ewe milk

Parameters

- **Reduction of spring production of milk (Apr/Jul)**
- Fat content (Apr)
- Maximum temperature
- Minimum temperature
- Mean Relative humidity
- Precipitation
- Dry spells
- THI (max temp – mean RH)

Aggregation

- Monthly base

Multivariate analysis

- PCA
- Conditional inference trees
- Software R
- Vegan package
- Partykit package

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Analysis of effects of climate on ewe milk

Reduction of spring production (Apr-Jul) – RED is calculated as:

$$\left(\frac{\text{Milk apr}_{ij} - \text{Milk jul}_{ij}}{\text{Milk apr}_{ij}} \cdot 100 \right) - \left(\frac{\text{Milk apr}_{i} - \text{Milk jul}_{i}}{\text{Milk apr}_{i}} \cdot 100 \right)$$

Where:

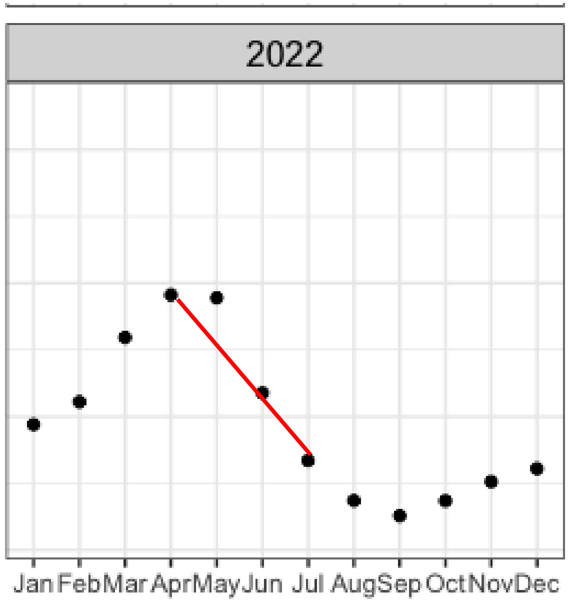
Milk apr = Total production of ewe milk in April

