PREDICTION OF TOTAL FEED INTAKE OF DAIRY COWS USING A PORTABLE NEAR-INFRARED MICROSPECTROMETER

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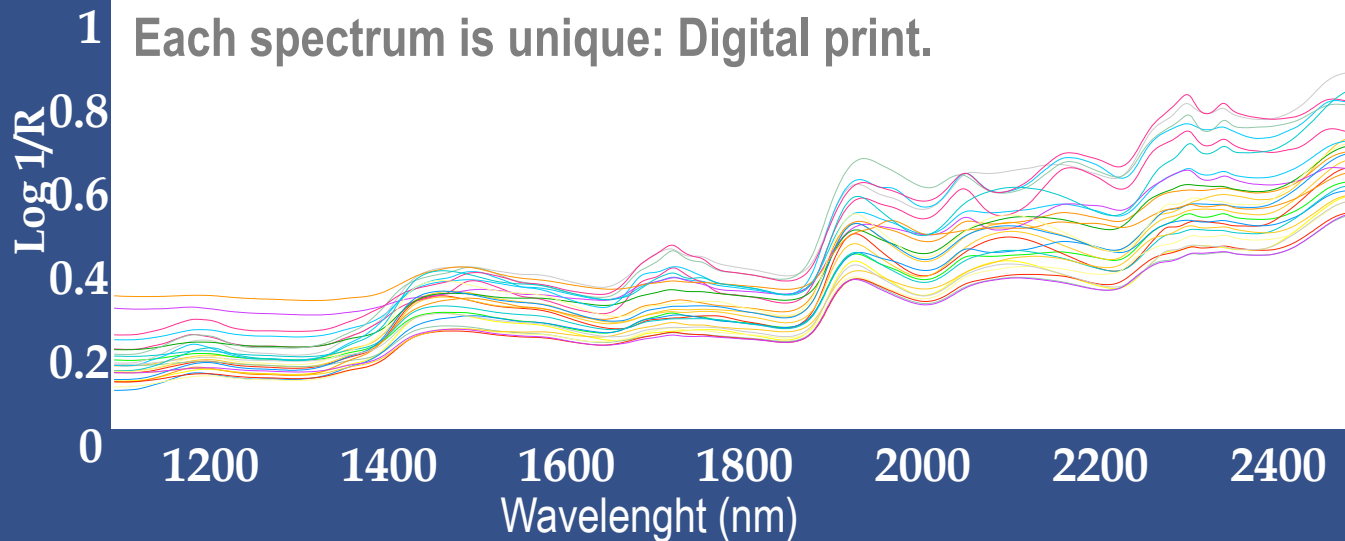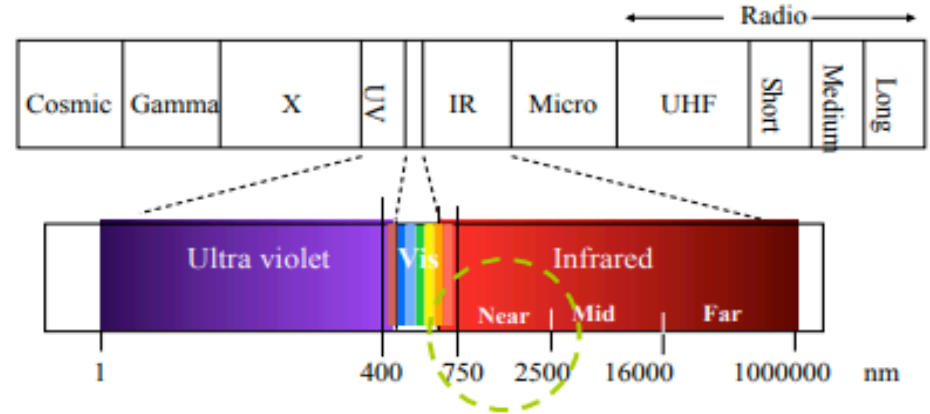2. *Aarhus University, Denmark*

