Milk as a management tool in sheep and goat farming

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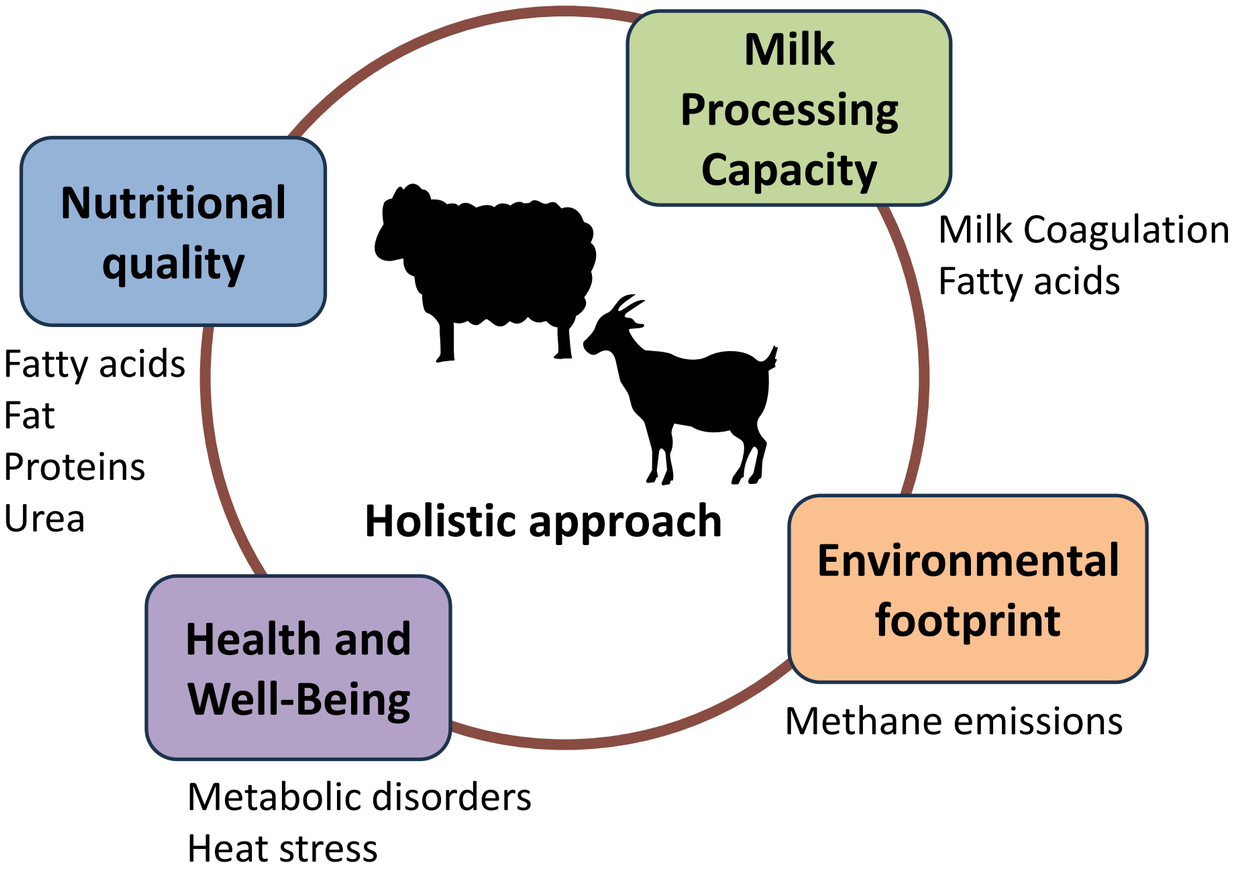
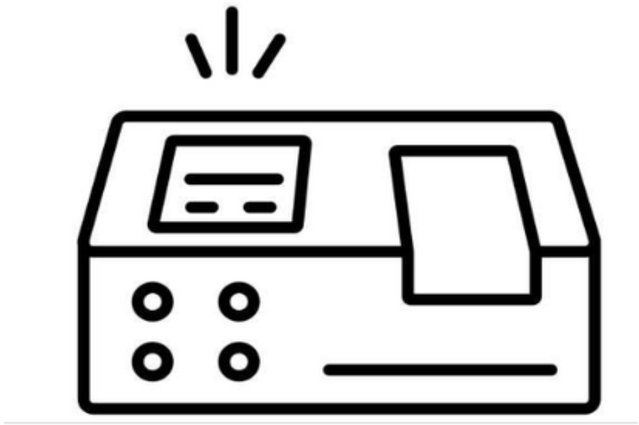
Context

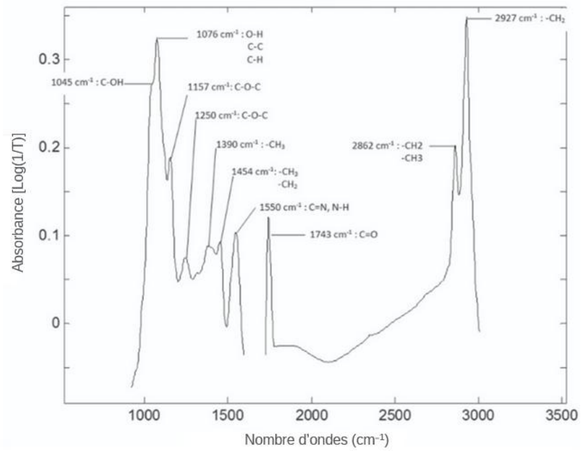

Milk Processing Capacity
Milk Coagulation
Fatty acids
Nutritional quality
Fatty acids
Fat
Proteins
Urea
Holistic approach
Environmental footprint
Methane emissions
Health and Well-Being
Metabolic disorders
Heat stress

