



Avec
la contribution
financière du compte
d'affectation spéciale
développement
agricole et rural
CASDAR


**MINISTÈRE
DE L'AGRICULTURE
ET DE L'ALIMENTATION**
*Liberté
Égalité
Fraternité*

➤ New directions on precision management for dairy cows



Charlotte GAILLARD¹, Justine ABARNOU¹, Olivier MARTIN²
FISCHER A.³, LEHURAUX R.³, JURQUET J.³, OBLE L.⁴, DERMENJIAN N.¹, BRUN-LAFLEUR L.³

¹ Institut Agro, PEGASE, INRAE, 35590, Saint Gilles, France ; ² INRAE, AgroParisTech, UMR 791 MoSAR, 75005 Paris, France,

³ Institut de l'élevage, 149 rue de Bercy, 75012 Paris, France ; ⁴ SAS ferme expérimentale laitière des Trinottières, La Futaie, 49140 Montreuil sur Loir, France

charlotte.gaillard@inrae.fr



The 75th EAAP Annual Meeting
1/5 September 2024 - Florence, Italy

➤ Context “tailored breeding”

- The development of **new technologies**
- allows the collection of **high amount of data**,
- **automatically and on real-time recorded**,
- that can be used to manage the herd more efficiently at an **individual level**.



Ferme des Trinottières

Explore, via simulations and experimentations, different management strategies (**feeding & reproductive**) to reach specific production, reproduction and welfare objectives

➤ Focus on experimental feeding strategies

Everything to create and test !



- **2 recent / on-going projects:** to determine the feasibility and define the rules of application of precision feeding for dairy cows
- Both based on the adjustment of the quantity of extra concentrate distributed:

○ WIN Feed, INRAE: **Weekly & indiv. adjustment** based on body weight gain of previous week

○ HARPAGON, IDELE



+ 6kg



0kg

Ad lib.

EXTRA concentrate
(adjusted)

BASE RATION (forages +
concentrates)



INRAE

EAAP 2024

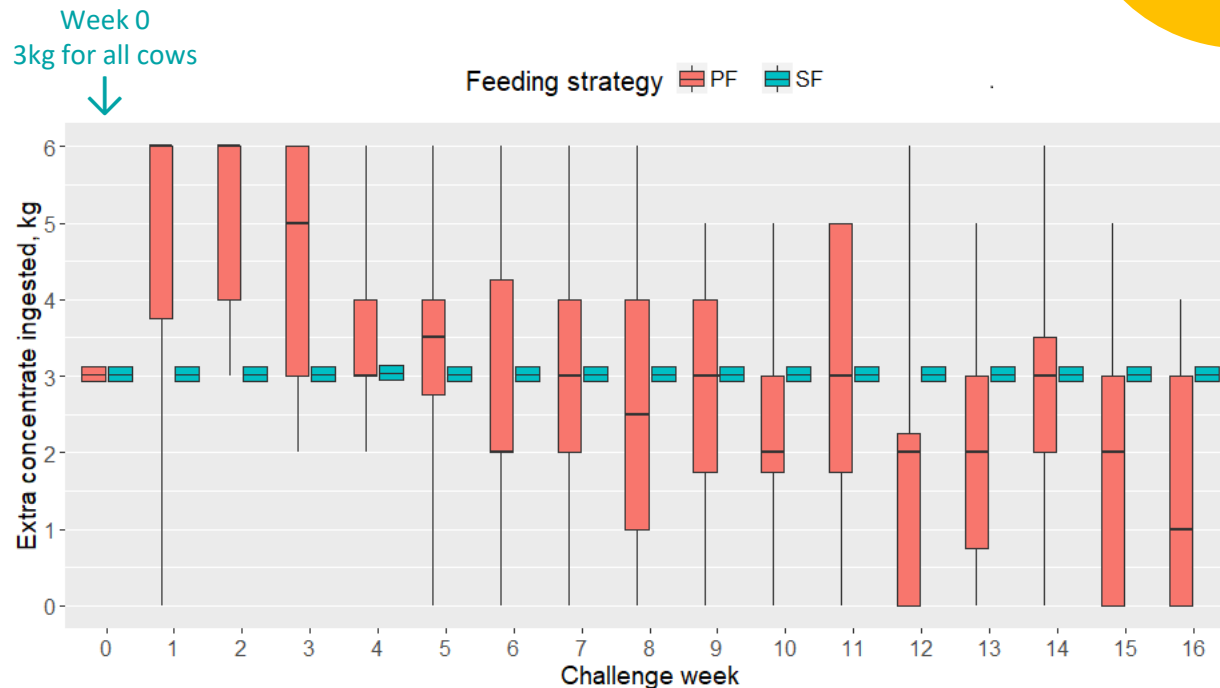
New directions on precision management for dairy cows

