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Modelling the management of heat stress in permanently housed dairy farms

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OptiBarn

Objective

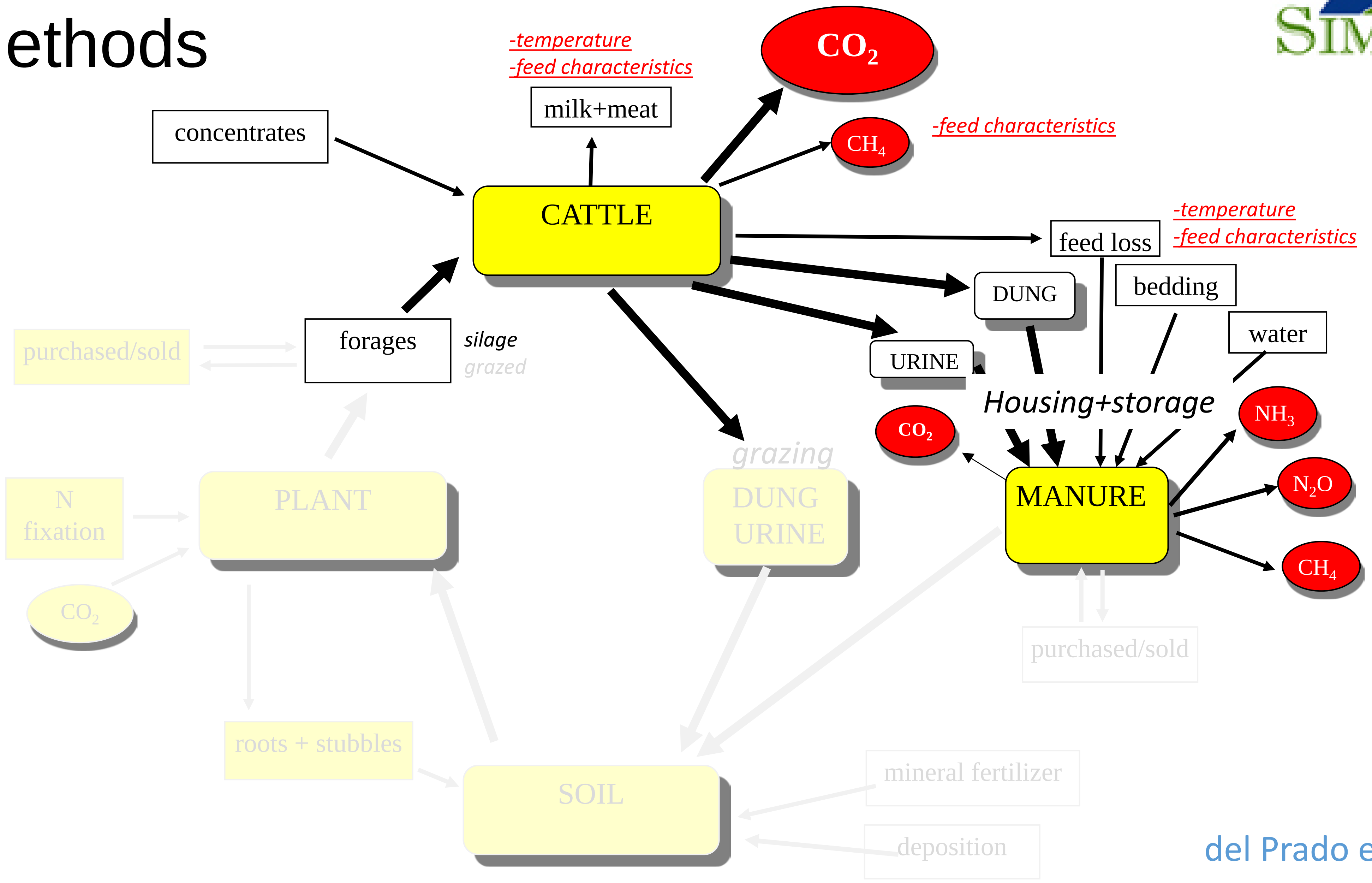
- **How effective and practical are the optimisation approaches?**

Fully housed!

- In the framework of the ERANET+ project OptiBarn our aim is to assess three potential impacts of climate change at **farm-scale** in dairy cow systems: welfare, economic costs and emissions

- Today: **How we build the baseline scenario to introduce the climatic effects on dairy farms and apply in future barn modification effects?**

