Additive genetic, non-additive genetic and permanent environmental effects for female reproductive traits in seasonal calving herds

M.M. Kelleher[1], F. Buckley[1], R.D. Evans[2], D. Ryan[3], K. Pierce[4], & D.P. Berry[1]

[1]Teagasc, Moorepark, Ireland
[2]Irish Cattle Breeding Federation , Ireland
[3]Reprodoc Ltd. Ireland
[4]University College Dublin, Dublin 4, Ireland

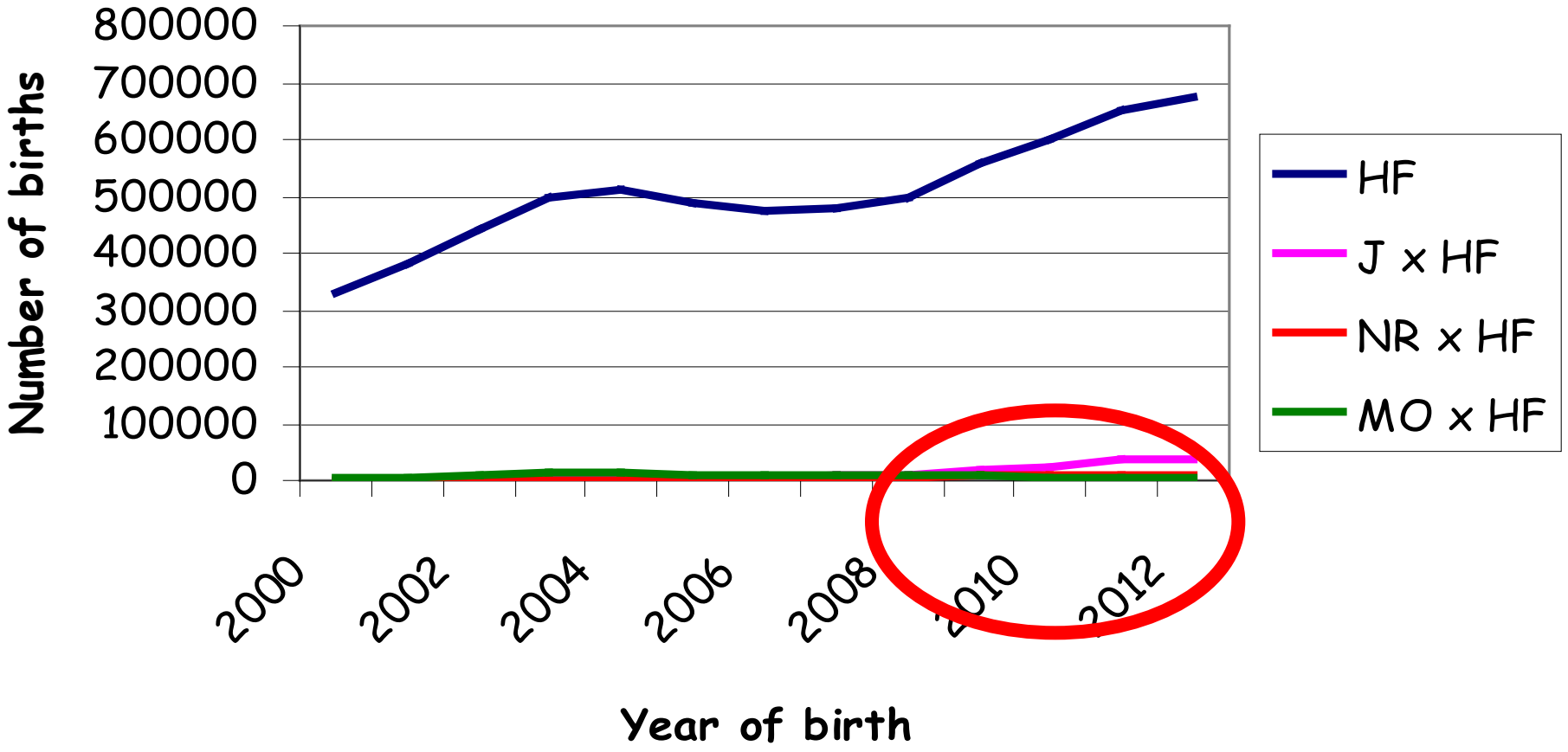
Margaret.Kelleher@teagasc.ie

64th Annual Meeting of the EAAP, Nantes, 26-30 August 2013

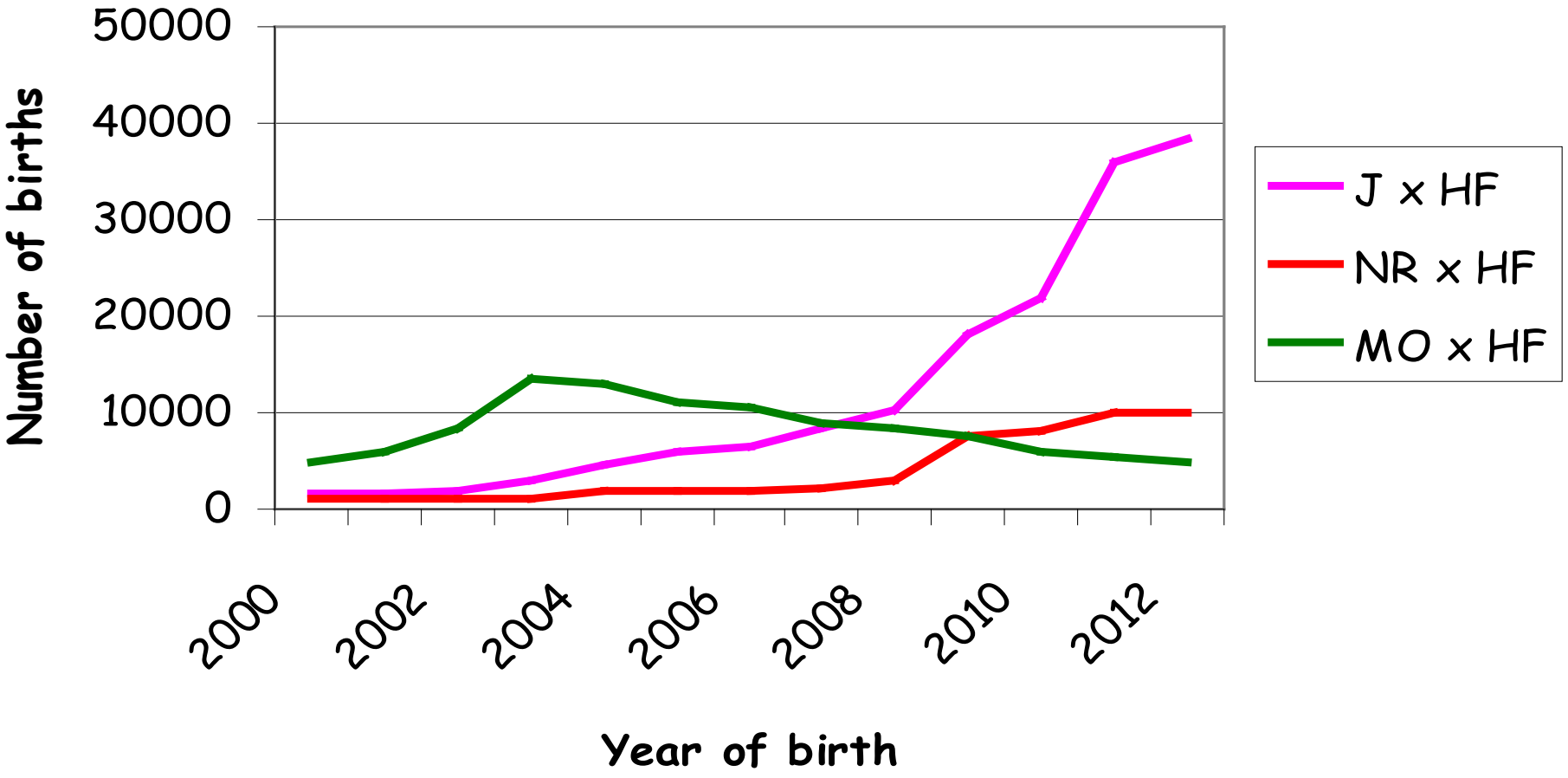
Motivation

- The Economic Breeding Index (EBI) – a tool used for breeding
  - Additive genetic merit
- Crossbreeding
  - Benefits of non-additive genetic effects

