Breeding for lower CH_4 emissions of dairy cows in the Netherlands

23-05-2024, **A.E. van Breukelen**, M.N. Aldridge, Y. de Haas, C. Schrooten, J.M.L. Heck, M.H.P.W. Visker, R.F. Veerkamp

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anouk.vanbreukelen@wur.nl

Climate smart cattle breeding

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Methods of measuring methane

Sniffer

GreenFeed

(C-lock Inc. Rapid City, SD, US)

Research objectives

- Estimate genetic parameters for CH_4 (e.g. heritability, repeatability)
- Investigate different recording schemes
- Estimate phenotypic and genetic correlations with cows measured with sniffers and GreenFeed
- Estimate genetic correlations with other breeding goal traits

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Phenotypes up to November 2023

	N farms	N cows	N records
Weekly mean CH_4	72	7,139	74,569

- Uni- and bivariate repeatability animal models in ASReml 4.2

Fixed effects:
•Herd x Year x Week
•Breed fraction x Breed
•Days in milk
•Parity

Random effects:
•Additive genetic
•Parity x permanent environment
•Residual

Results

- Heritability of weekly mean CH_4 concentrations 0.17 ± 0.04, and repeatability 0.56 ± 0.03
    - Genetic correlation sniffer and GreenFeed: 0.76 ± 0.15

- To reach a 50% reliability, twelve daughters per sire would have to be recorded with each five weeks of recording

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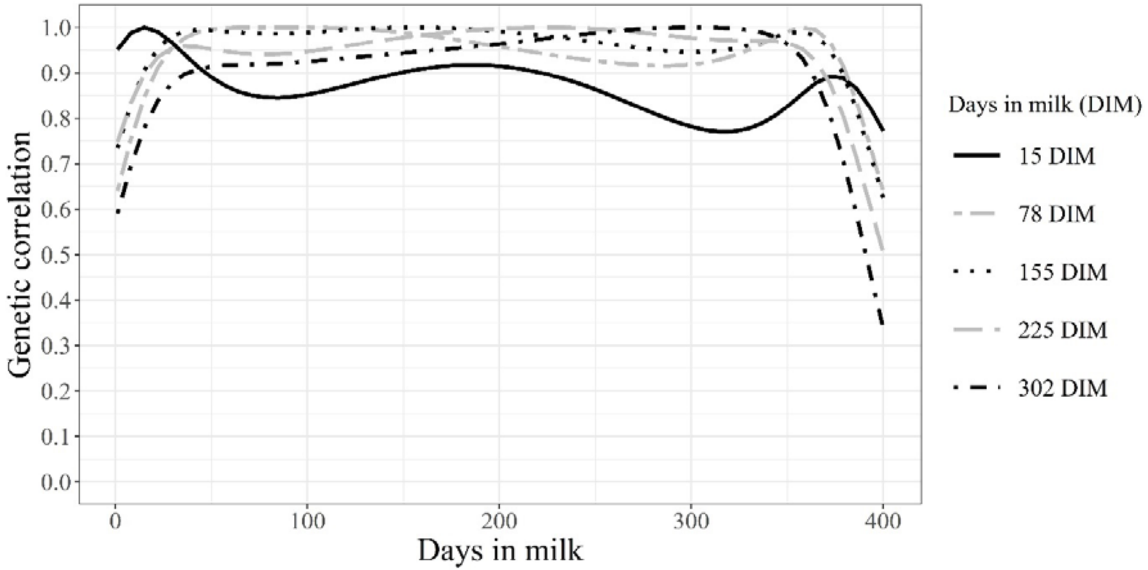
Results

- Heritability highest mid lactation, on average 0.17 ± 0.04
- High genetic correlations between lactation stages



Results

- For short recording periods, it is preferred to record cows during mid lactation as this would yield the highest reliabilities
- Reliability may be overestimated by fixed repeatability models when cows would be recorded only in early lactation, but additional analyses required

