Methods and systems used for protein evaluation for ruminants

REDNEX

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SEVENTH FRAMEWORK PROGRAMME

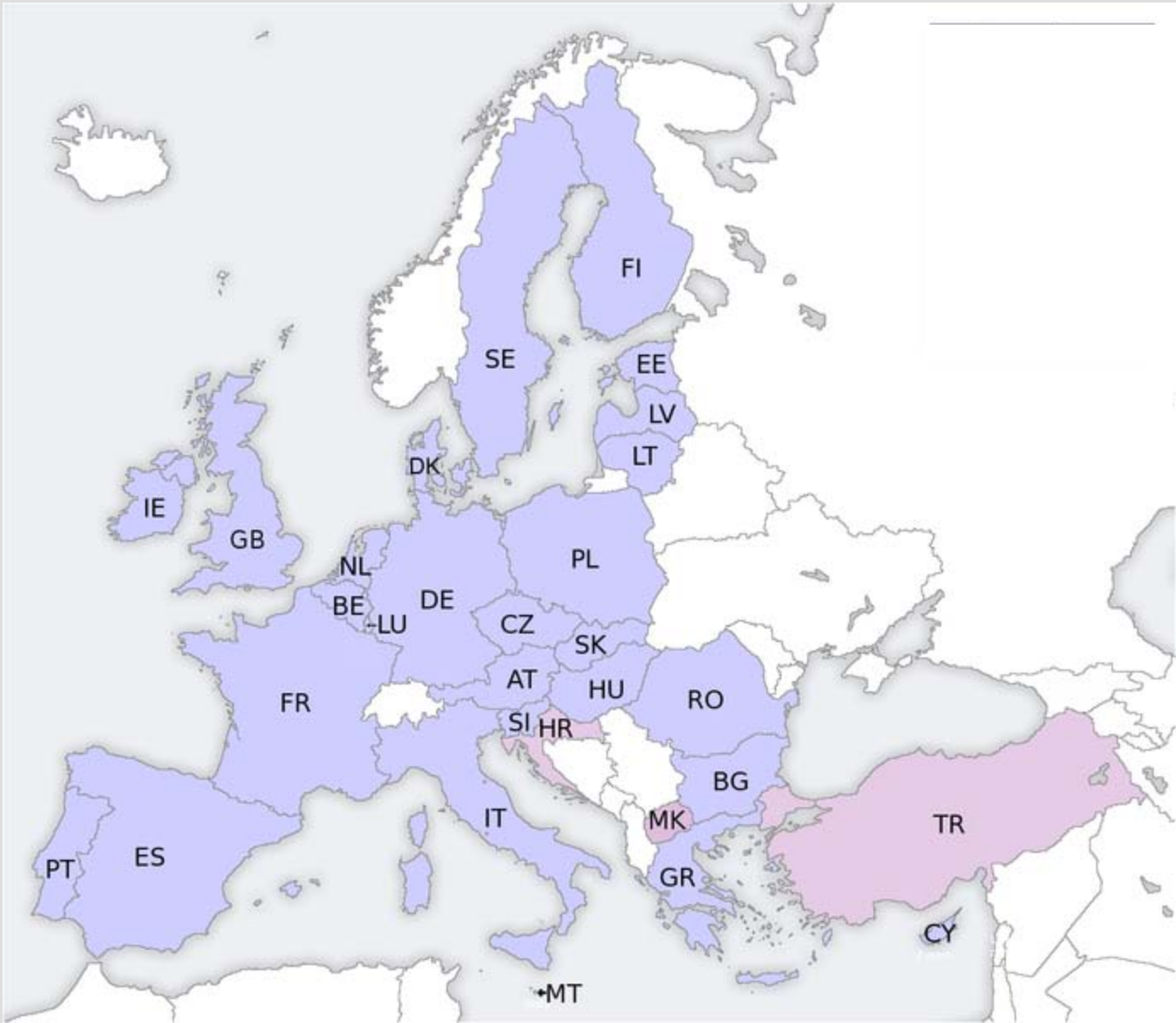
Innovative and practical management approaches to reduce nitrogen excretion by ruminants

Background

- REDNEX Workshop in 2008 in Vilnius on “Nitrogen Utilization and Loss by Dairy Cows –State of the Art in Modelling and Prediction”.

