Agrar- und Ernährungswissenschaftliche Fakultät

Christian-Albrechts-Universität zu Kiel

Institut für Tierzucht und Tierhaltung

Pedigree analysis and estimation of inbreeding effects on calving traits in an organized performance test for functional traits

D. Hinrichs, J. Almeroth, and G. Thaller

Institute of Animal Breeding and Husbandry, Christian-Albrechts-University

Outline

- Introduction
- Material and methods
- Results
- Discussion
- Outlook

Introduction

Inbreeding occurs if parents have ancestors in common

Inbreeding can not be avoided in closed populations

Inbreeding is associated with:

- Loss of heterozygosity
- Reduction of genetic variance
- Inbreeding depression

Introduction

- **Inbreeding depression in Holstein Friesian (some examples)**
  - **Wiggans et al. (1995)**
    - **Inbreeding depression per percent increase in F**
      - **- 29.6kg milk**
      - **- 1.08kg fat**
      - **- 0.97kg protein**
  - **Sörensen et al. (2006) reported inbreeding depression for mastitis**

Material and Methods

Performance test - phenotypic data

Data recording on three commercial farms with an overall herd size of 3,200 cows – mimic HF situation in Germany

- **Data recording period from February 1998 to December 2008**
- **36,610 calvings observed**
- **All calves were weighed after birth**
- **Calving ease was recorded on a scale between 1 and 5**

Introduction

Aim of this study

- Pedigree analysis, with respect to
  - Effective number of founders
  - Ancestors with highest impact
- Estimation of inbreeding effects for
  - Stillbirth
  - Birth weight

Material and Methods

Incidence of stillbirth in data set

- 8.08% of all calving events were coded as stillbirth in total
  - 10.11% bull calves were born dead
  - 5.85% cow calves were born dead
  - First calving cows had a stillbirth rate of 13.52%
  - Stillbirth rate in lactation numbers > 1 was 4.87%

Material and Methods

Pedigree information

- Pedigree was constructed in collaboration with VIT Verden
  - Pedigree includes 70,938 animals
    - 25,485 bulls
    - 45,453 cows
  - Pedigree goes back until 1906, but most animals were born after 1950
  - Program PEDIG was used