➤ WIN Feed results

40
Holstein
cows



Adjusted concentrate ingested over weeks



- **Extra concentrate ingested** : no treatment effect over 120 days **High variability between cows**
- **Over 16 weeks** treatment had no effect on BW gain, milk, or ingestions, even if numerically, milk PF > SF (+12 kg) and ingestion lower
Total ingestion : 2772 vs 2822 kg so around -50 kg,
Forages : 2061 vs 2095 kg so around -34 kg,
Total concentrates : 733 vs 748 kg so around -15 kg

PF: precision feeding (variable extra conc.)

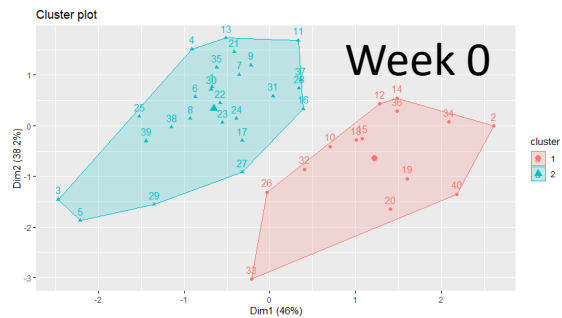
SF: standard feeding (3kg extra conc.)

The great variability in response between cows clearly illustrates the need to adapt the feeding strategy individually, but which strategy should be adopted?

➤ WIN Feed Results

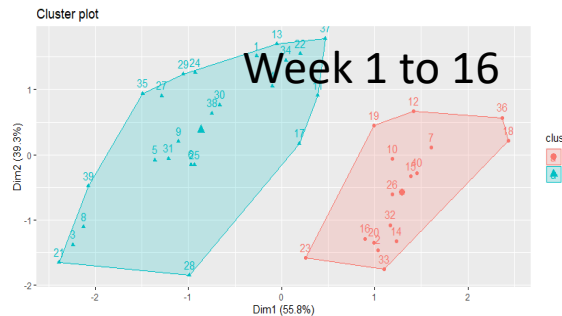
Metabolic profiles

Clustering approach based on blood metabolites...



2 clusters :

- cow with higher BHB and lower glucose than the other cluster = **metabolic imbalance (MI)**
- Other cluster = **metabolic balance (MB)**



36 cows sorted in the same group at W0 and W1-W16
→ a classification at Week 0 could predict the metabolic group for the next 4 months with 90% accuracy.

...or on production variables ?



At week 0 : **BW gain + total ingestion**
cluster prediction **accuracy 60%**

Toward an automatisisation to
determine metabolic profil?

MB cows produce more milk, eat more and lose more weight than MI cows.
Individual feeding strategy based on these metabolic groups?

> Feeding strategies

Everything to create and test !



- **2 recent / on-going projects:** to determine the feasibility and define the rules of application of precision feeding for dairy cows
- Both based on the adjustment of the quantity of extra concentrate distributed:
 - WIN Feed, INRAE: **Weekly & indiv. adjustment** based on body weight gain of previous week
 - **HARPAGON, IDELE:** Starting by **challenges** (↓ 3 kg/d of concentrate) **every 3 weeks** to understand cows responses & define adjustment rules regarding cows profiles to run the 2nd experiment



+ 6kg



0kg

Ad lib.