Methods

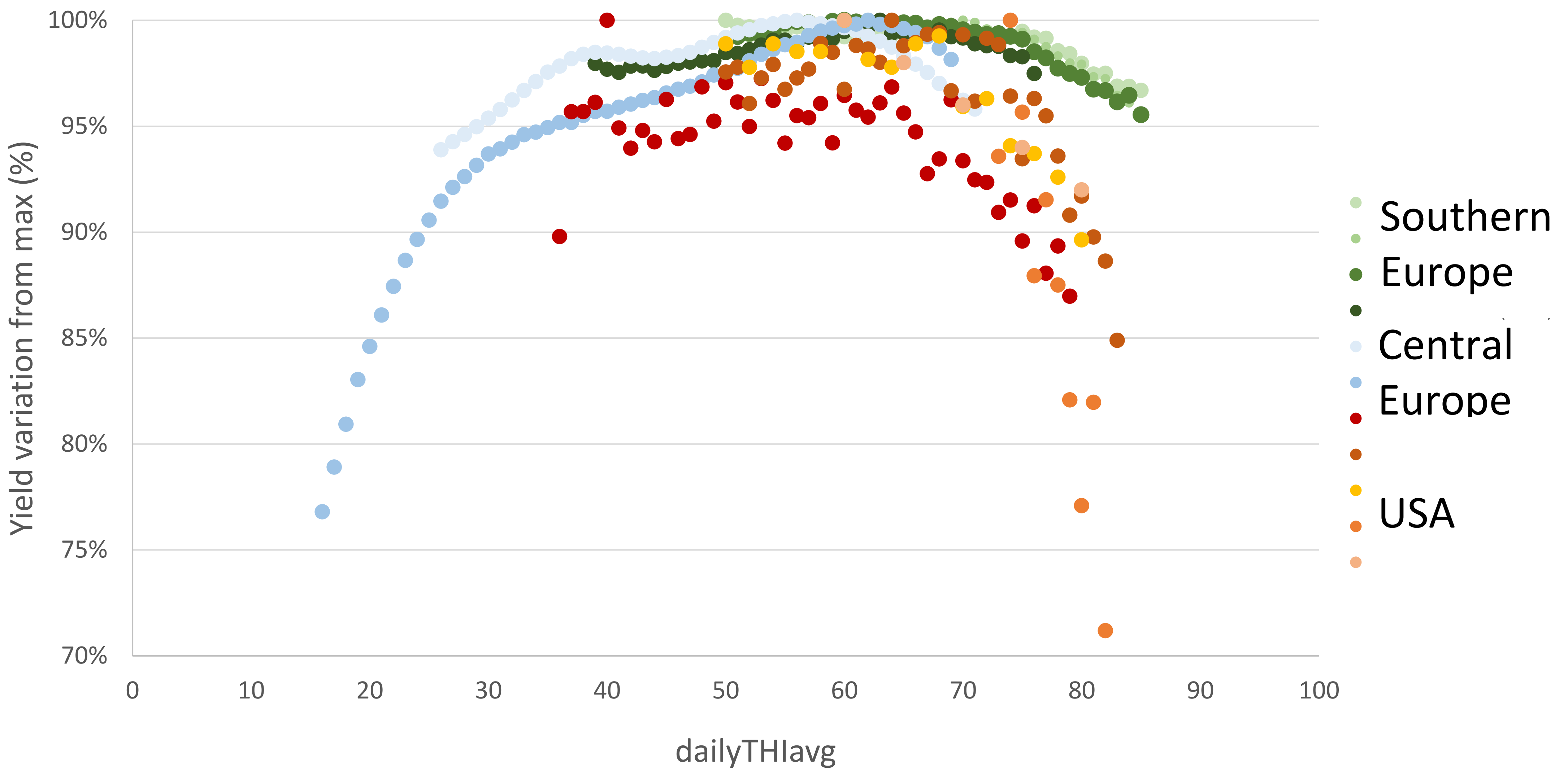


del Prado et al. (2013)

Methods

- Review to quantify impacts of heat stress at farm scale:
  - Milk yield:
    - Meta-analysis: St-Pierre et al. (2003)
    - Regression models:…
    - Case study: Lack of data (only slot, DIM and milk yield, no parity, diet, etc)
  - Lengthen calving intervals
    - Meta-analysis: St-Pierre et al. (2003)
    - Regression models:…

Effect of THI in yield of permanent housed dairy systems



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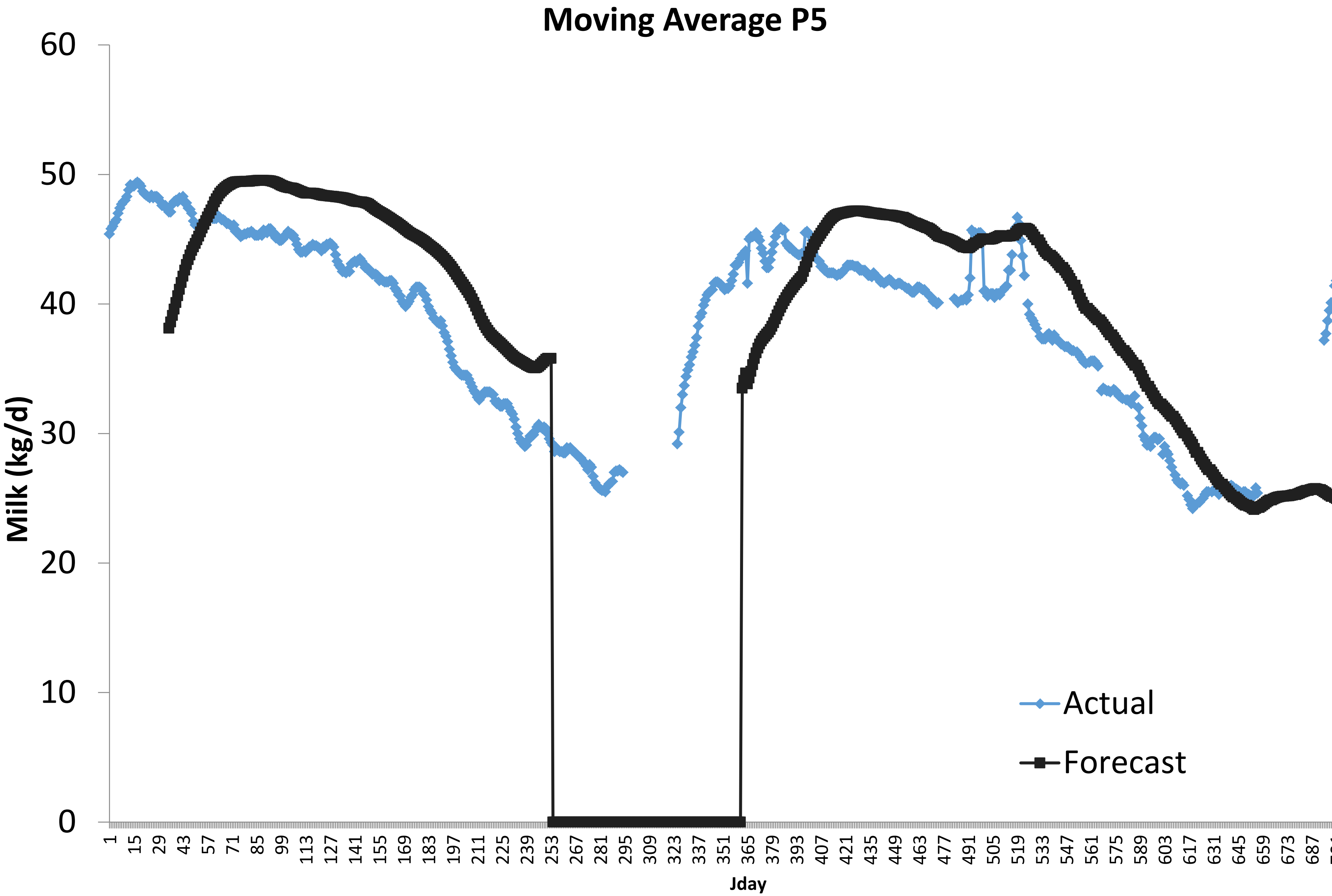
    - Regression models:…
    - Case study: Lack of data (only slot, DIM and milk yield, no parity, diet, etc). **Let's see some descriptive statistics**
  - Lengthen calving intervals
    - Regional scale models: St-Pierre et al. (2003)
    - Farm scale regression models:…

