The state of the art about the development of mid-infrared based fatty acids predictions and their applications along the dairy food chain

Michael Whittaker

S. Orlandini2, C. Baumgartner2, S. Holroyd3, G. Scott3, P. Jamieson3, D. Santschi4, M. Bahadi4, B. Harris5, K. Sanders5 H. Soyeurt6

2 International Committee of Animal Recording, Arthur van Schendelstraat 650, 3511 MJ Utrecht, The Netherlands

3 Fonterra Co-Operative Group Limited, 2226 State Highway 56, Longburn, New Zealand

4 Lactanet, 555, Boul. Des Anciens-Combattants, Sainte-Anne-de-Bellevue, Quebec, Canada

5 Livestock Improvement Corporation, 605 Ruakura Road, Newstead 3286, New Zealand

6 TERRA Research and Teaching Centre, Gembloux Agro-Bio Tech, University of Liège, Gembloux, Belgium

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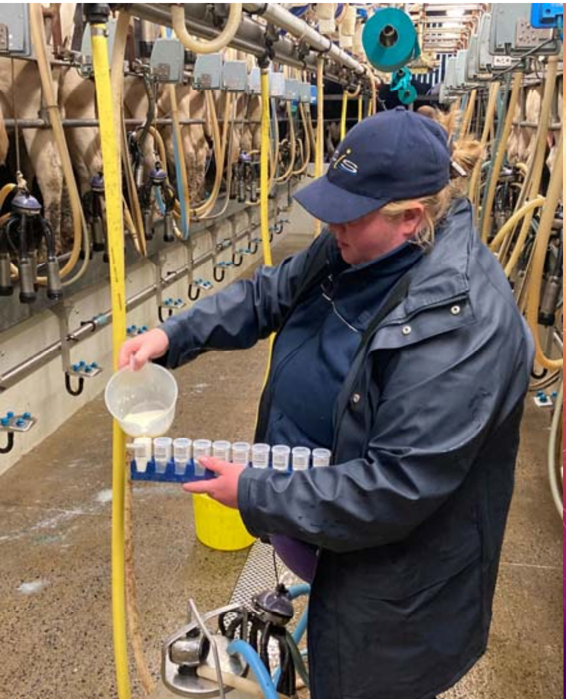
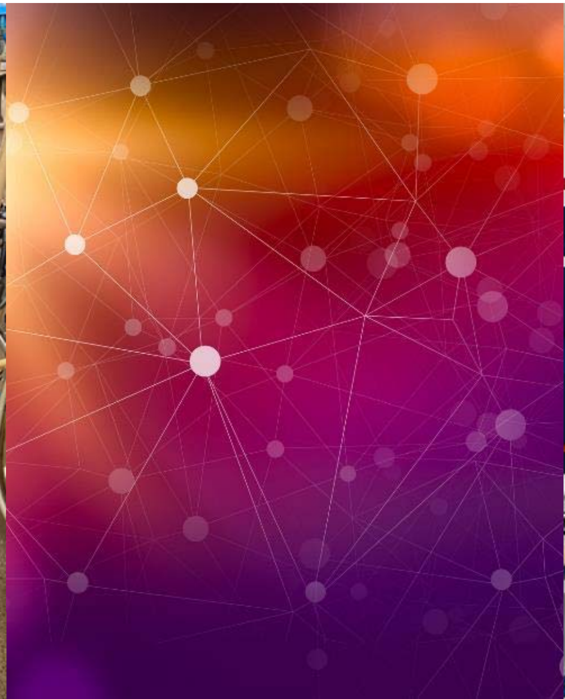

Introduction

- The ICAR Brian Wickham Young Person Exchange Program (BWYPEX) exists to build future connections between the younger generation of members and the long-standing experienced members. This is to promote the sharing of essential knowledge to continue key research in the future.
- My nominated topic of interest to research during the BWYPEX project is ExtraMIR.
- ExtraMIR is a joint ICAR and IDF project

What is the ExtraMIR Project?

- Aim is to reduce gap between research and practical application.
- By investigating the variability and reliability of reference data sets.
- These data sets use FA modelling to predict the milk FA composition from MIR spectra.
- 6 published FA models from 6 different countries (Belgium, Netherlands, Australia, Canada, France and China).
- Analysed the application potential based on the R square value using the mean-centred cross-validation ranking method (Grelet et al 2021).
- Results – model useability ranged from quantitative screening to highly imprecise and only for the use of detecting extreme values.
- Used to inform the various practical applications of ExtraMIR analysis in the field.

