Predicting the likelihood of conception to first insemination using milk mid-infrared spectroscopy: a model for FOSS instrument

P.N. Ho, A.J. Chamberlain, M. Haile-Mariam and J.E. Pryce

DairyBio

Dairy Australia
Your Levy at Work

GARDINER FOUNDATION

AGRICULTURE VICTORIA

Why is fertility important?

- Fertility is a key driver of profit in dairy farming as it ensures appropriate culling rate, milk sales and number of replacements
- Multiple factc genetic, nutrition, mar
- Few studies can be used to make informed breeding decisions

Benefits of improved fertility

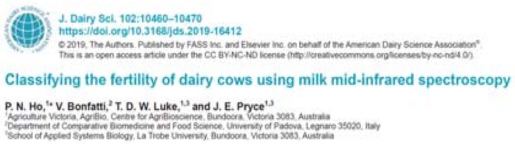
Dairy Australia
InCalf
Your Levy at Work

Improved fertility gives you flexibility to better manage your dairy farm and your herd. You can choose your calving pattern and the best time to calve. As fertility declines you lose this ability.

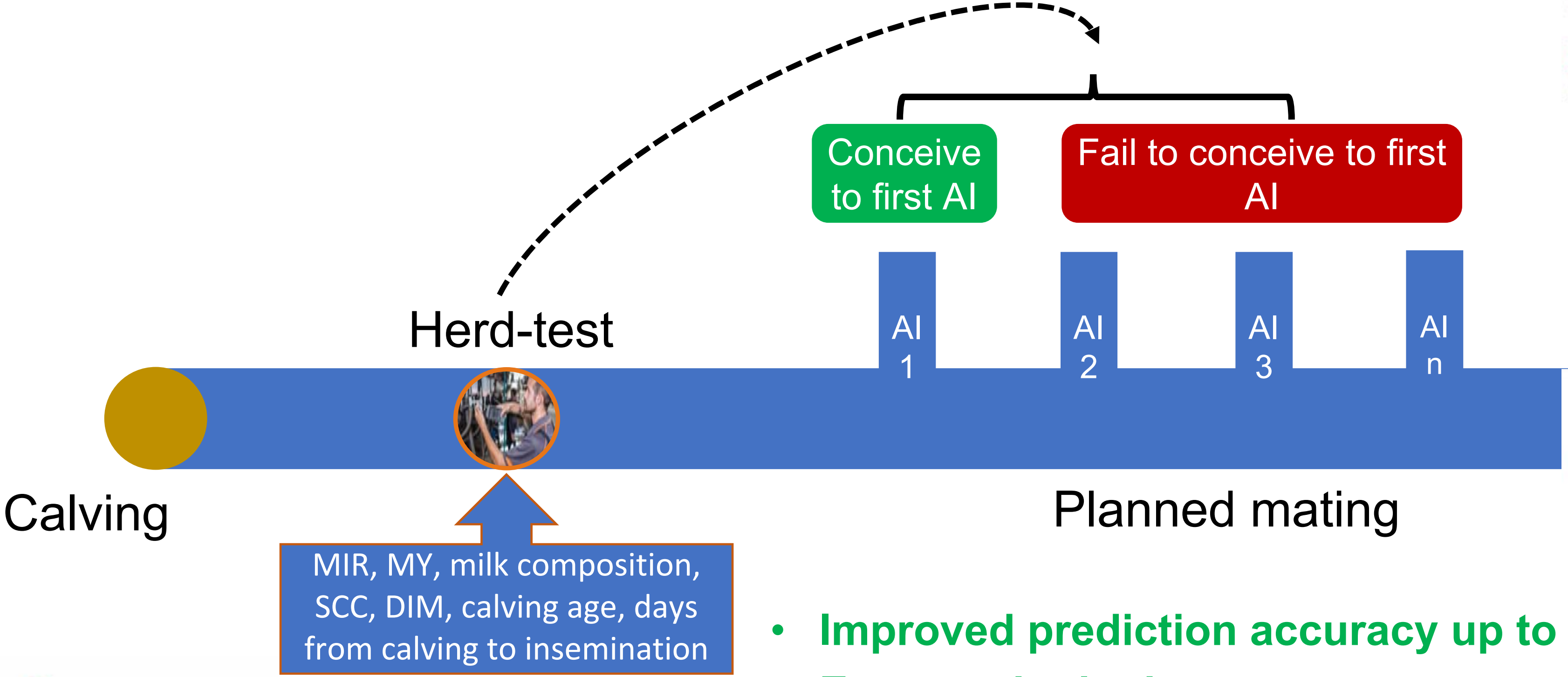
DairyBio

AGRICULTURE VICTORIA

MIR Conception: a model to predict the likelihood of conception to first insemination of dairy cows, using MIR and other on-farm data


