Approaching a crossroads in selecting for methane production: Trait definition and its consequences for breeding programs

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Using ratio traits in selection indexes

Methane production or efficiency?

Pro's

- Easy to understand for farmers
- Interest perspective industry
- Methane per product

Con's

- Difficult to predict response of component traits
- Economic values difficult to derive
- Response likely not optimal economically

Using ratio traits in selection indexes

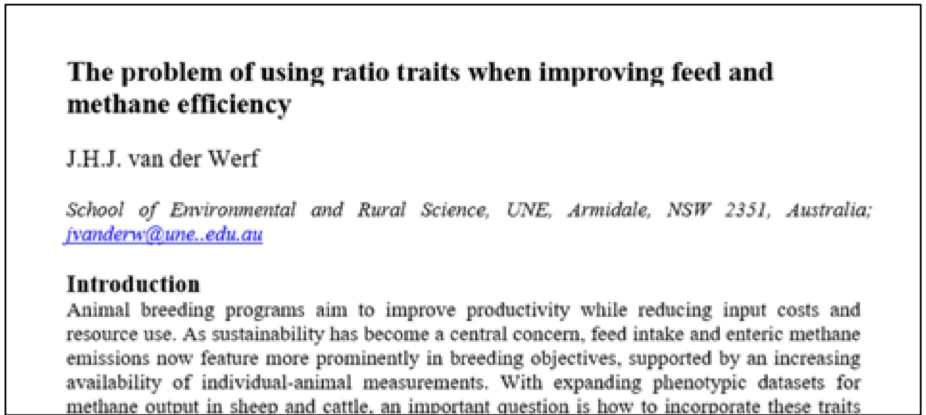
Ratio traits

Theory about selection response for a ratio trait is available (Sutherland, 1965)

The advice was classically **not** to use ratio traits (e.g. Veerkamp, 1992)

Van der Werf has developed tools, which enables exploration of the mechanics

Paper by Van der Werf - WCGALP 2026



The problem of using ratio traits when improving feed and methane efficiency

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Introduction

Animal breeding programs aim to improve productivity while reducing input costs and resource use. As sustainability has become a central concern, feed intake and enteric methane emissions now feature more prominently in breeding objectives, supported by an increasing availability of individual-animal measurements. With expanding phenotypic datasets for methane output in sheep and cattle, an important question is how to incorporate these traits

Using ratio traits in selection indexes

Two scenario's:

Breeding goal and index (2 traits):

v1 x trait1 + v2 x trait2 + …

or

Breeding goal and index (1 ratio trait):

v3 x trait1/ trait2 + …

Central question:

What are the consequences of this choice in the context of index selection?

Using ratio traits in selection indexes

Coefficient of variation and Lambda

The coefficient of genetic variation and lambda are key for ratio traits:

$$\text{cv} = v_{a,T1} = \left(\frac{\sigma_{a,T1}}{\mu_{T1}}\right)$$

Lambda (genetic): $$\lambda = \left(\frac{v_{a,T1}}{v_{a,T2}}\right)$$

When $\lambda < 1$, the denominator trait (T2) is dominant in the response (in units σ_a)

