Using on-farm milk progesterone levels to define new fertility traits for dairy cows

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Background

- low heritability of conventional fertility traits
- declining cow fertility
- progesterone-based new fertility traits are promising…

Background

- low heritability of conventional fertility traits

- declining cow fertility

- progesterone-based new fertility traits are promising…

...BUT:

- Biological fertility of the cow not easy to measure automatically

- No common standard on definition of progesterone-based fertility traits (e.g. sampling frequency, progesterone threshold for luteal activity, method of measurement …)

Objective

- Analyzing progesterone-based fertility traits for dairy cows that could be included in a breeding program in the future

→ Which progesterone-based traits can be easily measured on-farm?

→ Which traits are suitable for genetic selection?

→ What influence do method and sampling frequency have?

Progesterone-based traits

Commencement of Luteal Activity
= first rise above threshold

CLA

Proportion of Luteal Activity
= proportion of samples above threshold

PLA

Progesterone-based traits

Commencement of Luteal Activity
= first rise above threshold

CLA

- **CLA1**: Visual inspection of profile
- **CLA2**: prog_mean
- **CLA3**: 3 ng/ml
- **CLAOpt**: herd-optimized threshold (with visual CLA as reference)

Proportion of Luteal Activity
= proportion of samples above threshold

PLA

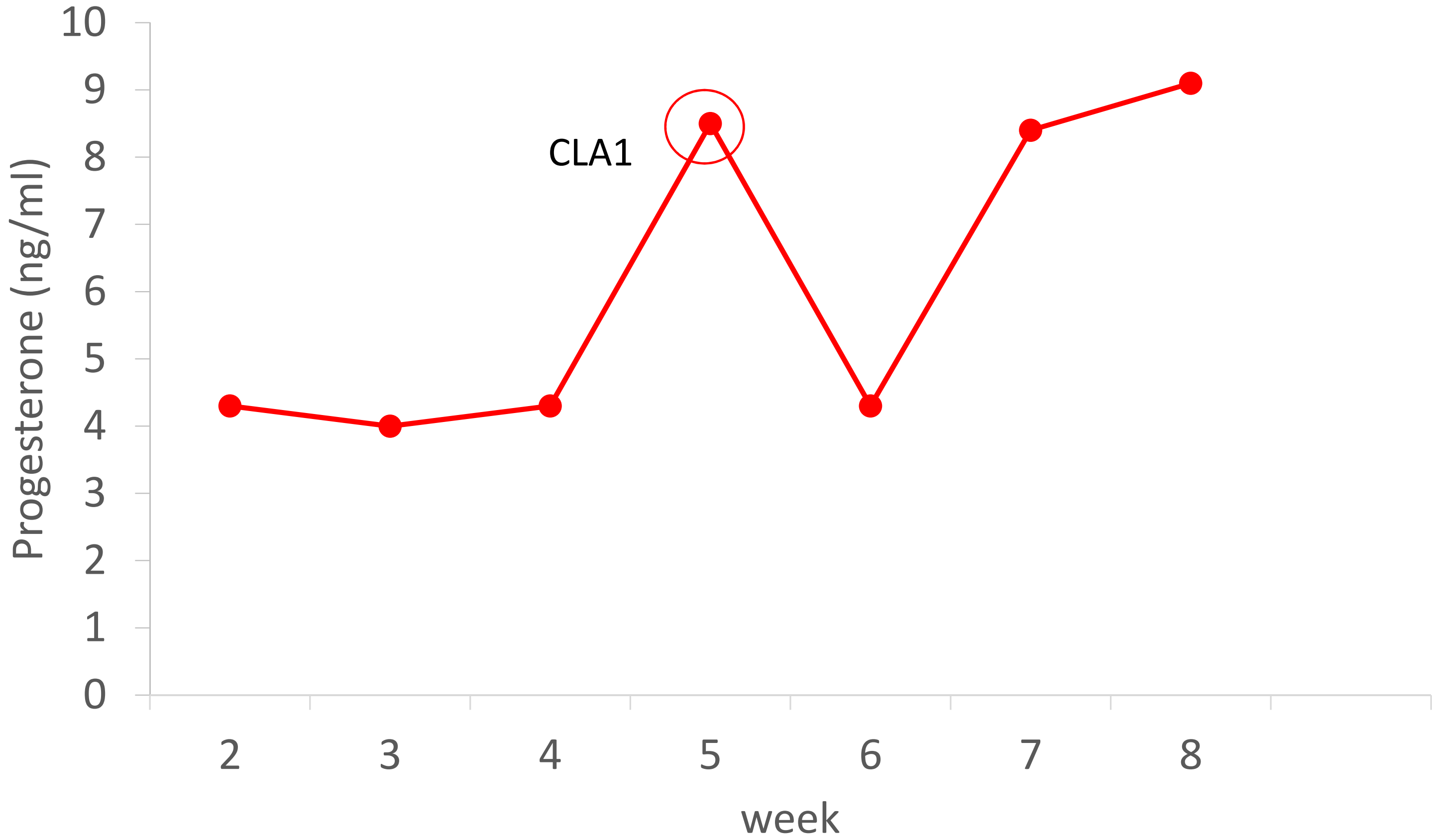
- **PLA2**: prog_mean
- **PLA3**: 3 ng/ml
- **PLAOpt**: herd-optimized threshold