J. Dairy Sci. 102:10460–10470
https://doi.org/10.3168/jds.2019-16412
© 2019, The Authors. Published by FASS Inc. and Elsevier Inc. on behalf of the American Dairy Science Association®.
This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Classifying the fertility of dairy cows using milk mid-infrared spectroscopy
P. N. Ho,[1*] V. Bonfatti,[2] T. D. W. Luke,[1,3] and J. E. Pryce[1,3]
[1]Agriculture Victoria, AgriBio, Centre for AgriBioscience, Bundoora, Victoria 3083, Australia
[2]Department of Comparative Biomedicine and Food Science, University of Padova, Legnaro 35020, Italy
[3]School of Applied Systems Biology, La Trobe University, Bundoora, Victoria 3083, Australia


J. Dairy Sci. 103:11535–11544
https://doi.org/10.3168/jds.2020-18589
© 2020, The Authors. Published by Elsevier Inc. and Fass Inc. on behalf of the American Dairy Science Association®.
This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).
Predicting the likelihood of conception to first insemination of dairy cows using milk mid-infrared spectroscopy
P. N. Ho[1*] and J. E. Pryce[1,2]
[1]Agriculture Victoria Research, AgriBio, Centre for AgriBioscience, Bundoora, Victoria 3083, Australia
[2]School of Applied Systems Biology, La Trobe University, Bundoora, Victoria 3083, Australia




COLLECTION | RESEARCH PAPER
ANIMAL PRODUCTION SCIENCE
Using mid-infrared spectroscopy to identify more fertile cows for insemination to sexed semen
Joanna E. Newton[A,*], Phuong N. Ho[A] and Jennie E. Pryce[A,B]

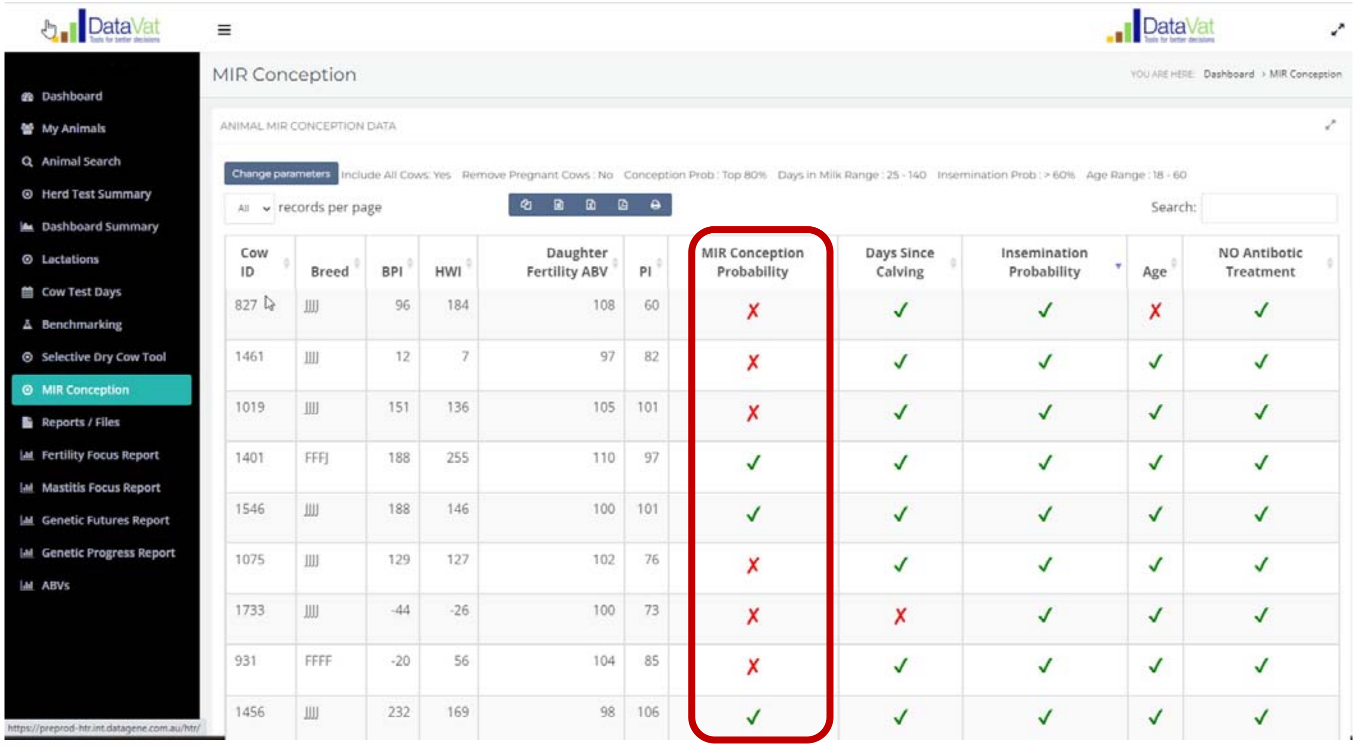

JDS Communications 2021; 2:361–365
https://doi.org/10.3168/jdsc.2021-0141
Short Communication
Genetics
Genetic parameters for mid-infrared spectroscopy–predicted fertility
I. van den Berg,[1*] P. N. Ho,[1] M. Haile-Mariam,[1] and J. E. Pryce[1,2]