EXTRA concentrate
(adjusted)

+1kg vs.
+ 4kg

BASE RATION (forages +
concentrates)

Ad lib. Vs.
Restricted



➤ Concentrates challenges at the automaton

IDELE : Amélie Fisher, Julien Jurquet, Laure Brun-Lafleur

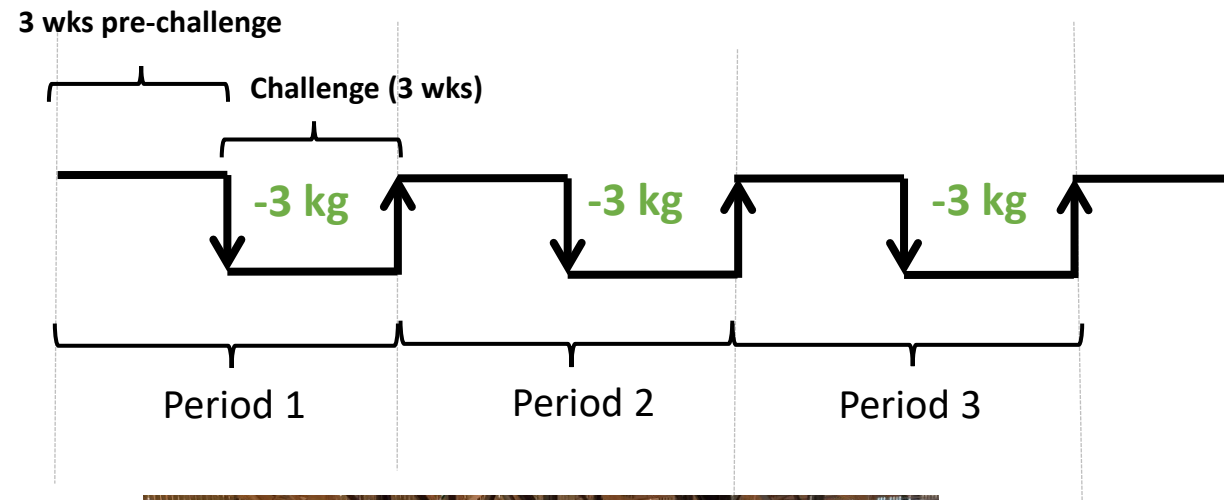
During challenges :

