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DEPARTMENT OF
AGRICULTURE, FOOD
ENVIRONMENT AND FORESTRY



Genetic correlations between feed intake and **GHG emissions** measured on young bulls with **production** and reproduction traits measured in Italian Holstein cows.

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Phenotypic information - Bulls.



220 bulls:



- "Morpho" data



- "Feed Intake" data



- "Green" data



Roughage Intake Control system



GreenFeed system

Phenotypic information - Cows.



- **Milk yield and components**
- **Conception rate**
- **Predicted methane emissions**



The traits.

Bulls:

- CH₄ emissions
- CO₂ emissions
- Feed intake
- Morpholinear traits

Cows:

- Milk Yield
- Fat Yield
- Protein Yield
- Conception rate
- Methane emissions (predicted)

The problem.

**The breeding goal traits cannot be measured
on the same animals**

The problem.

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on the same animals**



**The trade-off could be assessed at the population
level
in terms of genetic progress achievable**

The estimation.



The estimation.



The traits.

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- CO₂ emissions
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Cows:

- Milk Yield
- Fat Yield
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- Methane emissions (predicted)

Estimates of genetic correlation.

Bulls:

- CH₄ emissions
- CO₂ emissions
- Feed intake
- Morpholinear traits

0.30

Estimates of genetic correlation.

Bulls:

- CH₄ emissions
- CO₂ emissions
- Feed intake
- Morpholinear traits

0.50 – 0.90



Estimates of genetic correlation.

Bulls:

- CH₄ emissions
- CO₂ emissions
- Feed intake
- Morpholinear traits

0.40

Cows:

- Milk Yield
- Fat Yield
- Protein Yield
- Conception rate
- CH₄ emissions (predicted)

Estimates of genetic correlation.

Bulls:

- CH₄ emissions
- CO₂ emissions
- **Feed intake**
- Morpholinear traits

0.25

Cows:

- **Milk Yield**
- Fat Yield
- Protein Yield
- Conception rate
- CH₄ emissions
(predicted)

Estimates of genetic correlation.

Bulls:

- CH₄ emissions
- CO₂ emissions
- Feed intake
- Morphological traits

0.50

Cows:

- Milk Yield
- Fat Yield
- Protein Yield
- Conception rate
- CH₄ emissions
(predicted)

Estimates of genetic correlation.

Bulls:

- CH₄ emissions
- CO₂ emissions
- **Feed intake**
- Morpholinear traits

~0.00

Cows:

- Milk Yield
- **Fat Yield**
- Protein Yield
- Conception rate
- CH₄ emissions
(predicted)

Estimates of genetic correlation.

Bulls:

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- Morpholinear traits

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- **Protein Yield**
- Conception rate
- CH₄ emissions
(predicted)

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- Fat Yield
- Protein Yield
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(predicted)

Estimates of genetic correlation.

Bulls:

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- Feed intake
- Morphological traits

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Cows:

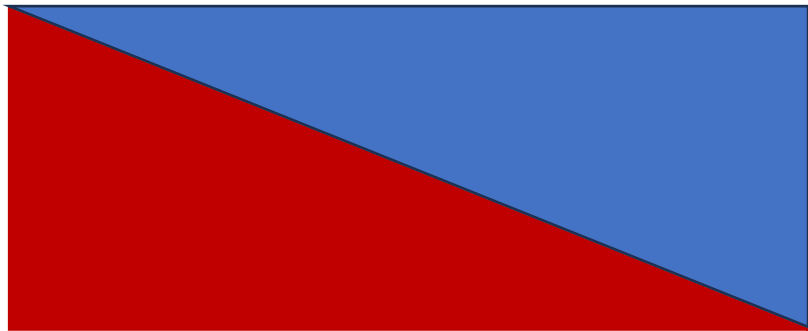
- Milk Yield
- Fat Yield
- Protein Yield
- Conception rate
- CH₄ emissions (predicted)

Selection response.

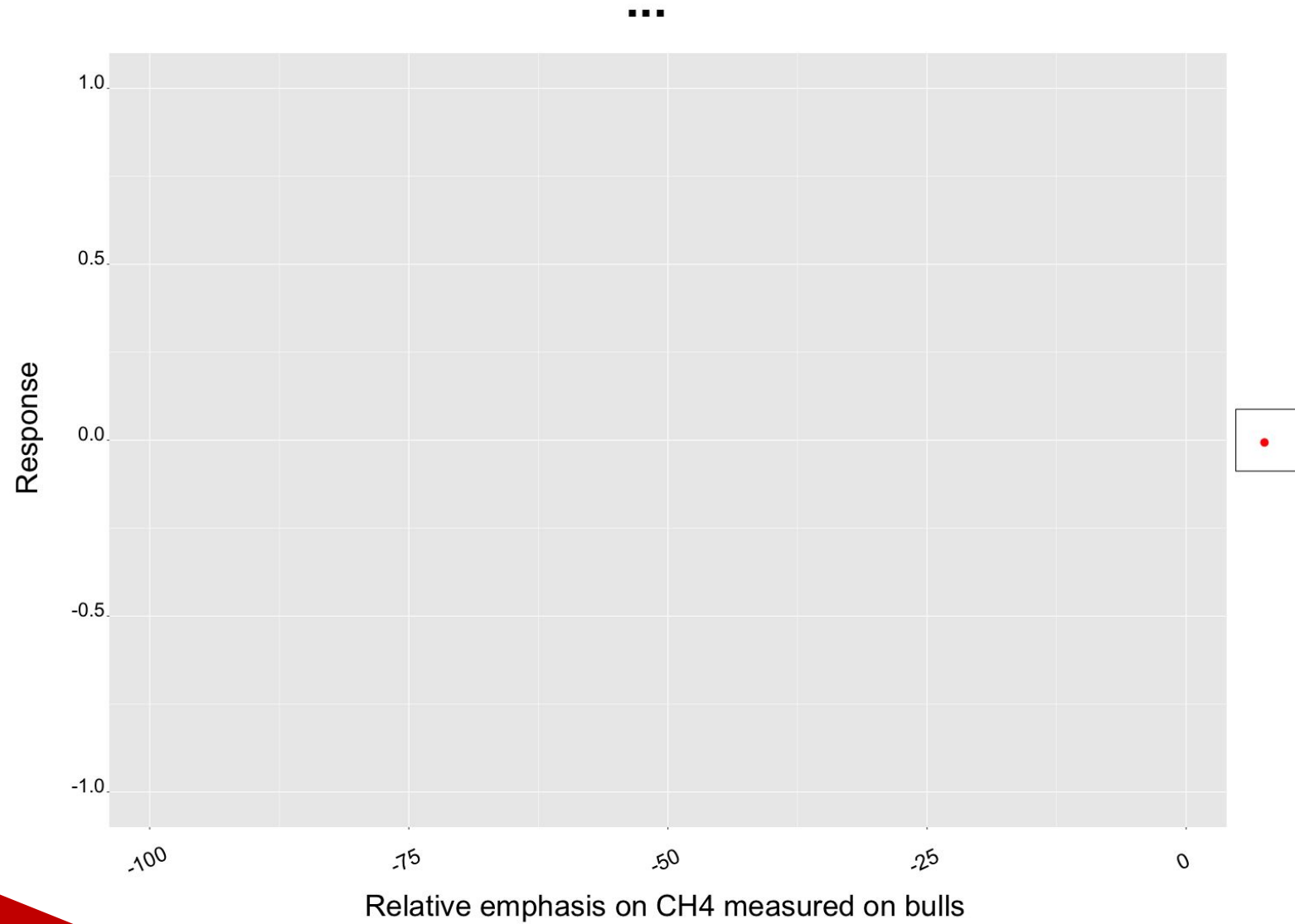
Scenario 1:

- **CH₄ emissions** measured on bulls
- **Fat Yield** measured on cows

Emphasis on Fat Yield - cows

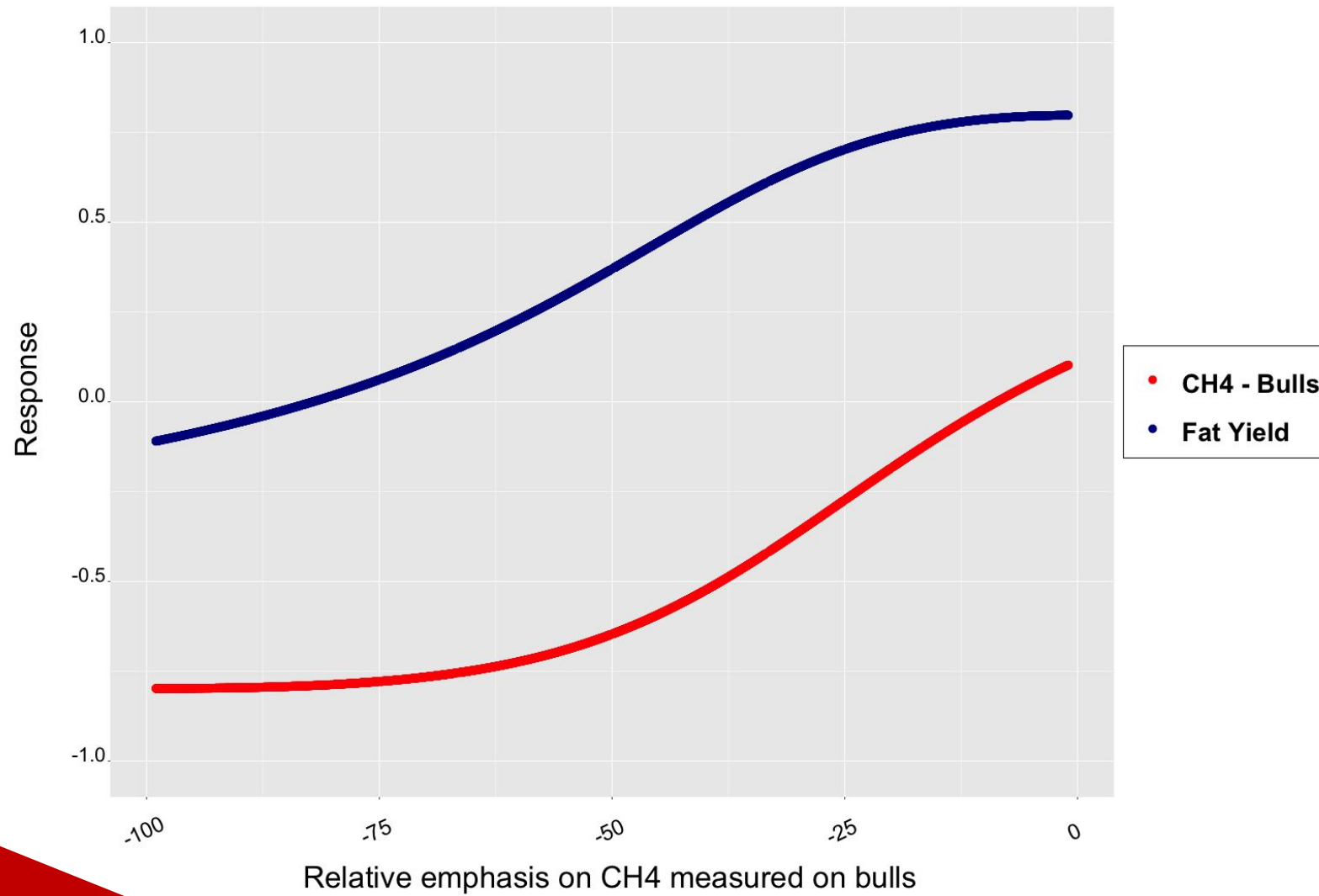


Emphasis on bulls' CH₄



Emphasis on bulls' CH₄

Scenario 1



Emphasis on bulls' CH₄

Selection response.

Scenario 1:

- **CH₄ emissions** measured on bulls
- **Fat Yield** measured on cows

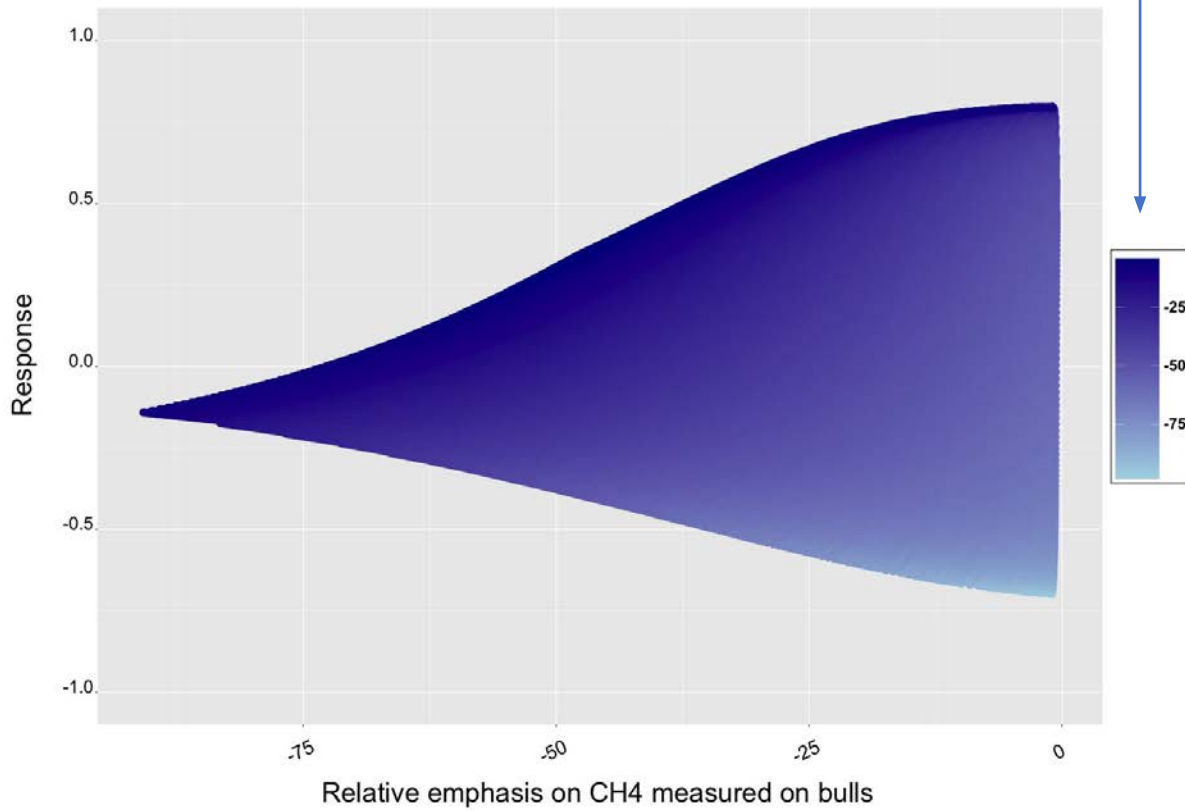
Scenario 2:

- **CH₄ emissions** measured on bulls
- **Fat Yield** measured on cows
- **CH₄ emissions** predicted for cows



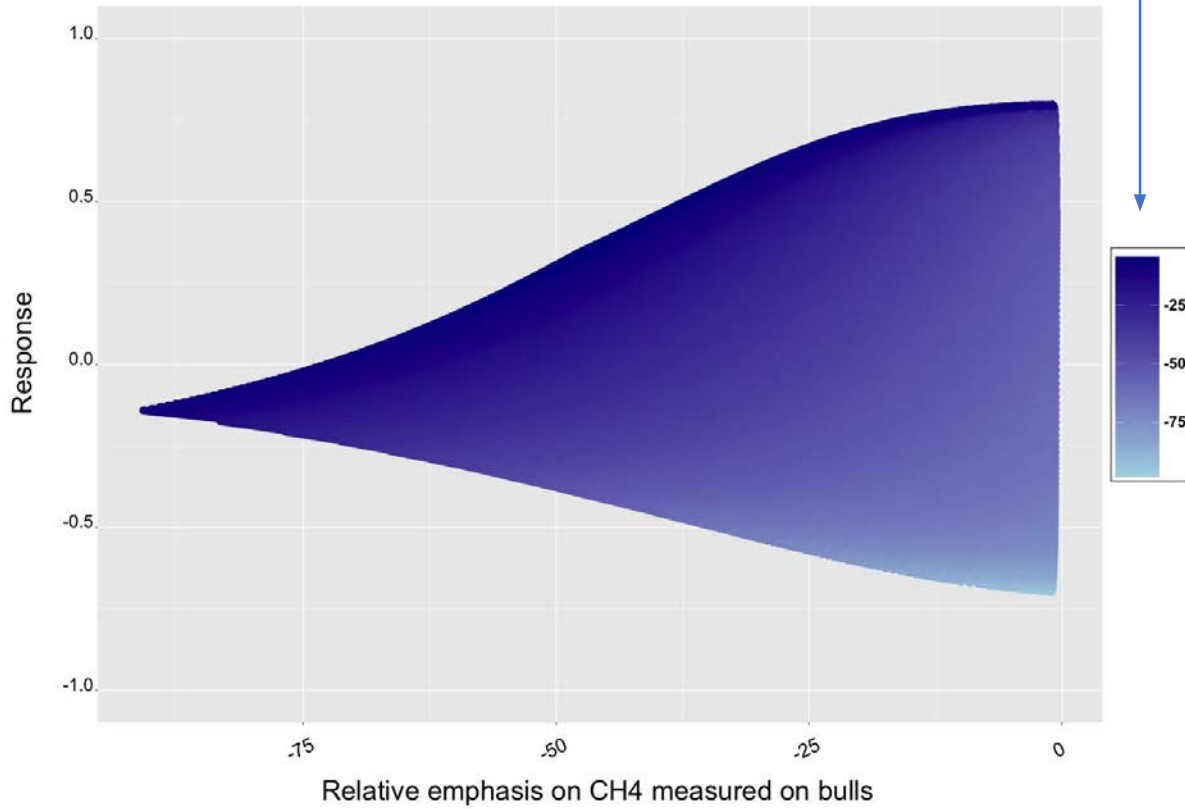
Varying emphasis on CH₄ emissions predicted on cows