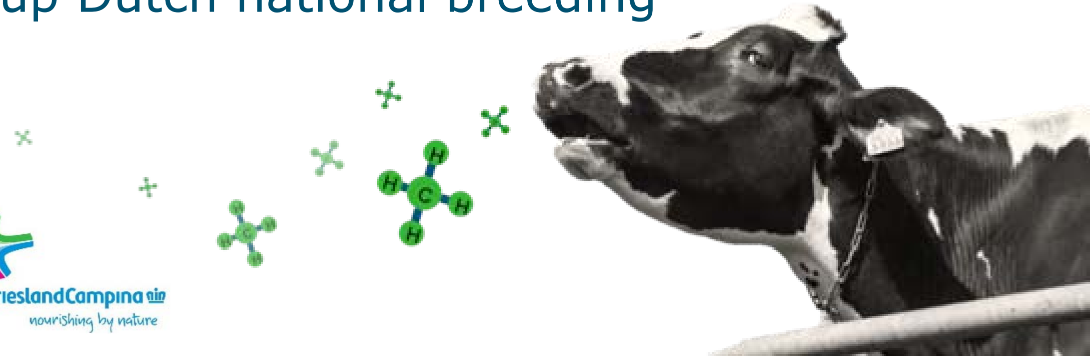
Results

	CH_4c	DMI	MY	PY	FY	P%	F%	BW
CH_4c		0.02 ± 0.03	0.05 ± 0.10	0.02 ± 0.10	0.06 ± 0.10	-0.25 ± 0.09	-0.04 ± 0.09	0.03 ± 0.04
DMI	0.06 ± 0.10		0.50 ± 0.01	0.54 ± 0.01	0.43 ± 0.01	0.06 ± 0.01	-0.16 ± 0.01	0.21 ± 0.02
MY	-0.04 ± 0.08	0.62 ± 0.03		0.92 ± <0.01	0.75 ± <0.01	-0.30 ± 0.01	-0.49 ± 0.01	0.10 ± 0.02
PY	<0.01 ± 0.08	0.66 ± 0.03	0.93 ± <0.01		0.80 ± <0.01	0.08 ± 0.01	-0.30 ± 0.01	0.17 ± 0.02
FY	0.12 ± 0.08	0.62 ± 0.03	0.73 ± 0.02	0.81 ± 0.01		0.04 ± 0.01	0.18 ± 0.01	0.16 ± 0.01
P%	0.10 ± 0.09	0.11 ± 0.05	-0.40 ± 0.03	-0.02 ± 0.03	0.06 ± 0.04		0.54 ± 0.01	0.14 ± 0.01
F%	0.21 ± 0.08	-0.19 ± 0.04	-0.63 ± 0.02	-0.42 ± 0.03	0.08 ± 0.03	0.65 ± 0.02		0.03 ± 0.02
BW	-0.04 ± 0.10	0.25 ± 0.02	0.15 ± 0.04	0.21 ± 0.04	0.19 ± 0.05	0.16 ± 0.04	-0.06 ± 0.04	

Genetic correlations below diagonal, and phenotypic correlations above diagonal

Take home messages

- Sniffers provide a cost-effective method of measuring gas concentrations
- The genetic correlation of 0.76 suggests that selection for lower CH_4 concentrations results in lower CH_4 production
- CH_4 concentrations measured with sniffers have weak correlations with milk production traits, DMI, and BW
- The results are used to set up Dutch national breeding value estimations for CH_4



anouk.vanbreukelen@wur.nl

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Material and methods, analyses sniffer and GF

Number of	GF	Sniffer	Both total	Both recording overlaps
Farms	16	15	6	4
Cows	822	1,800	184	75
Daily records	24,284	170,826		1,786
Weekly records	4,358	30,982		334

