Genetic Trends for Long Term Drivers of Dairy Efficiency

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- Professor of Dairy Genetics

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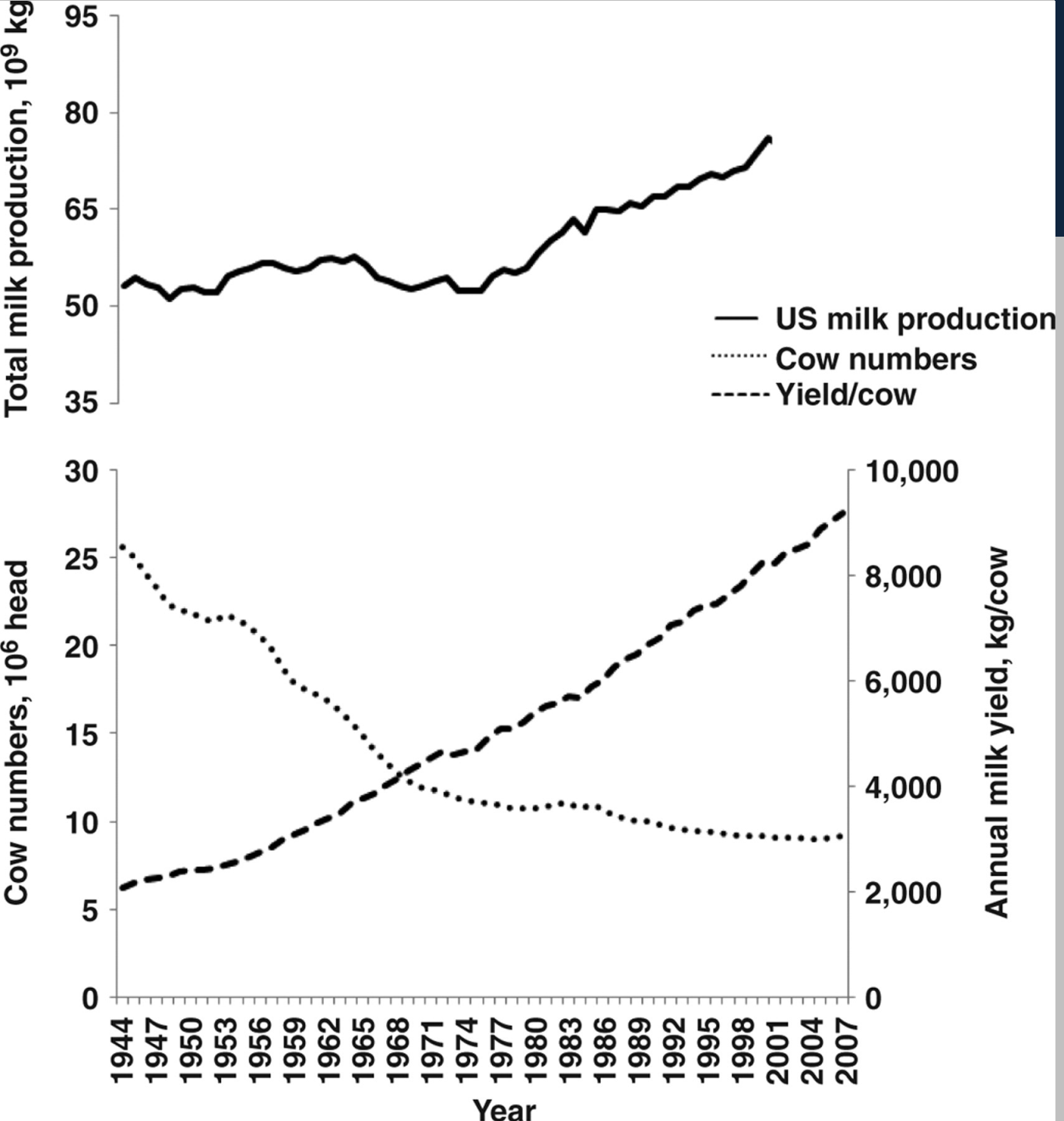
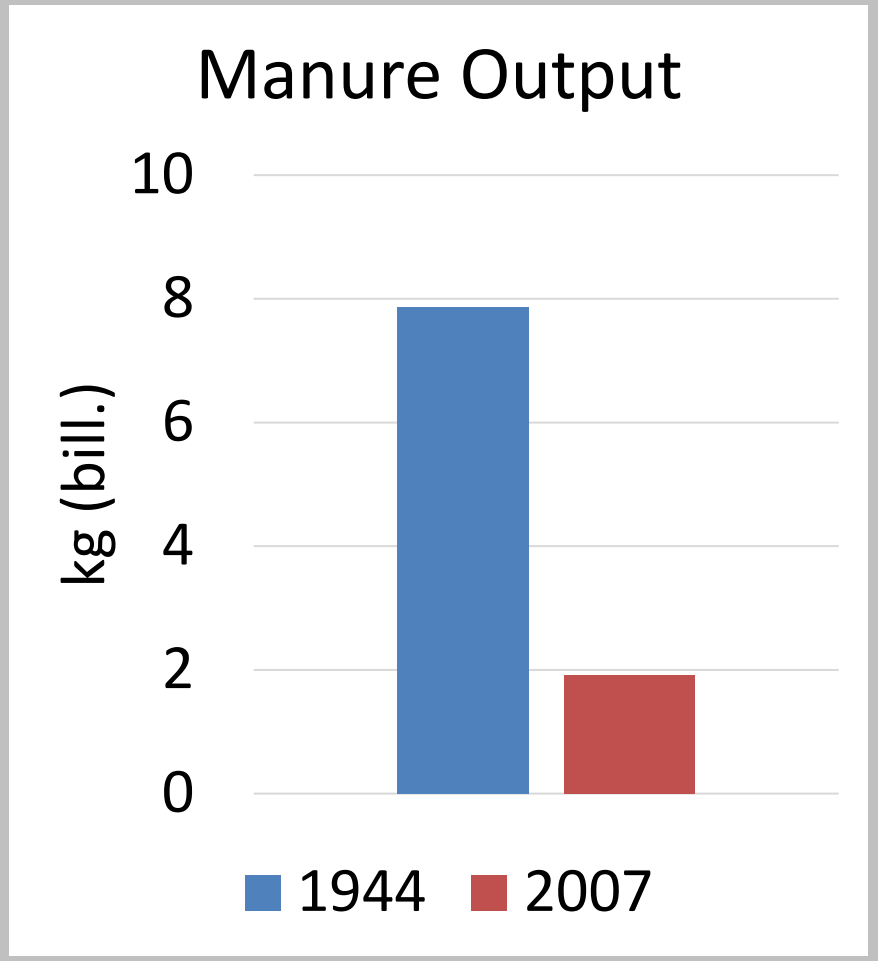
Agricultural Sciences