- Base ration **ad libitum**

Cows allowed to substitute

- Base ration **limited**

Cows not allowed to substitute

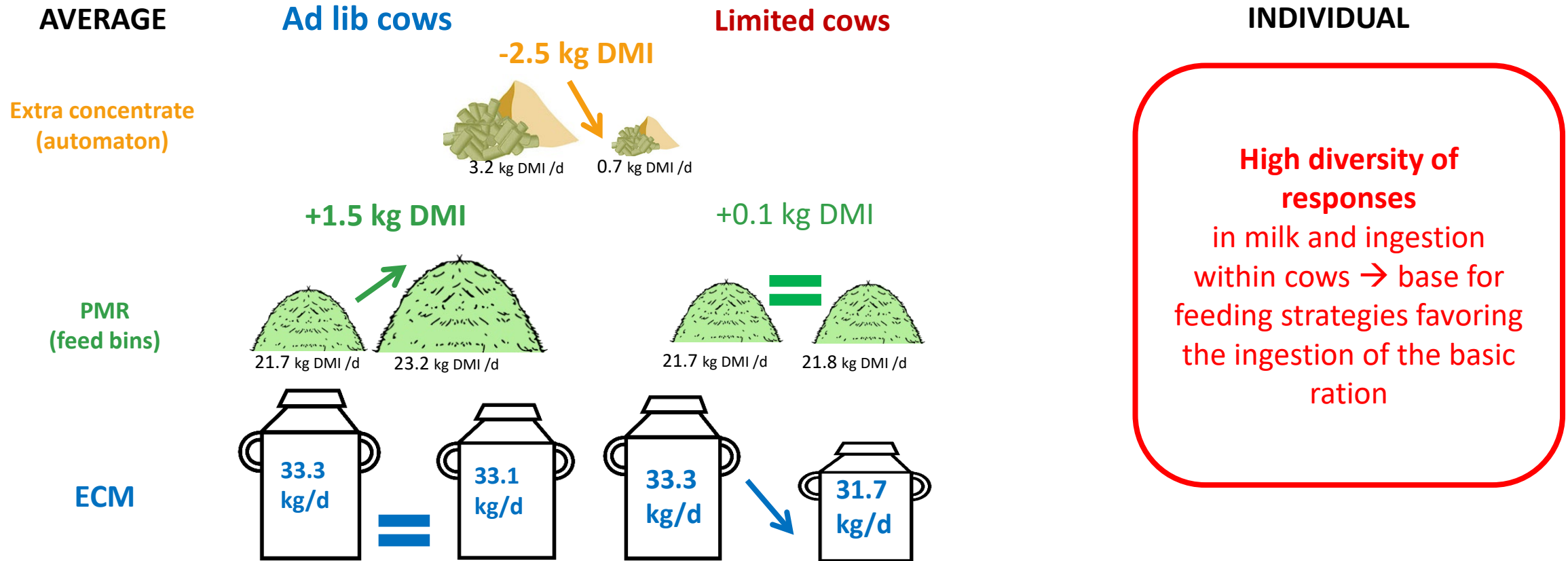


**60
Holstein
cows**



Feed bins at the experimental Farm « Les Trinottières »

➤ HARPAGON results – responses to challenges



On average, in response to a concentrate challenge:

- **Ad lib cows** will maintain milk production thanks to an $\nearrow$ in ingestion (trough) and body reserves mobilization
- **Limited cows** will adapt by $\searrow$ milk production and do not mobilize more than ad lib cows