- **Improved prediction accuracy up to 76%**
- **Easy to obtain data**

DairyBio

AGRICULTURE VICTORIA

Sample report of MIR Conception – Dec 2022



Cow ID	Breed	BPI	HWI	Daughter Fertility ABV	PI	MIR Conception Probability	Days Since Calving	Insemination Probability	Age	NO Antibiotic Treatment
827	JJJJ	96	184	108	60	✗	✓	✓	✗	✓
1461	JJJJ	12	7	97	82	✗	✓	✓	✓	✓
1019	JJJJ	151	136	105	101	✗	✓	✓	✓	✓
1401	FFFJ	188	255	110	97	✓	✓	✓	✓	✓
1546	JJJJ	188	146	100	101	✓	✓	✓	✓	✓
1075	JJJJ	129	127	102	76	✗	✓	✓	✓	✓
1733	JJJJ	-44	-26	100	73	✗	✗	✓	✓	✓
931	FFFF	-20	56	104	85	✗	✓	✓	✓	✓
1456	JJJJ	232	169	98	106	✓	✓	✓	✓	✓

DairyBio

AGRICULTURE VICTORIA

OFFICIAL

Objectives

- Evaluate the performance of the current Bentley model on FOSS instrument data
- Develop and validate a new model for FOSS instrument

Animal data

- 9,120 insemination and calving records of 3,518 cows from 31 commercial dairy herds collected in 2021 and 2022 (conception to first service ~ 0.41)
- Days in milk, days from calving to first insemination, calving age, percents of fat, protein and lactose, SCC, herd-test milk yield and MIR spectra
  - Remove noisy and non-informative areas
  - Remove outliers
  - Apply first derivative

DairyBio

AGRICULTURE VICTORIA

Model concept: Extreme data approach

J. Dairy Sci. 97:731–742
http://dx.doi.org/10.3168/jds.2013-6693

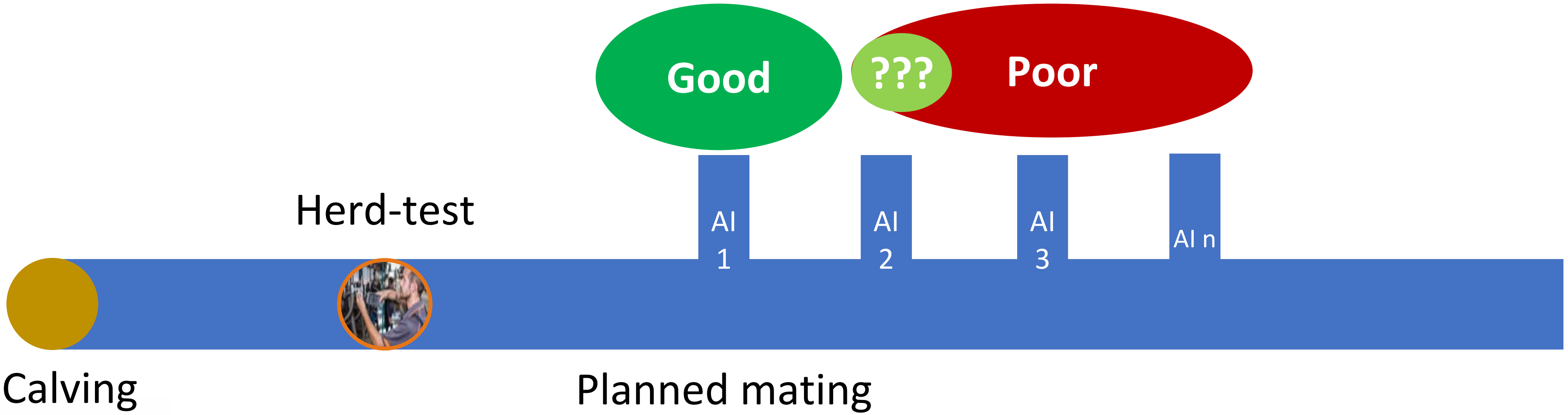
Prediction of insemination outcomes in Holstein dairy cattle using alternative machine learning algorithms

Saleh Shahinfar,*[1] David Page,† Jerry Guenther,* Victor Cabrera,* Paul Fricke,* and Kent Weigel*
*Department of Dairy Science, and
†Department of Biostatistics and Medical Informatics and Department of Computer Science, University of Wisconsin, Madison 53706

