

Repeatability and heritability of dairy cow methane concentration using sniffer sensors

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Sniffers

- ❑ 50 sniffer methane sensors (one per feed bin) in the herringbone system at Ellinbank SmatFarm.
- ❑ 25 bins per side; bins raised together, ensuring a clean entry/exit pattern.
- ❑ Arcoflex International Pty Ltd based in Melbourne
- ❑ The heated electrode sensors continuously records methane in ppm (100–5000 ppm).



Extracting data from Arcoflex data exporter

The time interval is extracted every 10 sec

Select the desired date and time to export the data

Select the bays to extract CH4. Bays 1-25 correspond to the left-gate and bays 26 to 50 correspond to the right-gate.

Arcoflex Data Exporter V1.6.9.0

Reports

Logged in User: Fazel Almasi

Customer: Agriculture Victoria

Device: Dairy Ellinbank (172 Sensors)

Device ID: 521

Site Address: 1301 Hazeldean Rd Ellinbank Victoria 3821

Export Parameters

Sampling Frequency: ☐ 1 hours ☐ 10 mins ☒ 10 secs

From Date: 16/08/2024 00:00

To Date: 16/08/2024 09:43

Export Template Name: Trial H + MP

Save/Update Delete

Sensors:

Sort: ☒ Alphabetic ☐ Tag

Selected	Value Type	Name	Description	Tag	ID	Measurement
☐	Most Recent	24V Supply	24V DDC Converter	DI12	15841	24V OK/No Supply
☐	Most Recent	Ambient Humidity	Outside air humidity	AI64	15383	%
☐	Most Recent	Ambient Temperature	Outside air temperature	AI63	15382	°C
☒	Most Recent	CH4 Bay 01	Methane Sensor on Bay 1	IO001	15427	ppm
☒	Most Recent	CH4 Bay 02	Methane Sensor on Bay 02	IO002	15428	ppm
☒	Most Recent	CH4 Bay 03	Methane Sensor on Bay 03	IO003	15429	ppm
☒	Most Recent	CH4 Bay 04	Methane Sensor on Bay 04	IO004	15430	ppm
☒	Most Recent	CH4 Bay 05	Methane Sensor on 05	IO005	15435	ppm
☐	Most Recent	CH4 Bay 06	Methane Sensor on 06	IO006	15436	ppm
☐	Most Recent	CH4 Bay 07	Methane Sensor on 07	IO007	15437	ppm
☐	Most Recent	CH4 Bay 08	Methane Sensor on 08	IO008	15438	ppm
☐	Most Recent	CH4 Bay 09	Methane Sensor on 09	IO009	15443	ppm
☐	Most Recent	CH4 Bay 10	Methane Sensor on 10	IO010	15444	ppm
☐	Most Recent	CH4 Bay 11	Methane Sensor on 11	IO011	15445	ppm
☐	Most Recent	CH4 Bay 12	Methane Sensor on 12	IO012	15446	ppm
☐	Most Recent	CH4 Bay 13	Methane Sensor on Bay 13	IO013	15431	ppm
☐	Most Recent	CH4 Bay 14	Methane Sensor on 14	IO014	15432	ppm
☐	Most Recent	CH4 Bay 15	Methane Sensor on 15	IO015	15433	ppm
☐	Most Recent	CH4 Bay 16	Methane Sensor on 16	IO016	15434	ppm
☐	Most Recent	CH4 Bay 17	Methane Sensor on 17	IO017	15439	ppm
☐	Most Recent	CH4 Bay 18	Methane Sensor on 18	IO018	15441	ppm
☐	Most Recent	CH4 Bay 19	Methane Sensor on 19	IO019	15440	ppm
☐	Most Recent	CH4 Bay 20	Methane Sensor on 20	IO020	15442	ppm
☐	Most Recent	CH4 Bay 21	Methane Sensor on 21	IO021	15753	ppm
☐	Most Recent	CH4 Bay 22	Methane Sensor on 22	IO022	15754	ppm

Select All Unselect All View Data Export Data Close

Matching methane data to milking data

- ❑ Exported methane data do not have animal ID.
- ❑ The data match based on the order animals enter to the bay.