Scenario 2 - Fat Yield response

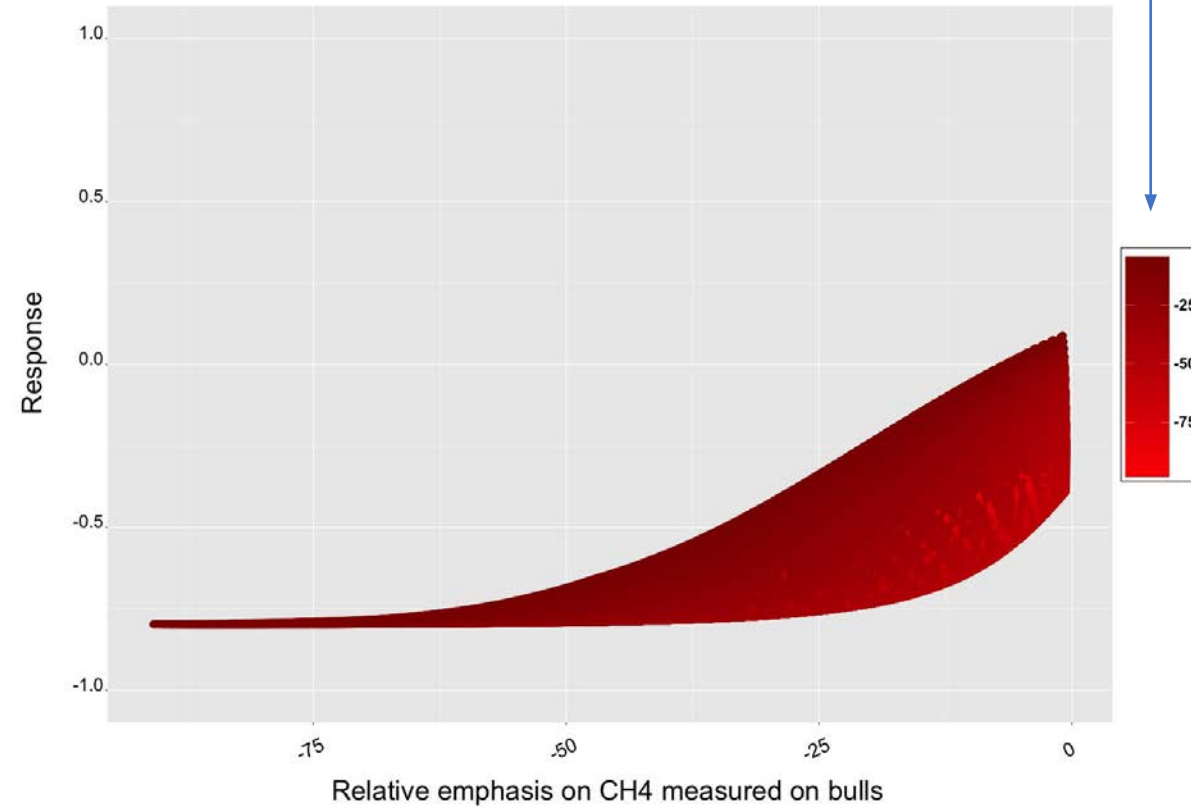


Varying emphasis on CH₄ emissions predicted on cows

Scenario 2 - Fat Yield response

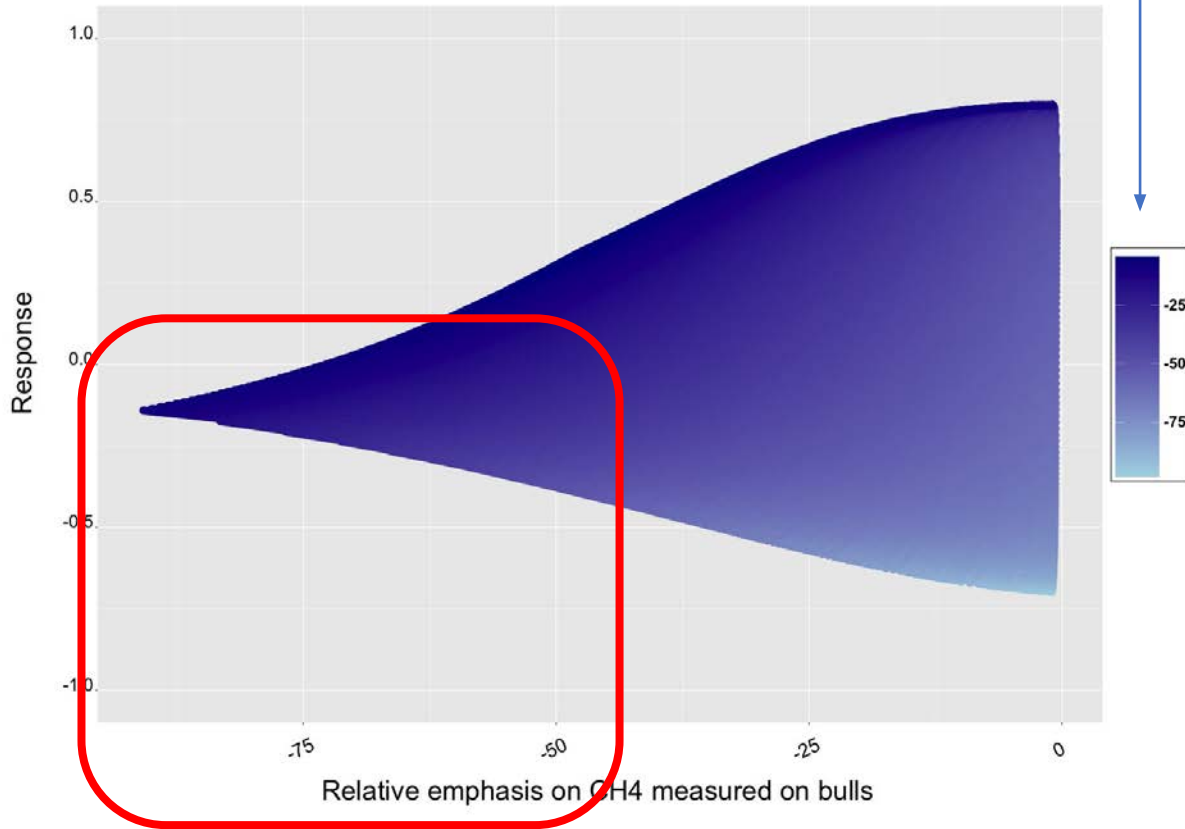


Scenario 2 - CH4 emissions response

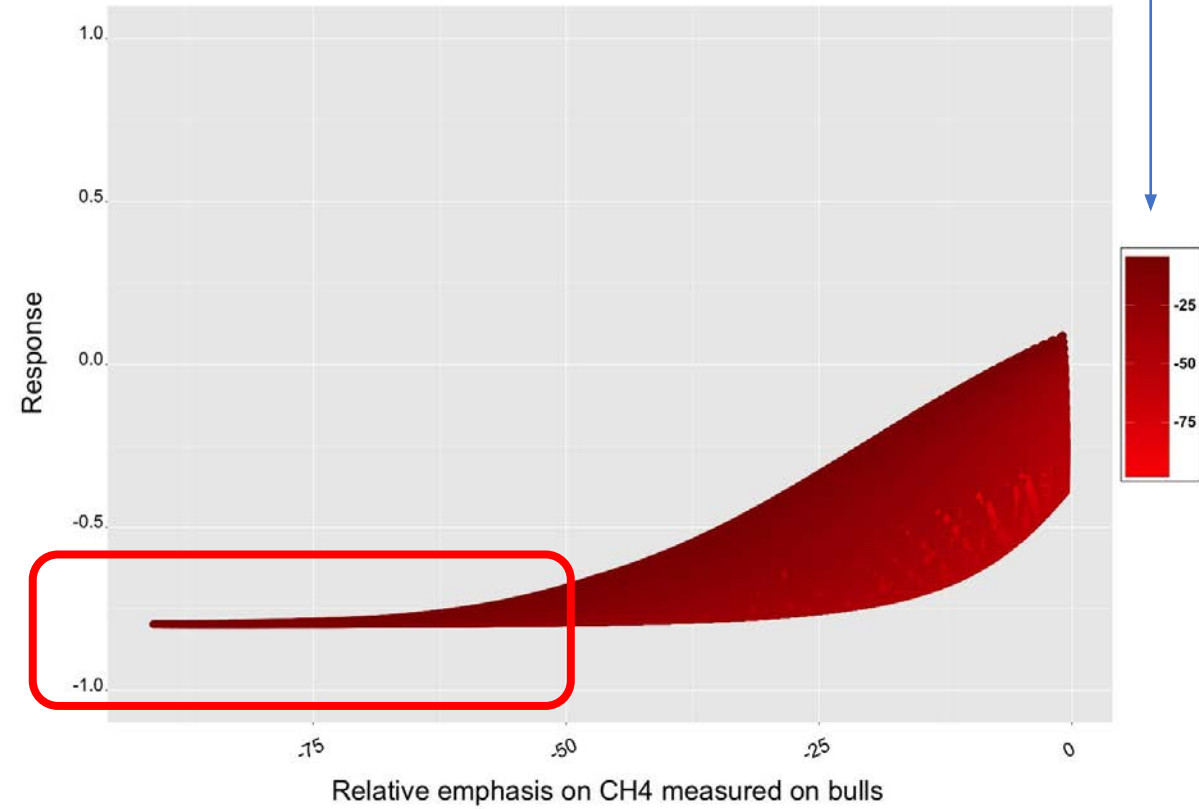