Calf registrations in Ireland



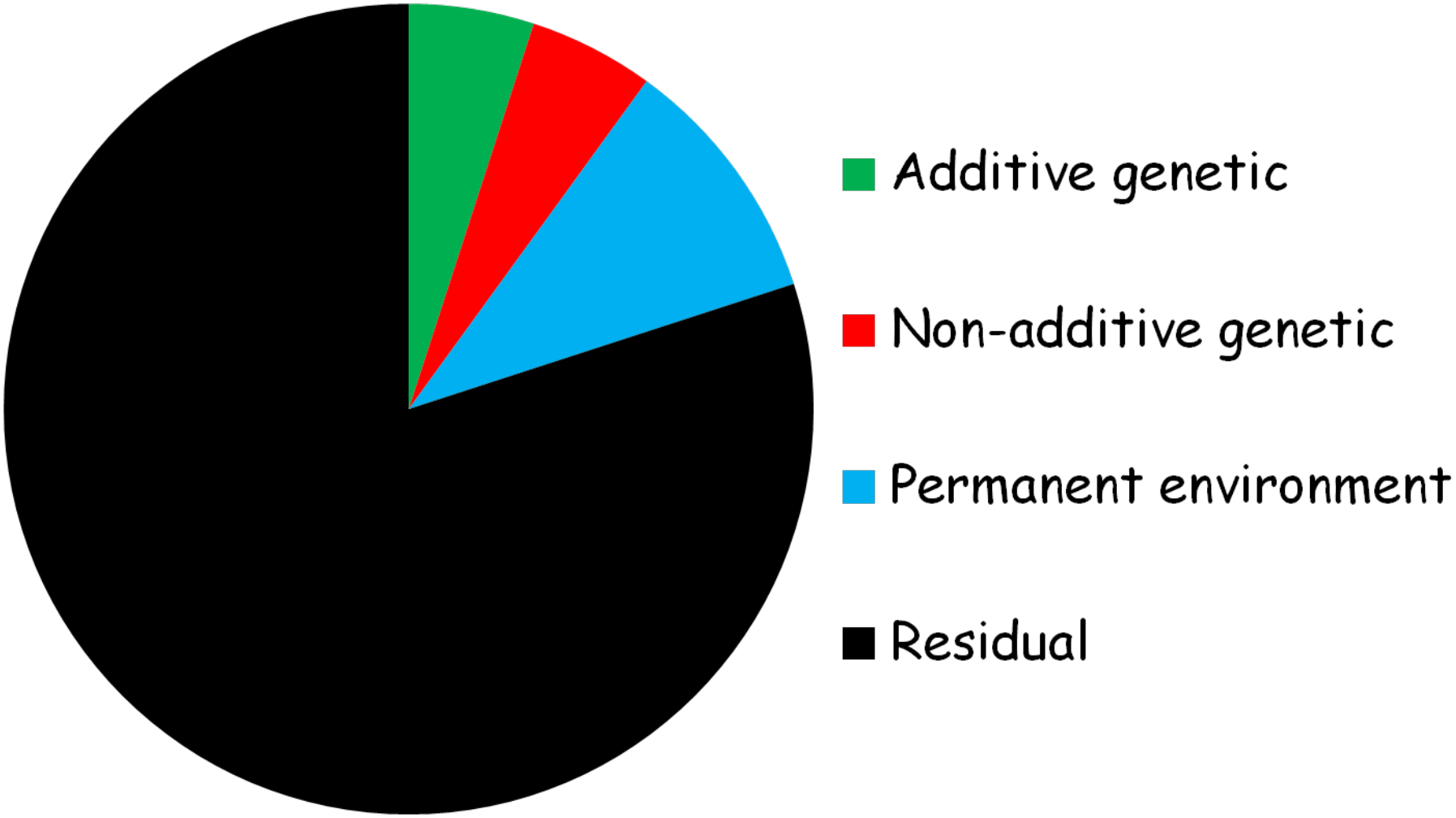
Calf registrations in Ireland



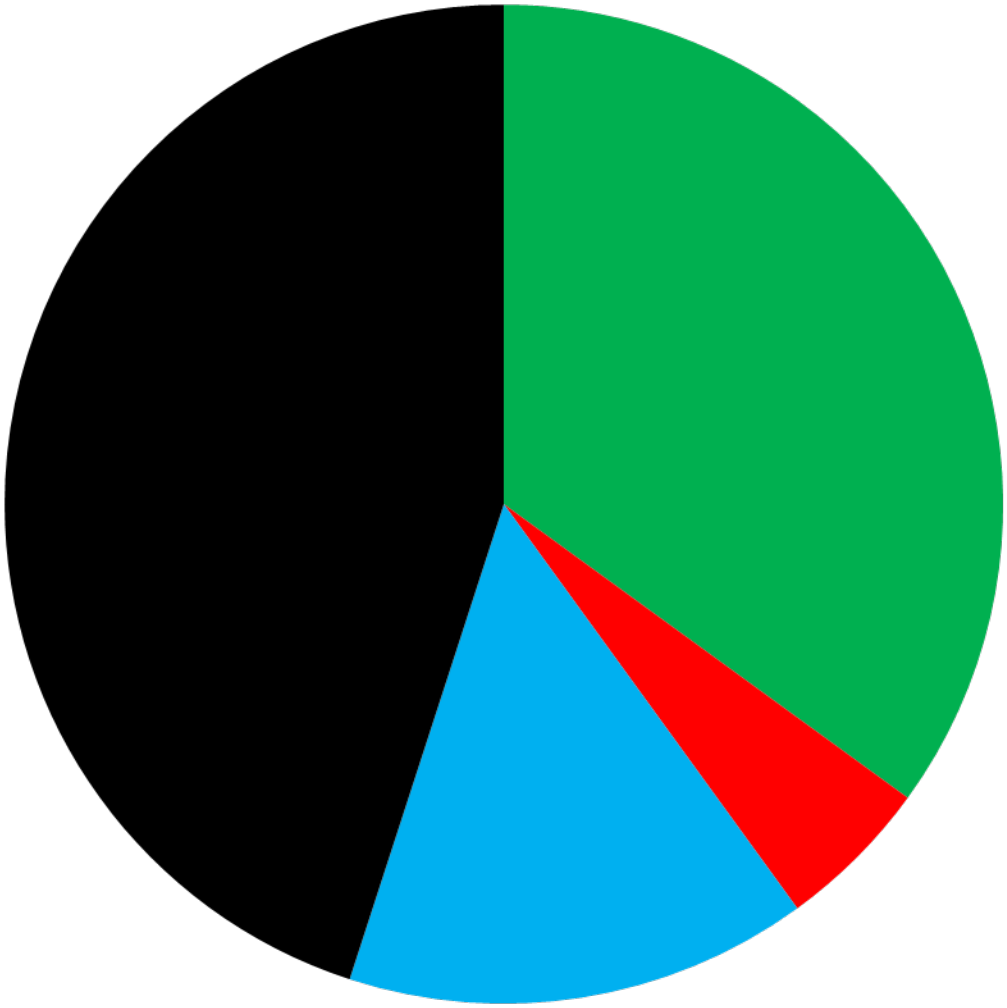
Motivation

- The Economic Breeding Index (EBI) – a tool used for breeding
  - Additive genetic merit
- Crossbreeding
  - Benefits of non-additive genetic effects
- Advances in technology
  - Use of sexed semen
- Reflect phenotypic performance
  - Permanent environment effect