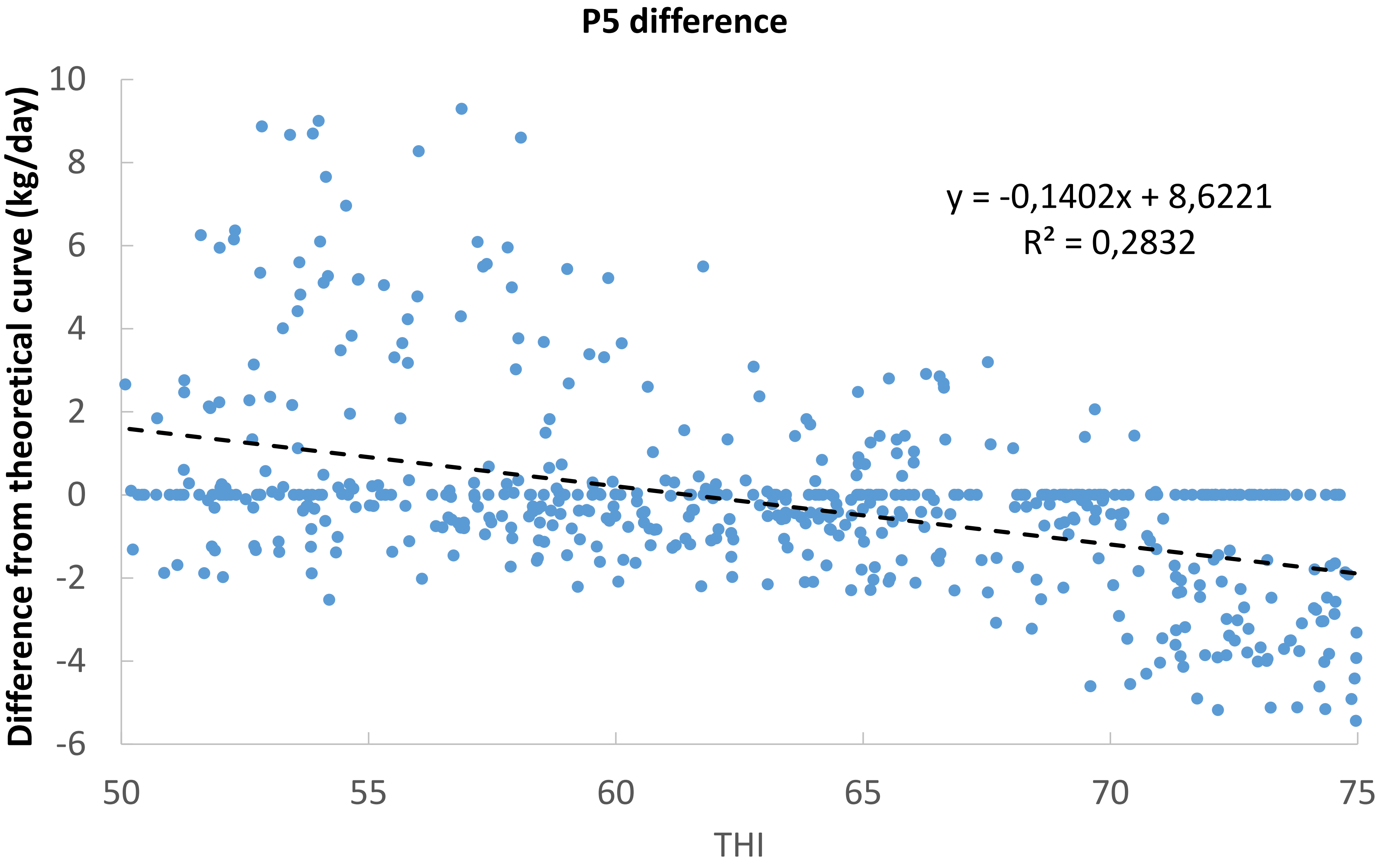
With commercial data…

We calculated a theoretical lactation curve per each slot using moving averages of 5 weeks and then calculated the daily difference between the theoretical and the real