Milk jul = Total production of ewe milk in Juli

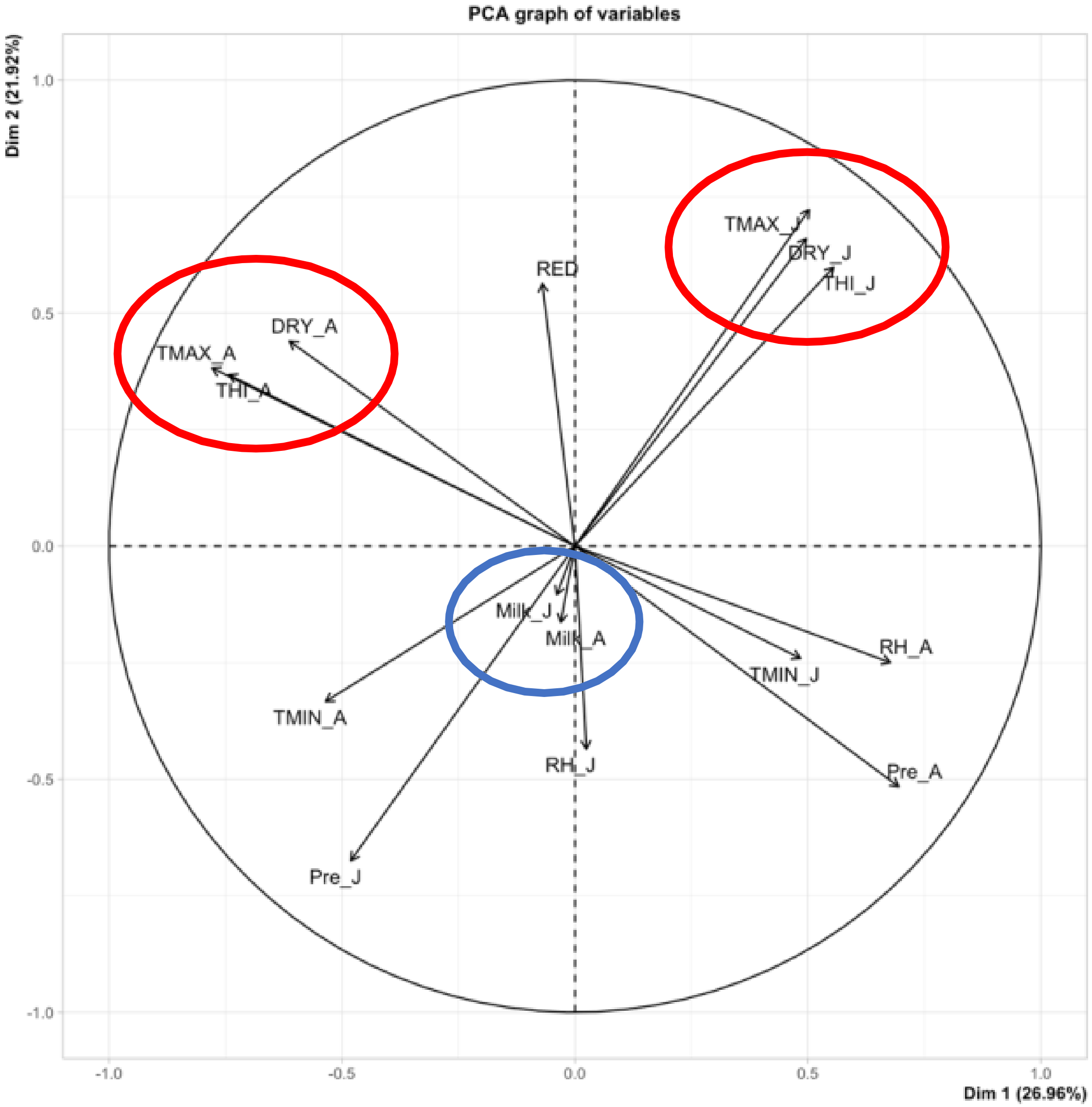
i = Farm

j = Year

Aggregation per year



Analysis of effects of climate on ewe milk



RED = Reduction of spring production (Apr-Jul)

Milk_A | _J = Milk production in April | July

TMAX_A | _J = Maximin temperature of April | July

TMIN_A | _J = Minimum temperature of April | July

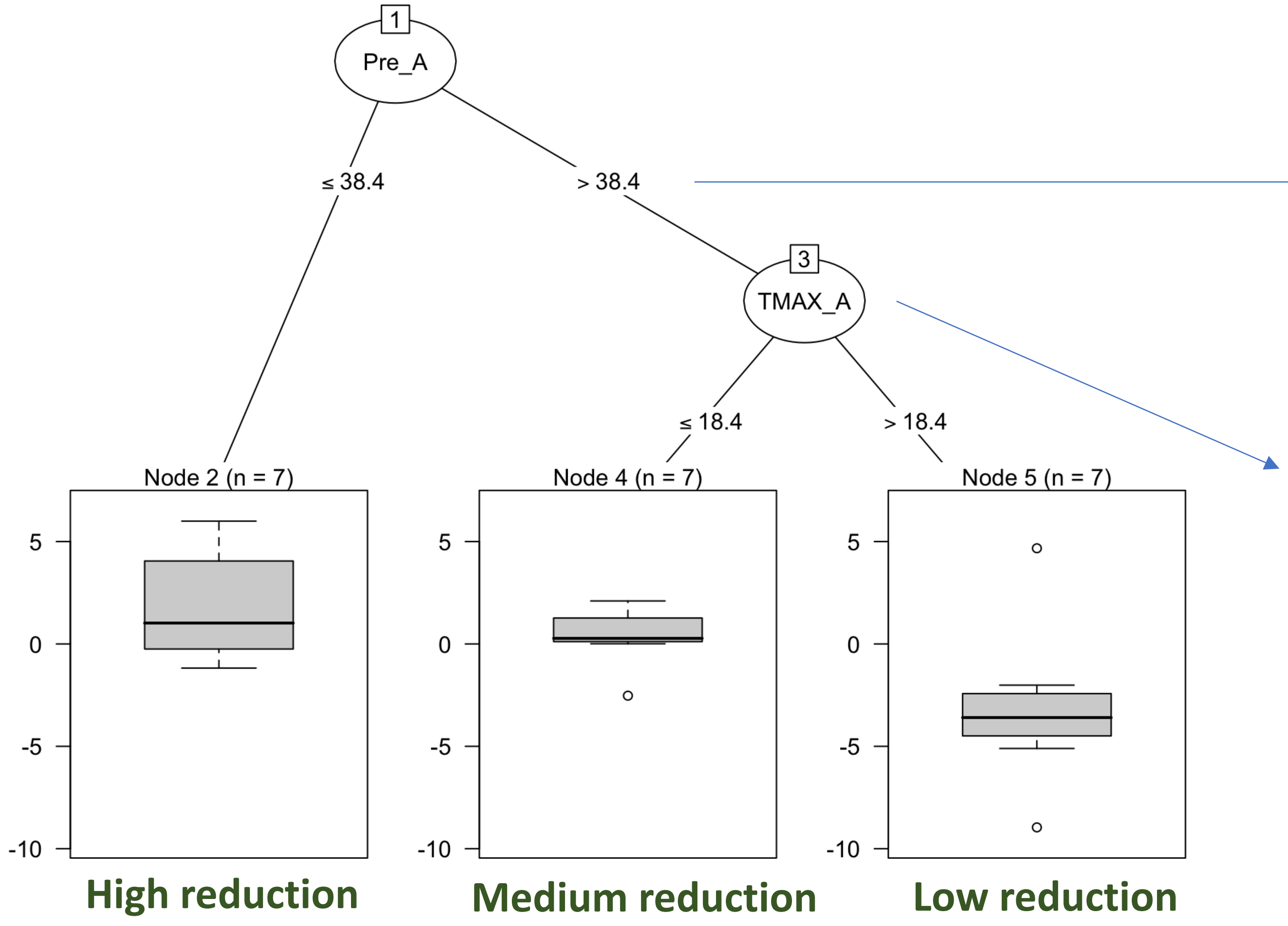
THI_A |_J = Temperature humidity index of April | July