Official Reg. No. (ORN)	Animal Number	Group Number	Yield Today Session 1	Yield Today Session 2	Total Yield Today	MP	Number Session 1 Today	PC Number Session 2 Today	Milk Time Today For Session 1	Milk Time Today For Session 2
221035405	7652	11	12.22	5.94	18.16		1	1	6:33 AM	3:10 PM
221035445	7692	11	10.01	5.31	15.32		1		6:50 AM	3:32 PM
221035415	7662	11	7.91	4.50	12.41		1	2	7:07 AM	3:09 PM
221035475	7723	11	7.37	3.33	10.70		1		7:21 AM	3:33 PM
221035437	7684	11	12.23	9.07	21.30		1		7:35 AM	3:33 PM
221035421	7668	11	8.69	4.01	12.70		1		7:52 AM	3:41 PM
217025298	7084	14	7.48	3.45	10.93		1	1	8:07 AM	3:51 PM
221035429	7676	11	8.43	3.86	12.29		1	2	8:17 AM	3:20 PM
221035480	7728	11	11.79	4.04	15.83		1	2	8:29 AM	4:09 PM

Methane records
in ppm per bay

Time	CH4 Bay 01 (15427)	CH4 Bay 02 (15428)	CH4 Bay 03 (15429)	CH4 Bay 04 (15430)	CH4 Bay 05 (15435)	CH4 Bay 06 (15436)	Left Gate (15385)
1/08/2024 6:52	569	944	795	792	476	514	1
1/08/2024 6:52	0	819	749	1606	339	481	1
1/08/2024 6:52	445	0	521	993	286	603	1
1/08/2024 6:53	306	0	849	823	200	851	1
1/08/2024 6:53	0	0	0	716	0	772	1
1/08/2024 6:53	492	772	550	450	2086	653	1
1/08/2024 6:53	354	730	428	372	0	0	1
1/08/2024 6:53	224	579	350	671	1650	368	1
1/08/2024 6:53	184	497	288	1119	603	306	1
1/08/2024 6:54	159	445	205	1281	372	775	1
1/08/2024 6:54	0	737	0	1036	0	1039	0
1/08/2024 6:54	129	510	235	515	296	945	0
1/08/2024 6:54	0	349	0	304	228	480	0
1/08/2024 6:54	0	279	0	274	189	277	0
1/08/2024 6:54	0	235	186	222	0	213	0
1/08/2024 6:55	0	0	0	0	141	179	1
1/08/2024 6:55	0	0	0	0	0	0	1
1/08/2024 6:55	0	0	159	187	0	143	1
1/08/2024 6:55	0	0	0	0	115	0	1
1/08/2024 6:55	0	0	0	0	0	0	1
1/08/2024 6:55	0	0	0	0	0	0	1
1/08/2024 6:56	194	0	0	0	151	0	1
1/08/2024 6:56	0	279	0	0	0	0	1
1/08/2024 6:56	0	0	377	196	0	0	1
1/08/2024 6:56	0	230	649	473	0	0	1
1/08/2024 6:56	162	0	599	572	249	0	1

Gate status, 1
means gate
close and
animal is inside,
and 0 means
gate open and
animal exit.

Challenges in matching the data

- ❑ The gate status is 0 but still sensors recorded methane.
- ❑ Discrepancies between the number of cows read by sensors and milked.