OUTLINE

- Introduction to NIRS technology and its use in animal nutrition

- Objective

- Experimental data and main results

- Conclusions

INTRODUCTION

- NIRS: Near Infrared Spectroscopy

- Vibrational spectroscopy

- Bonds C-H, O-H, N-H
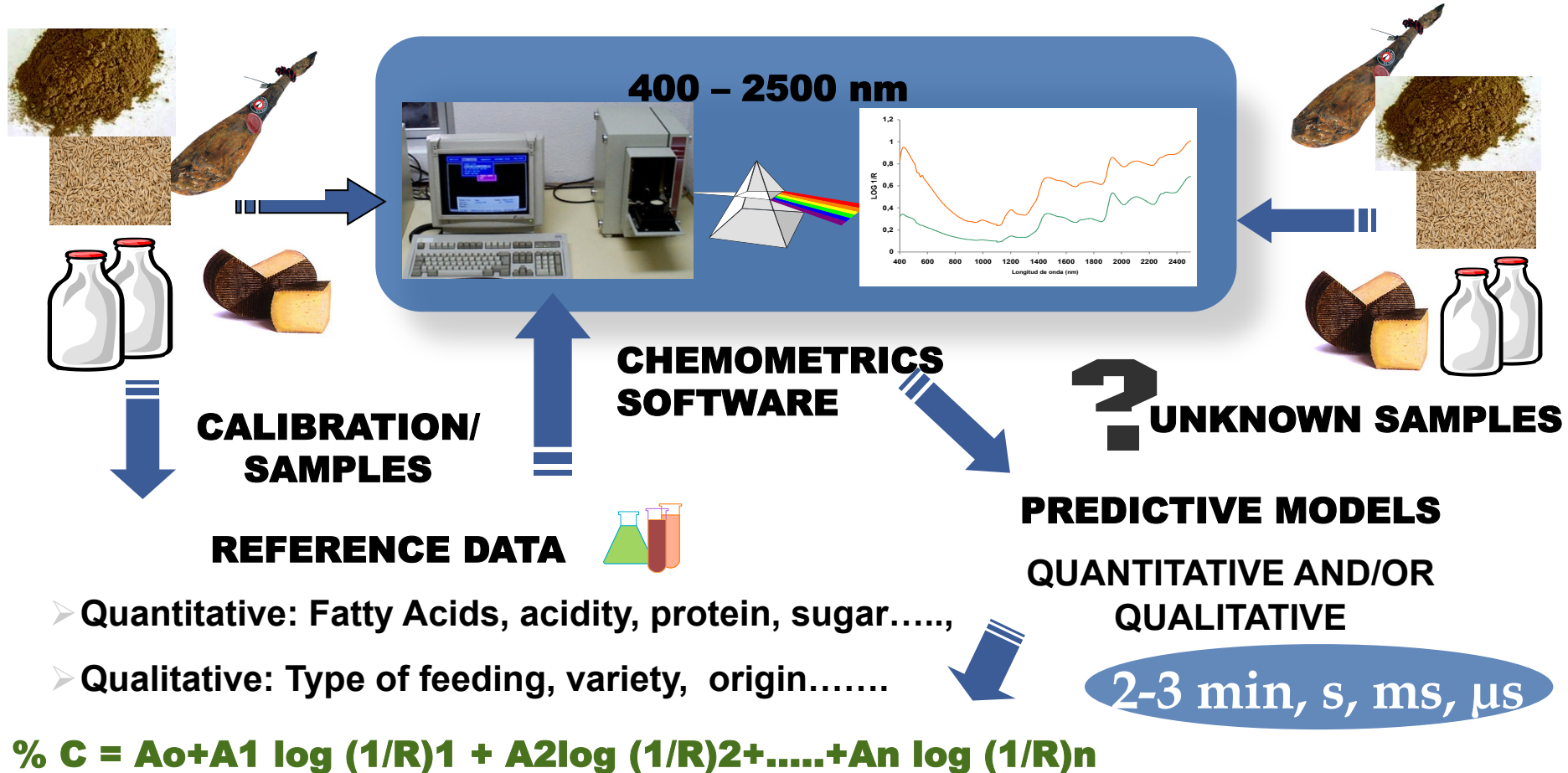
Each spectrum is unique: Digital print.