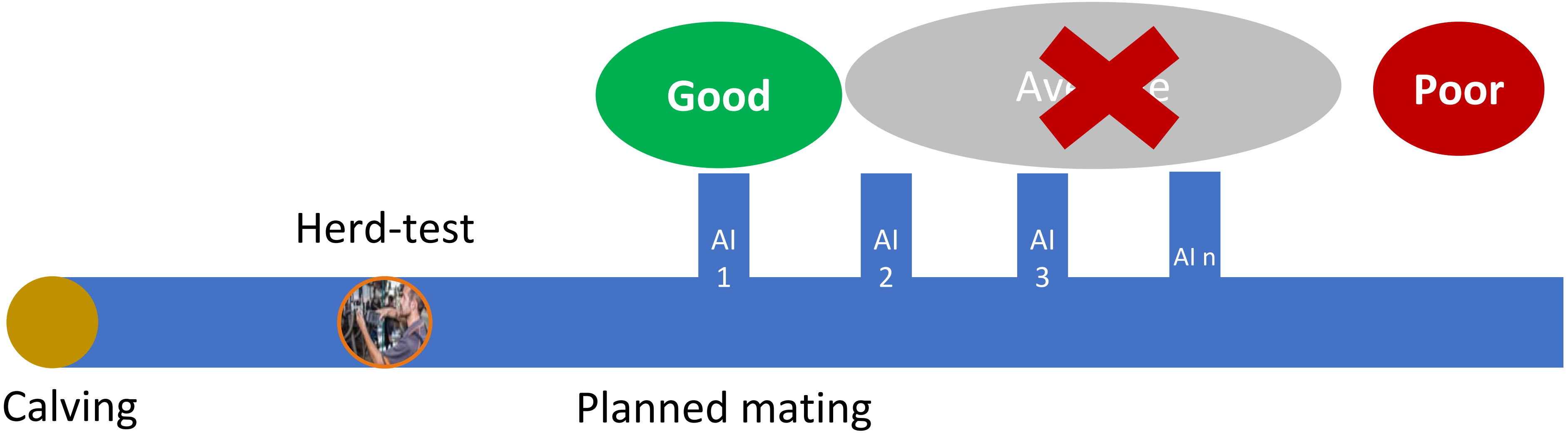
J. Dairy Sci. 98:5262–5273
http://dx.doi.org/10.3168/jds.2014-8984

Machine learning algorithms for the prediction of conception success to a given insemination in lactating dairy cows

K. Hempstalk,*[1] S. McParland,† and D. P. Berry†
*Livestock Improvement Corporation, Private Bag 3016, Hamilton 3240, New Zealand
†Animal and Grassland Research and Innovation Center, Teagasc, Moorepark, Fermoy, Co. Cork, Ireland



Model concept: Extreme data approach

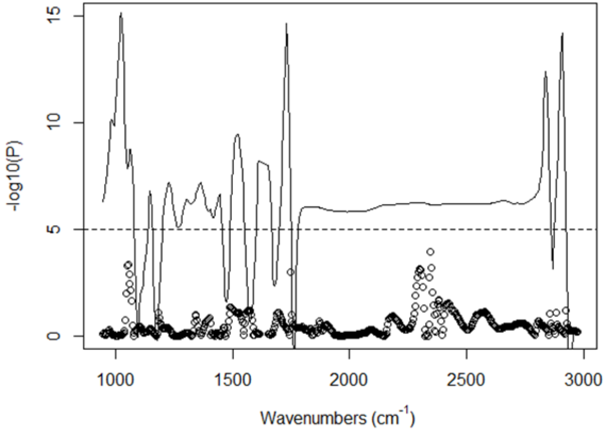


Good and poor cows might have significantly different metabolic conditions, and consequently likelihood to conceive, while the metabolic conditions of average cows could be similar to that of good and poor cows

