A dynamic mechanistic model to forecast the oscillatory feeding behavior of lactating dairy cows

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Introduction: Animal Nutrition Model

➢"Understanding and predicting animal **Voluntary Feed Intake** is crucial in any nutrition program. It helps formulate rations with the correct concentrations of energy and nutrients necessary to meet the desired animal performance, health, and welfare". (Tedeschi and Fox, 2021)

➢**Empirical model:**

- input-output;
- based on relationships of observed data;

➢**Mechanistic model:**

- explicitly represent underlying structure of system;
- output arise from integration of lower levels;

Introduction: Feeding Behavior

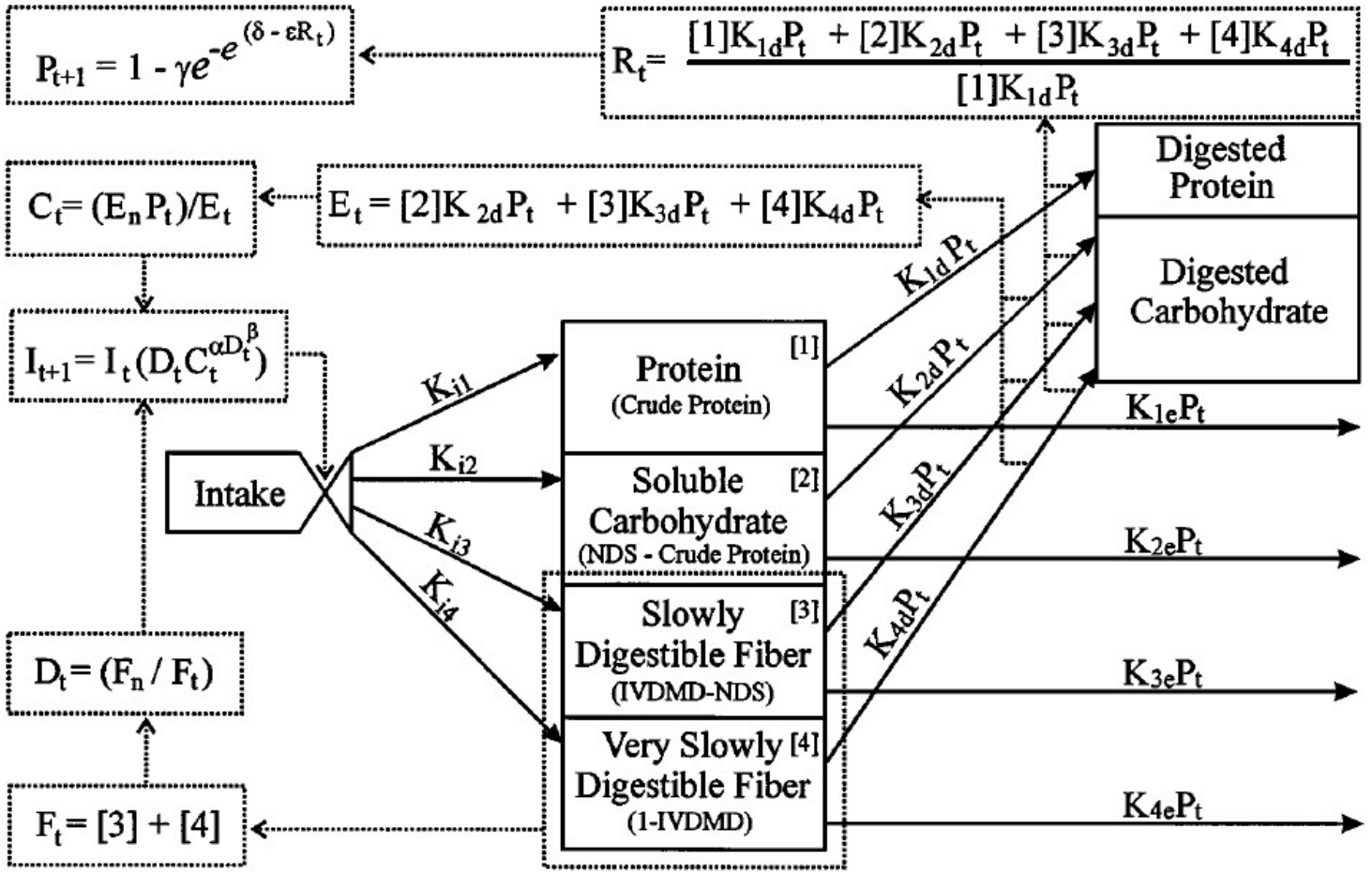
Much of the recent research on dairy cattle nutrition has focused on metabolic and nutritional factors that contribute to the physiological regulation of feed intake (Keyserling V. et al.,2010)

However, voluntary feed intake is mediated by the cow's behavior, including where, when and how she eats the diet provided (Grant and Albright 1995).