INTRODUCTION

NIRS SENSORS

- ✓ Fast
- ✓ Precise
- ✓ Easy use in routine analysis
- ✓ Versatile
- ✓ Non contaminant

- ✓ Low cost
- ✓ Non destructive
- ✓ Better sampling
- ✓ Digital signal: IoT
- ✓ Portability, on site analysis

HOW TO DEVELOP A NIR APPLICATION?

400 – 2500 nm

CHEMOMETRICS SOFTWARE

CALIBRATION/ SAMPLES

? UNKNOWN SAMPLES

REFERENCE DATA

PREDICTIVE MODELS

QUANTITATIVE AND/OR QUALITATIVE

➢ **Quantitative: Fatty Acids, acidity, protein, sugar…..,**

➢ **Qualitative: Type of feeding, variety, origin…….**

2-3 min, s, ms, μs

% C = Ao+A1 log (1/R)1 + A2log (1/R)2+…..+An log (1/R)n

NIRS INSTRUMENT EVOLUTION: ON SITE ANALYSIS

USE OF NIRS IN ANIMAL NUTRITION

FEEDS QUALITY

RAW MATERIALS, COMPOUND FEEDS,TOTAL MIXED RATIONS

- **Chemical composition** (Moisture, Protein, Fiber, Starch,..)

- **Ingredient composition* and others (durability, digestibility…)**

  ***In compound feeds**: Declaring all the raw materials used in the production, together with the inclusion percentages. Tolerance 15%

Then this information is used to predict the animal response

THE OBJECTIVE

To evaluate the potential of NIRS to directly predict the voluntary intake of dairy cows using the NIR spectra of the total mixed rations (TMR) used as diets.

EXPERIMENTAL DATA

- **60 cows** from **Aarhus University** farm.

- **4 groups fed with four different TMR diets** (control diet, and three other diets with an increasing level of 5, 10 and 15% of straw instead of silage).

- Duration**: 8 weeks** (2 control, 4 experimental and 2 control at the end).

- **Intake**, Milk Production, Milk composition, etc.

EXPERIMENTAL DATA: NIRS SPECTRA

- 142 TMR samples

- Portable & compact NIR instrument: Aurora diode array (GrainNit, Italy)

- Reflectance 950-1650 nm

- Analysis mode: dynamic (moving the instrument along the sample)

RESULTS: PREDICTION OF COW INTAKE

Population characterization (N=142 TMR samples)

| Parameter	Range	Mean	SD	CV
Intake (kg)	35.36 – 58.38	49.41	5.21	10.54
Intake corrected (g/kg weight)	259.78-432.78	362.53	37.84	10.43

RESULTS: PREDICTION OF COW INTAKE

PLS models to predict the animal response using the NIR data of total mixed rations.

Parameter	Pre-treatment	Mean	SD	R^2cv	SECV	CV
Intake	2nd derivative	49.71	5.03	0.78	2.32	4.67
Intake corrected (g/kg weight)	1st derivative	365.35	36.03	0.78	16.93	4.63