➤ Reproductive strategies

REPROLAC experimentation and simulations

N = 10-mo lactations
EL = 16-mo lactations

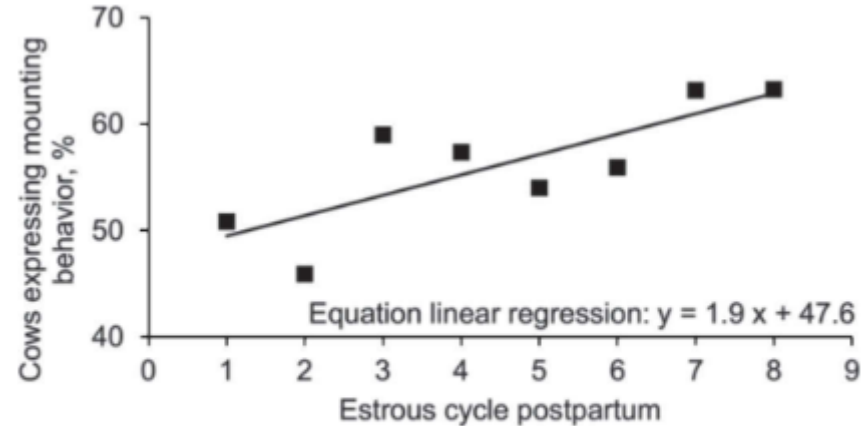
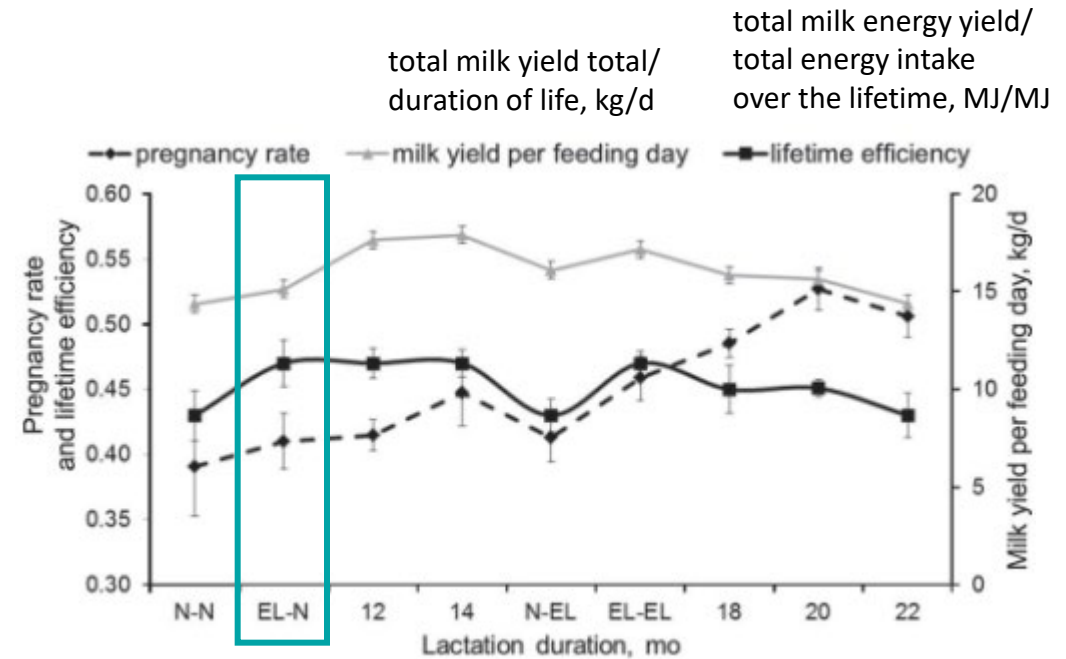


Figure 4. Percentage of cows exhibiting estrous behavior (mounting, being mounted) at each of the 8 estruses postpartum, and regression line from the correlation analysis.

Journal of Dairy Science Vol. 99 No. 4, 2016

Delaying insemination after peak lactation could enhance pregnancy rates and reduce the IA number per gestation & health risks.



Journal of Dairy Science Vol. 99 No. 11, 2016

Simulations suggested that especially primiparous could benefit from this strategy to optimize performance and improve cow longevity.

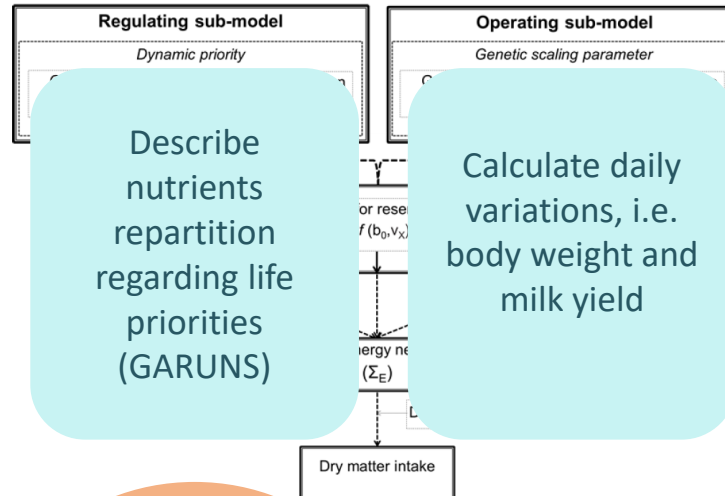
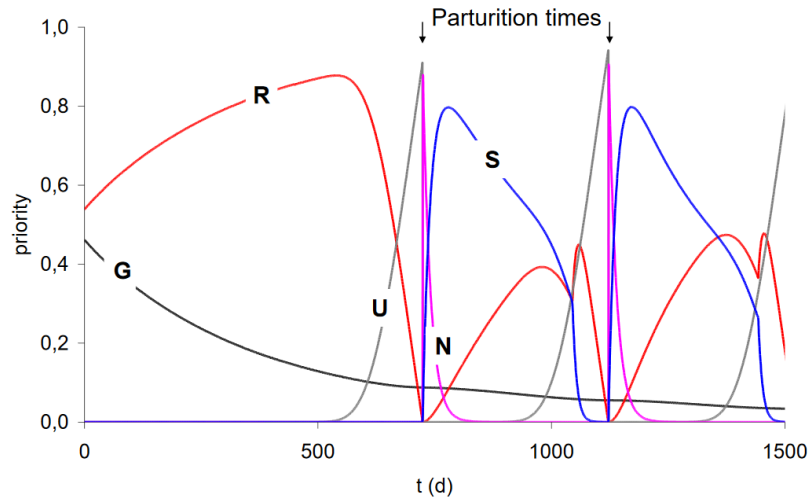