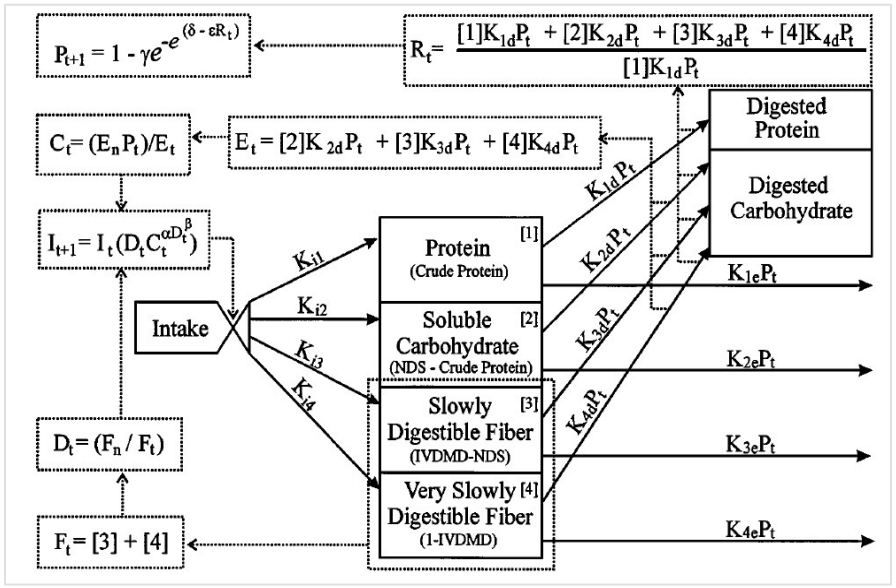
Fisher's Model (1996)

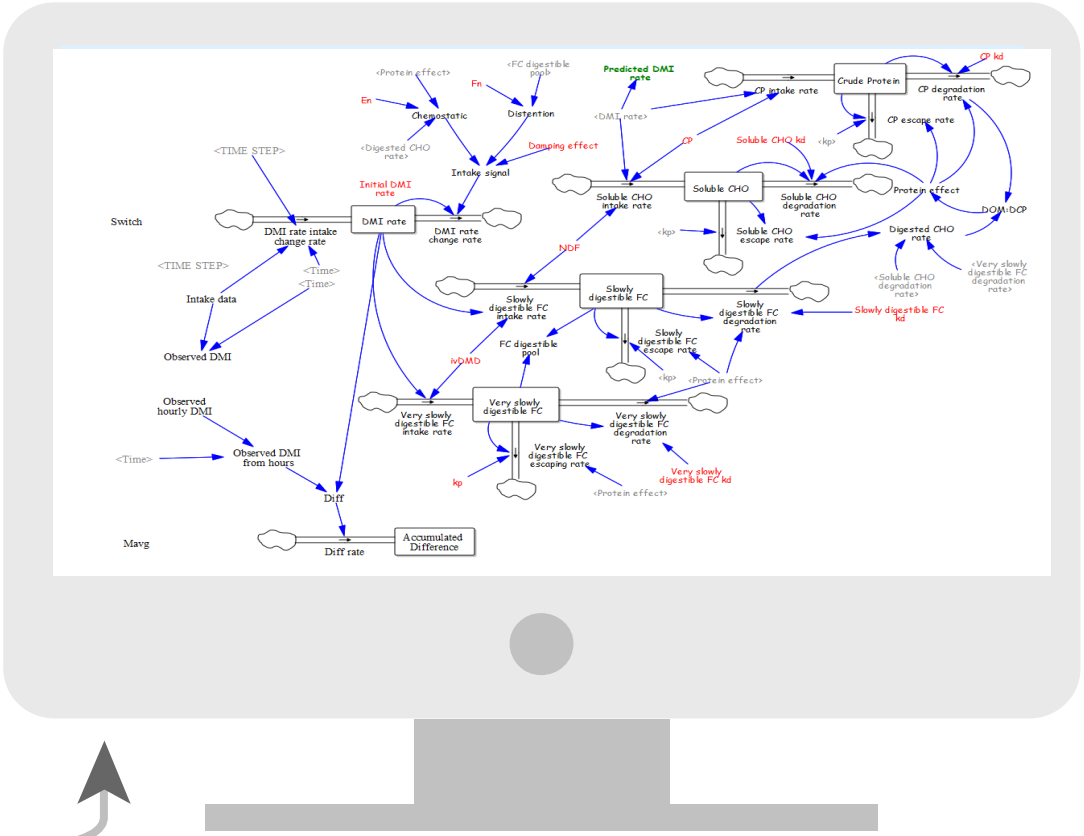
Modeling ruminant feed intake with protein, chemostatic, and distention feedbacks.

