# A meta-analysis of the effect of the diet fed to Holstein cows on their milk calcium content

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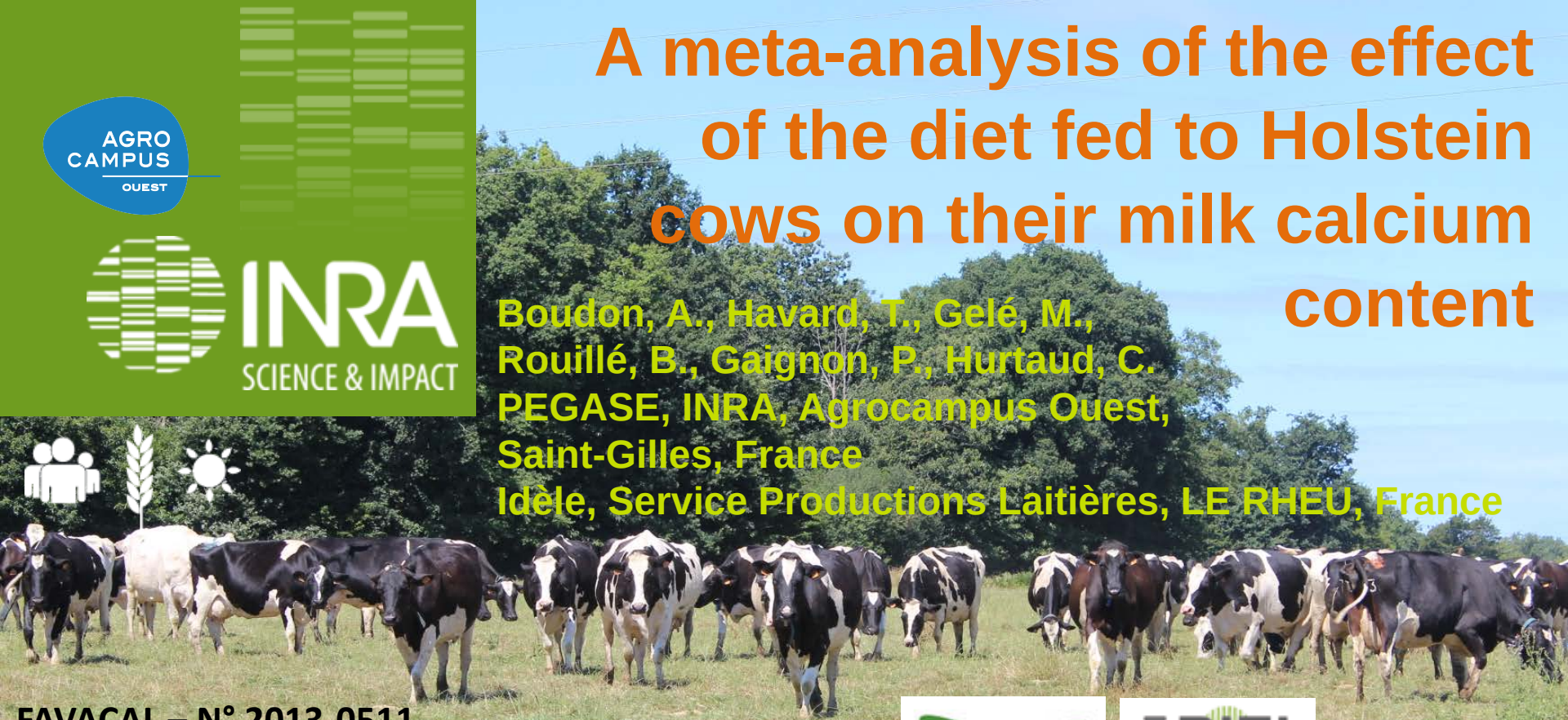

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# An effect of the diet on the milk calcium contents of cows ?

- Milk Calcium = a determinant of milk coagulation and cheese-making abilities & a source of calcium for human nutrition in westernized diets.
- A paradigm : **”Milk calcium content is determined by the genetics of the cows and by the stage of lactation. The nature of the diet has a very limited effect on the milk calcium content of the cows even in situation of deficiency”** (Alais, 1984)
- However, a certain variability observed related to the diets of the cows in isolated trials.
- **Our objective : to better characterize the variability of the milk calcium content linked to nutritional characteristics of the diets of the cows.**

# A database of experimental results from trials testing the effect of diets on milk quality

- **611 milk calcium analyses of morning milk samples gathered from 41 nutritional trials** carried out at the Rennes INRA experimental farms (North-West of France ) between 1988 and 2011.