- Inventory in 2009 on:
  - Systems
  - Methods
  - Acceptance
- Based on responses from colleagues working in research

27 countries in EU. How many protein evaluation systems for ruminants are in use?



Protein evaluation systems

- 16 countries in EU responded to the inventory
- From the replies there are 5 major European systems in use in Europe
- Systems from USA are also used in Europe

Main European systems

- France: PDI
- United Kingdom: ARC; FiM
- Netherlands: DVE/OEB
- Nordic: AAT/PBV; NorFor
- Germany: nXP

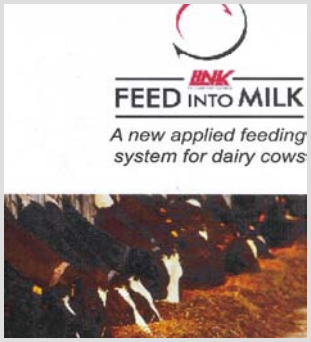
Since first introduced many of the systems are updated to also include individual amino acids

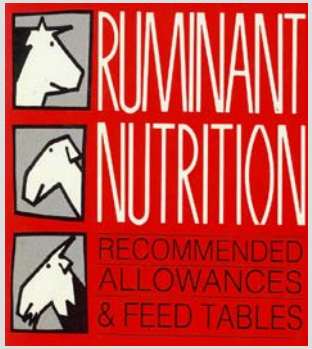
Other systems

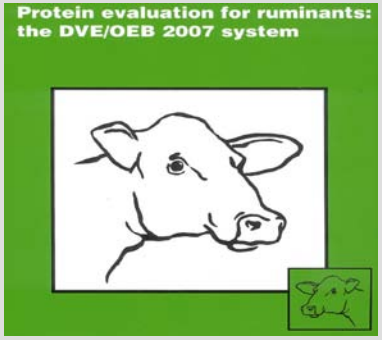
- **Two main American systems**
  - **CNCPS/CPM Dairy**
  - **NRC Dairy**

