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Prediction of milk protein yield using different feed evaluation systems

Canada

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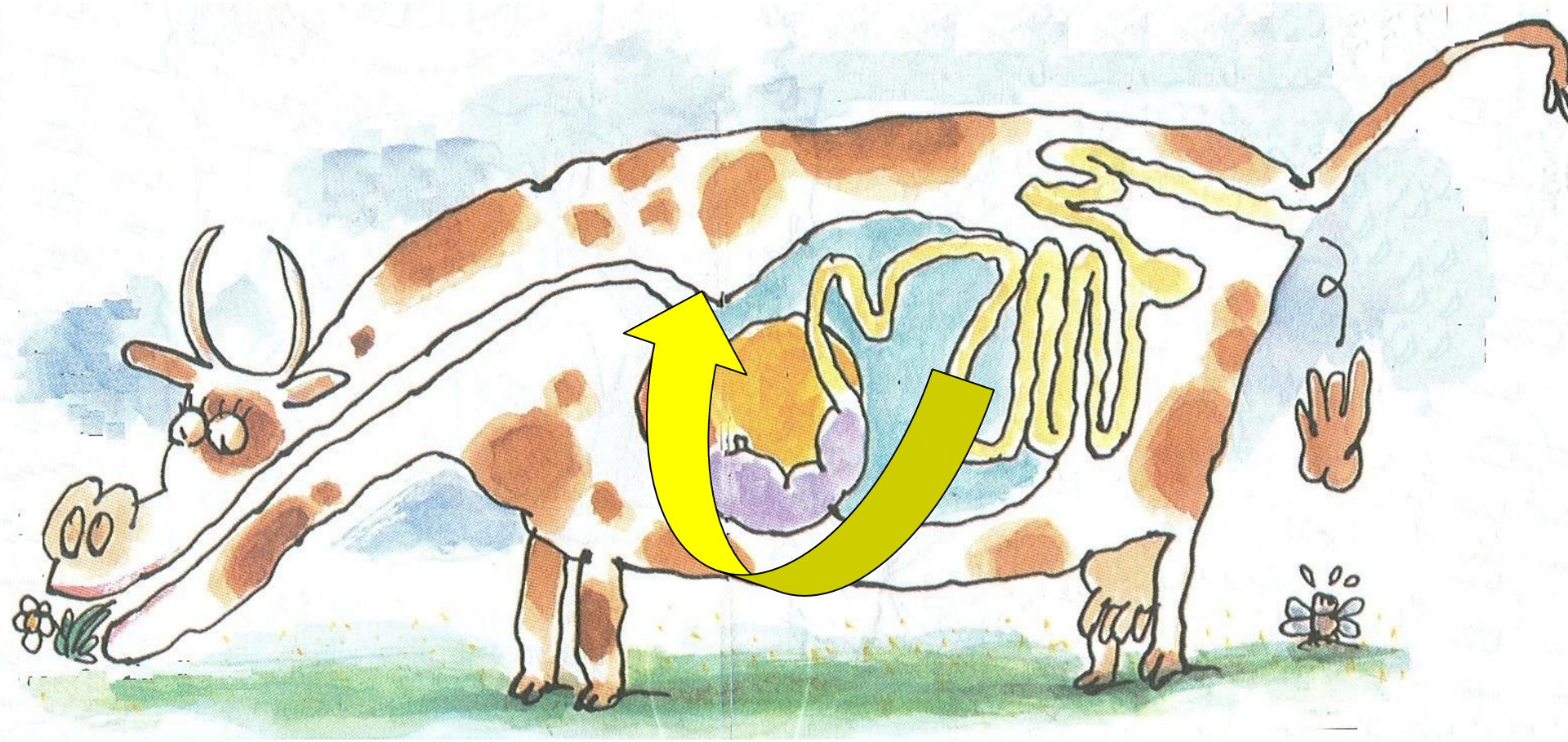
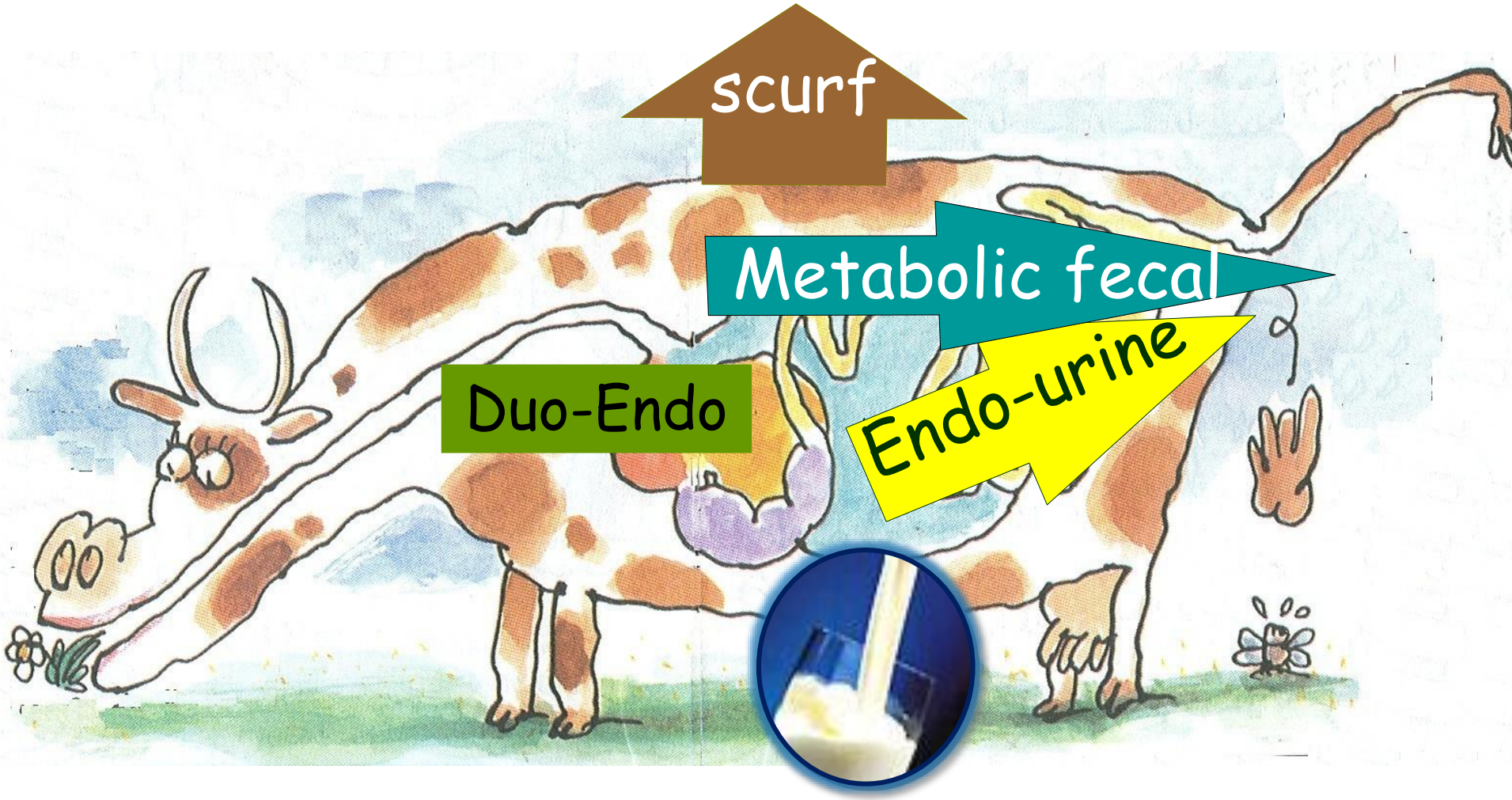
Supply = « Requirements »

Feeding system

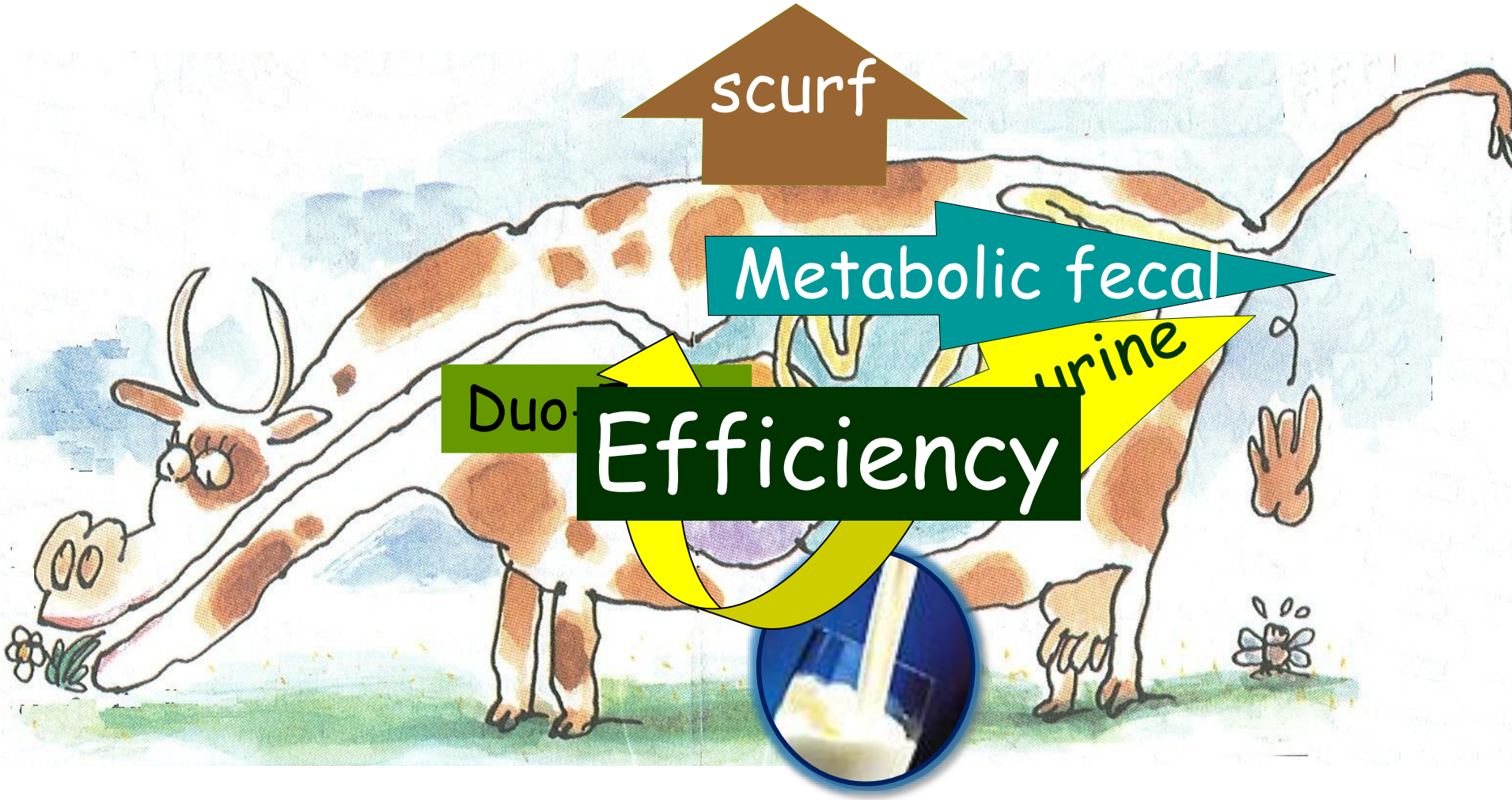
Supply = proteins digested



Proteins exported (+ accretion)



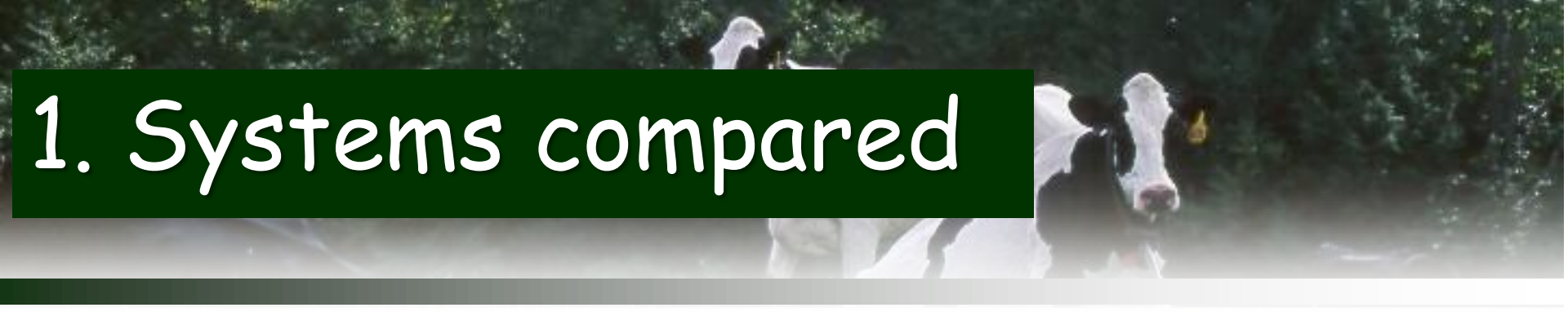
Requirements (recommandations)



