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Are we near recommendations for individual amino acids to dairy cows?

Canada

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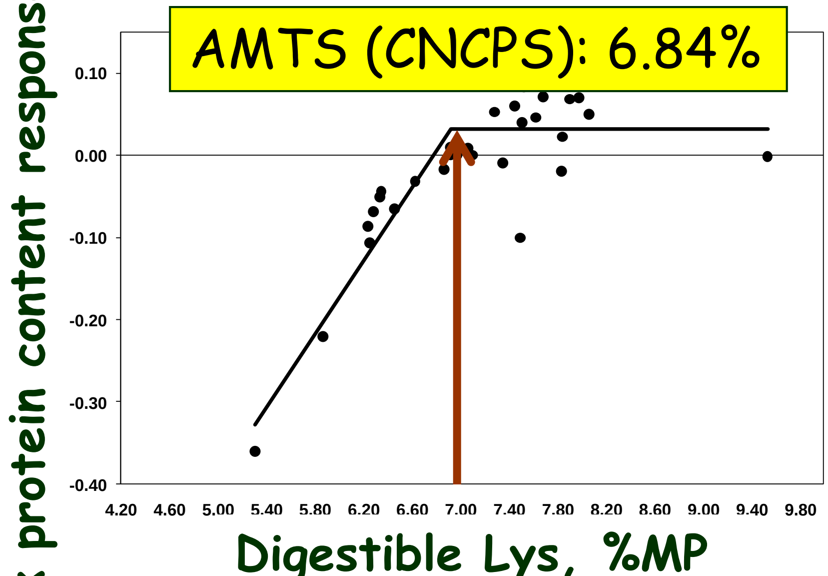
AA: Amino Acid
CP: Crude Protein
EAA: essential AA
FPCM: Fat and Protein Corrected Milk
MP: Metabolizable Protein
MPY: Milk Protein Yield
Rqt: Requirements

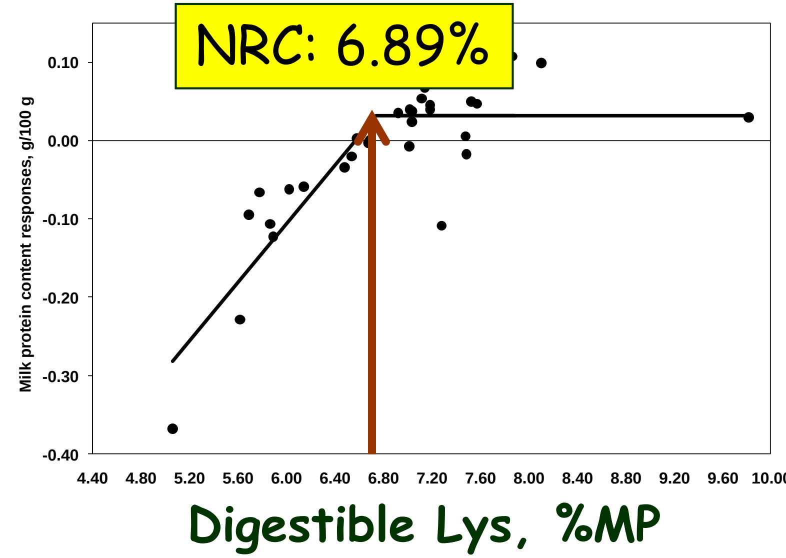
Balancing dairy rations for AA

- Proportional:
  - simple: fixed number
  - initiated the implementation of AA balance

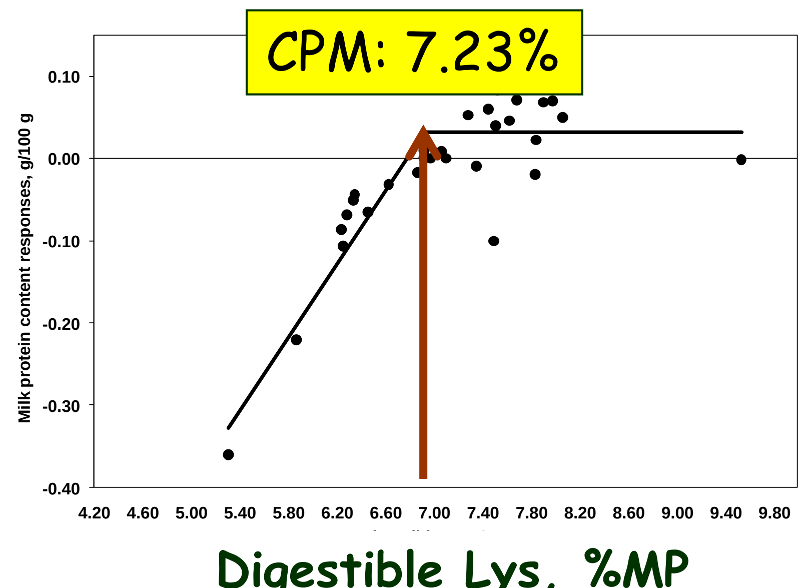
Proportional



CNCPS v.6.5: 6.77%
vanAmburgh et al. 2015



New data, book version

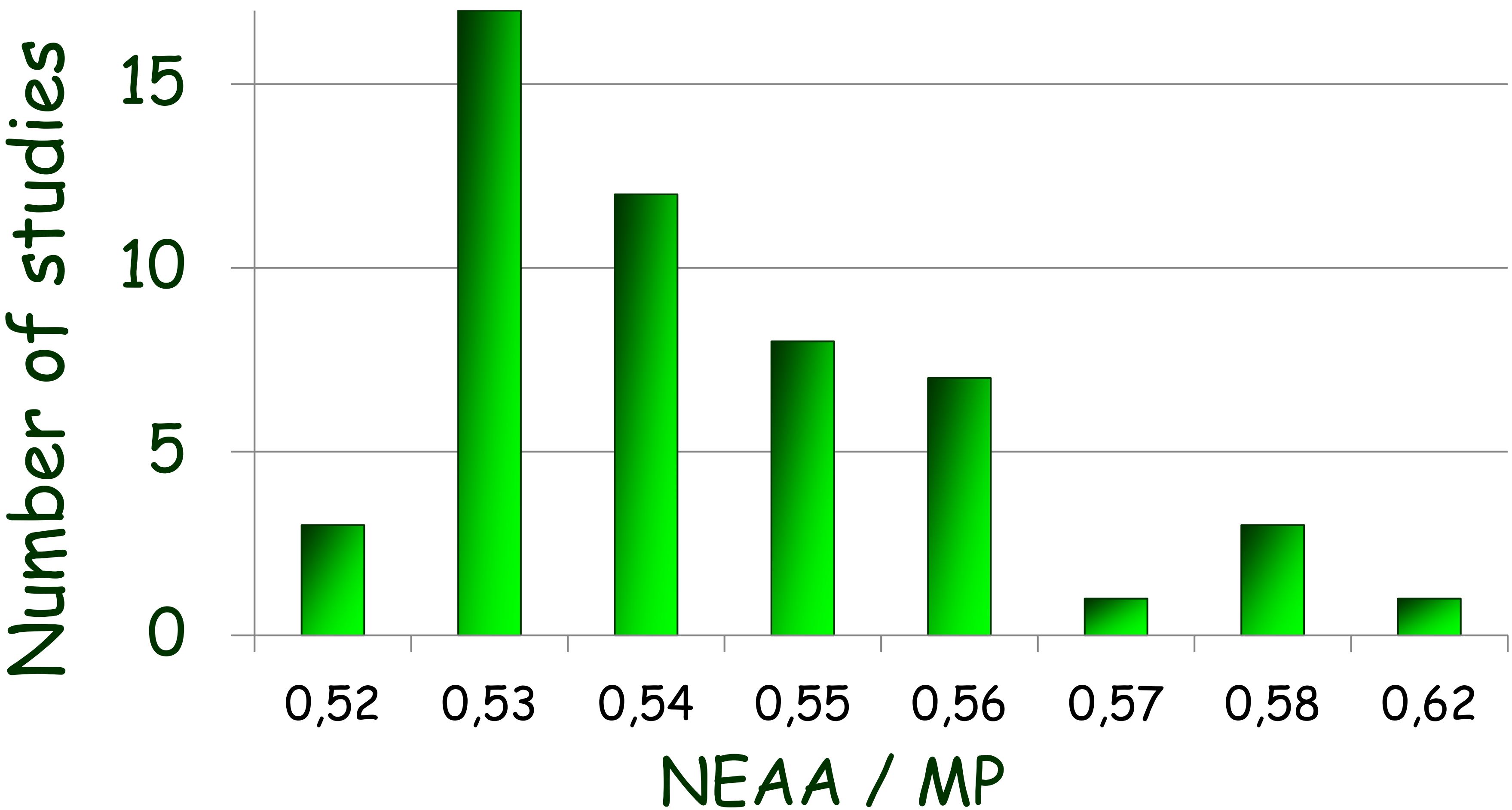


Whitehouse, Schwab et al. 2010

Balancing dairy rations for AA

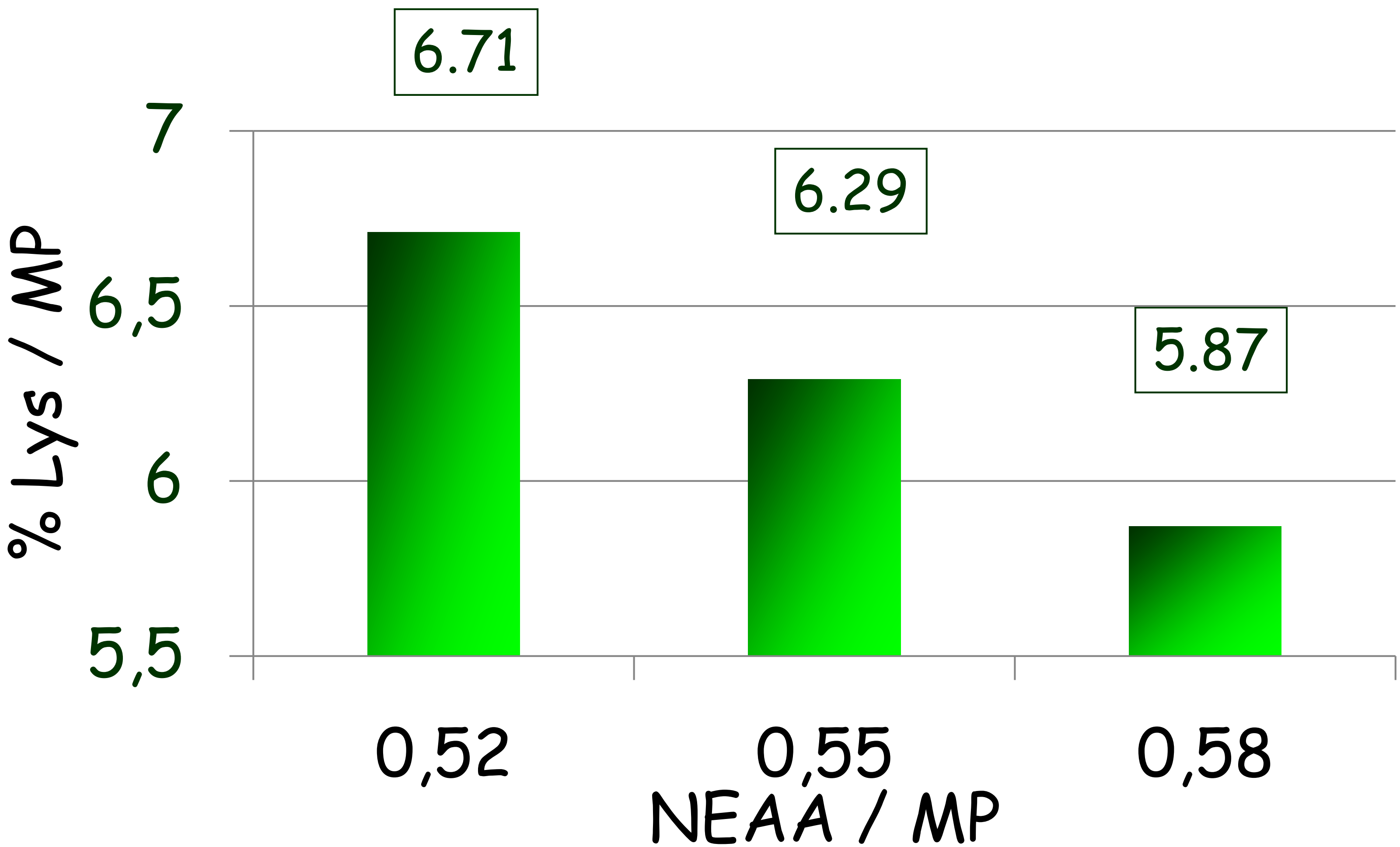
- Proportional:
  - Does not take into account that the proportion of non essential AA (NEAA) relative to MP varies.
  - Recommendations are fixed, independent of milk yield.