Example: FI/ADG (beef) → λ = (1.4/14.9) / (0.2/1.59) = 0.096/0.126 = 0.763

Example: CH4/MILK (dairy) → λ = (10/300) / (5/30) = 0.033/0.167 = 0.2

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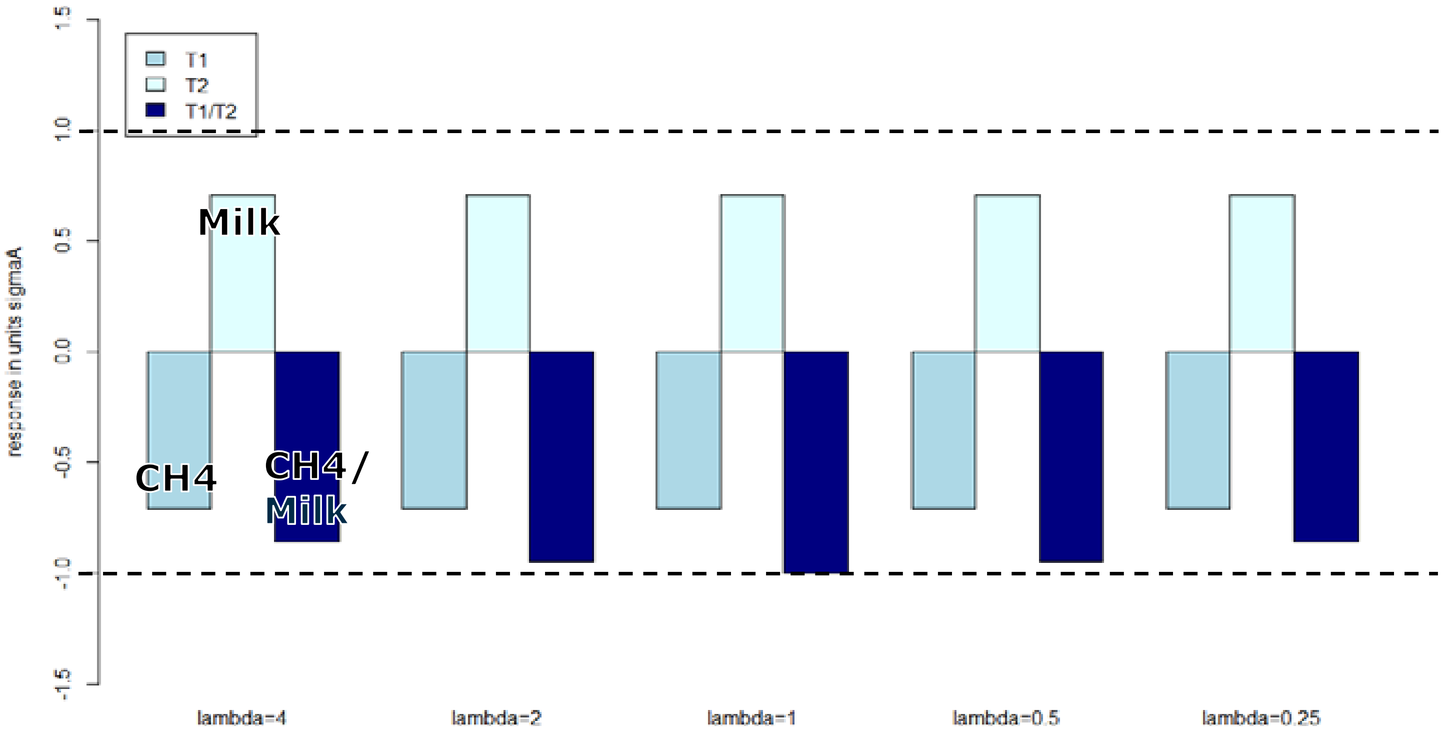
Basic scenario

- *Heritability CH4=Milk=0.2*
- *Zero genetic correlation*
- *Lots of information r_{IH}=0.99*
- *Selection intensity = 1*