  Holstein cows, mid lactation. **Individual data.**

- Most experimental designs = Latin squares or inversion design (except 5 trials)

**Diet :** DMI, centesimal composition of the diet, and biochimical analyses of the feeds

**Individual parameters** : parity, stage of lactation, milk yield, Live Weight

**Requirement coverage (INRA 2007) :**

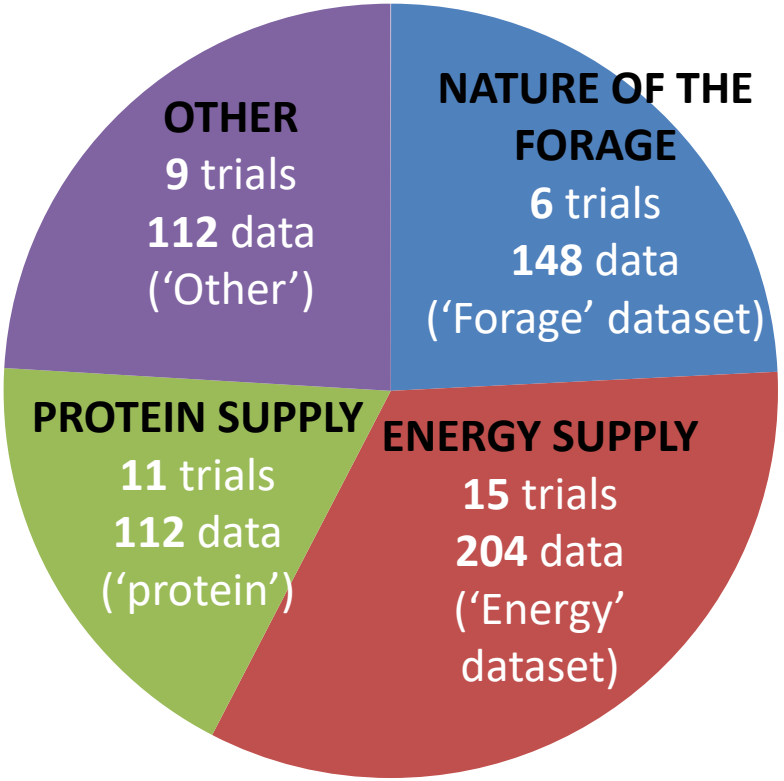
$NE_L$, PDI, Ca, P

**Milk composition** : fat, protein and lactose contents, Cells, urea, non protein content, soluble N

Milk total, soluble and colloidal Ca

# Nature of the compared treatments

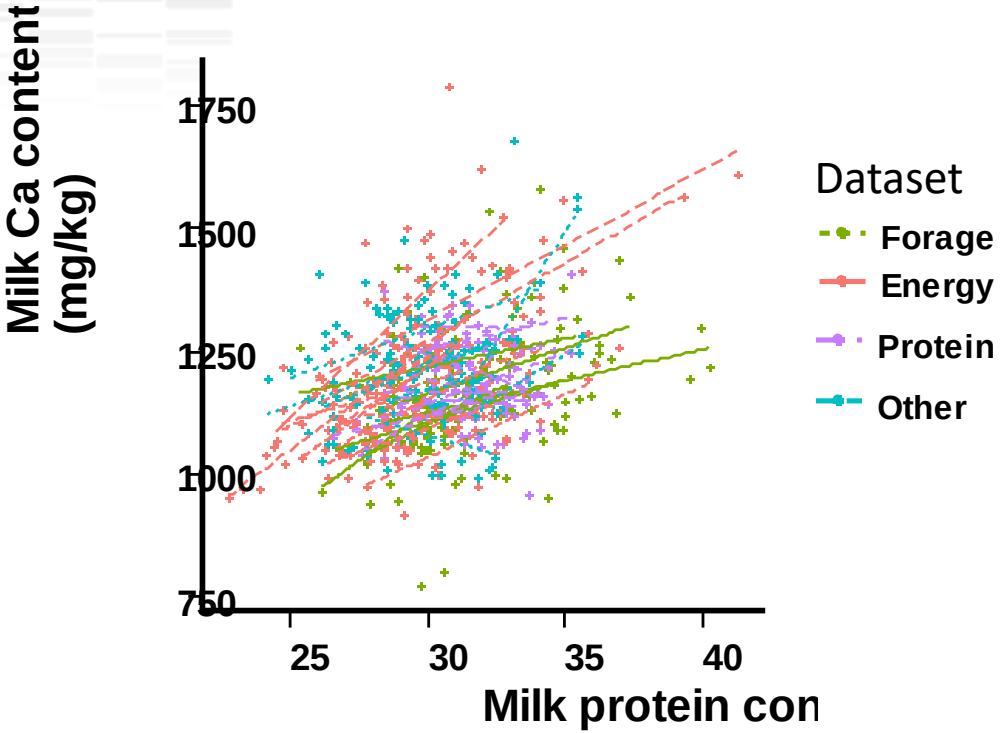
- <u>Trials comparing several levels of E supply</u>: half of the trials involved ruminal or duodenal infusion of energy nutrient (VFA, glucose).
- <u>Trials comparing several levels of protein supply:</u> inclusion of protected AA.
- Others trials mostly with nutritional treatments (nature of energy or protein supply).