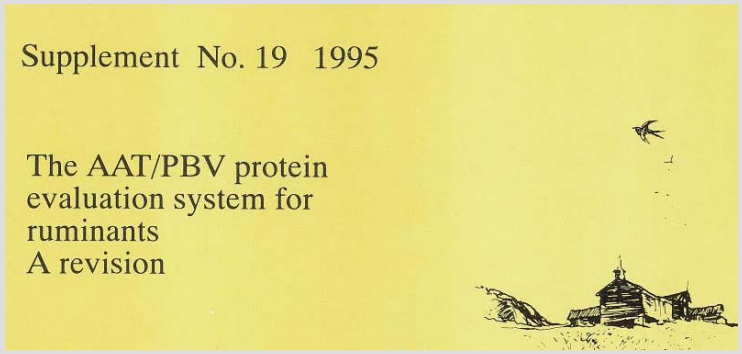
- **Australian system**
  - **CSIRO**

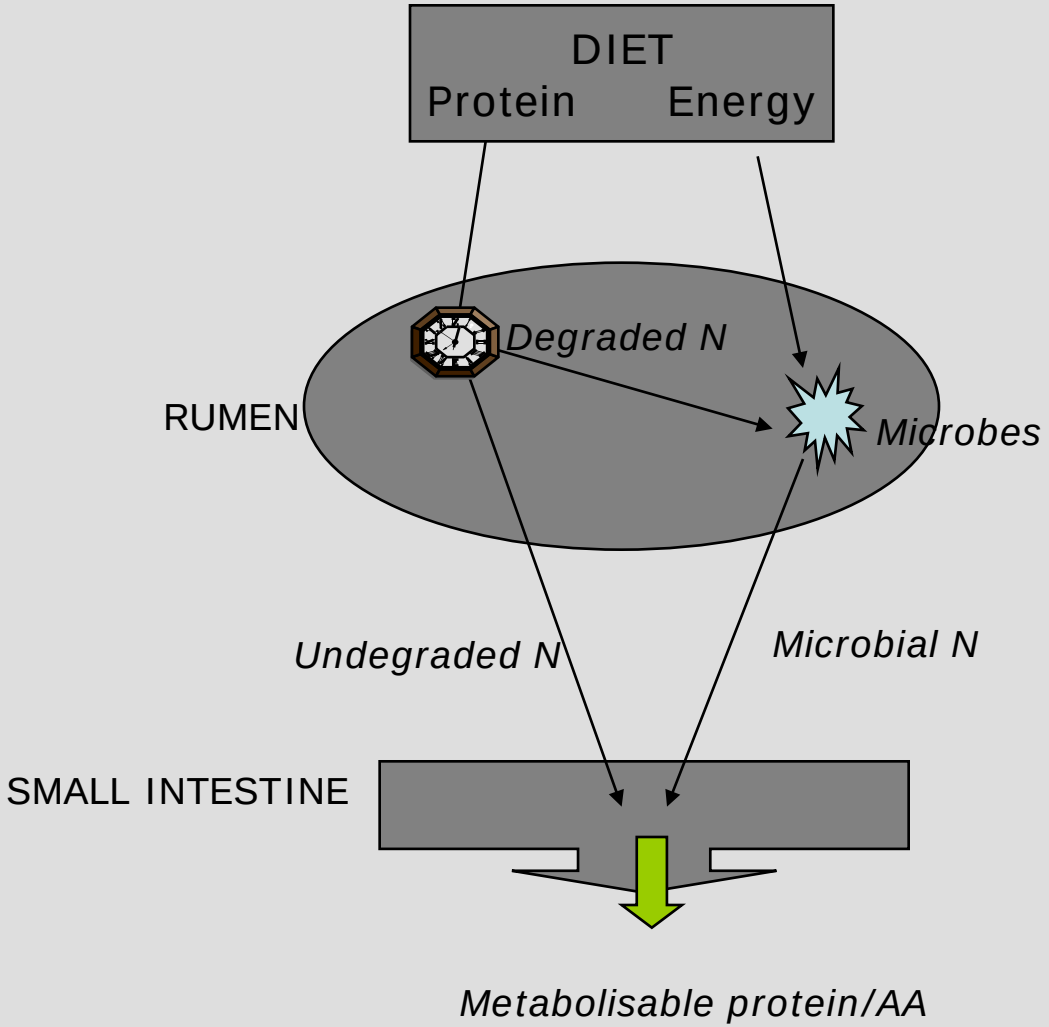
Concept of Metabolisable Protein











The European systems slightly differ in:

- Protein degradation in the rumen
- Energy supply for microbial protein synthesis
- Rumen outflow issues
- AA content of undegraded protein
- AA content of microbial protein
- Digestibility of AA in undegraded protein
- Digestibility of AA in microbial protein

Measurement of protein degradation

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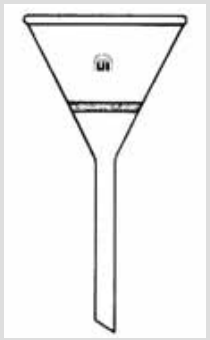

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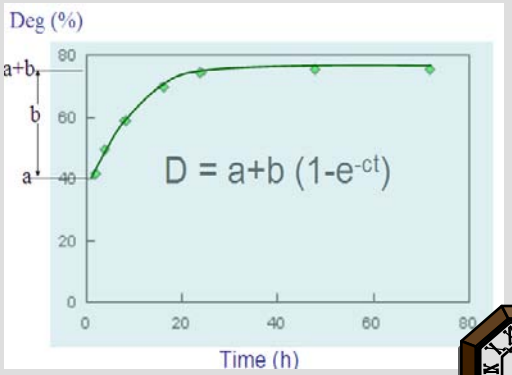
UK FiM
Nordic AAT/PBV
Dutch DVE/OEB
French PDI