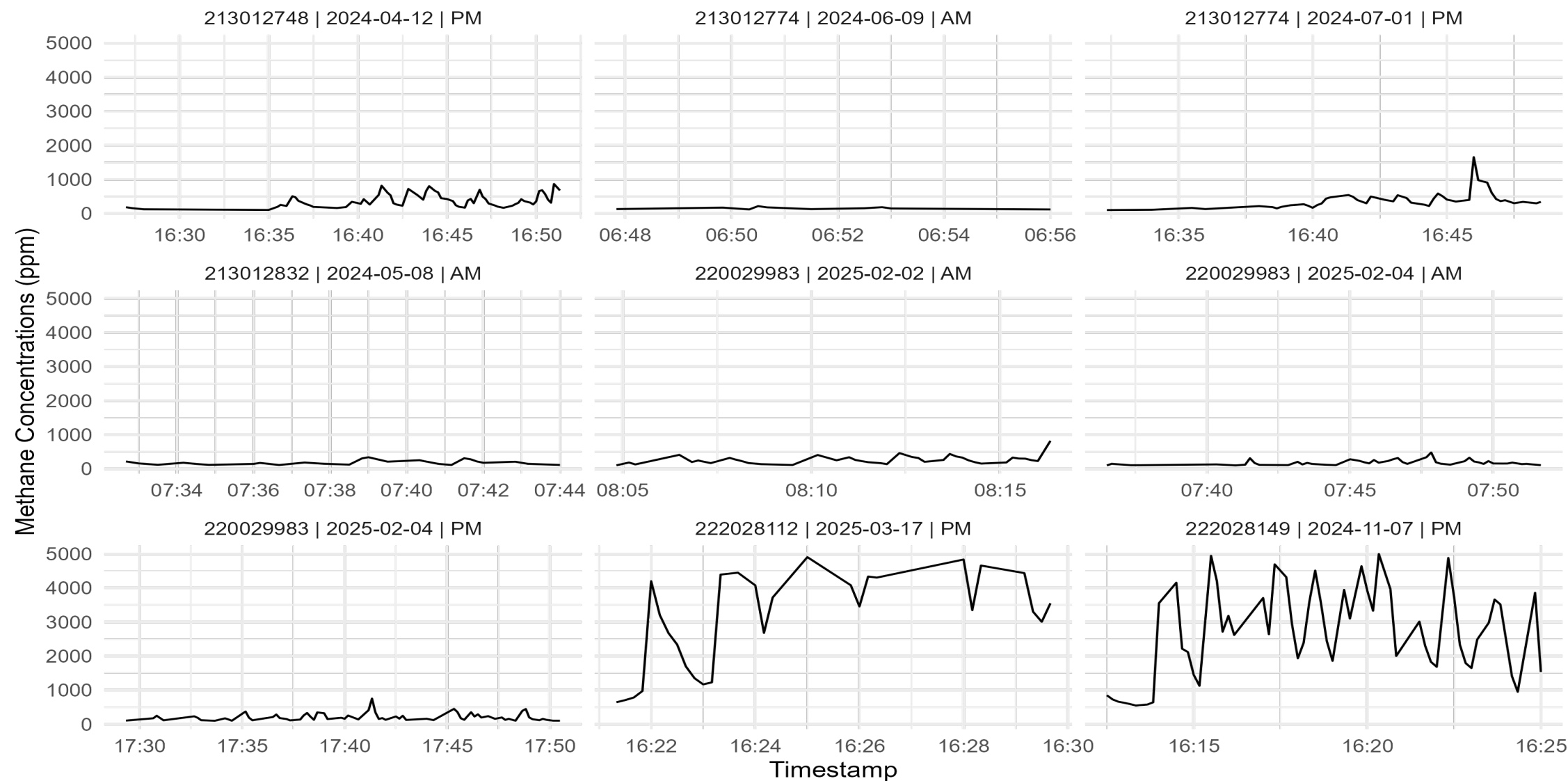
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
Time	CH4 Bay 34 (15483)	CH4 Bay 3	CH4 Bay 3	CH4 Bay 3	CH4 Bay 3	CH4 Bay 3	CH4 Bay 4	CH4 Bay 41	CH4 Bay 42 (15455)	CH4 Bay 43 (15456)	CH4 Bay 44 (15457)	CH4 Bay 4	CH4 Bay 4	CH4 Bay 4	CH4 Bay 4	CH4 Bay 4	CH4 Bay 4	CH4 Bay 4	Right Gate (15386)
2/09/2024 7:23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2/09/2024 7:24	102	0	102	0	0	102	0	116	0	0	0	0	0	0	0	0	0	0	0
2/09/2024 7:24	186	121	0	0	174	130	534	0	0	0	0	0	0	0	0	0	0	0	0
2/09/2024 7:24	0	176	0	0	212	0	207	175	100	299	148	0	0	0	0	0	0	0	0
2/09/2024 7:24	146	125	0	317	179	712	0	203	0	268	0	0	0	0	0	0	0	0	0
2/09/2024 7:24	0	0	0	276	0	466	174	0	0	222	0	232	0	0	0	0	0	0	0
2/09/2024 7:24	0	0	112	0	144	443	0	237	108	189	0	0	0	0	0	0	0	0	0
2/09/2024 7:25	399	0	0	182	0	292	141	796	134	0	0	175	0	0	0	0	0	0	0
2/09/2024 7:25	379	113	0	0	0	232	0	867	0	152	179	0	281	0	0	214	0	0	0
2/09/2024 7:25	301	0	100	287	112	0	225	795	0	0	337	134	224	105	0	0	111	0	0
2/09/2024 7:25	244	0	0	235	0	189	267	637	288	0	233	0	0	0	0	212	0	0	0
2/09/2024 7:25	191	113	0	0	148	0	204	490	0	0	179	106	162	0	0	0	0	0	0
2/09/2024 7:25	0	193	103	0	0	0	184	321	420	0	224	0	128	0	0	153	0	0	0
2/09/2024 7:26	191	0	0	190	0	0	0	399	507	114	137	0	0	133	0	179	0	0	0
2/09/2024 7:26	0	259	162	146	0	0	0	336	359	154	170	0	0	0	0	0	0	0	0
2/09/2024 7:26	0	0	0	225	120	0	132	630	260	129	132	0	227	0	0	760	113	0	0