Porportion of NEAA / MP

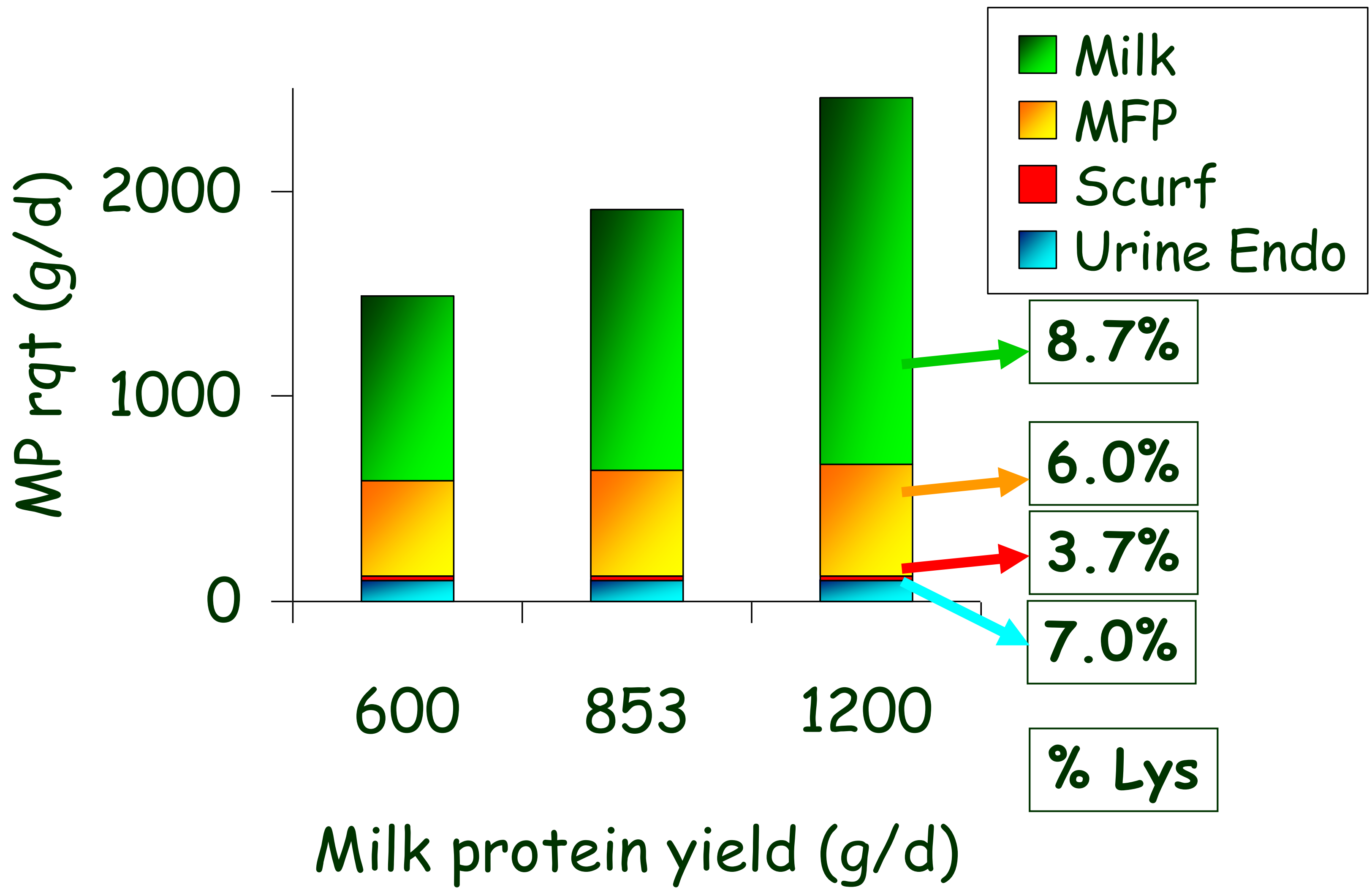


(CTL trts in Doepel et al. 2004 JDS)

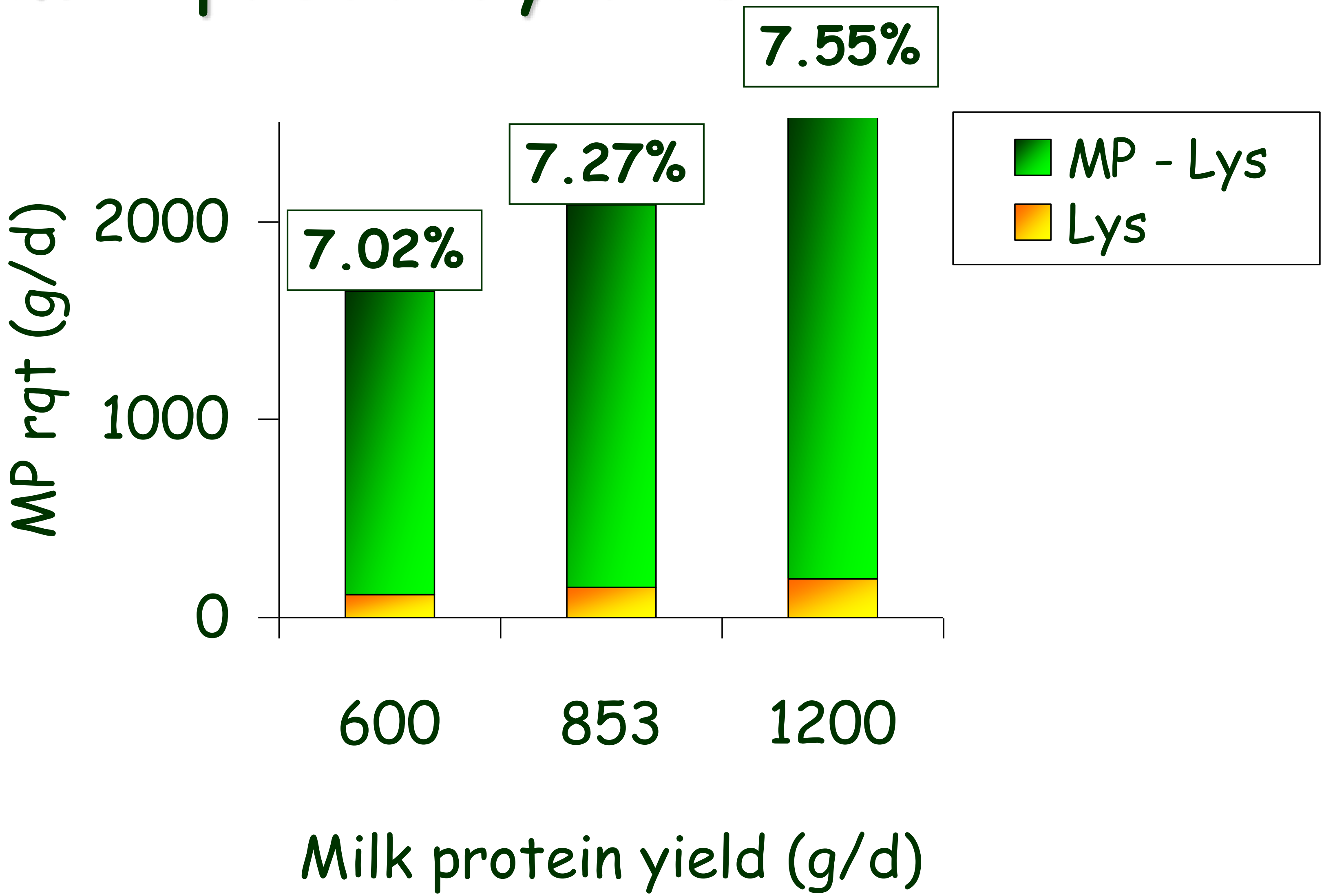
Supply of 105 g of Lys with same EAA supply but different NEAA/MP



MP requirement with different milk protein yields



Lys requirement with different milk protein yields



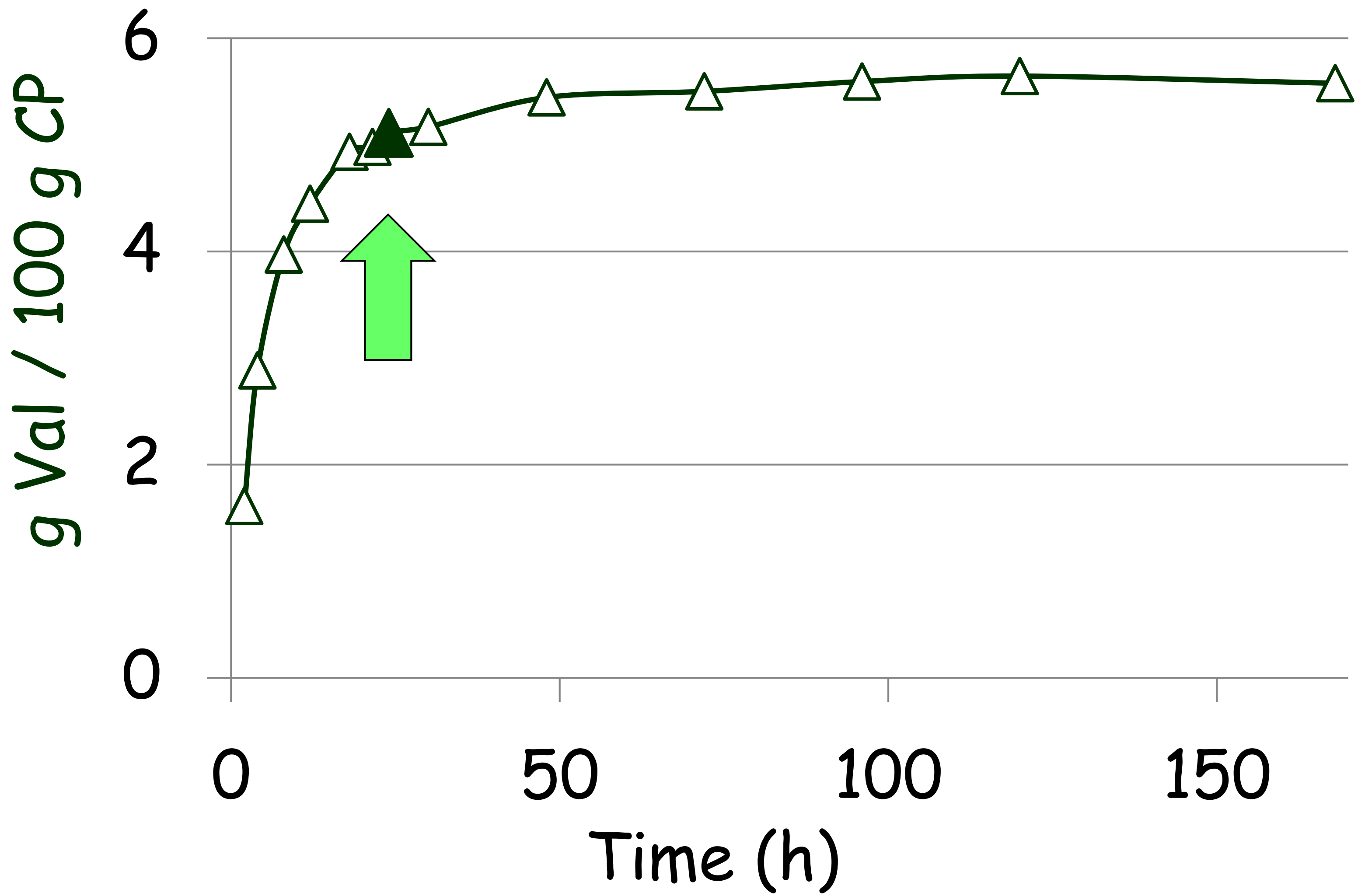
Factorial approach requires:

1. AA composition of proteins
2. AA supply
3. AA requirement
   - a. Export proteins – in previous talk
   - b. [AA] in export proteins
   - c. Efficiency of utilization of AA
4. Impact of balancing for His, Lys & Met

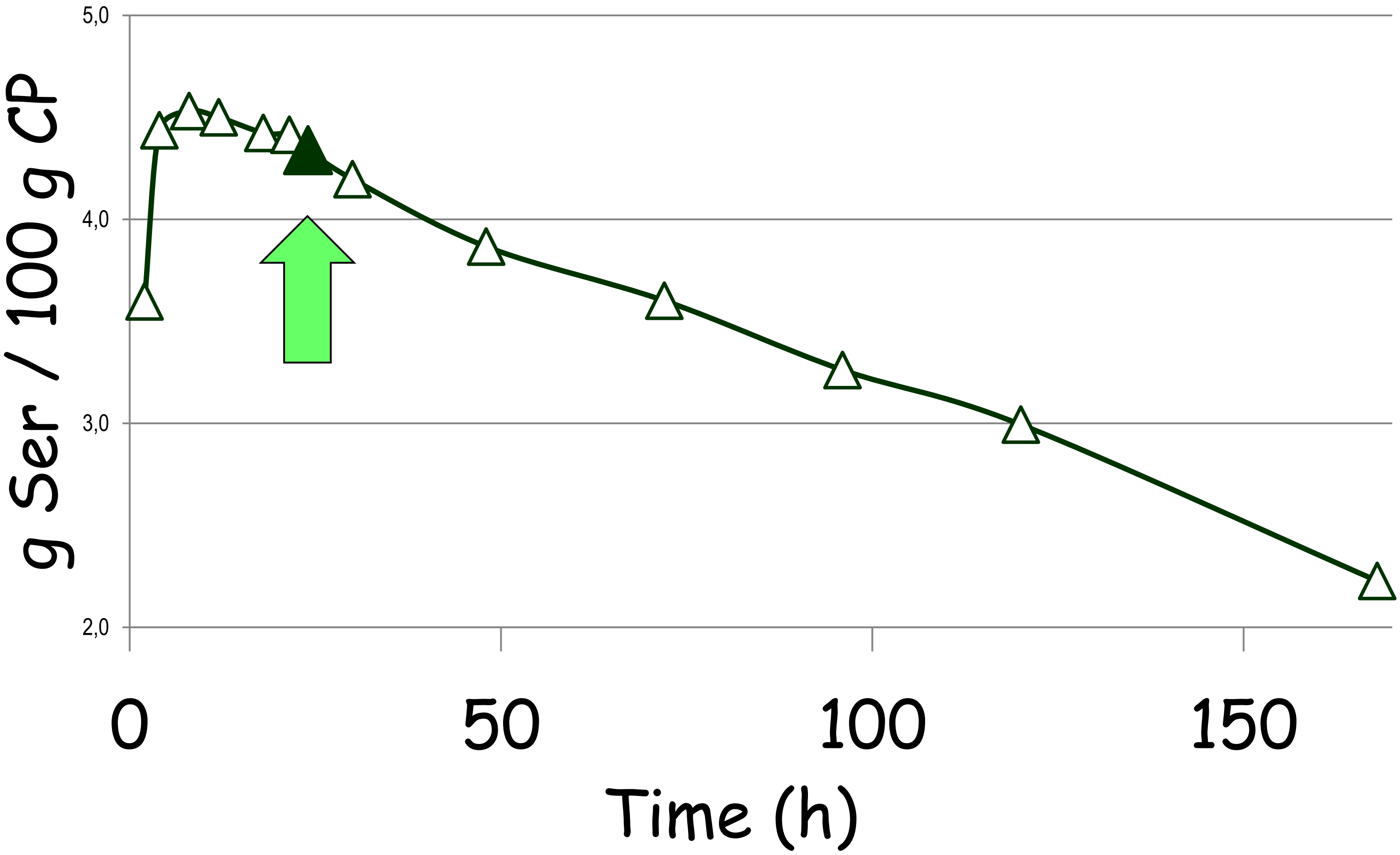
1. AA composition of proteins

- [AA] obtained from hydrolysis
- Correction factors need to be used for 24-h measurements
- 1 kg of protein
  ≈ 1.15-1.17 kg of AA