Characteristics of the 7 k-mean clusters resulting from the classification of the 57 milk MIR models following their mean-centred cross validation RPD, relative RMSE and R^2 (Grelet et al, 2021)

Cluster	RPDcv	Relative RMSEcv	R^2cv	Interpretation for Application
1	>6	<5%	>0.97	Any application
2	4.2 - 6	<10%	0.94 – 0.97	Quality control
3	3 – 4.2	<10%	0.89 – 0.94	Quantitative screening
4	2 - 3	<25%	0.74 – 0.89	Rough screening
5	1.5 - 2	<25%	0.55 – 0.74	Allows to compare groups, discriminate high or low values
6	1.5 - 2	>25%	0.55 – 0.74	Highly imprecise, can be used to detect extreme values
7	<1.5	-	<0.55	Not recommended

Large-scale phenotyping in dairy sector using milk MIR spectra: Key factors affecting the quality of predictions (Belgium)

C. Grelet, P. Dardenne, H. Soyeurt, J.A. Fernandez, A. Vanlierde, F. Stevens, N. Gengler, F. Dehareng, (2021)

Phenotype (Fatty Acid)	R^2cv	Cluster Group Ranking	Interpretation
SAT FA (g/dL)	0.99	1	Any application
C18:1cis9 (g/dL)	0.95	2	Quality control
LCFA (g/dL)	0.95	2	Quality control
MCFA (g/dL)	0.97	2	Quality control
MONO FA (g/dL)	0.97	2	Quality control
Tot18:1cis (g/dL)	0.95	2	Quality control
Total _C18:1 (g/dL)	0.96	2	Quality control
UNSAT (g/dL)	0.97	2	Quality control
C10 (g/dL)	0.91	3	Quantitative screening
C12 (g/dL)	0.92	3	Quantitative screening
C14 (g/dL)	0.93	3	Quantitative screening
C16 (g/dL)	0.94	3	Quantitative screening
C4 (g/dL)	0.93	3	Quantitative screening
C6 (g/dL)	0.91	3	Quantitative screening
C8 (g/dL)	0.91	3	Quantitative screening
SCFA (g/dL)	0.93	3	Quantitative screening
C17 (g/dL)	0.80	4	Rough screening
C18 (g/dL)	0.84	4	Rough screening
Odd Fatty Acids (g/dL)	0.83	4	Rough screening
PUFA (g/dL)	0.77	4	Rough screening
Total Trans (g/dL)	0.80	4	Rough screening
18:1 trans (g/dL)	0.79	4	Rough screening
C14:1 (g/dL)	0.68	5	Allows to compare groups, discriminate high or low values
C16:1c (g/dL)	0.73	5	Allows to compare groups, discriminate high or low values
C18:2c9c12 (g/dL)	0.72	5	Allows to compare groups, discriminate high or low values
C18:3c9c12c15 (g/dL)	0.68	5	Allows to compare groups, discriminate high or low values
FA isoanteiso (g/dL)	0.75	5	Rough screening
Omega3 (g/dL)	0.66	5	Allows to compare groups, discriminate high or low values
Omega6 (g/dL)	0.72	5	Allows to compare groups, discriminate high or low values
Tot18:2 (g/dL)	0.69	5	Allows to compare groups, discriminate high or low values
C18:2c9t11 (g/dL)	0.74	6	Allows to compare groups, discriminate high or low values

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Predicting bovine milk fat composition using infrared spectroscopy based on milk samples collected in winter and summer (Netherlands)

M.J. Rutten, H. Bovenhuis, K.A. Hettinga, H.J.F van Valenberg and J.A.M. van Arendonk (2009)