2/09/2024 7:26	514	362	389	235	0	0	0	692	244	442	175	0	416	206	0	492	0	0	0
2/09/2024 7:26	502	422	443	631	0	220	180	625	0	507	324	237	682	233	0	352	0	0	0
2/09/2024 7:26	293	505	207	392	0	277	220	403	872	653	656	188	373	171	0	209	0	0	0
2/09/2024 7:27	306	368	250	487	103	645	0	0	676	481	469	0	641	0	0	0	0	0	0
2/09/2024 7:27	0	495	0	299	139	692	188	416	576	451	313	137	553	0	0	349	0	0	0
2/09/2024 7:27	1624	528	177	218	196	464	231	330	330	280	190	0	245	199	0	347	0	0	0
2/09/2024 7:27	523	443	570	847	0	351	259	628	0	172	155	0	202	167	0	250	382	0	0
2/09/2024 7:27	622	377	493	875	146	273	180	716	245	208	129	0	789	184	0	212	581	0	0
2/09/2024 7:27	421	281	390	403	116	243	150	902	709	420	309	175	693	528	112	401	342	0	0
2/09/2024 7:28	290	364	222	432	0	0	109	835	930	743	532	0	347	193	0	506	316	0	0
2/09/2024 7:28	246	908	224	253	0	0	142	1215	712	456	634	150	302	166	0	372	166	0	0
2/09/2024 7:28	225	853	256	208	162	200	0	1802	617	589	326	0	410	206	0	252	199	0	0
2/09/2024 7:28	232	651	405	0	0	402	0	803	522	485	169	109	267	126	0	174	681	0	0
2/09/2024 7:28	200	987	0	473	0	436	0	661	358	621	0	0	204	0	0	0	439	0	0
2/09/2024 7:28	193	877	283	0	0	274	115	624	253	1905	139	0	822	0	0	0	219	0	0
2/09/2024 7:29	0	768	0	405	358	299	0	413	820	894	243	252	745	214	0	436	187	0	0
2/09/2024 7:29	153	2946	233	276	0	0	0	2066	521	559	268	0	377	251	0	741	130	0	0
2/09/2024 7:29	188	1889	223	841	232	255	195	1577	0	530	0	190	657	156	105	383	103	0	0