Spectrum FT-MIR

Milk sampling

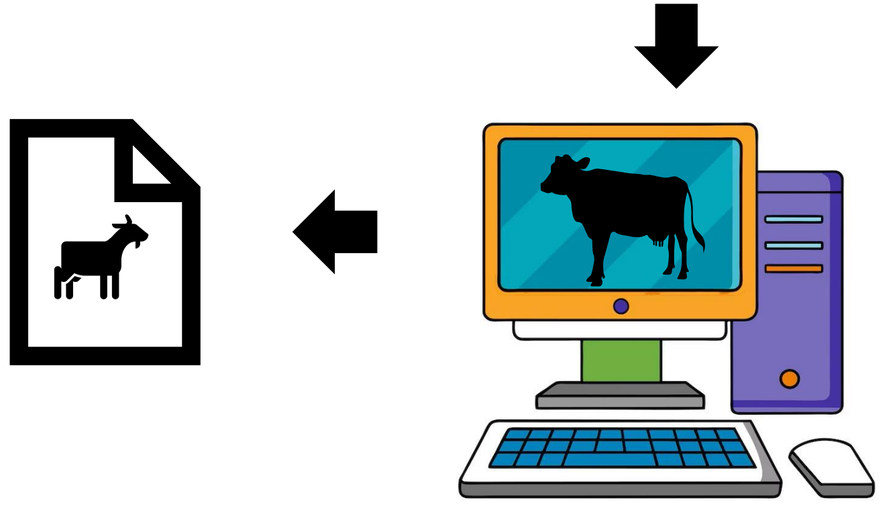


Spectroscopy FT-MIR



Spectrum of analysis

(Grelet *et al.*, 2015)



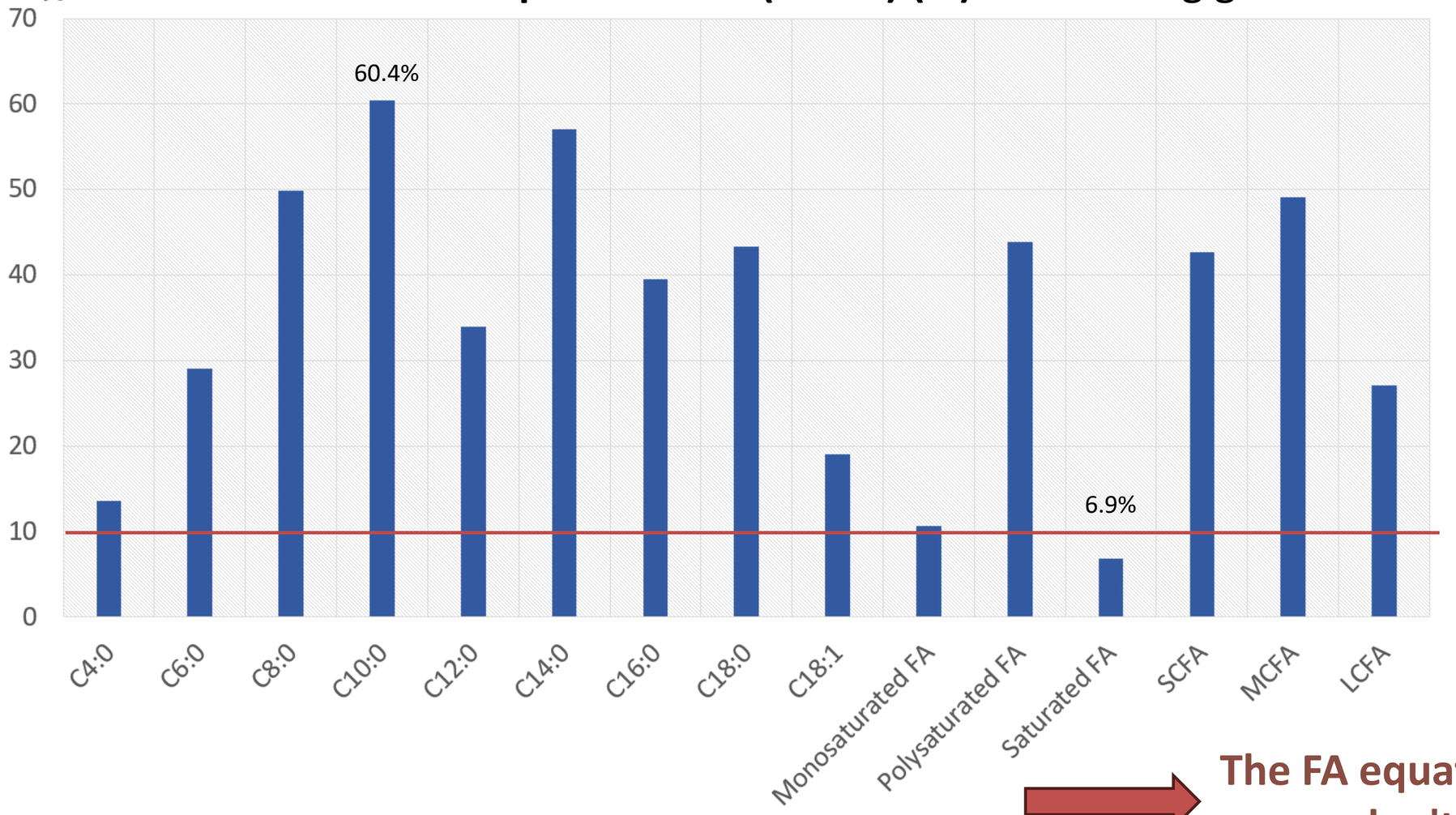
Are the equations used for cattle suitable for goat and sheep?

Example with fatty acids (FA) for goat

Bovine PLS

Are the equations used for cattle suitable for goat and sheep?

