



Mid-infrared spectroscopy adapted to sheep milk for flock management, performance recording and milk processing

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 **MINISTÈRE DE L'AGRICULTURE, DE L'AGRO-ALIMENTAIRE ET DE LA SOUVERAINETÉ ALIMENTAIRE**
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FRENCH DAIRY SHEEP MILK PRODUCTION



4,080
professional
farms



1.5 million
dairy sheep



320 million liters

90 %



> 90 % in
mountainous
areas

3 production areas each with their own inter-professional association, technical support, breed and cheese



1 national
interprofessional
organisation

CNBL
Comité National
Brebis Laitières

1 national
technical body





WHY DEVELOP MIR TOOLS FOR DAIRY SHEEP?

Dairy sheep systems are facing major transformations



These changes affect milk composition and processing properties

Need for routine tools and indicators to monitor these changes, optimize the management of dairy sheep feeding and cheese production

MIR spectra is a response to these practical needs

- low cost, non-invasive, easy to use
- but often unsuitable for sheep's milk
- Species-specific calibration equations are required**





BUILDING THE DAIRY SHEEP MIR ECOSYSTEM IN FRANCE



18 years of collective investment to transform routine milk spectra into operational tools for the dairy sheep sector

An involved dairy sheep sector

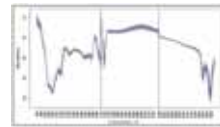
- Milk producers
- Dairy processing actors
- Milk recording organisations
- Breeding organisations
- Technical body (CNBL)
- FBL (interprofessional association created in 2019)



Identify useful indicators and ensure adoption

A data infrastructure

- Routine milk recording



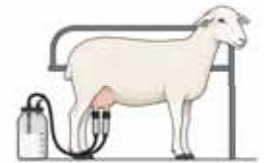
- MIR spectra collection



Generate large and standardised datasets



730 herds
300 000 spectra / year



Storage of individual MIR spectra from official milk testing in routine in SIEOL database





BUILDING THE DAIRY SHEEP MIR ECOSYSTEM IN FRANCE



18 years of collective investment to transform routine milk spectra into operational tools for the dairy sheep sector

An analytical and scientific network



+ Collaborations abroad (Spain – Portugal – Belgium)



Produce reference data and develop specific MIR equations

Standardization of ewe milk MIR spectra by using cow milk samples

C. Grelet, M. Bouffier, A. Legrand, M. J. Delgado

INRAE, Université de Bourgogne, INRAE, Université de Bourgogne, INRAE, Université de Bourgogne

Content:

Interest of the ewe milk supply chain to use MIR spectra of milk to generate new phenotypes about the milk quality, nature of individual animals or technological properties of milk.

Necessity to harmonize the spectra from different instruments into a common basis in order to coordinate various datasets, create common metrics and be able to use these common metrics on different instruments.

Typical standardization method already exists for cow milk (Grelet et al., 2017). The method is based on routine analysis by all instruments of cow milk standard samples.

Objective: test whether this standardization method designed on cow milk could be reliable to standardize ewe milk spectra.

Method:

Matching of 3 secondary instruments (1 Foss® & 2 Data Instruments®) into the format of a reference instrument.

Determination of 2 sets of standardization coefficients, by analyzing:

- 2 cow milk standard samples
- 4 ewe milk standard samples

Results:

Determination of standardization coefficients: all sets of coefficients allow to reduce differences between reference and secondary instruments.

Example of standardization of an instrument with ewe milk standard samples.

Reference instrument		Secondary instrument	
Raw milk	Standardized milk	Raw milk	Standardized milk
2.9	3.0	2.9	2.7
6.0	6.0	5.8	6.1
5.8	6.4	5.7	6.4
6.2	7.6	6.7	6.4
9.3	9.7	9.0	9.3

Comparison of standardization performances by analyzing an external set of ewe milk standard samples (external calibration).

Evaluation by looking at the difference (MIR_{sec} - Raw milk spectrum) between the predictions of secondary and reference instruments, after standardization with 2 sets of coefficients.

Conclusions:

- Similar results observed with cow and ewe milk based sets of coefficients to standardize ewe milk spectra.
- Possibility to use the cow standard milk in order to harmonize and use MIR spectra of ewe milk.

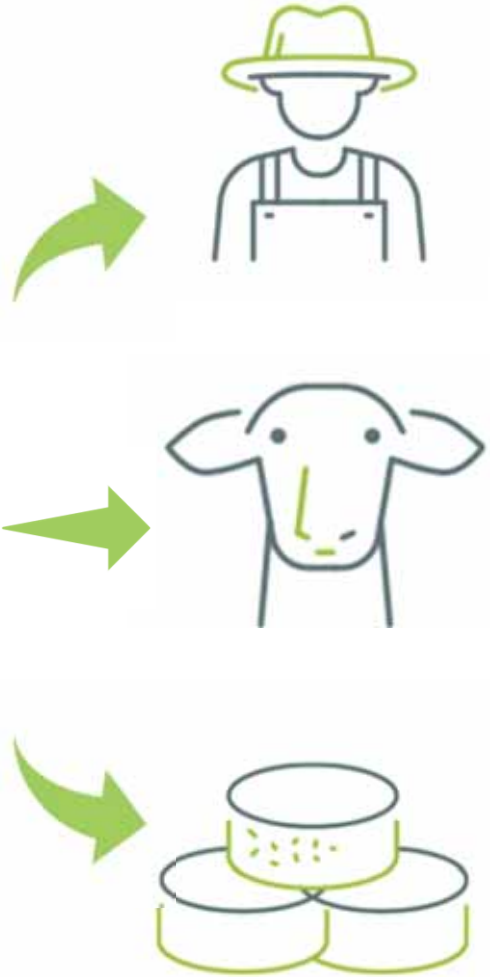
Grelet et al., ICAR 2019



FROM MILK RECORDING TO VALUE CREATION ACROSS THE DAIRY SHEEP SECTOR



Better characterising sheep milk with sheep-specific MIR equations



Farmers & advisory services

- **Managing herd adaptation**
 - Feeding management
 - Supporting climate adaptation
 - New decision-support indicators

