Building new feed unit systems for ruminants based on absorbed nutrients and animal responses in France.

D.Sauvant[1], P.Noziere[2],
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Modern story of ruminant Feeding Systems in France:

1978: « Alimentation des Ruminants »
(R.Jarrige & 25 co-W)

1. A new Energy System for milk and meat
   (with NL and Switz.)

2. Launching 1st functional Protein Unit System (PDI) *(adopted It, Sp, Pol, Switz…; adapted NL 94…)*

3. Launching 1st Fill Unit System

4. All the requirements and feed values
   → INRATION computer program

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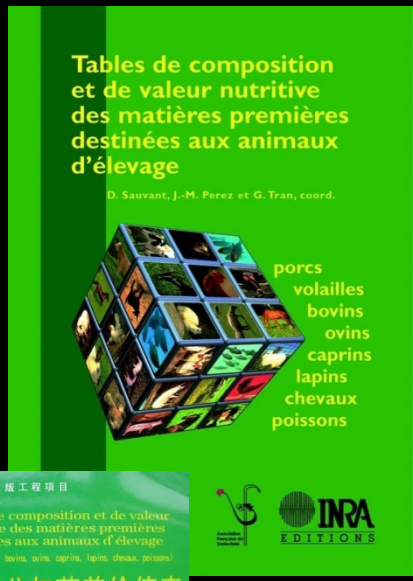
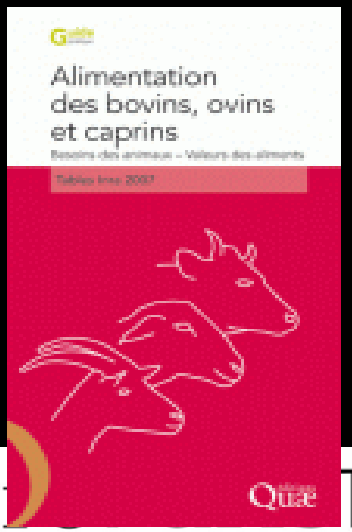
Further updatings

1. 1988: 1st updating + English version

2. 2002/2004 INRA-AFZ multispecies tables for concentrates & by-products (french, english, spanish, chineese)



3. 2007 last updating: requirements, responses,dynamic events, feed values, new computerized version …



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REMAINING ISSUES…CHALLENGES…

Feed unit systems (energy, protein…) are becoming obsolete despite marginal updatings

Mechanistic models cannot (yet ?) replace the practical interest of the feed unit systems

Knowledge is continuously accumulating and new challenges are emerging: *impact on environment, quality of products, wellbeing…*

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➔"Systali" working group in France to update the french Feed unit systems *(1st step: 2010-2013)*

Head of the project: P.Noziere

Assistants: J.L. Peyraud and D.Sauvant

and 28 other research workers from 4 INRA lab (Theix, Rennes, Paris, Guadeloupe)

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Targets of systali ?

- More precise prediction of NE, PDI, AADI…
- Prediction of the <u>flows of nutrients:</u>

  VFA + Gaz + Glucose + Fatty acids + Ess.Am.Ac…
- Prediction of the animal responses to these flows
- Enlarge the fields of applications *(warm countries…)* and the feed data bases

➔ 1st necessity to improve the accuracy of the current basic unit systems

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SYSTALI PROJECT: PLAN

1. Organization of the project
2. Methods of approach
3. Digestive Part
4. Animal Part

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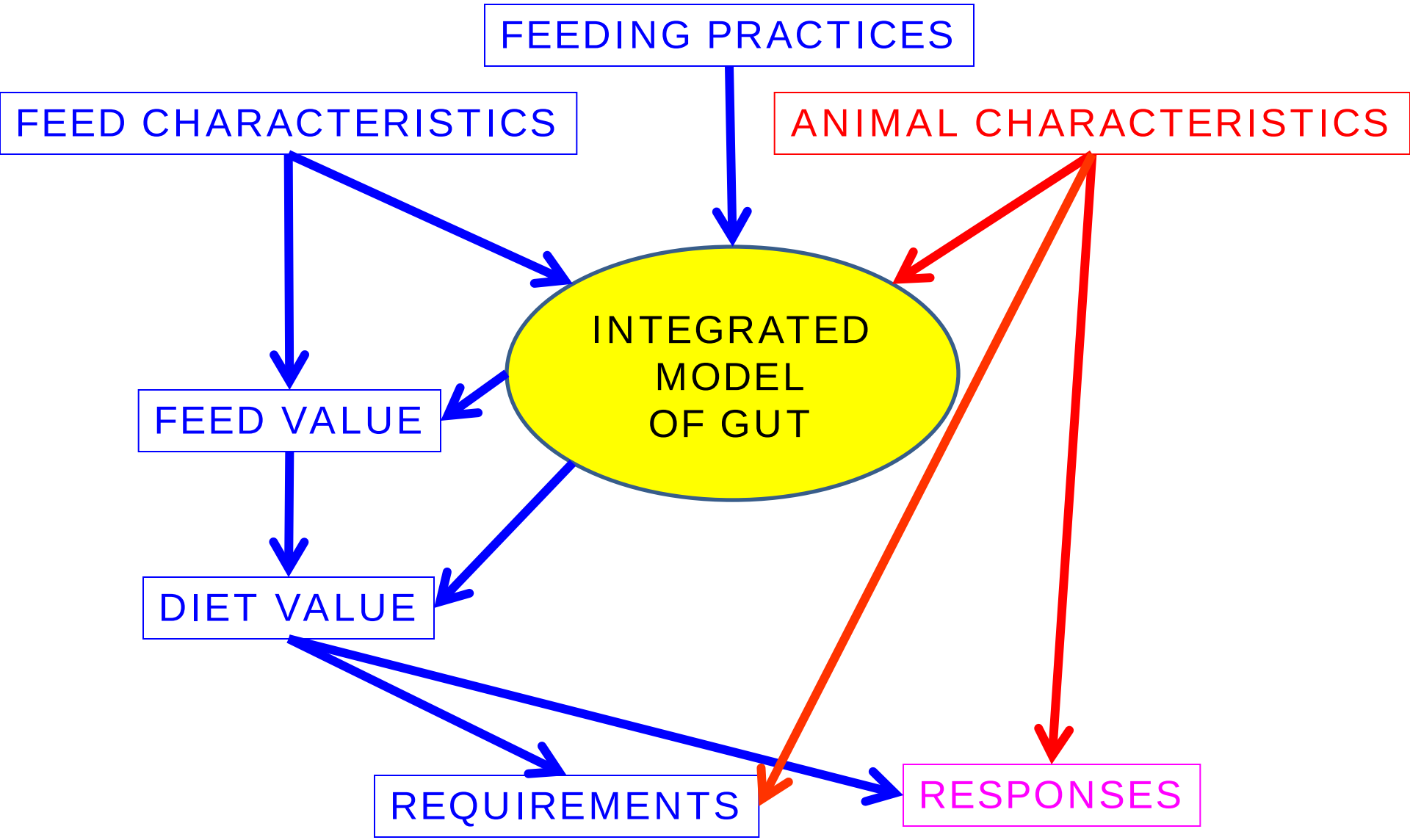
1. Global systali project



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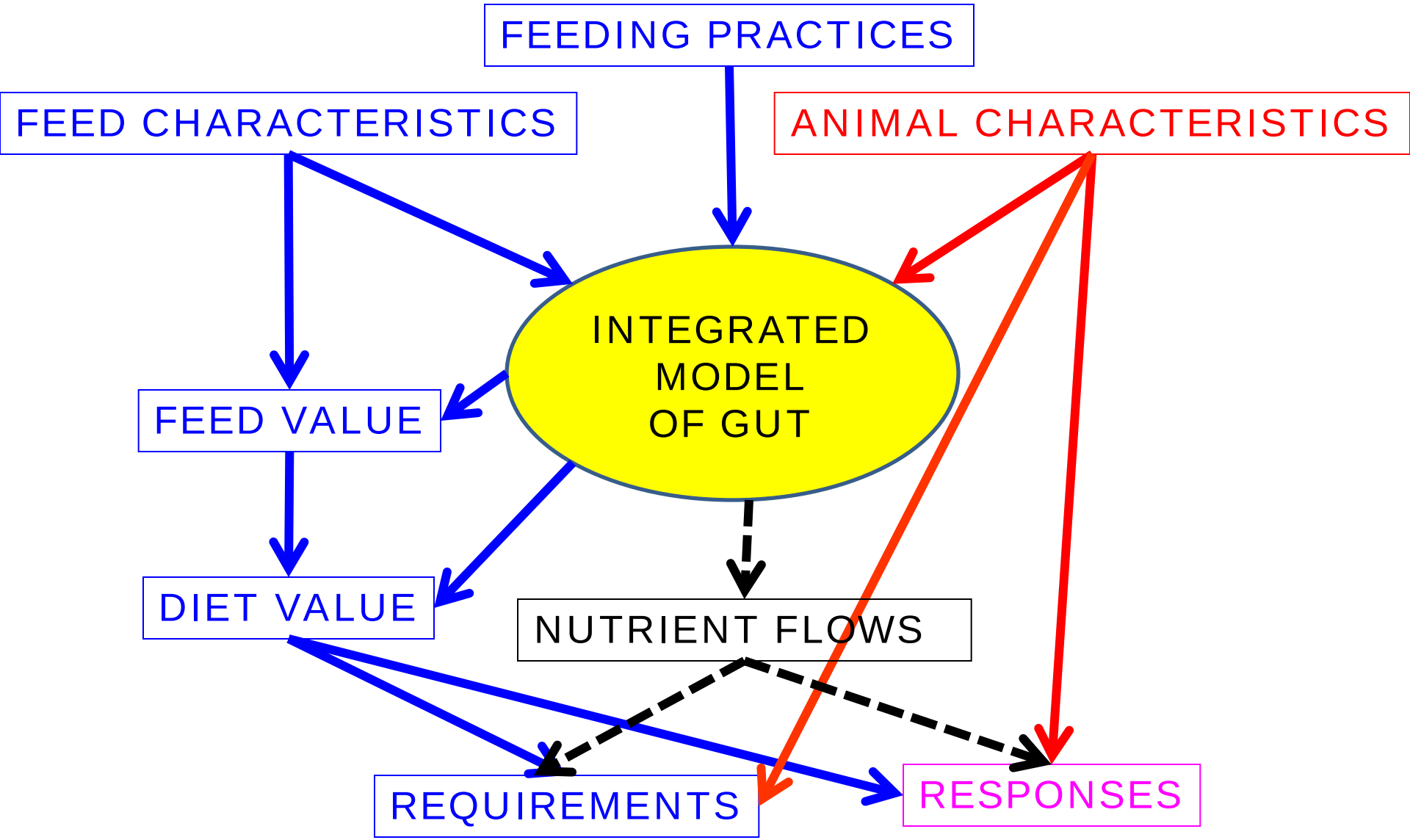

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2. methods of approach:

2.1. Building large data bases from experimental results from INRA, or from the literature.

2.2. Study of the meta-designs (representativity, orthogonality…) and experiment encoding

2.3. Meta-analyses of data ➔ empirical models
(St Pierre, 2001, Sauvant et al., 2008)

➔ Integration of the empirical models ?