1. Systems compared
2. Digestible protein (DiP) supply
3. Proteins exported
4. Efficiency of utilization of DiP
5. Case study
   a. Variation of DiP supply
   b. DiP × Energy
6. Conclusion

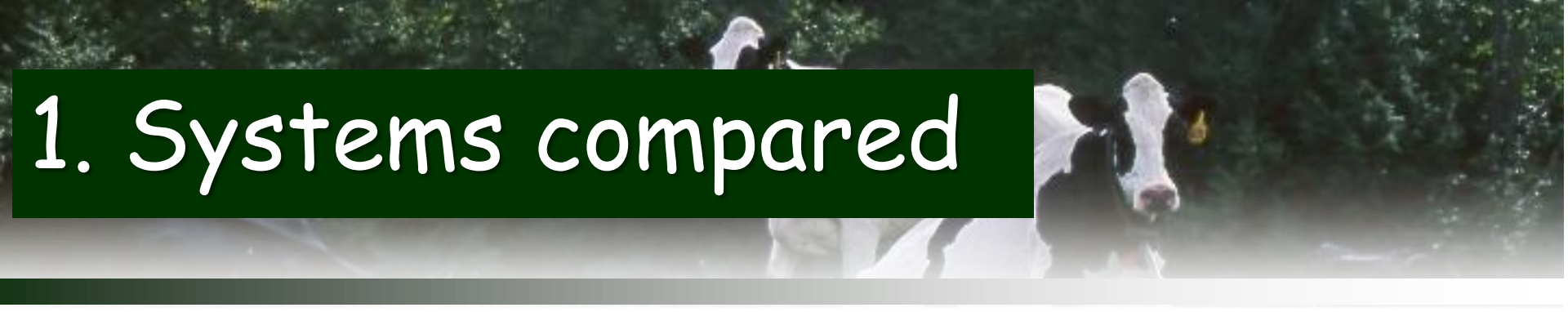
1. Systems compared

1. CNCPS
   - Cornell Net Carbohydrate and Protein System, v6.5
   - USA
   - Fox *et al.* 2004; van Amburgh *et al.* 2015



1. Systems compared

1. CNCPS
2. DVE/OEB
   - DVE (DarmVerteerbaar Eiwit): ileal digestible protein;
   - OEB (Onbestendig Eiwit Balans): rumen degradable protein balance
   - The Netherlands
   - -1991 : Tamminga *et al.* 1994
   - -2007: van Duinkerken *et al.* 2011

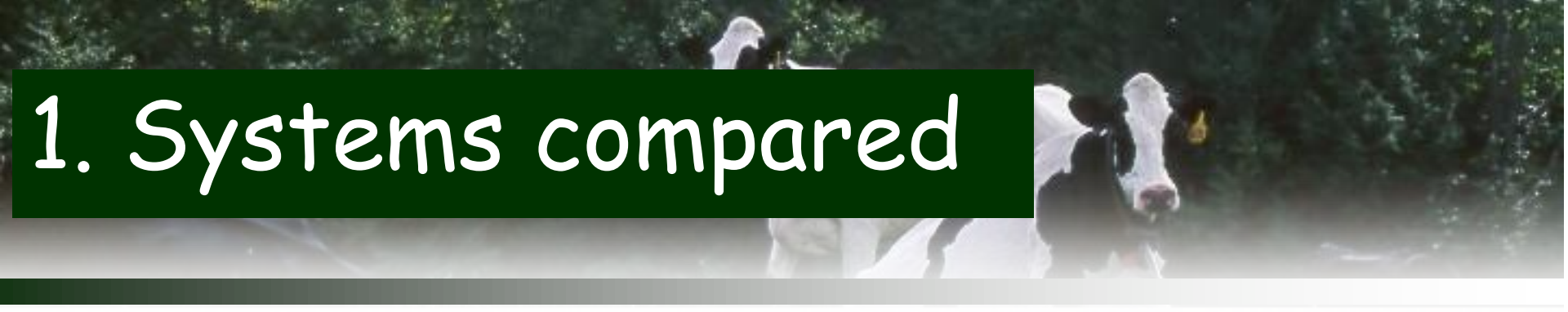


1. Systems compared

1. CNCPS
2. DVE 1991 & 2007
3. INRA
   - Institut national de la recherche agronomique
   - France
   - 2018: INRA feeding system for ruminants

1. Systems compared

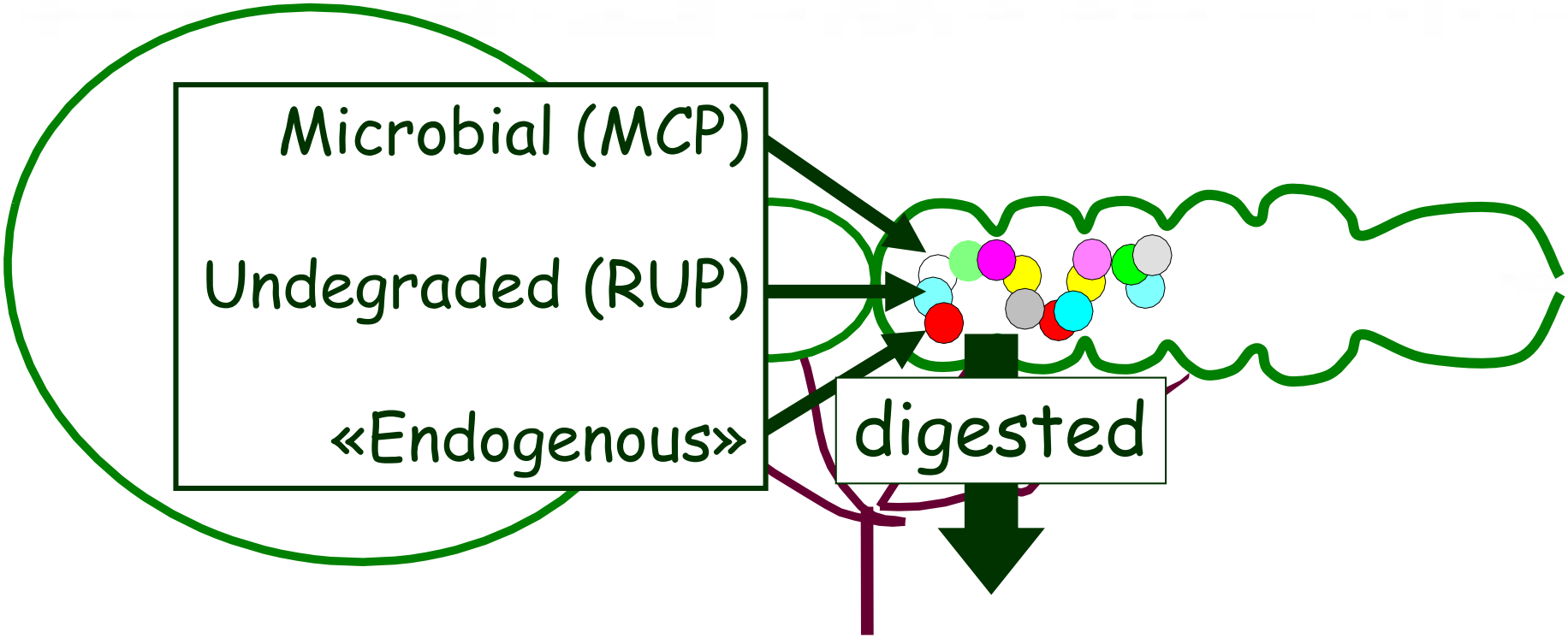
1. CNCPS
2. DVE 1991 & 2007
3. INRA
4. NorFor
   - Denmark, Iceland, Norway and Sweden
   - 2011 + www.norfor.info



1. Systems compared

1. CNCPS
2. DVE 1991 & 2007
3. INRA
4. NorFor
5. NRC
   - National Research Council
   - USA
   - 2001; 7th edition

2. DiP supply



Digestible protein (DiP) = metabolizable protein

MCP & RUP duodenal flow

- rate of protein degradation
  - CNCPS: laboratory (PA1, PA2, PB1, PB2, PC fractions)
  - Others: in sacco rumen incubation (a, b, c fractions)
- rate of passage
- energy availability in the rumen
- efficiency of MCP synthesis

From MCP duodenal flow to DiP

- True protein / CP:
  - DVE: 0.75
  - NorFor: 0.73
  - Others: 0.80
- Intestinal digestibility:
  - DVE & NorFor: 0.85
  - Others: 0.80
- From duodenal MCP to DiP
  - DVE: 0.638
  - NorFor: 0.62
  - Others: 0.64

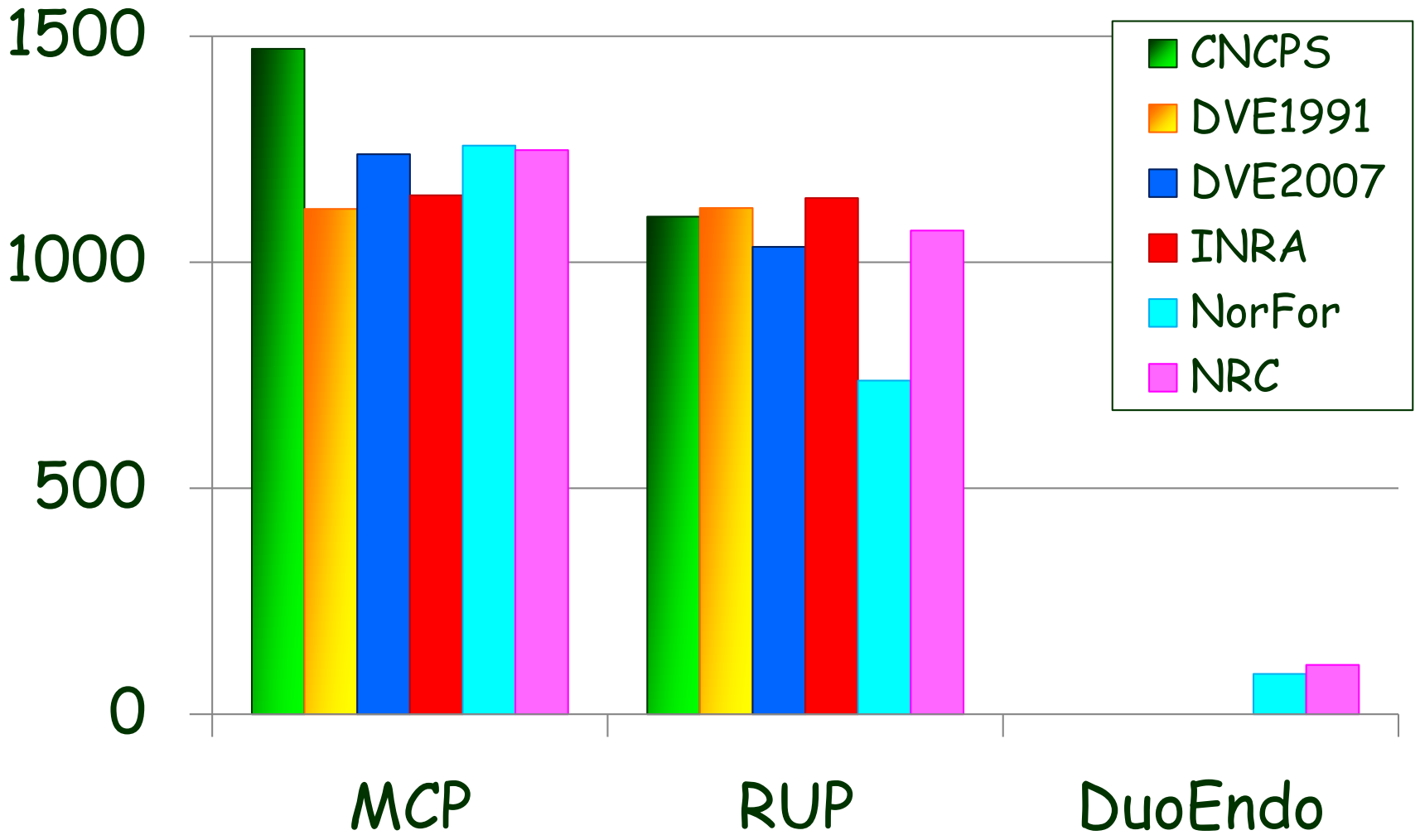
From RUP duodenal flow to DiP

- True protein = CP
- Intestinal digestibility:
  - All models: mobile bag technique
  - CNCPS (next): in vitro procedure