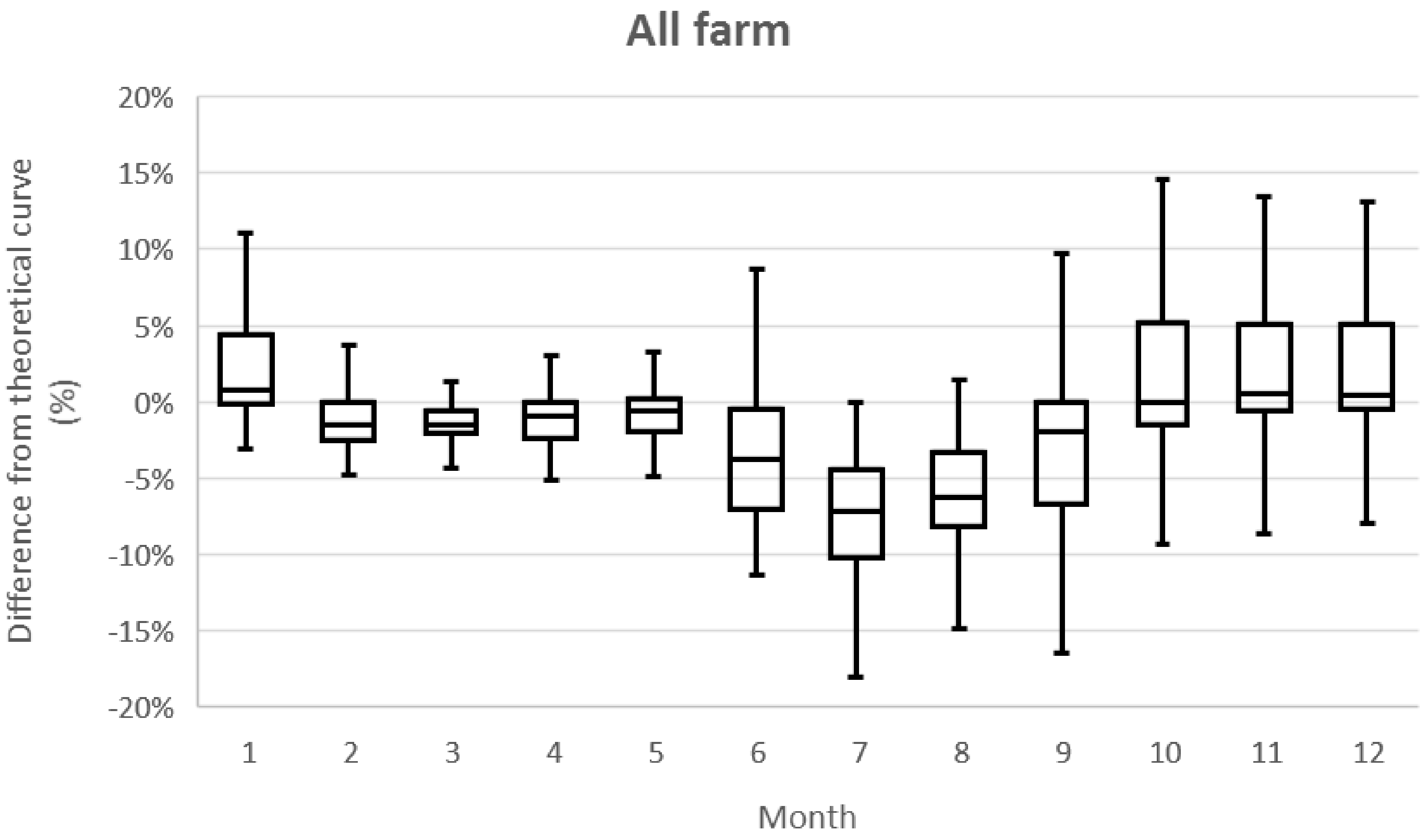
With commercial data…

We plotted the difference with the daily THImean of the correspondent day (weaker relation for 2 or 3 days before THI)