[Val] in canola meal



[Ser] in canola meal

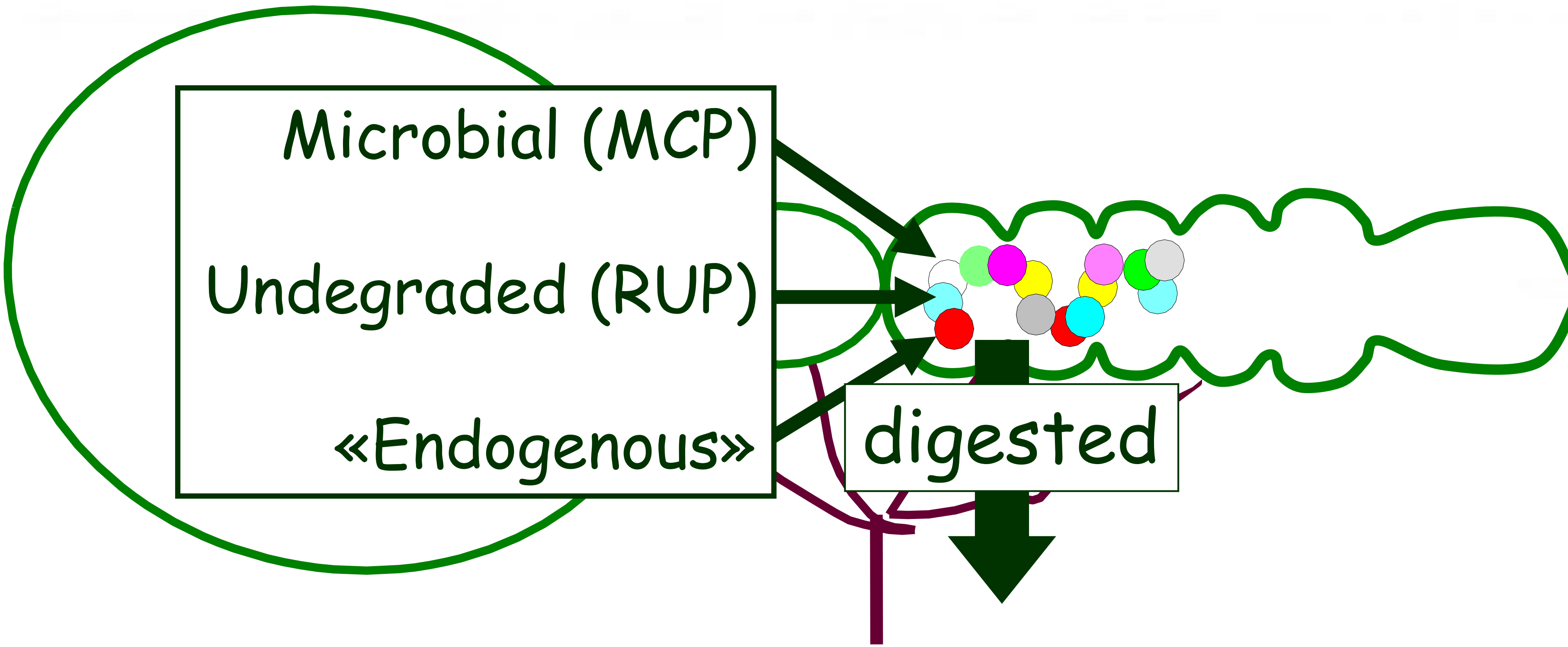


Correction factors for [AA] from hydrolysis

AA		**Missing in 24-h hydrolysis**	
His		1.02	
Lys		1.06	
Met		1.05	
Val		1.11	
Δ		1.02 – 1.23	

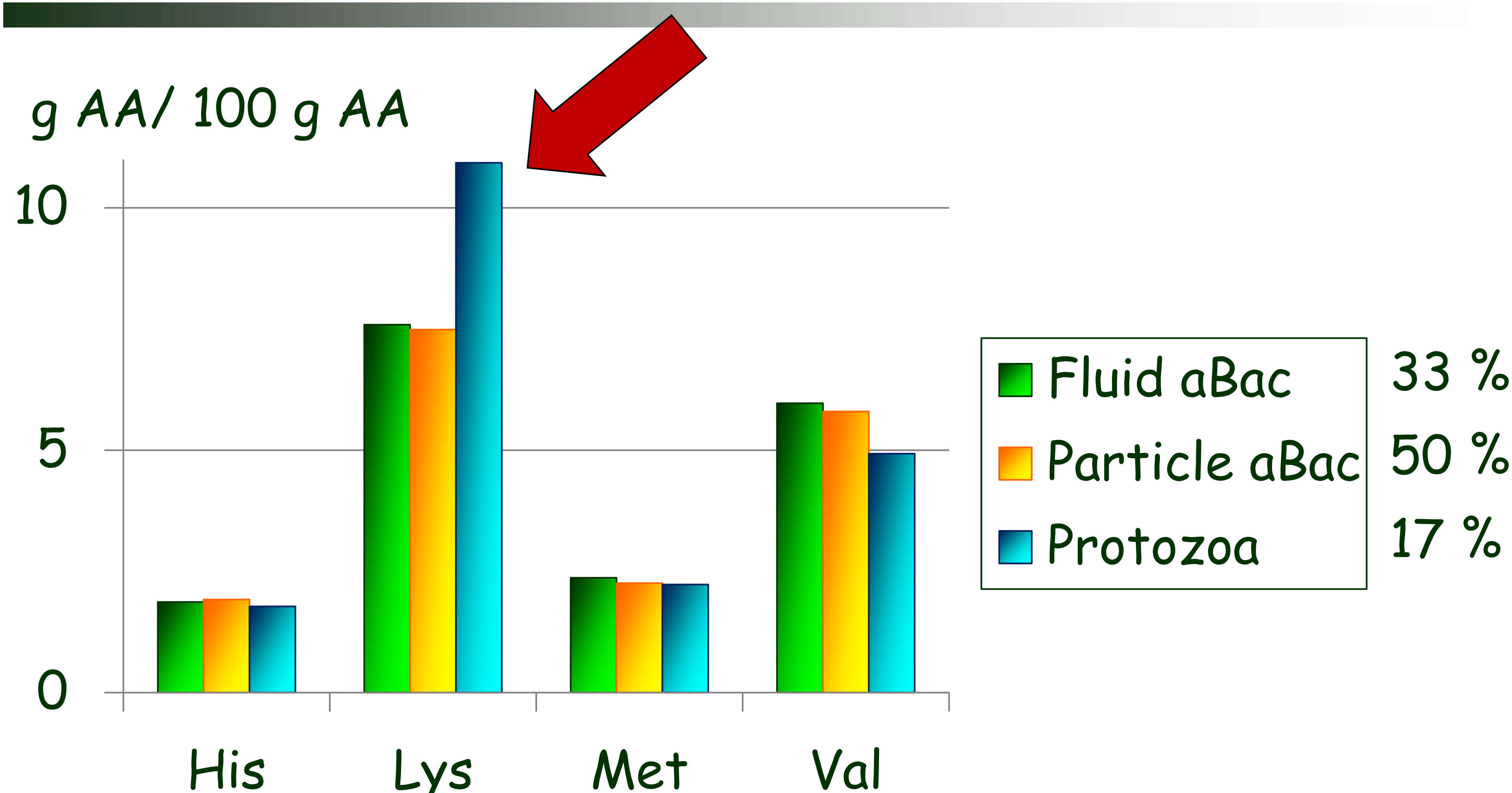
(Lapierre et al. 2016 CNC and submitted)

2. AA supply



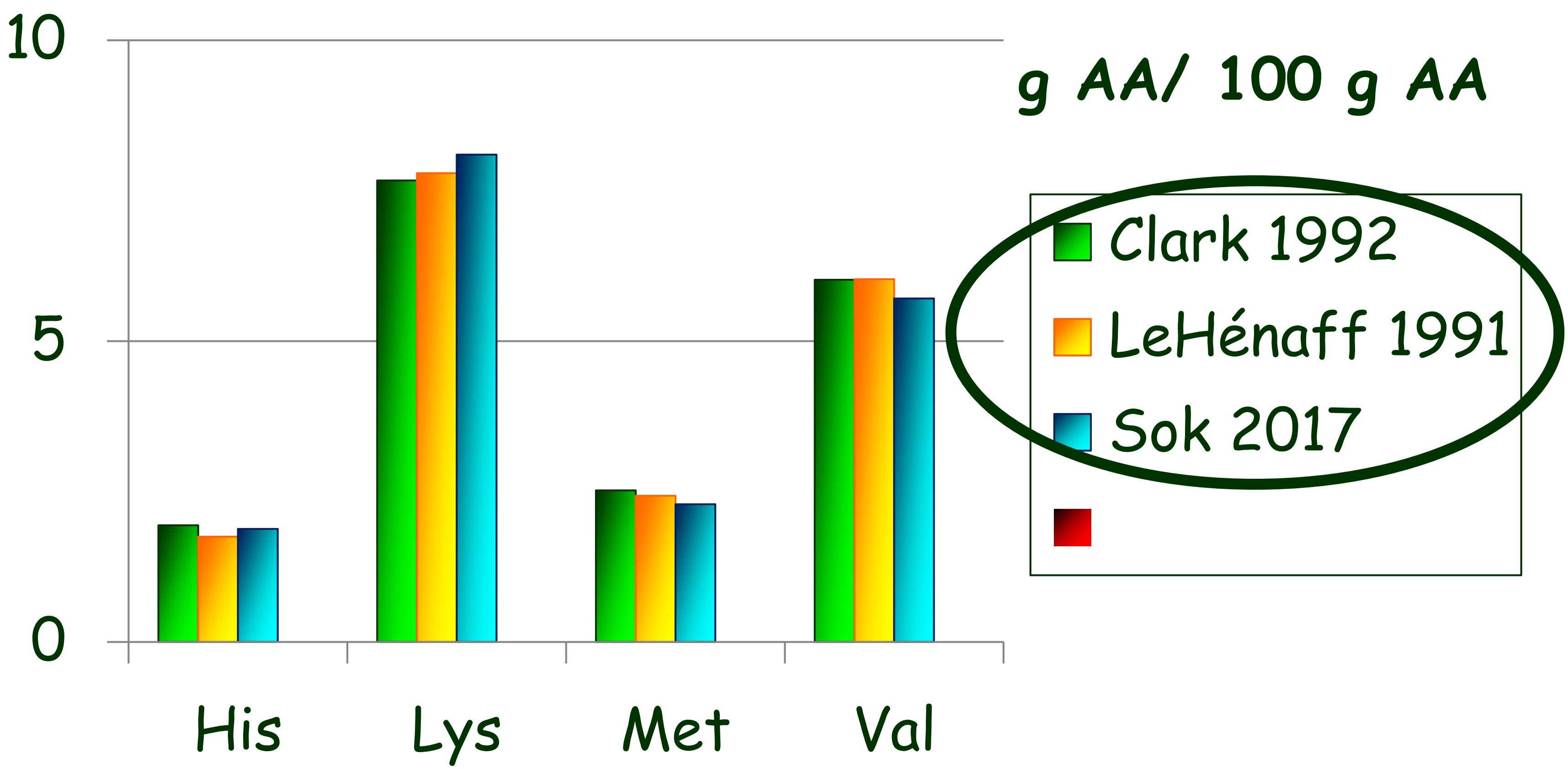
Metabolizable protein -> AA digestible flow

AA composition of rumen microbial population



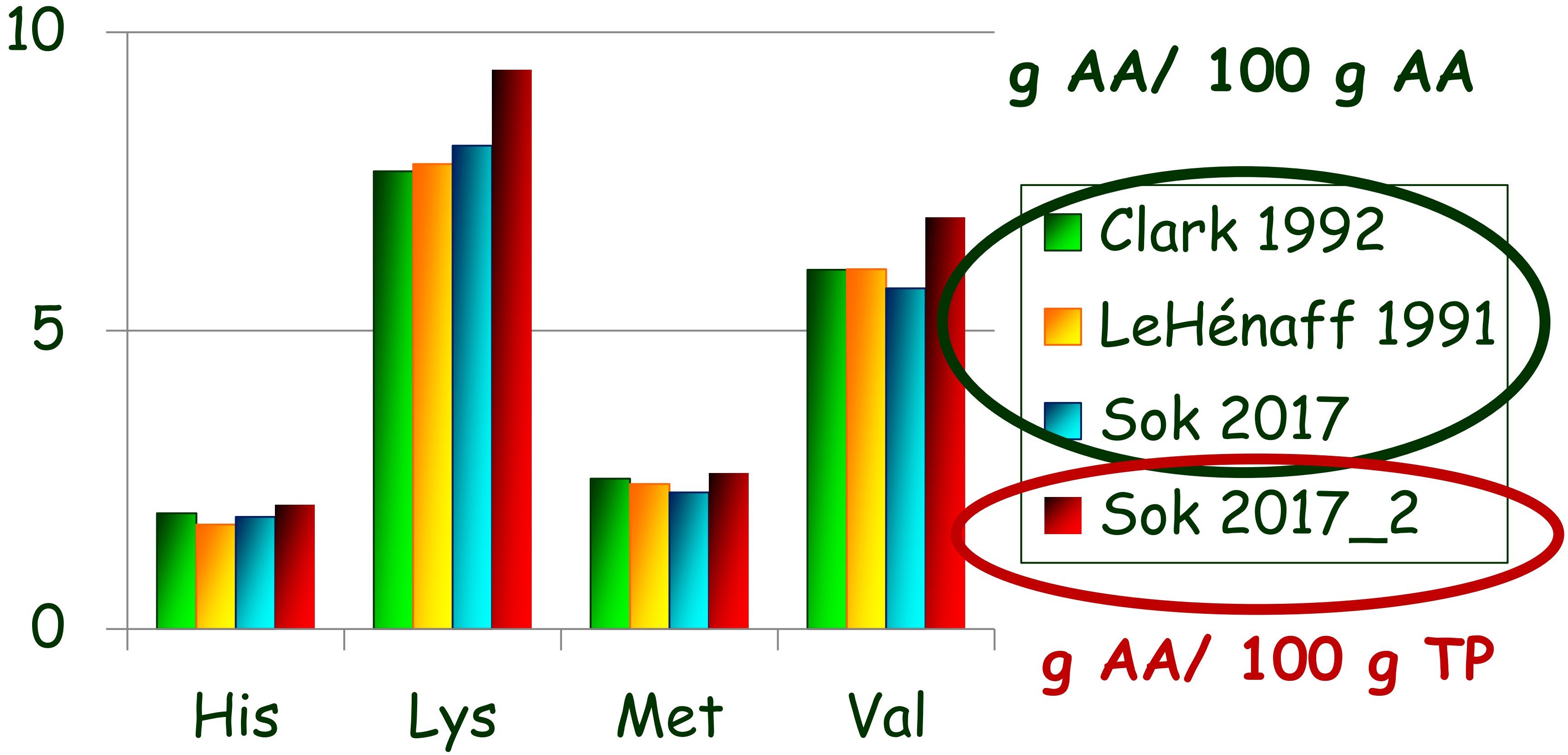
(Sok et al. 2017 JDS)