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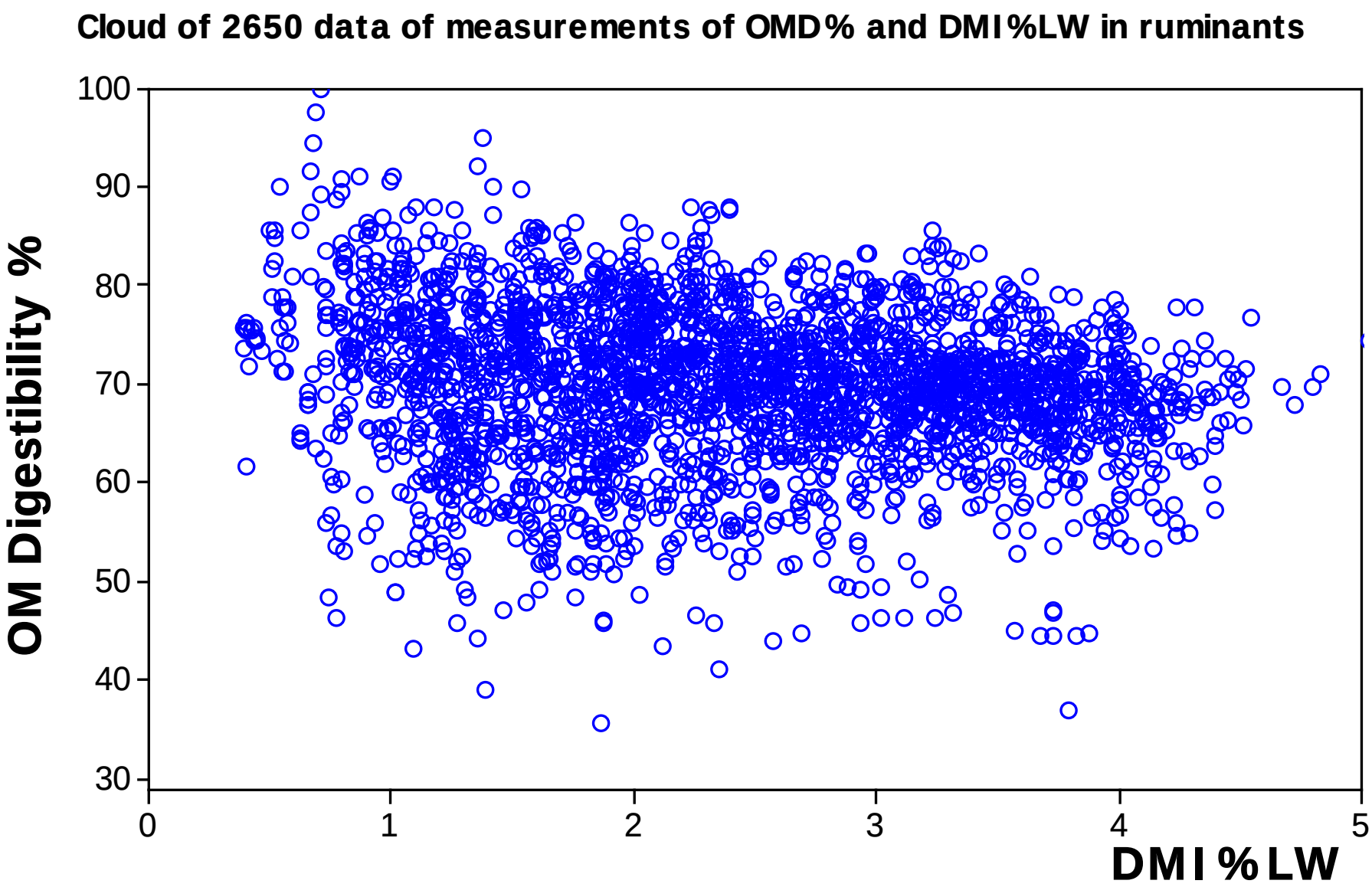
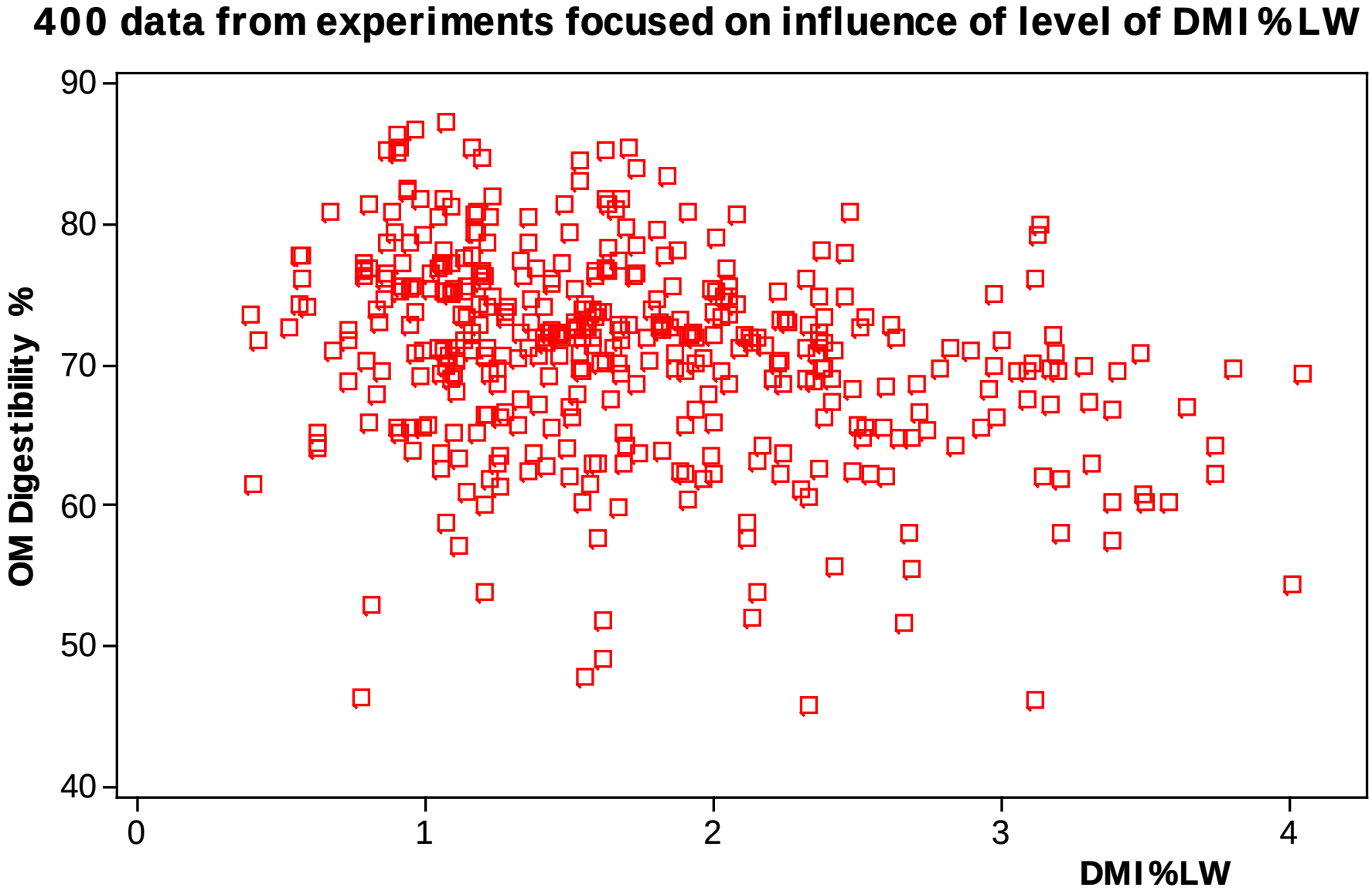
EXAMPLE OF META-ANALYSIS: Influence of DMI%LW on OMD%, phase 1