	Date	Bay	Count_Methane	Count_Milk	discrepancies
1	2024-08-01	01	6	8	-2
2	2024-08-01	02	6	8	-2
3	2024-08-01	03	6	8	-2
4	2024-08-01	04	6	7	-1
5	2024-08-01	05	6	8	-2
6	2024-08-01	06	6	8	-2
7	2024-08-01	07	6	8	-2
8	2024-08-01	08	6	8	-2
9	2024-08-01	09	6	8	-2
10	2024-08-01	10	6	8	-2
11	2024-08-01	11	6	8	-2
12	2024-08-01	12	6	8	-2
13	2024-08-01	13	6	8	-2
14	2024-08-01	14	6	8	-2
15	2024-08-01	15	6	8	-2
16	2024-08-01	16	6	7	-1
17	2024-08-01	19	3	6	-3
18	2024-08-01	42	2	6	-4

Processing data

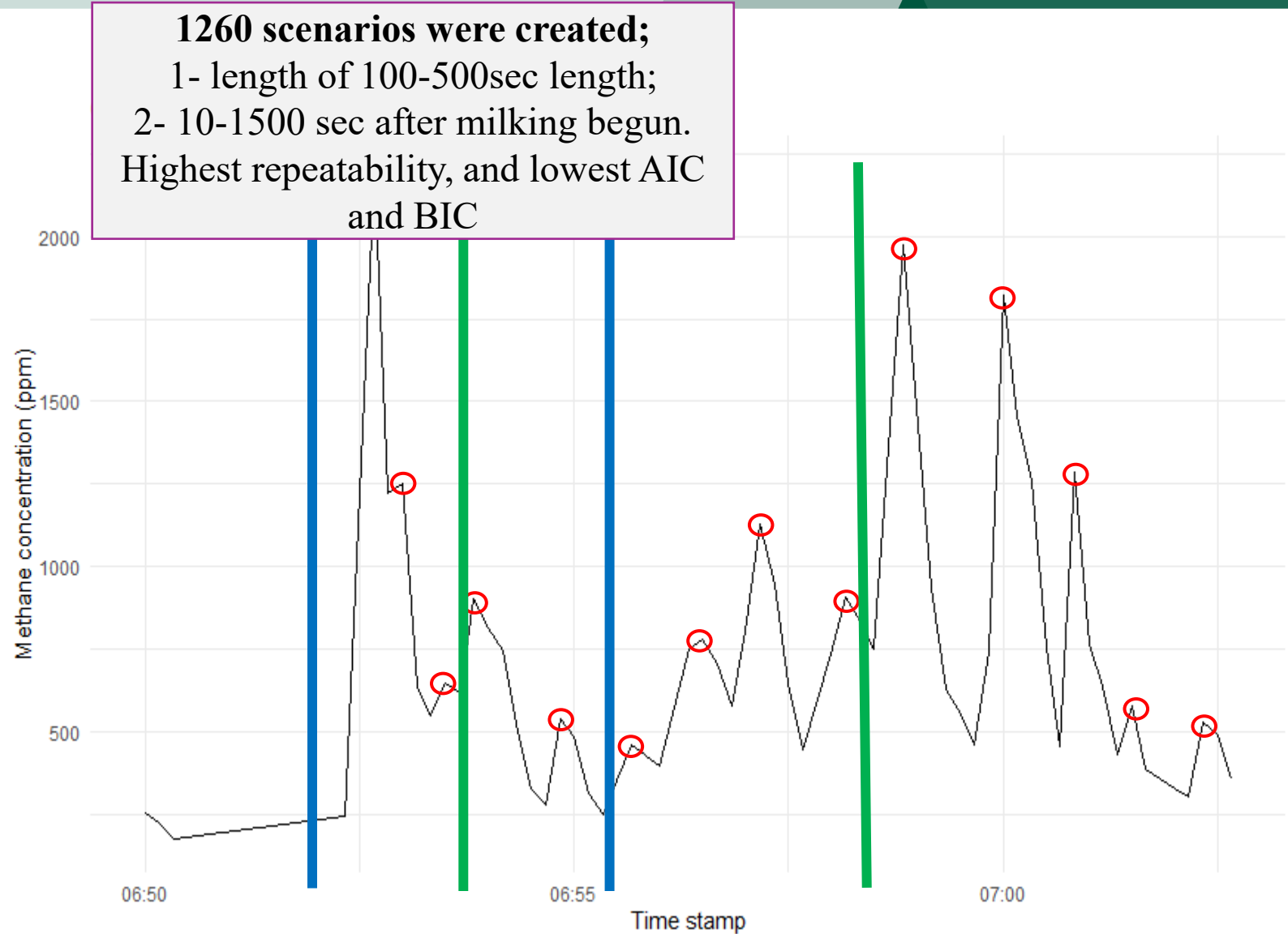
- ☐ Data were extracted from **1 Mar 2024 to 14 Apr 2025**.
- ☐ The visit was discarded if it was shorter than 150 seconds and longer than 2400.
- ☐ All zeros excluded as they are not actual zeros (sensors record between 100-5000ppm).
- ☐ The visit was discarded if the datapoint per visit was less than 10.
- ☐ DIM over 450 removed.
- ☐ Cows involved in feed additive experiments were removed.
- ☐ In total 581 individual cows were phenotyped but only 538 of them were genotyped.