Varying emphasis on CH₄ emissions predicted on cows

Scenario 2 - Fat Yield response

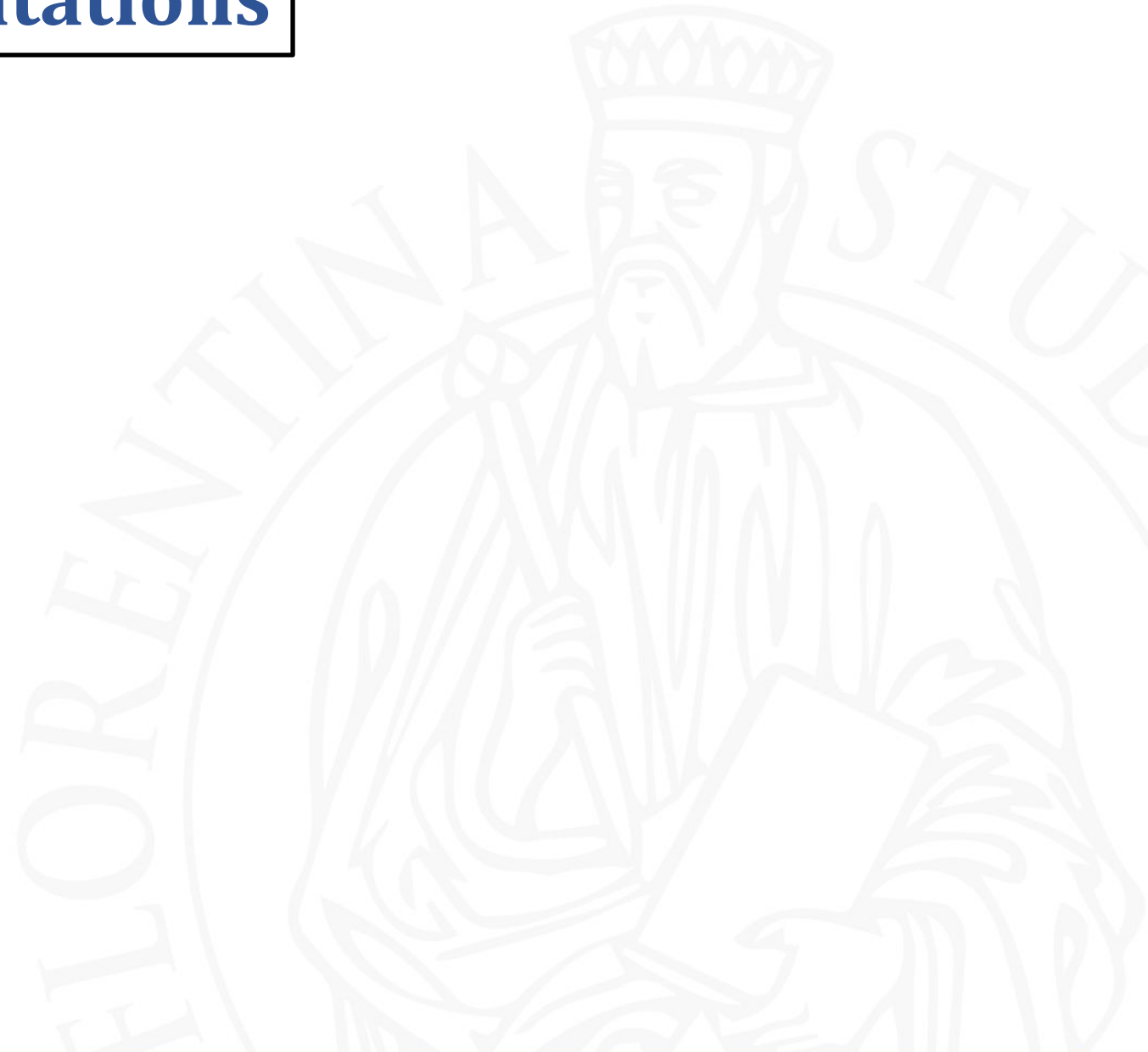


Scenario 2 - CH₄ emissions response





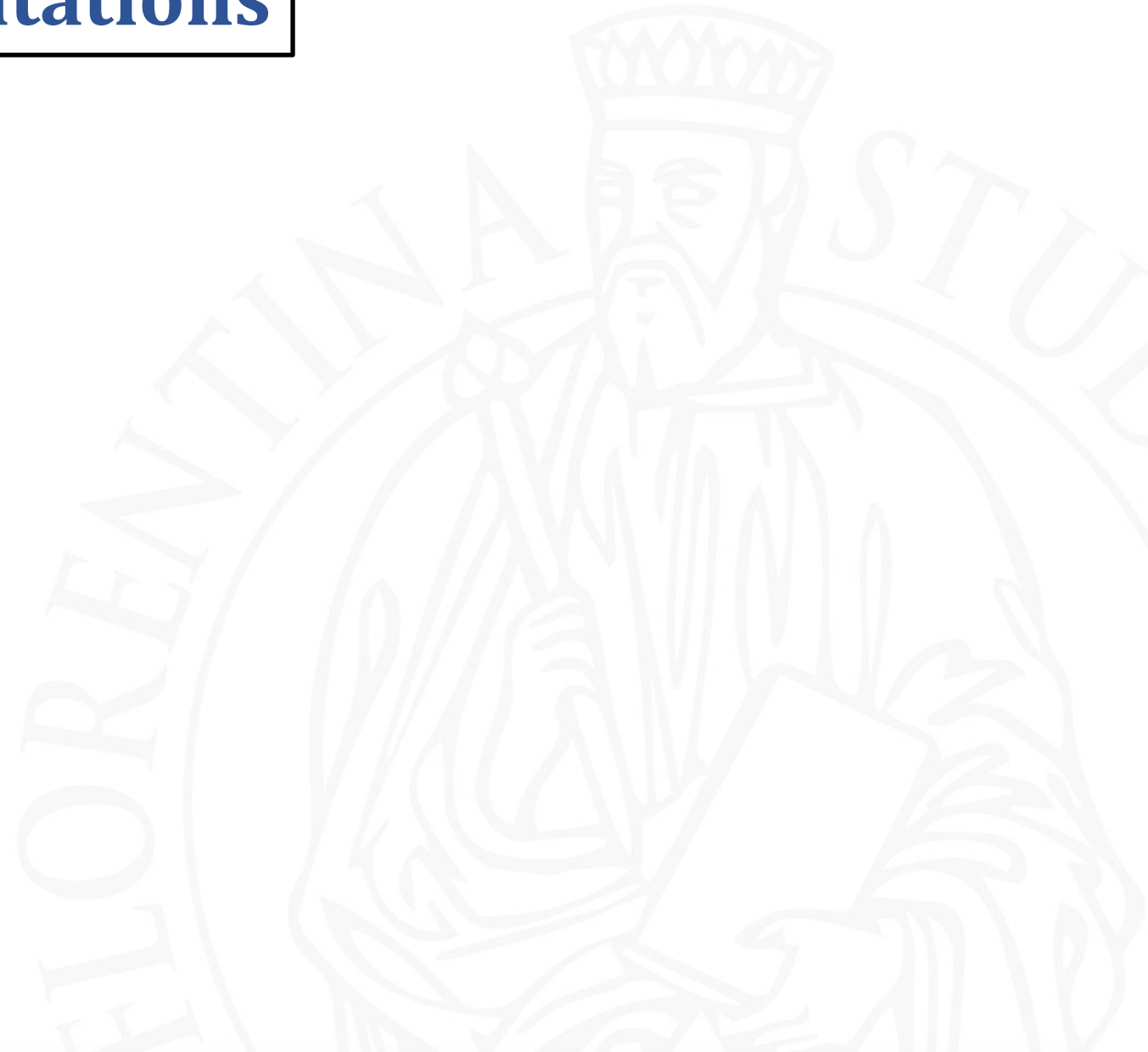
Pitfalls and limitations





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- This is too simple.