Fatty Acids - Milk (g/dL)										
Trait	AA	AA Cluster Group Ranking	WW	WW Cluster Group Ranking	WS	WS Cluster Group Ranking	SS	SS Cluster Group Ranking	SW	SW Cluster Group Ranking
C4:0	0.91	3	0.83	4	0.78	4	0.77	4	0.82	4
C6:0	0.96	2	0.89	3	0.89	4	0.89	3	0.90	3
C8:0	0.94	2	0.85	4	0.84	4	0.84	4	0.85	4
C10:0	0.92	3	0.75	4	0.81	4	0.81	4	0.76	4
C12:0	0.85	4	0.61	5	0.71	5	0.73	5	0.62	5
C14:0	0.94	3	0.81	4	0.84	4	0.85	4	0.82	4
C16:0	0.94	2	0.85	4	0.75	4	0.79	4	0.83	4
C18:0	0.82	4	0.58	5	0.64	5	0.70	5	0.59	6
C18:1 cis-9	0.92	3	0.69	5	0.79	4	0.81	4	0.68	6
C18:1 cis-11	0.27	7	0.18	7	0.15	7	0.23	7	0.12	7
C18:1 trans-4-8	0.48	7	0.23	7	0.13	7	0.20	7	0.15	7
C18:1 trans-9	0.53	7	0.32	7	0.27	7	0.29	7	0.27	7
C18:1 trans-11	0.63	6	0.26	7	0.09	7	0.17	7	0.18	7
C18:2 cis-9,12	0.36	7	0.19	7	0.14	7	0.17	7	0.15	7
C18:2 cis-9, trans-11	0.58	3	0.27	7	0.14	7	0.20	7	0.13	7
C18:3 cis-9,12,15	0.45	7	0.19	7	0.22	7	0.23	7	0.14	7
C6-C12	0.95	2	0.81	4	0.87	4	0.87	4	0.82	4
C14-C16	0.97	2	0.90	3	0.81	4	0.85	4	0.89	3
C18u	0.94	2	0.69	5	0.77	4	0.80	4	0.68	5
Ratio SFA:UFA	0.91	3	0.43	7	0.65	5	0.59	5	0.38	7

AA - Calibration in half of all data and validation in the other half of all data
WW - Calibration in half on the winter data and calidation in the other half of the winter data
WS - Validation of the midel from scenario WW in all summer data
SS - Calibration in half of the summer data and validation in the other half of the summer data
SW - Validation of the model scenario SS in all winter data

Prediction of fatty acid profiles in cow, ewe and goat milk by mid-infrared spectrometry (France)

M. Ferrand-Calmels, I. Palhiere, M. Brochard, O. Leray, J.M. Astruc, M.R. Aurel, S. Barbey, F. Bouvier, P. Brunschwig, H. Caillat, M. Douguet, F. Faucan-Lahalle, M. Gele, G. Thomas, J.M. Trommenschlager and H. Larroque (2014)

Comparison of the methods used to develop calibration equations on the MilkoScna FT6000 Analyzer (Food Electric A/S Hillerod, Denmark) data for FA in cows milk

Fatty Acid	PLS R^2	Cluster Group Ranking	AG1PLS R^2	Cluster Group Ranking	AG2PLS R^2	Cluster Group Ranking	Elastic net R^2	Cluster Group Ranking	LASSO R^2	Cluster Group Ranking	Ridge Regression R^2	Cluster Group Ranking	First Derivative + PLS R^2	Cluster Group Ranking	Wavelet + PLS R^2	Cluster Group Ranking
C4:0	0.93	2	0.93	2	0.93	3	0.87	4	0.90	3	0.84	4	0.92	3	0.94	2
C6:0	0.96	2	0.96	2	0.97	1	0.93	3	0.93	3	0.84	4	0.96	2	0.96	2
C8:0	0.97	1	0.98	1	0.97	1	0.89	3	0.90	3	0.75	4	0.97	1	0.97	1
C10:0	0.95	2	0.95	2	0.96	2	0.84	4	0.85	4	0.62	5	0.96	2	0.96	2
C12:0	0.96	2	0.96	2	0.96	2	0.82	4	0.84	4	0.48	7	0.97	1	0.96	2
C14:0	0.95	2	0.95	2	0.95	2	0.84	4	0.86	4	0.74	5	0.96	2	0.95	2
C16:0	0.94	2	0.92	3	0.93	3	0.86	4	0.87	4	0.71	5	0.93	3	0.92	3
C18:0	0.85	4	0.89	3	0.85	4	0.76	4	0.77	4	0.46	7	0.85	4	0.87	4
Total trans 18:1	0.85	4	0.83	4	0.83	4	0.71	5	0.71	5	0.30	7	0.88	4	0.87	4
cis-9 C18:1	0.97	1	0.97	1	0.97	1	0.85	4	0.90	3	0.38	7	0.98	1	0.96	2
Total cis C18:1	0.97	1	0.97	1	0.96	2	0.84	4	0.90	3	0.37	7	0.98	1	0.95	2
Total C18:1	0.97	1	0.97	1	0.96	2	0.84	4	0.88	4	0.38	7	0.98	1	0.96	2
cis-9, cis-12 C18:2 (linoleic acid)	0.78	4	0.76	4	0.75	4	0.58	5	0.61	5	0.45	7	0.80	5	0.80	4
cis-9, trans-11 C18:2 (conjugated linoleic acid)	0.83	4	0.83	4	0.83	4	0.58	6	0.71	5	0.21	7	0.87	4	0.78	4
C18:3n-3 (linolenic acid)	0.86	4	0.69	5	0.25	7	0.54	7	0.58	6	0.30	7	0.82	5	0.85	4
SFA	1.00	1	1.00	1	0.99	1	0.96	2	0.96	2	0.91	3	1.00	1	0.99	1
MUFA	0.98	1	0.98	1	0.97	1	0.84	4	0.89	3	0.41	7	0.99	1	0.97	1
PUFA	0.78	4	0.81	4	0.81	4	0.71	5	0.73	5	0.53	7	0.87	4	0.82	4
trans FA	0.86	4	0.86	4	0.86	4	0.74	5	0.74	4	0.26	7	0.90	3	0.88	4
n-3	0.84	4	0.79	4	0.81	4	0.67	5	0.65	5	0.26	7	0.86	4	0.84	4