AA composition of MCP



(Sok et al. 2017 JDS)

AA composition of MCP



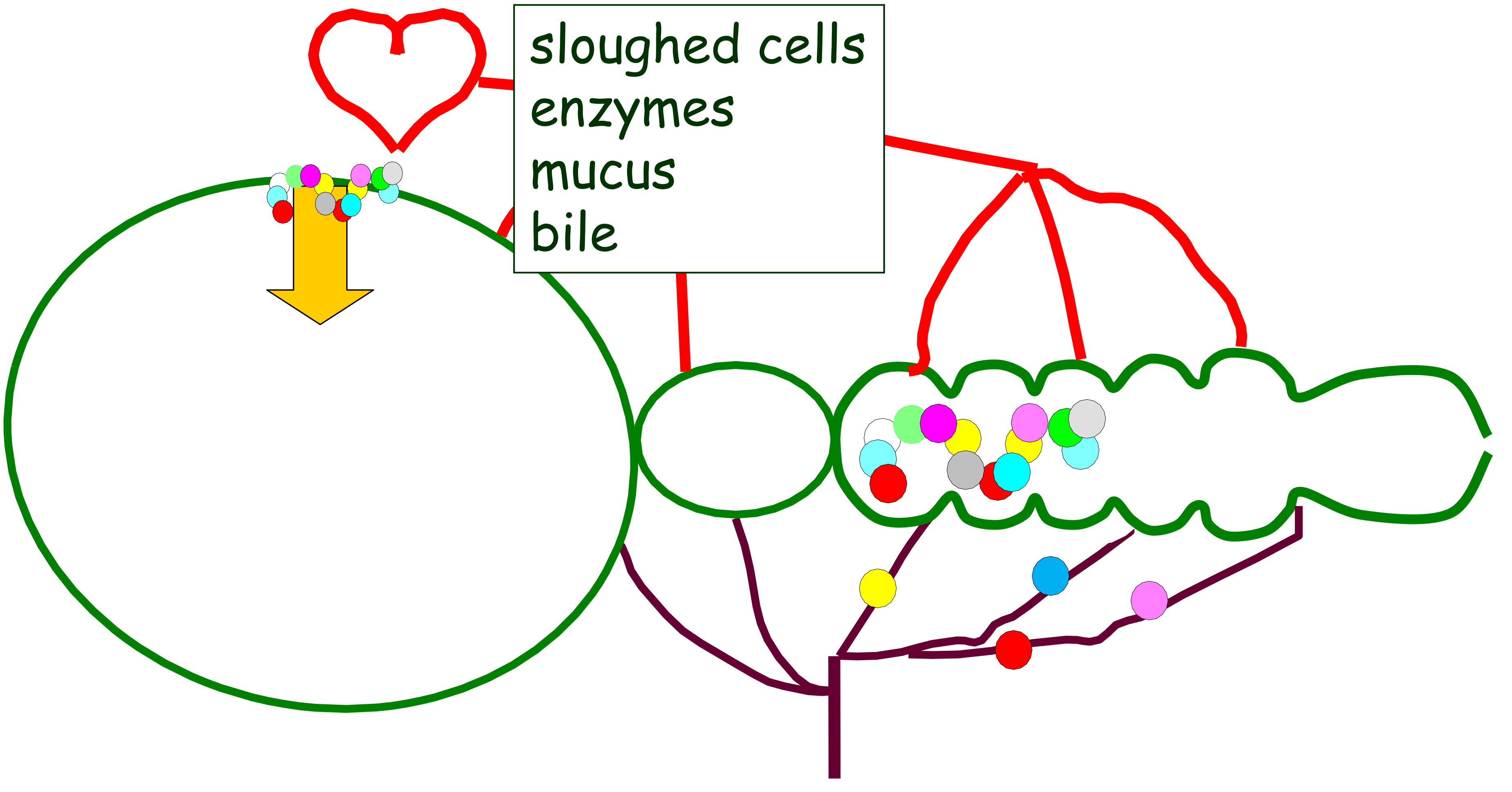
(Sok et al. 2017 JDS)

Correction factors for RUP

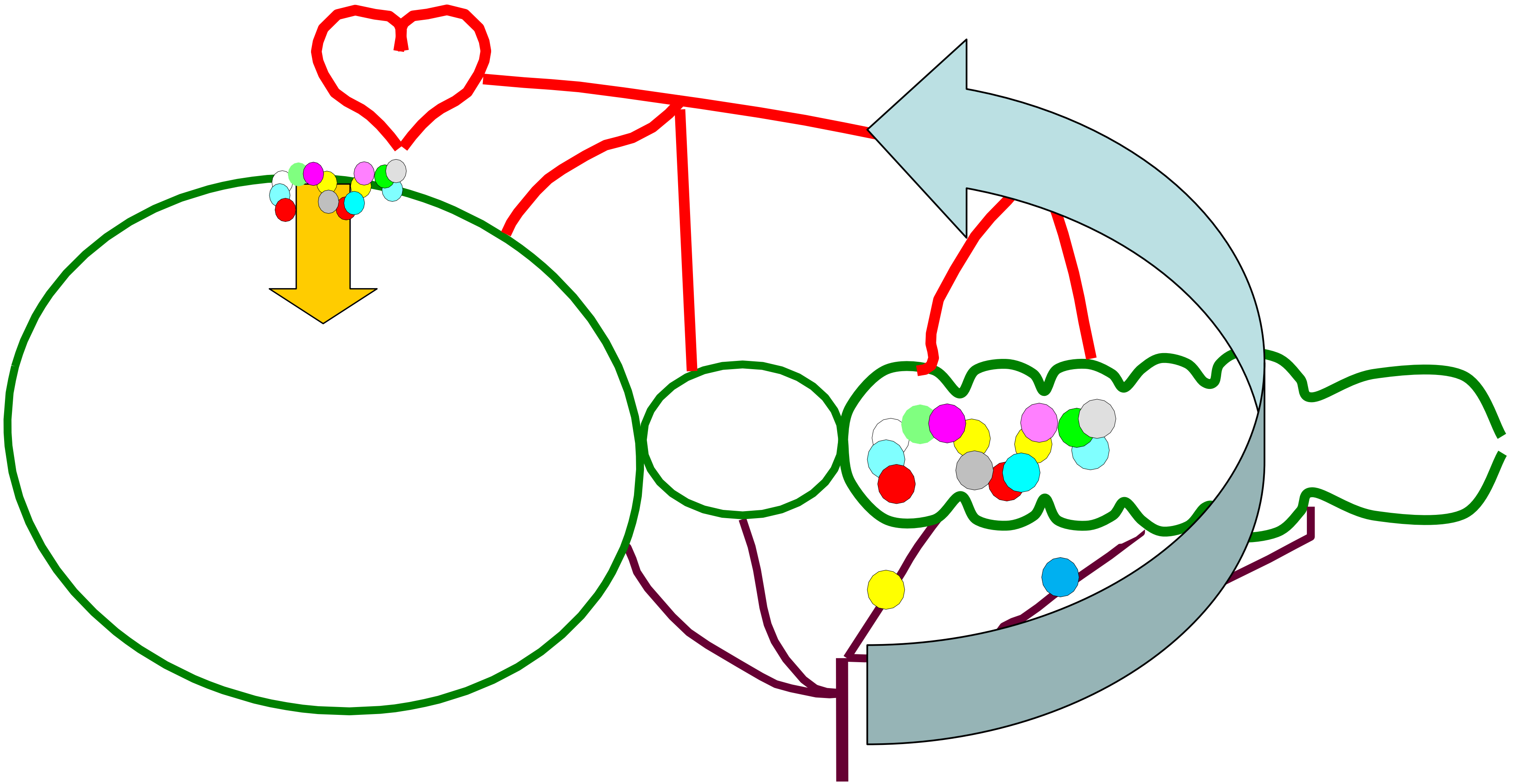
AA		Missing in 24-h hydrolysis	
His		1.02	
Lys		1.06	
Met		1.05	
Val		1.11	
Δ		1.02 – 1.23	

(Lapierre et al. 2016 CNC and submitted)

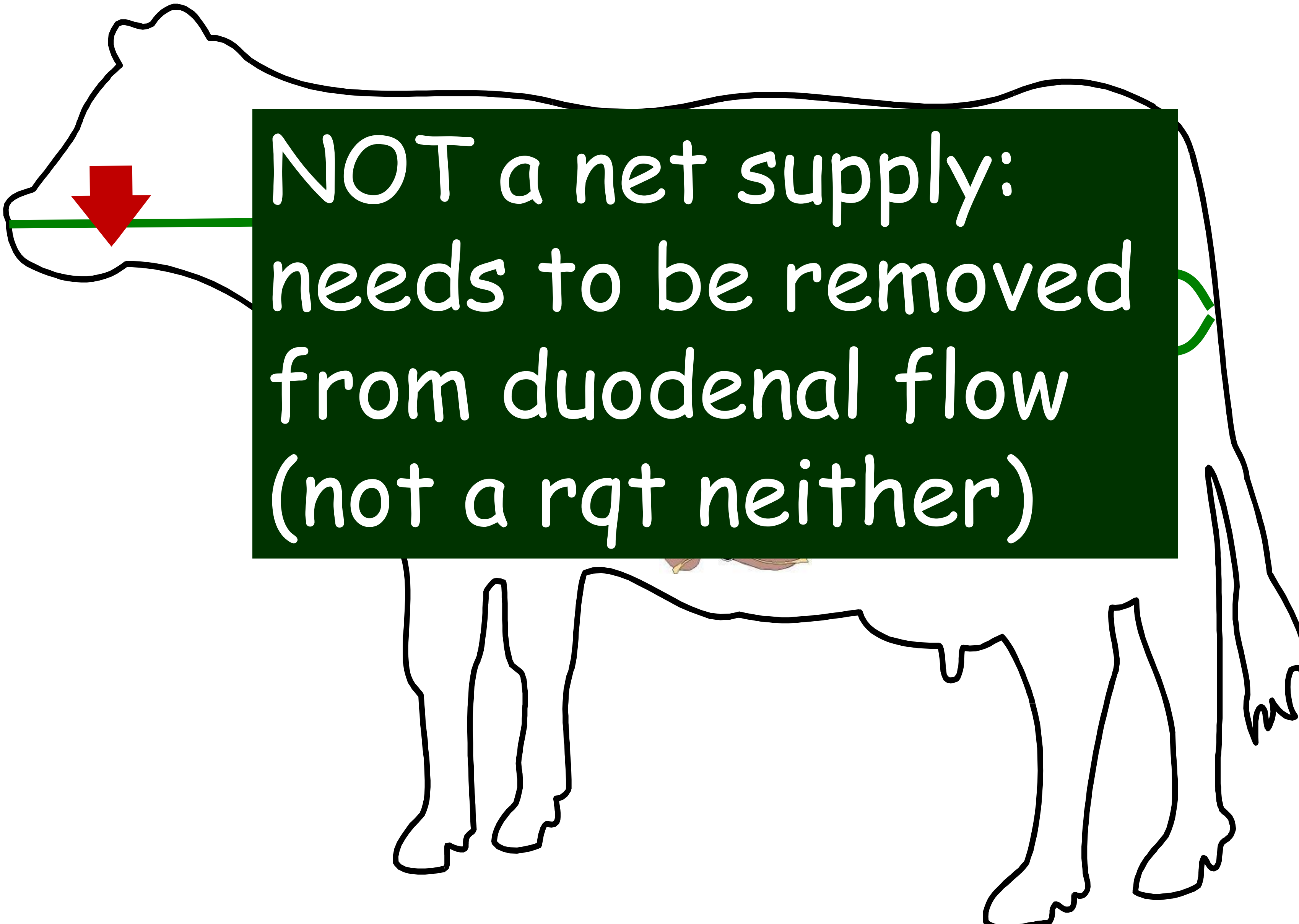
Duodenal Endogenous N?



Duodenal Endo-N : supply / rqt?

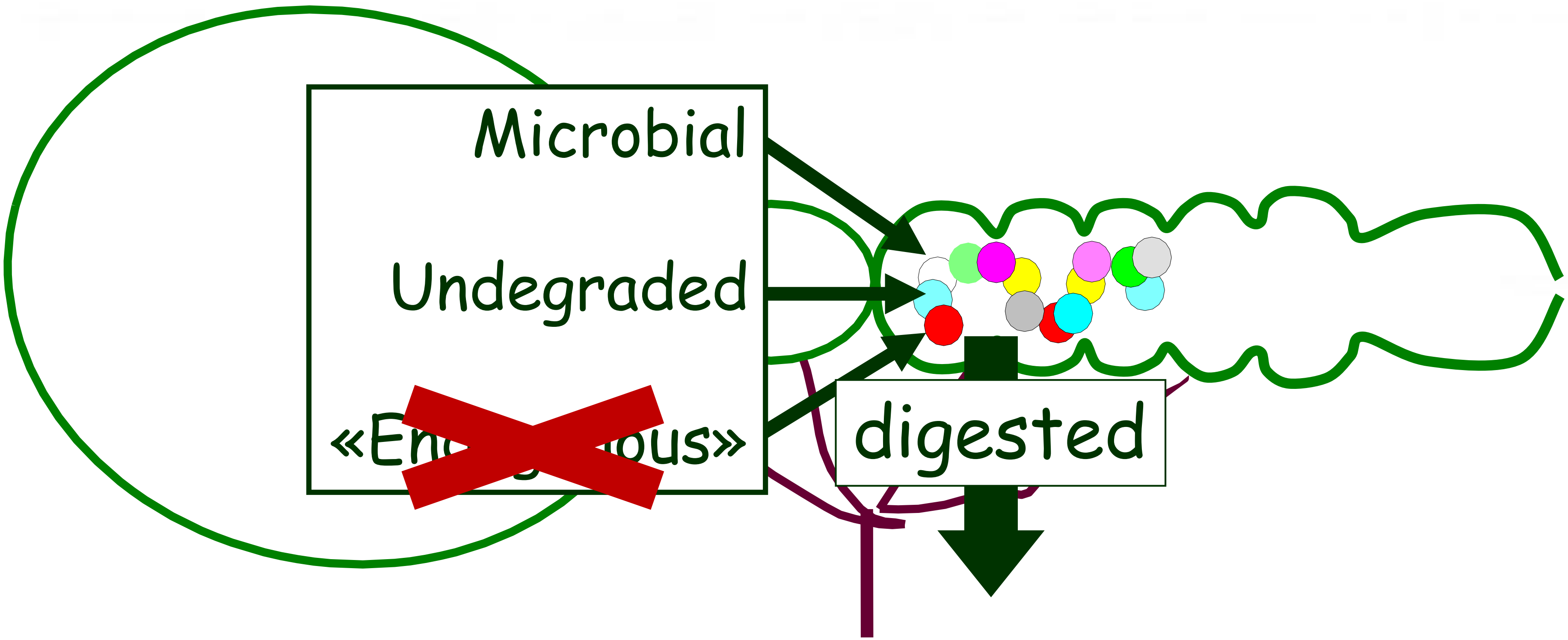


Duodenal Endo-N : supply?