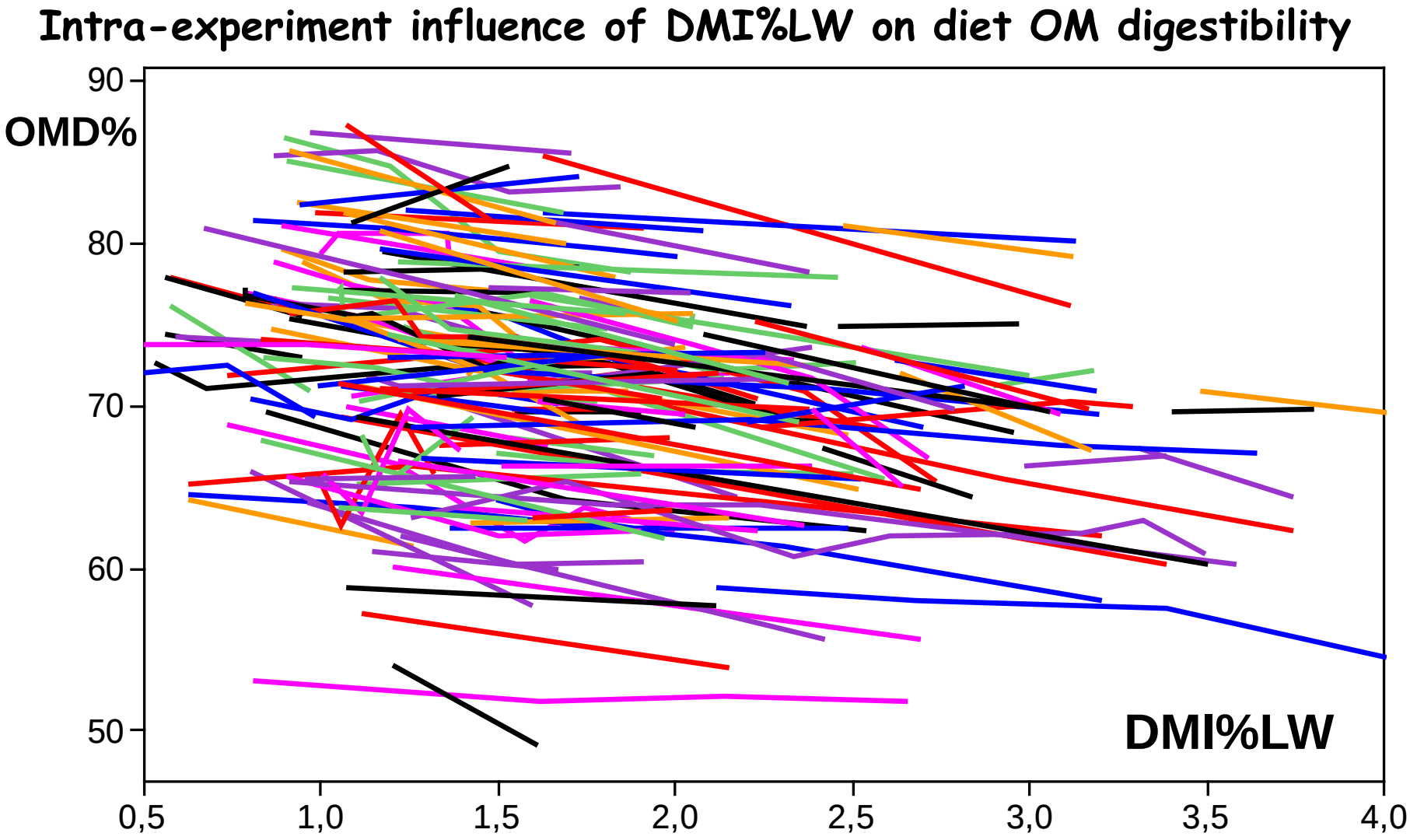


1 point = 1 treatment = 1 group of animals

EXAMPLE OF META-ANALYSIS: phase 2



EXAMPLE OF META-ANALYSIS: phase 3



152 experiments focused on influence of level of DMI
Databases « Bovidig » & « Rumener », D.Sauvant & al., 2011

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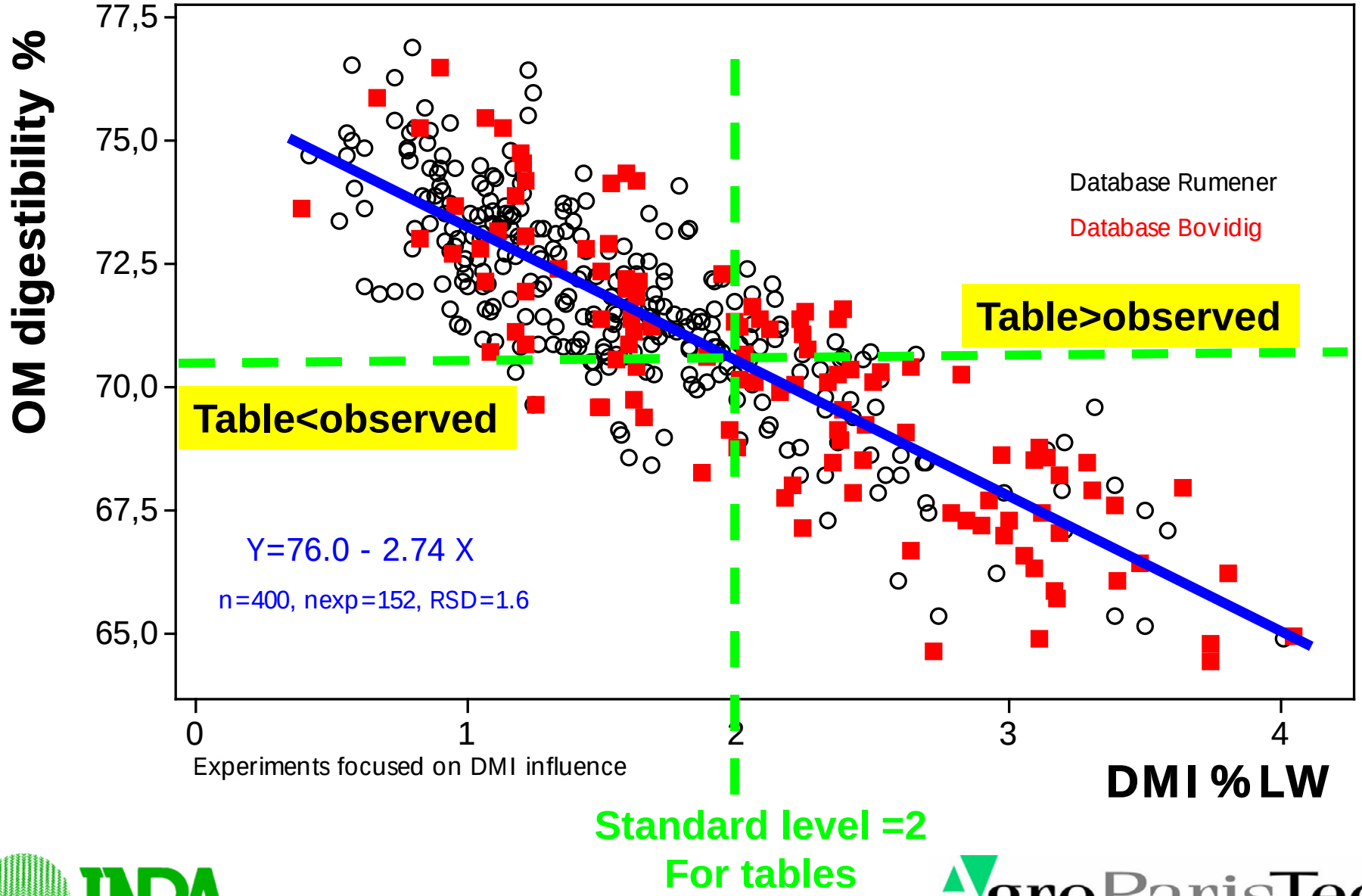
Intra-experiment influence of DMI%LW on diet OM digestibility



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3. Digestive part

3.1. Digestive interactions

3.2. Substrate degradation

- *N & starch*
- *Fermentable OM*

3.3. Microbial protein production

3.4. Integration of the various equations

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3.1. Digestive interactions (I)

$$VALUEdiet = \Sigma_i \, p_i \, TABLEVALUEfeed_i \pm I$$

Modelling I ?

- *Impacted item = OMD%*
- *Causes ➔ Predictors ?*

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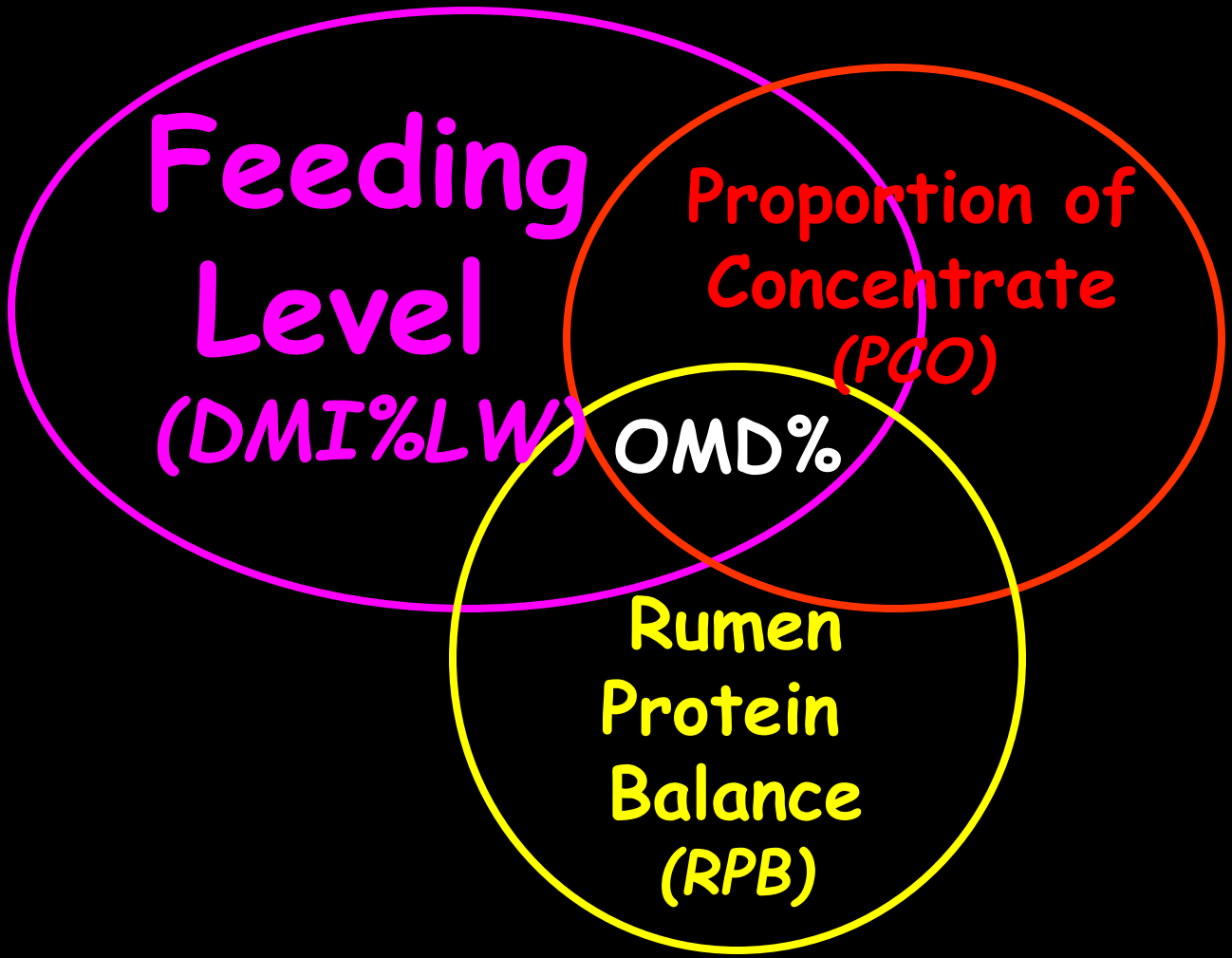
Major causes of digestive interactions altering OM Digestibility ?