With commercial data…

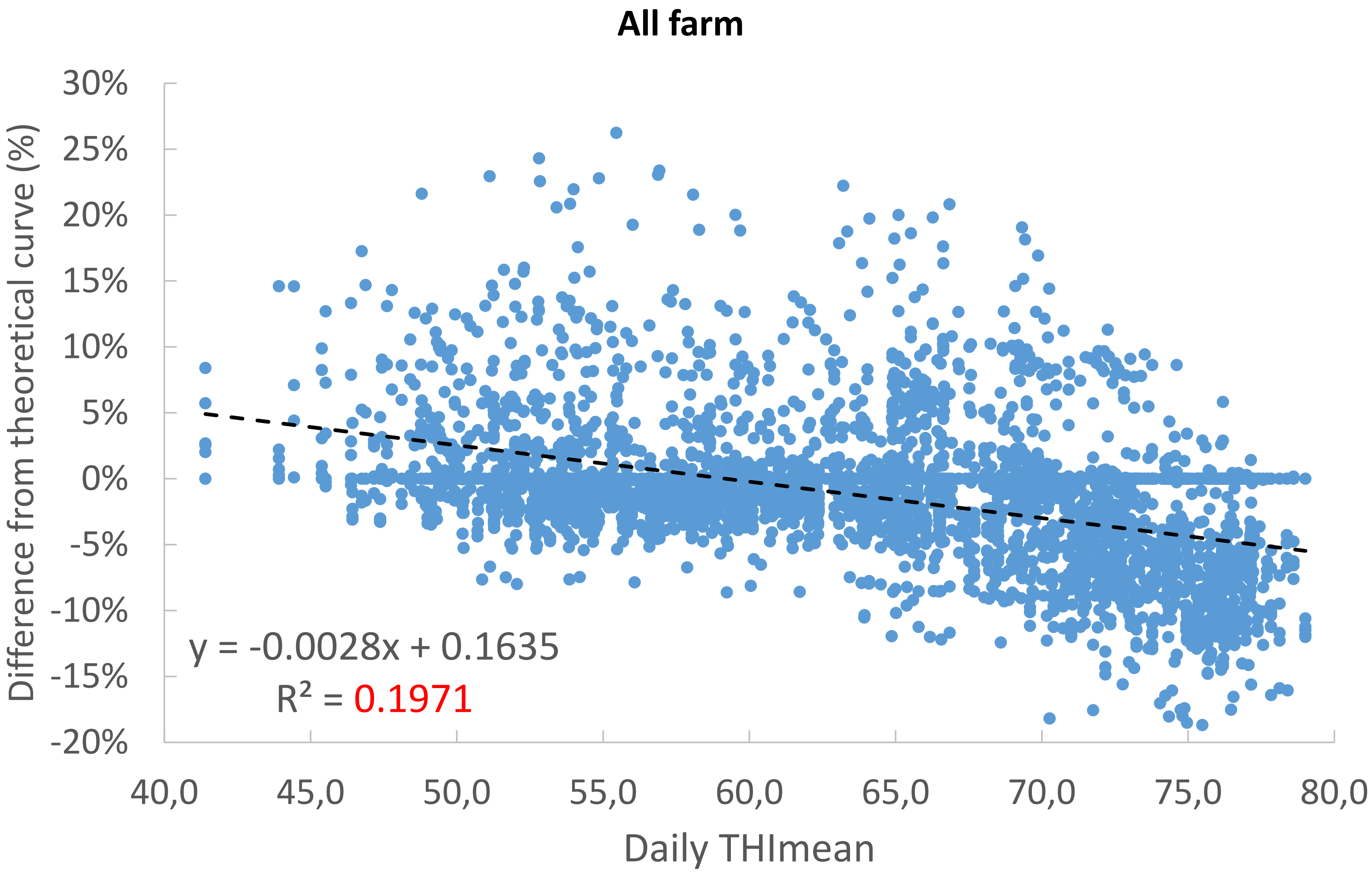
There is a trend for the entire farm…

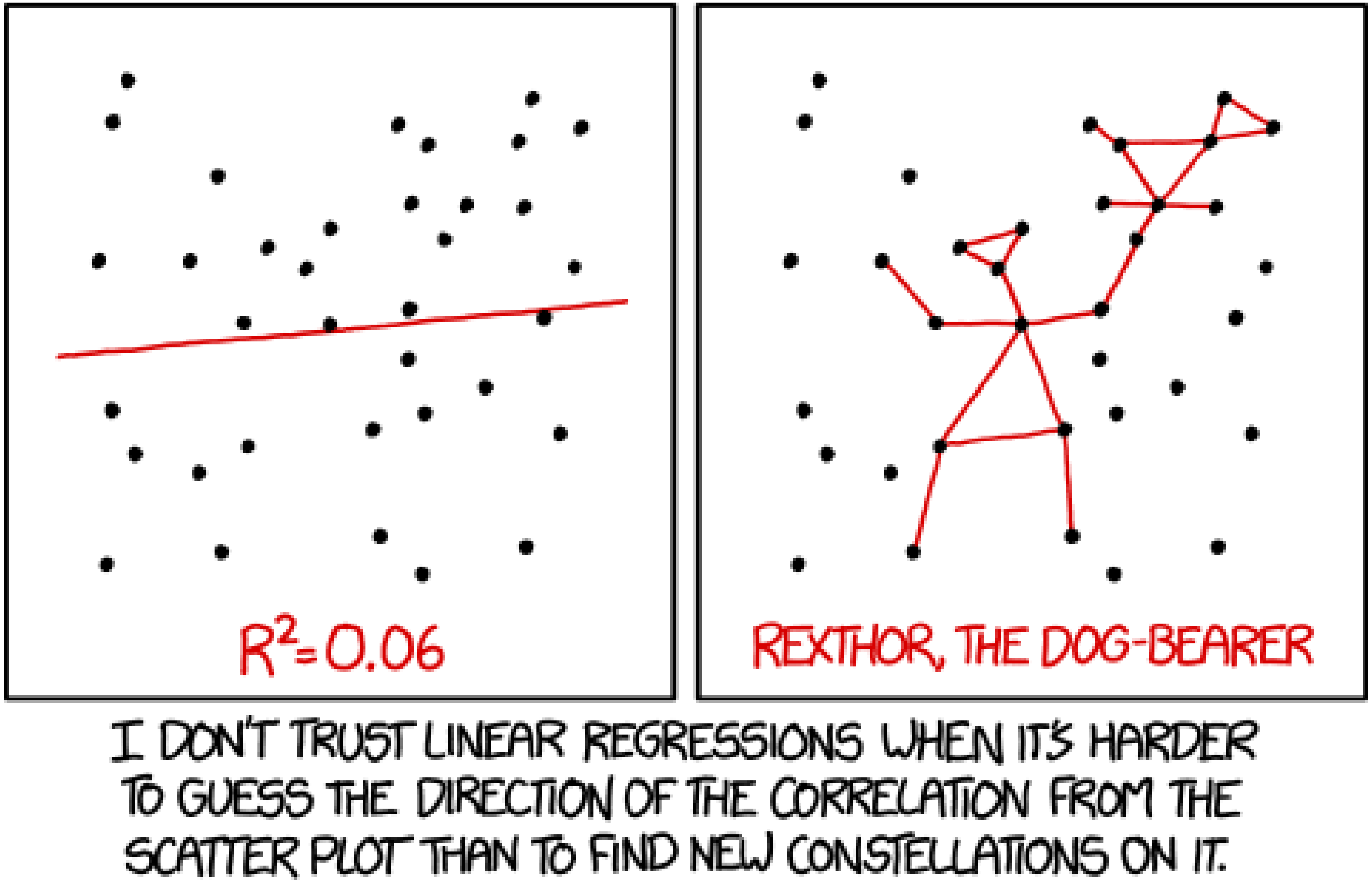


With commercial data…

…but other factors are missing…

(and more information)