Progesterone profiles

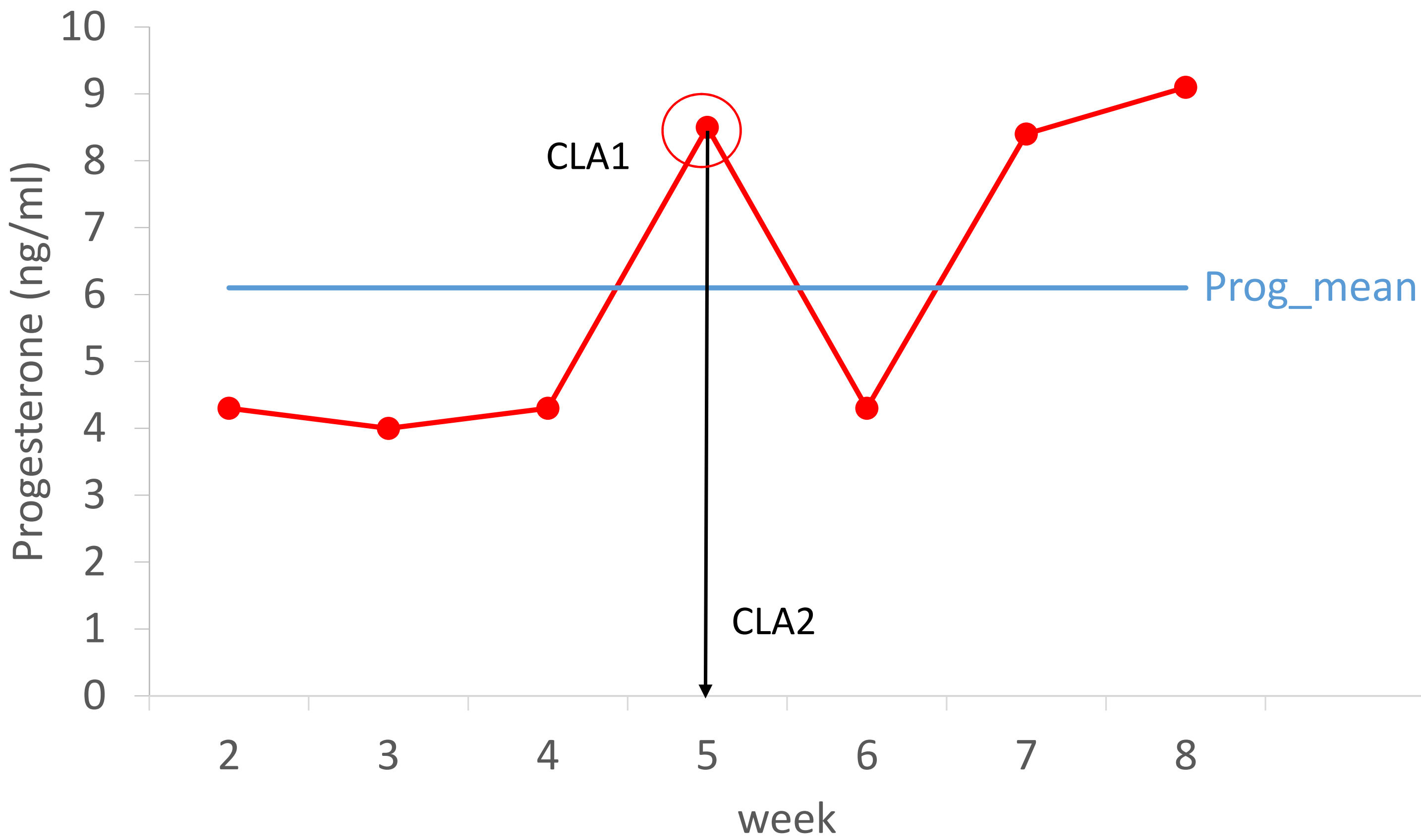
- Week 2 – 9 pp.
- on-farm ELISA measurement (eProCheck from FrimTec, Oberostendorf, Germany) in skimmed milk
- 5 large commercial dairy herds in Eastern Germany forming 2 data sets:

	data set 1	**data set 2**
Number of profiles	1,446	296
Herd #	1,2,3,4	5
Parity	1-3	1-12
305-d milk yield	10,300 kg	11,900 kg
Progesterone measurements	1 per week	2 per week

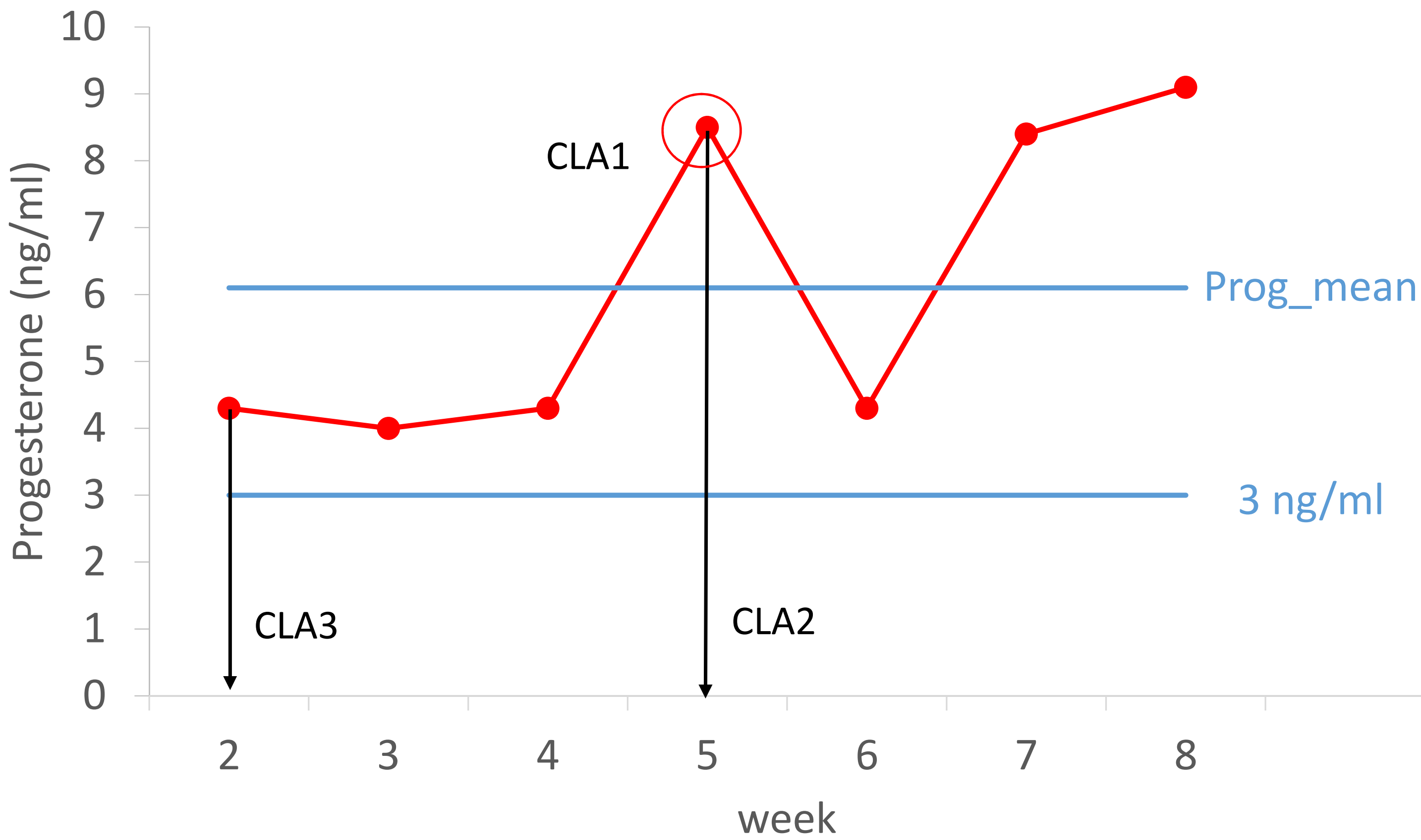
Progesterone profiles



Progesterone profiles



Progesterone profiles



Statistical analysis

- Mixed model with SAS proc mixed and cow as random effect (accounting for repeated records) to examine fixed effects
- Genetic analysis with VCE and full relationships

Single trait animal model – genetic analysis

$$y_{ijk} = \mu + HYS_i + P_j + a_{ijk} + e_{ijk}$$

y_{ijk} = trait (CLA1, CLA2, CLA3, CLAOpt, PLA2, PLA3, PLAOpt, prog_mean)