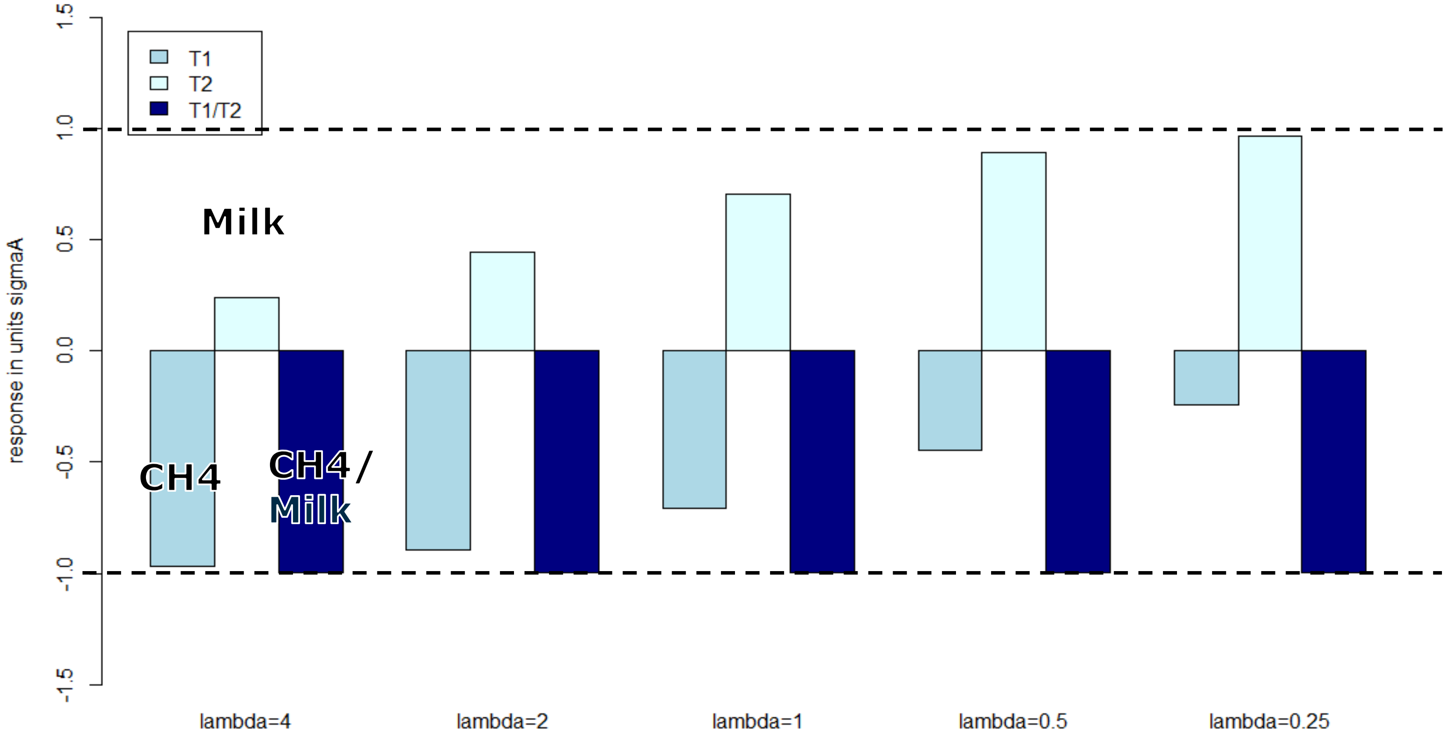
Breeding goal H = v1 x CH4 + v2 x Milk

rp=0
rg=0
V1=-1
V2=1



Breeding goal H = v3 x CH4 / Milk

rp=0
rg=0
V3=1



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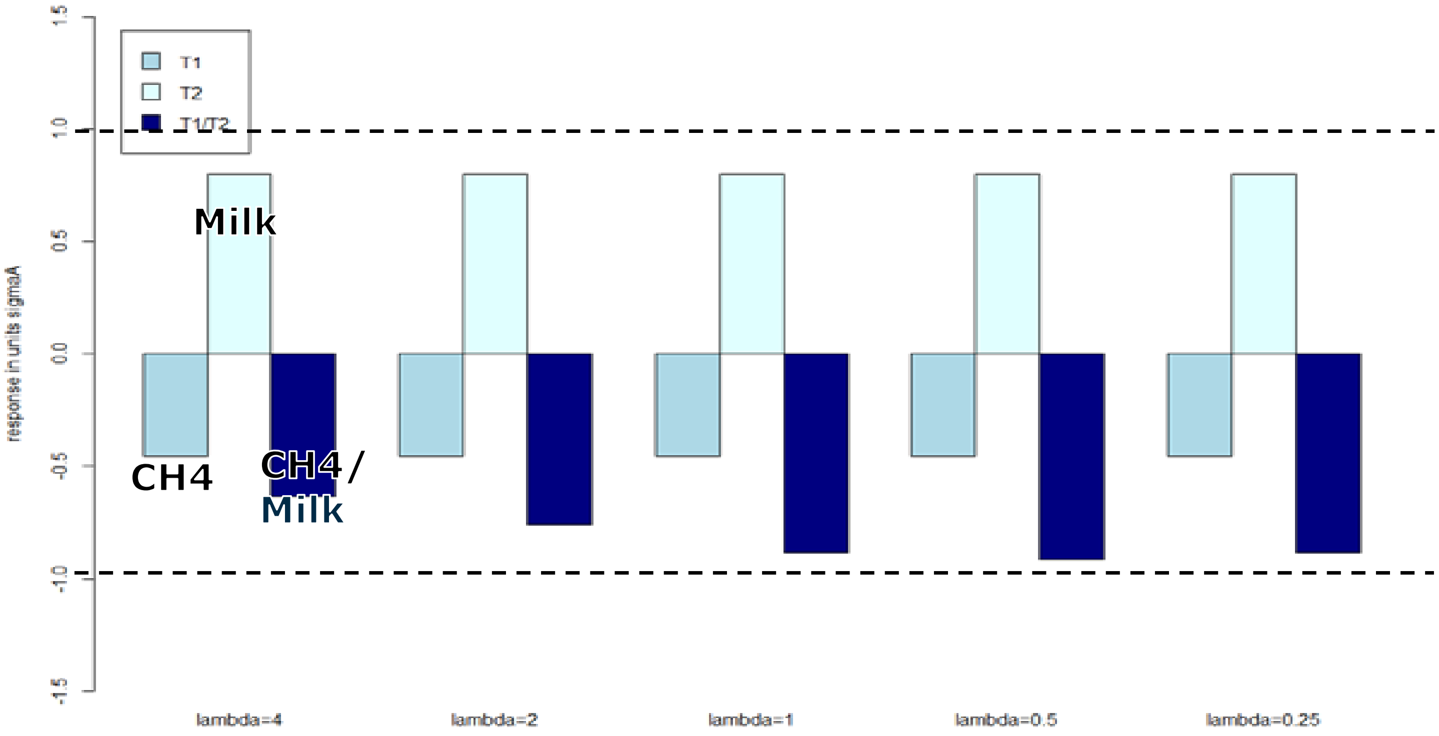
Next, less info for CH4