Fisher D.S., 1996. J Anim Sci. 1996 Dec;74(12):3076-81.



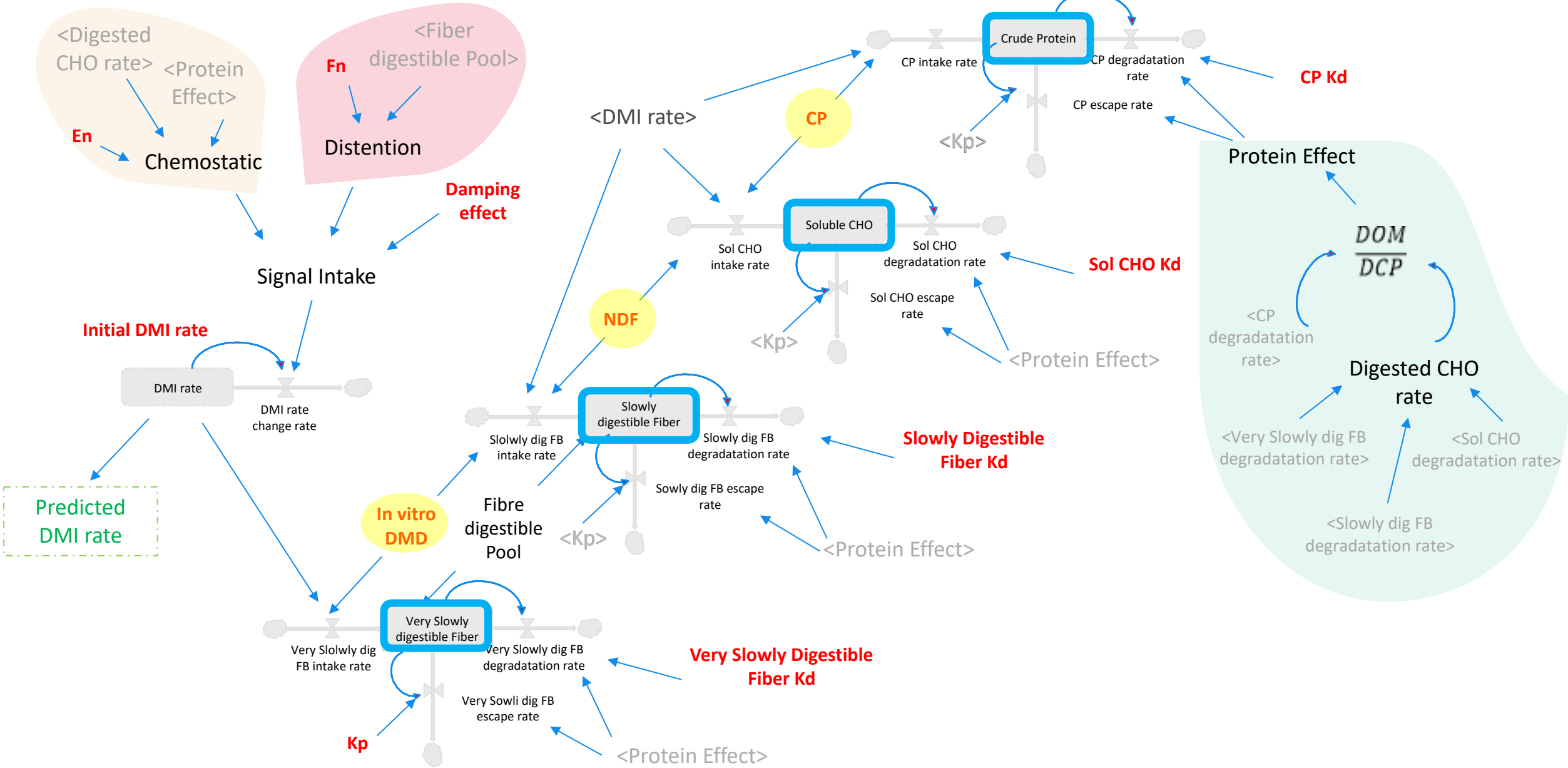
Tedeschi and Fox (2020)*





*Tedeschi LO. and Fox DG. **The Ruminant Nutrition System** (RNS) Volume 1 An applied model for Predicting Nutrient Requirements and Feed Utilization in Ruminants. Third Edition. XanEdu Publishing 2020.

Graphical Model



Aims of this study

✓To monitor and collect feeding behavior and productive data;

✓To study the predictive ability of a dynamic mechanistic model in capturing the oscillatory system of feeding behavior;