# Questions & strategy of analysis

- **Our main questions:**
  - **Does the nature of the diet to the cows have an effect on the milk calcium content ?**
  - **Is this effect linked to the effect of the diet on the milk protein content ?**
  - **Does the Ca and P contents of the diet influence the milk calcium content ?**
    - **Strategy:**
      - **Analyses of variance, mixed models considering the trial intercept (and slope) as random effects (St-Pierre, 2001)**
      - **Analyses on partial datasets according to the considered factor.**

# A clear relationship between milk calcium and protein contents

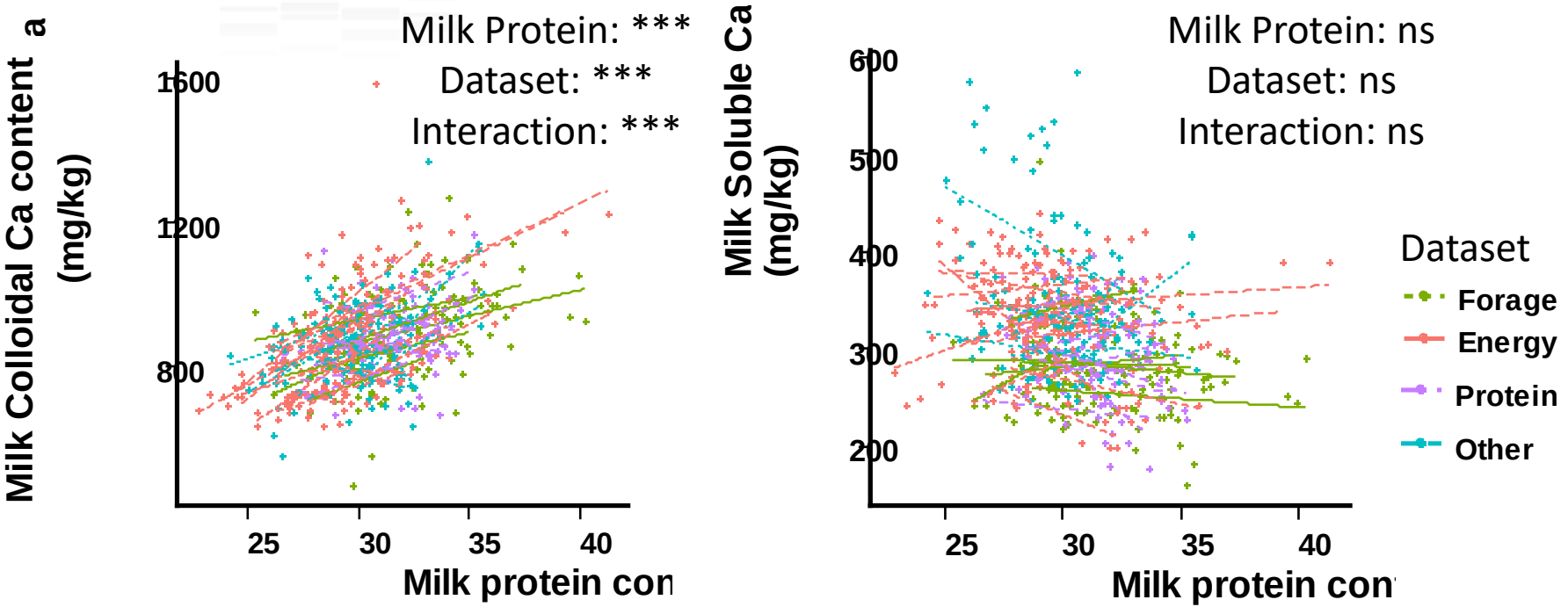



Milk Protein: ***
Dataset: ***
Interaction: ***

$$Y_{ijkl} = \mu + MPC_i + Dataset_k + MPC \times Dataset + Trial_l + \varepsilon_{ijkl}$$