Variance components



Variance components



- Additive genetic
- Non-additive genetic
- Permanent environment
- Residual

Objective

- To partition the phenotypic variance for a series of fertility traits into:
  - additive genetic
  - non-additive genetic
  - permanent environmental variance

- Part of a larger project to develop index including non-additive genetic effects
  - Better reflection of phenotypic performance

Data

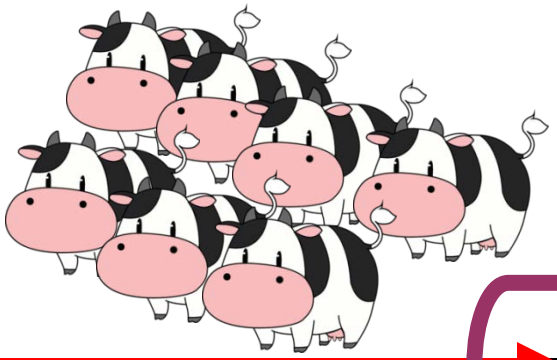
- Dairy cow data from 2006 to 2012
- Fertility traits for:
    - Maiden heifers
    - Primiparous cows
    - Multiparous cows
- Edits: obvious errors / severe outliers, contemporary group size

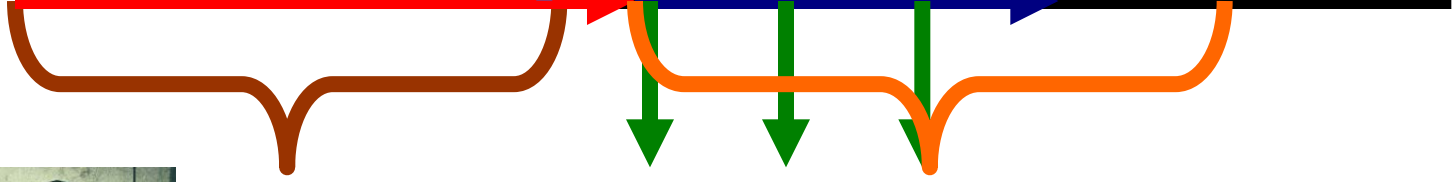
Heifer Fertility Traits

Age at first calving

Heifer success rate

Cow Fertility Traits





Calving rate 42 days

Calving to first service

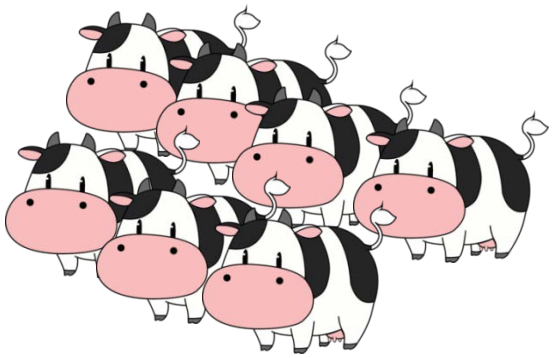
Number of services

Submission rate 21 days

Pregnancy rate first service

Pregnancy rate 42 days

Cow Fertility Traits



Calving interval

Analysis

- Repeatability animal model

$$Y = Xb + Za + Wp + e$$

- Fixed effects
  - Contemporary group
  - Parity
  - Heterosis
  - Recombination loss

Analysis

- Alternative cow ranking indices
  1. Phenotype

Analysis

- Alternative cow ranking indices
  1. Phenotype
  2. Fixed + additive genetic effects