Relative Root Mean Squared error (RMSE) (%) for FA using goat data

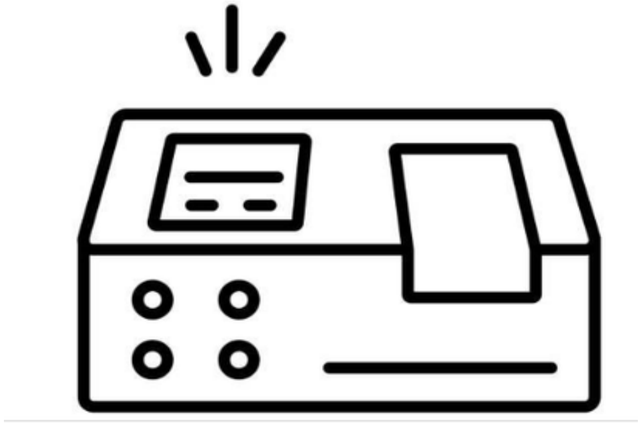


Error is relatively high : > than 10 % except for saturated FA

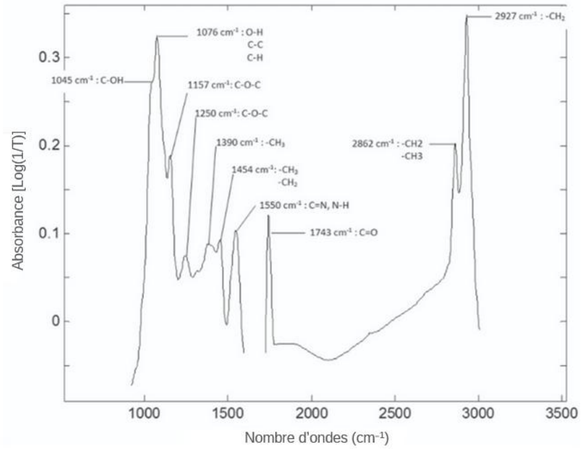
The FA equations built using cows' data don't apply to goat's milk

Spectrum FT-MIR

Milk sampling

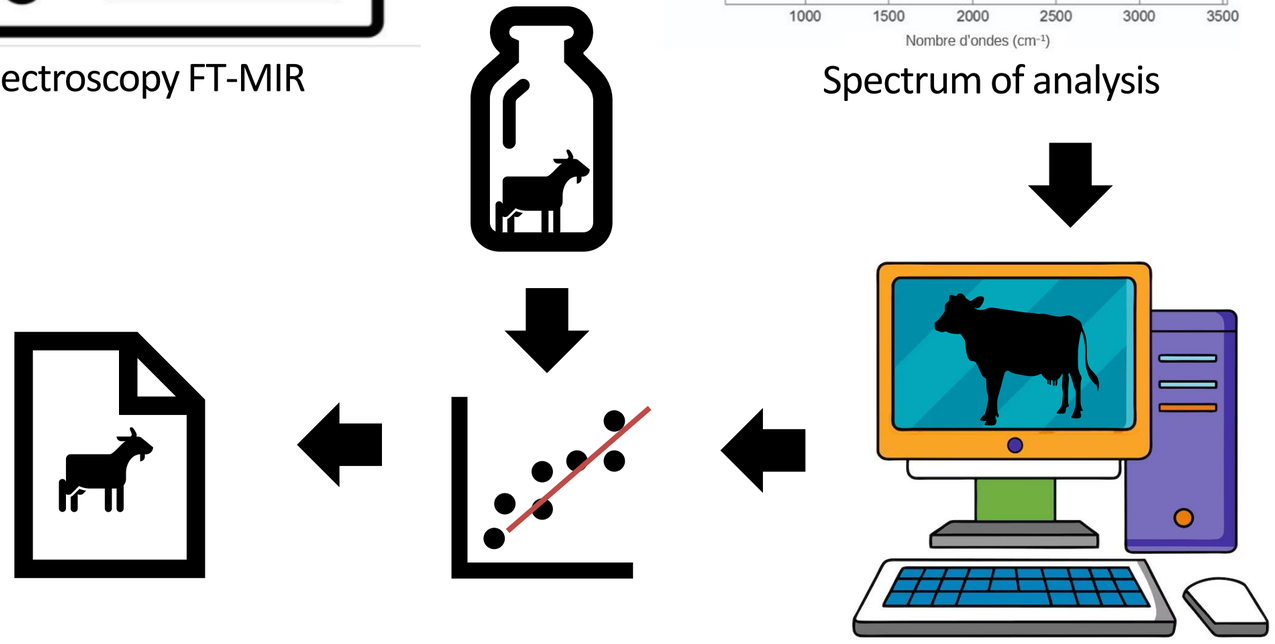


Spectroscopy FT-MIR



Spectrum of analysis

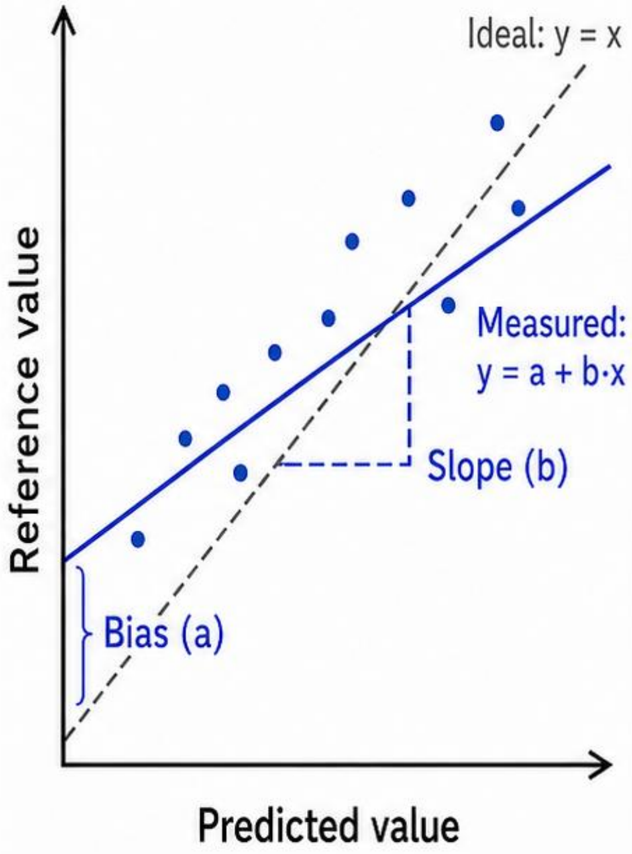
(Grelet *et al.*, 2015)



The FA equations built using cows' data don't apply to goat's milk BUT is it better with a slope and bias correction based on goat's milk ?