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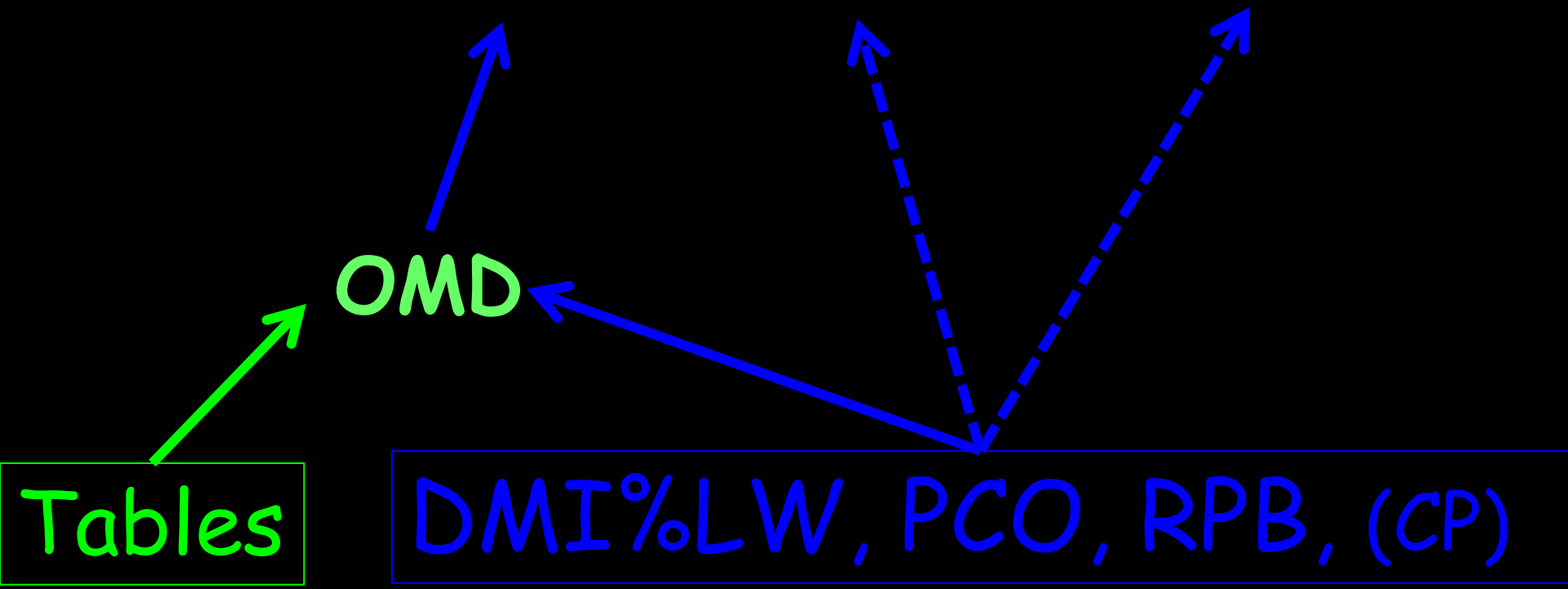
From OMD to ME

ME = GE * Edig - ECH4/GE - EU/GE



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3. Substrate degradation

3.1. N and starch

EDN & EDst = a (100/100+kl) + b (kd/kd+kp)

a, b, kd ⇔ in situ data

kl, kpf, kpc = f(DMI%LW, PCO) by metaA

Evaluation *in situ* vs *in vivo* ?

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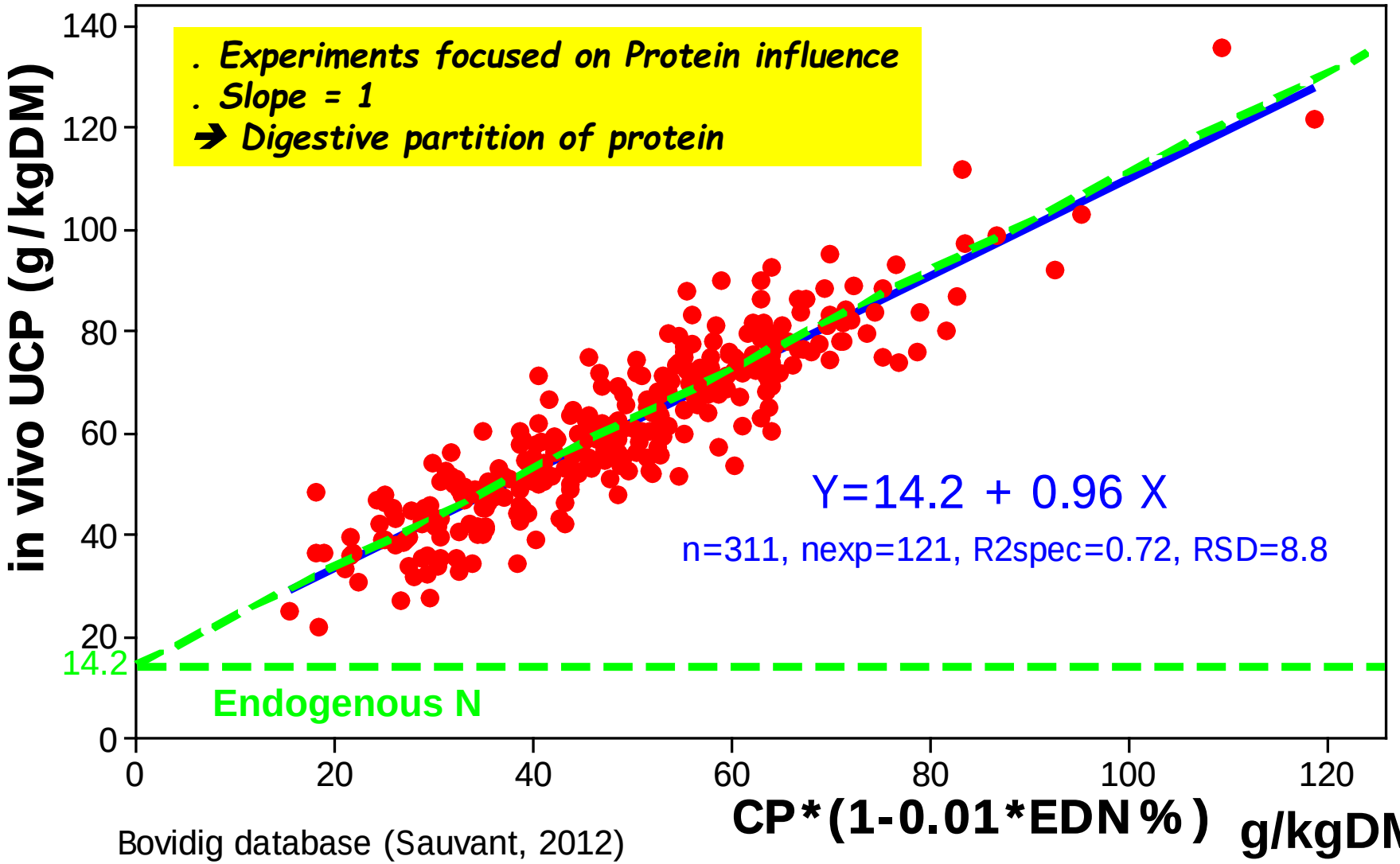
Intra-experiment prediction of UCP from in sacco data



Bovidig database (Sauvant, 2012)

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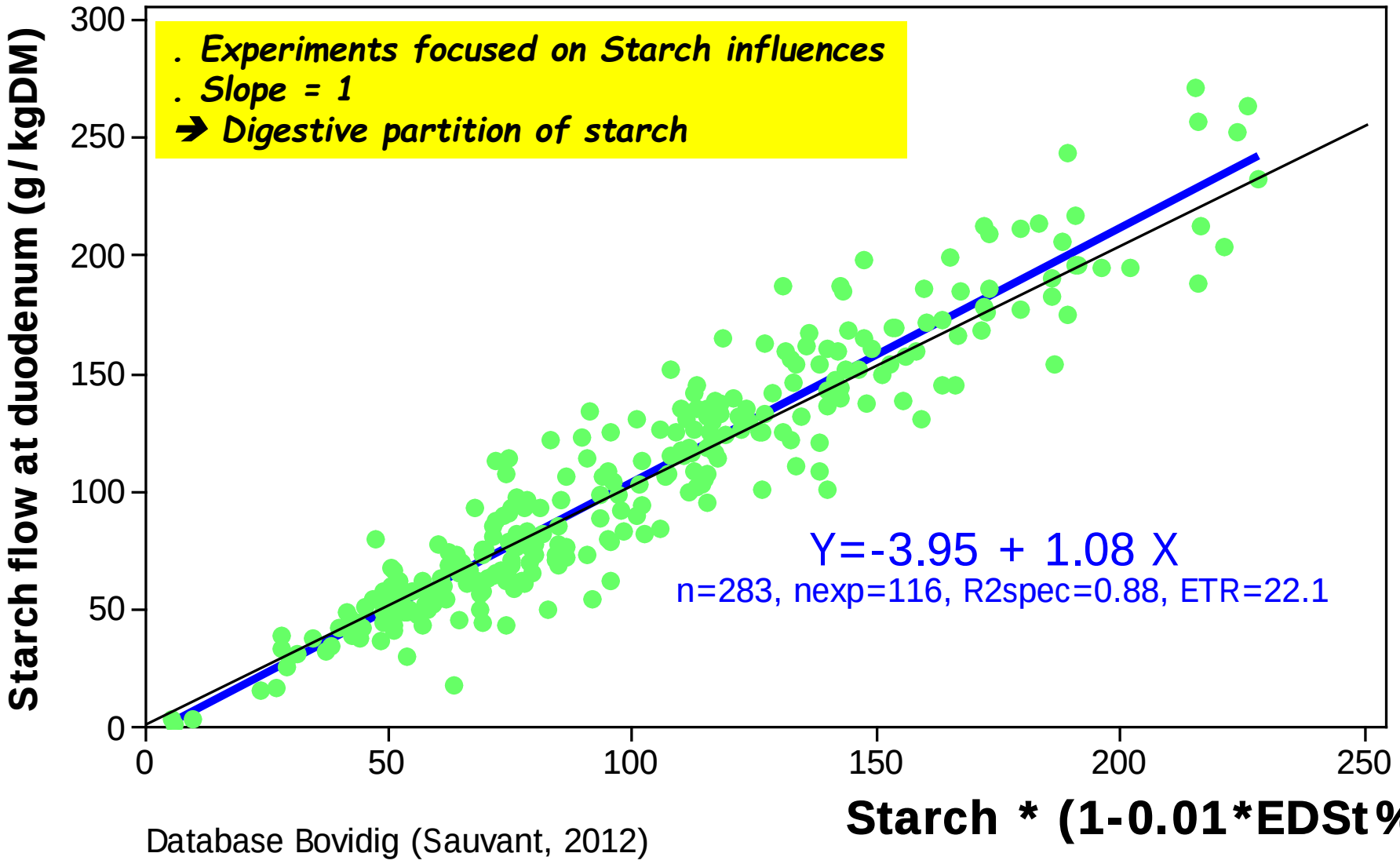
Intra experiment prediction of by-pass starch from in sacco data