http://imgs.xkcd.com/comics/linear_regression.png

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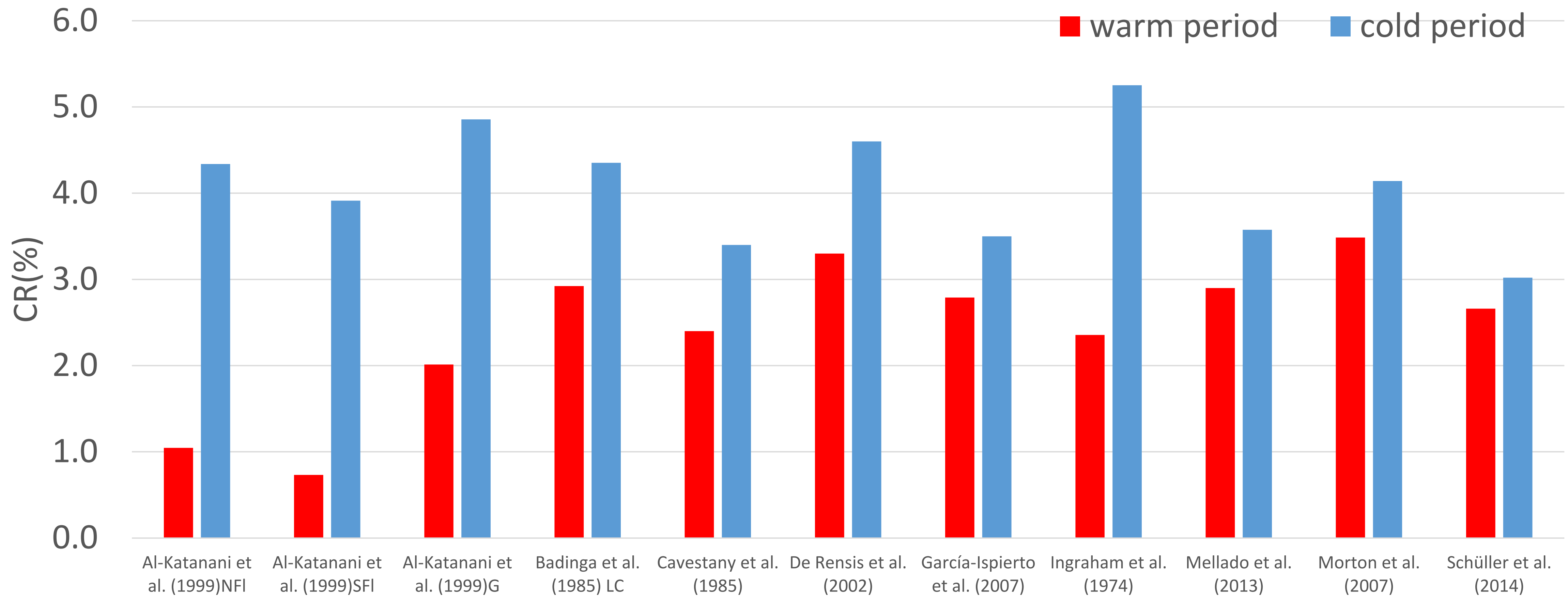
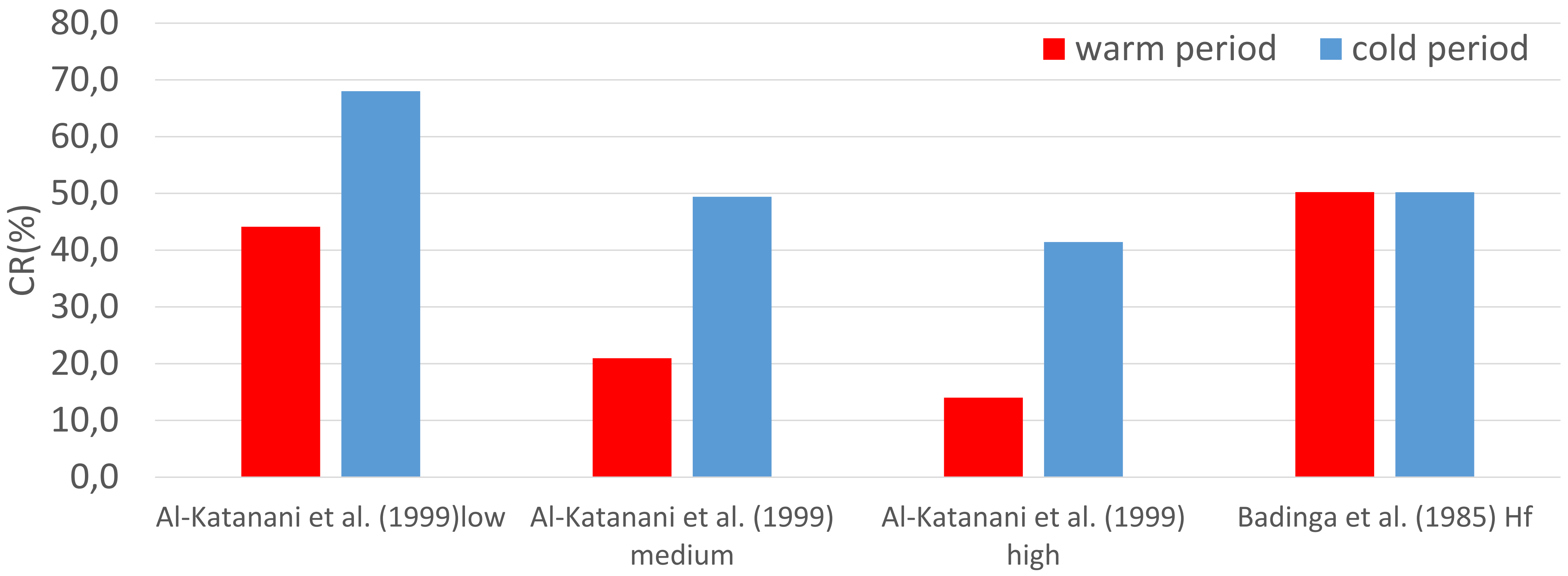
Conception rate in warm vs. cold period