Bias and Slope Correction

1 Raw conversion



2 Correction

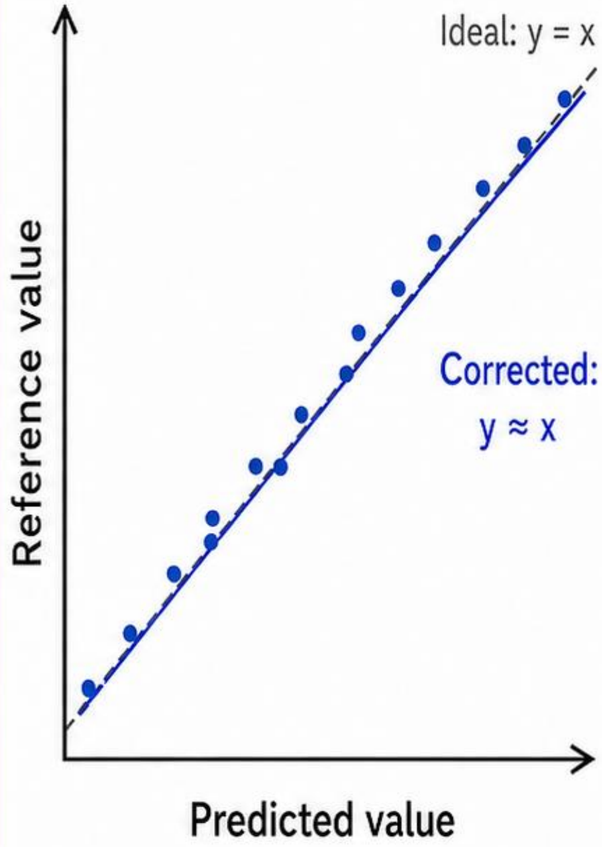
Residue =
Reference value − Predicted value

$$y = a + b \cdot x$$

Bias (a): intercept error

Slope (b): proportional error

3 After correction



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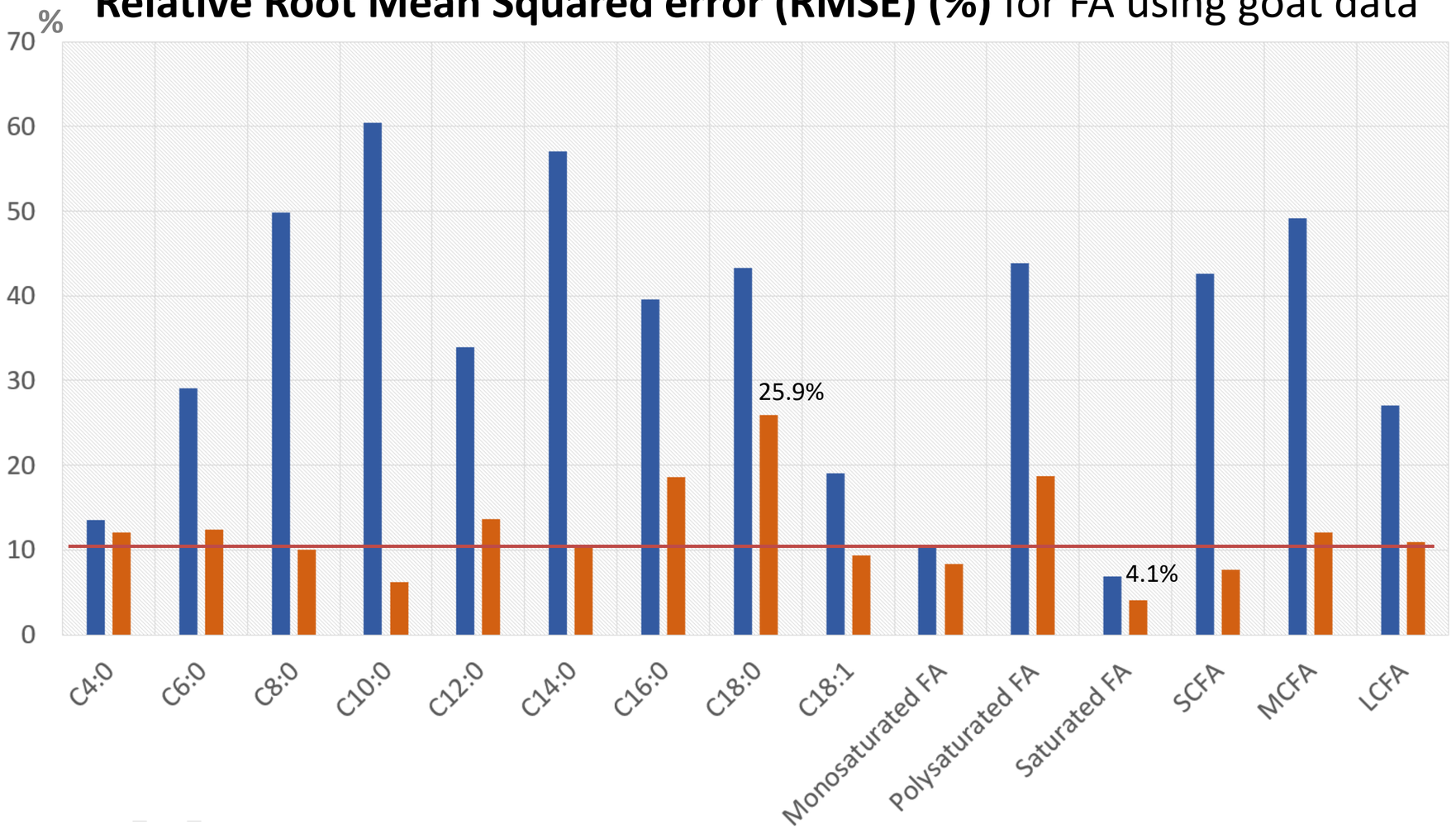
Bias and Slope Correction

Relative Root Mean Squared error (RMSE) (%) for FA using goat data



The correction significantly reduces the error

Error range decreases

Error lower than 10% for SFA, MUFA, SCFA, C8:0, C18:1

Could it be better to create models with goat's data to improve all FA ?