> A tool to evaluate scenarios

Martin and Sauvant, 2010



- GARUNS model (or « InSiliCow »)**, a dynamic and stochastic model taking into account the changing priorities of an animal during its life → simulation of the production performances of each cow during its life



Reproductive sub-model

added by Phuong et al. (2016)

To simulate gestation rates and productive lifespan

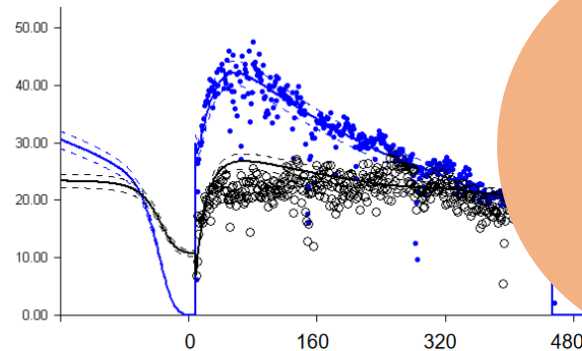
Feed module

(EAAP 2021)

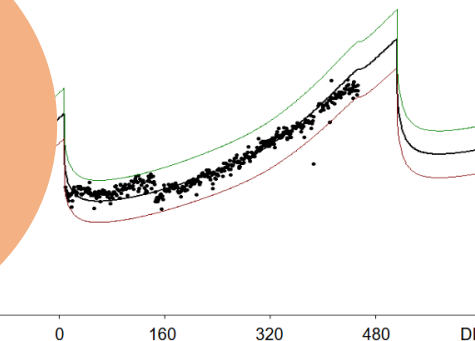
To take into account the ration composition of each cow during its life

Milk yield

Ingestion



Need to automatize the adjustment



Body weight

Evaluation tool of performance & reproductive scenarios (i.e. lactation length)