DRY_A | _J = Dry spells (number of dry days) of April | Ju

RH_A | _J = Relative humidity of April | July

Prec_A | _J = Precipitation of April | July

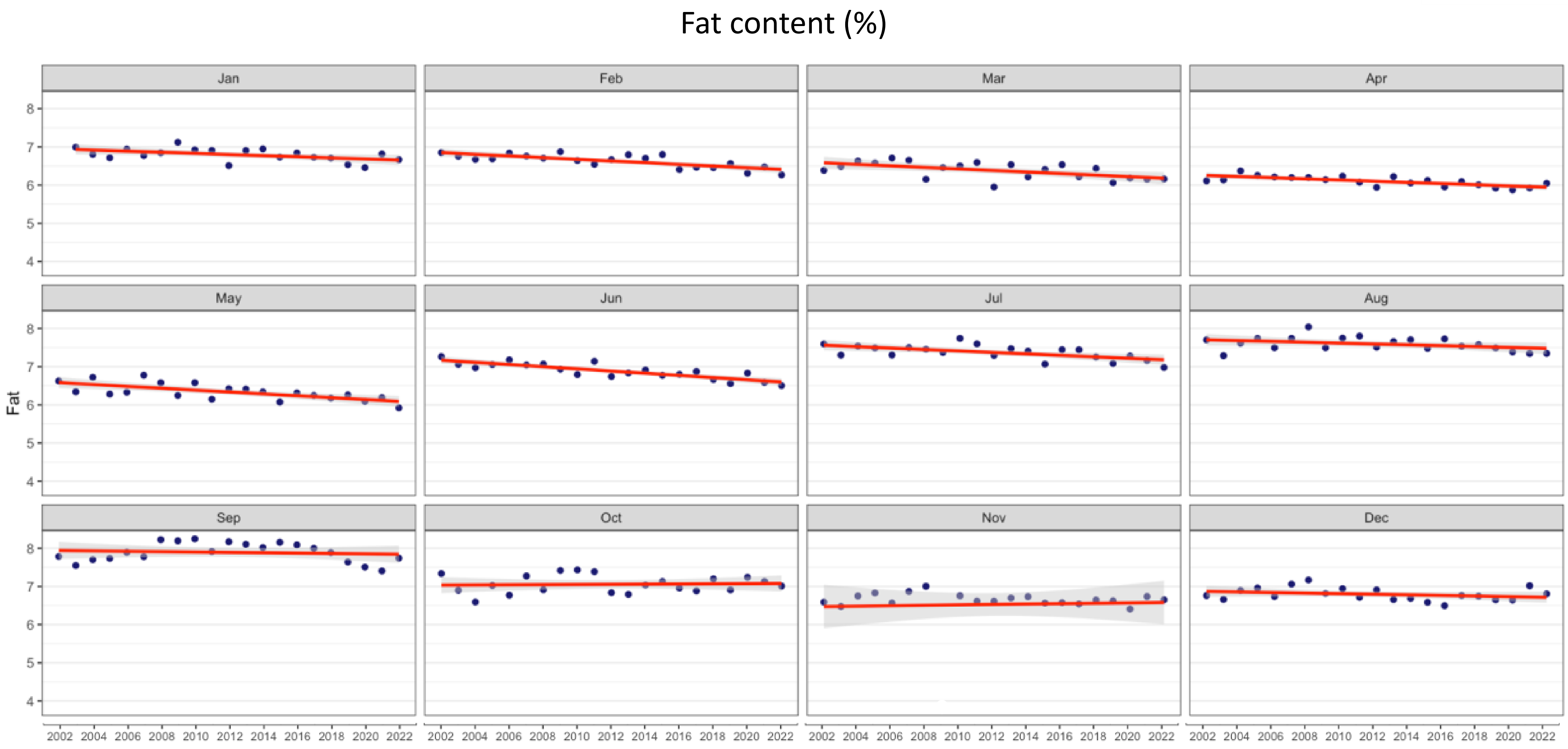
Analysis of effects of climate on ewe milk