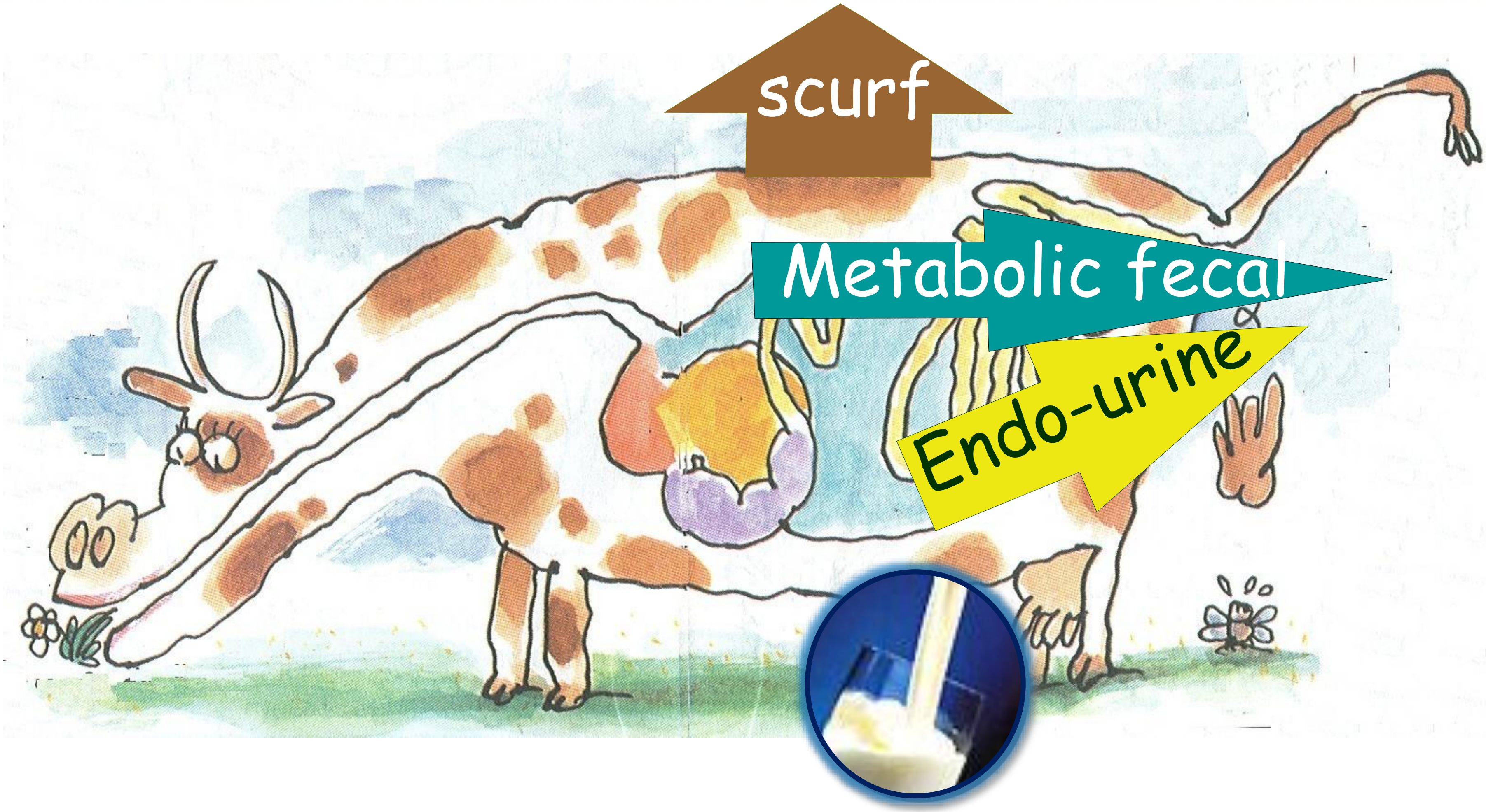
NOT a net supply:
needs to be removed from duodenal flow
(not a rqt neither)

2. AA supply



Metabolizable protein -> AA digestible flow

3. Requirement:
a. Export « proteins »



3b. [AA] in export proteins

- MP rqt = true protein
- [AA] in export proteins
  -> [AA] in g AA / <u>**100 g TP**</u>

3b.i [AA]: Scurf

- TP / CP = 0.85

- Head, hide, feet and tail

(Williams 1978 & Van Amburgh et al. 2015)

3b.ii [AA]: Endo Uri

- Endogenous urea (±18% of EndoUri):
  -> **empty body composition**
- Endogenous PD: Asp, Gln, Gly
- Creatinine / creatine: Arg, Gly
- 3-methyl His: His
- Hippuric acid: Gly

3b.iii [AA]: MFP

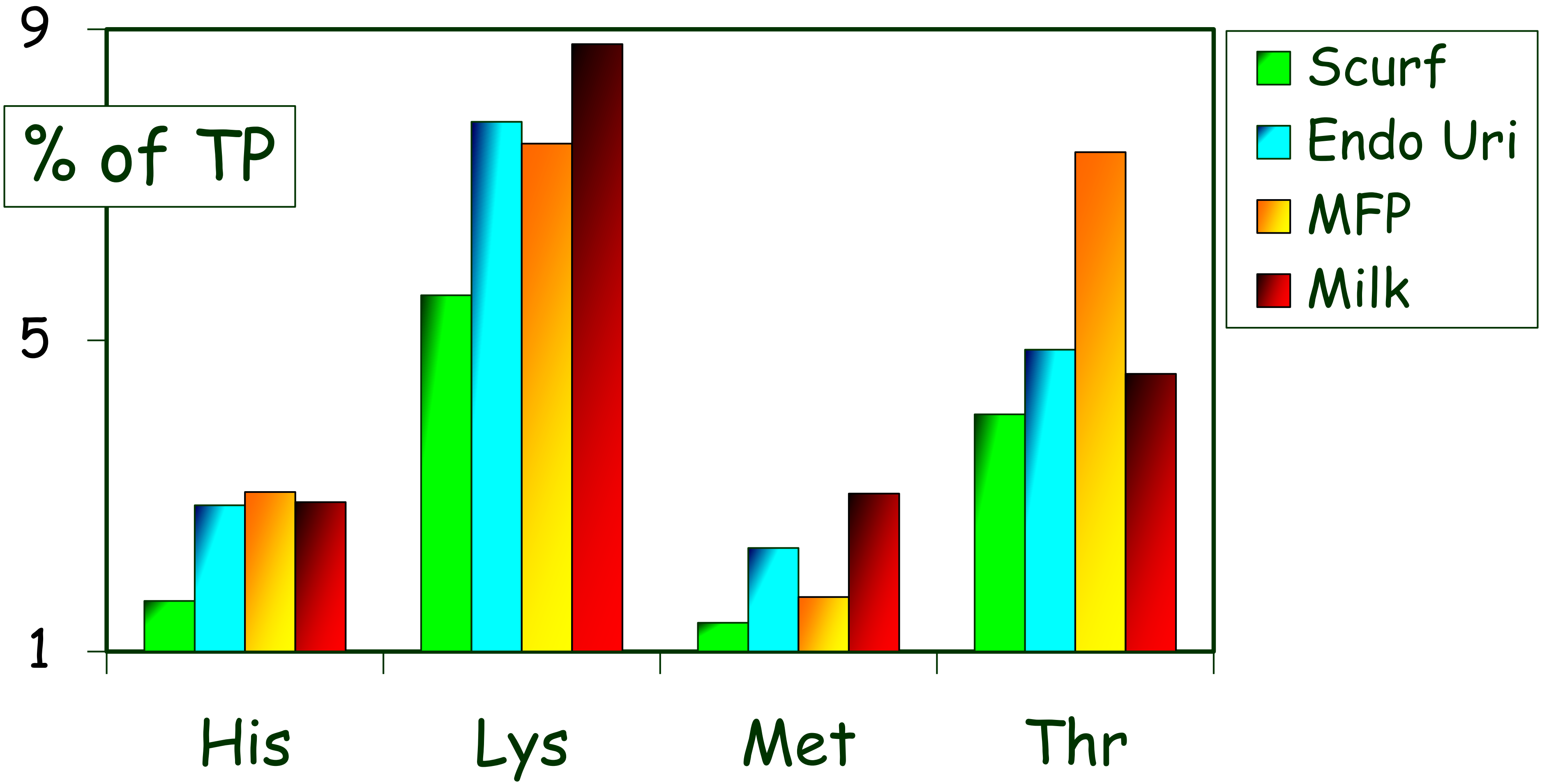
- 70% forestomach segment:
  Ørskov et al. 1986
- 30% small intestinal endogenous secretion in pigs: Jansman et al. 2002

- TP / CP = 0.73

3b.v [AA]: Milk

- from primary structures (DNA seq.) of protein fractions *(Farrell et al. 2004)*
- average contribution of protein fractions to milk protein *(15 studies)*
  - 82.4 % CN
  - 17.6 % whey

3b. [AA] in export TP



3c. Efficiency

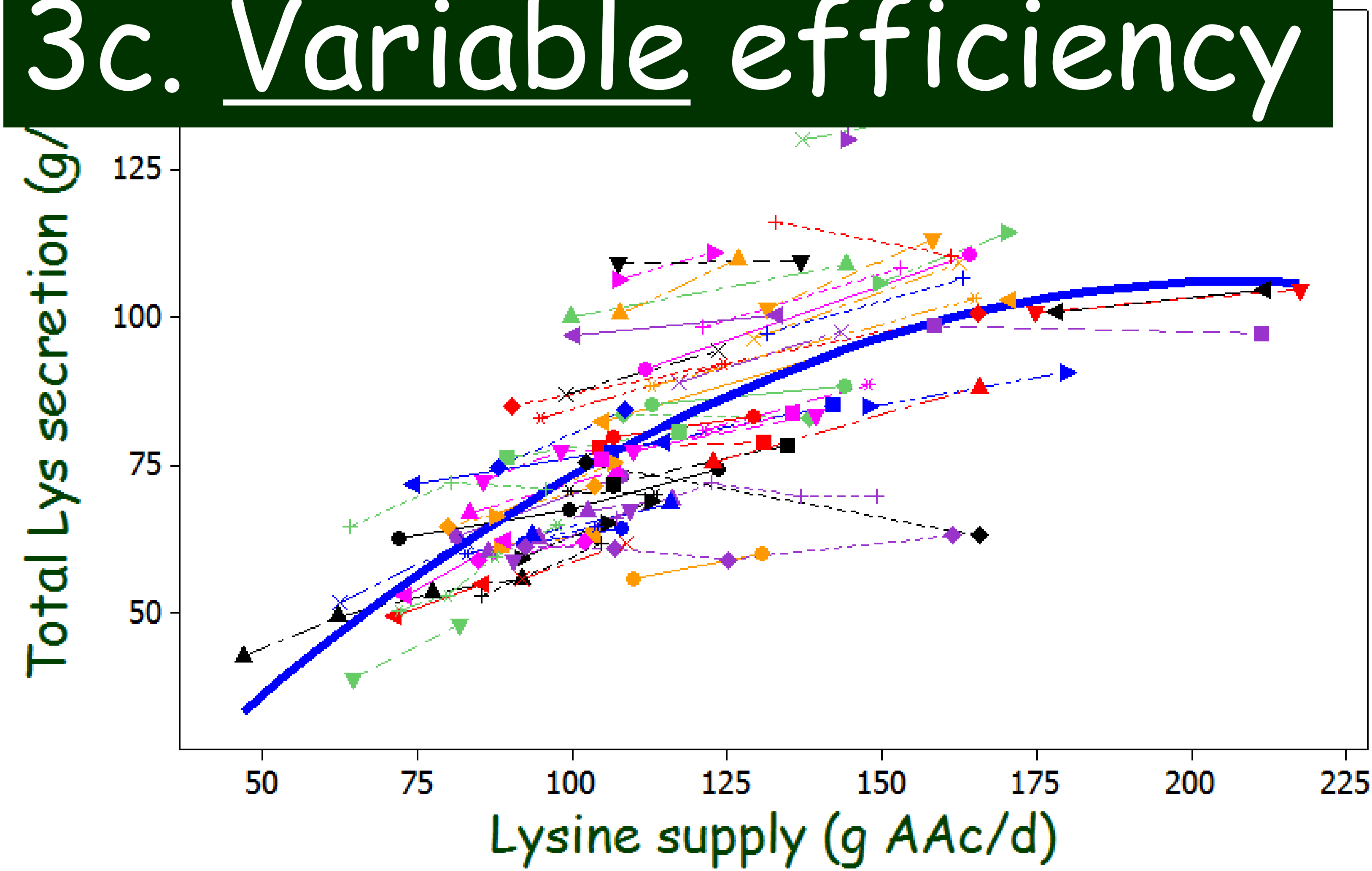
- For *AA* (and MP), an efficiency for maintenance and an efficiency for lactation have been traditionally used
- $$RQT = \frac{Export_{MAINT}}{Eff_{MAINT}} + \frac{Export_{MILK}}{Eff_{MILK}}$$