Objective

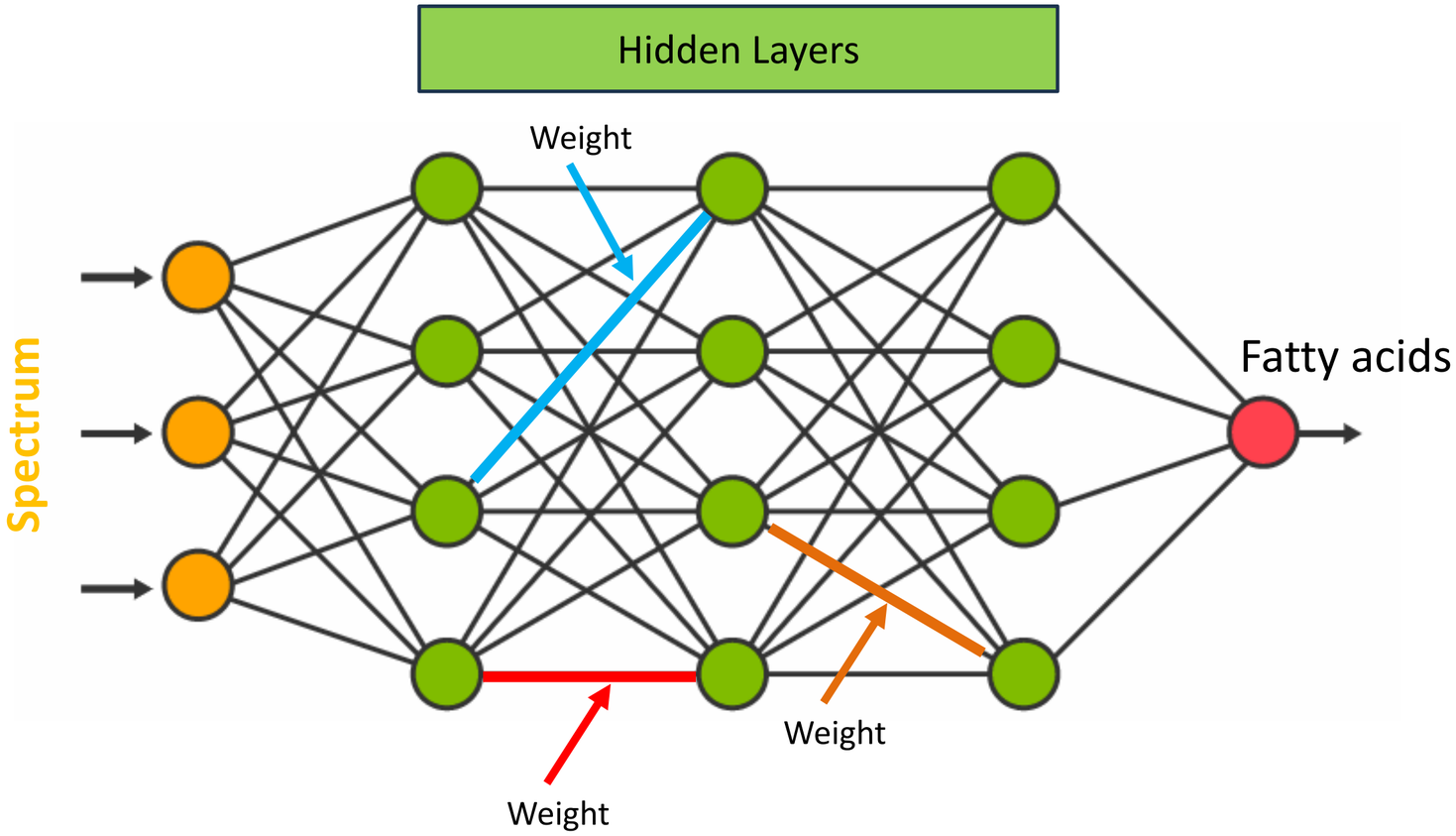
→ Development of specific equations for dairy goat based on **Transfer Learning**

Cost of a reference database

INNOVATION

Transfer learning

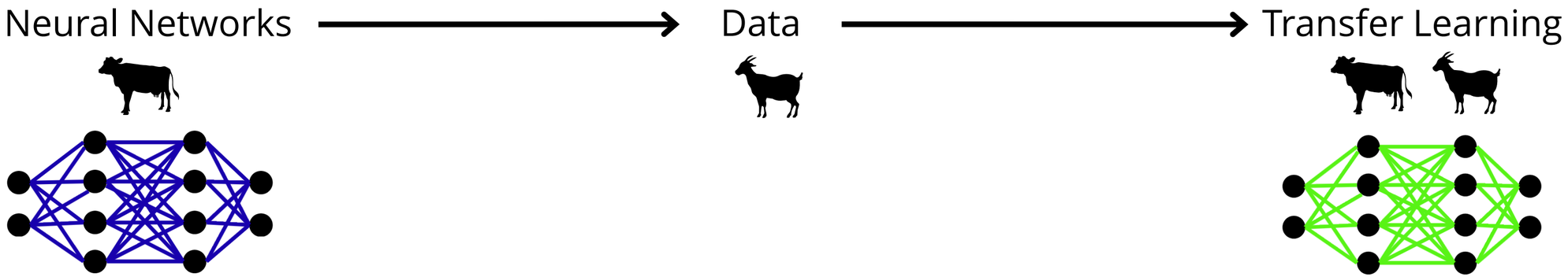
Artificial Neural Network (ANN)