✓To Analise the [Observed – Predicted] data with Partial Least Squares regression model (SAS software) by using different variables;

Dataset: Feeding Behavior

In the experimental facility (Stalla Sperimentale Romeo and Enrica Invernizzi, San Bonico, Piacenza, Italy) was monitored the feeding behavior of **20 cows** for **4 consecutive days** using an automatic intake recorder.

Roughage Intake Control System = RIC; Hokofarm group, Marknesse, The Netherlands

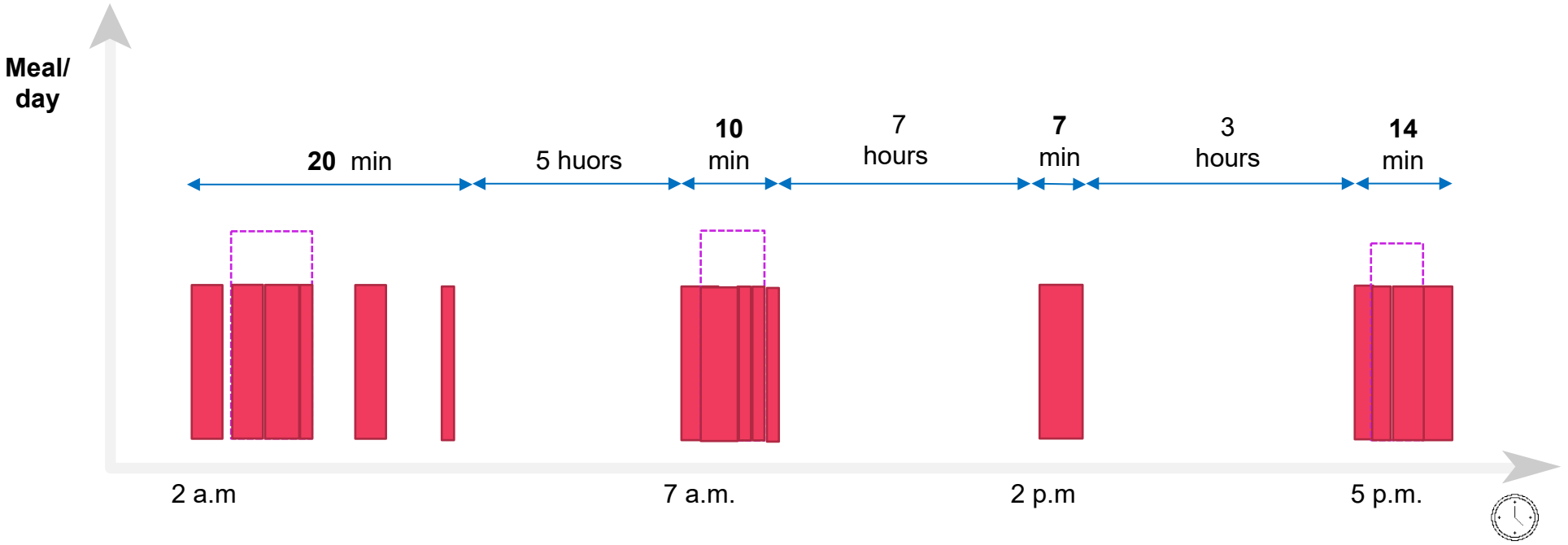
Dataset: Feeding Behaviour -Raw data

- Visiting time (hh:mm:ss)
- Visit frequency (no./d)
- Visit length (min/visit)
- Visit size (kg of as fed/visit)