« Example - average » cow

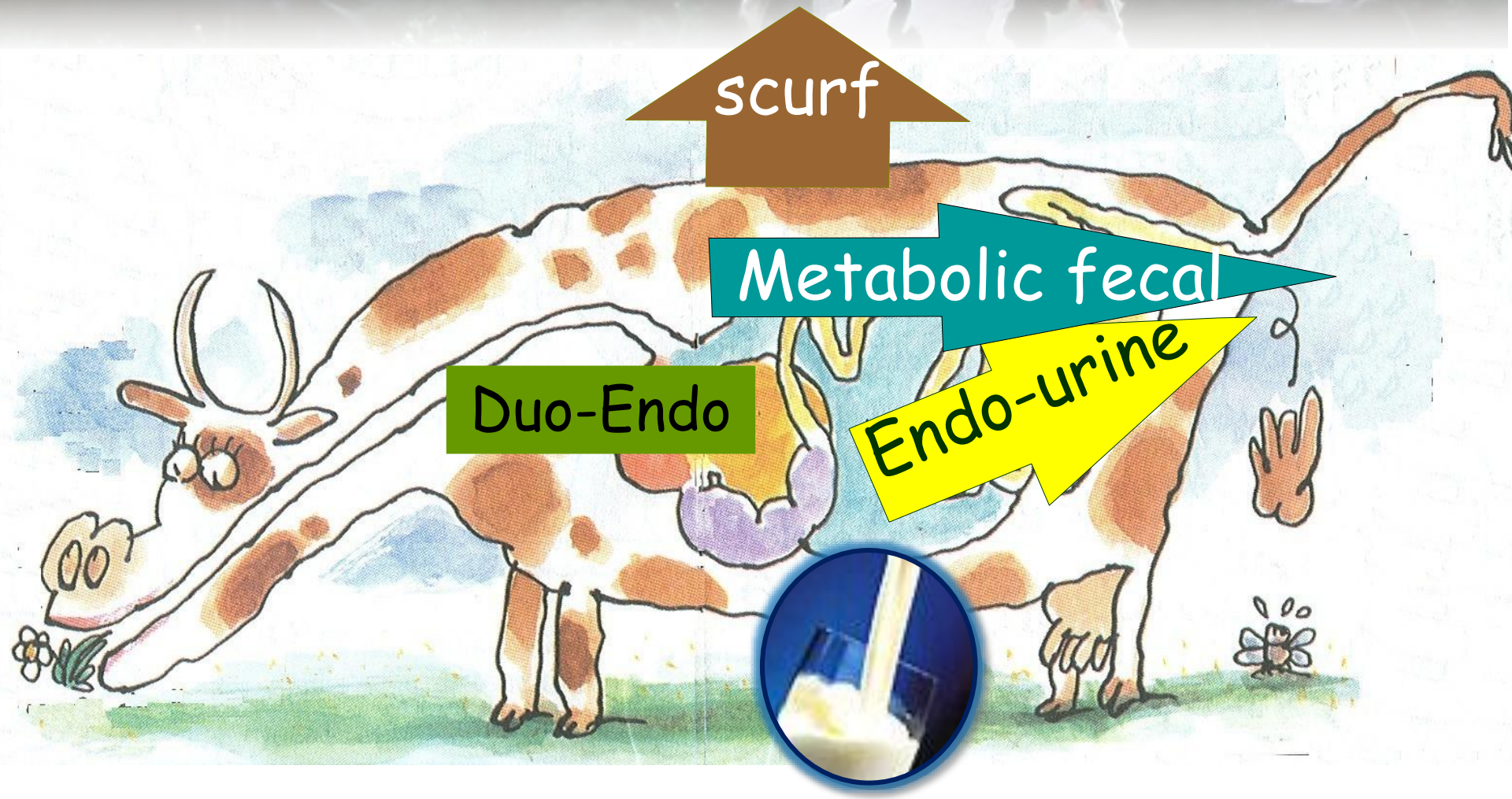
- from Case study #1
- 38.3 kg/d of milk
- 3.09% true protein, 3.27% fat
- eating 23 kg/d of DM
- 16.5% CP diet
- 120 DIM
- not changing BW (589 kg)
- not gestating

Distribution of DiP supply, g/d



Example cow

3. Proteins exported



Scurf and milk true protein yield (MTPY)

- Scurf:
  - 0.2 g CP / $BW^{0.60}$
  - Small: ± 10 g/d
  - Swanson (1977)
  - Used by all systems

- MTPY:
  - As measured!

Endogenous urinary

- Swanson (1977) : used by most systems

- With cattle maintained on low-N diets

- **Excretion,** g CP/d = $2.75 \times BW^{0.50}$

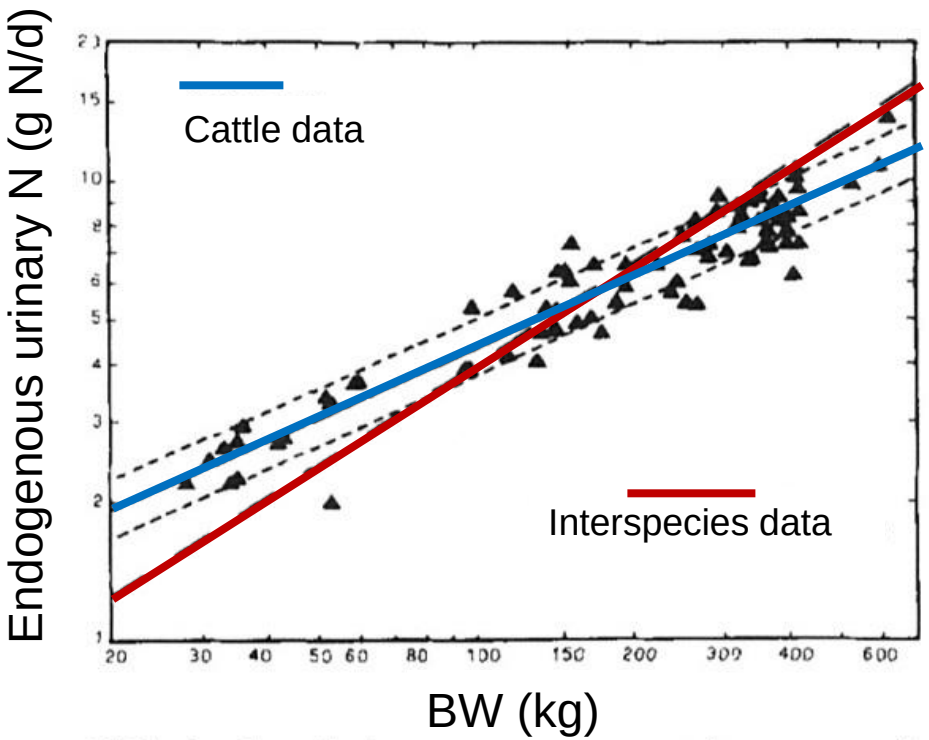
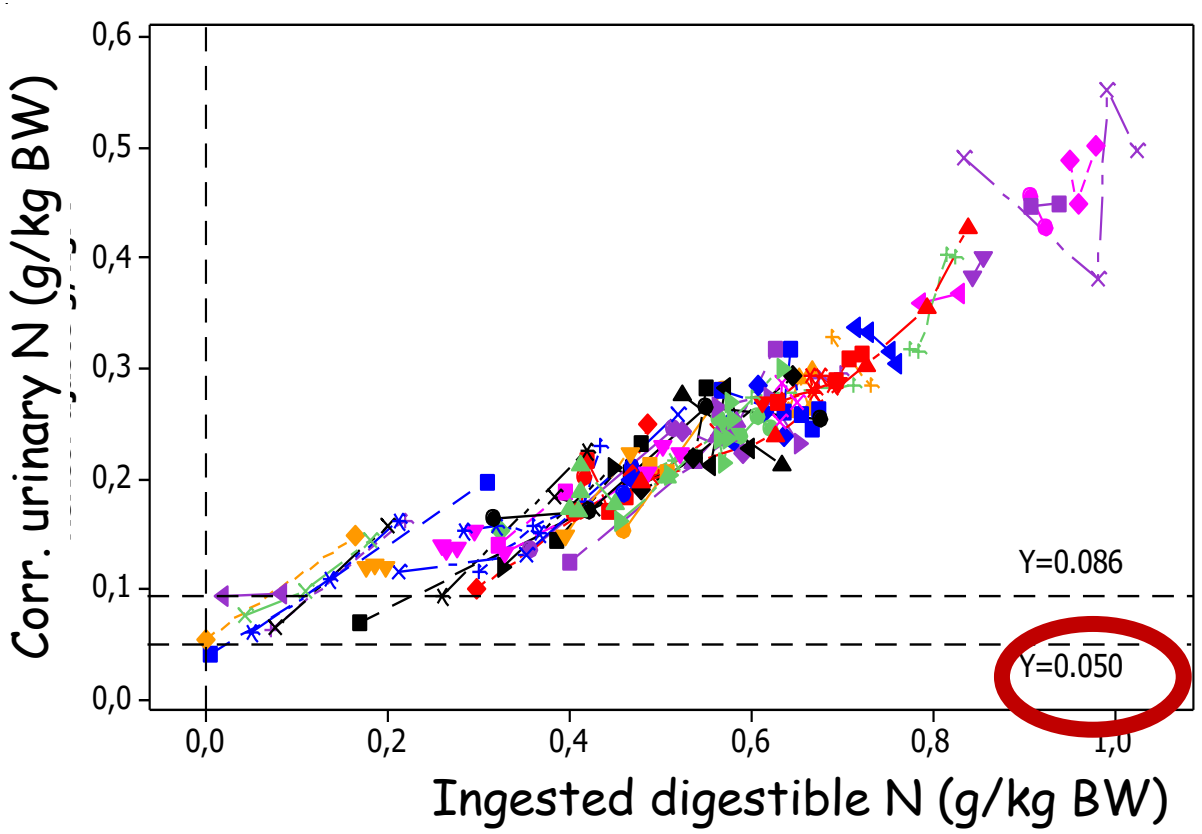


FIG. 1. Correlation of estimated endogenous urinary nitrogen (EUN) with body weights (W) of cattle showing that EUN can be predicted accurately as a function of W by the formula EUN = $.44W^{.5}$. The curve for the interspecies mean, EUN = $.146W^{.72}$ (23) is outside the standard errors of estimate of the cattle mean regression over more than one-half of the body weight range.

Endogenous urinary in INRA



Y at X = 0; for studies where N Intake = Faecal N

Endo urinary excretion = 0.05 g N/kg BW/d

(Sauvant *et al.* 2015)

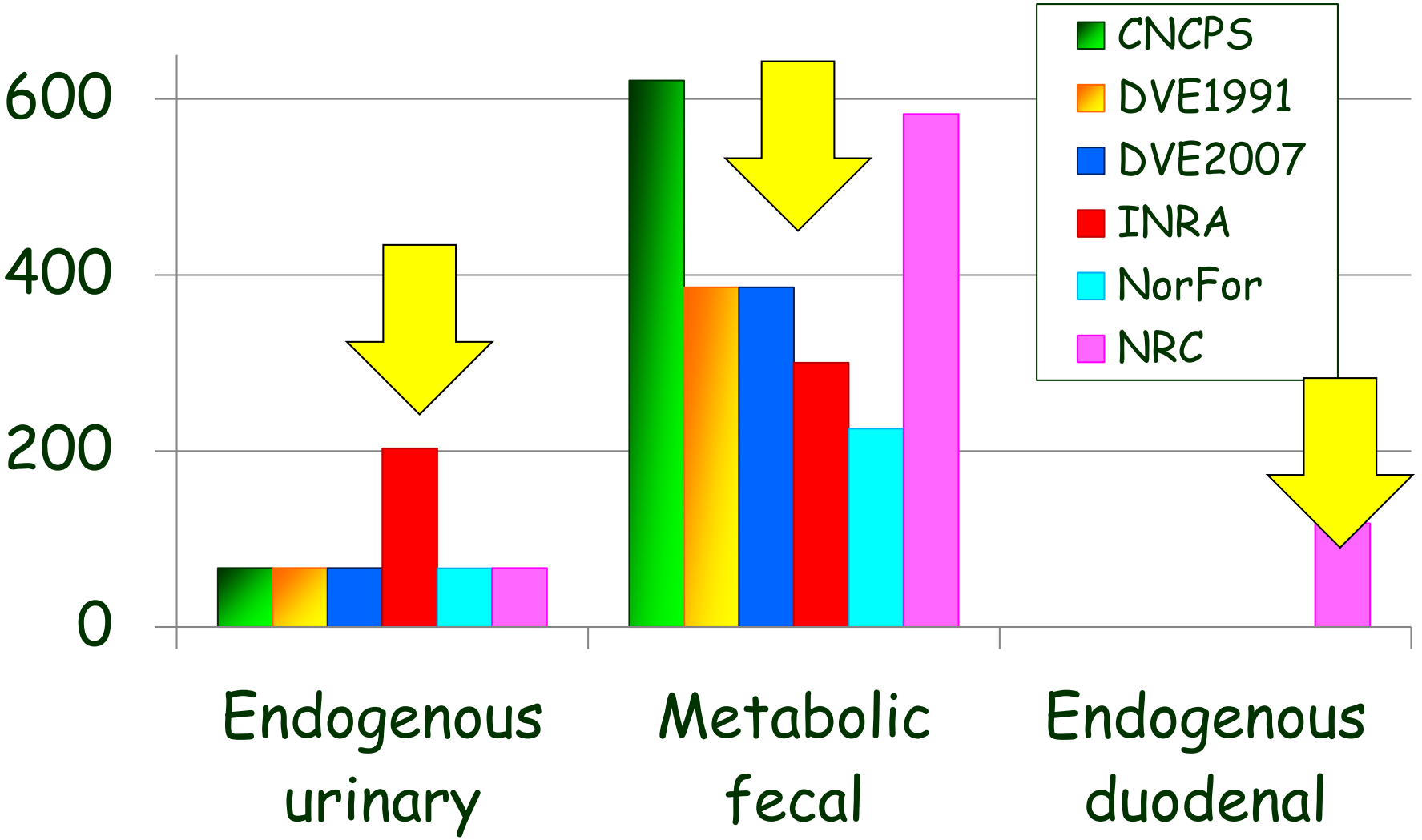
Metabolic fecal

- CNCPS & NRC:
  - From Swanson (1977)
  - CNCPS: 90 g DiP/kg undigested DM
  - NRC removes part of undigested MCP
- DVE:
  - 50 g DiP/kg undigested DM
  - Incuded here for comparison purpose
- INRA: revised
  - Undigested OM
- NorFor: new
  - OM flows out of the rumen and intestine