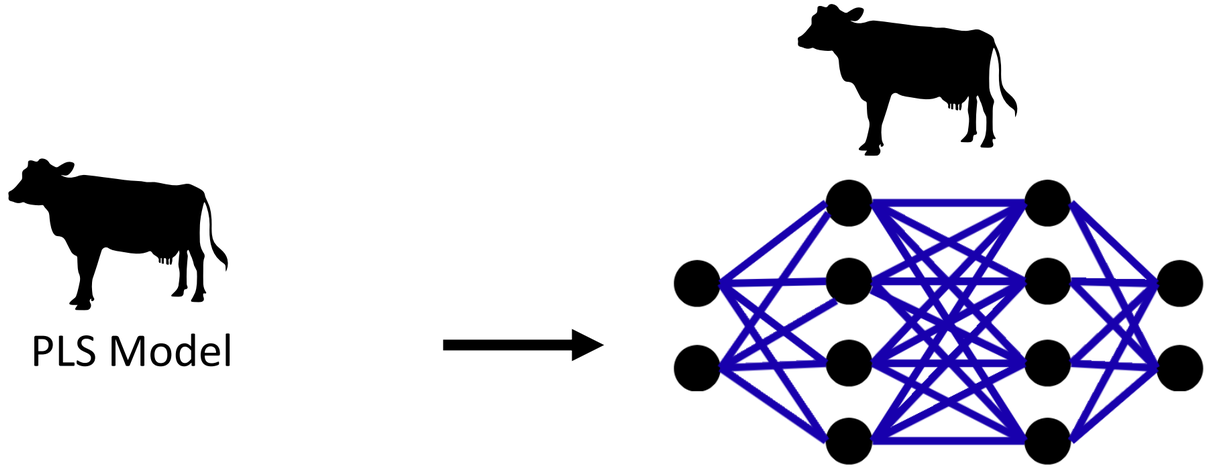
Transfer Learning (TL)

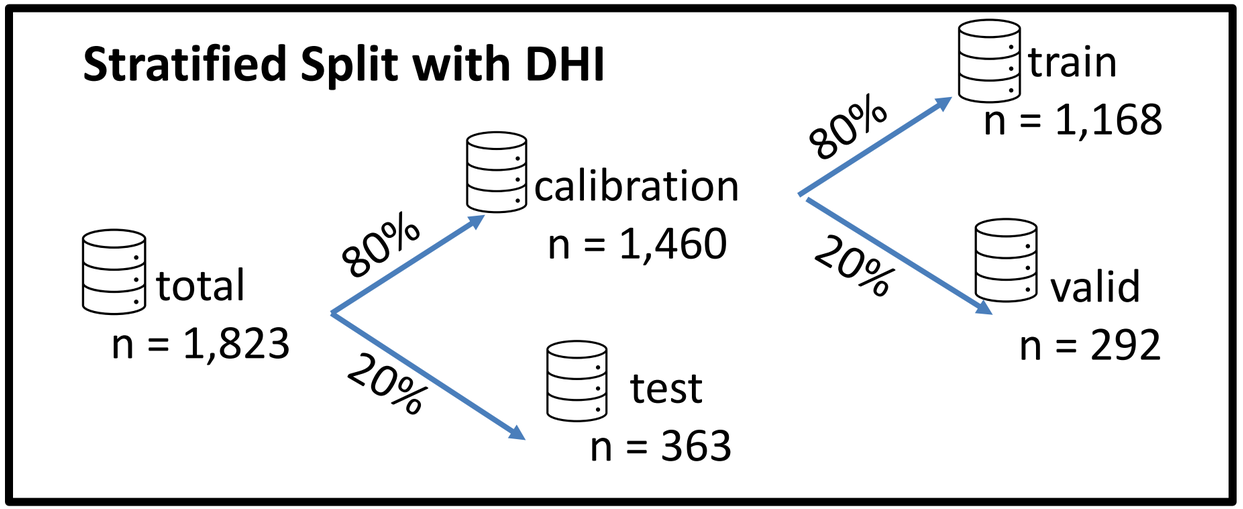
Transfer Learning

Method that uses previously trained models to apply knowledge learned in previous tasks to new tasks.



Creation of ANN





Creation of ANN

Phase 1
Hyperparameter selection :
Learning rate : [0.005, 0.001]
Weight decay : [0.0001, 0.0005]
Layers : [2,4]
Nodes : [5, 10, 15, 20, 25, 30, 35, 40, 45, 50]

Epochs : 500 max
Patience : 20

Research methods : Optuna (M1 et M2) or Random Search (M3 et M4)

Selection of 10 models

Phase 2
Hyperparameter selection :
Learning rate et Weight decay : Fixed
Layers : Layers ± 1 (-1,0,1)
Nodes : Nodes ± 3 (-3,-2,-1,0,1,2,3)

Epochs : 600 max
Patience : 50

Research methods : Cross-validation 4-fold (M1 et M3) + Optuna (M1 et M2)