Material and Methods

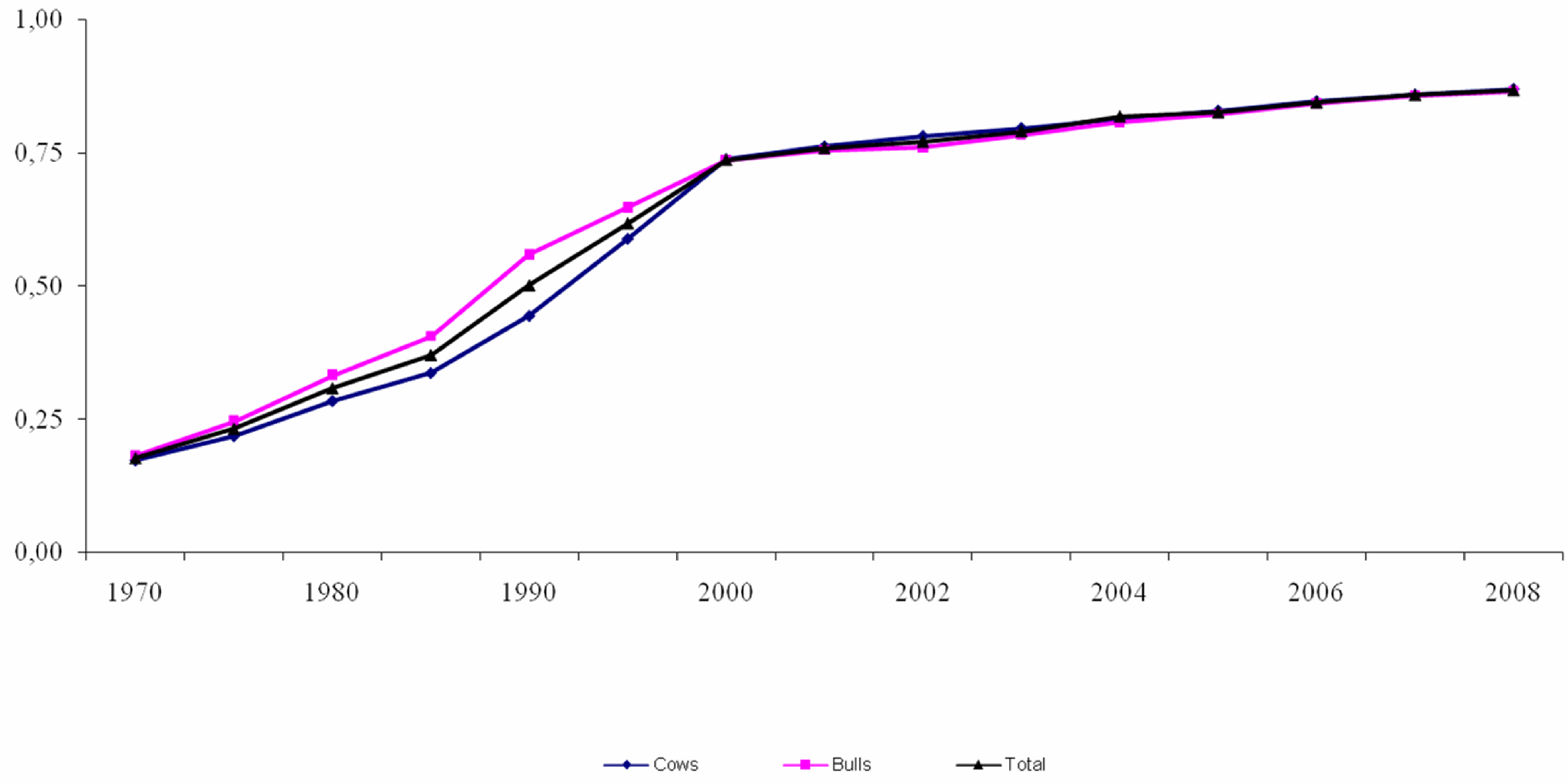
Model

- $y_{ijklmn} = hks_i + glnr_j + \beta F_k + mv_l + animal_m + e_{ijklmn}$

  where:
  - y_{ijklmn} = Observation (birth weight or stillbirth)
  - hks_i = Effect of ith herd-calving-season
  - $glnr_j$ = Effect of sex within lactation
  - βF_k = Regression on inbreeding coefficient of the dam or of the calf
  - mv_l = Effect of the maternal grandsire
  - $animal_m$ = Effect of the animal
  - e_{ijklmn} = Residual effect

Results

Pedigree completeness (10 generations)



Results

	Reference population 1 (1999 – 2003)	Reference population 2 (2003-2008)
Effective number of founders	95	83
Number of ancestors explaining 50% of the gene pool	8	7
Number of ancestors explaining 75% of the gene pool	50	30
Number of ancestors explaining 95% of the gene pool	600	400

Results

Total and marginal genetic contribution (%) of the 10 ancestors with the highest impact on reference population 1 (1999 – 2003)

Name	total	marginal	year of birth
Elevation	14.66	14.66	1965
Chief	10.03	10.03	1962
Bell	5.50	5.50	1974
Cleitus	7.67	4.80	1981
Blackstar	7.31	4.57	1983
Dam of Starbuck	4.08	4.08	1971
Dam of Valerian	3.73	3.73	1966
Ivanho	9.02	2.44	1952
Fond Matt	2.58	2.12	1960
Ned Boy	2.21	1.79	1979
Total		53.72	