Cluster	RPDcv	Relative RMSEcv	R^2cv	Interpretation for Application
1	>6	<5%	>0.97	Any application
2	4.2 - 6	<10%	0.94 – 0.97	Quality control
3	3 – 4.2	<10%	0.89 – 0.94	Quantitative screening
4	2 - 3	<25%	0.74 – 0.89	Rough screening
5	1.5 - 2	<25%	0.55 – 0.74	Allows to compare groups, discriminate high or low values
6	1.5 - 2	>25%	0.55 – 0.74	Highly imprecise, can be used to detect extreme values
7	<1.5	-	<0.55	Not recommended

Prediction of milk fatty acid content with mid-infrared spectroscopy in Canadian dairy cattle using differently distributed model development sets (Canada)

A. Fleming, F.S. Schenkel, J. Chen, F. Malchiodi, V. Bonfatti, R.A. Ali, B. Mallard, M. Corredig and F. Miglior (2017)

Individual Fatty Acid	R^2	Cluster Group Ranking	Interpretation
C4:0	0.66	5	Allows to compare groups, discriminate high or low values
C6:0	0.38	7	Not recommended
C8:0	0.37	7	Not recommended
C10:0	0.66	5	Allows to compare groups, discriminate high or low values
C11:0	0.21	7	Not recommended
C12:0	0.71	5	Allows to compare groups, discriminate high or low values
C13:0	0.19	7	Not recommended
C14:0	0.80	4	Rough screening
C14:1	0.61	5	Allows to compare groups, discriminate high or low values
C15:0	0.61	5	Allows to compare groups, discriminate high or low values
C16:0	0.86	4	Rough screening
C16:1	0.62	6	Highly imprecise, can be used to detect extreme values
C17:0	0.53	7	Not recommended
C17:1	0.31	7	Not recommended
C18:0	0.73	6	Highly imprecise, can be used to detect extreme values
C18:1 in-9 trans	0.60	5	Allows to compare groups, discriminate high or low values
C18:1 in-9 cis	0.79	4	Rough screening
C18:2n-6 trans	0.17	7	Not recommended
C18:2n-6 cis	0.62	5	Allows to compare groups, discriminate high or low values
C18:3n-3	0.58	6	Highly imprecise, can be used to detect extreme values
C18:2 cis-9,cis-12	0.65	5	Allows to compare groups, discriminate high or low values
C22:6n-3	0.22	7	Not recommended
SFA	0.94	2	Quality control
MUFA	0.84	3	Quantitative screening
PUFA	0.66	5	Allows to compare groups, discriminate high or low values
UFA	0.84	4	Rough screening
Short-Chain	0.72	5	Allows to compare groups, discriminate high or low values
Medium-Chain	0.90	3	Quantitative screening
Long-Chain	0.83	4	Rough screening