Breeding organisations

- **Large-scale phenotyping**
 - New traits for genetic evaluation
 - Accelerated genetic progress

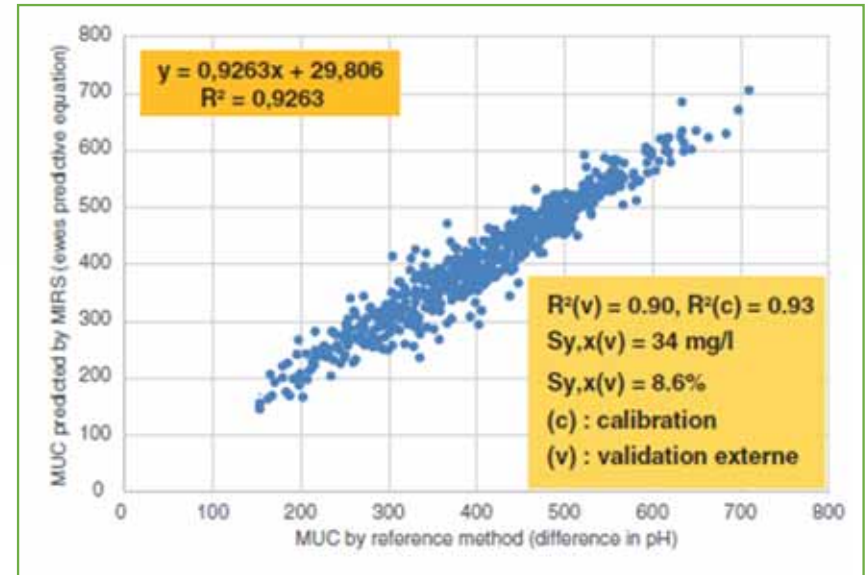
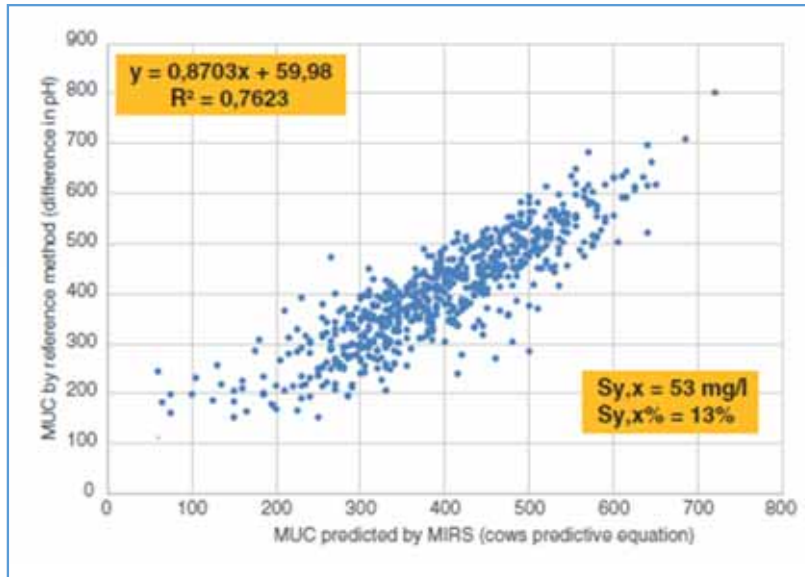
Dairy processors

- **Improving milk valorisation**
 - Milk composition and cheesemaking abilities
 - Renovation of advisory report



GREATER ACCURACY IN ANALYSIS RESULTS THANKS TO THE DEVELOPMENT OF SHEEP-SPECIFIC EQUATIONS

Example of UREA



Prediction equation based on	COW milk	COW milk	SHEEP milk
Applied on	COW milk	SHEEP milk	SHEEP milk
Precision of the estimates	± 70 mg/l	± 106 mg/l	± 68 mg/l

Valid urea equation for individual and herd milks

→ Towards more accurate advice on flock feeding leading to potential savings for the farmer



SEVERAL PASSED AND ON-GOING PROJETS TO DEVELOP SHEEP-SPECIFIC MIR EQUATIONS

Developing specific mathematical models for dairy sheep

- CASEINS (update)
- FATTY ACIDS (update)
- CALCIUM
- PHOSPHORUS
- LIPOLYSIS
- LACTOSE



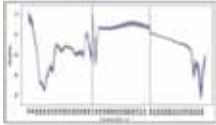
Results Dissemination Process – SIEOL

- Development of specifications for the operational model
- Revision of quality reports for farmers / creation of a quality report for cheese vats milk
- Review of the business model





KEY MESSAGES



✓ **MIR is a key phenotyping tool for management, breeding and milk processing**



✓ **Species-specific equations are essential for reliable MIR predictions in sheep milk, at the individual and herd milk scales**



✓ **France now has a complete sheep MIR ecosystem capable of transforming 300,000 annual spectra into new phenotypes that are useful across the entire value chain**



✓ **Work is continuing to provide stakeholders with useful and responsive tools that address current challenges**

TO BE
CONTINUED... 

✓ **Next challenge: new traits, including sustainability-related indicators such as methane proxies**



Thank you for your attention!

Questions ?

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