Analysis

- Alternative cow ranking indices
  1. Phenotype
  2. Fixed + additive genetic effects
  3. + Non-additive and permanent environmental effects

Results

Variance components

Traits	h^2
Maiden heifer traits	
Heifer calving rate	0.02
Age of first calving	0.07
Primiparous cow trait	
Calving rate at 42 days	0.01

Variance components

Multiparous cow traits	h^2
Calving to first service	0.04
Calving interval	0.04
Number of services	0.02
Submission rate	0.02
Calving rate	0.001
Pregnant to first service	0.02
Preg 42 d from start breed	0.03

Plenty of additive genetic variation

Non-additive effects

Trait	Heterosis	Rec. Loss
Heifer calving rate	-0.05%	0.30%
Age of first calving	-1.00%	-0.72%
Calving rate primiparous	5.44%	0.01%
Calving to first service	-0.69%	-1.02%
Calving interval	-1.43%	-0.02%
Number of services	-2.75%	-2.53%
Submission rate	3.12%	1.66%
Calving rate	2.85%	0.49%
Pregnant to first service	5.19%	2.07%
Preg 42 d from start breed	5.66%	-2.37%

Non-additive effects

Trait	Heterosis	Rec. Loss
Heifer calving rate	-0.05%	0.30%
Age of first calving	-1.00%	-0.72%
Calving rate primiparous	5.44%	0.01%
Calving to first service	-0.69%	-1.02%
Calving interval	-1.43%	-0.02%
Number of services	-2.75%	-2.53%
Submission rate	3.12%	1.66%
Calving rate	2.85%	0.49%
Pregnant to first service	5.19%	2.07%
Preg 42 d from start breed	5.66%	-2.37%

Non-additive effects

Trait	Heterosis	Rec. Loss
Heifer calving rate	-0.05%	0.30%
Age of first calving	-1.00%	-0.72%
Calving rate primiparous	5.44%	0.01%
Calving to first service	-0.69%	-1.02%
Calving interval	-1.43%	-0.02%
Number of services	-2.75%	-2.53%
Submission rate	3.12%	1.66%
Calving rate	2.85%	0.49%
Pregnant to first service	5.19%	2.07%
Preg 42 d from start breed	5.66%	-2.37%

Genetic correlations

	CIV	CFS	NS	SR21	CR42
CFS	0.92				
NS	0.75	0.10			
SR21	-0.78	-0.82	-0.17		
CR42	-0.83	-0.50	-0.51	0.43	
PR42	-0.95	-0.71	-0.80	0.78	0.70

CFS= Calving to first service CIV= Calving interval NS= Number of services

SR21= Submission rate in first 21 days of breeding season

CR42= Calving rate in the first 42 days of calving season

Genetic correlations

	CIV	CFS	NS	SR21	CR42
CFS	0.92				
NS	0.75	0.10			
SR21	-0.78	-0.82	-0.17		
CR42	-0.83	-0.50	-0.51	0.43	
PR42	-0.95	-0.71	-0.80	0.78	0.70

CFS= Calving to first service CIV= Calving interval NS= Number of services

SR21= Submission rate in first 21 days of breeding season

CR42= Calving rate in the first 42 days of calving season

Genetic correlations

	CIV	CFS	NS	SR21	CR42
CFS	0.92				
NS	0.75	0.10			
SR21	-0.78	-0.82	-0.17		
CR42	-0.83	-0.50	-0.51	0.43	
PR42	-0.95	-0.71	-0.80	0.78	0.70

