GenTORE

Genomic management Tools to Optimise Resilience and Efficiency

'Farm system characterization across Europe, and climate change impacts on farm system resilience

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Dairy in Europe with climate change

• Winners:
  – nordic countries and alpine regions

• Loser
  – Italy, France, Northern Spain, Hungary, lowland Poland
Resilience of European dairy?

• Most European dairy systems are forage based
• Climate change will/is already impacting forage production
• Impacts likely to vary according to climatic region and farm system
• We aimed identify area in which current farming system will be mostly under pressure from climate change
Methodology

FADN data (EU-FADN – DG AGRI, 2019) – farm level data

Gridded Agro-Meteorological data (AGRI4CAST)

Climate classes

Dairy productivity model

Dairy productivity prediction

Global Agro-Ecological Zones (GAEZ) agro-potential data (FAO, 2012)
For scenario Hadley CM3 model with SRES A2 scenario
Estimation equation

- **PROD** = \(\text{forage}_\text{bl}*a + \text{non}_\text{fodder}_\text{bl}*b + \text{ce}_\text{conc}_\text{ha}*c + \text{ce}_\text{coarse}_\text{ha}*d + \text{ce}_\text{mach}_\text{ha}*e + \text{ce}_\text{oth}_\text{ha}*f + i.\text{cl}*g + \text{constant}\)

  Where
  - **PROD** is the production of milk (kg) per forage hectare,
  - \(i.\text{class}\) the climatic class \(cl\) (a fixed effect to account for major differences in the “technology” across different regions),
  - **forage_bl** is the forage yield (individual weight for maize, pasture, grass legume, alfalfa)
  - **non_fodder_bl** is the home-grown non-fodder costs,
  - **ce_conc_ha** is the purchased concentrate costs,
  - **ce_coarse_ha** is the purchased fodder costs,
  - **ce_mach_ha** is the maintenance costs
  - **ce_oth_ha** are the other costs.
Forage productivity (ton DM ha$^{-1}$)

Yield (ton/ha)
- 5 to 0
- 0 to 5
- 5 to 10
- 10 to 15
- 15 to 20

Based on:
agro-ecological potential from GAEZ v3
HadCM3 model SRES A2 scenario assuming Rainfed high intensity production
Milk productivity (kg ha$^{-1}$)

Baseline Milk productivity baseline
- 3,735
- 7,758
- 10,028
- 11,955
- 27,287
- Missing

2030 Milk productivity change (%)
- -17
- -1
- 1
- 3
- 17
- Missing

2050
Results

• Some regions are expected to suffer reduced forage productivity and therefore milk productivity – Southern areas, especially France, Italy, but also Hungary in the East

• However, Northern regions and upland areas can expect to see improved productivity, through higher forage yields
Discussion & Conclusions

• Results provide an indication of priority regions for system re-design – red warning lights

• Mitigation options
  – Adapt forage crop choice to suit the future environment
  – When farmers utilize the highest yielding forage crops for their region that their productivity can remain above their current levels in virtually all regions and farm types (though of course there may be local difficulties in achieving this).

• Limitation
  – other factors such as the potential of more erratic weather and damaging heatwaves
=> Need to adapt livestock productions systems as a whole.
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THANK YOU FOR YOUR ATTENTION!

https://www.gentore.eu/

This project has received funding from the European Union’s Horizon 2020 research and innovation program under Grant Agreement No 727213
References

- **EU. (2019b).** "Nomenclature of Territorial Units for statistics." from https://ec.europa.eu/eurostat/web/nuts/background
Predicted milk yield per climate class

![Graph showing predicted milk yield per climate class for different periods (A: Baseline, B: Mid-term, C: Long-term) for different climate classes (NAT, WAT, BOR, CEN, SCEN, MED, AUPL, CUPL, MUPL).]
How to describe environments?

• We all have an understanding of the production environment, but how did we describe it?
  – Climatic environment zone
  – Forage type – grass, maize, forage crops?
  – Concentrate feeding level and type

• How to define this production environment in a consistent way?
## Nine environmental zones across Europe

<table>
<thead>
<tr>
<th>Classes</th>
<th>Description</th>
<th>tmax_summ</th>
<th>tmin_wint</th>
<th>sd_tavg</th>
<th>dry (days 0-1mm)</th>
<th>Rainfall (mm/d)</th>
<th>Milk prod/cow (2010-2013)</th>
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<tr>
<td>1</td>
<td>North Atlantic</td>
<td>18.3</td>
<td>2.7</td>
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<td>6075</td>
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<td>2</td>
<td>West Atlantic</td>
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<td>1.7</td>
<td>6.1</td>
<td>241.2</td>
<td>2.1</td>
<td>7450</td>
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<tr>
<td>3</td>
<td>Boreal</td>
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<td>-9.6</td>
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<td>252.2</td>
<td>1.7</td>
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<td>5.3</td>
<td>6.6</td>
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<td>7</td>
<td>Atlantic Mountain</td>
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<td>8</td>
<td>Central Mountain (Alpine)</td>
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<td>7.7</td>
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<tr>
<td>9</td>
<td>Mediterranean Mountain</td>
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<td>6.9</td>
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<td>1.9</td>
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</tbody>
</table>
T1.1. Database development

Indicators:
- “Yes”
- “No”
- UAA: sum of cropping and forage area
- TG_PP/RG%: % of UAA that is Temp. Grass, Permanent Pasture and Rough Grazing

FADN farm database.
Cattle farm types: 45, 49, 70, 80 selected

- Dairy specialisation rate >35%?
- Beef specialisation rate >35%?
- Suckler cows >5?
- Weaned calves >75% of beef sales?

Dairy farms

Diverse farms excluded from analysis

Beef Fattener farms

Beef Breeder/Fattener farms

Beef Breeder farm farms

Dairy farms

Climate zone class

- N Atlantic
- W Atlantic
- Boreal
- Continental
- Mediterranean
- Upland Atlantic
- Upland Continental
- Upland Mediterranean

Altitude zones

- Lowland (0-600m)
- Upland (600m+)

Basic farm types

- Intensive/Industrial
- Grass
- Grass mixed
- Mixed
- Intensive Mountain
- Mountain

GLU/forage ha >=5?

TG_PP/RG% >80%?

TG_PP/RG% 50%?

GLU/forage ha >=5?
Detailed farm typology

This project has received funding from the European Union’s Horizon 2020 research and innovation program under Grant Agreement No 727213
Why describe environments?

- The production environment strongly influences gene expression – G*E interaction
- Two Swiss dairy systems...

Source: Ian Grant

Source: Stefan Wermuth