Cluster	RPDcv	Relative RMSEcv	R^2cv	Interpretation for Application
1	>6	<5%	>0.97	Any application
2	4.2 - 6	<10%	0.94 – 0.97	Quality control
3	3 – 4.2	<10%	0.89 – 0.94	Quantitative screening
4	2 - 3	<25%	0.74 – 0.89	Rough screening
5	1.5 - 2	<25%	0.55 – 0.74	Allows to compare groups, discriminate high or low values
6	1.5 - 2	>25%	0.55 – 0.74	Highly imprecise, can be used to detect extreme values
7	<1.5	-	<0.55	Not recommended

The use of mid-infrared Spectrometry to predict milk fatty acid, energy balance and methane emissions for Australian dairy cows (Australia)

T. Wang, H.N. Phuong, E. Wall, S. Smith and J.E. Pryce (2017)

Individual Fatty Acid	R^2	Cluster Group Ranking	Interpretation
Un-identified	0.54	7	Not recommended
C4:0	0.73	5	Allows to compare groups, discriminate high or low values
C6:0	0.78	4	Rough screening
C8:0	0.76	4	Rough screening
C10:0	0.72	5	Allows to compare groups, discriminate high or low values
C10:1	0.61	5	Allows to compare groups, discriminate high or low values
C12:0	0.72	5	Allows to compare groups, discriminate high or low values
C14 iso	0.68	6	Highly imprecise, can be used to detect extreme values
C14:0	0.73	5	Allows to compare groups, discriminate high or low values
C14:1	0.56	6	Highly imprecise, can be used to detect extreme values
C15 iso	0.68	5	Allows to compare groups, discriminate high or low values
C15 anteiso	0.55	6	Highly imprecise, can be used to detect extreme values
C15:0	0.72	5	Allows to compare groups, discriminate high or low values
C16 iso	0.69	5	Allows to compare groups, discriminate high or low values
C16:0	0.74	4	Rough screening
C16:1	0.62	5	Allows to compare groups, discriminate high or low values
C17 iso	0.53	7	Not recommended
C17 anteiso	0.49	7	Not recommended
C17:0	0.61	6	Highly imprecise, can be used to detect extreme values
C17:1	0.52	7	Not recommended
C18:0	0.80	4	Rough screening
C18:1 t9	0.65	5	Allows to compare groups, discriminate high or low values
C18:1 t10	0.59	6	Highly imprecise, can be used to detect extreme values
C18:1 t11	0.58	6	Highly imprecise, can be used to detect extreme values
C18:1 cis	0.63	5	Allows to compare groups, discriminate high or low values
C18:1 c9	0.51	7	Not recommended
C18:1 c11	0.65	5	Allows to compare groups, discriminate high or low values
C18:2 n6	0.56	6	Highly imprecise, can be used to detect extreme values
C18:3 n3	0.57	6	Highly imprecise, can be used to detect extreme values
C20:0	0.79	4	Rough screening
C20:1 c11	0.68	5	Allows to compare groups, discriminate high or low values
CLA	0.65	6	Highly imprecise, can be used to detect extreme values

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5	1.5 - 2	<25%	0.55 – 0.74	Allows to compare groups, discriminate high or low values
6	1.5 - 2	>25%	0.55 – 0.74	Highly imprecise, can be used to detect extreme values
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Predictions of milk fatty acid contents by mid-infrared spectroscopy in Chinese Holstein cows (China)

Ziuxin Zhao, Yuetong Song, Yuanpei Zhang, Gaozhan Cai, Guanghui Xue, Yan Liu, Kewei Chen, Fan Zhang, Kun Wang, Miao Zhang, Yundong Gao, Dongxiao Sun, Xiao Wang (2022)