r_{IH}*=0.7*

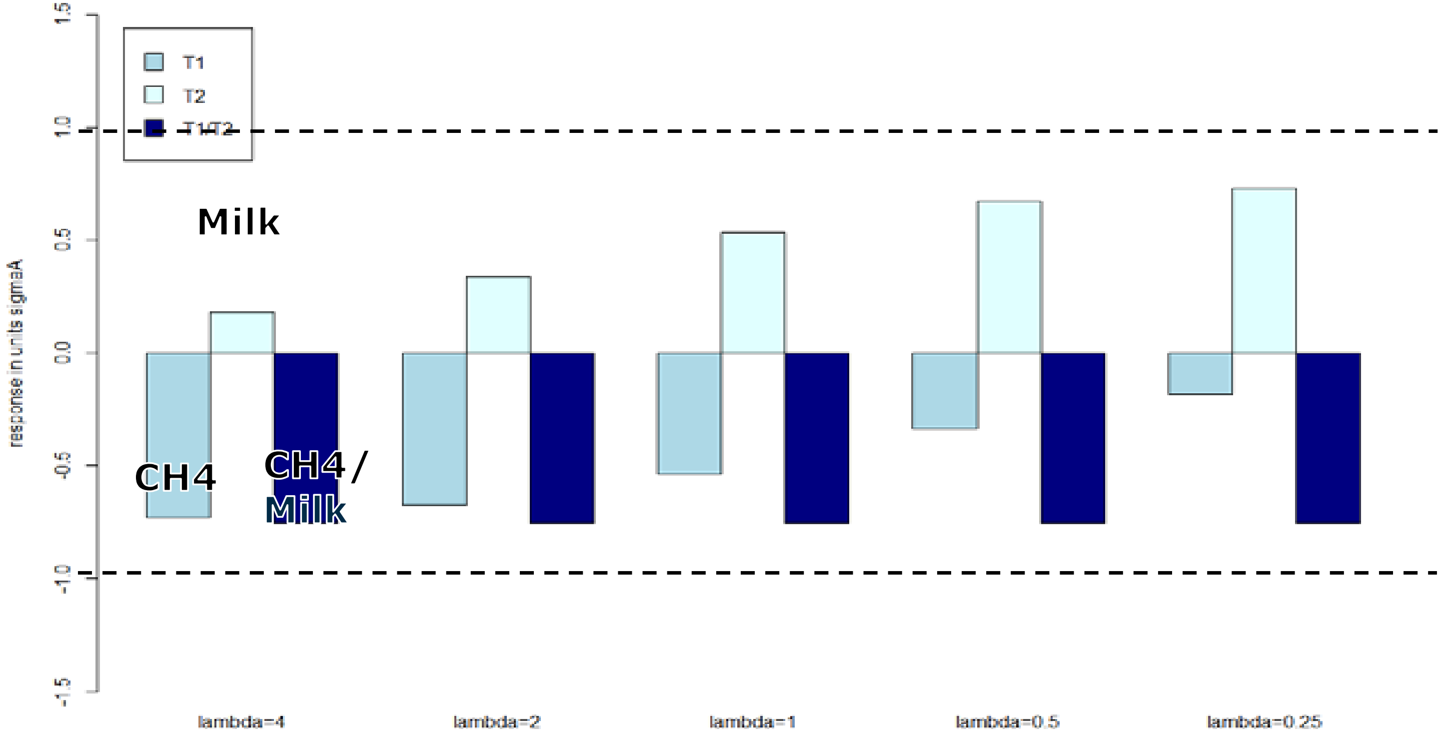
Breeding goal H = v1 x CH4 + v2 x Milk

rp=0
rg=0
V1=-1
V2=1



Breeding goal H = v3 x CH4 / Milk