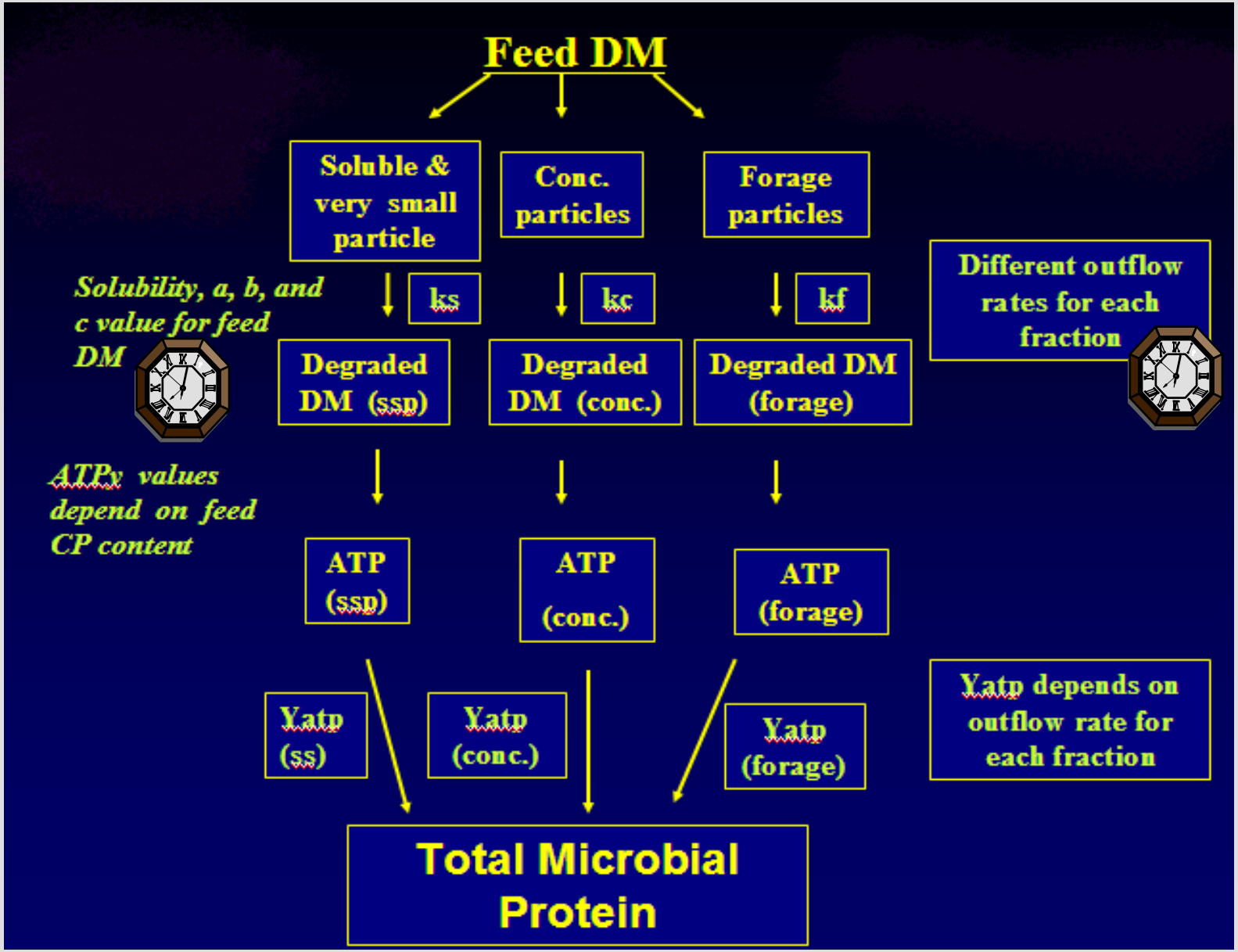


German nXP

Energy supply for microbial protein synthesis

- Two systems are more complex....

UK FiM System



Dutch DVE/OEB 2007

ATP yield (mol kg^{-1}) from ....

Component	Soluble frac. & Fine partic.	Potential deg. fraction
NDF		27.3
RNSP	23.9	27.3
Starch	27.3	
CP	13.6	
Sugars	23.9	

UK FiM

Does not fractionate into substrates

↓

Degradation of DM

↓

ATP from degraded DM

Dutch DVE/OEB

Fractionates feed in substrates

↓

Degradation of each substrate

↓

ATP from each substrate

Energy supply for microbial protein synthesis

- Three systems have a more simple approach.....