Combined efficiency

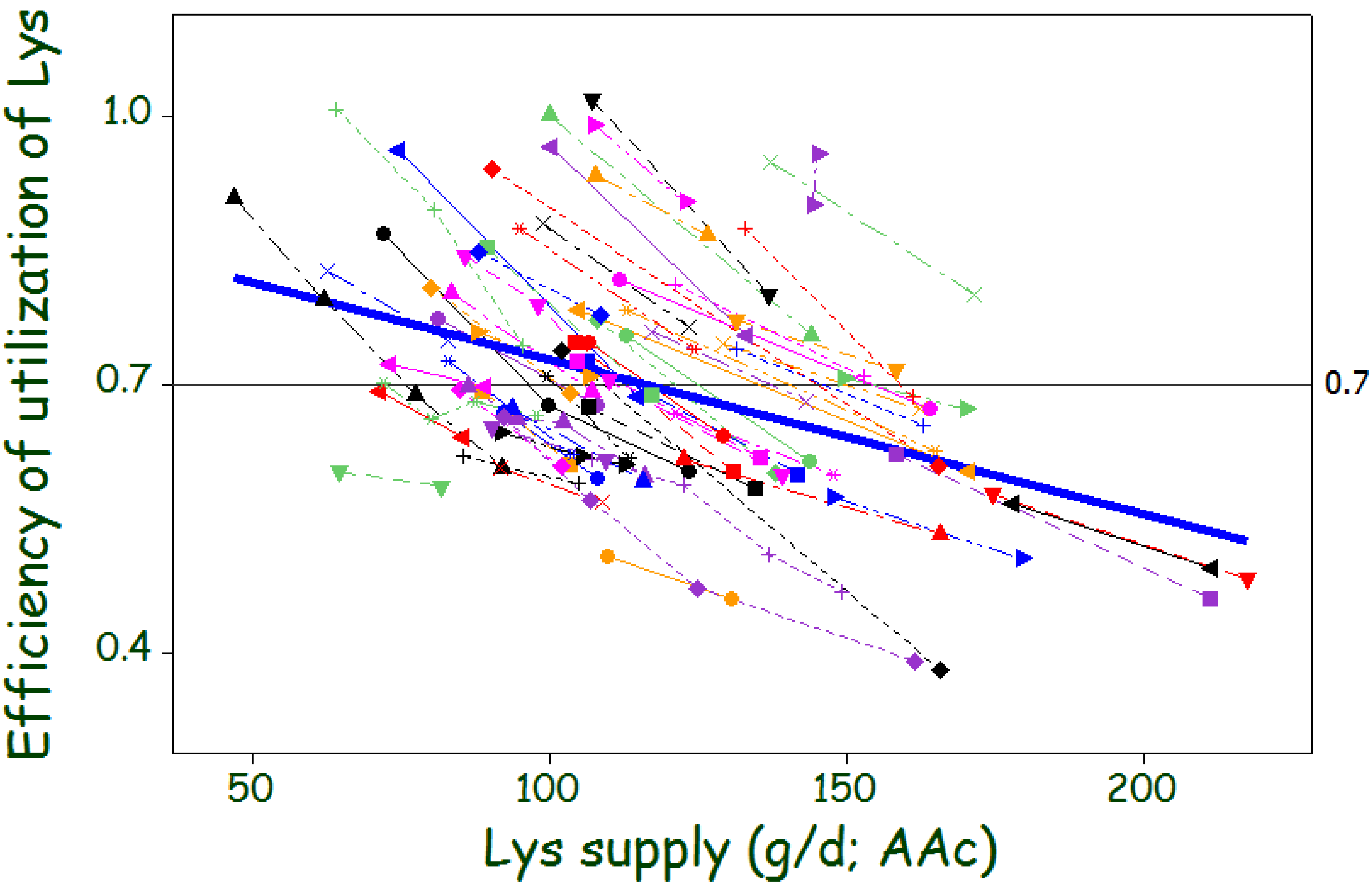
$$= \frac{\sum[\text{Export} + \text{Accretion}]}{\text{Supply}}$$

- Export = Milk + metabolic fecal protein (MFP) + scurf
- Accretion = growth + gestation
- Endogenous urinary = end-products -> efficiency of 1

3c. Variable efficiency



Studies from Martineau et al. 2016;
Export and supply exclude Endo Uri for which efficiency has been set at 100%



Efficiency of utilization of Lys
1.0
0.7
0.4
0.7
50
100
150
200
Lys supply (g/d; AAc)

Variable efficiency of utilization of AAc

AA	Mean	Min	Max	
His	0.79	0.41	1.28	
Lys	0.70	0.38	1.02	
Met	0.77	0.39	1.21	
Val	0.65	0.38	0.97	

Studies from Martineau et al. 2016;
Export and supply exclude Endo Uri for which efficiency has been set at 100%

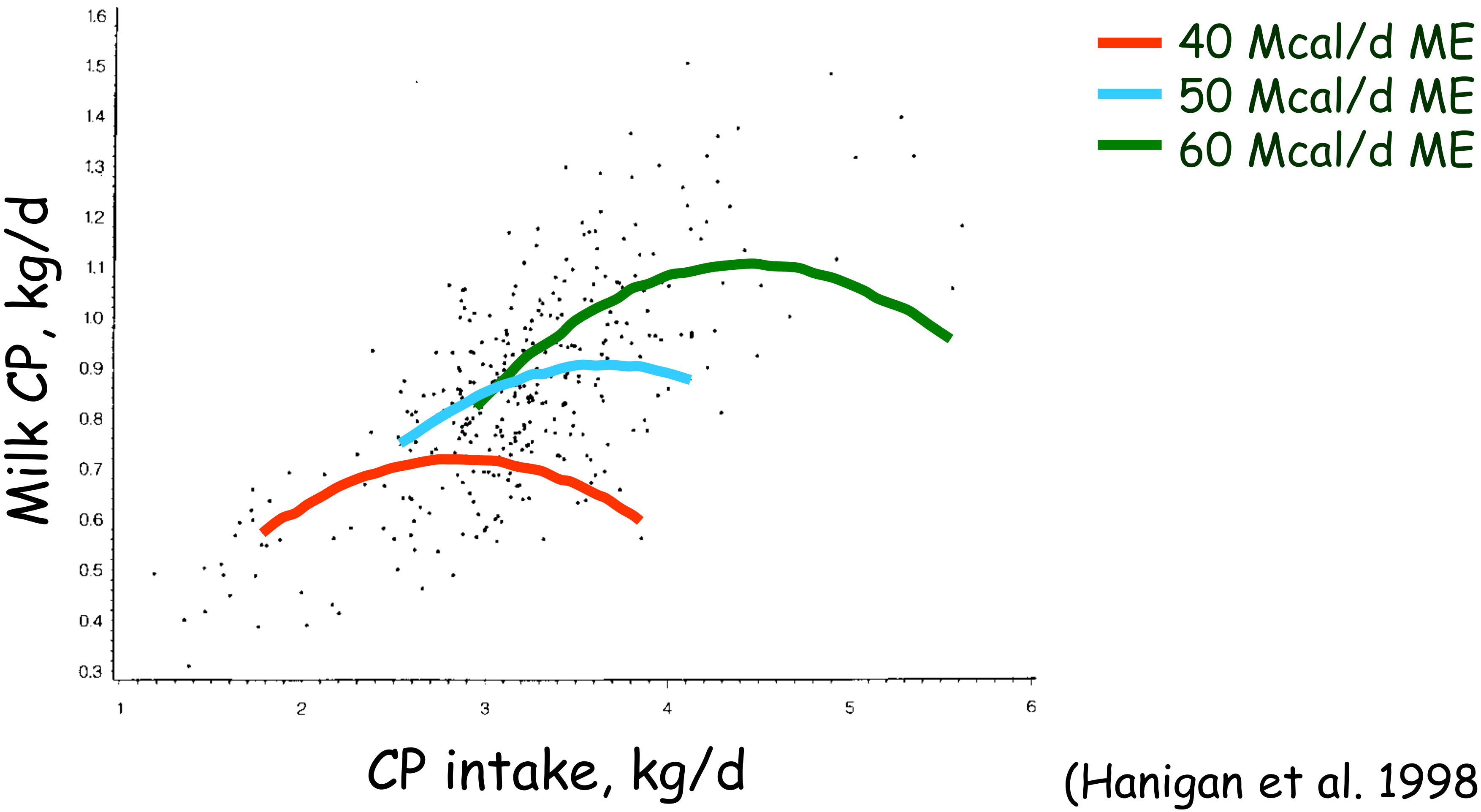
3c. Efficiency of AA use

- Variable
- Decreases with increased supply

  -> α increased [AA]

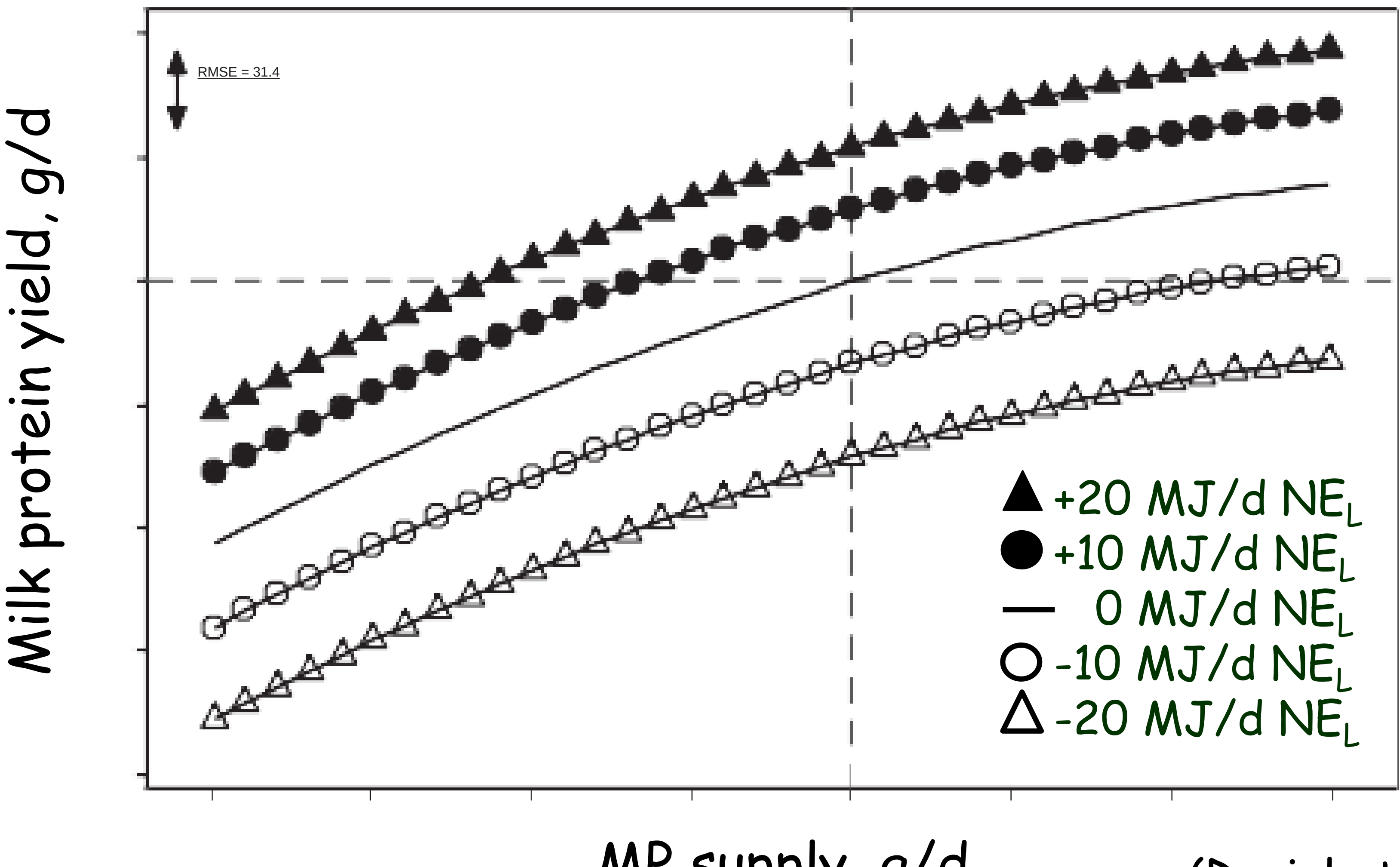
3. Other factors related to variable efficiency?

Energy affects MPY response to CP supply

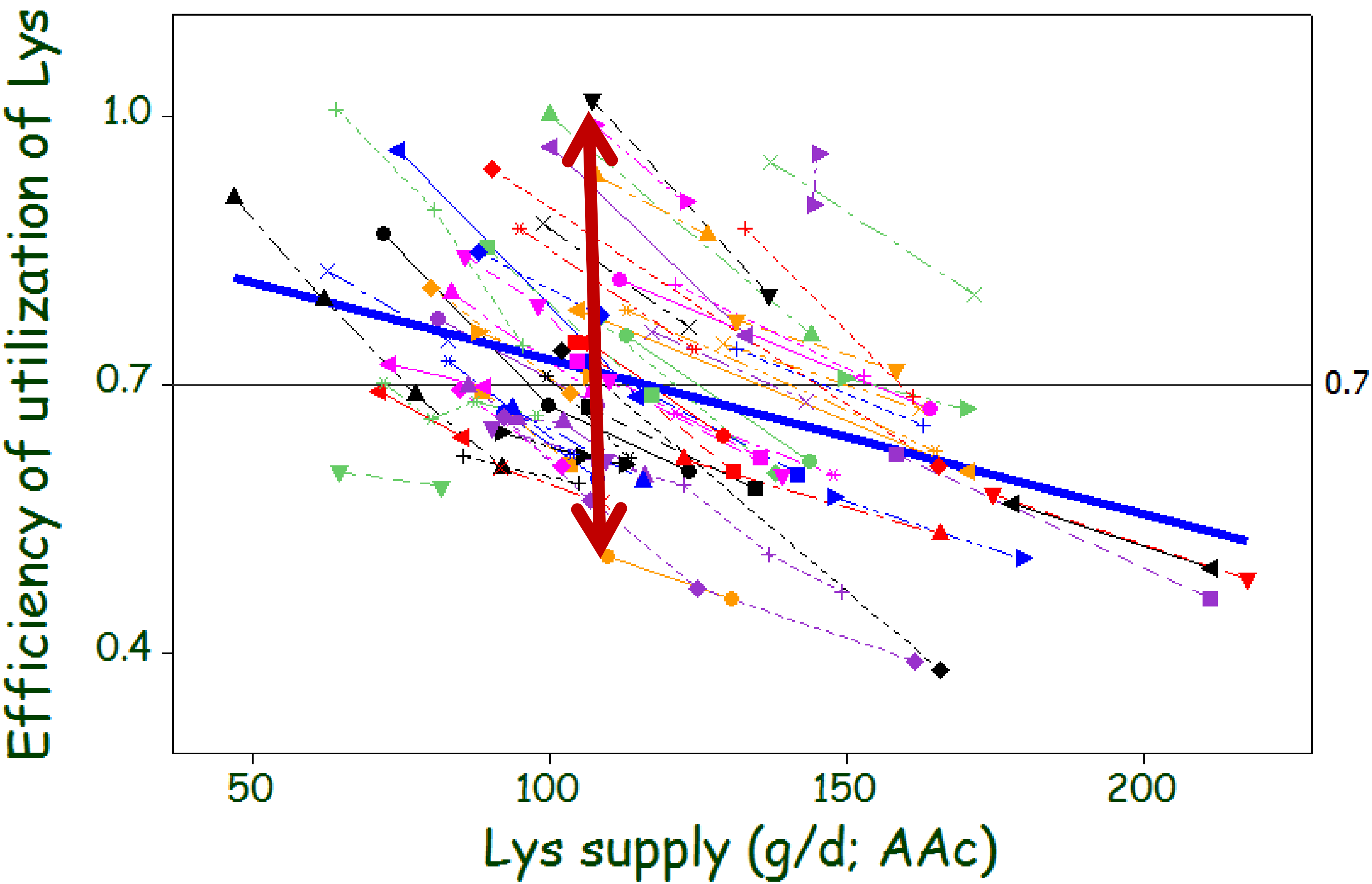


(Hanigan et al. 1998)