rp=0
rg=0
V3=1



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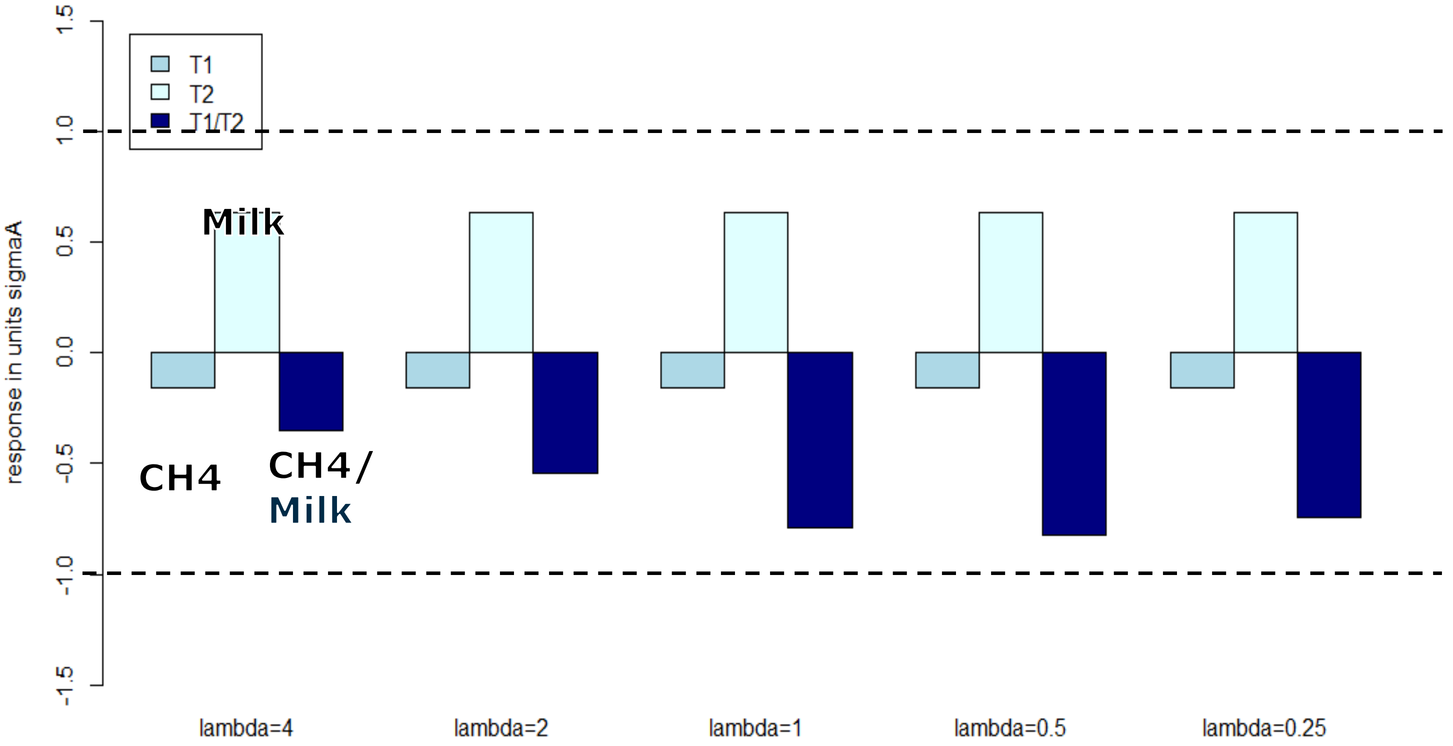
Next, phenotypic & genetic correlation = 0.5