Trait[1]	Parity	N cows	N records	Unit	Mean	SD	Min	Max	CV (%)
CH_4c	1	2,084	17,936		515	259	12	2,369	50
	2	1,843	15,265	ppm	557	282	7	2,095	51
	3+	3,743	38,364		592	305	5	2,087	51
CO_2c	1	385	2,369		4,168	1,685	7	9,483	40
	2	390	2,090	ppm	4,324	1,711	13	9,511	40
	3+	758	5,389		4,315	1,730	6	9,837	40
DMI	1	4,998	87,306		19.7	3.6	8	51	18
	2	3,500	54,660	kg/d	22.1	4.2	8	53	19
	3+	2,943	64,525		22.5	4.5	8	50	20
MY	1	8,891	179,469		27.4	7.1	1.0	59.1	26
	2	7,553	139,875	kg/d	31.6	9.6	1.0	59.4	31
	3+	5,776	213,539		32.1	10.3	0.9	59.4	32
ECM	1	8,889	139,295		27.5	6.0	3.1	56.4	22
	2	7,529	112,539	kg/d	32.4	8.6	3.8	60.3	27
	3+	5,760	186,581		33.6	9.5	3.2	59.3	28
PY	1	8,889	139,317		0.9	0.2	0.2	1.9	24
	2	7,539	112,996	kg/d	1.09	0.3	0.2	1.9	27
	3+	5,772	188,235		1.11	0.3	0.2	1.9	28
FY	1	8,889	139,328		1.13	0.3	0.1	2.5	22
	2	7,538	112,990	kg/d	1.34	0.4	0.1	2.5	27
	3+	5,767	187,445		1.40	0.4	0.1	2.5	29
P%	1	8,889	139,314		3.56	0.4	1.3	18.7	11
	2	7,539	112,850	%	3.61	0.4	0.4	12.4	12
	3+	5,768	187,801		3.55	0.4	1.0	14.6	12
F%	1	8,889	139,326		4.39	0.8	1.3	22.5	17
	2	7,536	112,778	%	4.47	0.8	0.6	14.5	17
	3+	5,763	186,934		4.50	0.7	0.5	18.6	17
BW	1	5,919	119,523		600	72	306	988	12
	2	4,532	91,817	kg	667	75	301	995	11
	3+	4,194	164,715		713	71	310	1,000	10

	CH_4c	CO_2c	DMI	MY	ECM	PY	FY	P%	F%	BW
CH_4c		0.84 ± 0.01	0.02 ± 0.03	0.05 ± 0.10	0.05 ± 0.10	0.02 ± 0.10	0.06 ± 0.10	-0.25 ± 0.09	-0.04 ± 0.09	0.03 ± 0.04
CO_2c	0.81 ± 0.10		0.05 ± 0.06	0.04 ± 0.17	0.01 ± 0.17	<0.01 ± 0.17	0.01 ± 0.17	-0.20 ± 0.22	-0.04 ± 0.17	-0.09 ± 0.08
DMI	0.06 ± 0.10	0.19 ± 0.23		0.50 ± 0.01	0.52 ± 0.01	0.54 ± 0.01	0.43 ± 0.01	0.06 ± 0.01	-0.16 ± 0.01	0.21 ± 0.02
MY	-0.04 ± 0.08	0.04 ± 0.16	0.62 ± 0.03		0.91 ± <0.01	0.92 ± <0.01	0.75 ± <0.01	-0.30 ± 0.01	-0.49 ± 0.01	0.10 ± 0.02
ECM	0.04 ± 0.08	0.07 ± 0.16	0.66 ± 0.03	0.92 ± 0.01		0.94 ± <0.01	0.94 ± <0.01	-0.04 ± 0.01	-0.12 ± 0.01	0.16 ± 0.02
PY	<0.01 ± 0.08	0.02 ± 0.16	0.66 ± 0.03	0.93 ± <0.01	0.96 ± <0.01		0.80 ± <0.01	0.08 ± 0.01	-0.30 ± 0.01	0.17 ± 0.02
FY	0.12 ± 0.08	0.13 ± 0.16	0.62 ± 0.03	0.73 ± 0.02	0.93 ± <0.01	0.81 ± 0.01		0.04 ± 0.01	0.18 ± 0.01	0.16 ± 0.01
P%	0.10 ± 0.09	-0.14 ± 0.23	0.11 ± 0.05	-0.40 ± 0.03	-0.10 ± 0.03	-0.02 ± 0.03	0.06 ± 0.04		0.54 ± 0.01	0.14 ± 0.01
F%	0.21 ± 0.08	0.23 ± 0.25	-0.19 ± 0.04	-0.63 ± 0.02	-0.28 ± 0.03	-0.42 ± 0.03	0.08 ± 0.03	0.65 ± 0.02		0.03 ± 0.02
BW	-0.04 ± 0.10	-0.04 ± 0.26	0.25 ± 0.02	0.15 ± 0.04	0.19 ± 0.04	0.21 ± 0.04	0.19 ± 0.05	0.16 ± 0.04	-0.06 ± 0.04	