Duodenal endogenous

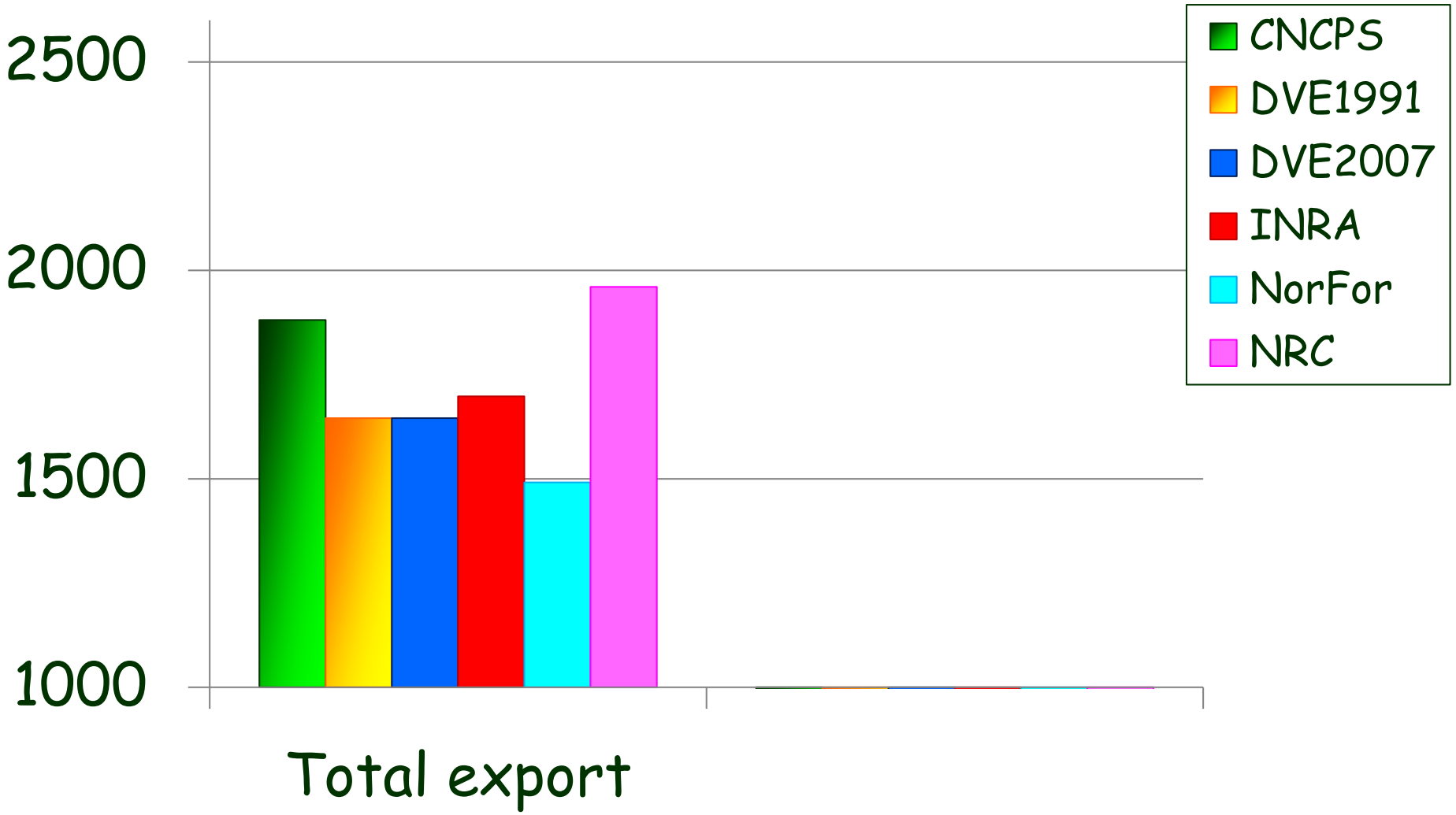
- Only in NRC
  - 1.9 g N/ kg DMI (duodenal flow)
  - x 0.50 [TP/CP]
  - x 0.80 intestinal digestibility

Proteins exported, g/d



Example cow

Protein exported, g/d



Example cow

Protein exported vs. supply, g/d

Efficiency

- An efficiency for maintenance and an efficiency for lactation have been traditionally used

- $$RQT = \frac{Export_{MAINT}}{Eff_{MAINT}} + \frac{Export_{MILK}}{Eff_{MILK}}$$

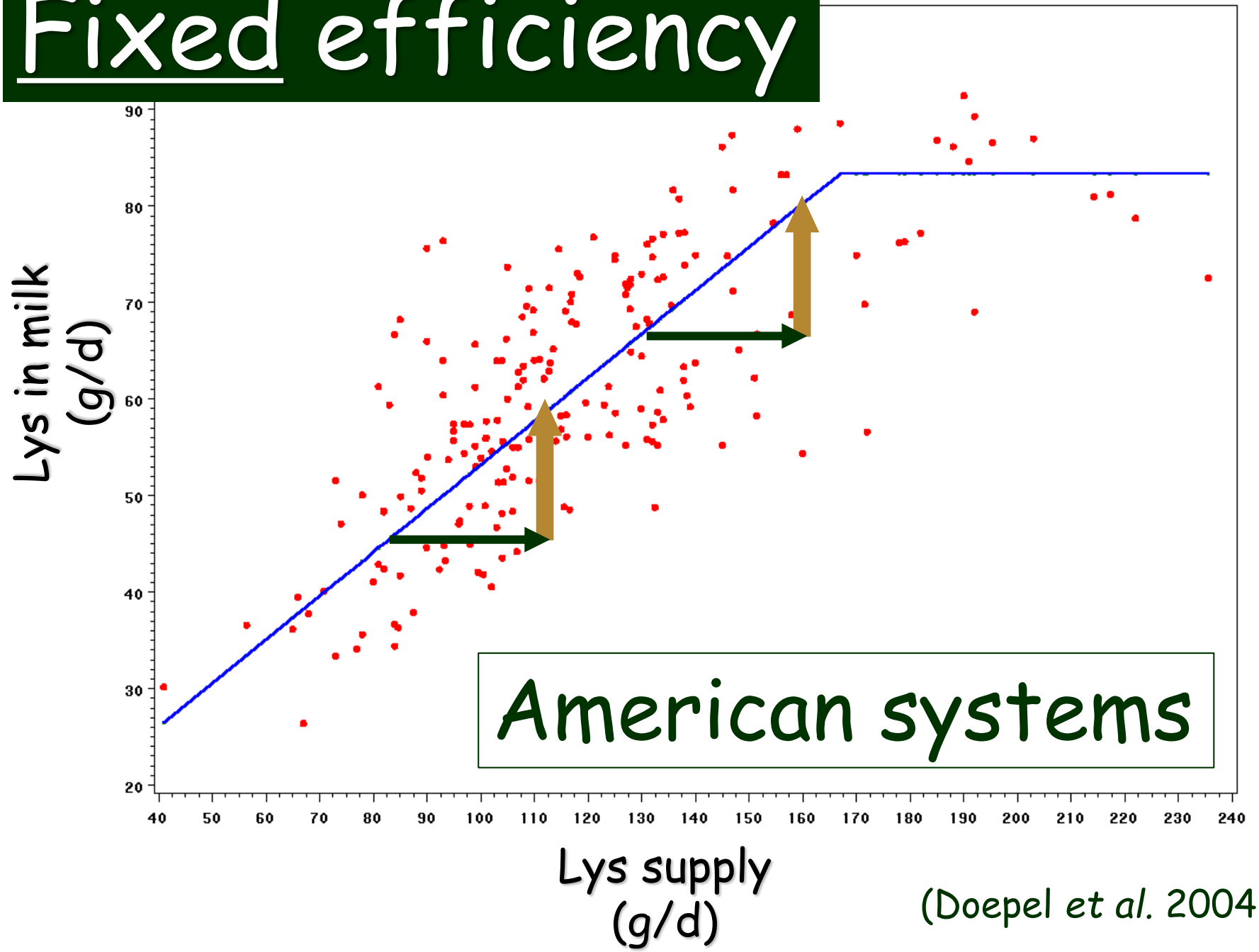
INRA: Combined efficiency

$$= \frac{\Sigma[\text{Export}]}{\text{Supply}}$$

- Export = Milk + metabolic fecal protein (MFP) + scurf
- Supply excludes endogenous urinary

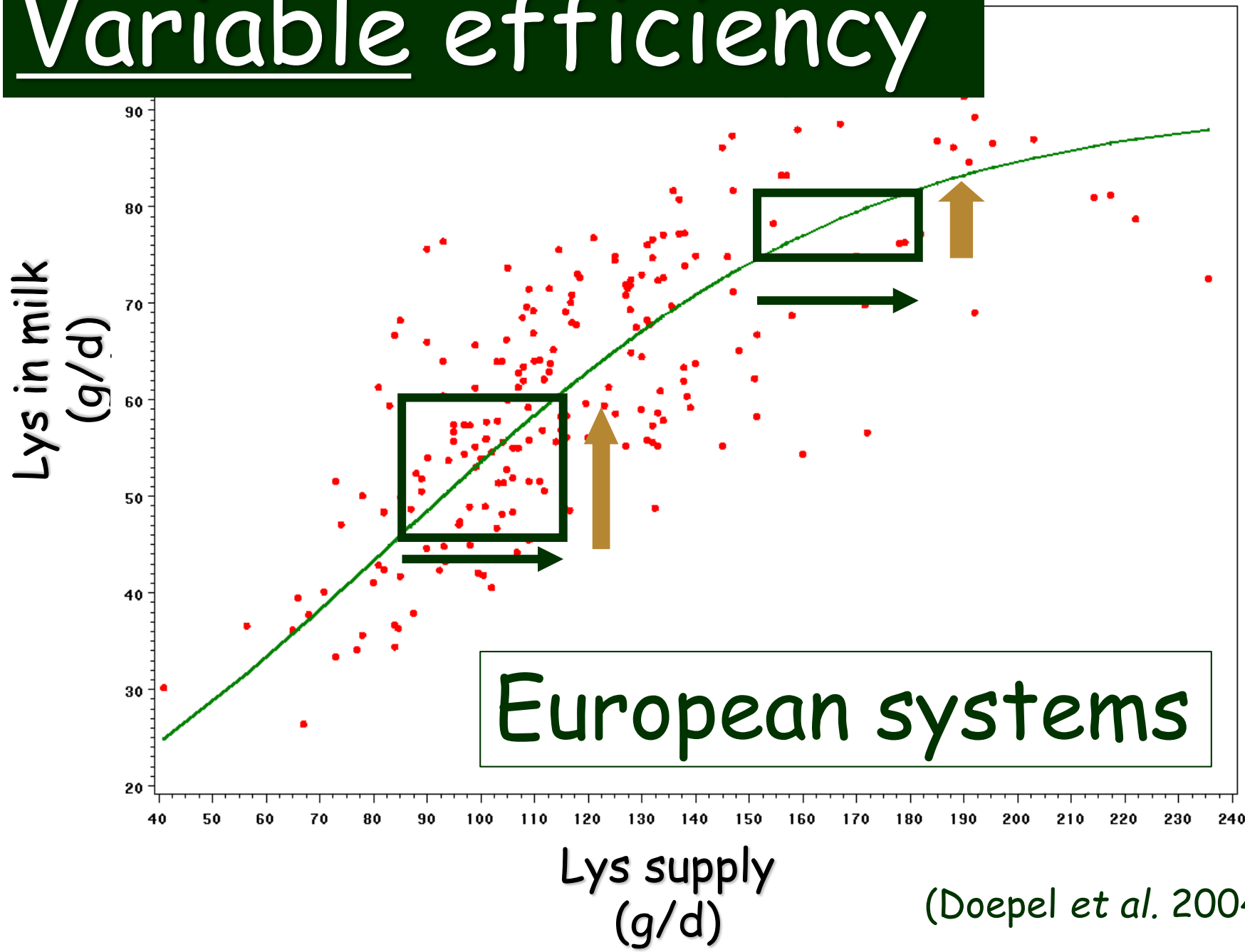
-> Endogenous urinary = end-products
-> efficiency of 1