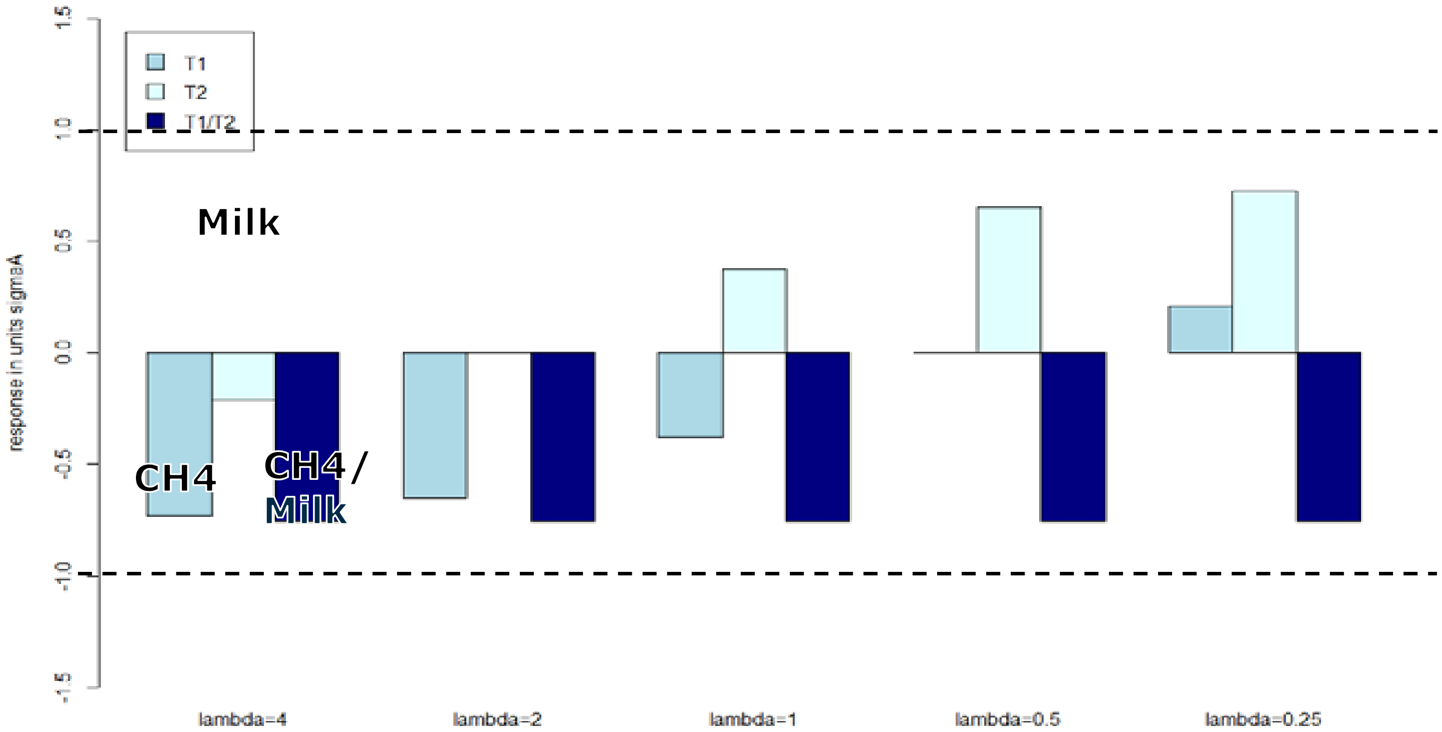
Breeding goal H = v1 x CH4 + v2 x Milk

rp=0.5
rg=0.5
V1=-1
V2=1



Breeding goal H = v3 x CH4 / Milk

rp=0.5
rg=0.5
V3=1