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- This is too simple.
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- We didn't consider the accuracy of the index.
- We didn't consider measured methane on cows.

Take home message: CH₄ measured on cows is needed



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Session 30

-> A holistic approach for monitoring the environmental sustainability of the Italian Holstein cattle population

Session 51

-> The evolution of dairy cattle breeding objectives





```
# Literature formula used for PFE and CH4 phenotypes development approach
FCM=milk*(0.4 + 0.15*fp); # /*latte corretto al 4% grasso*/
ECM=(milk*(((0.383*fp)+(0.242*pp)+0.7832)/3.140)); # /*Sjaunja et al.1990- formula con coeff. per lattosio*/
# /*predicted dry matter intake*/
pBWM=PBWDIM**0.75; # /*metabolic weight*/
pDMI=(0.372*(FCM) + 0.0968*pBWM); # /* predicted dry matter intake */
pFE_ECM=ECM/pDMI;
ch4_g_d=39.35+15.055*pDMI; # /*cassandro presentazione 2018*/
# /*Predicted methane emission*/
CH4=3.23 + (0.809*pDMI); # /*stima produzione di ch4*/ Ellis et al. 2017
ch4d=CH4/ECM; # /*Methane intensity*/ - ANAFIBJ PHENOTYPE AND BREEDING VALUE
*ch4_g_d=39.35+15.055*pDMI; # /*cassandro presentazione 2018*/
```




$$\text{FCM} = \text{milk} * (0.4 + 0.15 * \text{fp})$$

$$\text{pBWM} = \text{PBWDIM} ** 0.75$$

$$\text{pDMI} = (0.372 * (\text{FCM}) + 0.0968 * \text{pBWM})$$

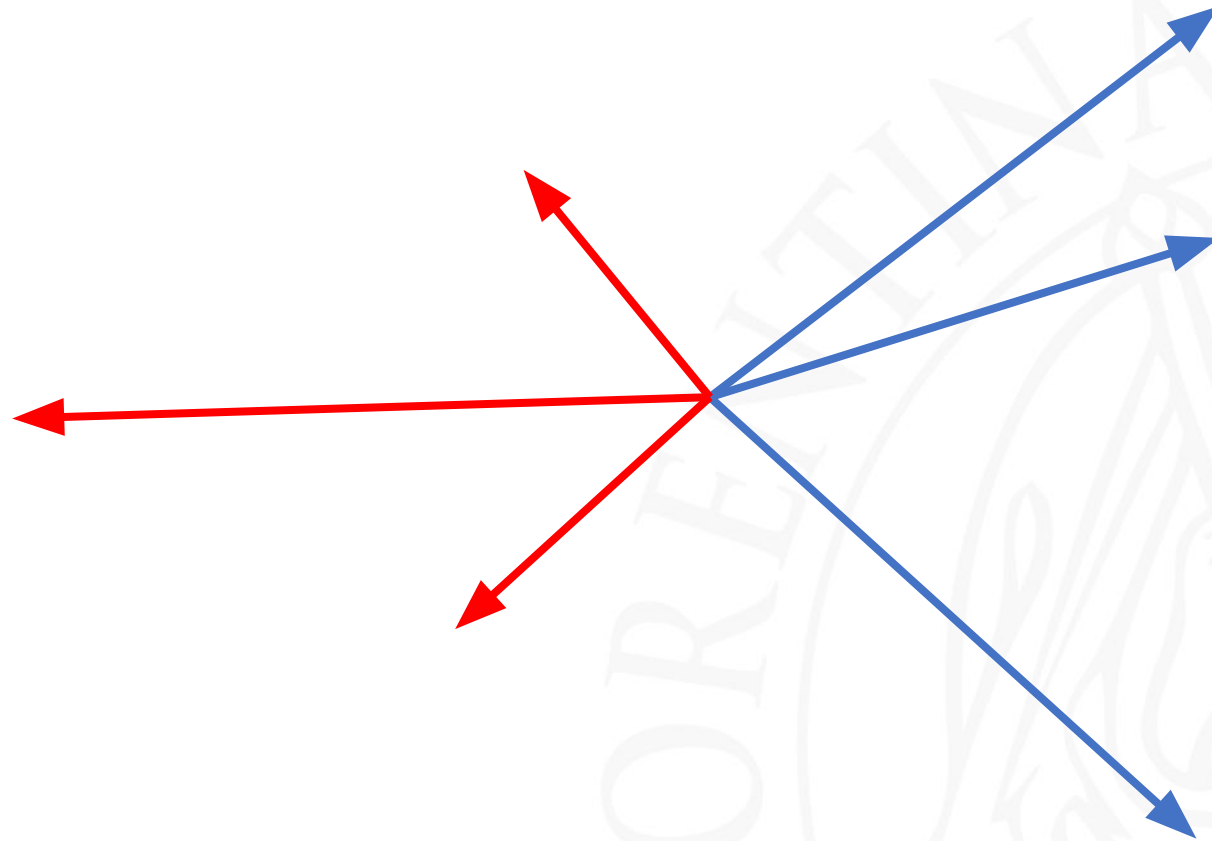
$$\text{ch4_g_d} = 39.35 + 15.055 * \text{pdmi}$$

Selection response.

