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Using farmers' records to determine genetic parameters for fertility traits for South African Holstein cows

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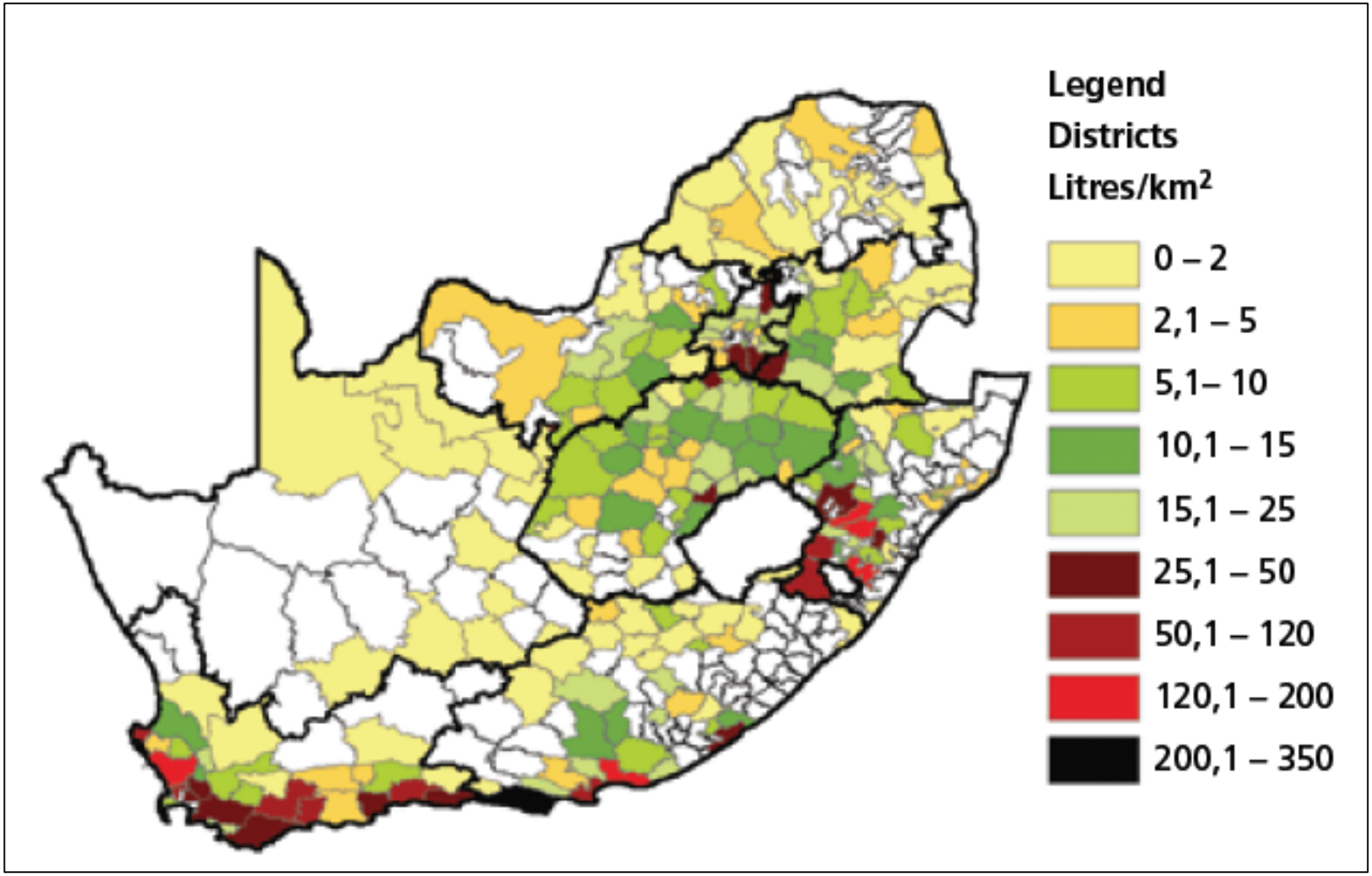
Background (1) :