Fixed efficiency



(Doepel *et al.* 2004)

Variable efficiency



(Doepel *et al.* 2004)

DiP & NE_L used to estimate Eff_{Milk}

- DVE & NorFor:
  - ratio of DiP / NE_L
- INRA:
  - Milk protein yield = Potential + response (fct DiP and NE_L supply + % Lys and % Met)
  - Combined efficiency is back-calculated

Efficiency used in the « example cow »

	Scurf	Endo Uri	MFP	Endo Duo	Milk
CNCPS	0.67	0.67	1	--	0.67
DVE	0.67	0.67	0.67	--	0.73
INRA	0.73	1	0.73	--	0.73
Norfor	0.67	0.67	0.67/1	--	0.69
NRC	0.67	0.67	1	0.67	0.67

Efficiency used in the « example cow »

	Scurf	Endo Uri	MFP	Endo Duo	Milk
CNCPS	0.67	0.67	1	--	0.67
DVE	0.67	0.67	0.67	--	0.73
INRA	0.73	1	0.73	--	0.73
Norfor	0.67	0.67	0.67/1	--	0.69
NRC	0.67	0.67	1	0.67	0.67

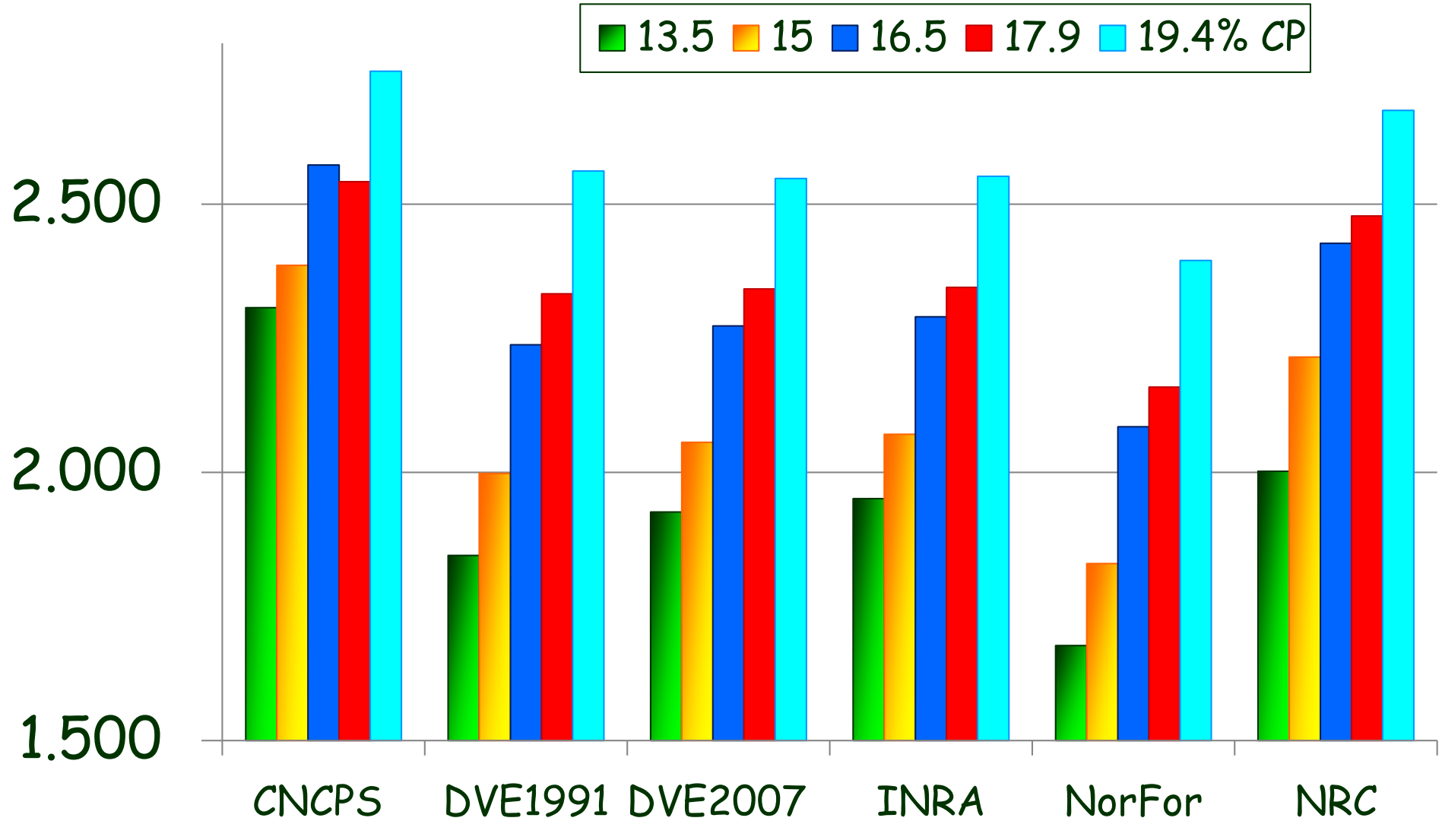
5. Case study

- **Not to make a thorough comparison** of the feeding systems
- Determine which factor(s) should be included in feeding systems to improve predictions of MTPY
- Selection of 2 studies based on the report of diet composition (feed ingredients, chemical composition) and characteristics of cows (BW, DIM) with MTPY reported for each individual treatment

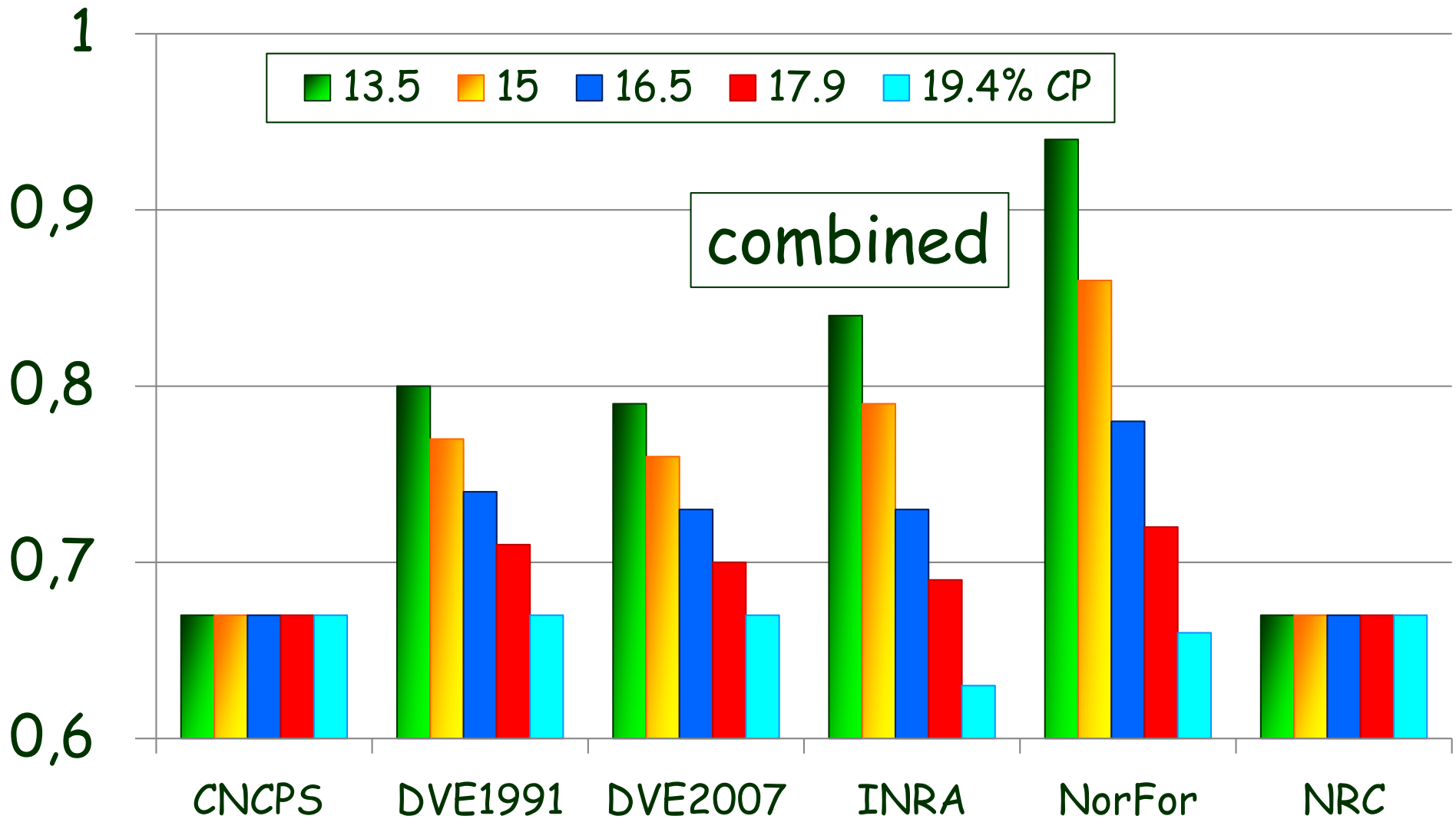
5. Case study: study #1

- **Δ Protein supply**
- 5 levels of CP concentration, from 13.5 to 19.4 % of DM
- 22.5 kg DMI/d
- 589 kg BW
- 120 DIM, multiparous
- Olmos Colmenero and Broderick, 2006

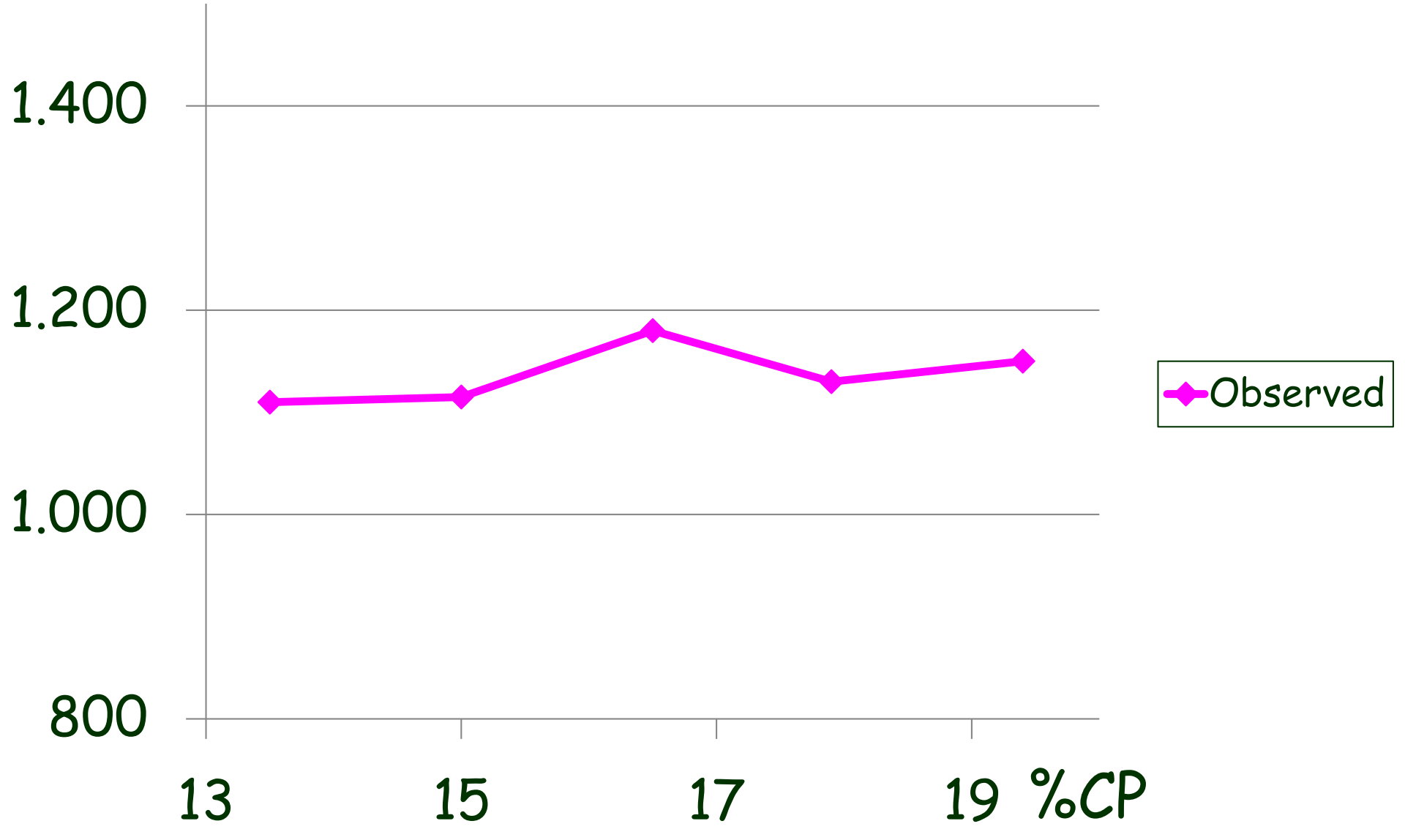
DiP supply (g/d) calculated by each feeding system, Study #1