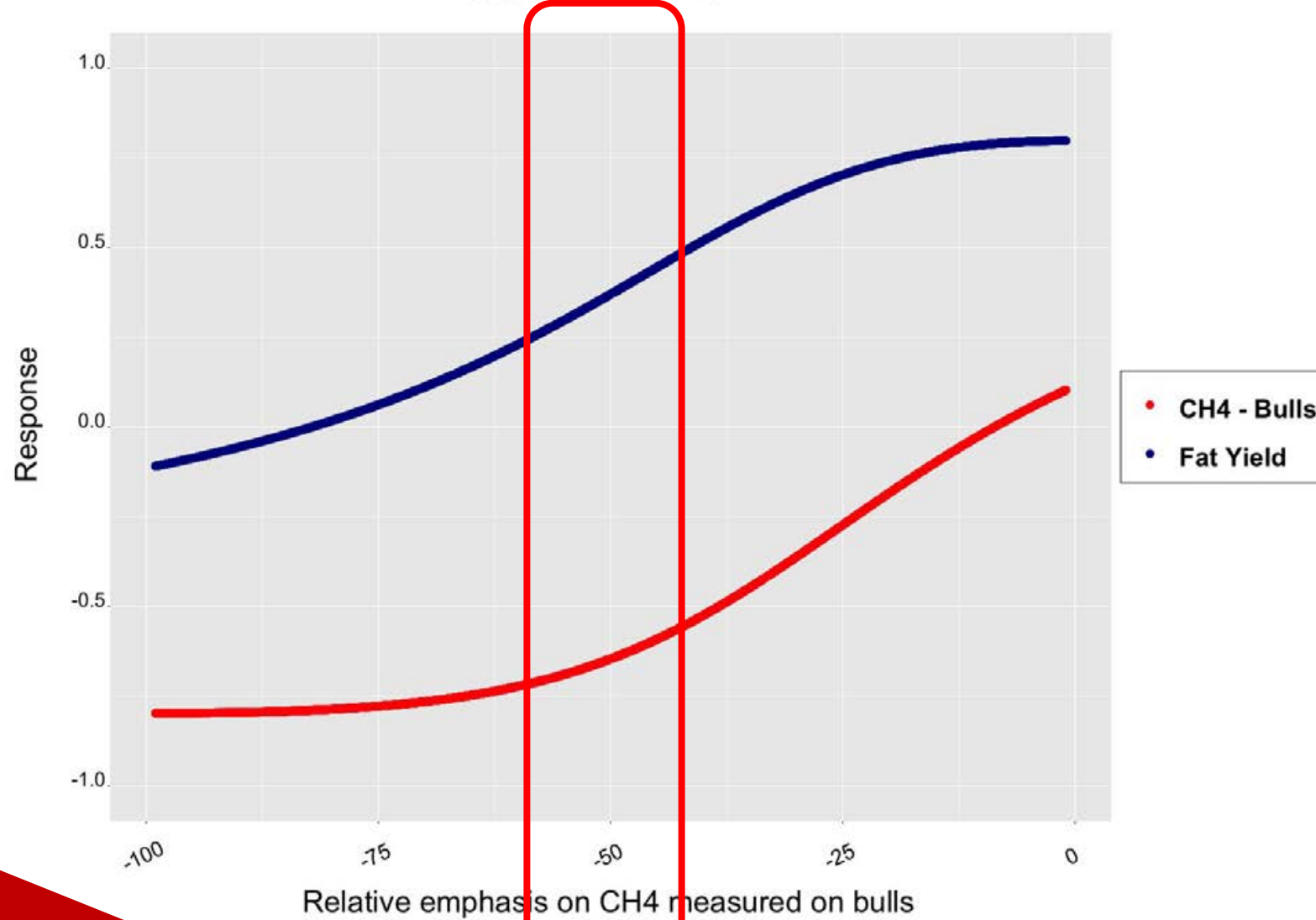
$$SR_p = \frac{\mathbf{b}^T \mathbf{G}_{11}}{\sqrt{\mathbf{b}^T \mathbf{G}_{12} \mathbf{b}}}$$

$$\mathbf{b} = \mathbf{G}_{12}^{-1} \mathbf{G}_{11} \mathbf{v}$$

Selection response.