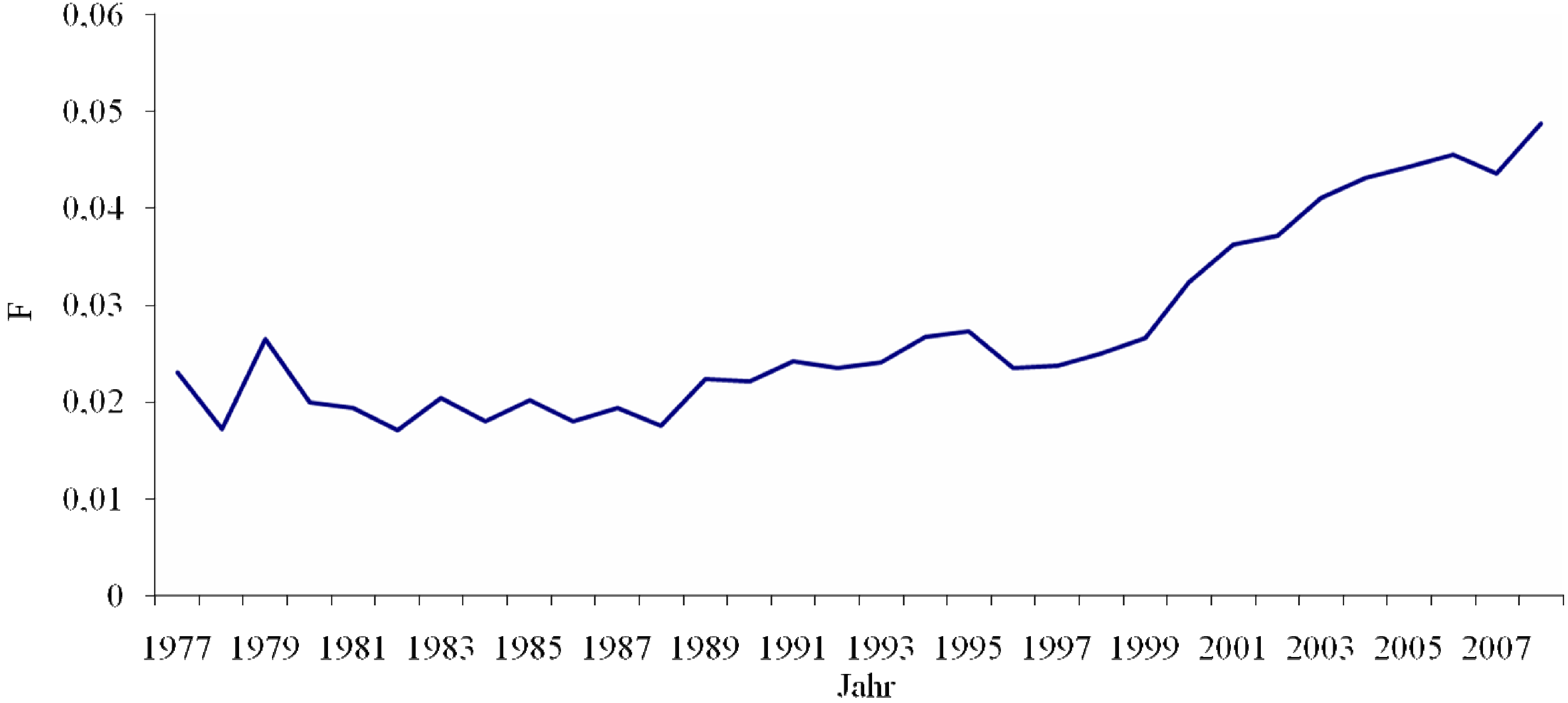
Results

Total and marginal genetic contribution (%) of the 10 ancestors with the highest impact on reference population 2 (2003 – 2008)

Name	total	marginal	year of birth
Elevation	15.73	15.73	1965
Chief	10.57	10.57	1962
Bell	6.67	6.67	1974
Blackstar	8.01	5.00	1983
Dam of Starbuck	4.87	4.87	1971
Dam of Valerian	3.87	3.87	1966
Cleitus	6.11	3.82	1981
Ivanho	9.73	2.42	1952
Dam of Aerostar	2.92	2.19	1980
Ned Boy	2.61	2.12	1979
Total		57.26	