Selection of 10 models

Phase 3
Epochs : 1000 max
Patience : 80

Selection of 3 models

Phase 4 :
Model Selection following the parcimony

Results of ANN

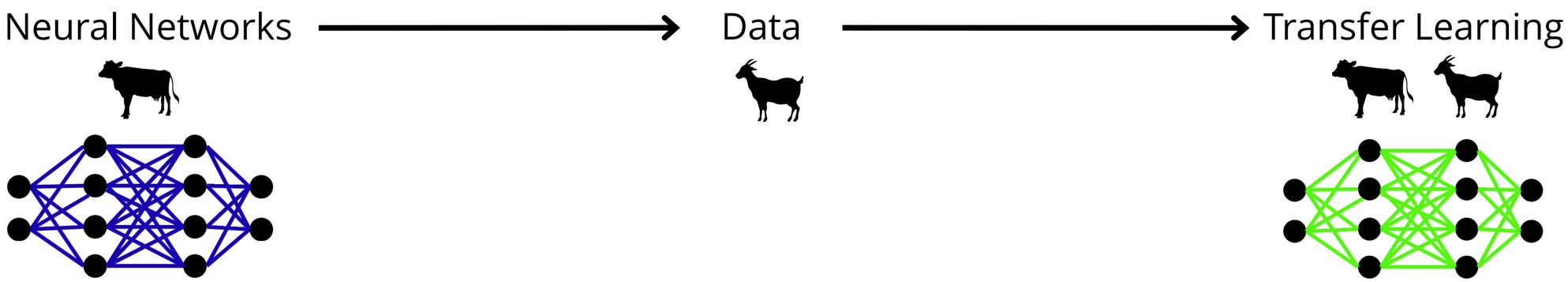
4 Methodologies

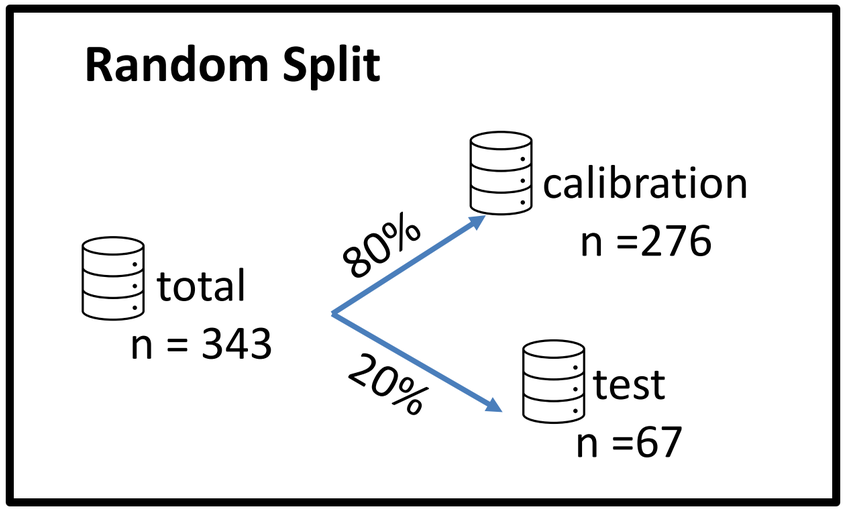
	M1	M2	M3	M4
Optuna (TPE + Hyperband) (Phase 1 et Phase 2)	Yes	Yes	No	No
Cross-validation (Phase 2)	Yes	No	Yes	No

Methodologies	RMSEtest modelA	RMSEtest modelB	std modelA	std modelB	Student Test	p-value	best model
M1 & M2	0.0256	0.0254	0.0333	0.0328	1.2536	0.2171	Not significant
M1 & M3	0.0256	0.0254	0.0333	0.0333	1.3878	0.1727	Not significant
M1& M4	0.0256	0.0285	0.0333	0.0381	-2.5857	0.0134	M1
M2 & M3	0.0254	0.0254	0.0328	0.0333	-0.4689	0.6416	Not significant
M2 & M4	0.0254	0.0285	0.0328	0.0381	-2.8520	0.0068	M2
M3 & M4	0.0254	0.0285	0.0333	0.0381	-2.7463	0.0089	M3

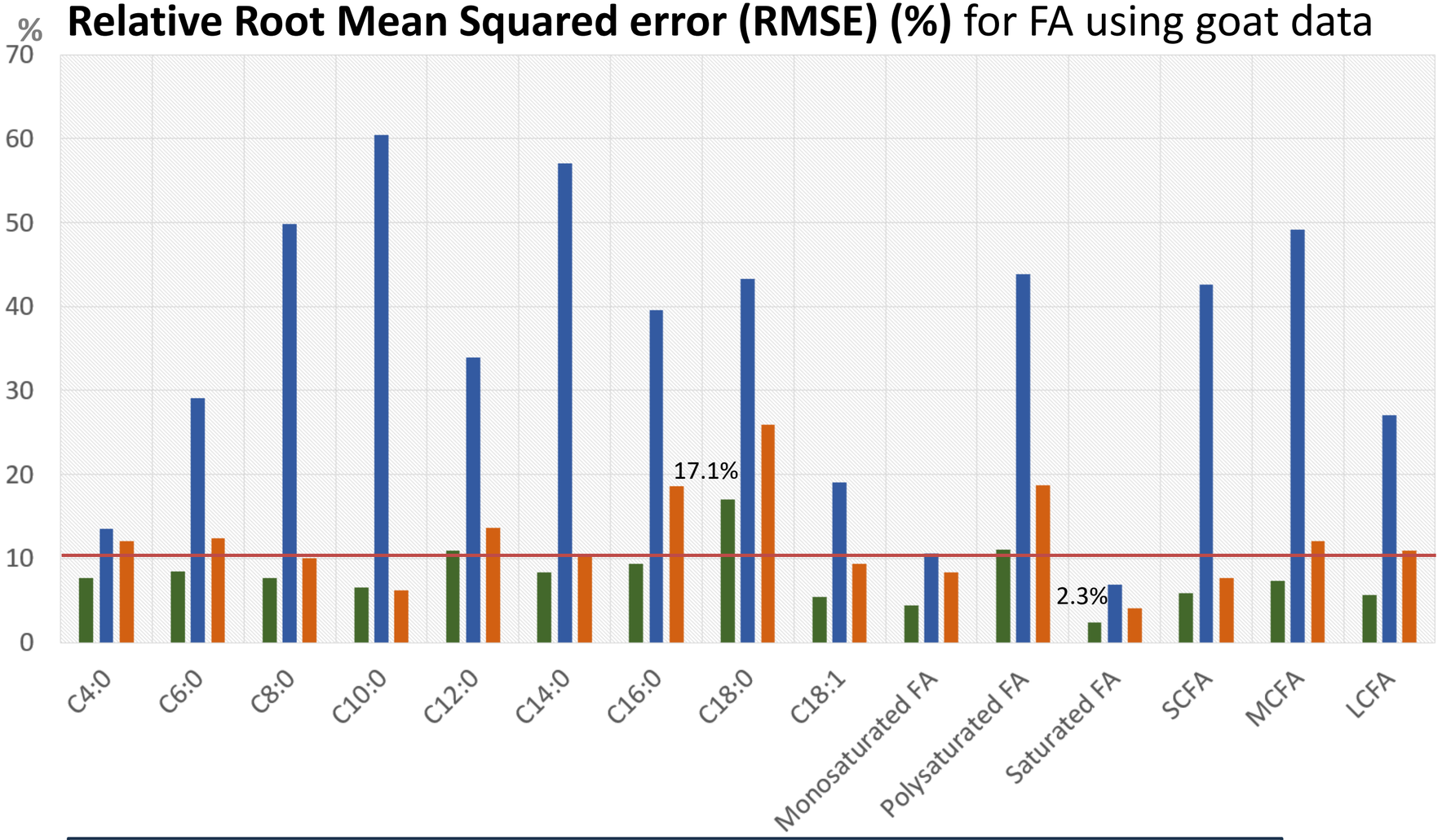
Methodologies	RMSEtest ANN	RMSEtest PLS	std ANN	std PLS	Student Test	p-value	best model
M1 & PLS	0.0256	0.0264	0.0333	0.0341	-2.3519	0.0236	M1
M2 & PLS	0.0254	0.0264	0.0328	0.0341	-2.9591	0.0051	M2
M3 & PLS	0.0254	0.0264	0.0333	0.0341	-3.1637	0.0029	M3
M4 & PLS	0.0285	0.0264	0.0381	0.0341	1.7341	0.0904	Not significant