Fatty Acid	R^2	Cluster Group Ranking	Interpretation
C8:0	0.75	4	Rough screening
C10:0	0.61	5	Allows to compare groups, discriminate high or low values
C11:0	0.57	6	Highly imprecise, can be used to detect extreme values
C12:0	0.79	4	Rough screening
C13:0	0.24	7	Not recommended
C14:0	0.66	5	Allows to compare groups, discriminate high or low values
C15:0	0.45	7	Not recommended
C16:0	0.64	6	Highly imprecise, can be used to detect extreme values
C17:0	0.65	5	Allows to compare groups, discriminate high or low values
C18:0	0.66	5	Allows to compare groups, discriminate high or low values
C20:0	0.52	5	Allows to compare groups, discriminate high or low values
C22:0	0.70	5	Allows to compare groups, discriminate high or low values
C24:0	0.64	5	Allows to compare groups, discriminate high or low values
C14:1	0.63	5	Allows to compare groups, discriminate high or low values
C16:1	0.54	7	Not recommended
C18:1n9c	0.60	6	Highly imprecise, can be used to detect extreme values
C20:1	0.54	7	Not recommended
C22:1n9	0.51	7	Not recommended
C18:2n6c	0.59	6	Highly imprecise, can be used to detect extreme values
C18:3n3	0.60	6	Highly imprecise, can be used to detect extreme values
C18:3n6	0.18	7	Not recommended
C20:3n6	0.50	7	Not recommended
C20:4n6	0.44	7	Not recommended
C20:5n3	0.33	7	Not recommended
LCFA	0.68	5	Allows to compare groups, discriminate high or low values
MCFA	0.64	5	Allows to compare groups, discriminate high or low values
MUFA	0.61	6	Highly imprecise, can be used to detect extreme values
PUFA	0.71	5	Allows to compare groups, discriminate high or low values
SCFA	0.66	5	Allows to compare groups, discriminate high or low values
SFA	0.66	5	Allows to compare groups, discriminate high or low values
UFA	0.62	6	Highly imprecise, can be used to detect extreme values

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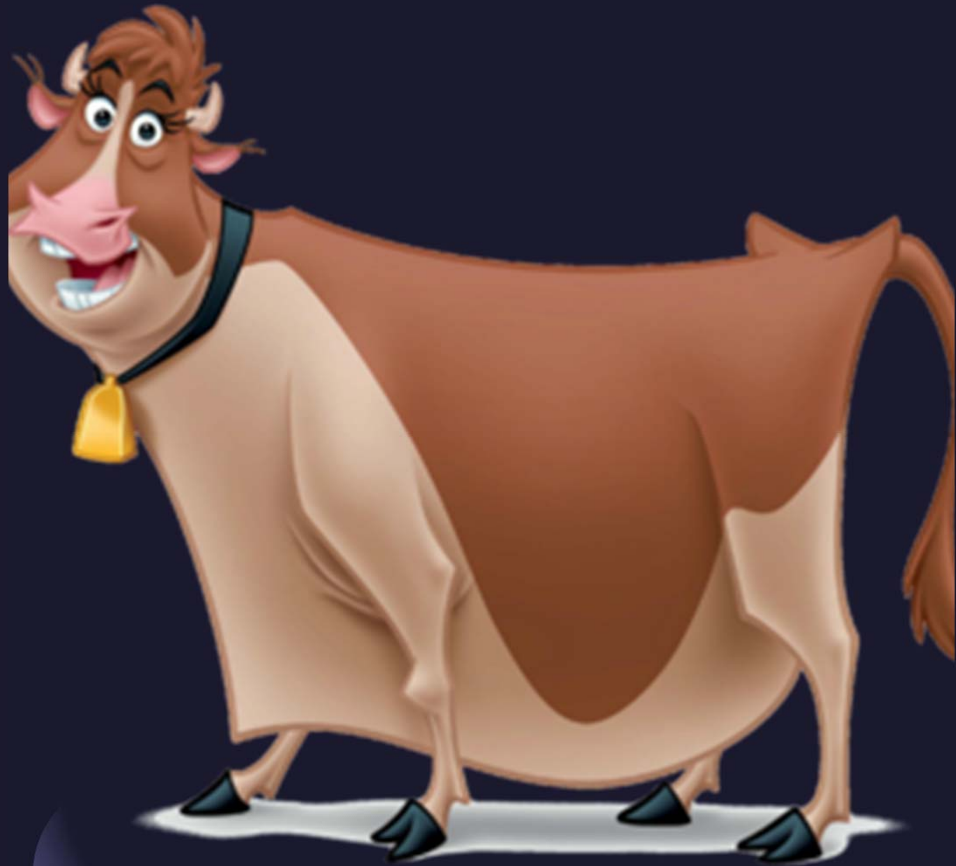
The way to get started is to quit talking and begin doing.