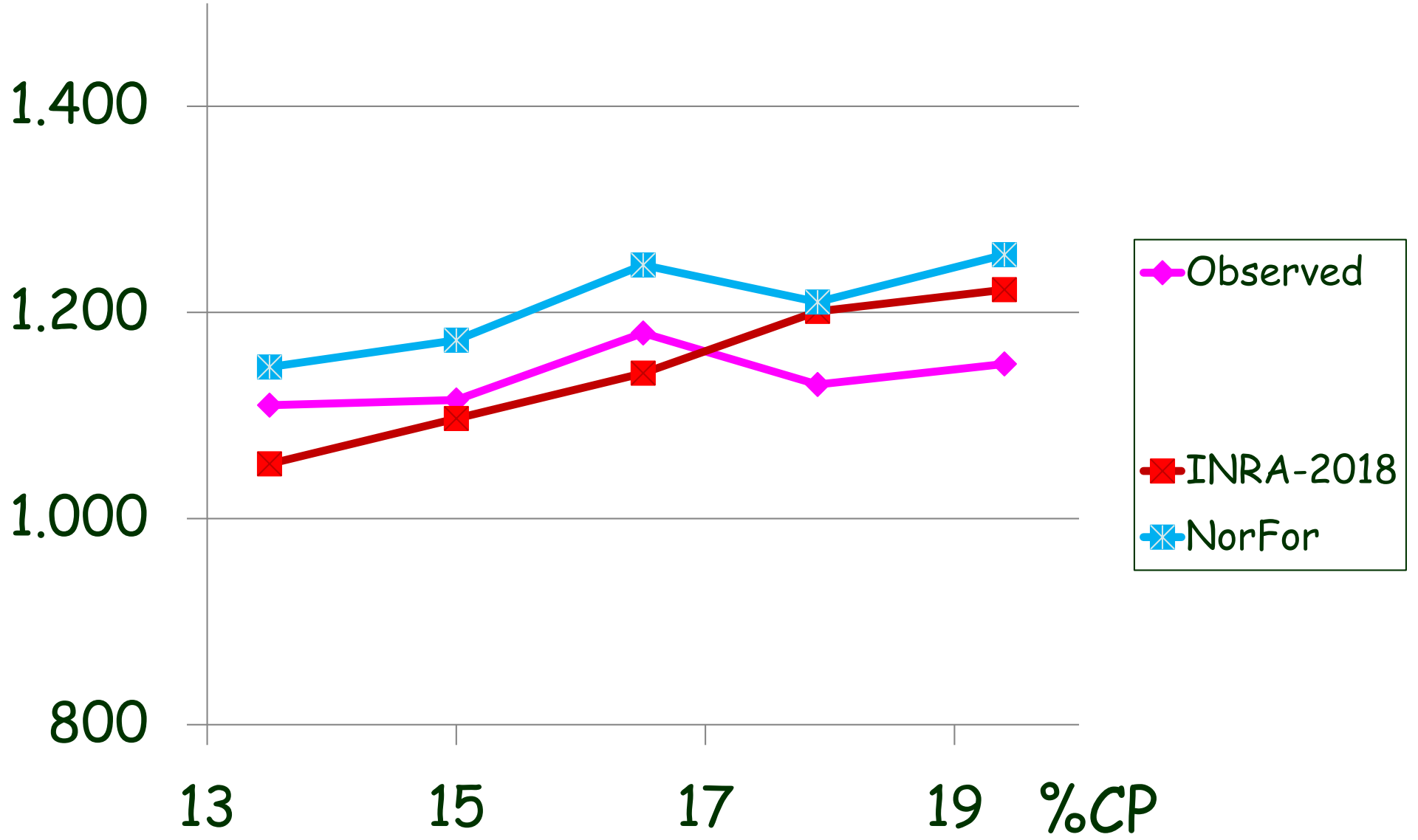
Efficiency of lactation used by each feeding system, Study #1



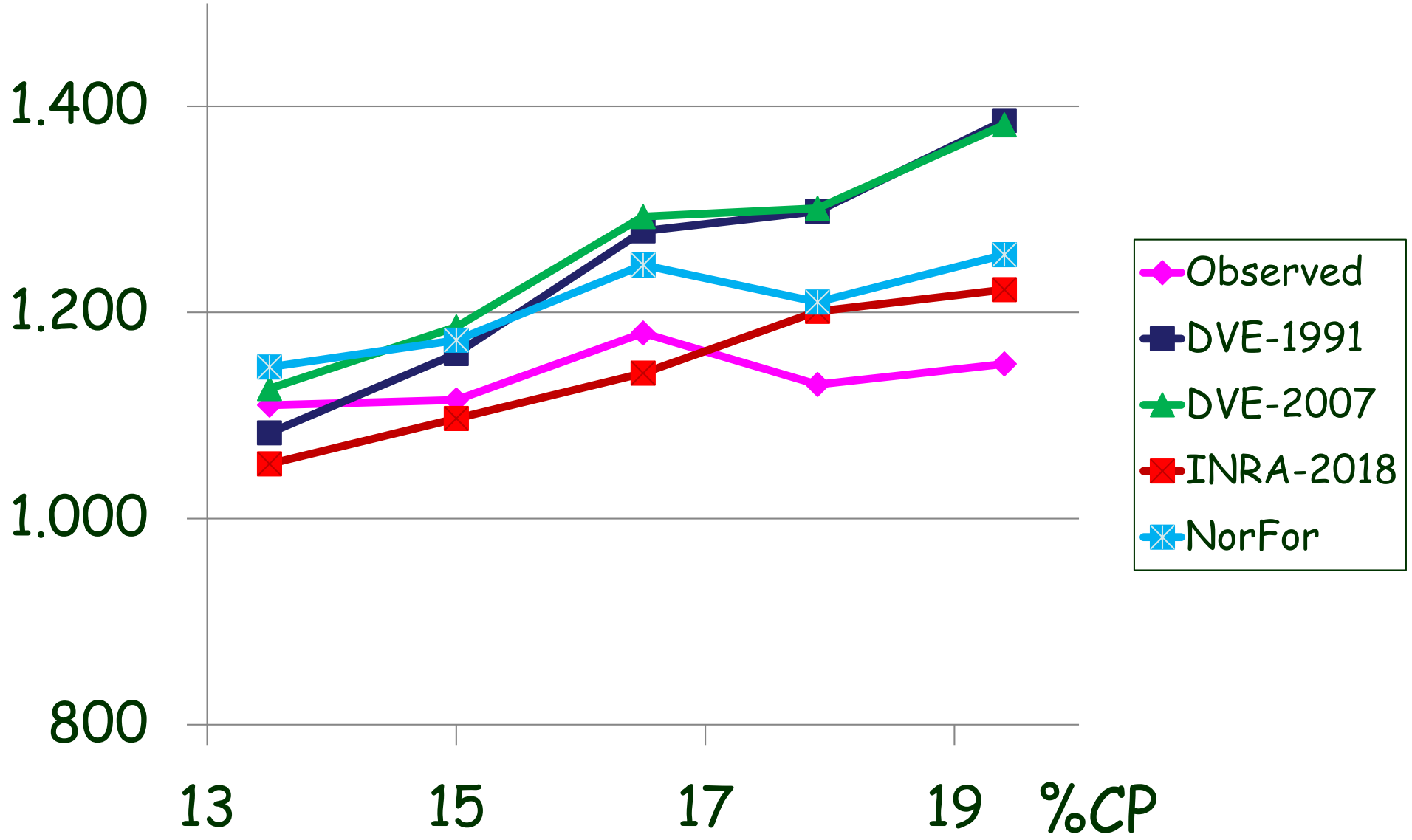
Milk true milk protein yield, g/d
Observed and predicted, Study #1



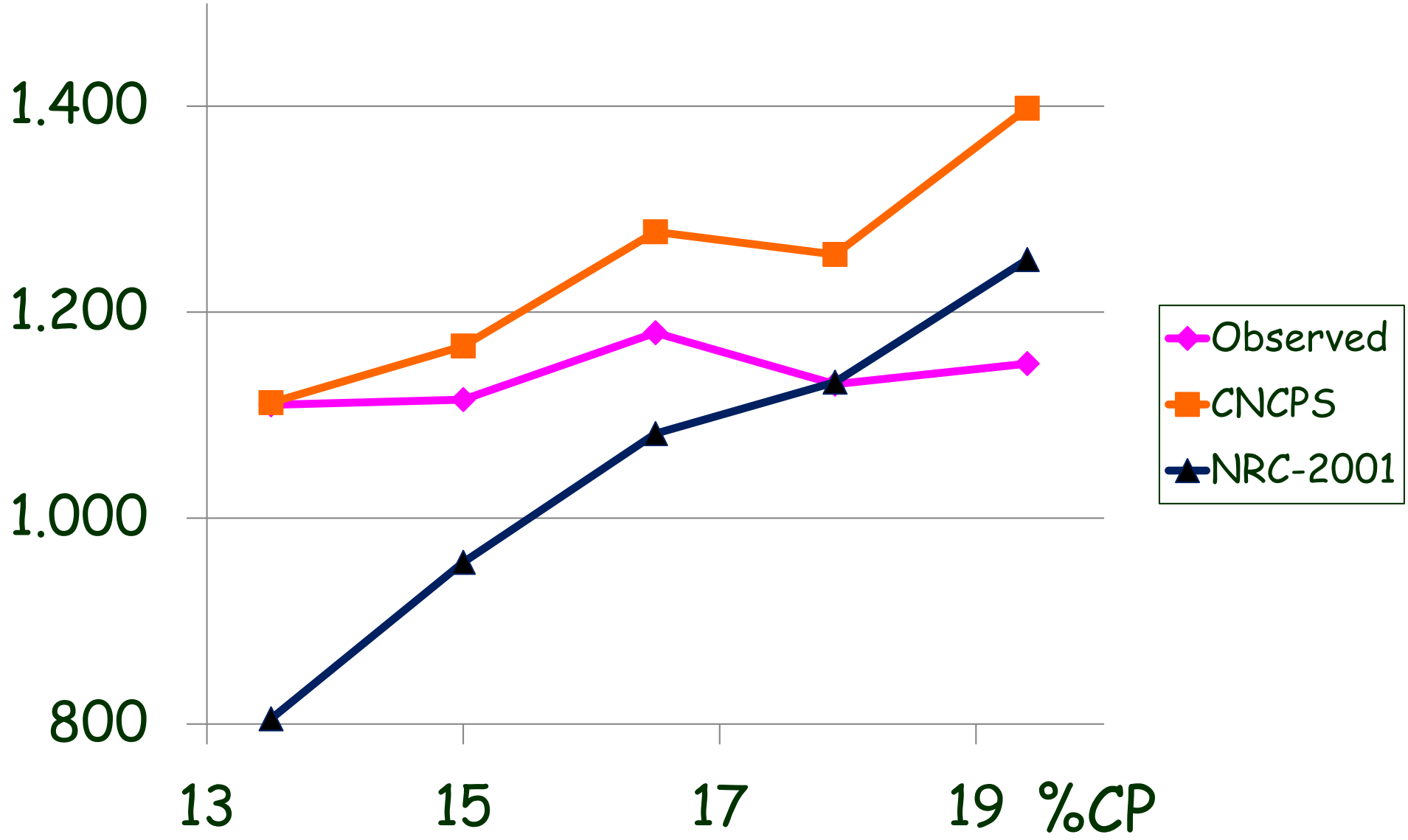
Milk true milk protein yield, g/d
Observed and predicted, Study #1