SECV= Standard Error of Cross Validation; CV=Coefficient of Variation

RESULTS: PREDICTION OF COW INTAKE
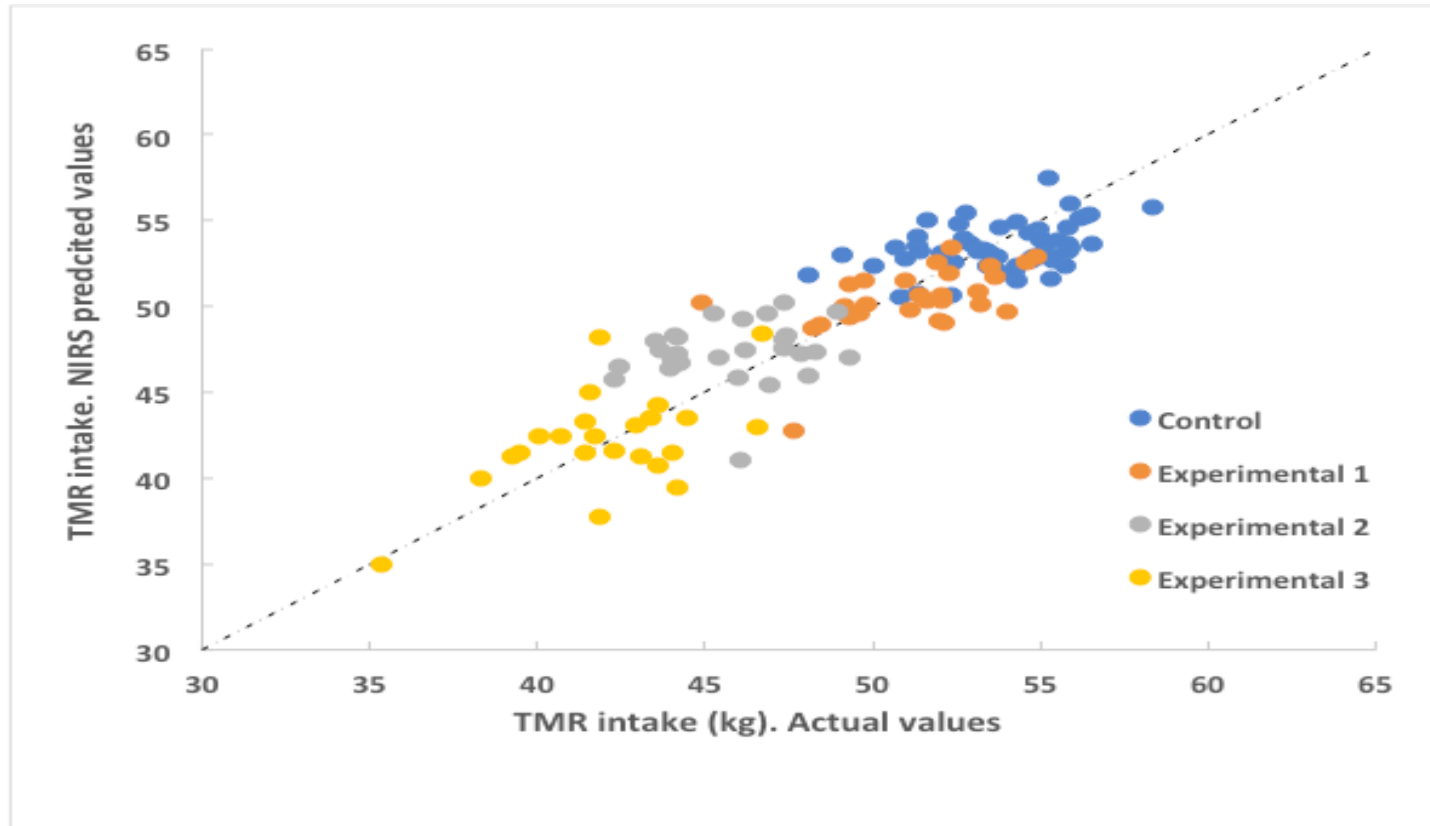
CONCLUSIONS & FUTURE WORK

- Results confirm the viability of NIRS portable sensors to predict directly the voluntary intake of a dairy diet.

- More data and variability are needed to develop robust models (including more animals, farms, diets, etc.).

- The estimation of milk production from NIR diet spectra is being studied as well.

- NIRS is a powerful sensor to be used in livestock precision farming: it provides many possibilities.

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SCIENTIFIC SOLUTIONS
TO DIFFERENT DEMANDS ON THE LIVESTOCK SECTOR

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THANKS FOR YOUR ATTENTION

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