Precipitation in April over 38.4 mm lead to a minor reduction on milk in spring

The lower reduction is registered when the average **maximum temperature in April** is over 18.4 °C

Milk quality over the years (2002-2022)



Analysis of effects of climate on ewe milk

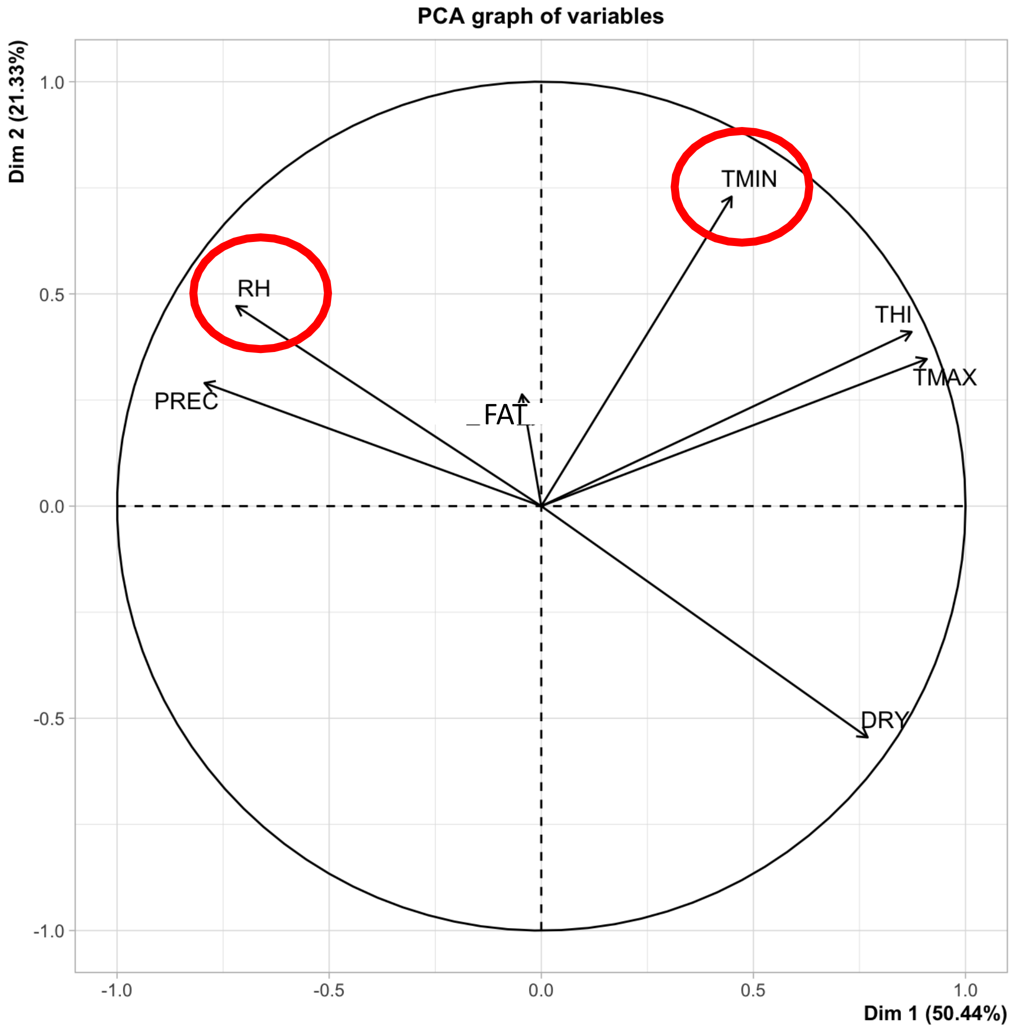
Fat content per farm

FAT index is calculated as:

$$\left(\text{Fat content (Apr)} - \text{Fat content (mean apr 2002-2022)} \right)$$