Energy supply for microbial protein synthesis

- **Nordic: Total tract digestible CHO using sheep at M & fixed amount (179 g) of microbial crude protein produced per kg digested carbohydrate.**

- **French: Fermented OM and a fixed amount (145 g) of microbial crude protein produced per kg fermented OM**

  [FOM= DOM - (UDP+ fermentation products + fat]

Energy supply for microbial protein synthesis

- **German: Very different approach**
- **Predicts the combination of undegraded protein and microbial protein (nXP) on either ME or DOM basis**

nXP = [11.93 - (6.82 (UDP/CP))] ME + 1.03 UDP

nXP = [187.7 – (115.4 (UDP/CP))] DOM +1.03 UDP

Digestibility of UDP

- F: Based on mobile bag N digestibility
- NL: Based on mobile bag N digestibility
- Nordic: Based on mobile bag N digestibility
- UK FiM: 0.9 of ADIN-free N
- D: True digestibility of all amino acids measured *in vivo* with duodenal and ileal cannulation
- All except for the Nordic system assume AAN/N in UDP to be 1.0

  Nordic: Concentrate 0.85; Roughage 0.65

Digestibility of microbial true protein / amino acids

Country	AA Proportion	AA Digest.	Digestible AA / CP
F	0.80	0.8	0.64
GB	0.75	0.80	0.60
NL	0.75	0.85	0.64
Nordic	0.70	0.85	0.60
D	0.73	0.85	0.62