μ = intercept

HYS_i = fixed effect of herd-year-season of calving

P_j = fixed effect of parity (j = 1 for lactation 1, j = 2 for lactation 2 and above)

a_{ijk} = animal's random additive genetic effect

e_{ijk} = random residual effect

Two trait animal model – genetic analysis

$$y1_{ijk}\ y2_{ijk} = \mu + HYS_i + P_j + a_{ijk} + e_{ijk}$$

y_{ijk} = trait (CLA2, CLA3, CLAOpt, PLA2, PLA3, PLAOpt, prog_mean)

μ = intercept

HYS_i = fixed effect of herd-year-season of calving

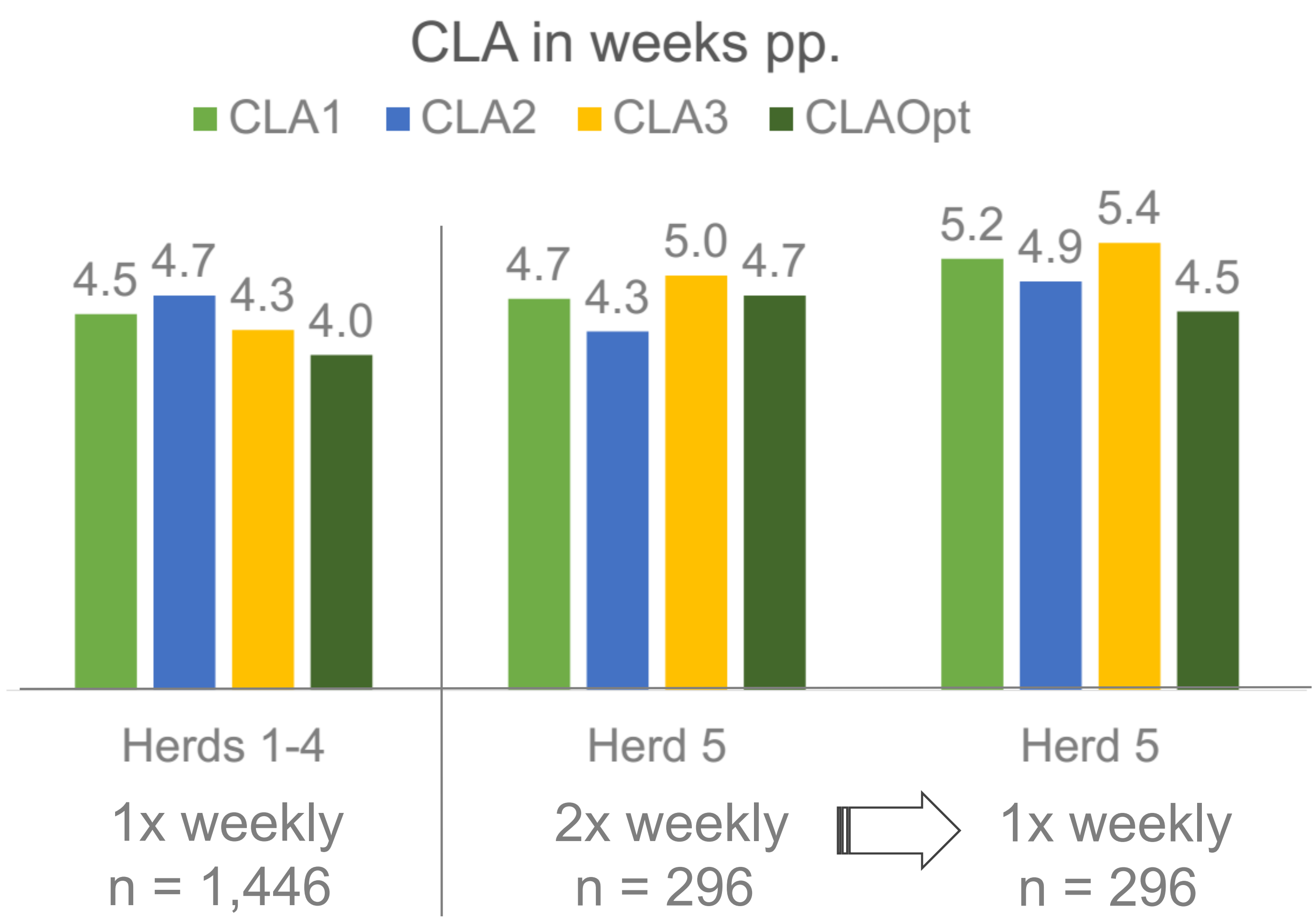
P_j = fixed effect of parity (j = 1 for lactation 1, j = 2 for lactation 2 and above)