- Elsenburg Agricultural College – est. 1902
- 100 Holstein, 50 Jersey and 75 crossbreds
- Situated 50 km from Cape Town
- Mediterranean climate:
  - warm dry summers &
  - cool wet winters, little/no snow
- Dairy farming - mostly intensive feedlot style
- Forages: oats, barley hay/silage, wheat straw
- Lucerne hay imported from other areas
- Pasture based systems – under irrigation

Background (2) :



Introduction (1) :

- **Poor reproduction results in farm income loss**
  - **cows culled for reproductive failure**
  - **reduces productive life of cows**

- **Calving interval (CI) increases**
  - **Larger % dry cows**
  - **Milk cows longer past drying-up date**
  - **Higher herd average DIM**

- **Lower average daily milk yield per cow**
- **Reduces herd total daily milk yield**

Introduction (2):

- See an increase in Calving interval – why?
  - Milk yield of cows is higher - ??
  - Feed less concentrates
  - Larger herds – no special attention for high producing cows
  - Fewer workers understand biology
  - Marketing of products aiding fertility

- Question: Has the genetic make-up of cows changed?

Poor fertility - cow or management problem?:

- In SA selection programmes focused on milk yield and conformation traits
- No emphasis on improving fertility in dairy cows
- Internationally fertility of bull daughters has only recently received attention
- At best, cows not pregnant, are culled
- Usually after an extended, costly breeding programme

What is the definition of cow fertility?:

- Getting her pregnant?
- At all costs?
- If she calves down a next time?
- Calving interval (CI) as fertility indicator?
- Herd CI-values could be for part of the herd
- What about cows not calving again?

Possible fertility traits:

Definition	Description	Traits
1. Coming on heat soon after calving	When is first AI?	1. CFS 2. CFS < 80dim
2. Conceive from few AI's	Number of AI's/conception	1. SPC 2. PD first AI
3. Staying pregnant until next calving	When did cows become pregnant?	1. Interval DO 2. DO < 100 days 3. DO < 150 days 4. DO < 200 days 5. Calving interval

Records for national fertility evaluation?:

- Reproduction information is available as herd management records
- Consist of calving and AI dates and pregnancy check results
- Require a system to move from farmers' computers to a national data base
- Require some converting from dates to intervals

Aim of our study:

Two outcomes:

1. **Evaluate alternative fertility traits to CI**
   - **establish level of reproduction management**

2. **Estimate genetic parameters for fertility traits**
   - **identify fertile cows**

Materials and Methods:

- Reproduction records from Holstein herds of all cows calving at least once
  - calving dates
  - lactation number
  - AI dates
  - pregnancy check results
- Determine interval traits
- Establish binomial status for intervals traits

Records available:

- 14 Holstein herds
- 9 046 cows
- 24 646 lactations
- 69 181 AI records

- Calving dates between 1991 to 2007

Interval traits:

- Calving date to first AI date (CFS)
- Calving date to conception date (DO)
- Number of AI's/conception

Other traits also available:

- Breeding period: interval C-date to last AI date minus Voluntary Waiting Period
- Average days between heats: Breeding period/all AI's
- Heat detection rate: 21/average days

Binomial traits:

- Yes = 1 and No = 0 for interval traits

  - CFS <80 DIM
  - PD <100 days
  - PD <150 days - optional
  - PD < 200 days
  - Pregnant from first AI

Example - Reproduction records of 5 cows (1):

Cow	C-date	Lact nr	AFC (m)	CFS (d)	CFS < 80d
3588	26/04/2006	1	28.3	59	1
3588	31/03/2007	2		138	0
4005	23/02/2006	1	25.3	73	1
4005	27/01/2007	2		67	1
4009	11/02/2006	1	24.7	120	0
4009	9/05/2007	2		94	0
4015	3/03/2006	1	25.2	101	0
4015	18/04/2007	2		98	0
4019	22/03/2006	1	25.6	73	1
4019	28/03/2007	2		60	1

Example - Reproduction records of 5 cows (2):