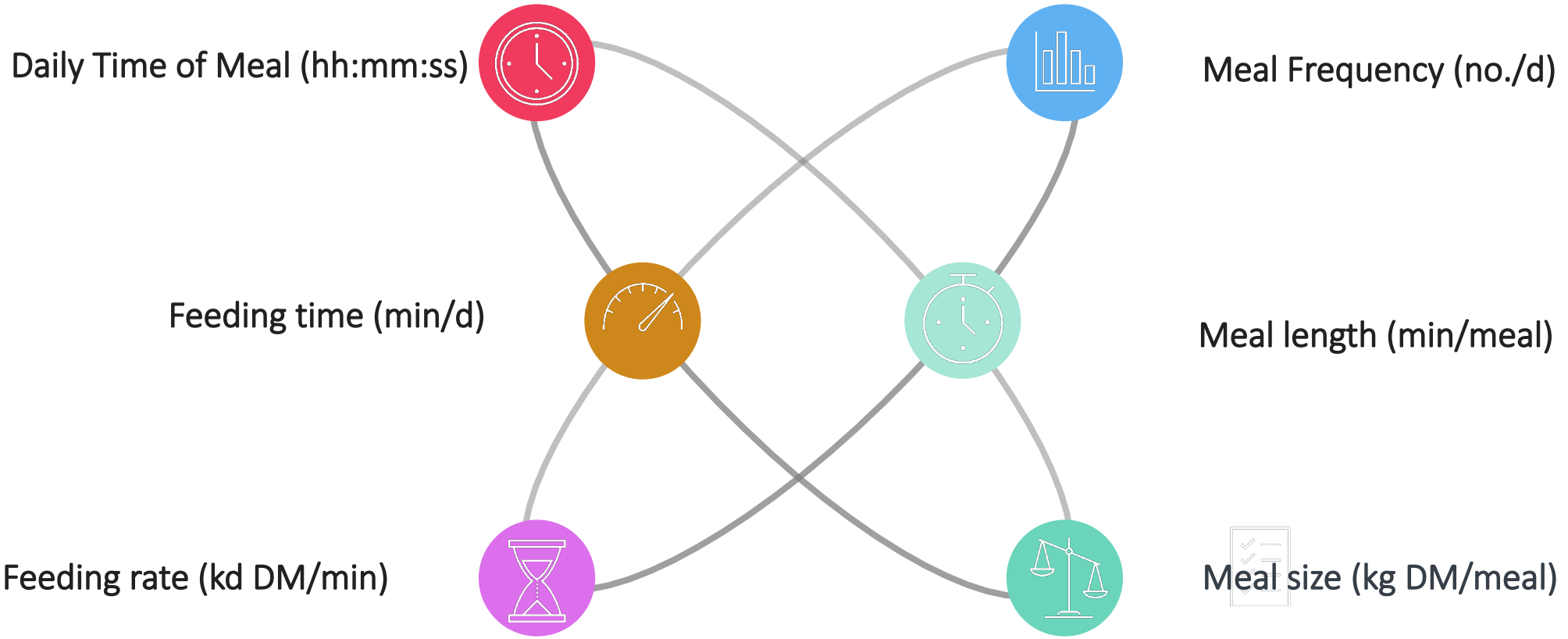
Dataset: Feeding Behaviour – Meal criteria

Meal criteria

The **Meal** is a **single visit** or a **sum of consecutive Visit** into the RIC between a range of 20 minutes (Grant&Albright, 2004)



Dataset: Feeding Behavior - Secondary index



Result : Feeding Behavior data

Data	Average	Standard Deviation
Animal		
Age (month)	38	7
Body weight (kg)	635,7	38,8
Day in Milking	120	41
Milk yield (litre)	33,3	4,4
Feeding behavior		
Dry matter intake/day (kg)	23,8	2,7
n° meal / day	7,2	2,0
n° visit /day	18,5	9,6
Meal size (kg DM/meal)	3,6	1,1
Feeding time (min/d)	139,7	35,0
Rumination time (min/d)	551,4	70,9