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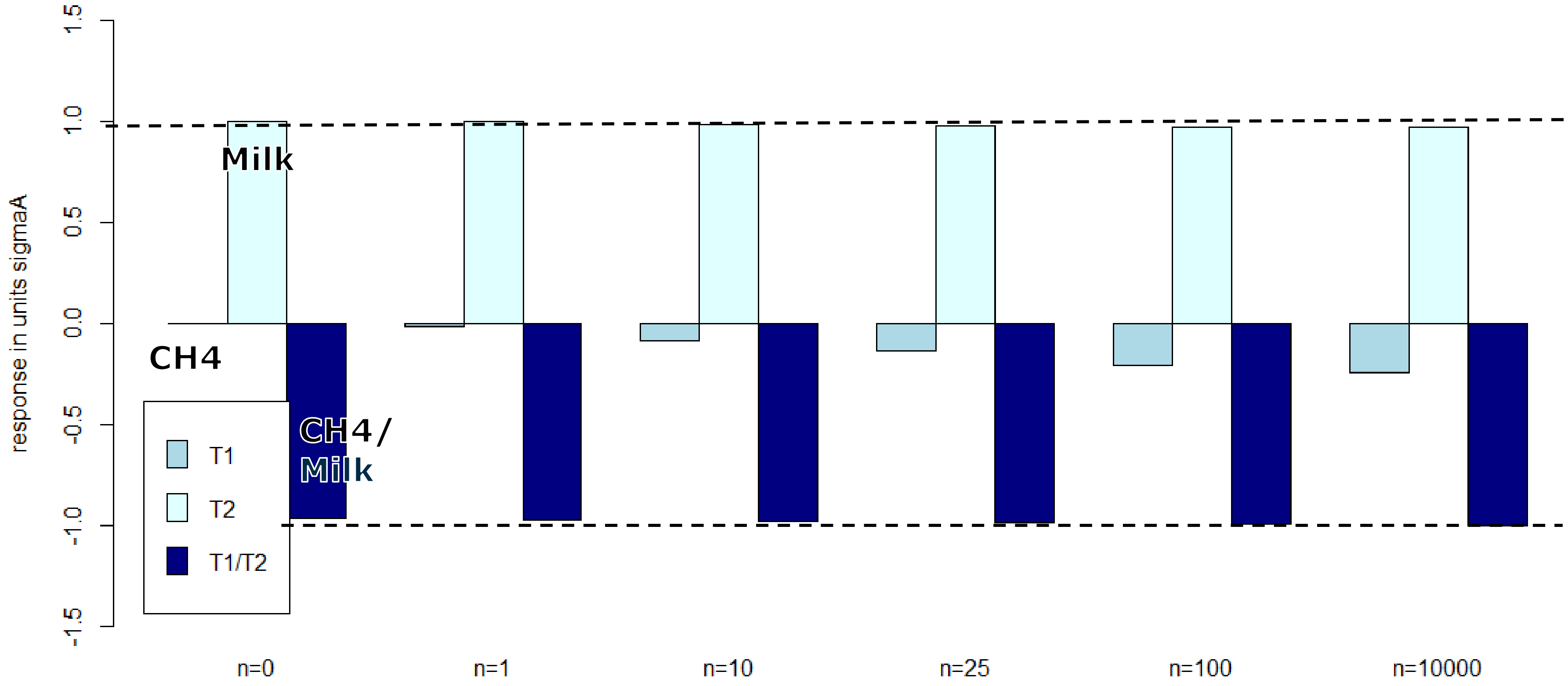
Next, building up information for CH4
Selection on CH4/Milk, Lambda = 0.25