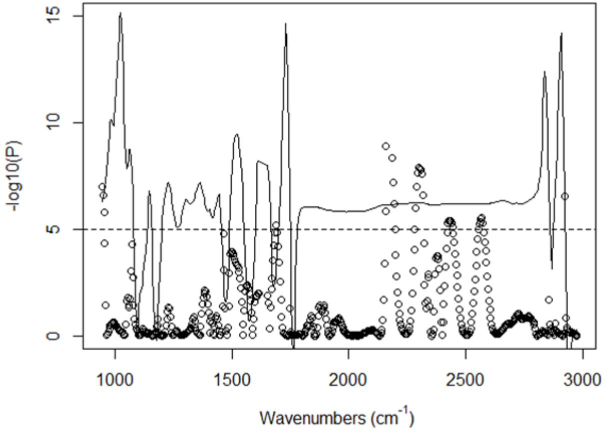
DairyBio

AGRICULTURE VICTORIA

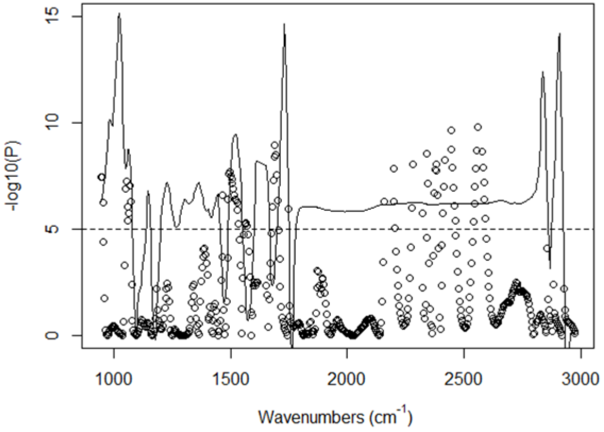
Comparisons of MIR spectra between 3 groups of cow



Good vs. Average



Poor vs. Average



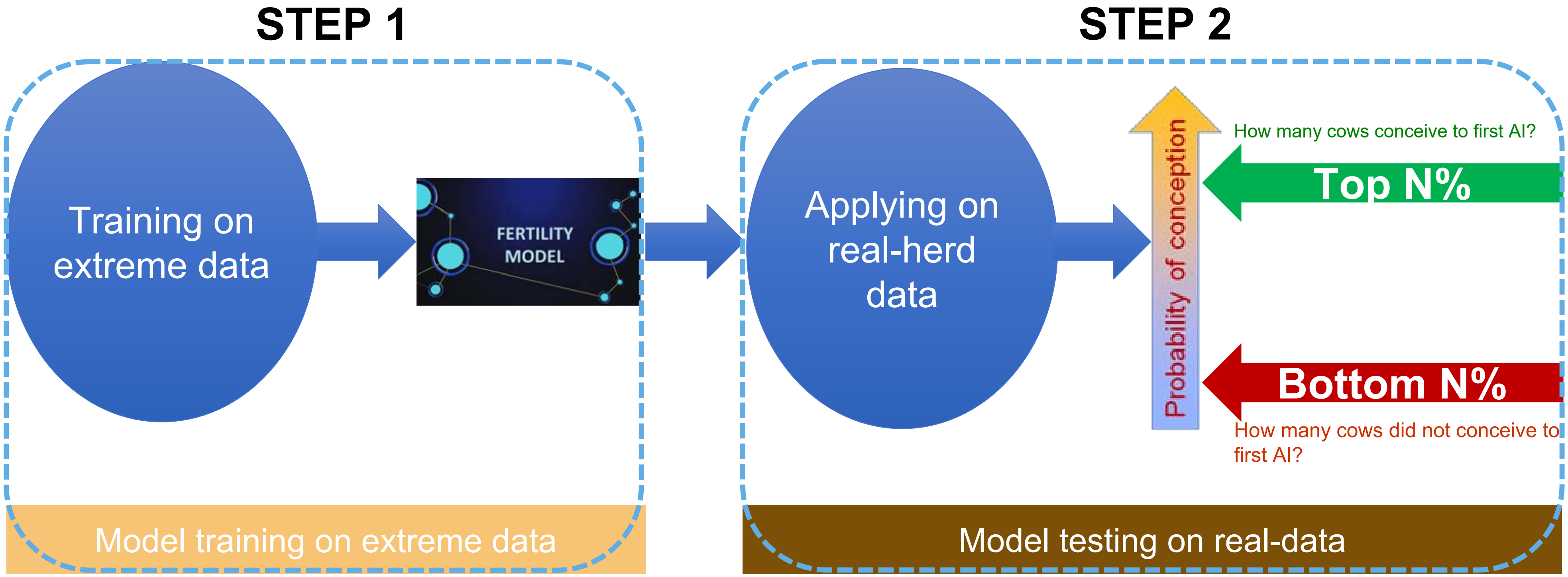
Good vs. Poor

J. Dairy Sci. 103:11535–11544
https://doi.org/10.3168/jds.2020-18589

Predicting the likelihood of conception to first insemination of dairy cows using milk mid-infrared spectroscopy