Walt Disney



BWYPEX ExtraMIR Hosts

Fonterra Co-Operative Group Limited	Lactanet	Livestock Improvement Corporation	TERRA Research and Teaching Centre
Hamilton, New Zealand	Montreal, Canada	Ruakura, New Zealand	Gembloux, Belgium

Timeline

TERRA Research and Teaching Centre - Hélène Soyuert

Walloon Agricultural Research Centre – Clément Grelet, Frédéric Dehareng, Octave Christophe

European Milk Recording – Julie Leblois

Lactanet – Josée Bordeleau, Débora Santschi, Mazen Bahadi

Belgium | New Zealand | Canada

Fonterra Co-Operative Group Limited – Steve Holroyd, Gavin Scott, Paul Jamieson

Milk Test New Zealand – Callie Smith

Livestock Improvement Corporation – Bevin Harris, Kathryn Sanders, Grant Anderson

Belgium

WALLOON AGRICULTURAL RESEARCH CENTRE & GEMBLOUX AGRO-BIO TECH

- The Walloon Agriculture Research Centre (CRA-W) was founded in 1872 as a Public Interest Organisation (OIP) under the regional Government of Wallonia.

- CRA-W brings together scientific research, service and support functions in support of Walloon farmers, stockbreeders, horticulturists, forestry producers and operators in the agri-food sector.10 staff and 120 scientists are employed over 3 sites in Belgium.There are 150 research projects at regional, national and European level ongoing.

- The Faculty of Gembloux Agro-Bio Tech provides assistance to the general public, professionals and companies in matters of environment, pollution and quality control.

- Prof. Hélène Soyeurt of Gembloux Agro-Bio is in the top 4 contributors in terms of publications in the domain of milk mid-infrared spectroscopy of bovine milk.

PROJECTS

- CRA-W and Gembloux Agro-Bio Tech are currently involved with research within the European Milk Recording (EMR) HappyMoo project, previously CRA-W have been integral in the RobustMilk and OptiMIR fatty acid projects.

- RobustMilk (2012) started using the fatty acid content of milk to improve the milk quality without compromising the health of the dairy cow.

- OptiMIR (2013) developed innovative ways to use MIR data to create indicators of a cows' status for a range of characteristics, such as energy balance, early mastitis diagnosis and insemination predictions.

- The HappyMoo project, run by EMR builds on the foundations of the OptiMIR and RubustMilk, bringing together previously developed fatty acid models

Belgium

EUROPEAN MILK RECORDING

- European Milk Recording (EMR) was created after the success of the OptiMIR project.
- There are 13 member organisations of EMR.
- EMR spans 7 different countries covering 5,118,654 recorded dairy cows on 70,000 farms.
- EMR offers standardization of MIR spectral data at the source, prediction services for new management indicators and decision making tools, a transnational database containing MIR spectra for dairy cows

PROJECTS

- The HappyMoo project started in 2018 as mentioned in the previous slide which aims to enable farmers and vets to evaluate the welfare of diary cows.
- HappyMoo focuses on using the fatty acid content of milk to predict lameness, mastitis, stress and negative energy balance.
- Alongside creating prediction tools for farmers and vets EMR have also developed a series of good practice guidelines to improve overall herd health and economic sustainability for the diary industry.
- Several aspects of the study are openly shared with a win-win strategy of offering calculation models in exchange for GC reference values and MIR associated spectra, making the information accessible to most interested parties.

New Zealand

FONTERRA CO-OPERATIVE GROUP LIMITED

- Fonterra was formed in 2001 after 84% of farmers involved voted to accept the merger of the New Zealand Dairy Board, New Zealand Dairy Group and Kiwi Co-Operative Dairies.
- One of the top six dairy companies in the world by turnover, the leading exporter of dairy products and responsible for more than a third of international dairy trade.
- Owned by over 11,000 NZ dairy farmers who supply Fonterra with more than 14 billion litres of milk each year.
- The Fonterra supply chain stretches out to over 140 countries.