Database Bovidig (Sauvant, 2012)

3.2. Substrate degradation

3.2.2. Fermented OM

- Former approach ⇔ index:

FOM = DOM – RUCP –RUSt – EE – Vol

- New approach ➔ « true » FOM

FOM = corDOM – Dig.Int.Fract of duod. flows of [CP + St + FA + NDF] – Vol

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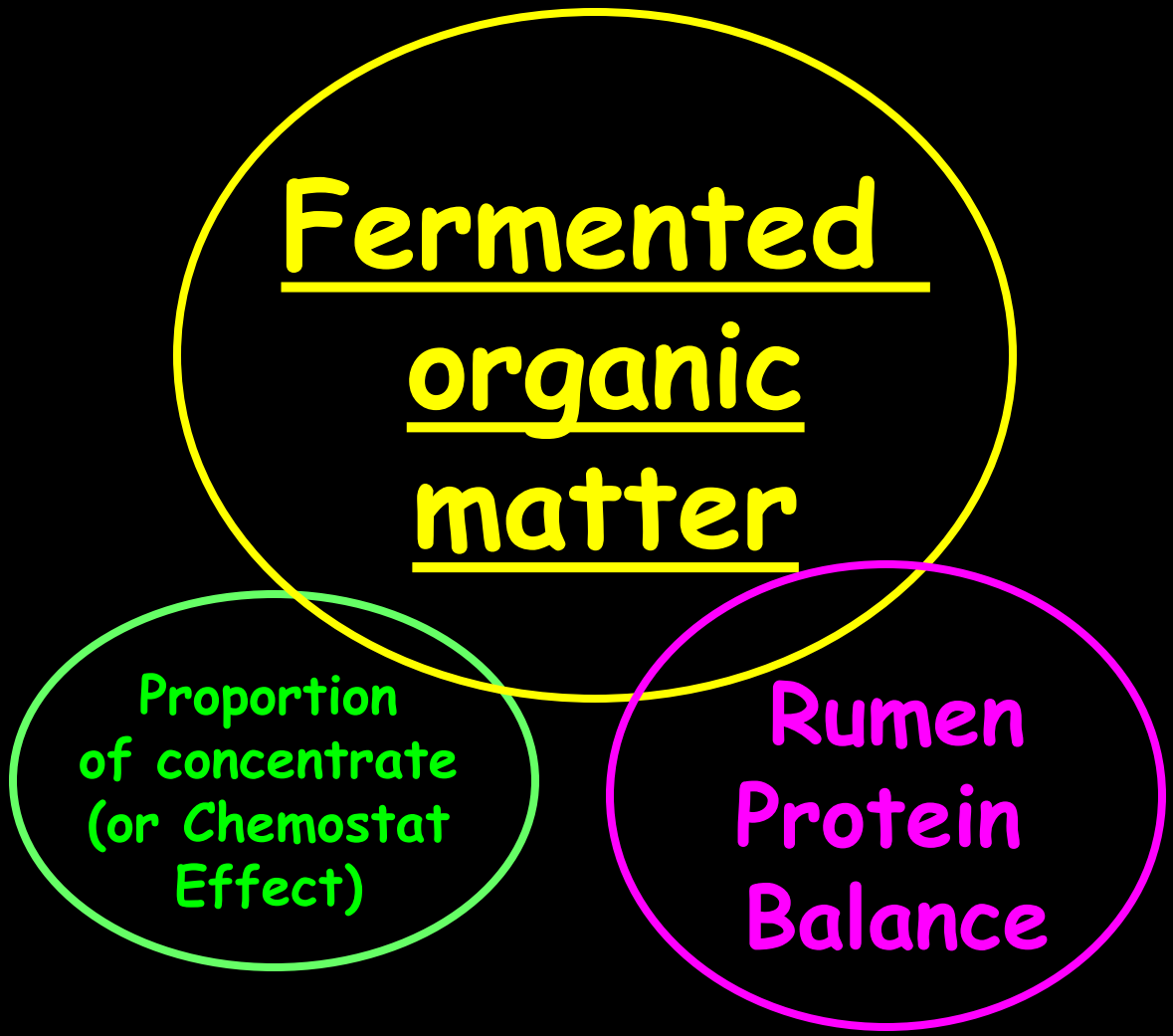
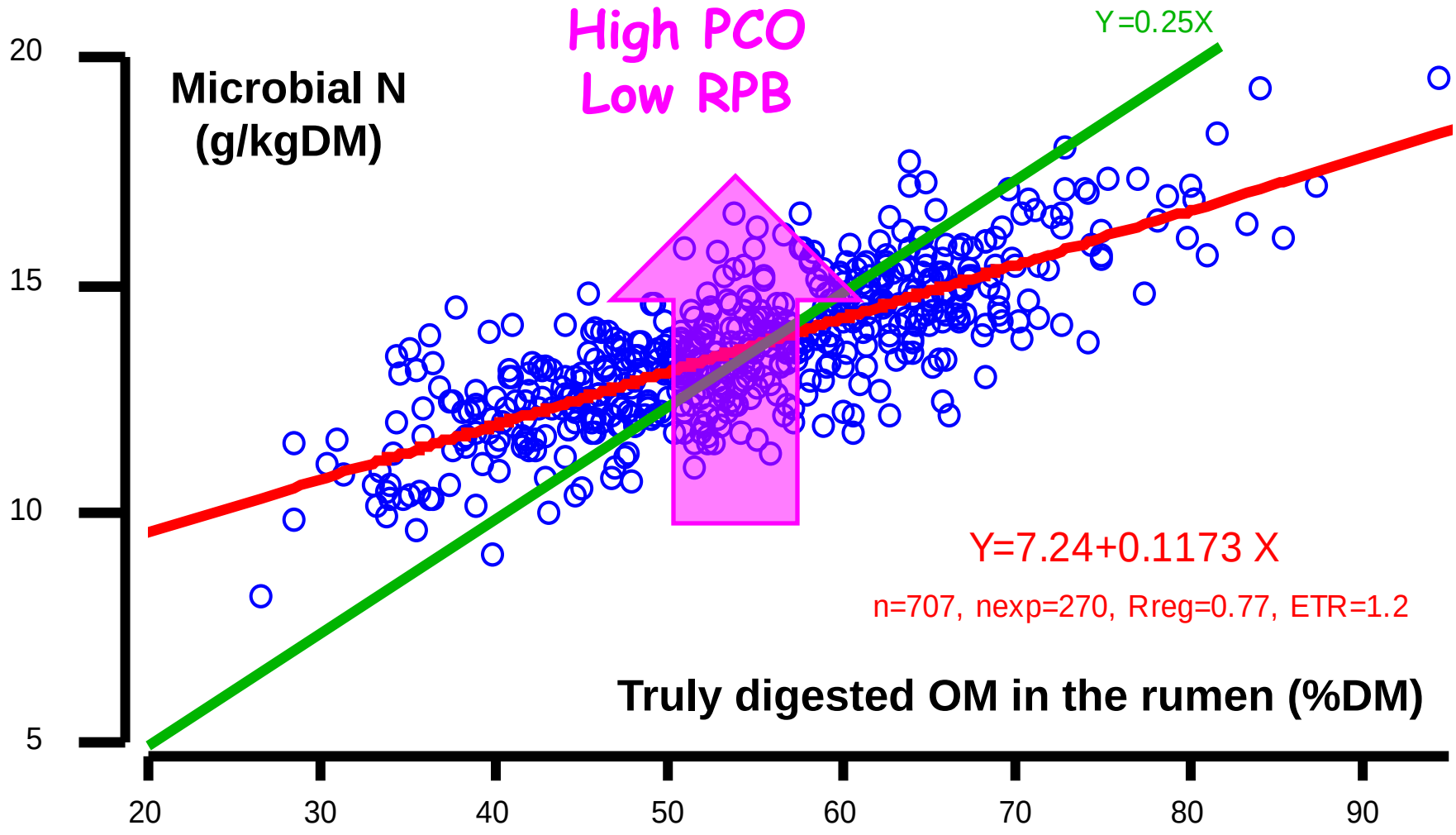
3.3. Major causes of variation of microbial protein production in the rumen?



Intra-experiment influence of TDOMru on microbial N



« Bovidig » database (D.Sauvant, 2012)

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3.4. Integration of the various equations ?