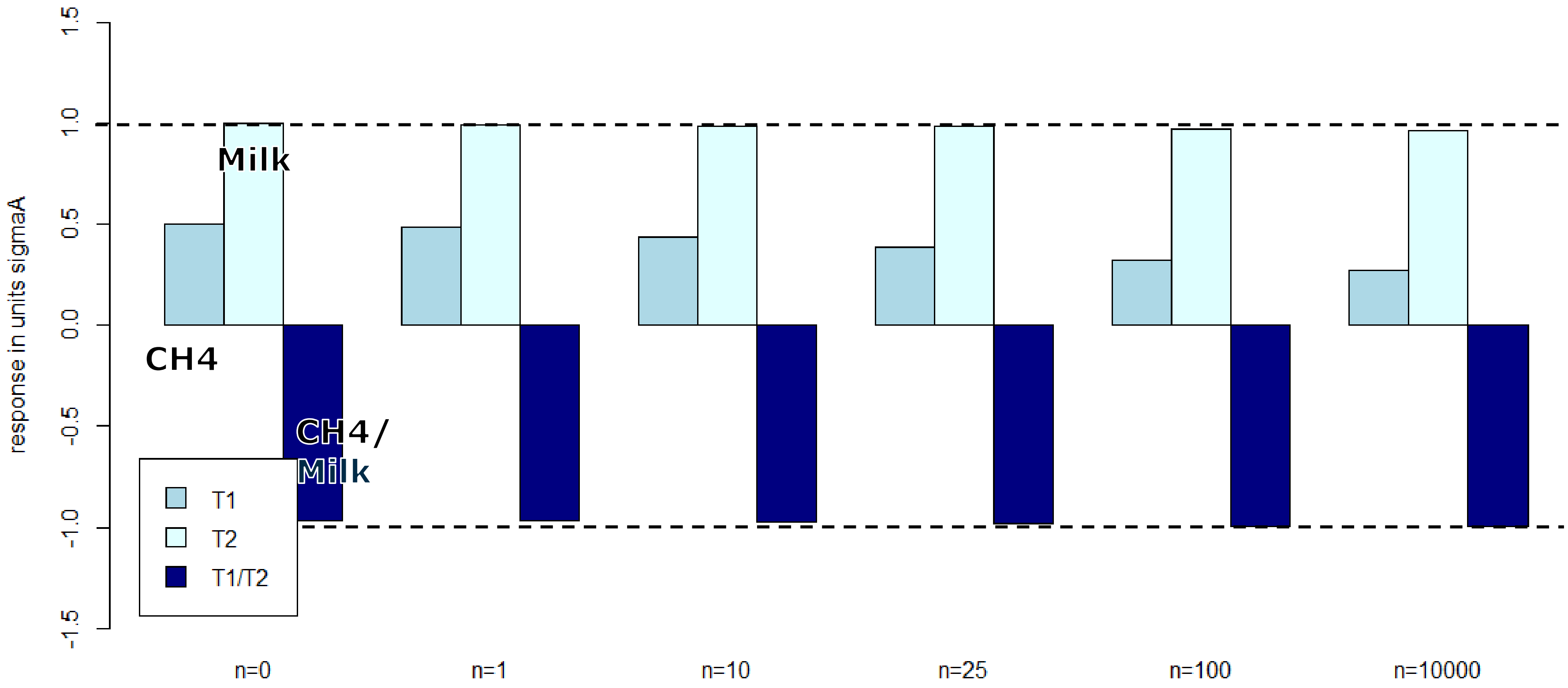
Breeding goal H = v3 x CH4 / Milk

Building up info T1 – rg = 0.0



Breeding goal H = v3 x CH4 / Milk

Building up info T1 – rg = 0.5



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Summary and conclusions

- A (simulation) tool is essential to explore the mechanics of selection on ratio traits
- Lambda is a given, but determines the response of underlying traits (of ratio traits) both in magnitude as well as in direction
- Using CH4/Milk as a ratio seems not to be effective as a methane mitigation strategy, even if routine phenotyping would be available
- A linear breeding goal for methane production seems the way to go

Using ratio traits in selection indexes

Thank you for your attention!