Cow	DO (d)	SPC	PD 1st AI	PD<100d	PD<150d	PD<200d
3588	59	1	1	1	1	1
3588	161	2	0	0	0	1
4005	73	1	1	1	1	1
4005	156	4	0	0	0	1
4009	182	2	0	0	0	1
4009	186	3	0	0	0	1
4015	134	2	0	0	1	1
4015	140	2	0	0	1	1
4019	93	2	0	1	1	1
4019	207	5	0	0	0	0

Example - Reproduction records of 5 cows (3):

Cow	All AI's	Breeding period (d)	Average days (d)	HDR %
3588	1	27	27	0.78
3588	2	129	65	0.33
4005	1	41	41	0.51
4005	4	124	31	0.68
4009	2	150	75	0.28
4009	3	154	51	0.41
4015	2	102	51	0.41
4015	2	108	54	0.39
4019	2	61	31	0.69
4019	5	175	35	0.60

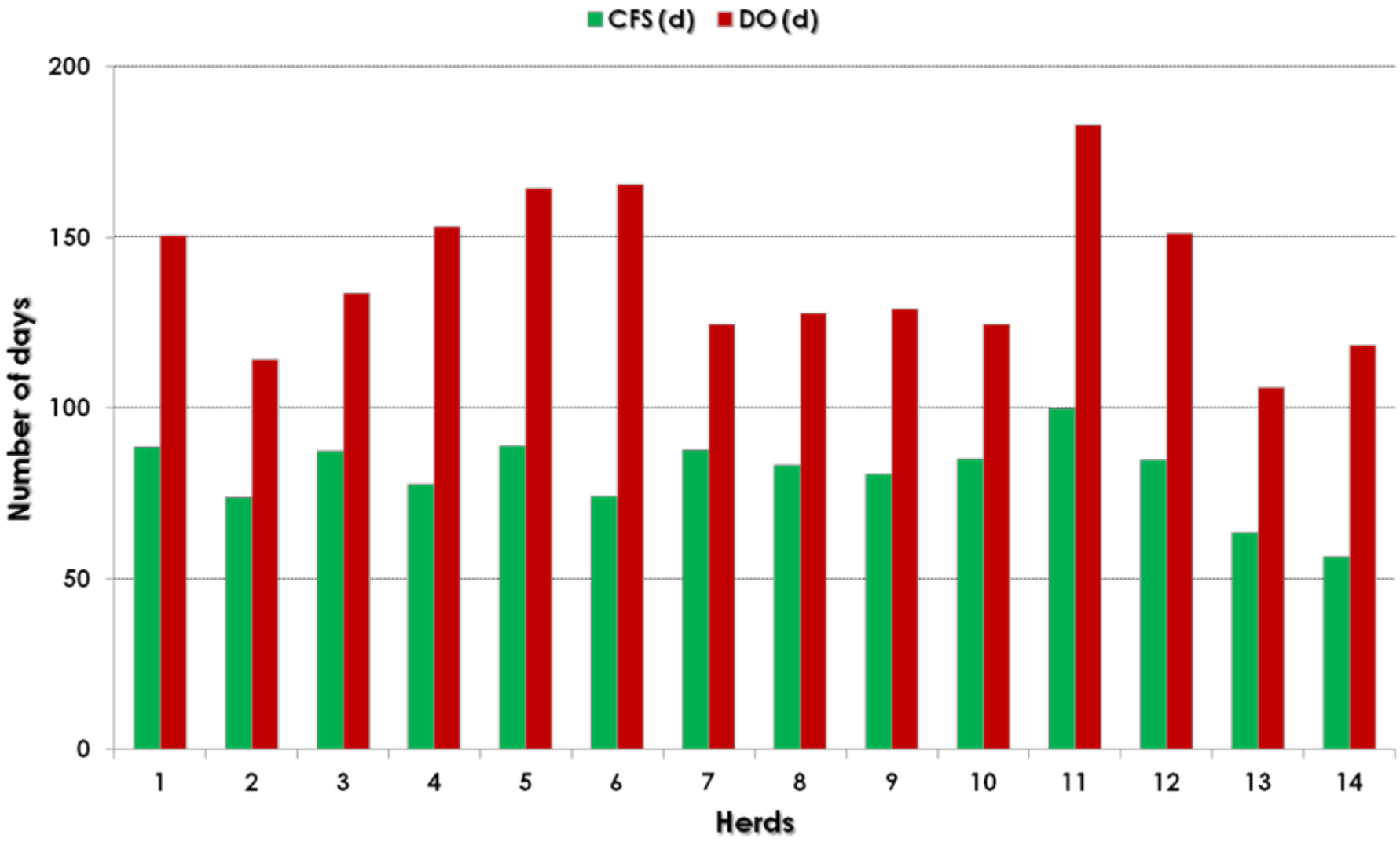
Statistical analyses:

- PROC GLM prodedure of Genstat software to determine fixed effects to be included in model for traits
- REML Linear Mixed Models implemented for continuous traits
- Generalized Linear Mixed Models for binomial traits via a LOGIT link back transformation
- Fixed effects were herd (14), year of calving (17), month of calving (12), lactation number (8)
- GLMM models included herd as a random effect
- Least square mean estimates and REML solutions for significant fixed effects were also derived

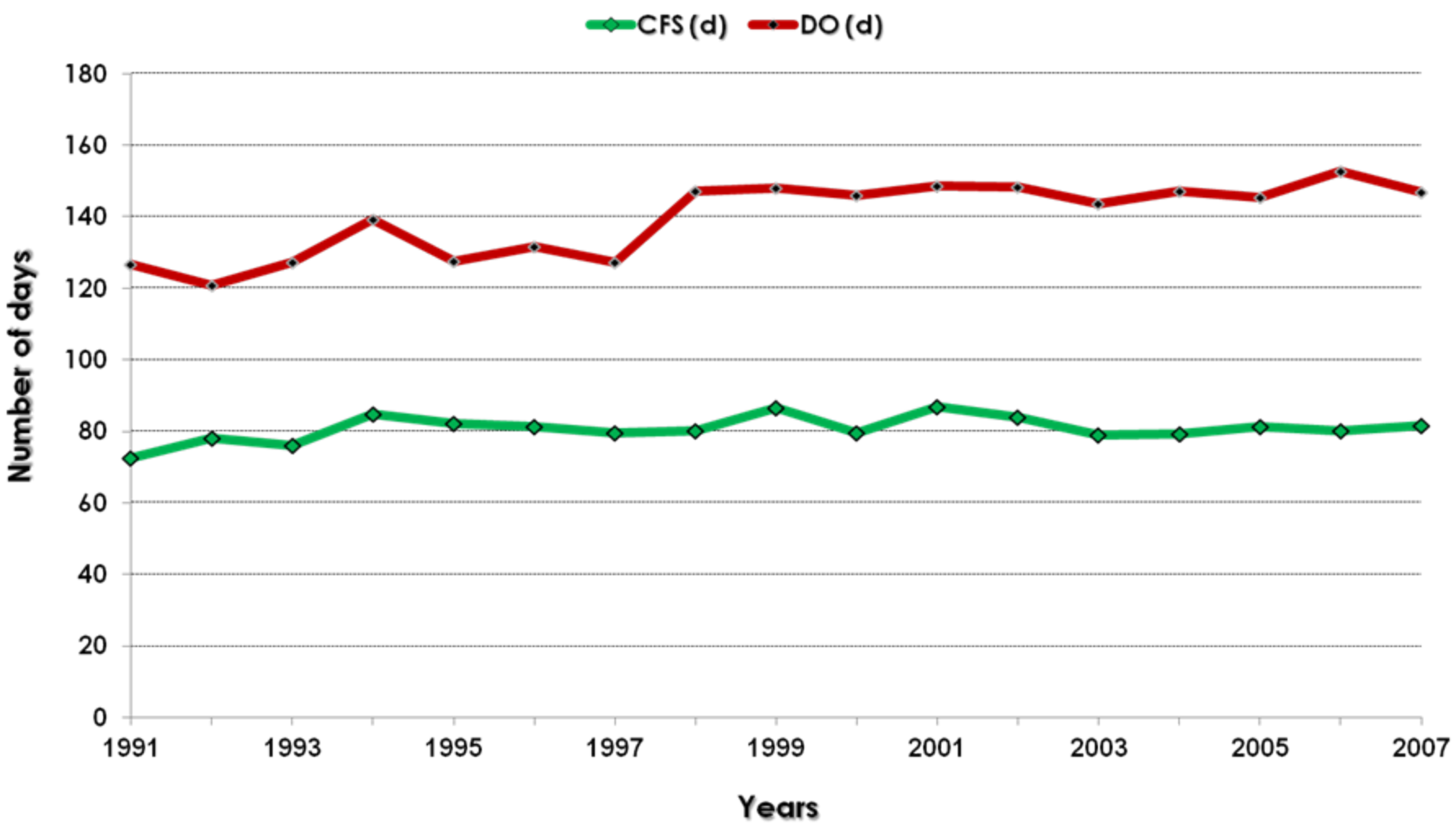
Results: Description of raw data:

Variables	Number of records	Mean	SD	Range
CFS (days)	16605	77	30	21-250
DO (days)	14255	134	74	21-435
SPC	14255	2.55	1.79	1-8
FS80d	16648	0.64	0.48	1-2
PD100d	16648	0.36	0.48	1-2
PD200d	16648	0.71	0.45	1-2

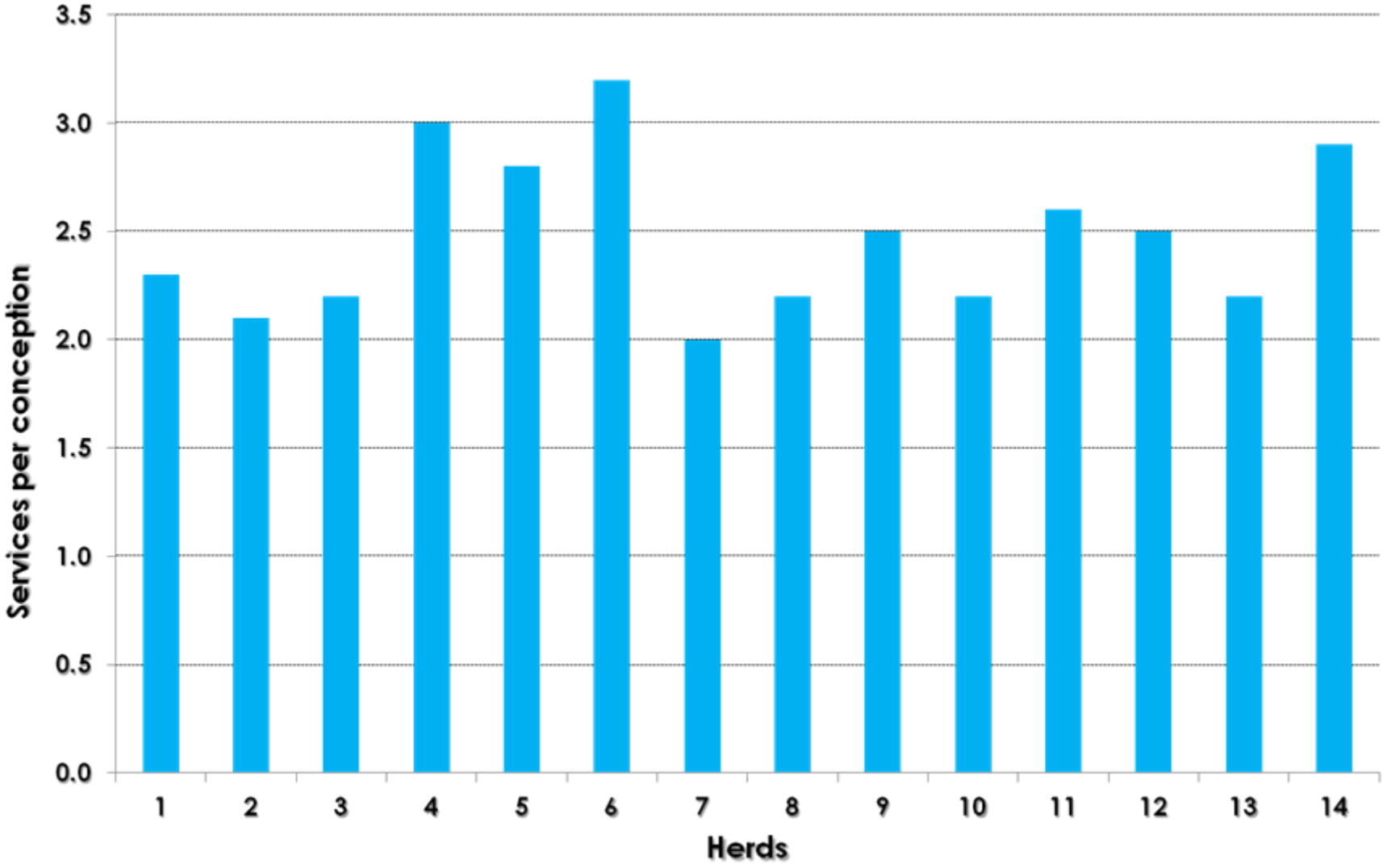
CFS and DO differences between herds:



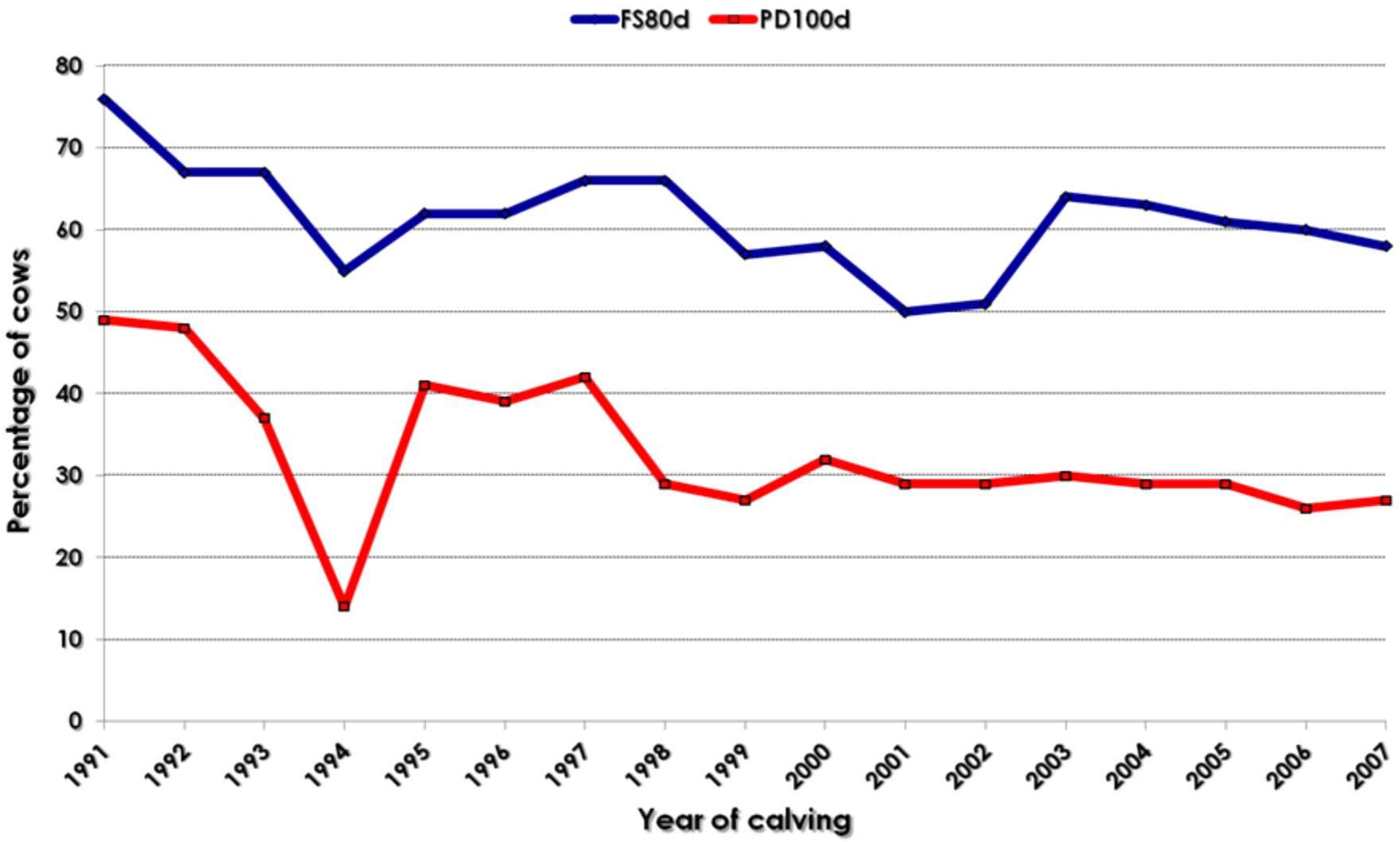
CFS and DO as affected by year of calving:



SPC as affected by herd:



FS80d and PD100d as affected by year of calving:



Effect of fixed effects on fertility traits:

Parameters	Herd	Calving year	Calving season	Lactation number
Df	13	16	4	5
CFS	2598201	118646	25816	75173
DO	1259070	2273999	21501[1]	331422
SPC	1474	1060	28[1]	34[1]
FS80d	488	41	6	12[1]
PD100d	120	25	9	15
PD200d	197	37	8	32

[1]Not significant (P>0.05)

Comparison to Australian survey:

Parameters	Ave All Herds	Range	InCalf project	
			Good	Problems
CFS<80 DIM (%)	61	36-89	73	<61
SPC	2.48	1.96-3.33	1.96	>2.32
AI efficiency (%)	40	30-51	51	<43
PD100d (%)	42	21-50	58	<45
PD200d (%)	83	58-90	87	<81

Results: Binary traits analysis:

Linear traits	Item	Heritability estimates		
		FS80d	PD100d	PD200d
DO	Direct heritability (h^2)	0.06±0.05	0.07±0.01	0.06±0.04
	Permanent environment (c^2_{pe})	0.07±0.05	0.08±0.01	0.09±0.04
CFS	Direct heritability (h^2)	0.04±0.01	0.08±0.02	0.08±0.02
	Permanent environment (c^2_{pe})	0.01±0.01	0.06±0.02	0.10±0.02
SPC	Direct heritability (h^2)	0.10±0.02	0.07±0.01	0.06±0.01
	Permanent environment (c^2_{pe})	0.14±0.02	0.07±0.02	0.10±0.02

Results: Binary traits analysis:

Linear traits	Type of correlation	Binary traits		
		FS80d	PD100d	PD200d
DO	Genetic	-0.50±0.01	0.99±0.01	-0.98±0.02
	Permanent Environment	-0.34±0.02	0.99±0.01	-1.00±0.04
CFS	Genetic	0.03±0.01	0.64±0.01	-0.36±0.01
	Permanent Environment	0.12±0.01	0.42±0.03	-0.19±0.02
SPC	Genetic	0.01±0.14	-0.88±0.16	-0.90±0.15
	Permanent Environment	0.14±0.02	-0.93±0.18	-0.93±0.16

Results: Genetic and residual correlations:

Trait type	Traits	Genetic (above) and residual (below) correlations		
		FS80d	PD100d	PD200d
Binary	FS80d	-	0.54±0.16	0.60±0.15
	PD100d	0.42±0.17	-	0.95±0.20
	PD200d	0.12±0.02	0.97±0.02	-
Linear	DO	-	0.56±0.11	0.03±0.01
	CFS	0.28±0.01	-	0.99±0.19
	SPC	0.04±0.01	0.81±0.02	-

Conclusion (2):

- Possible to obtain alternative fertility traits
- Genetic correlations indicate possible traits to be used:
- Best traits:
  - C-1stAI,
  - DOPEN and
  - AI's/conception
- Wide genetic variations between cows gives scope for selection

Conclusion (3):

- Must accept that management has a large effect on traits
- Poor management extends intervals – seen as less fertile or unfertile cows
- Fertility aids improves reproduction management – observed as fertile cows

Most important reproduction indicators:

- **Should reflect the current reproduction status of cows in the herd:**

1. **Service rate of cows > 60 days-in-milk**

2. **Pregnancy rate of cows > 150 days-in-milk**

- Thank you for your attention
- Good luck with reproduction management