(random)

# A clear relationship between milk calcium and protein content … due to colloidal calcium



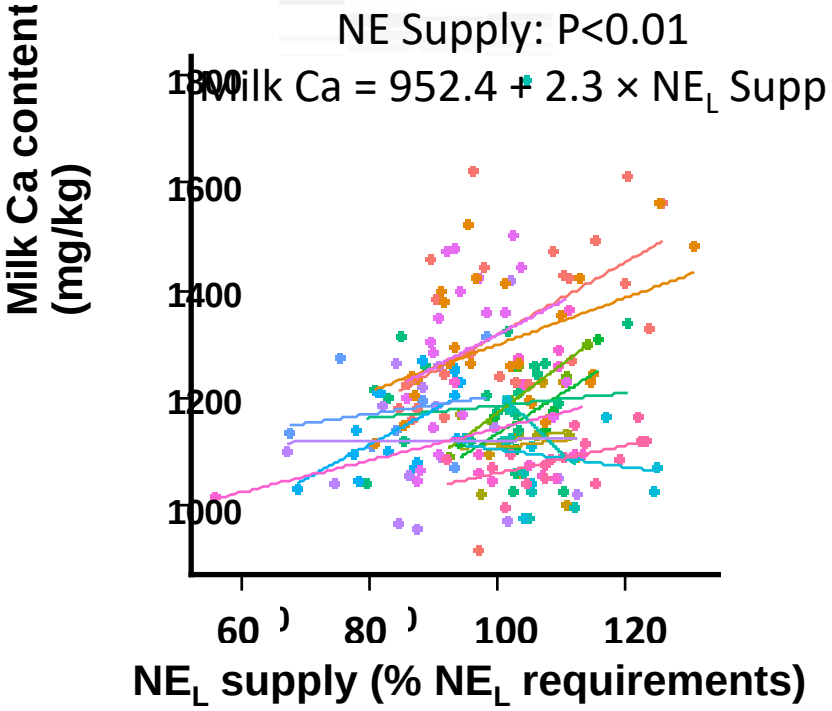
# A clear effect of the forage on milk calcium content ('Forage' Dataset)

$$Y_{ijk} = \mu + forage_i + trial_j + \varepsilon_{ijk}$$

(fixed) (random)

| | Maize silage | Mixture of grazing and maize silage | Hay | Grazing | P-Value |
|---|---|---|---|---|---|
| **Milk Ca Content (mg/g)** | **1222** | **1138** | **1146** | **1065** | **<0.0001** |
| Milk Protein content (mg/kg) | 31.6 | 31.9 | 30.0 | 31.7 | 0.06 |
| **Ratio Ca/Protein (mg/g)** | **38.7** | **36.0** | **38.6** | **34.1** | **<0.0001** |
| Soluble Ca/Total Ca (%) | 25.4 | 23.5 | 25.2 | 25.1 | Ns |
| **Colloidal Ca/Casein N (mg/g)** | **35.4** | **34.4** | **35.0** | **31.5** | **<0.001** |