A necessity to insure consistency across more than 100 empirical equations extracted from various contexts…

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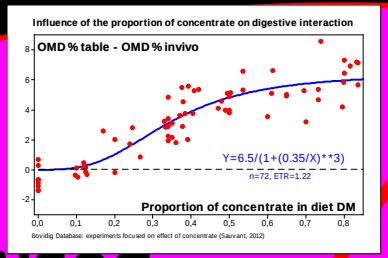
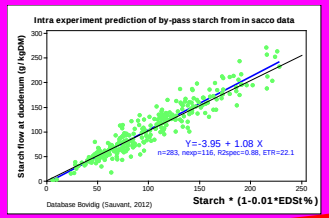
Partition of equations issued from meta-analyses



Equations used to predict UFL, PDI…

Other equations (chewing, fill, pH nutrients flows…)



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Partition of equations issued from meta-analyses

Integration into a new mechanistic model of the rumen and gut

Equations used to predict UFL, PDI…

Other equations (chewing, fill, pH nutrients flows…)

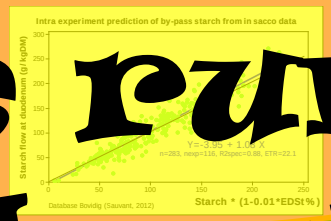

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Diagramme « systali »: equations ➔ PDI et UF

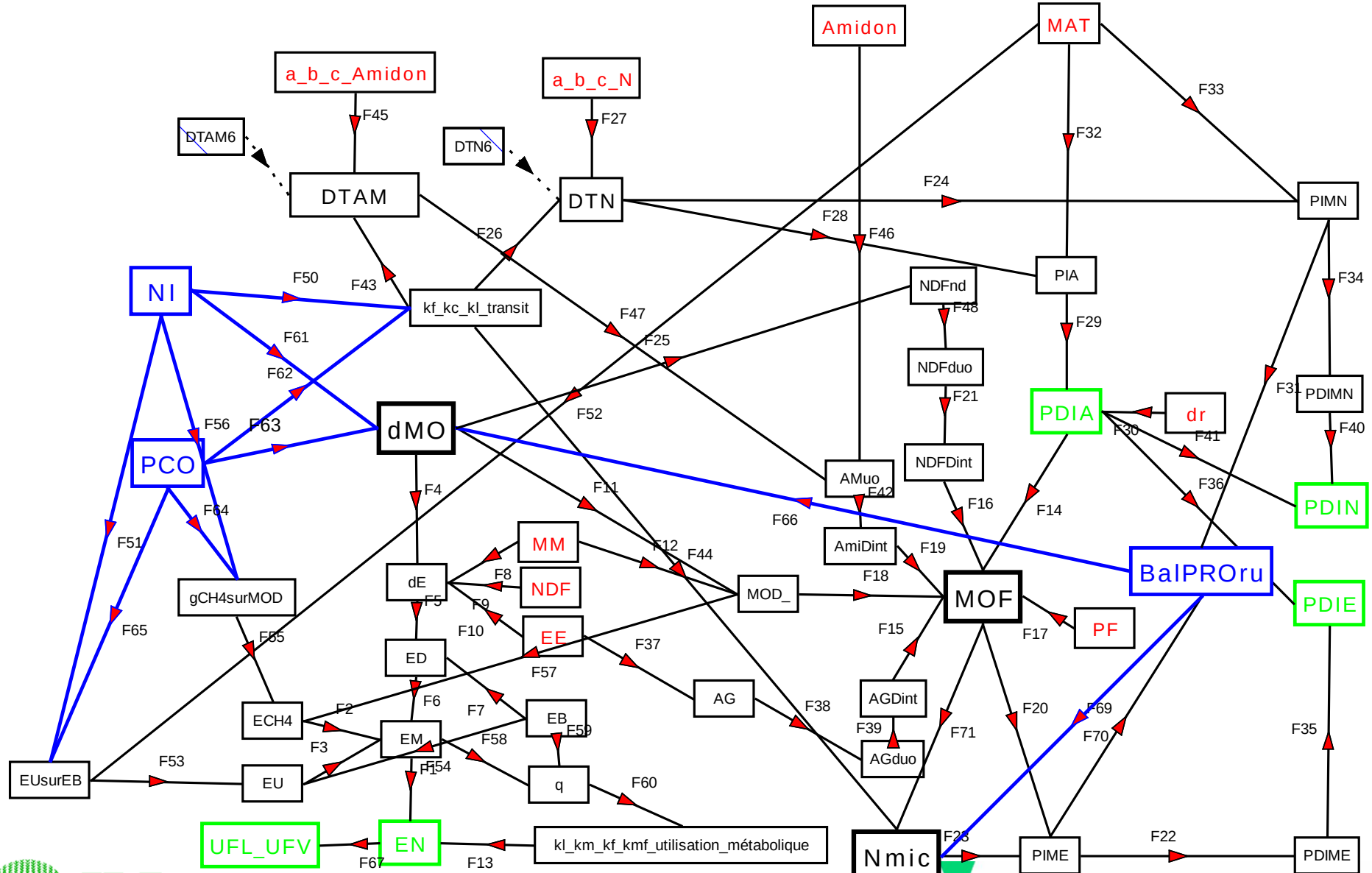

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Diagramme « systali »: equations ➔ PDI et UF

Integration in « Systool » to calculate the new values of the experimental rations (cf Poster)

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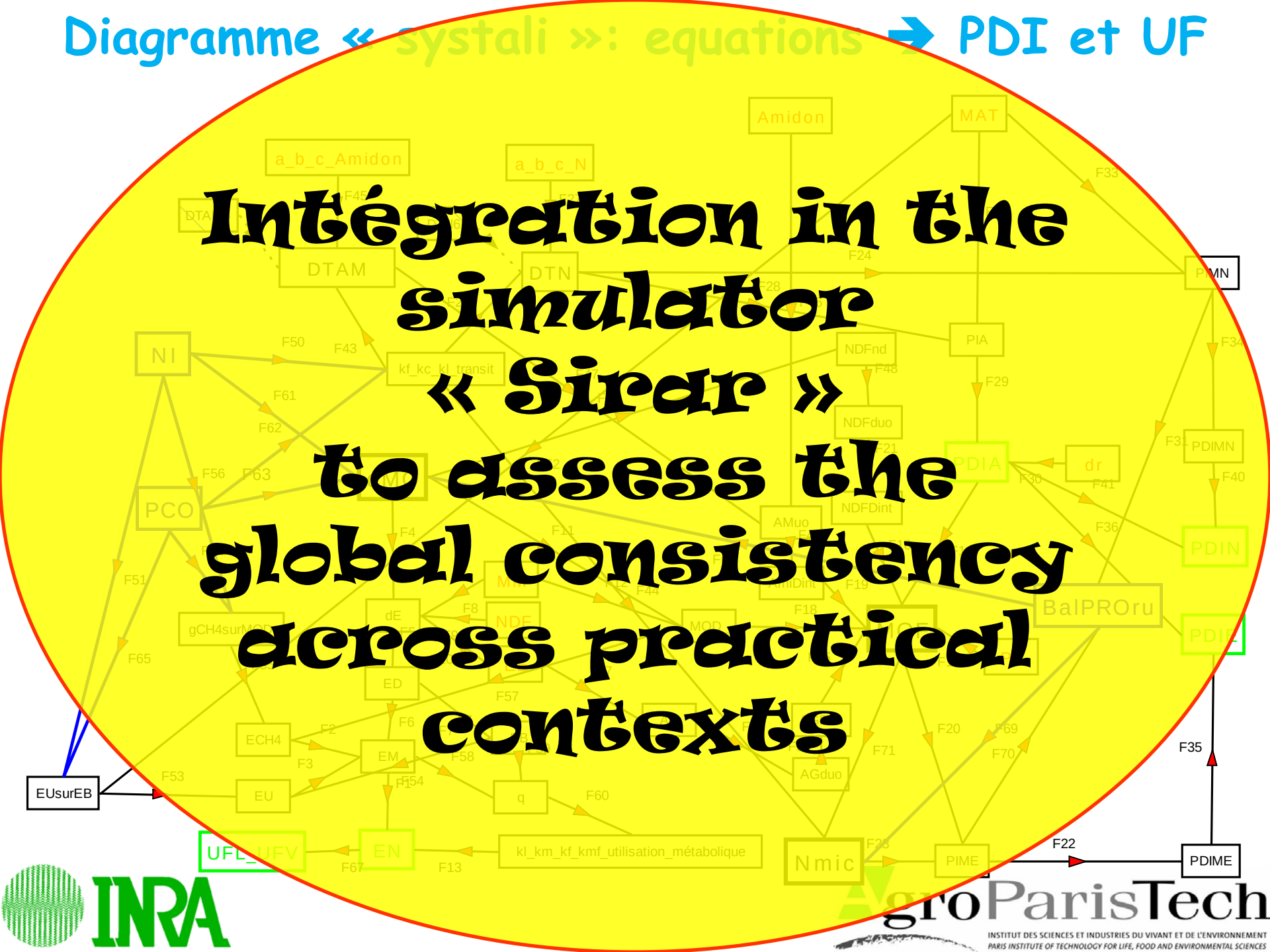
Diagramme « systali »: equations ➔ PDI et UF



Intégration in the simulator « Sirar » to assess the global consistency across practical contexts

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EVALUATION ON SHEEP OF THE INRA-SYSTALI MODEL OF DIGESTIVE INTERACTIONS

P. Nozière[1], P. Chapoutot[2] and D. Sauvant[2]

[3] INRA-VetAgroSup, UMR 1213 Herbivores, Theix, France
[1] INRA-AgroParisTech, UMR 791 Modélisation Systémique Appliquée aux Ruminants, Paris, France
email: pierre.noziere@clermont.inra.fr

See the poster !