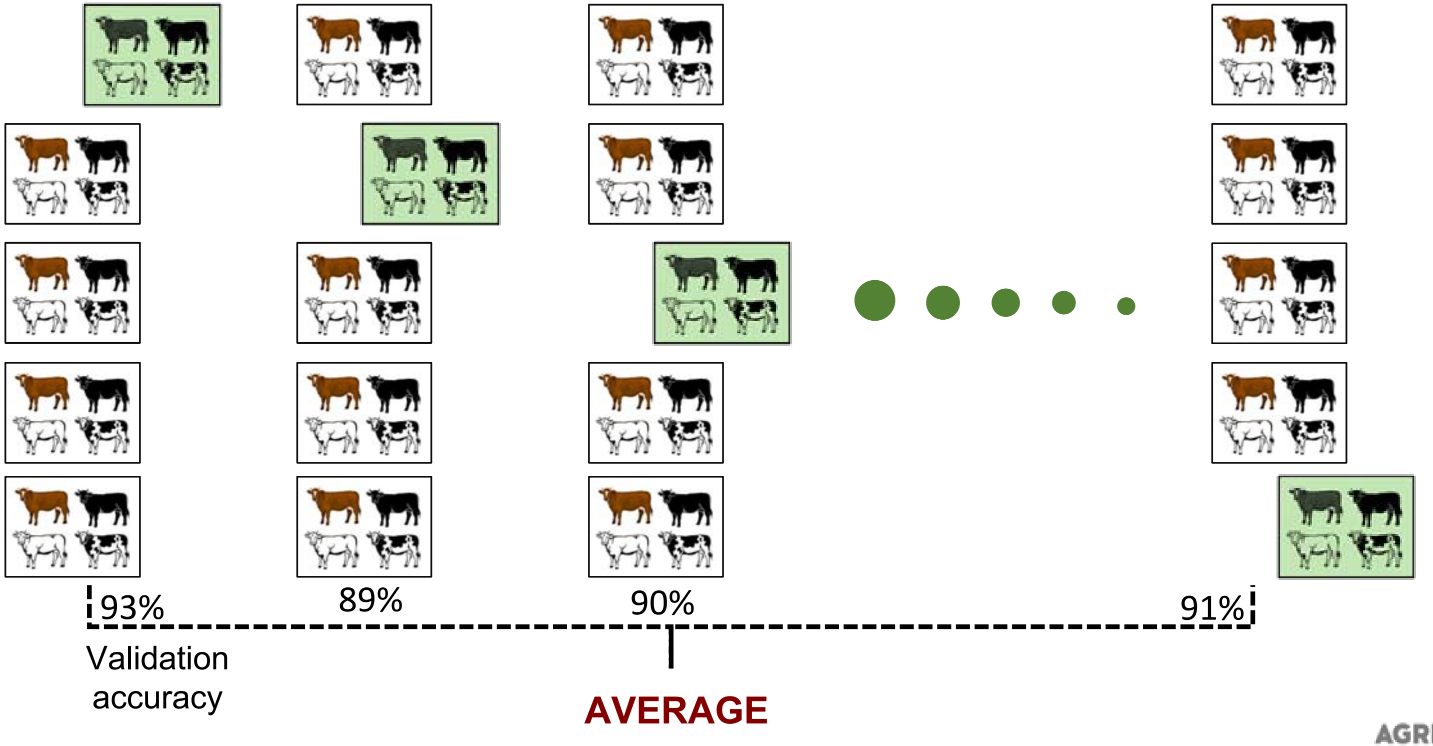
P. N. Ho[1]* and J. E. Pryce[1,2]
[1]Agriculture Victoria Research, AgriBio, Centre for AgriBioscience, Bundoora, Victoria 3083, Australia
[2]School of Applied Systems Biology, La Trobe University, Bundoora, Victoria 3083, Australia

Model framework



Evaluation of model performance

external herd by herd validation



Bentley model to predict fertility using FOSS data

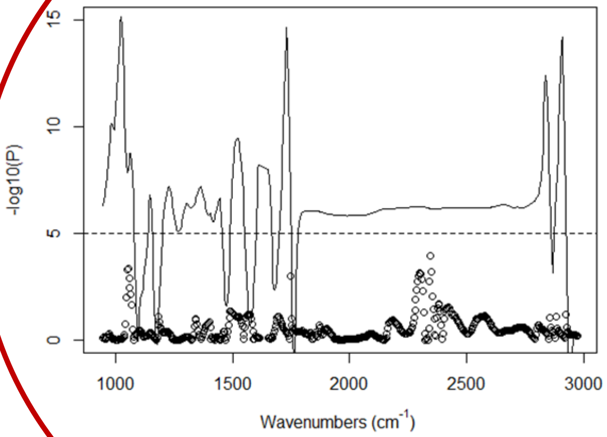
Proportions	Cows with good likelihood of conception at first insemination	Cows with good likelihood of conception at second insemination	Cows with poor likelihood of conception at first insemination
5	0.31 ± 0.34	0.39 ± 0.36	0.59 ± 0.29
10	0.31 ± 0.32	0.40 ± 0.35	0.58 ± 0.26
15	0.32 ± 0.32	0.41 ± 0.35	0.56 ± 0.24
20	0.32 ± 0.32	0.41 ± 0.35	0.55 ± 0.24
25	0.32 ± 0.32	0.41 ± 0.35	0.54 ± 0.24
30	0.32 ± 0.32	0.41 ± 0.35	0.54 ± 0.23