Energy affects MPY response to MP supply



(Daniel et al. 2016)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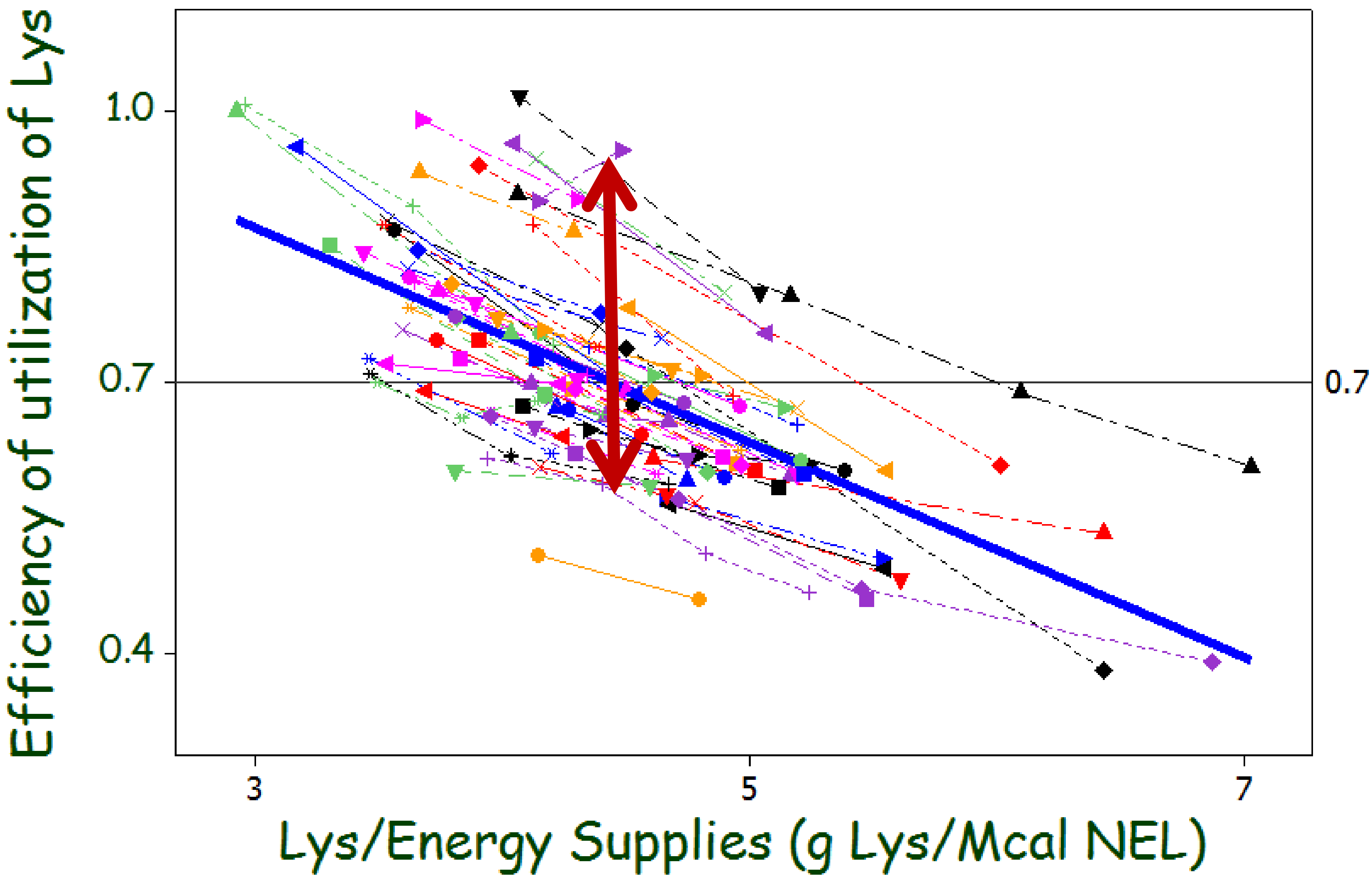


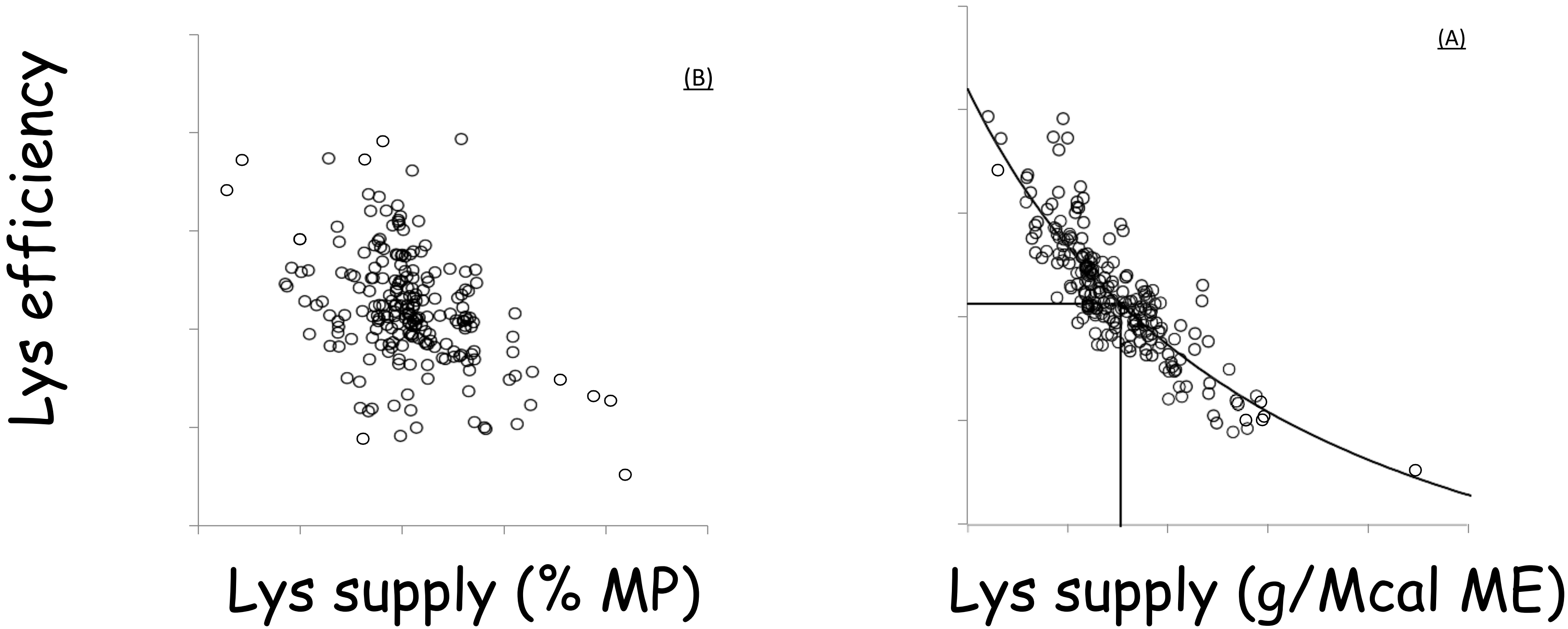
Efficiency of utilization of Lys
1.0
0.7
0.4
0.7
3
5
7
Lys/Energy Supplies (g Lys/Mcal NEL)

Inclusion of energy in the estimation of efficiency of MP

- NorFor -> MP/NE_L *(Volden et al. 2011)*
- DVE/OEB_{2011} -> MP/NE_L *(Van Duinkerken et al. 2011)*
- INRA (2018) : Export protein = fct (MP, NE_L, %Lys, %Met)

Ratio of AA/energy used to make recommendations

- Pigs
- CNCPS (van Amburgh, 2018)



3c. Efficiency of AA use

- Variable
  - Decreases with increased supply
  - Increases with energy supply

4. Impact of balancing for His, Lys & Met

N-CyCLES (Pellerin et al. 2017):

- Excel-based linear whole-farm model simulator
- Using initially NRC (2001) MP model **(MP 2001)**
- Adapted with MP and AA revised recommendations **(AA_Rev)** including variable efficiency of AA
- Assumes no change in MTPY
- Based on 2010-2014 records

Comparison made with 3 production systems/regions:

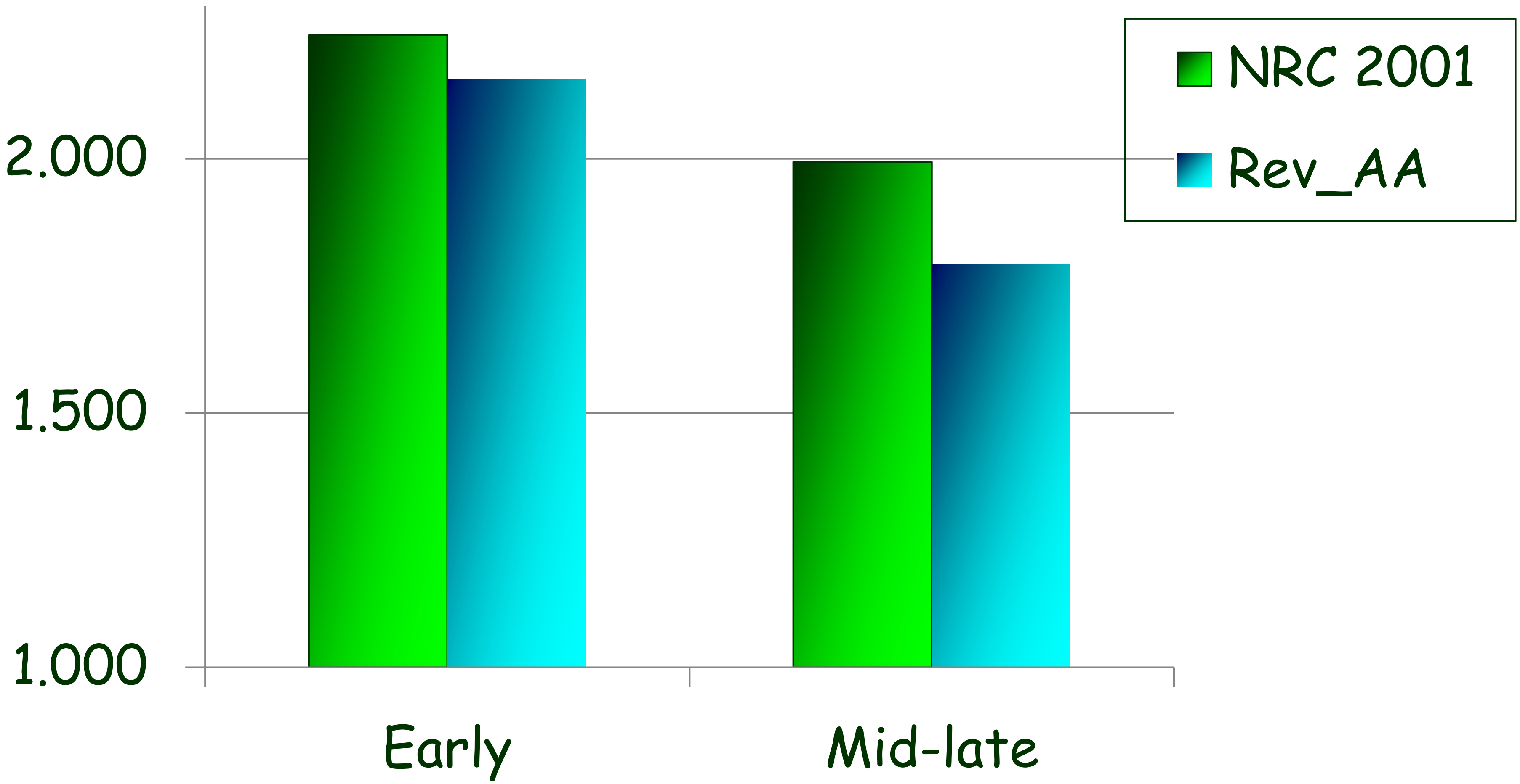
- Maritimes: 8608 kg milk /year, 63 cows
- Central Canada: 9102 kg milk /year, 71 cows
- Prairies: 9198 kg milk /year, 144 cows

Feed ingredients used

Forage	Energy	Protein
Alfalfa silage	Corn grain	Canola meal
Mix silage	Wheat grain	Soybean meal
Corn silage	Barley grain	Corn gluten meal
Grass hay	Ca soap fatty acids	Corn distillers
Straw		
Legume-haylage		Wheat distillers
Barley silage		Pea