INRAE

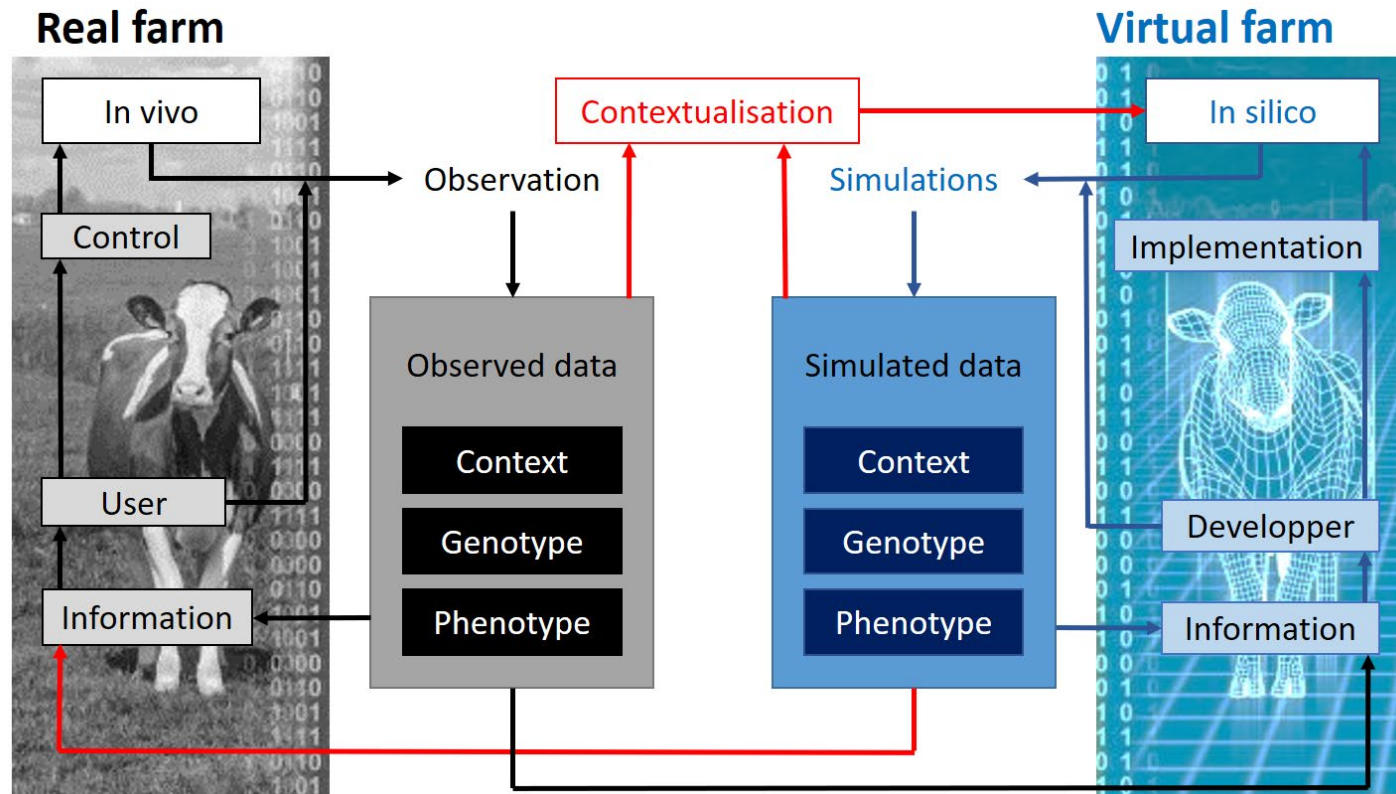
EAAP 2024

New directions on precision management for dairy cows

➤ A Digital Twin to achieve these goals



Digital twin imply: virtual **models** of real animals, with automatized **on-real time data** input. It can simulate and analyze feeding and reproductive scenarios, and allow an on-real time adaptation of the management.

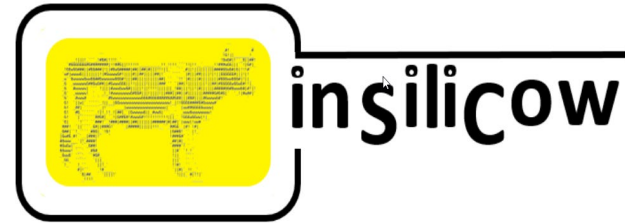


➤ CONCLUSION & GENERAL PERSPECTIVES



Picture: <https://www.gea.com/en/campaigns/gea-dairynet/gea-dairynet-functionality/>

- **Individualized feeding** would allow to take into account the variability of nutritional needs and production responses among cows
- **Decisions rules** need more exploration. They should integrate the metabolic profile or response profile of the cows.
- **Reproductive management** should also take individual information (i.e. age of the animal)
- **Digital twins** might help to achieve these goals, however the farm needs to be equipped with automatic feeders and other sensors to collect enough data for frequent decisions.



➤ Thank you for your attention !



INRAE

EAAP 2024

New directions on precision management for dairy cows