Result: Dry matter intake predicted vs observed

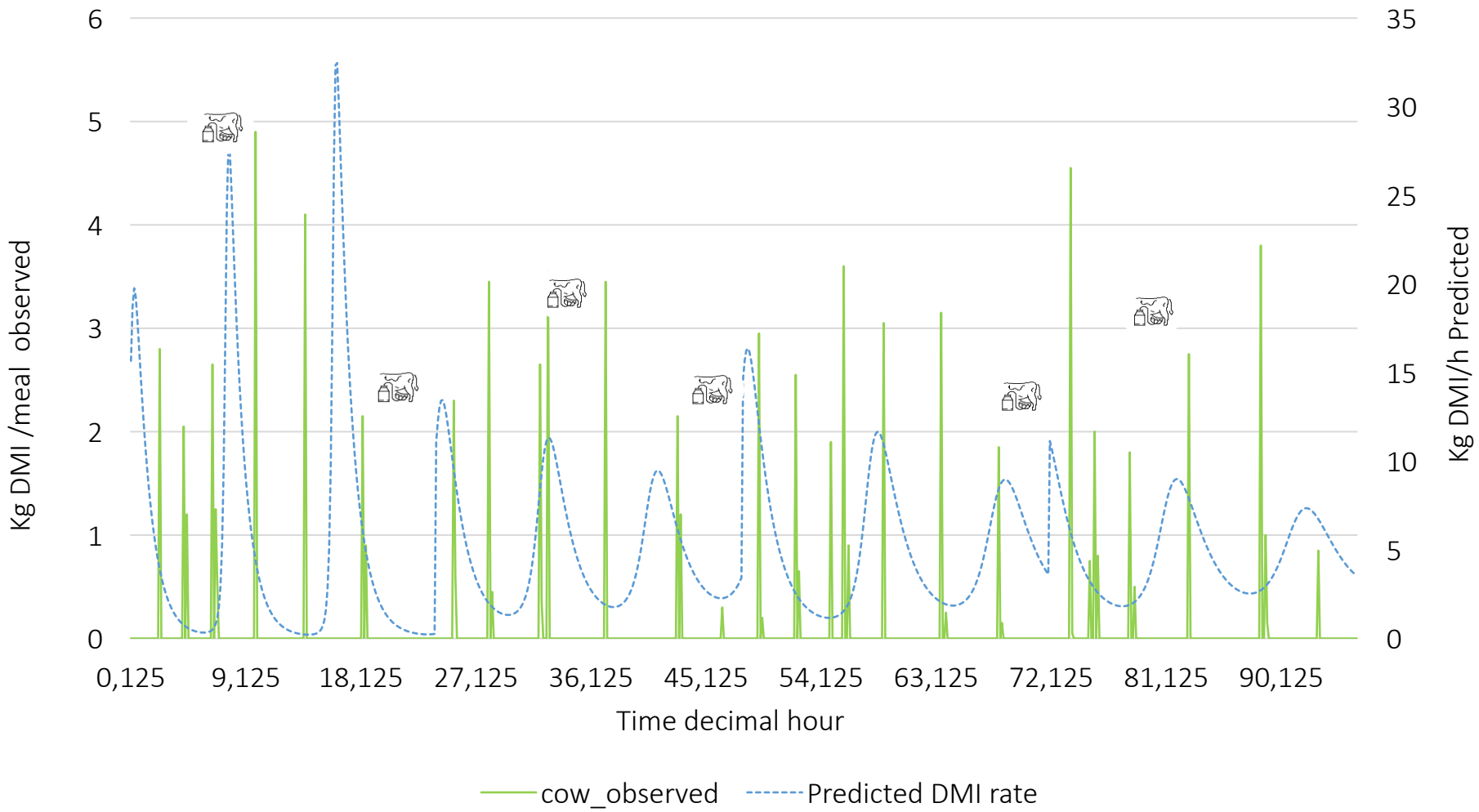
The oscillatory pattern of dry matter intake generated by Tedeschi and Fox (2021) on a given diet:

Input model

33.0 % NDF

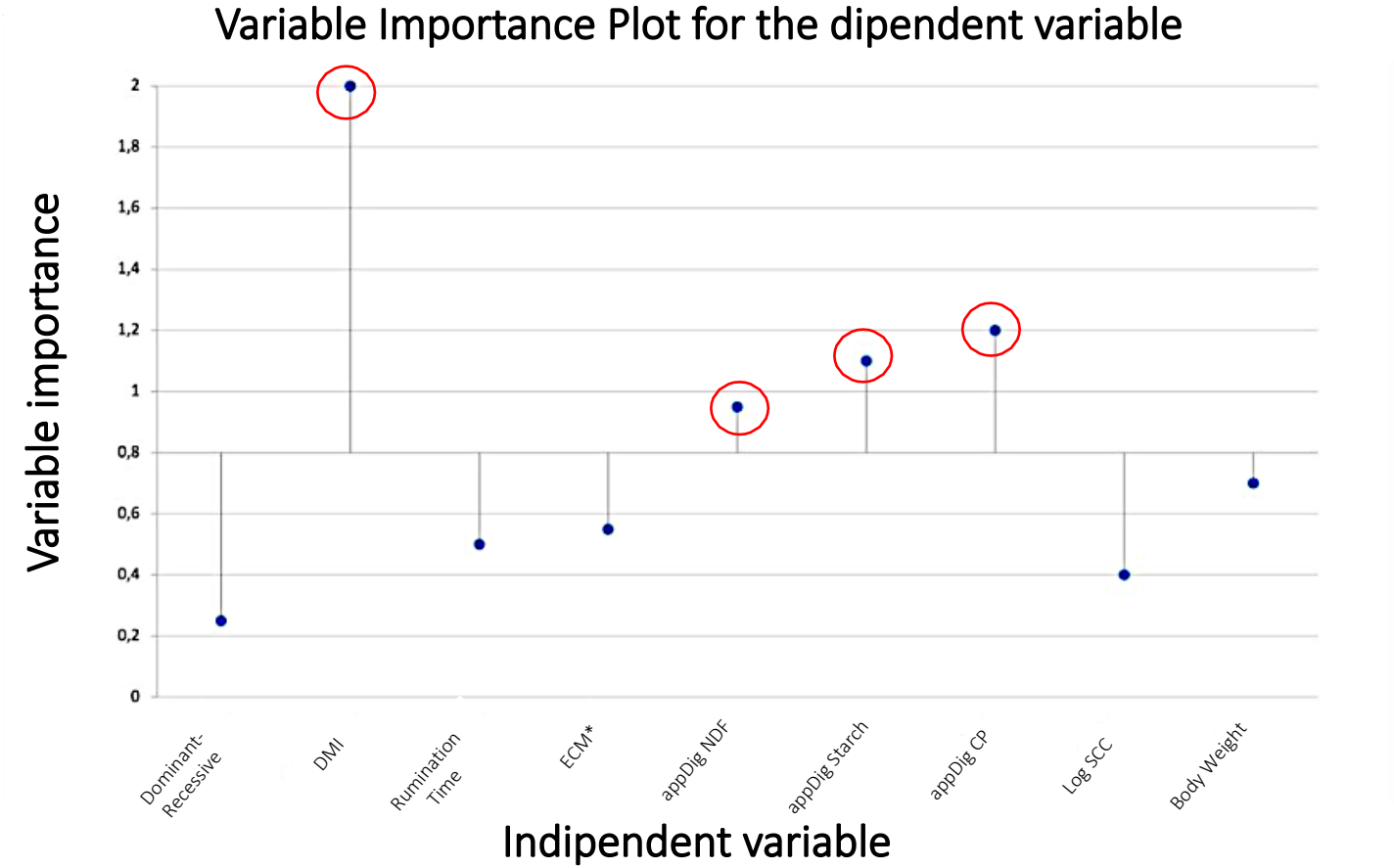
16.9 % CP

66.0 % ivDMD

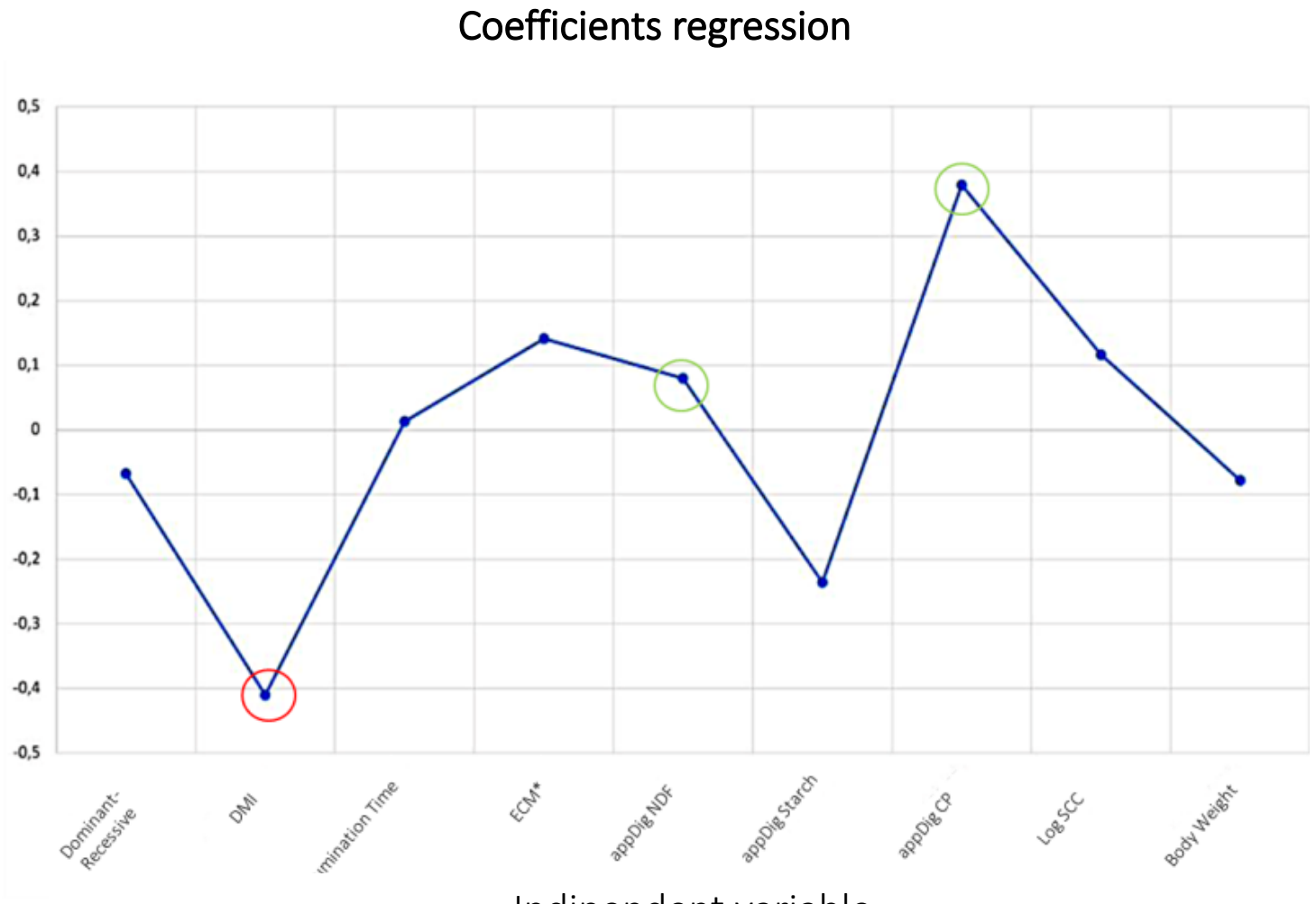


Result : PLS of Dry matter intake predicted vs observed

Variable Important Plot represents the statistical significance of each indipendent variable in the data with respect to Sum of square on the generated model.



Result: PLS of Dry matter intake predicted vs observed



Criticism and future perspectives

Suggestions for future work could be:

1. develop a better way to evaluate the oscillatory behavior;

2. Add more variables to the model to yield closer oscillatory behavior: methabolic vs ruminal factors, detail chemistatic effect, to mimic oscillatory frequency, and so on;

3. to improve the prediction of real feeding behavior of animals, by evaluating both intra- or inter-animal variations to nutritional, physiological or management factors, to better understand the complexity of DMI in cattle;

Thanks for the attention