- Bentley model could not be applied directly to FOSS data

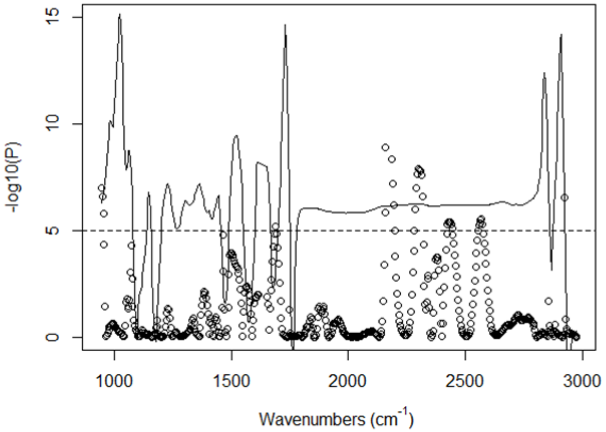
New FOSS model

Proportions	Cows with good likelihood of conception at first insemination	Cows with good likelihood of conception at second insemination	Cows with poor likelihood of conception at first insemination
5	0.54 ± 0.25	0.72 ± 0.21	0.81 ± 0.27
10	0.52 ± 0.20	0.69 ± 0.18	0.77 ± 0.26
15	0.49 ± 0.21	0.68 ± 0.16	0.76 ± 0.23
20	0.49 ± 0.20	0.67 ± 0.17	0.76 ± 0.20
25	0.48 ± 0.19	0.66 ± 0.16	0.76 ± 0.22
30	0.49 ± 0.13	0.66 ± 0.14	0.75 ± 0.23

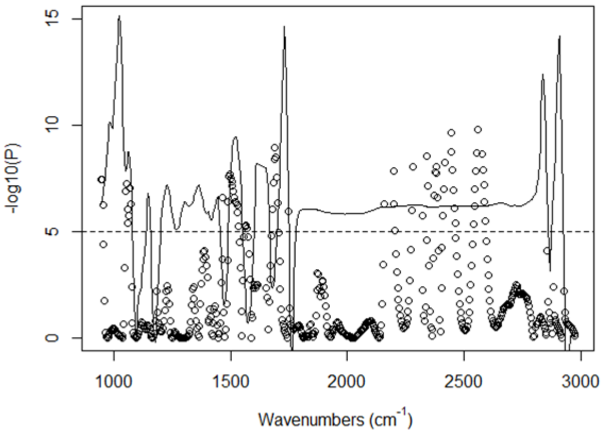
Comparisons of MIR spectra between 3 groups of cow



Good vs. Average



Poor vs. Average



Good vs. Poor

DairyBio

AGRICULTURE VICTORIA

OFFICIAL

New FOSS model

Proportions	Cows with good likelihood of conception at first insemination	Cows with good likelihood of conception at second insemination	Cows with poor likelihood of conception at first insemination
5	0.54 ± 0.25	0.72 ± 0.21	0.81 ± 0.27
10	0.52 ± 0.20	0.69 ± 0.18	0.77 ± 0.26
15	0.49 ± 0.21	0.68 ± 0.16	0.76 ± 0.23
20	0.49 ± 0.20	0.67 ± 0.17	0.76 ± 0.20
25	0.48 ± 0.19	0.66 ± 0.16	0.76 ± 0.22
30	0.49 ± 0.13	0.66 ± 0.14	0.75 ± 0.23

- Prediction accuracy was good and comparable to the Bentley model

DairyBio

AGRICULTURE VICTORIA

New FOSS model

Proportions	Cows with good likelihood of conception at first insemination	Cows with good likelihood of conception at second insemination	Cows with poor likelihood of conception at first insemination
5	0.54 ± 0.25	0.72 ± 0.21	0.81 ± 0.27
10	0.52 ± 0.20	0.69 ± 0.18	0.77 ± 0.26
15	0.49 ± 0.21	0.68 ± 0.16	0.76 ± 0.23
20	0.49 ± 0.20	0.67 ± 0.17	0.76 ± 0.20
25	0.48 ± 0.19	0.66 ± 0.16	0.76 ± 0.22
30	0.49 ± 0.13	0.66 ± 0.14	0.75 ± 0.23