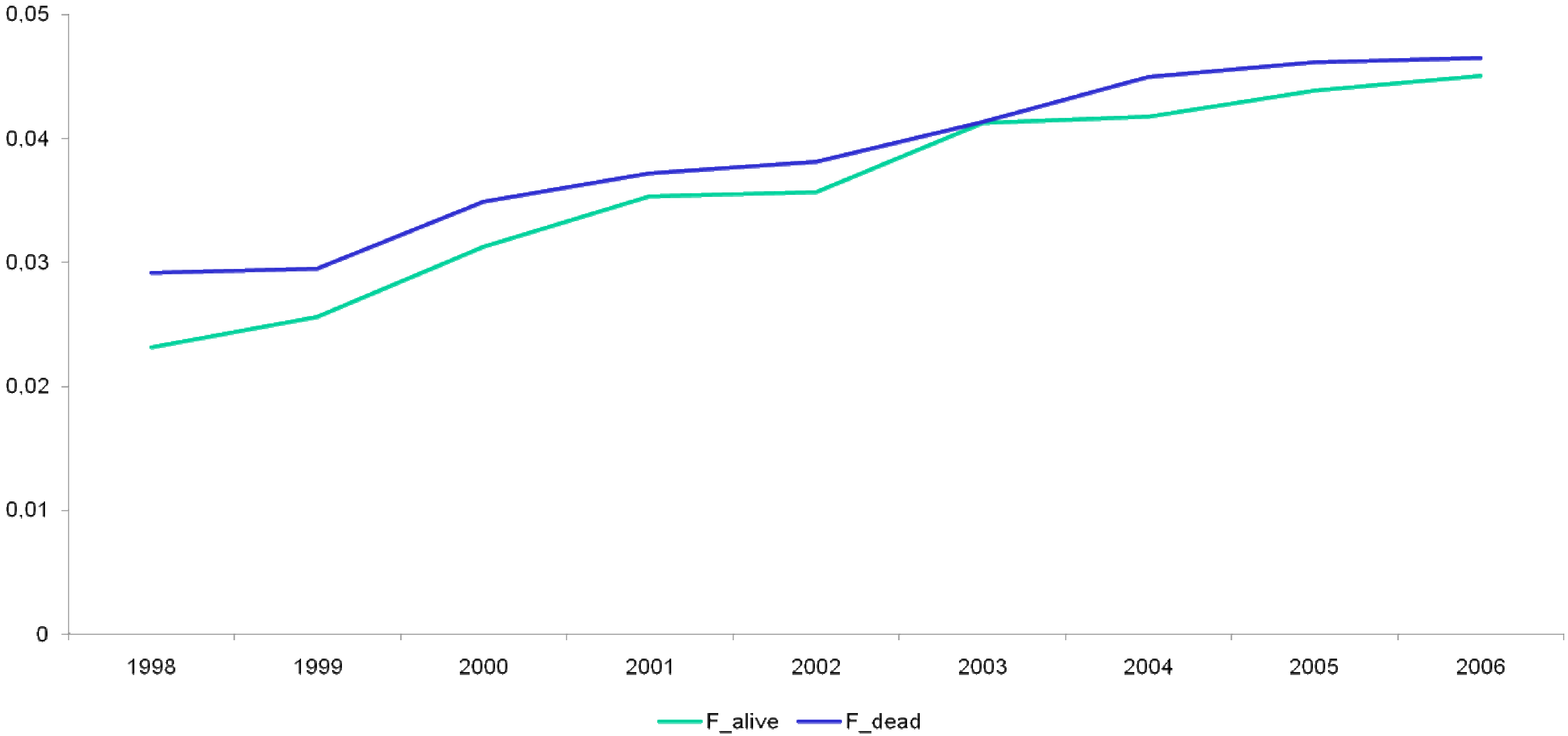
Results

Development of F over time



Results

Inbreeding coefficient of calves born alive vs. inbreeding coefficients of calves died within 48 hours after birth (stillbirth)



Results

Regression on inbreeding coefficient of the cow

	Birth weight (kg)	Stillbirth (%)
Additive genetic variance	5.26	0.0023
Maternal grandsire variance	0.049	0.0000007
Residual variance	19.59	0.07
Heritability	0.21	0.03
Regression on F	0.45	0.20

=> Both regression coefficients on F were not significant

Results

Regression on inbreeding coefficient of the calf

	Birth weight (kg)	Stillbirth (%)
Additive genetic variance	15.59	0.0017
Maternal grandsire variance	0.0000012	0.00043
Residual variance	11.70	0.07
Heritability	0.57	0.03
Regression on F	- 0.24	0.26

=> The regression coefficents on F for birth weight was not significant, *but the regression on F for stillbirth was significant.*

Conclusion

- Ancestors and marginal genetic contributions of this study are in agreement with other studies, e.g. Hansen (WCGALP,2006)

- The number of effective founders decreases from 95 to 83 (?)

Conclusion

Inbreeding of cow not significant but

*** higher birth weight of calf (0.453 kg / %F)**

*** higher stillbirth rate (+0.2% / %F)**

Inbreeding of the calf causes

*** lower birth weight (-0.244kg / %F), n.s.**

*** higher stillbirth rate (+0.26% / %F) (*)**

Outlook

– Using different approaches for the estimation of inbreeding effects, e.g.

  * concept of ancestral inbreeding

  * partial inbreeding -> ancestors

– Estimation of inbreeding effects for further functional traits, e.g. effect of inbreeding on different diseases

Thanks for your attention