Aggregation per year

Analysis of effects of climate on ewe milk



FAT = Reduction of spring production (Apr-Jul)

TMAX = Maximin temperature of April

TMIN = Minimum temperature of April

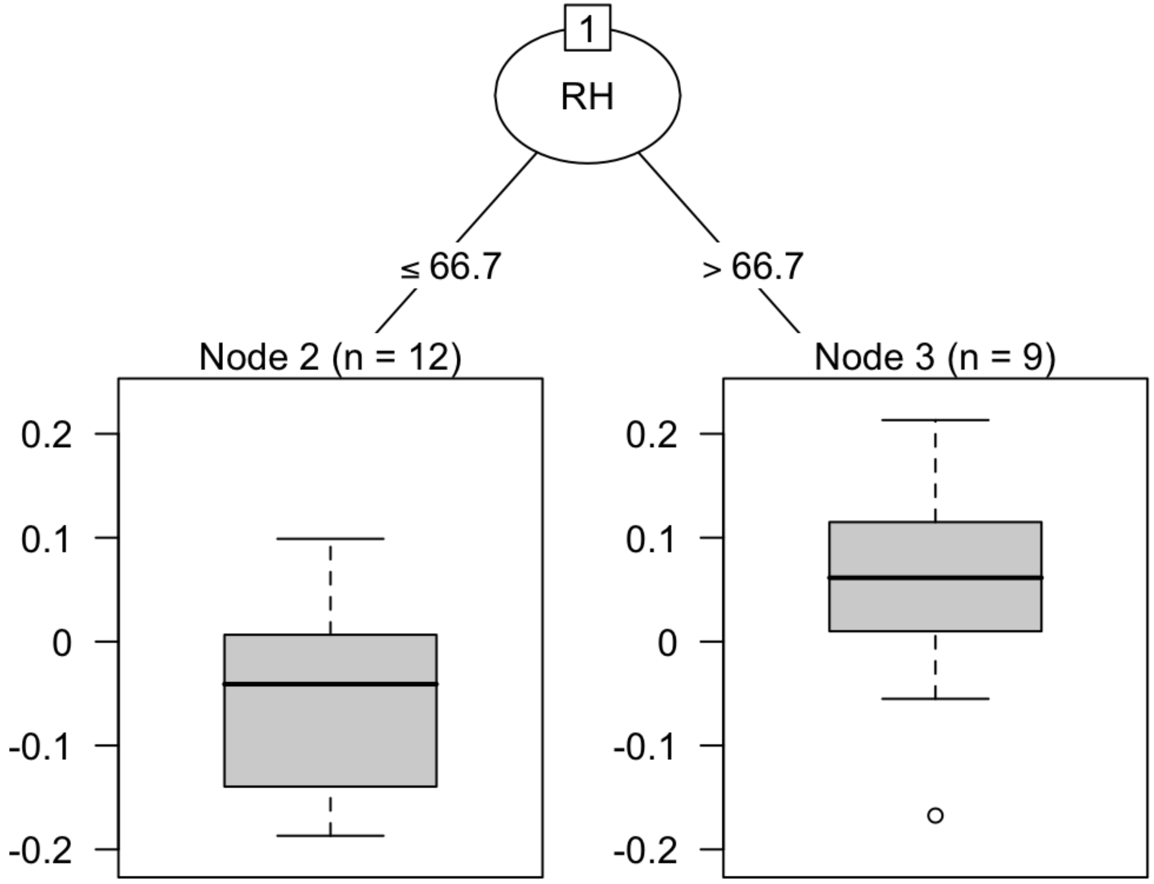
THI = Temperature humidity index of April

DRY = Dry spells (number of dry days) of April

RH = Relative humidity of April

PREC = Precipitation of April

Analysis of effects of climate on ewe milk



(average value)	Node 2	Node 3
FAT	-0.05	0.04
Precipitation (mm)	47	69
Relative himidity (%)	63.7	70
Minimum temperature (°C)	8.8	9.5
THI	17.88	17.83
Maximum temperature (°C)	18.8	18.5
Dry spells	23.6	19.1

Conclusions

In our case study conditions

- ✔ The reduction of ewes' milk production in spring is related to weather conditions
- ✔ Precipitation in April can mitigate the reduction
- ✔ Weather conditions lead to an increase of fat content in milk (feeding management)
- ✔ To enhance resilience of dairy sheep farms we need to explore more the relation with climate

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LinkedIn

THANK YOU
FOR YOUR ATTENTION

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