# A positive effect of the Net Energy supply on milk calcium content ('Energy' Dataset)

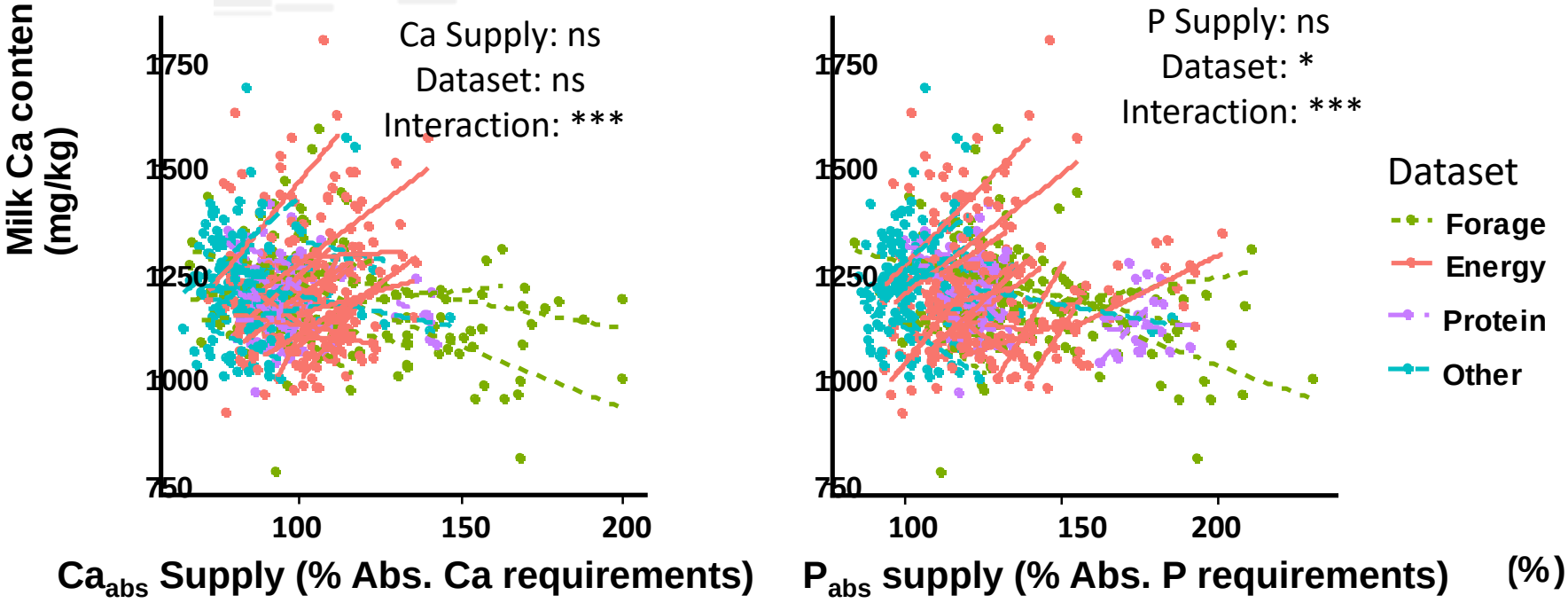



| | NE P-Value | Equation |
|---|---|---|
| **Milk Protein content (mg/kg)** | **<0.0001** | **= 20.61 + 0.09 × NE Supp** |
| Ratio Ca/Protein (mg/g) | Ns | |
| Soluble Ca/Total Ca (%) | <0.05 | = 17.14 - 0.10 × NE Supp |
| Colloidal Ca /Casein N (mg/g) | Ns | |

$$Y_{ijk} = \mu + NE_{L\,i} + trial_j + NE_{L\,i} \times trial_j + \varepsilon_{ijk}$$

(fixed) (random)

# The effect of Ca and P supplies on the milk calcium content depends on the considered dataset




**Non uniform effect of Ca and P supplies → not the main factors ?**

# Diet composition can influence milk calcium content of cows …

- … because milk Ca content decreases with diets based on grazed pasture rather than maize silage and increases when $NE_L$ supply increases.
- Likely limited effect of Ca and P supplies on milk calcium content (mid-lactation, short trials). No effect of protein supply.
- ✓ **The range of the effect of the diet of the cows on their milk calcium content is comparable to the range of the effect of the breed on milk calcium content …**
- … but the effects of the diet are not fully understood. (effect of $NE_L$ explained by the milk casein content, effect of the forage ?, relationship with Ca homeostasis ?)


Thank-you for your attention !