CFS= Calving to first service CIV= Calving interval NS= Number of services

SR21= Submission rate in first 21 days of breeding season

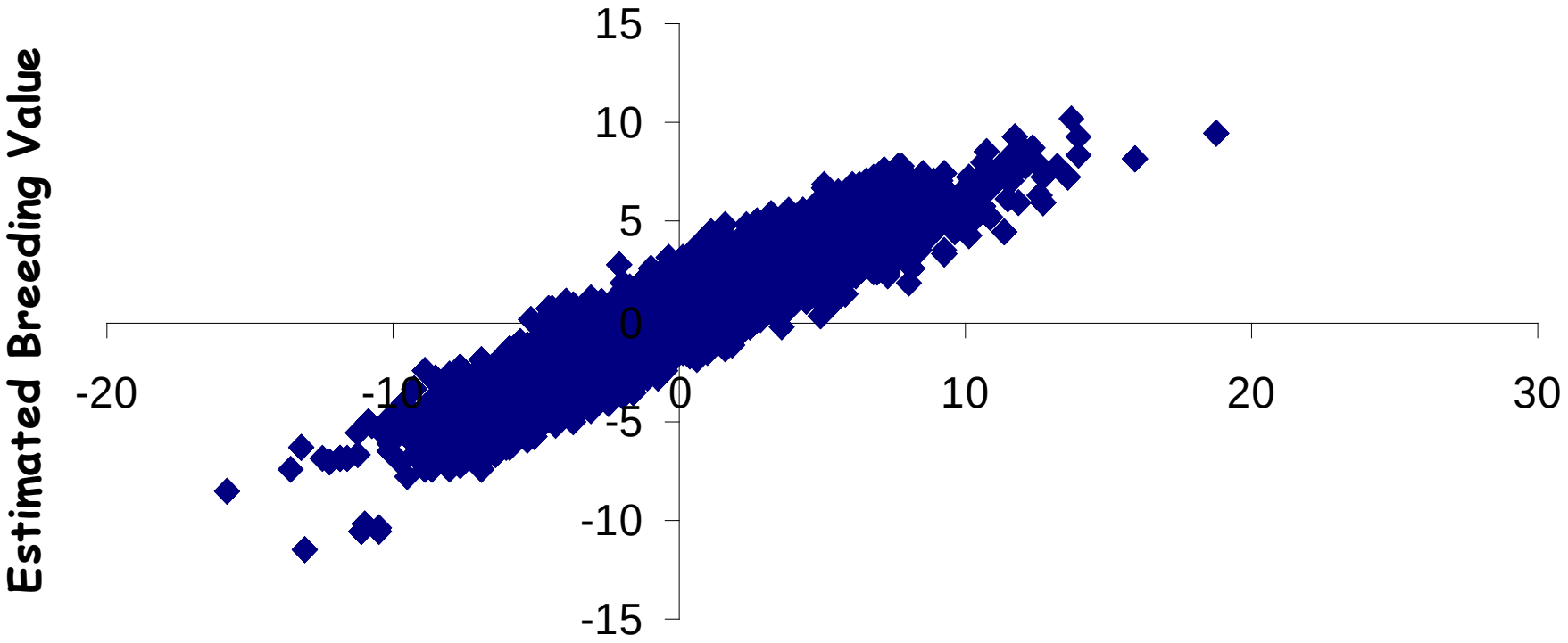
CR42= Calving rate in the first 42 days of calving season

Correlations: Alternative indexes

		Phenotypic	EBV
CFS	EBV	0.42	
	Fertility index	0.68	0.93
CIV	EBV	0.52	
	Fertility index	0.75	0.95
PR42	EBV	0.43	
	Fertility index	0.87	0.85

EBV= Estimated Breeding Values
Fertility index= Additive + Non-additive + Permanent environment
CFS= Calving to first service
CIV= Calving interval
PR42= Pregnancy rate in the first 42 days of calving season

Correlation between EBV and cow fertility index



Conclusions

- Ample exploitable genetic variation in female fertility
- Considerable (exploitable) contribution of non-additive genetic effects
- Considerable contribution of permanent environmental effects
- Combined index is biologically a better reflection of expected performance

Index: Additive + Non-Additive + Permanent Environment

Questions???