CHALLENGES AND SOLUTIONS

- The feeding of Palm Kernal Extract (PKE) to dairy cows was introduced by NZ farmers when there was a shortage of pasture.
- PKE is very high in short and medium chain saturated fatty acids (Dias et al,. 2008)
- Feeding PKE then led to changes in milk fatty acid profile that can impact milk product characteristics. PKE will increase milk fat content when supplemented to dairy cows (Shroeder et al. 2004)
- Fonterra developed the Fat Evaluation Index (FEI) in 2018 to indicate the suitability of the milk fat composition for processing into a variety of products.
- Fonterra have been successfully using the FEI to assess and analyse milk quality for the past 5 years and have also been feeding the information back to farmers to help with feed management. High quantities of PKE in a diet can lead to milk fever when fed close to calving

New Zealand

LIVESTOCK IMPROVEMENT CORPORATION

- LIC can trace their origins back to 1909 when the first organised routine herd testing service commenced.
- LIC employ over 700 permanent staff with this number increasing to over 2,000 during peak dairy and herd testing season in Spring.
- LIC started to collect MIR spectral data from routine herd testing in 2017 with 16 milk analysis instruments (a mixture of FOSS and Bentley).
- Alongside routine milk recording, LIC also offers farmers pregnancy, Johne's, BVD, Staph Aureus and A2/A2 testing from milk samples.
- LIC test process 1 sample every 6 seconds and 12 million samples a year.
- To date LIC have collected over 15 million MIR spectra records.

CHALLENGES AND SOLUTIONS

- LIC have the potential to do more with fatty acids, but to do so, would need to validate fatty acid equations across a wide range of herds in the NZ dairy setting.
- Currently there is no incentive for investment into the fatty acid area for the NZ market as milk price is largely driven by overall milk solids.
- The ongoing work is to try and predict Johne's disease from MIR data – not fatty acids. Of course they are related, but LIC want to relate the spectra directly to the Johne's disease phenotype.
- LIC looked predicting pregnancy from spectra data, but found that due to the confounding effect between stage of lactation and pregnancy status in the NZ dairy setting were not able to get prediction accuracies that were high enough to be used as a sole indicator of pregnancy status.
- Mastitis prediction from spectral data is another potential future application which is being considered.

Canada

LACTANET

- Lactanet is a farmer-run organisation serving Canadian dairy producers from coast-to-coast.
- The Lactanet team comprises of 450 people who cover 8,000 dairy farms across Canada in 6 different time zones.
- Lactanet operate 4 milk testing laboratories who process 5.2 million samples per year.
- The focus is to not only tell farmers what the content of a milk sample is but also to help manage and feed the cows as efficiently as possible, Lactanet employ 55 nutrition and management advisors for this purpose.
- 20 innovation and development experts are employed to continually drive forwards advancements in the dairy industry in Canada.

CHALLENGES AND SOLUTIONS

- Lactanet have created a tool designed called PROFILab to help farmers optimize their milk production and quality through fatty acid analysis of their milk samples.
- PROFILab analyses the grouped fatty acids; preformed, mixed and de novo.
- Preformed fatty acids represent the fat intake and mobilization of the animal a high level can indicate excess fat in the feed ration or an important mobilisation of body reserves.
- Mixed fatty acids indicates issues with the diet or rumen function, if the levels are high farmers need to observe their cattle and ensure the cow is healthy, the ration is potentially too safe and the cows could produce more.
- De novo fatty acids are used as an indicator or rumen health , if the content of the milk is high in de novo fatty acids this is be another indication that the ration may be too safe and the cows could be producing more milk, a low level of de novo fatty acids could indicate a risk of ruminal acidosis or a lack of nutrients.

Closing Remarks

SUMMARY

- 6 different research projects from 6 different countries with varying levels of reliability in the reference data sets. Which have been used fatty acid in studies.
- 6 leading organisations visited to discover the ongoing and completed research which in most cases has evolved to combat specific localised problems.

CONCLUSIONS

- Issues still exist unifying the research and applying available models to different laboratories and different countries.
- 6 large leading organisations visited however all the research is focused on different directions within the same field.
- Each study or organization researching fatty acids seek to solve an issue that is unique to their situation or is unknown in their field

NEXT STEPS

- Whilst the same fatty acid models may not be applicable to difference organisation or country due to discrepancies between feeding regimes, milking systems and climate the reference data sets could be aligned.
- The next step for the ExtraMIR project will be to create a World Representative Spectral Database whereby different organisations or researchers will be able to apply their fatty acid models to a common data set to find out how representative their equations are on a global scale.

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&
Thank You For Listening!

Michael Whittaker

michaelwhittaker@thecis.co.uk

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