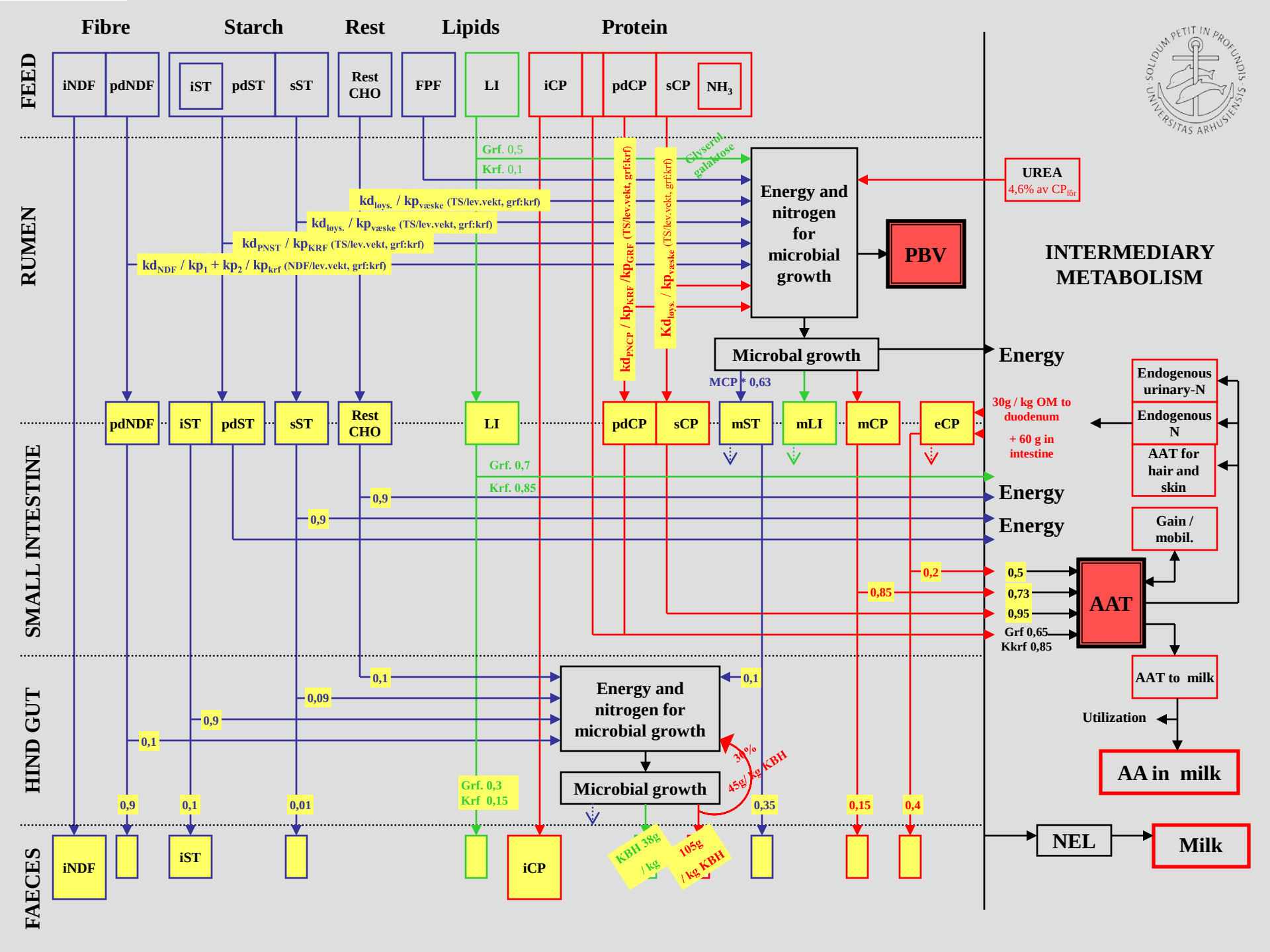
NorFor
Nordic Feed Evaluation System

- A common Nordic feed evaluation system for cattle
- Developed in cooperation between dairy farmer organizations in Island, Norway, Sweden and Denmark
- Based on a model developed by Harald Volden