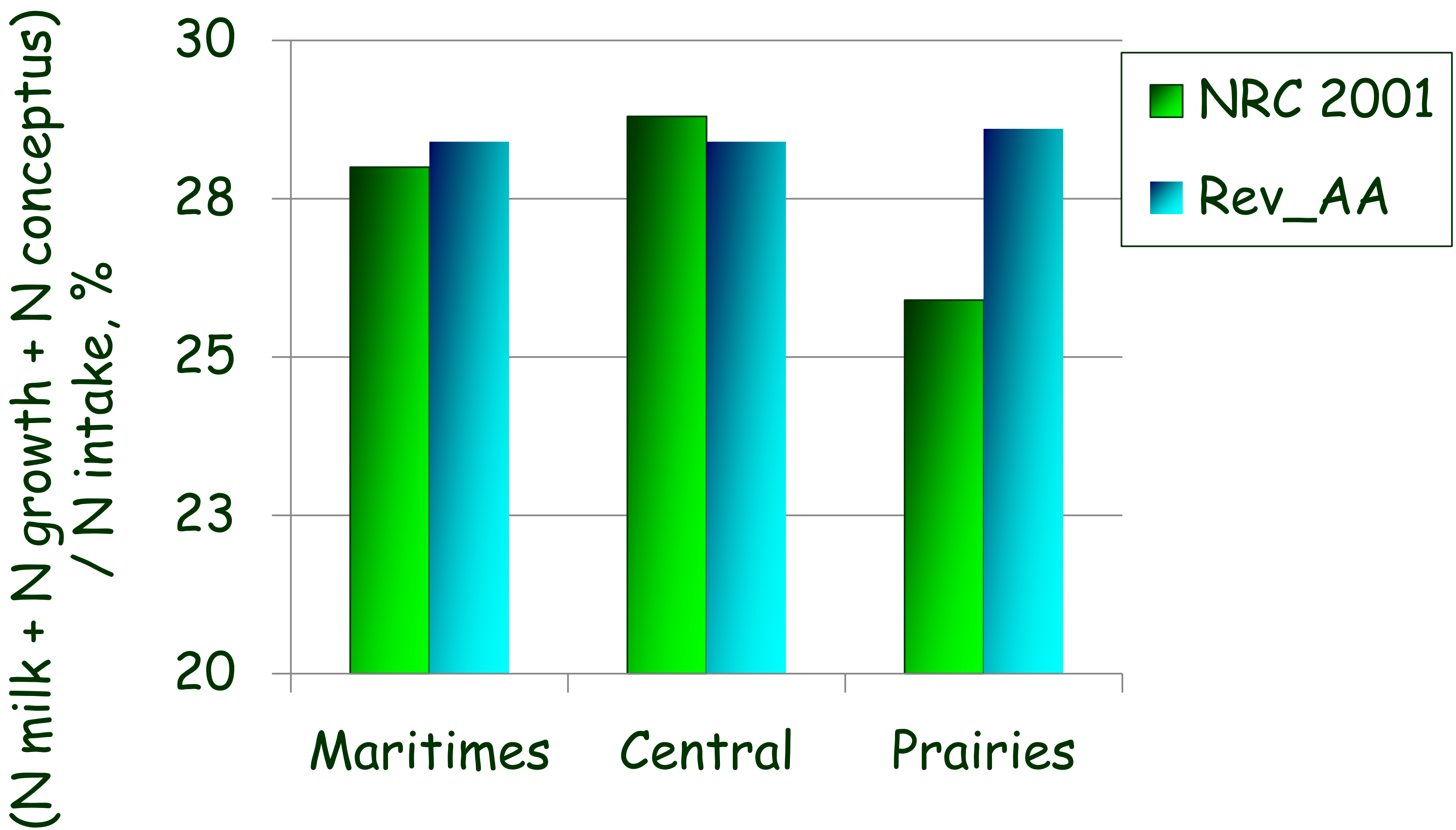
Not available in the Prairies system
Only available in the Prairies system

MP supply, g/d



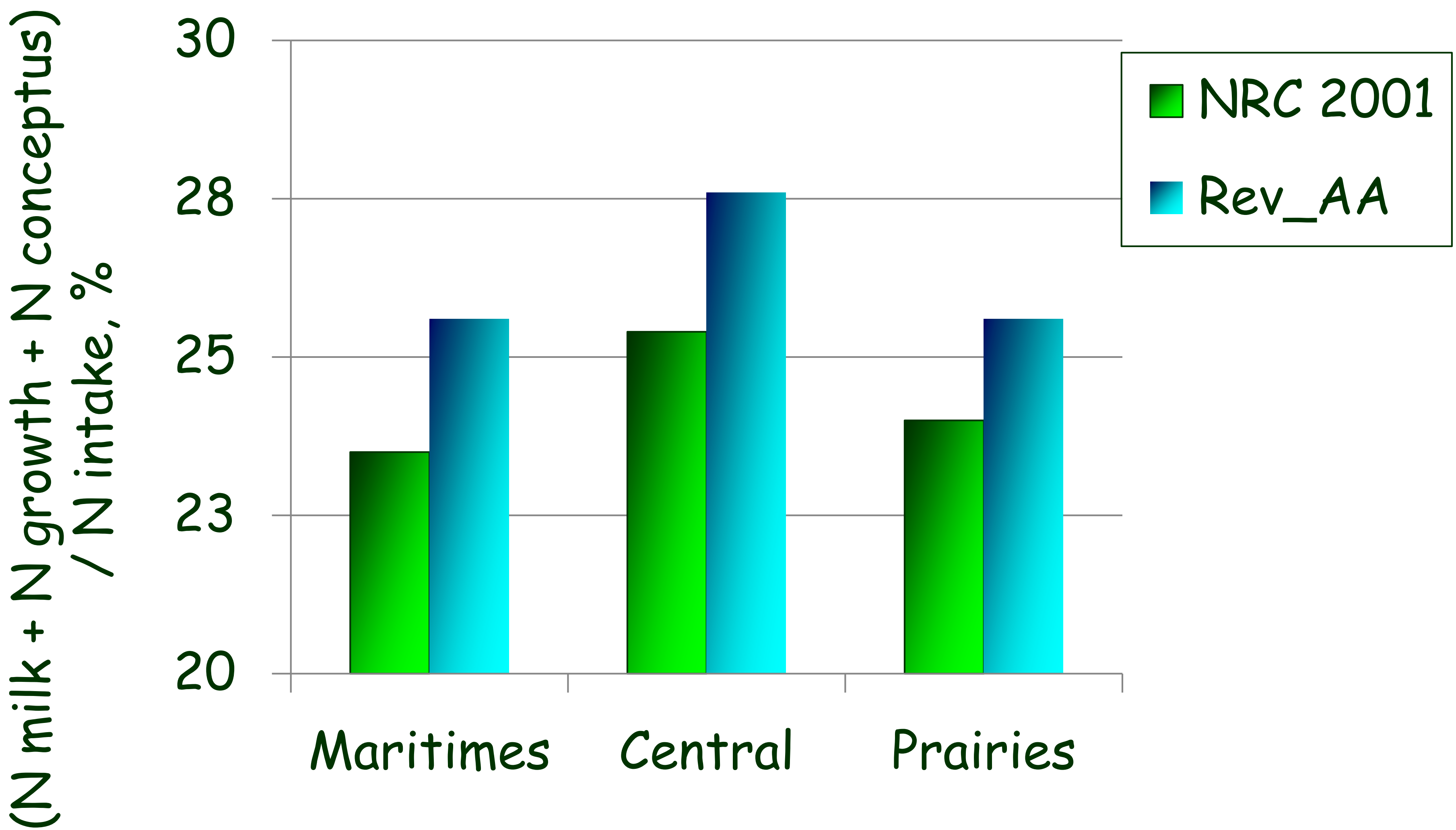
Binggeli et al. 2017 & unpublished

N efficiency in early lactating cows



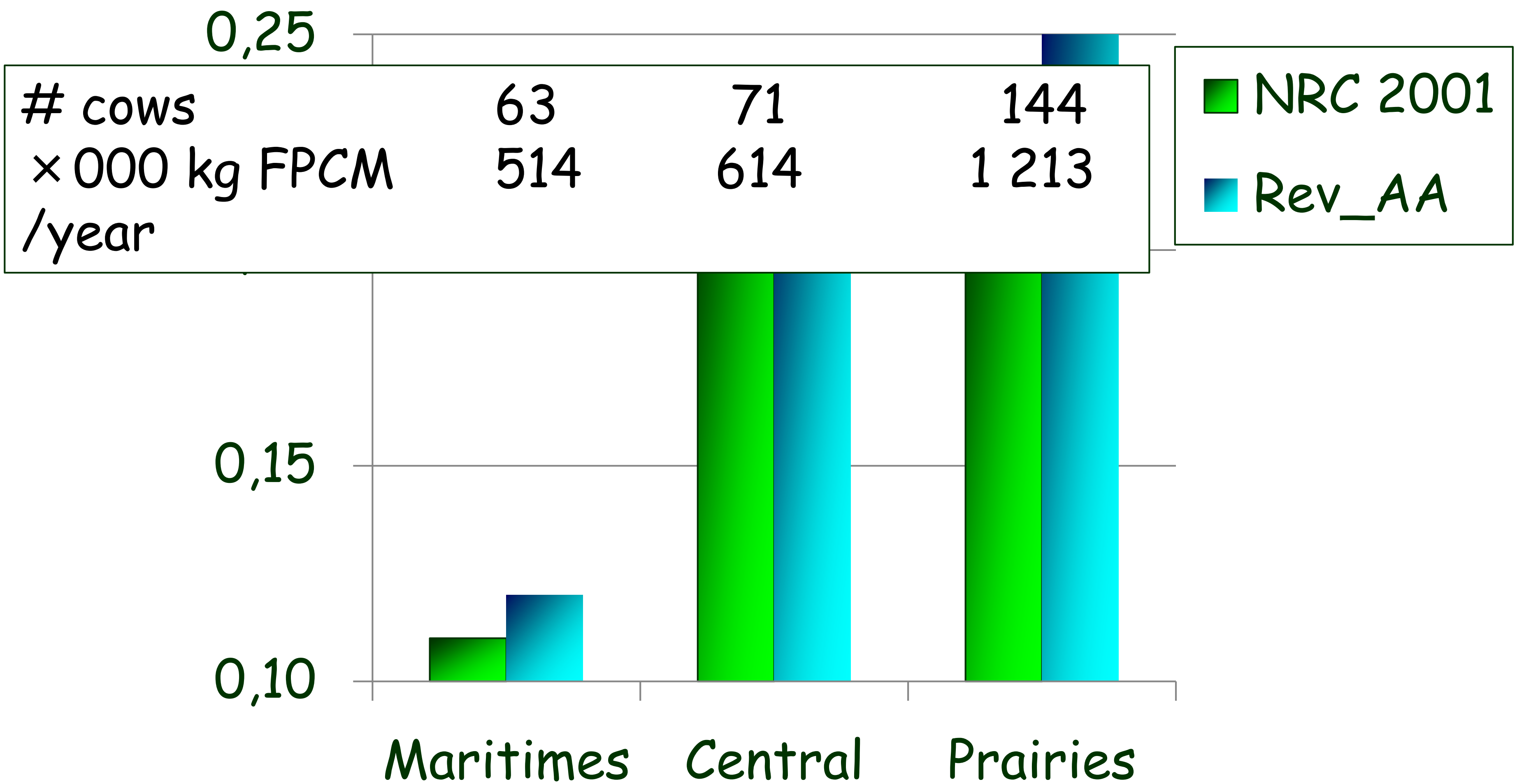
Binggeli et al. 2017 & unpublished

N efficiency in mid-late dairy cows



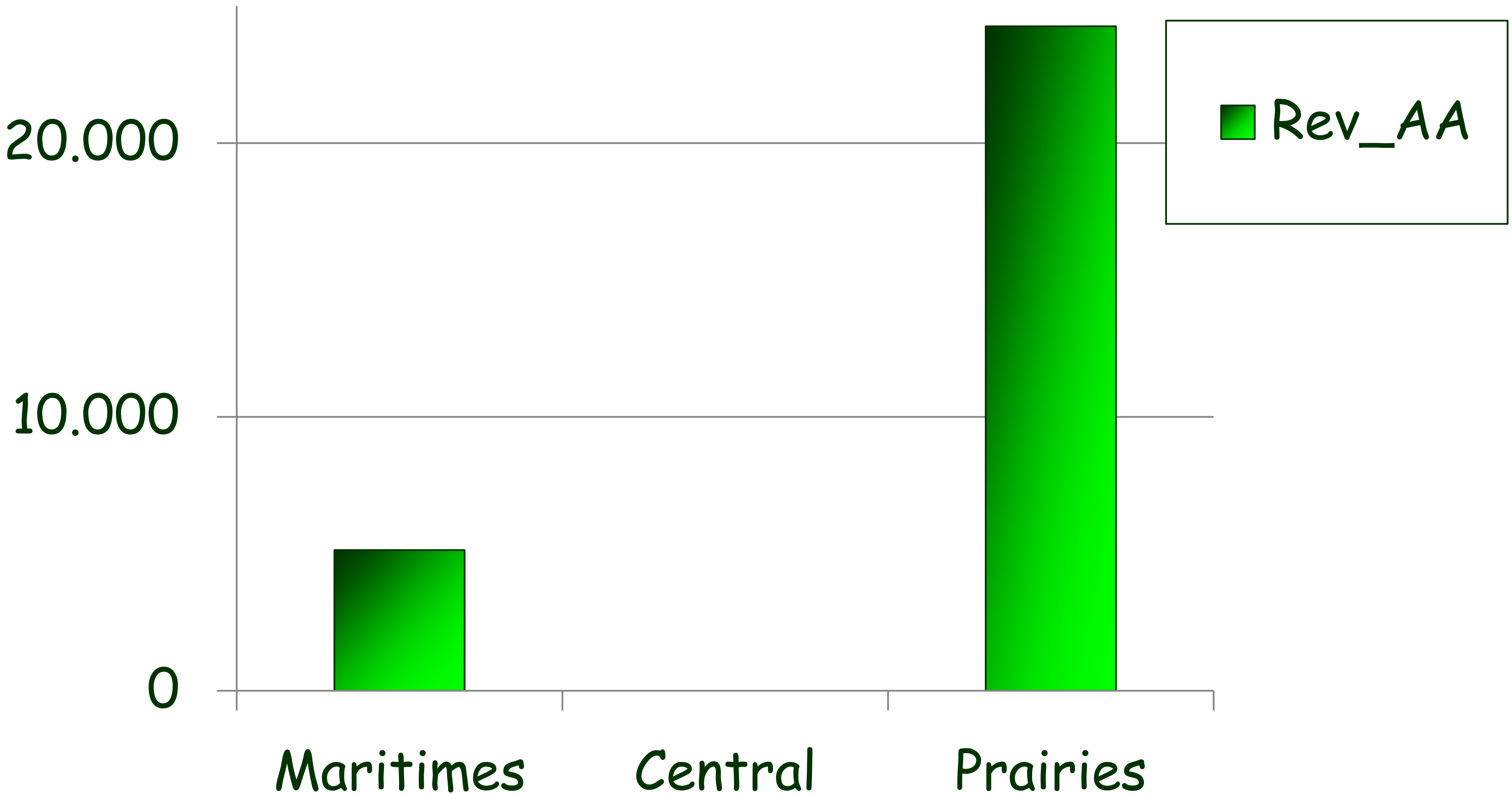
Binggeli et al. 2017 & unpublished

Net income, $/kg FPCM



Binggeli et al. 2017 & unpublished

Increased net income, CAN$ per farm



Binggeli et al. 2017 & unpublished

Conclusion

- ☑ Improved assesment of AA supply
- ☑ Improved assesment of exported AA
- ☑ Combined and variable efficiency

-> sufficient elements to improve the factorial method to balance dairy rations for EAA

-> should work for all EAA (not Arg)

Conclusion

- Balancing for EAA rather than MP would generally increase:
  - -> N efficiency
  - -> dairy farm profitability
  - -> but varies according to the production system
- **Are we ready to forget about MP and balance only for EAA?**


Questions?

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Agriculture et Agroalimentaire Canada

Mange tak!

Canada