Average difference: 18.8%±10.9%*

8.8%± 3.8%

Conception rate depending on cow variability



Initial scenario: methods

- Daily **THI**: 1 year (2008) data from Valencia airport (AEMET)
- Yield loss, Days Open: St-Pierre et el. (2003)
- Monthly **prices**: 1 year (2008) for Spain (Milk market observatory, 2016)
- Simulated farm: 1000 cows, 12 slots.
- Scenarios

  "**BAU**": without the module of heat stress

  "**Heat stress**": including heat stress

  "**Seasonality**": HS+ not breeding in jul, aug, sep to maximize milk yield and minimize breeding costs (data from González-Recio et al. (2004)

Initial scenario: southern Spain

Cubicles, straw bedding

Nº cows:100

Followers: 65

Lactations: 2.6

Calving interval: 365

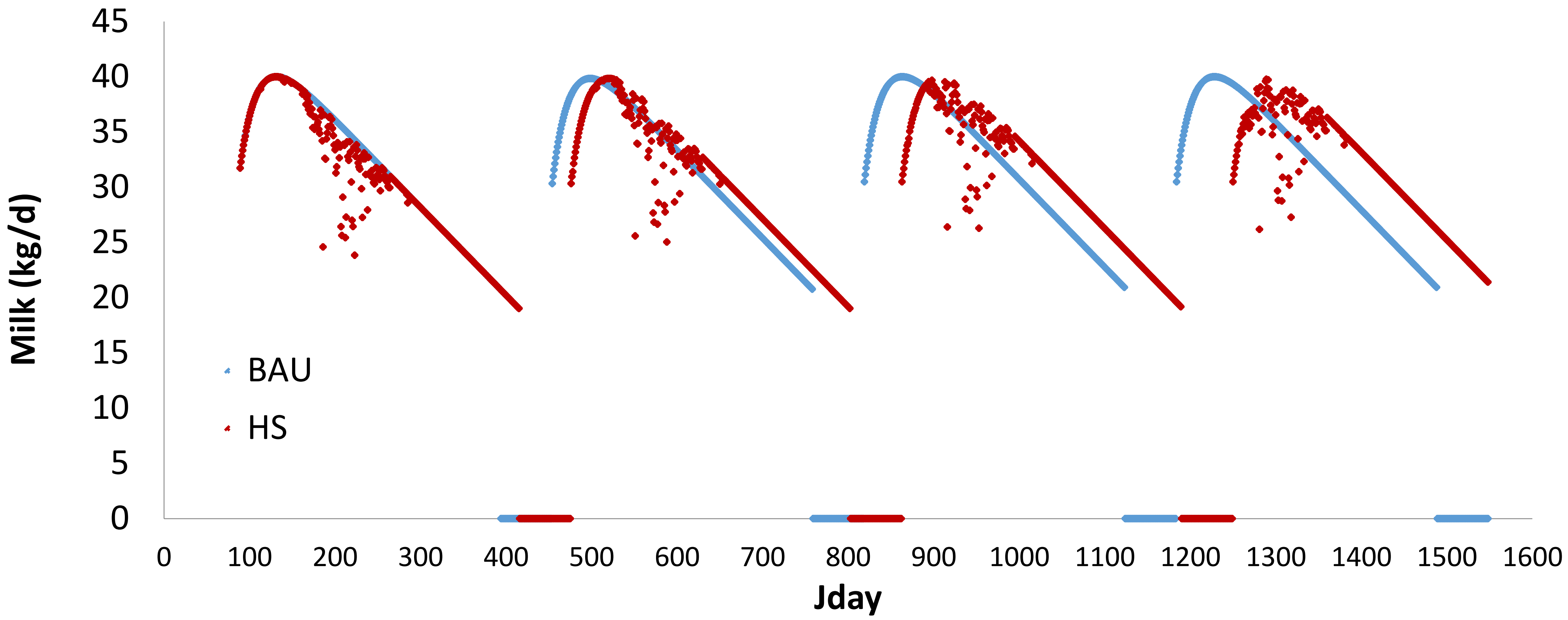
Milk average per cow: 9500

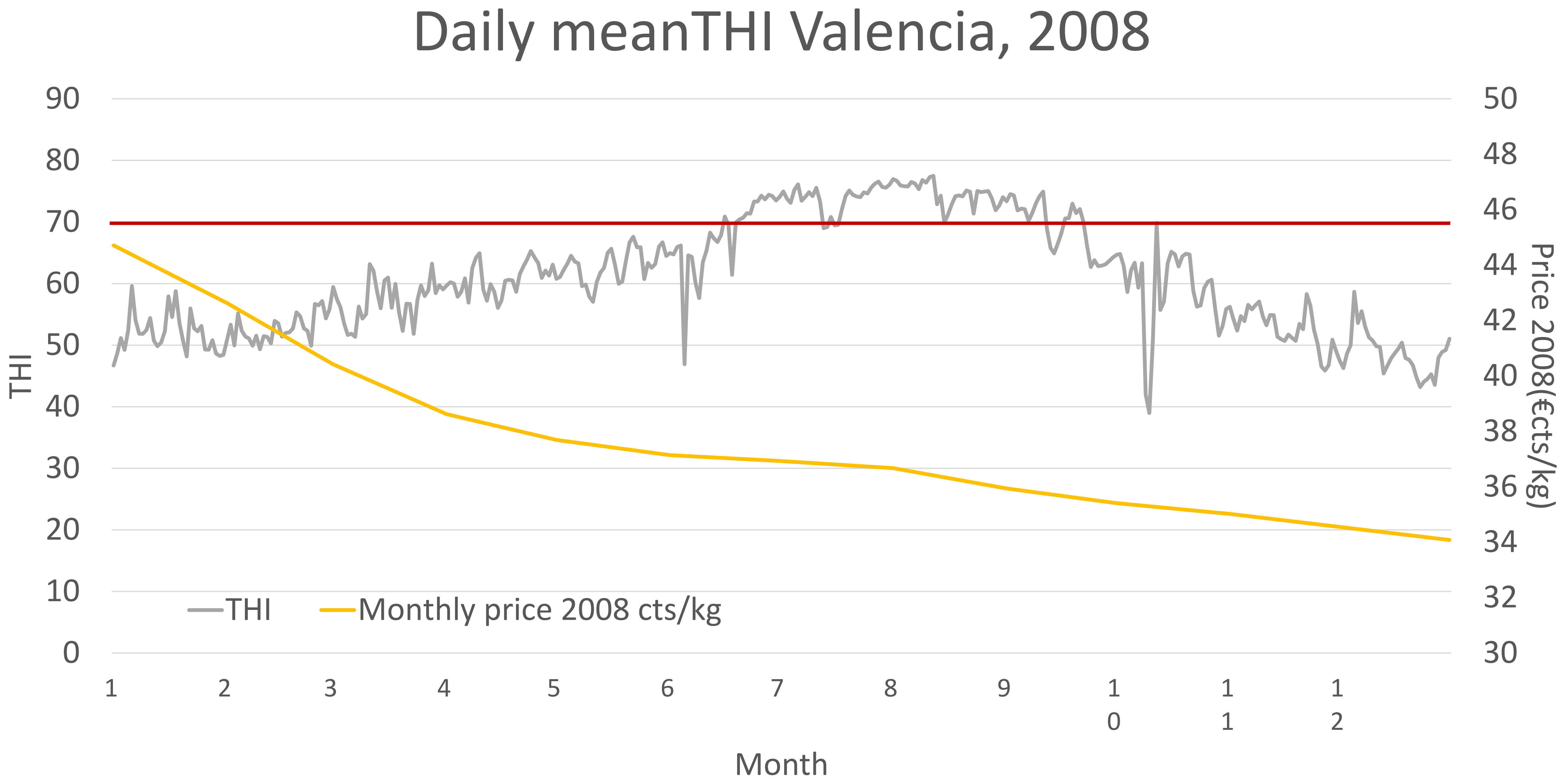
Surface excreta: 400 m2

Days slurry in storage: 45

Annual production in a 4 years base

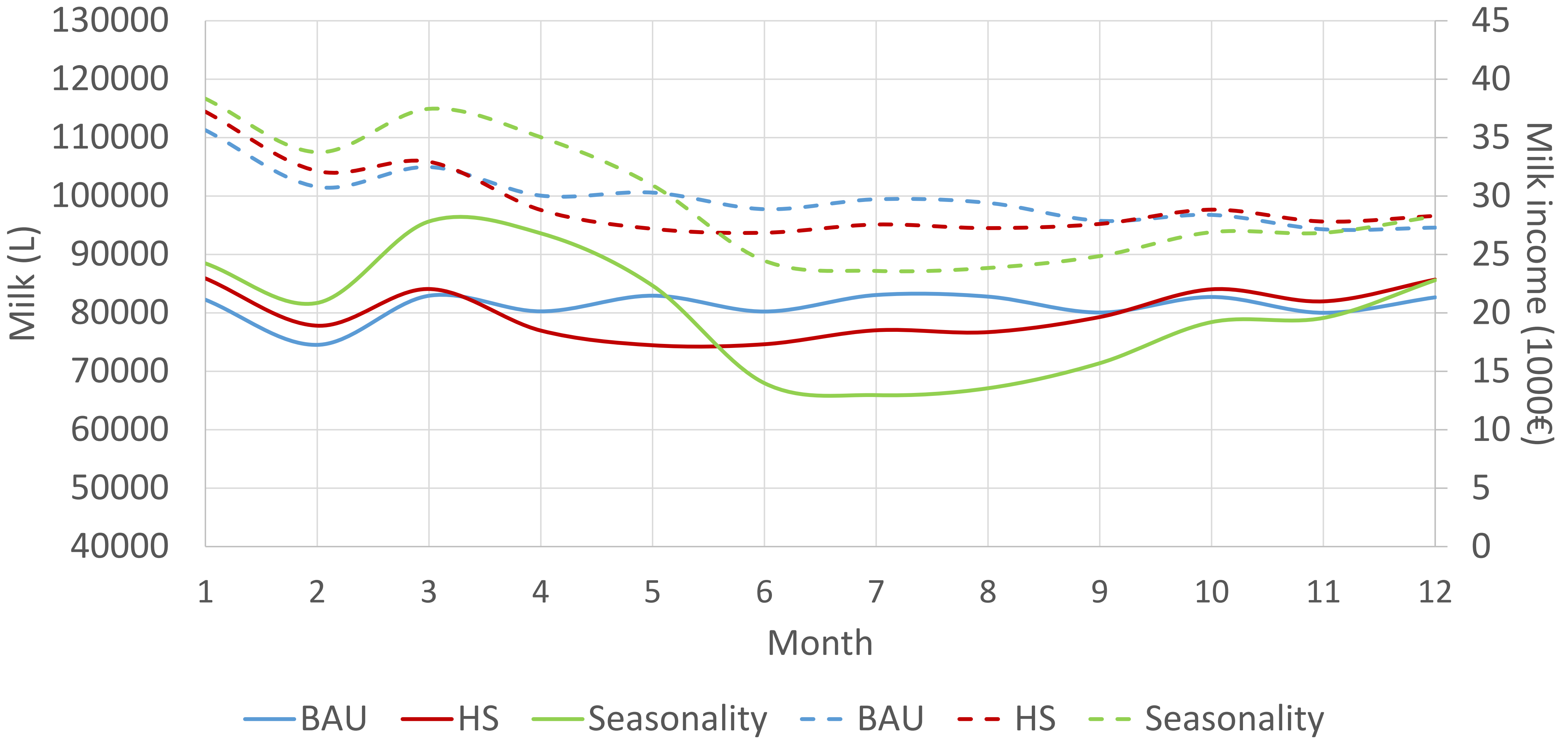
Modification of lactation curves in HS scenario: example for a slot starting in March