Milk true milk protein yield, g/d
Observed and predicted, Study #1



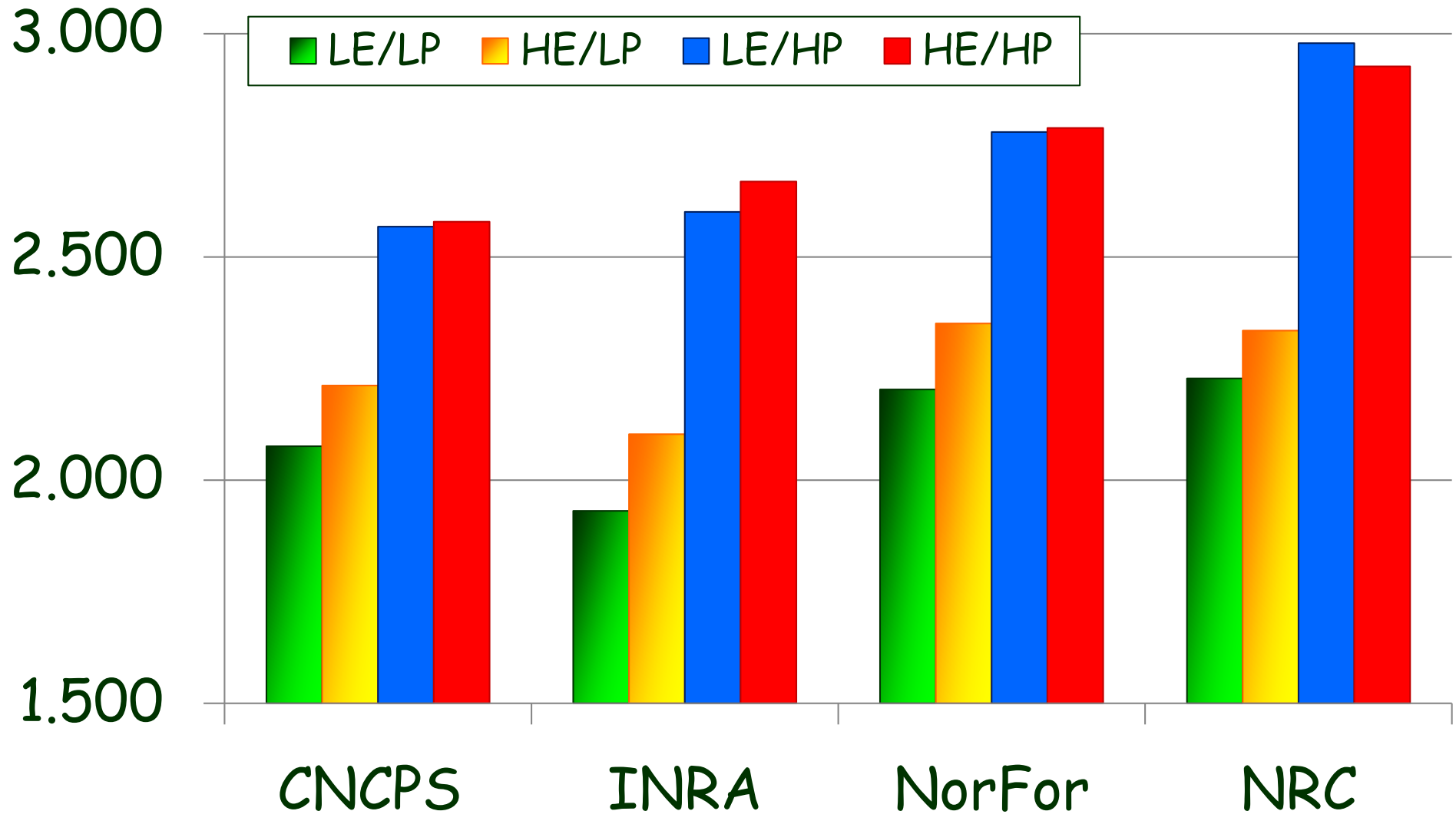
Milk true milk protein yield, g/d
Observed and predicted, Study #1



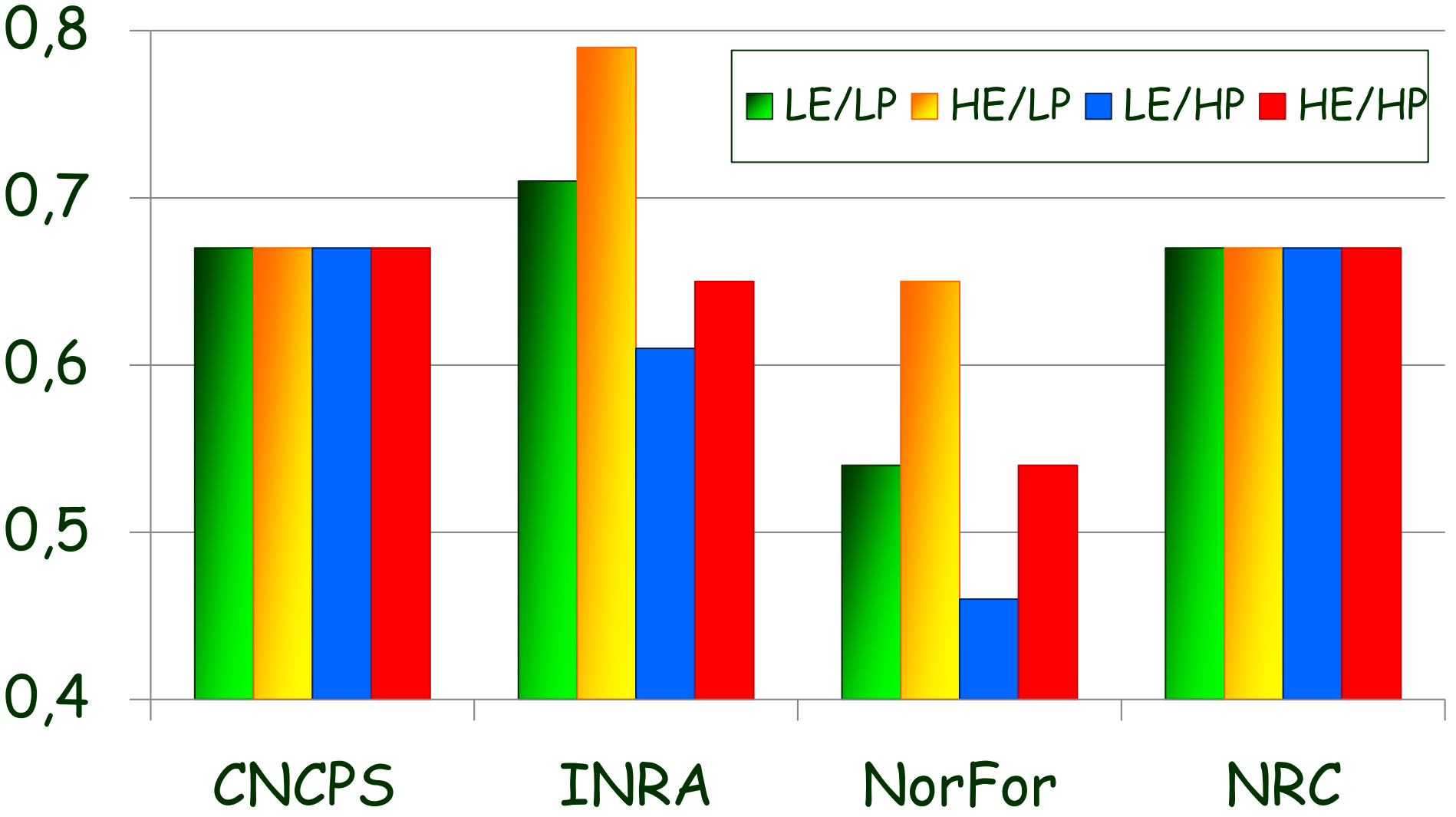
5. Case study: study #2

- **Protein x energy**
- 2 levels of DiP supply (2250 vs 3000 g/d) × 2 levels of energy (1.45 vs. 1.55 Mcal/kg) - factorial
- 22.5 kg DMI/d
- 630 kg BW, 185 DIM, multiparous
- Rius *et al.*, 2010 ; No DVE

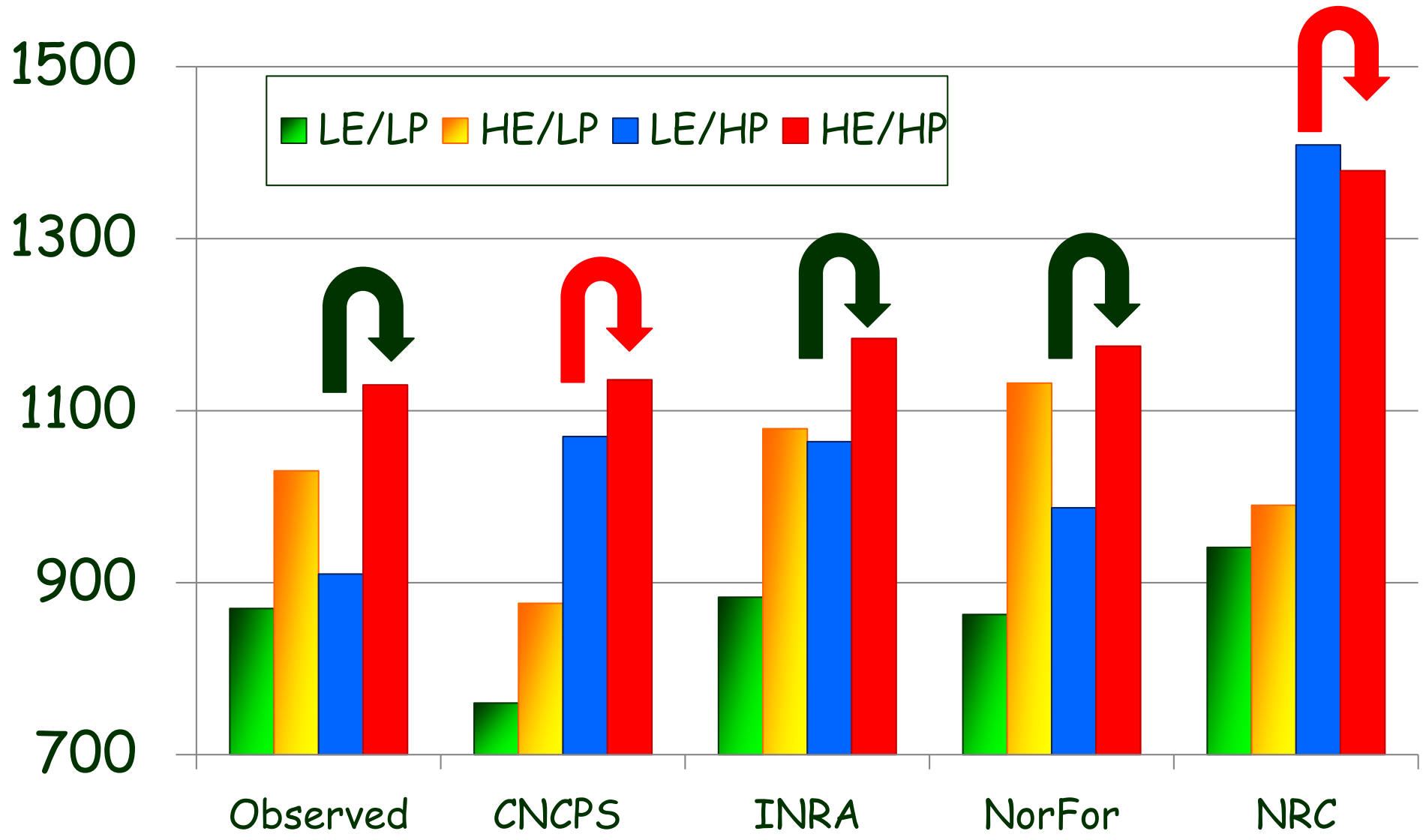
DiP supply (g/d) calculated by each feeding system, Study #2



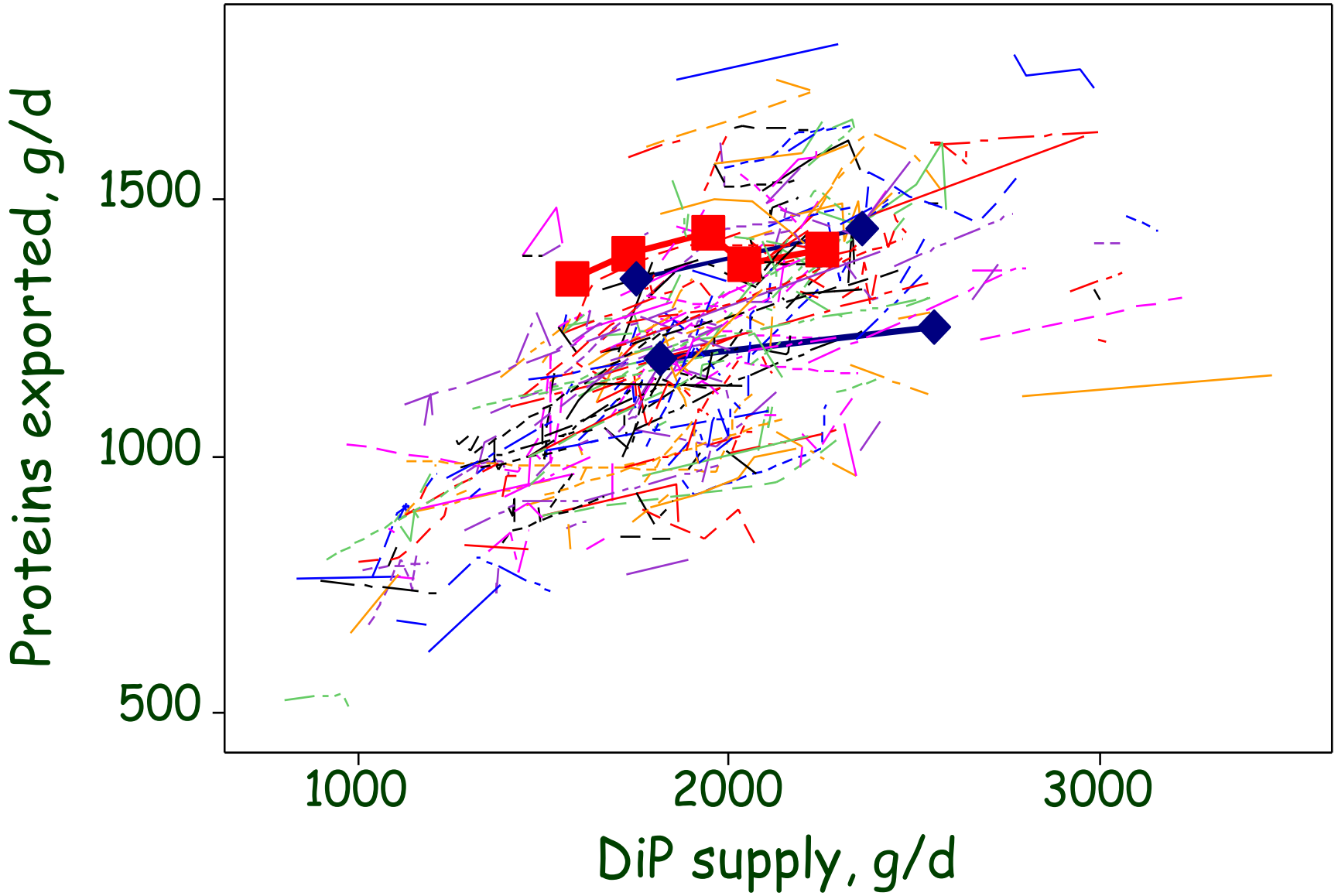
Efficiency of lactation used by each feeding system, Study #2