Visit examples



Defining phenotypes

- 1- Average of all datapoints
- 2- Average of peaks
- 3- Average of 90-410sec
- 4- Average of peaks of 90-410sec
- 5- Average of first seg
- 6- Average of peaks of first seg
- 7- Average of middle seg
- 8 - Average of peaks of middle seg
- 9- Average of end seg
- 10- Average of peaks of end seg



Adjustment to sensor position



Genetic model (ASReml 4.2.1)

$$Y = Xb + Zu + Wc + e$$

y: phenotypes

b: fixed effects; milking sessions (AM/PM), bay number, polynomial age, polynomial DIM, weight, parity, and period (pre and post Jan 2025).

u: random genetic effects for each animal

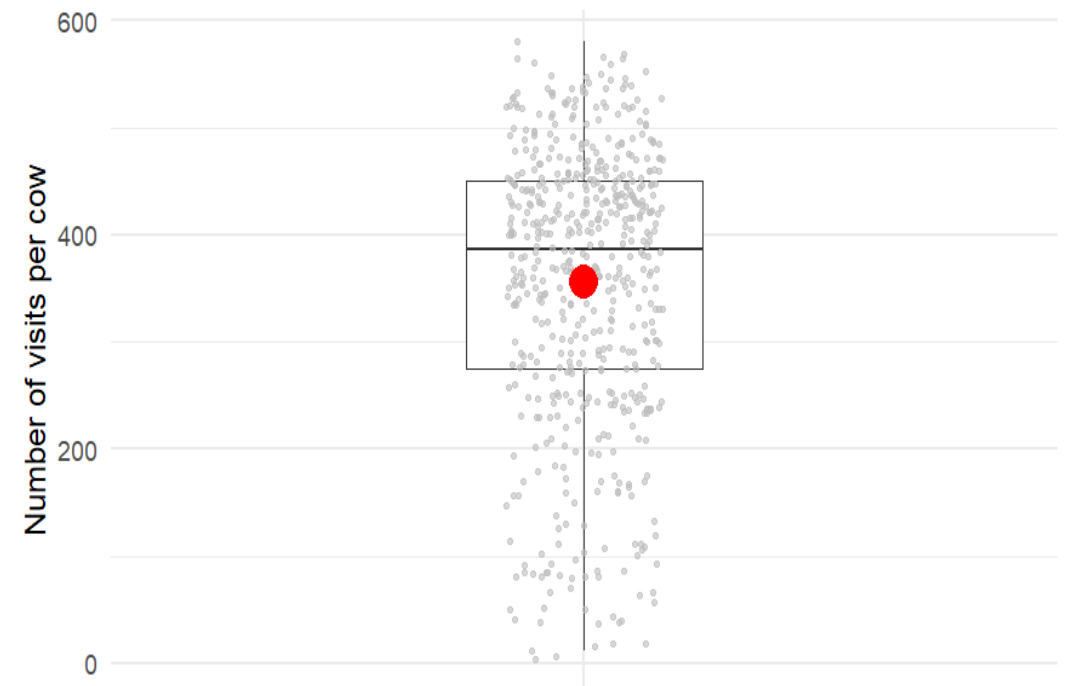
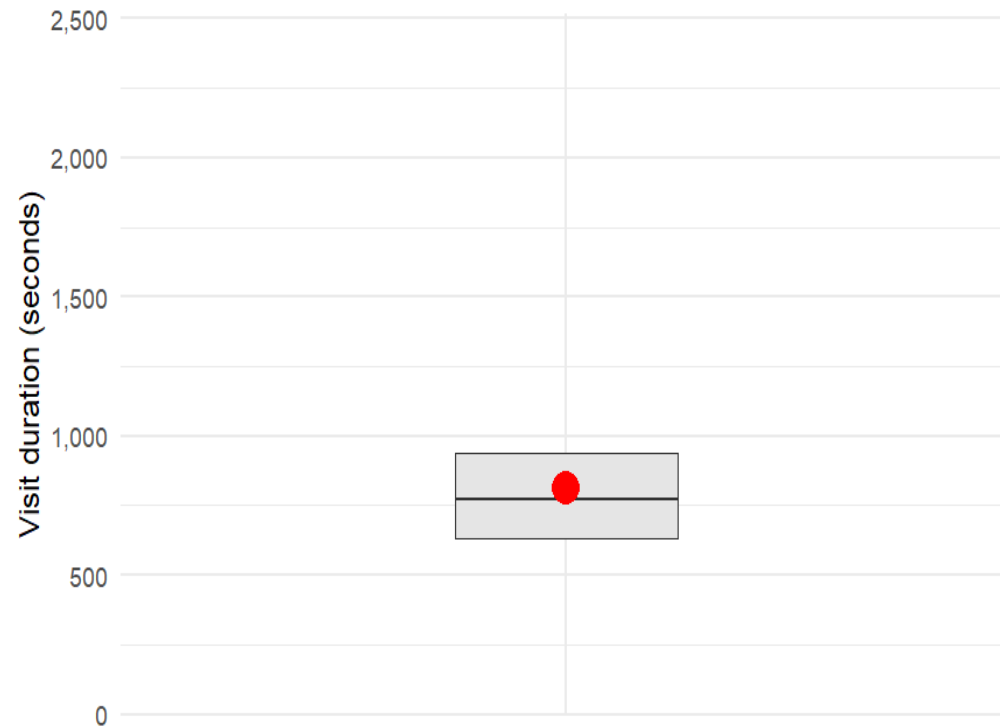
c: random permanent environment effect