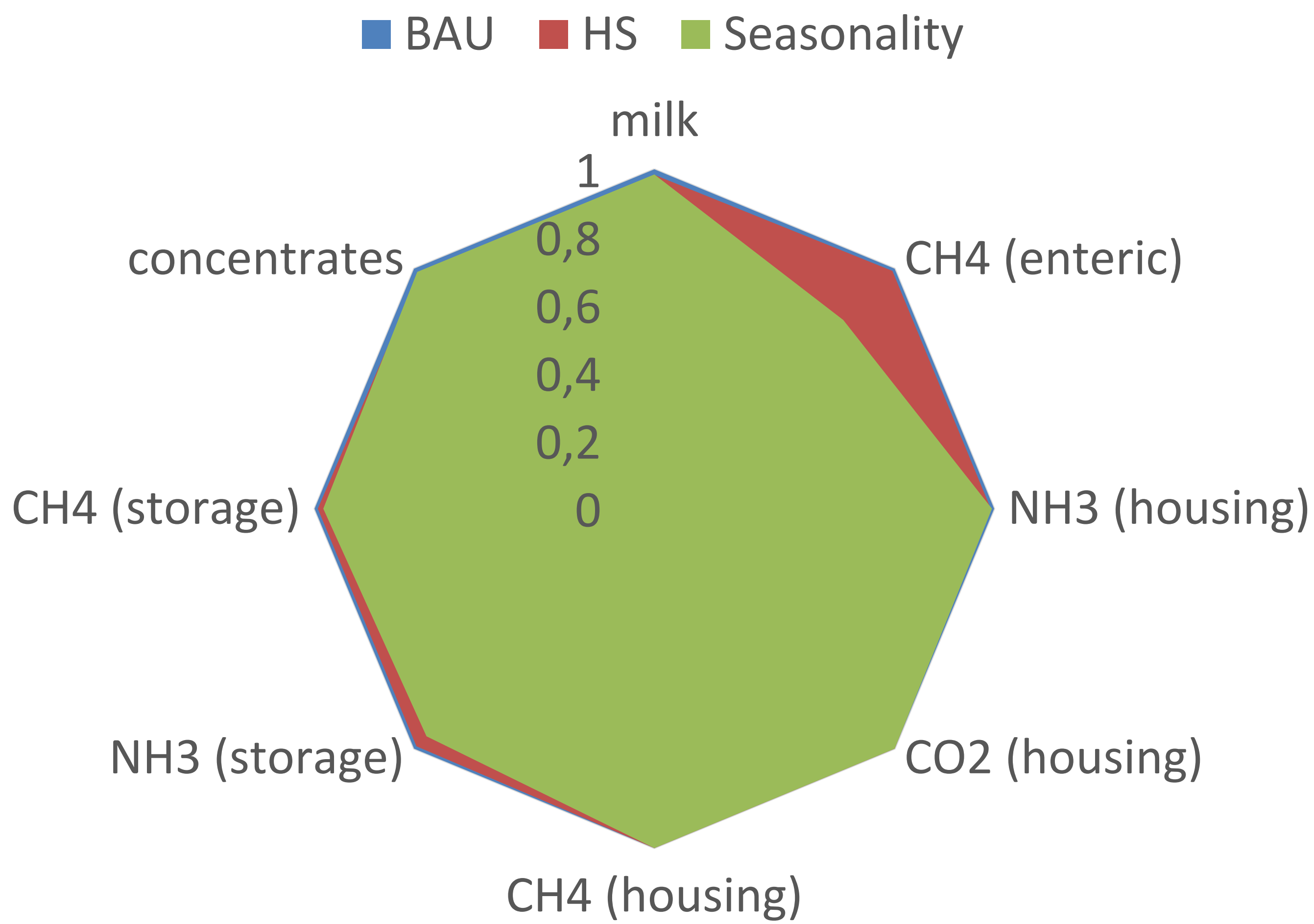
Daily meanTHI Valencia, 2008
90
80
70
60
50
40
30
20
10
0
THI
50
48
46
44
42
40
38
36
34
32
30
Price 2008(€cts/kg)
THI
Monthly price 2008 cts/kg
1
2
3
4
5
6
7
8
9
10
11
12
Month

Farm production scenarios in southern Spain



Source: AEMET, St-Pierre et al. (2003) and Milk market observatory (2016)

Comparison of farm production scenarios in southern Spain



Results

- Introducing the influence of Temperature and Humidity in the model had an effect of decreasing 1.63% total milk yield and lengthen by 6 days the Calving Interval.
- Seasonality scenario produces annually 0.11% more milk than the scenario without seasonality because cows exposed to highest THI are either dry or in late lactation.
- Prices in the year selected dropped down during the year. Hence, the difference of annual farm income increases up to 0.50 % when combined with the effect on fat and protein percentages losses.
- The main difference between scenarios was the CH4-enteric, which was 20% lessin total in seasonality scenario.
- To create a cool environment the barn should be able to decrease by 4 points the outdoor THI in Jul and Aug. However we are not taking into account indoor conditions.

Conclusion

- The effects of heat stress effects are minimal when we applied St-Pierre et al. (2003) equations to our modelling. In this case St-Pierre et al. (2003) need to be adjusted with real data.
- Herd management techniques such as seasonality on calving could reduce the effects of heat stress in milk yield at farm scale. Hence, we need to design scenarios to simulate the combined effect these (and other) common techniques

Future research

- Apply the simulations for Optibarn scenarios. We need outdoor-indoor climate relationship (Hempel et al. (forthcoming)) and indoor temperature-emissions relationship (Sanchís et al. (forthcoming))
- Develop an ‘Uncertainties module’ attached to the modelling framework
- Future scenarios are needed to predict the effects of climate change in farm economy, welfare, death rates and farm emissions
- Future scenarios may include also the drought effects in grasslands

Thanks for your attention!!!