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4. Animal part

4.1. Reconsideration of the basic requirements for maintenance and production

- *According to the new nutritive values of feed & diets*
- *Integration of new aspects & concepts*
- *For ruminants on poor quality diets,*
- *Consistancy with the INRA-CIRAD-AFZ-FAO « Feedipedia »*

4.2. Responses to feed units ?

- *N.E.(UF) and PDI and EAA*
- *VFA, glucose, fatty acids*

Responses = feed efficiency, performances, digestive risks, milk and carcasses composition, faecal and urinary N, P, CH4 excretions, behavior…

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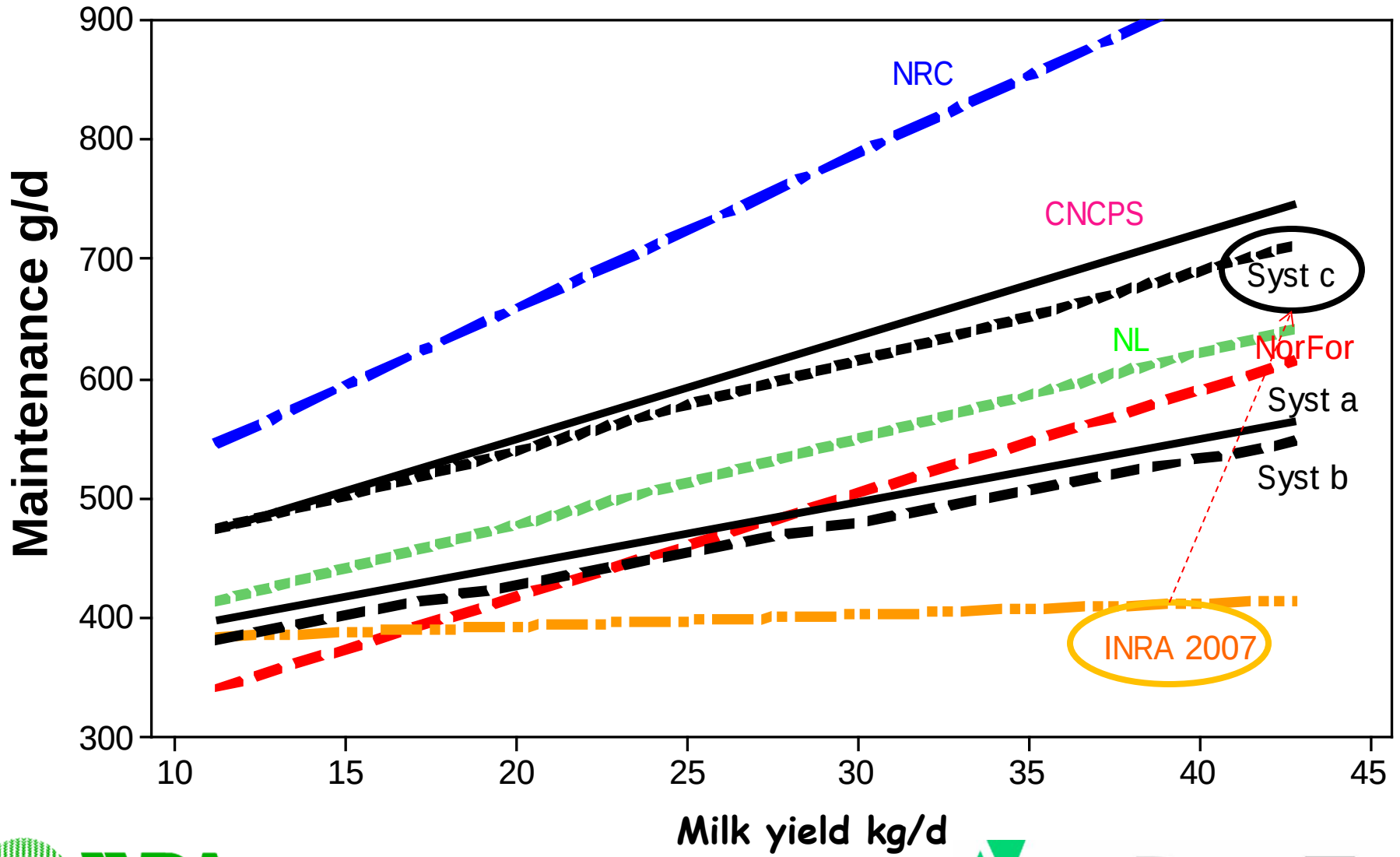
Maintenance protein requirements: comparison across proposals for cattle



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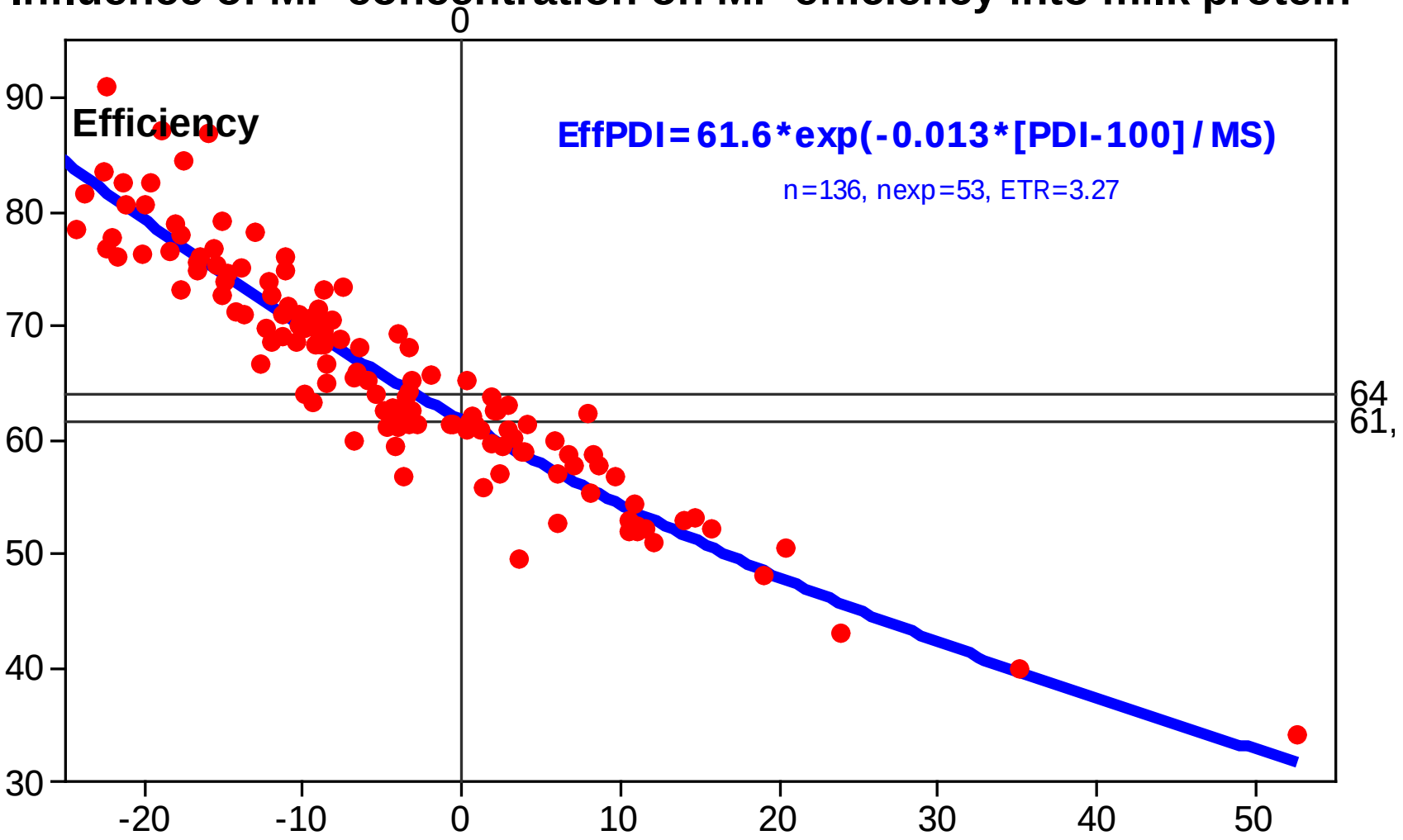
Influence of MP concentration on MP efficiency into milk protein



Bovidig-PDI database, D.Sauvant, 2013

[PDI-100] g/kgDMI

Similar trends with dairy goats
Influence of energy balance

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CONCLUSIONS

1. First step of systali is in 2013

2. A priority was accorded to model digestive processes:

3. Meta-analyses allowed to stress several new interesting relationships allowing to be more realistic and accurate

4. The integrative model allowed to check constancy across relationships issued from various contexts

5. The approach was completed/evaluated by 2 tools to calculate diets and to simulate practical situations

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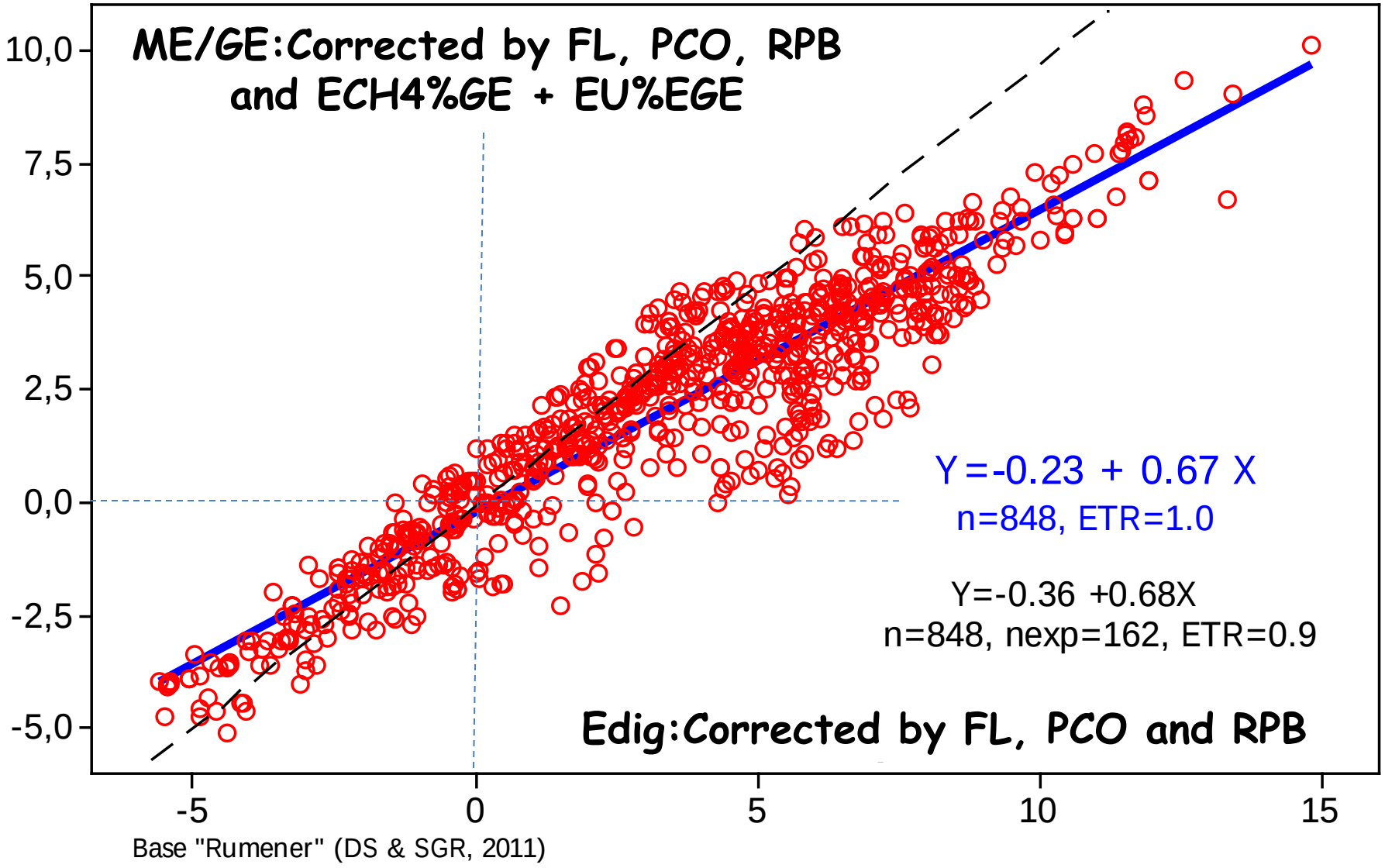
Necessity to integrate ECH4%GE and EU%GE to assess digestive interactions