- More data is needed to improve the robustness of the FOSS model

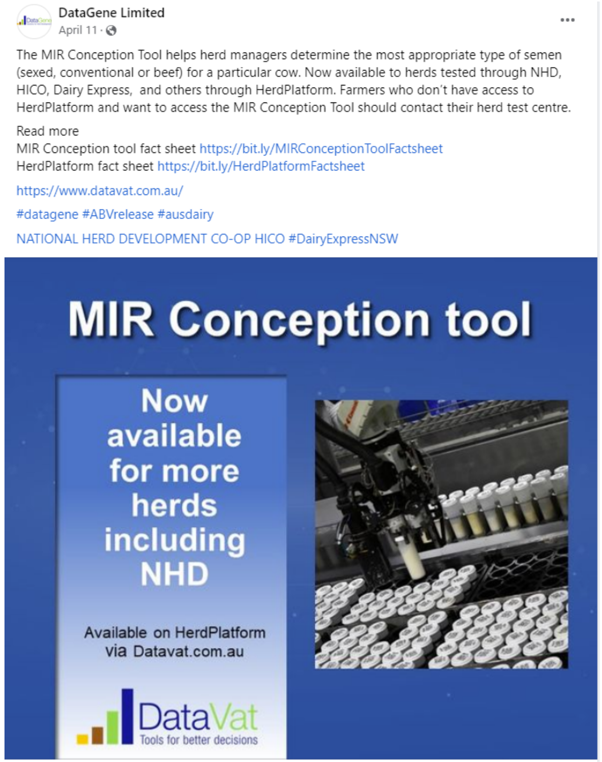
Genomic and phenotypic differences between high and low fertility cows compared to herd average

	Top 10%	Herd average	Bottom 10%
BPI	157 ± 100	152 ± 66	136 ± 69
HWI	161 ± 99	154 ± 64	133 ± 55
ABV_{milk}	58.2 ± 161	73.1 ± 64	74 ± 242
ABV_{fat}	11.1 ± 12.1	12.1 ± 7.5	12.3 ± 9.3
$ABV_{protein}$	7.2 ± 5.6	7.2 ± 5.1	6.9 ± 7.3
ABV_{scc}	129.8 ± 19.4	126.7 ± 12.1	122.2 ± 10.1
$ABV_{daughter\ fertility}$	104.1 ± 3.3	103.6 ± 2.5	102.8 ± 2.5
MY305	6,548 ± 1,270	6,880 ± 1,355	7,107 ± 1,427
Fat percent	3.95 ± 0.51	4.00 ± 0.43	4.05 ± 0.53
Protein percent	3.27 ± 0.28	3.22 ± 0.26	3.20 ± 0.36
MY24	24.0 ± 4.2[a]	27.2 ± 4.5[b]	27.5 ± 6.1[b]
DIM	47.2 ± 26.6[a]	55.6 ± 21.6[b]	66.7 ± 28.4[b]
SCC	63.7 ± 49.3[a]	164.5 ± 103.3[b]	676.4 ± 716.5[c]
Calving age	32.3 ± 8.9[a]	49.9 ± 10.1[b]	77.1 ± 20.3[c]
Calving to first AI	95.5 ± 22.8[a]	108.9 ± 29.3[ab]	124.7 ± 39.5[b]
Conception to first AI	0.47 ± 0.19[a]	0.40 ± 0.16[a]	0.23 ± 0.22[b]

DairyBio

AGRICULTURE VICTORIA

MIR Conception for FOSS instruments


DataGene Limited
April 11 ·

The MIR Conception Tool helps herd managers determine the most appropriate type of semen (sexed, conventional or beef) for a particular cow. Now available to herds tested through NHD, HICO, Dairy Express, and others through HerdPlatform. Farmers who don't have access to HerdPlatform and want to access the MIR Conception Tool should contact their herd test centre.

Read more
MIR Conception tool fact sheet https://bit.ly/MIRConceptionToolFactsheet
HerdPlatform fact sheet https://bit.ly/HerdPlatformFactsheet

https://www.datavat.com.au/

#datagene #ABVrelease #ausdairy

NATIONAL HERD DEVELOPMENT CO-OP HICO #DairyExpressNSW

- **Next round of model update: expected early 2025**

DairyBio

AGRICULTURE VICTORIA

Conclusions

- Bentley model did not work on FOSS instrument data
- FOSS model trained using "*extreme data*" approach produced good prediction accuracy and were comparable to that of Bentley model
- More data is required to improve the robustness of the model

Acknowledgements

DairyBio

Dairy Australia

GARDINER FOUNDATION

VICTORIA State Government

DataGene Solutions for Herd Development

DairyBio

AGRICULTURE VICTORIA

ARC Training Centre in Predictive Breeding for Agricultural Futures

- The world's first centre dedicated to ***training the next generation of plant and animal breeders*** is being established at The University of Queensland

- The Centre consists of seven University Nodes and over 30 industry and government partners

- 38 PhD studentships and postdoctoral positions are available within the Centre and projects focus on ***21 agriculturally important species/commodities***

- Projects include a ***placement with our leading industry partners***, access to ***short courses***, and an opportunity to learn and apply ***cutting-edge technologies*** to help solve real world problems

- ***Recruitment*** will commence shortly – email predictivebreeding@uq.edu.au to be part of this exciting new Centre!