a_{ijk} = animal's random additive genetic effect

e_{ijk} = random residual effect

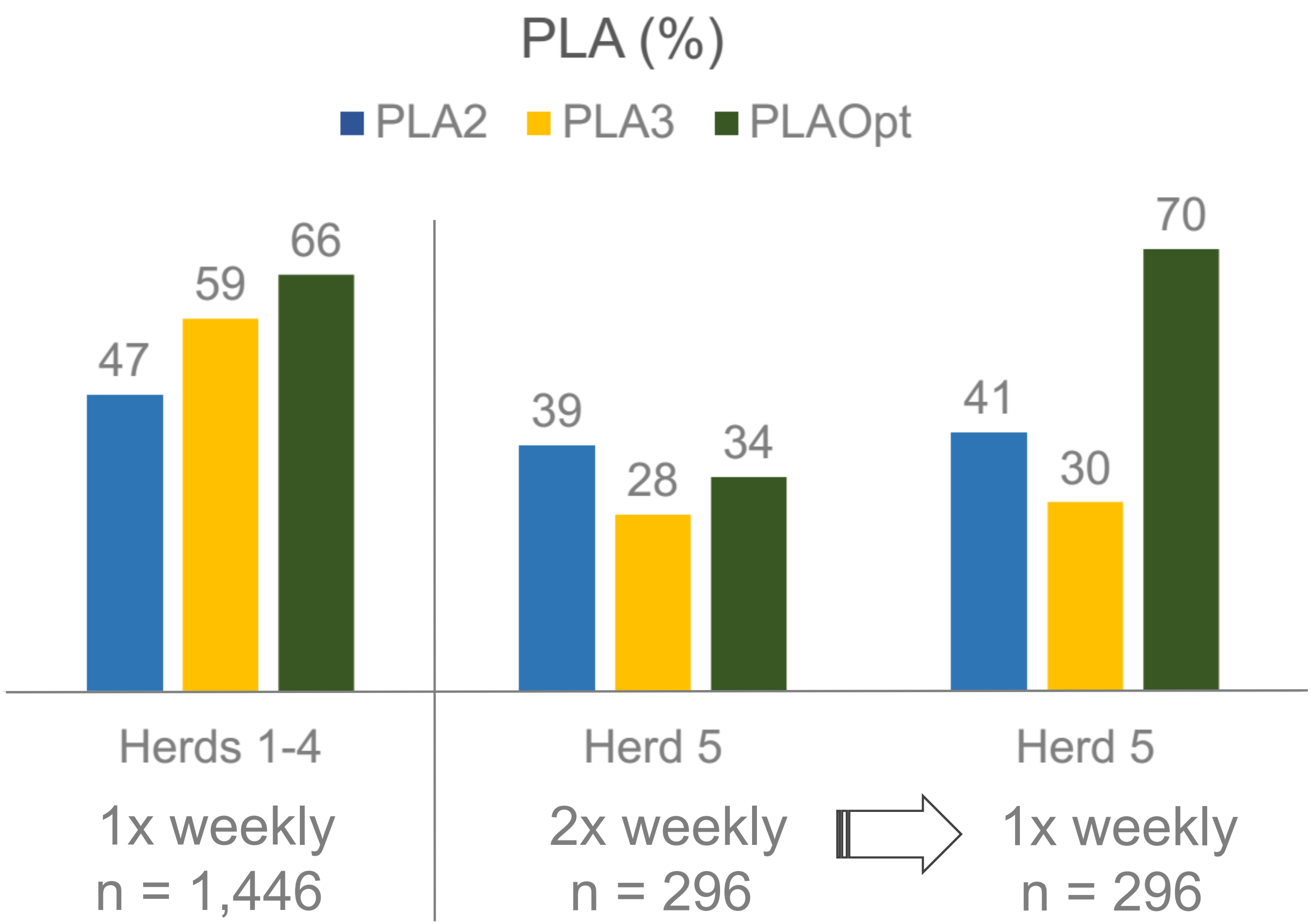
LSMeans

method, frequency p<0.0001
method*frequency p<0.0001



LSMeans

method, frequency	p<0.0001
method*frequency	p<0.0001



Genetic results herds 1-4

Single trait model

Trait	h^2	SE
CLA1	0.04	0.05
CLA2	0.07	0.06
CLA3	0.08	0.06
CLAOpt	0.07	0.04

Genetic results herds 1-4

Single trait model

Trait	h^2	SE	Trait	h^2	SE
CLA1	0.04	0.05			
CLA2	0.07	0.06	PLA2	0.18	0.06
CLA3	0.08	0.06	PLA3	0.18	0.07
CLAOpt	0.07	0.04	PLAOpt	0.13	0.06

Genetic results herds 1-4

Single trait model

Trait	h^2	SE	Trait	h^2	SE	**Trait**	**h^2**	**SE**
CLA1	0.04	0.05				Prog_ mean	0.25	0.07
CLA2	0.07	0.06	PLA2	0.18	0.06			
CLA3	0.08	0.06	PLA3	0.18	0.07			
CLAOpt	0.07	0.04	PLAOpt	0.13	0.06			

Genetic results herds 1-4

Two trait model

Trait 1	Trait 2	h_1^2	h_2^2	r_g	r_p
CLA2	PLA2	0.09	0.19	-1.0	-0.47
CLA3	PLA3	0.06	0.18	-1.0	-0.67
CLAOpt	PLAOpt	0.06	0.13	-1.0	-0.64
PLA2	Prog_mean	0.20	0.25	0.95	0.55

Conclusions

1. Progesterone-based fertility traits can be measured on-farm and once weekly in a commercial setting, but method of detection and sampling frequency have a significant influence on phenotypic levels of CLA and PLA

→ Exact and standardized definition of progesterone-based new fertility traits necessary

Conclusions

1. Exact definition of progesterone-based new fertility traits necessary!

2.
- High genetic correlation of PLA with CLA
- PLA easy to detect with a computer algorithm
- Higher heritability than CLA

→ using PLA as a proxy for CLA?

Conclusions

1. Exact definition of progesterone-based new fertility traits necessary!
2. Using PLA as a proxy for CLA?

3. Prog_mean had the highest heritability and can be easily calculated

→ new interesting trait

→ Further studies needed on physiological implications of prog_mean

Conclusions

1. Exact definition of progesterone-based new fertility traits necessary!
2. Using PLA as a proxy for CLA?
3. Prog_mean new interesting trait

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