Transfer Learning (TL)





Results of Transfer Learning

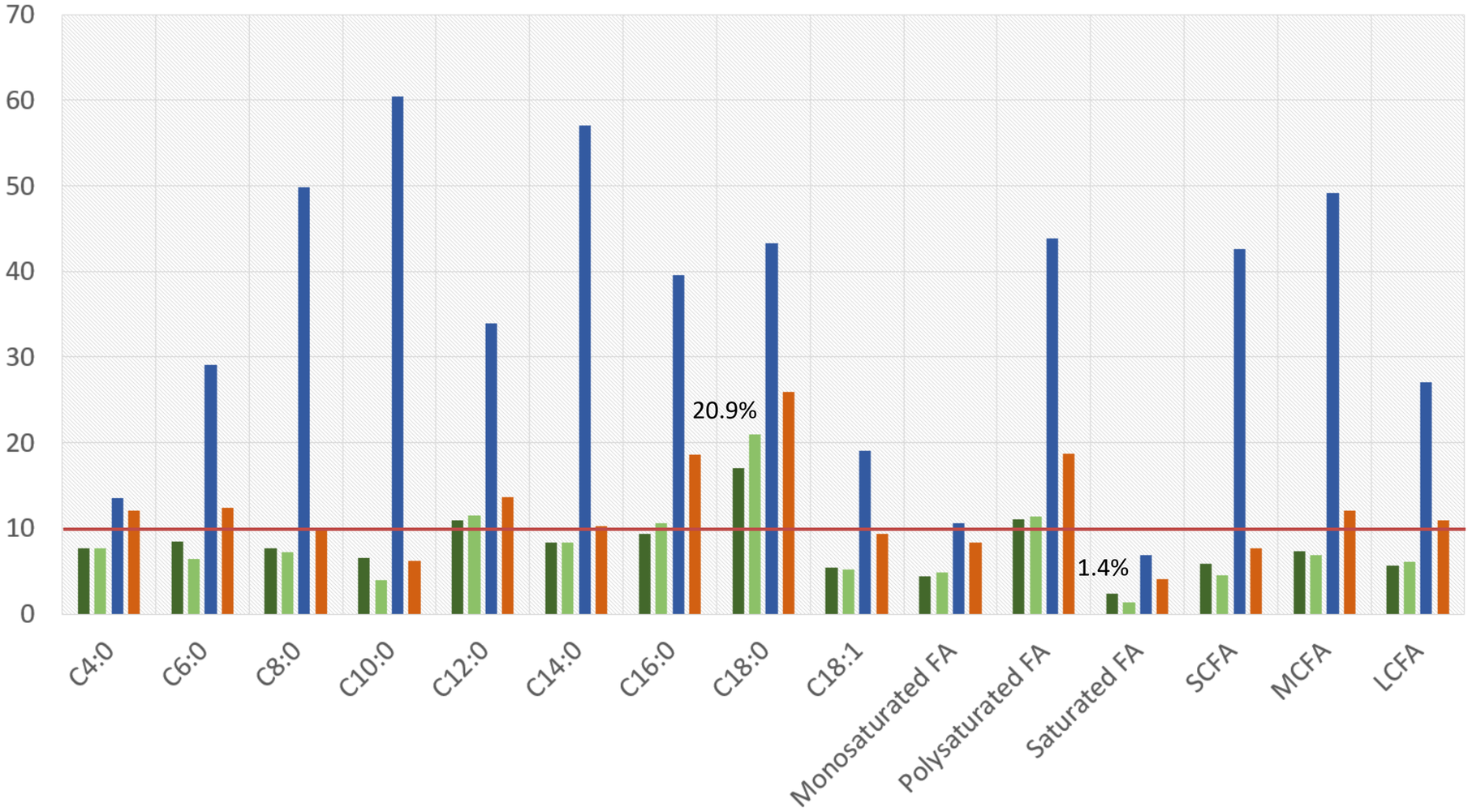


Transfer learning helps to reduce the prediction error compared to other models

Error lower than 10% for all FA except C12:0,C18:0 and PUFA

Results of goat-specific PLS model

% **Relative Root Mean Squared error (RMSE) (%)** for FA using goat data



Error lower than 10% for all FA except C12:0, C16:0, C18:0 and PUFA

- Direct use of PLS FA equation built from bovine data
- Use of PLS FA equation built from bovine data + bias and slope correction using goat's milk samples
- **Transfert learning**
- **PLS using only goat's milk samples**

TL and PLS goat are the best model

Methodologies	RMSEtest ANN	RMSEtest PLS	Student Test	p-value	best model
ANN VS PLS	0.0236	0.0228	0.8309	0.4112	Not significant

Conclusion

Take-home message

- A simple application of equations build from cow’s data don't apply to goat's milk
  → Minimum Slope and Biais correction

- Models train with goat data are better
  → Necessary to have goat’s dataset to create specific models

- TL can outperform goat-specific PLS models for some FA
  → Choice of the best model

Contact

If you would like to:

- Take part in the project
- Share data or your experience
- Collaborate with us

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Various topics to study