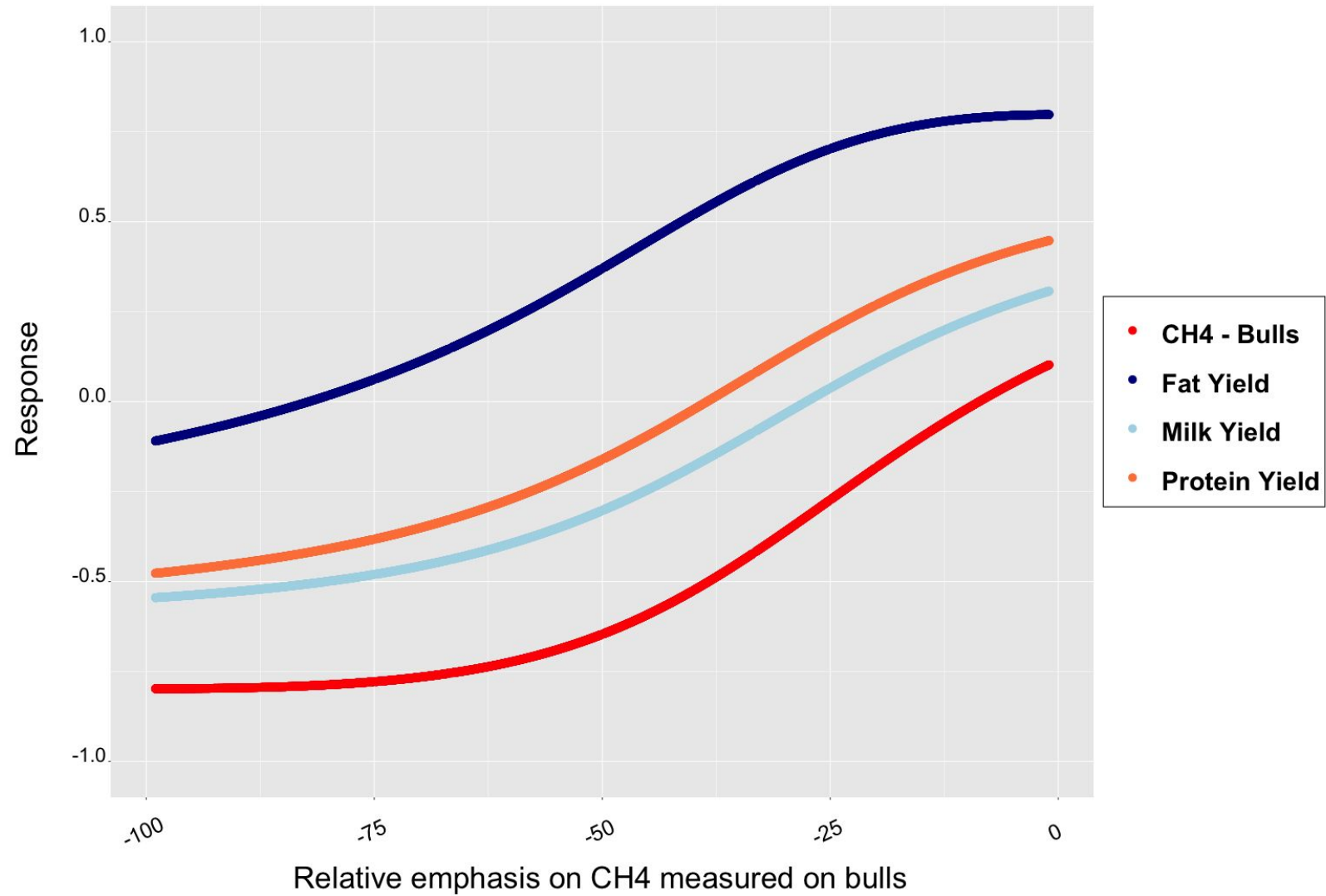


Scenario 1

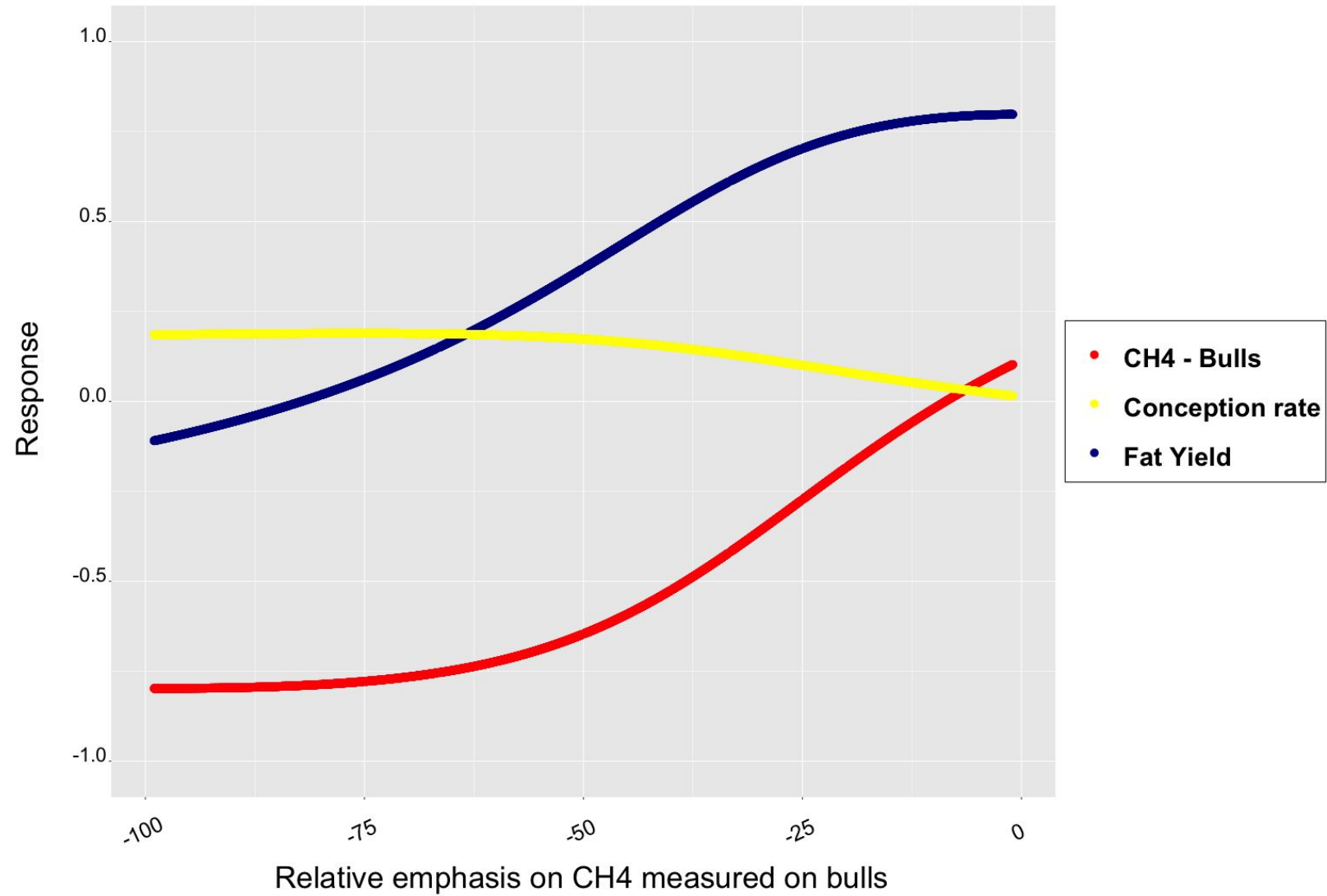


Emphasis on bulls' CH₄

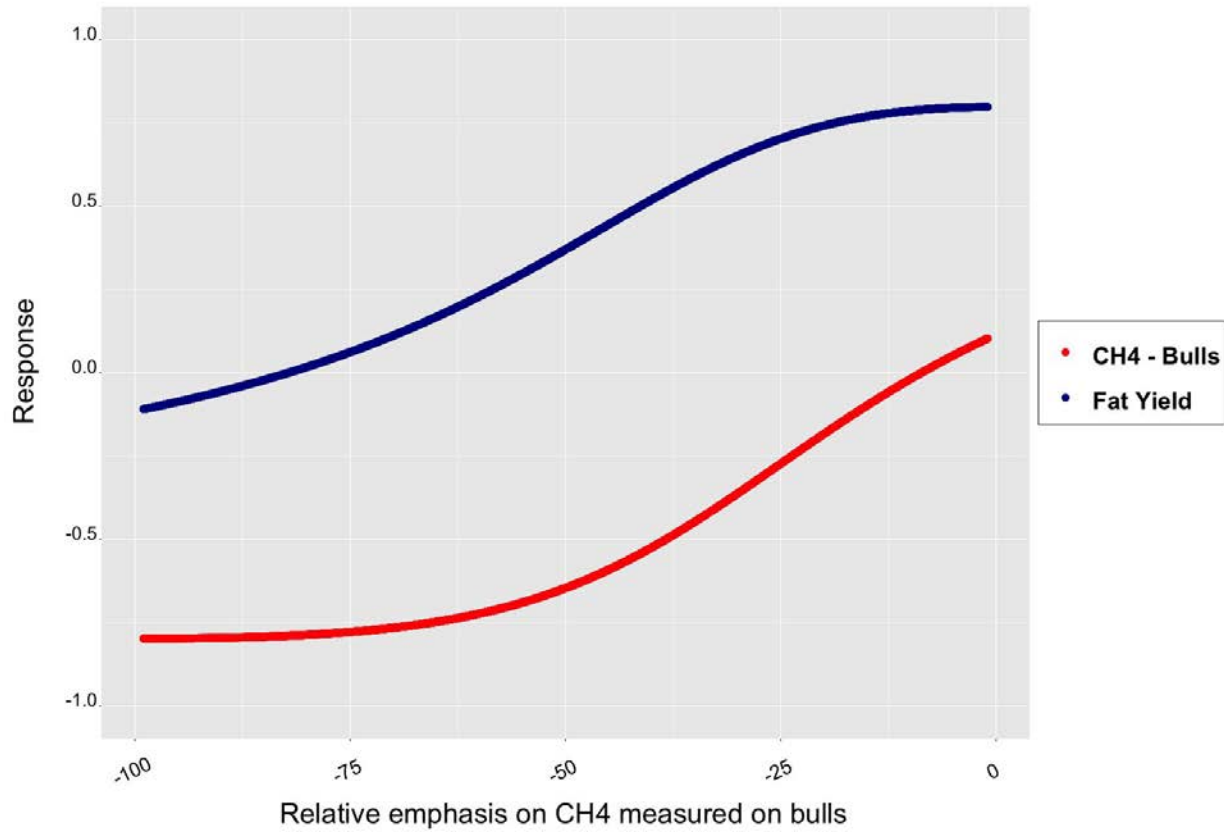
Scenario 1



Scenario 1



Scenario 1



Scenario 2