e: random residual effect

Genotype: utilised XST-74K genotype set. Compromises approximately 74,000 single nucleotide polymorphisms (SNPs) and is a combination of AVR's (Agriculture Victoria Research) custom DairyBio XT-50K chip and the standard Illumina Bovine 50K chip.

Summary of visits

❑ Total visit is 201,208





Results

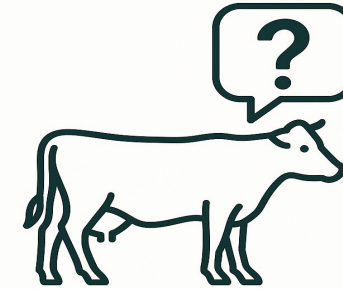
Phenotype	Mean (ppm)	SD	CV	Min-Max	h2	r
Average	496	283	0.63	103-3497	0.08	0.14
Average of peaks	720	451	0.62	101-4929	0.11	0.18
Average of 90-410	419	261	0.72	107-4214	0.19	0.26
Average of peaks 90-410sec	606	434	0.62	108-4743	0.23	0.29
Average of first segment	338	210	0.74	100-4492	0.09	0.15
Average of peaks of first segment	518	387	0.63	101-4850	0.11	0.18
Average of middle segment	508	323	0.70	100-4644	0.06	0.13
Average of peaks of middle segment	730	512	0.70	101-4993	0.06	0.14
Average of end segment	573	381	0.66	100-4427	0.01	0.06
Average of peaks of end segment	843	599	0.71	101-4935	0.0	0.06

SE < 0.02

- The window of 90-410sec provided best estimation of heritability (0.23) and repeatability (0.29).
- Sniffer sensors did not detect the statistical correlation between treatments compared to SF6.
- The majority of methane recorded per bay are in 100-399ppm.

Acknowledgement

- ❑ Green cow team.
- ❑ DairyBio and DairyFeedBase team in Agribio and Ellinbank.
- ❑ Ellinbank technical staff.



Questions & Comments