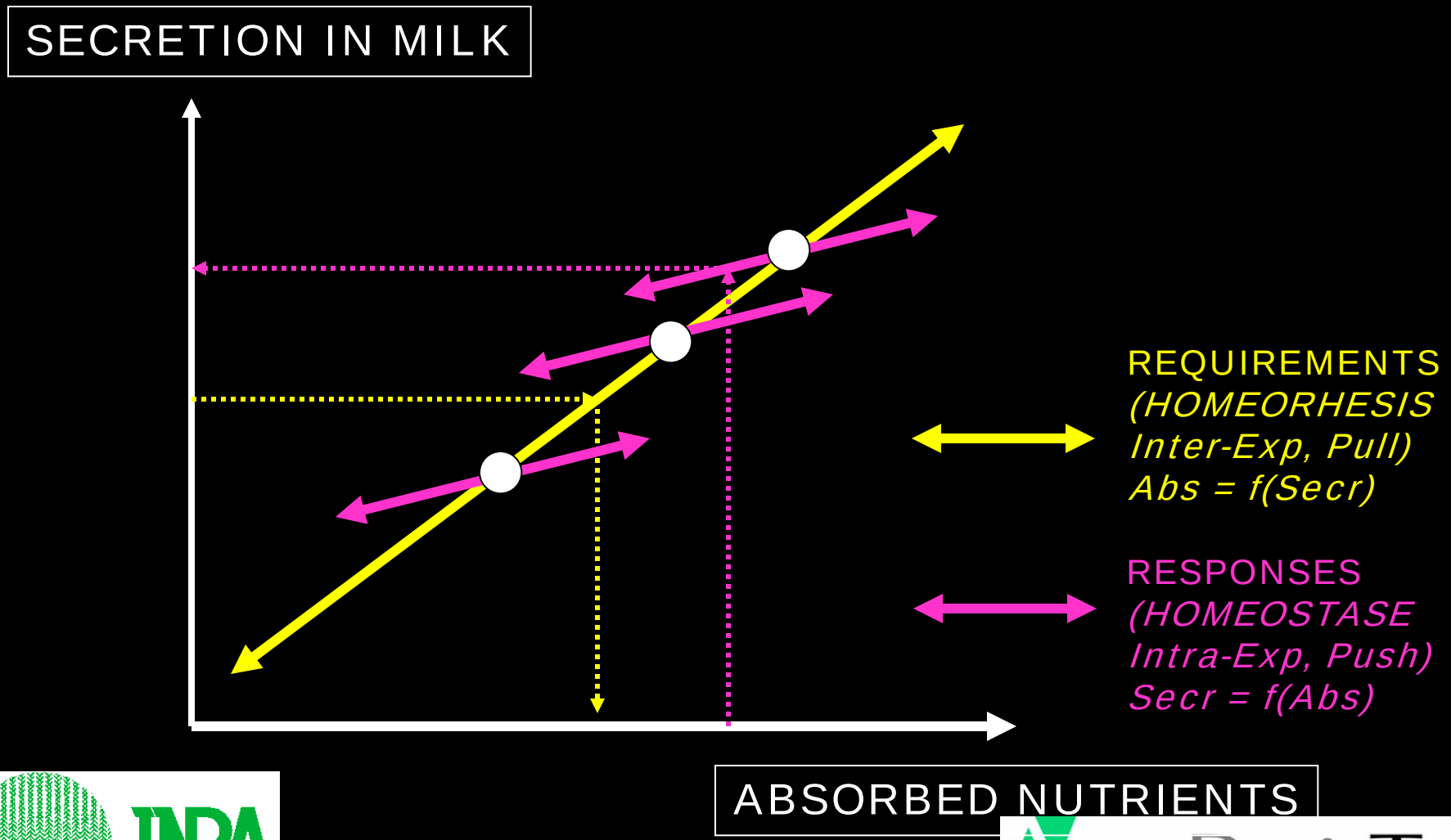


Base "Rumener" (DS & SGR, 2011)

➔ *ECH4 and EU induce a compensation, curvilinear ?*

RELATIONSHIP RESPONSES-REQUIREMENTS:

Can we estimate the both from a same data base ?



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The negative influence of digestive interactions

1. Feeding level (FL) or level of production:
+ 1 unit of DMI%LW ➔ - 2 to 3 points of OMD%

2. Concentrate supply: +10%CO ➔ - 0.3 to - 0.6 pts OMD%

3. Lack of nitrogen in the rumen:
- 10g CP/DM ➔ - 0.2 to - 0.4 point of OMD%
- 10g Rumen protein balance ➔ - 0.5 point of OMD%

Quantitative consequences ?

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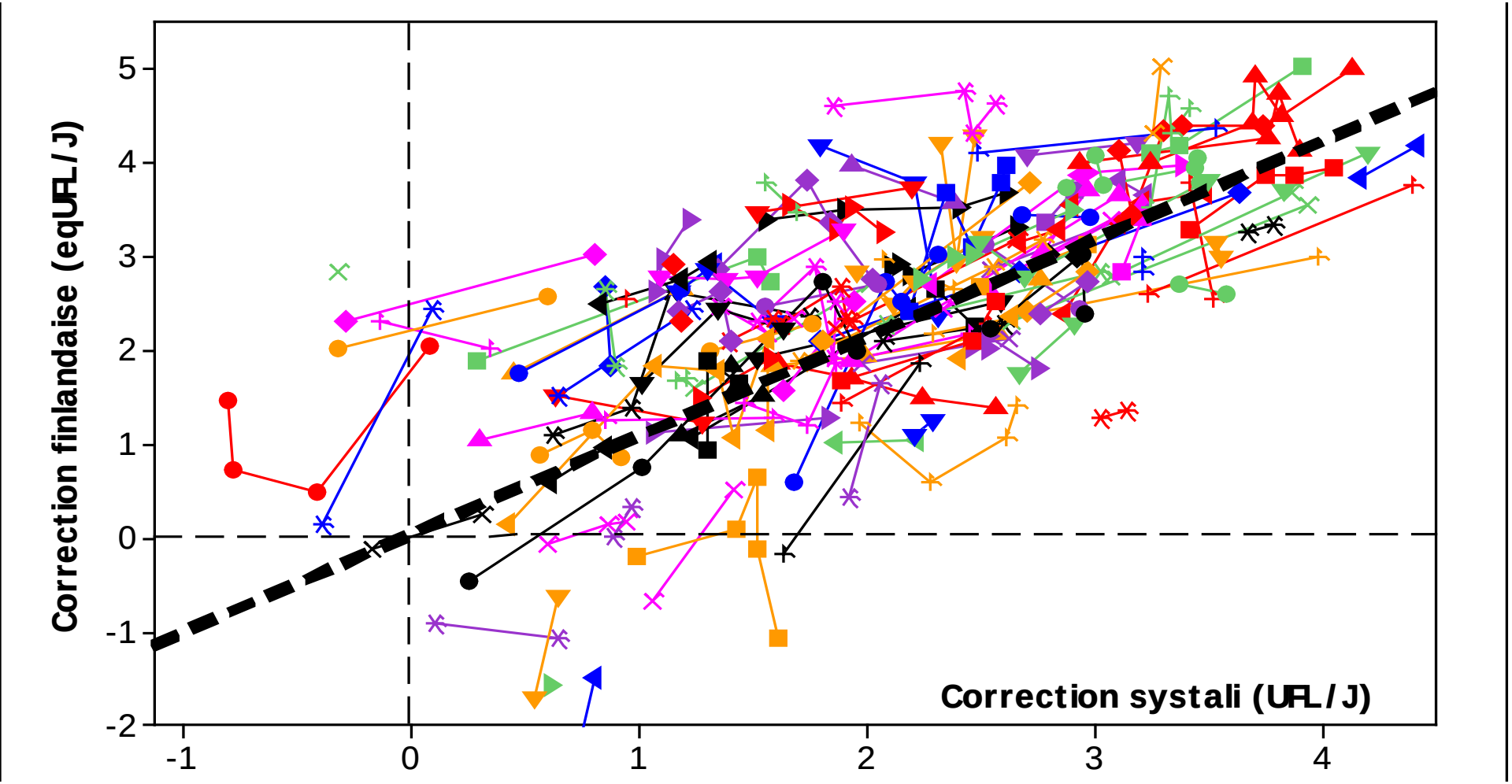
Comparison of proposals from Finland and France to take into account digestive interactions caused by feeding level, concentrate supply and dietary protein content, interpretation in milk feed unit/d (D.Sauvant, unpub)



No significant differences between both proposals
Calculated on the « Bovidig » database

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