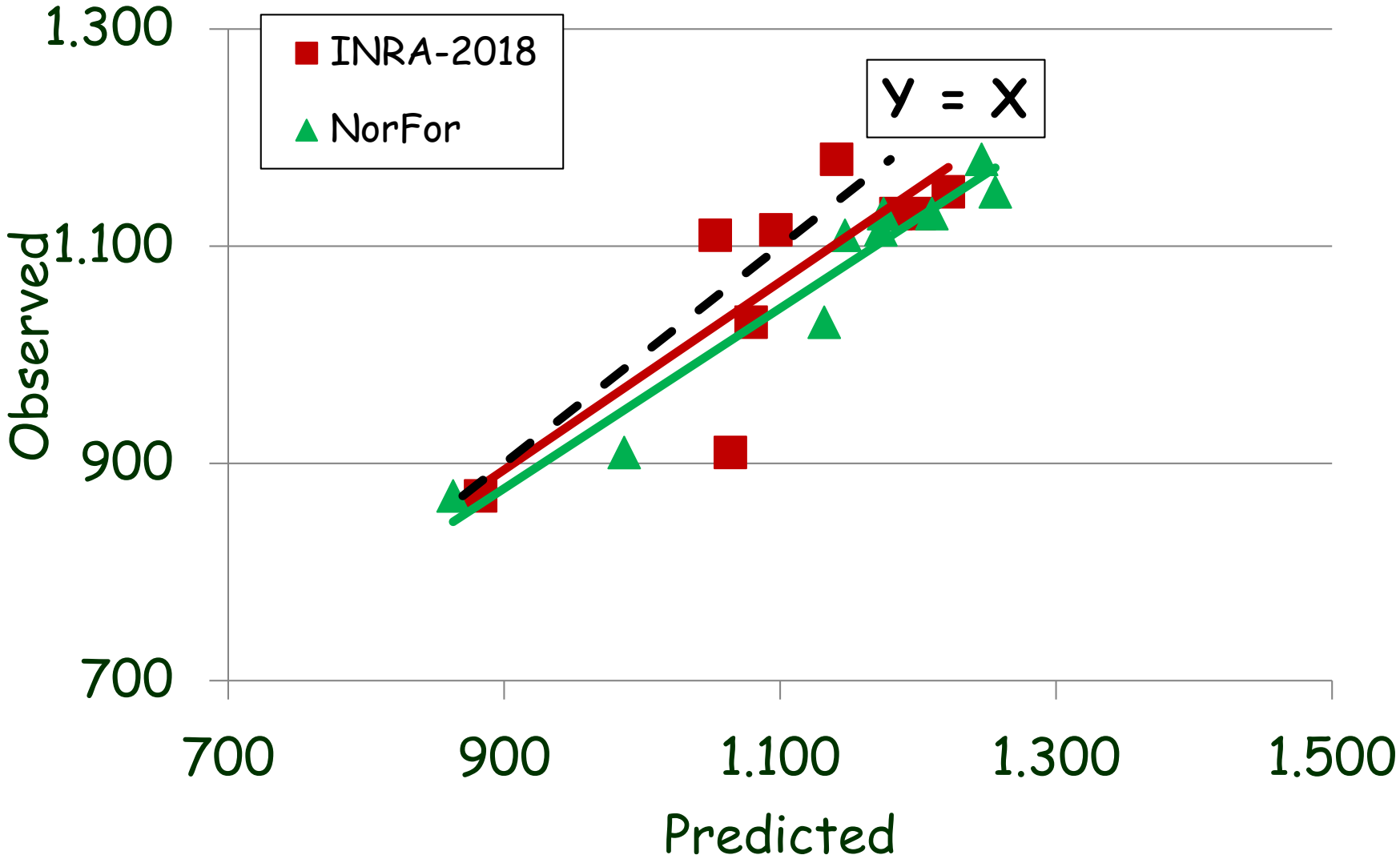
Milk true protein yield (g/d)
Observed and predicted, Study #2



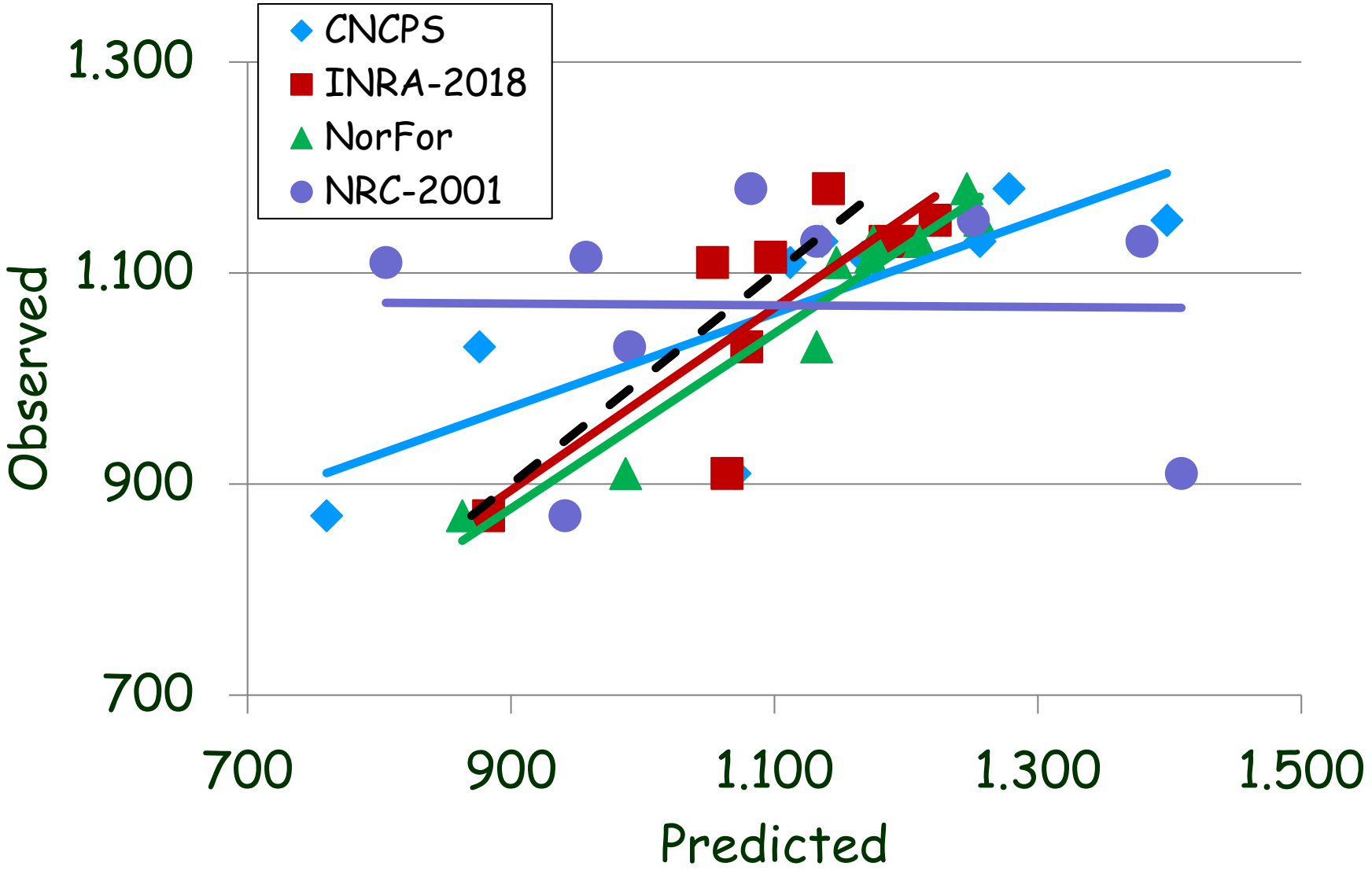

2 studies
together?


Proteins exported, g/d
1500
1000
500
1000
2000
3000
DiP supply, g/d

Milk true protein yield, g/d
Observed vs. predicted



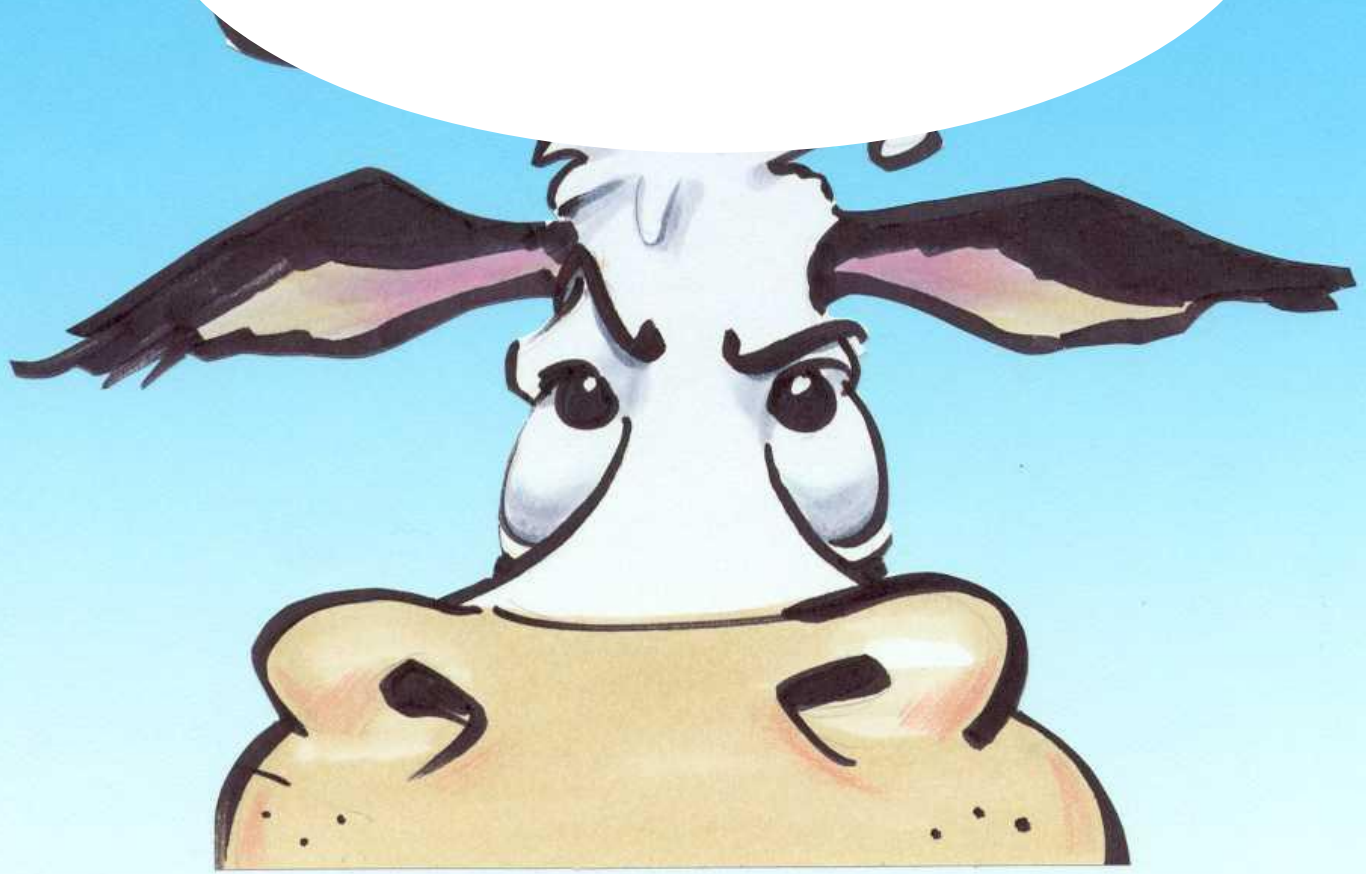
Milk true protein yield, g/d
Observed vs. predicted



6. Conclusions

- Improved assesment of endogenous urinary and metabolic fecal
- Variable efficiency:
  - a MUST
  - Includes supply of DiP and NE_L
- Thorough comparison is needed

Questions?



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Mange tak!

Canada