svenskmjölk
SWEDISH DAIRY ASSOCIATION

DANSK · KVÆG

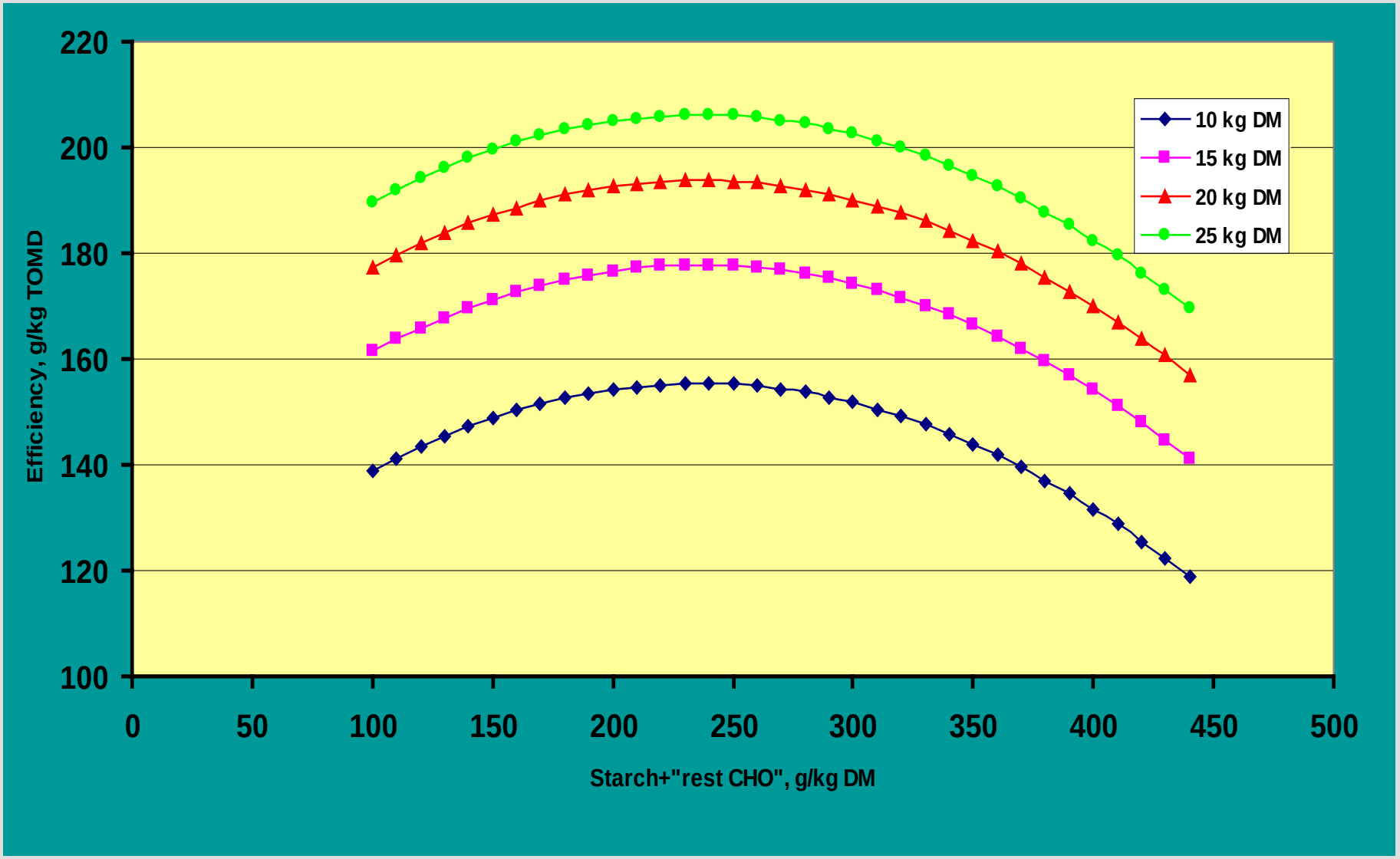
TINE ®


Fibre
Starch
Rest
Lipids
Protein
FEED
RUMEN
SMALL INTESTINE
HIND GUT
FAECES
iNDF
pdNDF
iST
pdST
sST
Rest CHO
FPF
LI
iCP
pdCP
sCP
NH3
Grf. 0,5
Krf. 0,1
Glycerol, galaktose
kdløys. / kpvæske (TS/lev.vekt, grf:krf)
kdløys. / kpvæske (TS/lev.vekt, grf:krf)
kdPNST / kpKRF (TS/lev.vekt, grf:krf)
kdNDF / kp1 + kp2 / kpkrf (NDF/lev.vekt, grf:krf)
kdPNCP / kpKRF /kpGRF (TS/lev.vekt, grf:krf)
Kdløys. / kpvæske (TS/lev.vekt, grf:krf)
Energy and nitrogen for microbial growth
PBV
UREA
4,6% av CPfôr
Microbal growth
Energy
MCP * 0,63
mST
mLI
mCP
eCP
30g / kg OM to duodenum
+ 60 g in intestine
Endogenous urinary-N
Endogenous N
AAT for hair and skin
Gain / mobil.
Grf. 0,7
Krf. 0,85
0,9
0,9
Energy
Energy
0,2
0,85
0,5
0,73
0,95
Grf 0,65
Kkrf 0,85
AAT
AAT to milk
Utilization
AA in milk
0,1
0,09
0,9
0,1
Energy and nitrogen for microbial growth
0,1
30%
45g / kg KBH
Grf. 0,3
Krf 0,15
Microbial growth
0,9
0,1
0,01
0,35
0,15
0,4
KBH 38g / kg
105g / kg KBH
NEL
Milk
INTERMEDIARY METABOLISM

Key features for NorFor

- Mechanistic model
- Non additive feed values
- Rumen degradabilities of feed fractions based on nylon bag data
- Fractional rate of passage is depending on feeding level and ration composition

NorFor - Efficiency of microbial protein synthesis



Protein evaluation systems and their use in different countries

System	Countries using the system (in brackets partly used)
PDI system	F, B, CZ, IRL, PL, P, SK, E, (I)
ARC system, FiM	GB, (IRL), (P)
AAT/PBV system	DK, S, FIN, N,IS, EST
NorFor	DK, S, N, IS (newly introduced)
DVE/OEB system	NL, B, (D)
nXP system	D, (PL)
NRC/CNCPS	USA, E, (I), (PL), (P)
CSIRO	AUS

Acceptance of the systems in different countries

Acceptance by users	Country
High	DK; FIN; F; D; NL; S; GB
Medium	CZ; EST; I; PL; SK; E
Low	B; IRL; P

Method used to obtain inputs to the systems

Method	Country
Wet chemistry, Nylon bag methods Enzymatic methods	All respondents
NIR methods developed	B; DK; D; E; EST; FIN; PL; S; GB
Feedstuff table	All respondents

Conclusions

- There are 5 main European protein evaluation systems for ruminants in use in Europe, but some countries also use American systems.
- The systems are all used in their countries of origin, but also in other countries where the French PDI system is the mostly used system in Europe.
- The European systems have been upgraded several times and are now moving towards more mechanistic models combining protein and energy evaluation.

Conclusions - continued

- In the countries of origin the systems seems to be well accepted by feed manufacturers, advisors and farmers
- In the countries where a system has been adopted from abroad the acceptance seems to be less
- Although methods have been developed to analyse for key values used in protein evaluation it seems that feed tables are the major source for input values for new batches of feeds

Conclusions - continued

- **Increased use of analyses on actual feed batches in practise demand cheap and fast methods – e.g. NIRS which is being adopted in many EU countries**

Acknowledgements

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All respondents to our inventory on issues related to protein evaluation are greatly acknowledged for their efforts

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It does not necessarily reflect its view and in no way anticipates the Commission's future policy in this area.

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