Dairy Efficiency





Capper et al., 2009

IFSM

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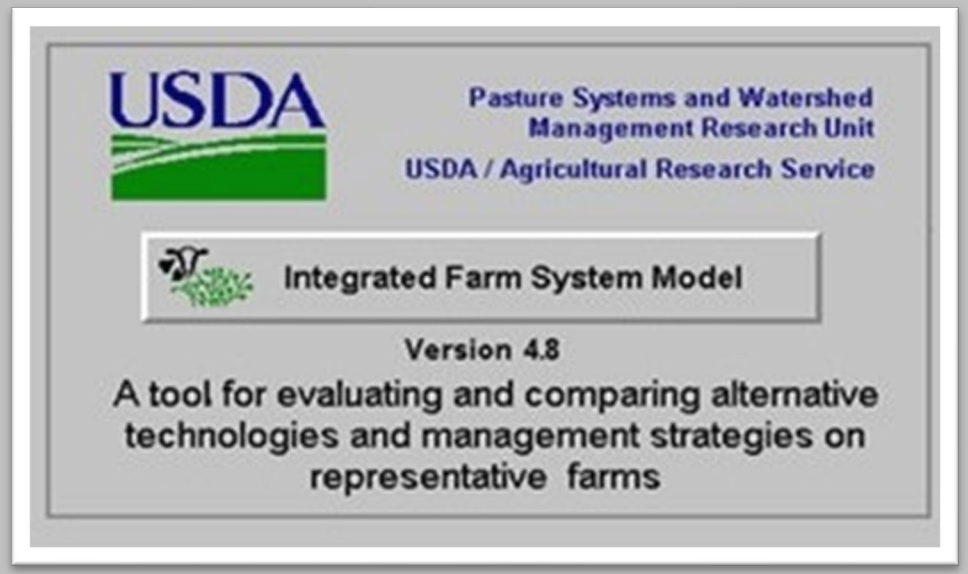
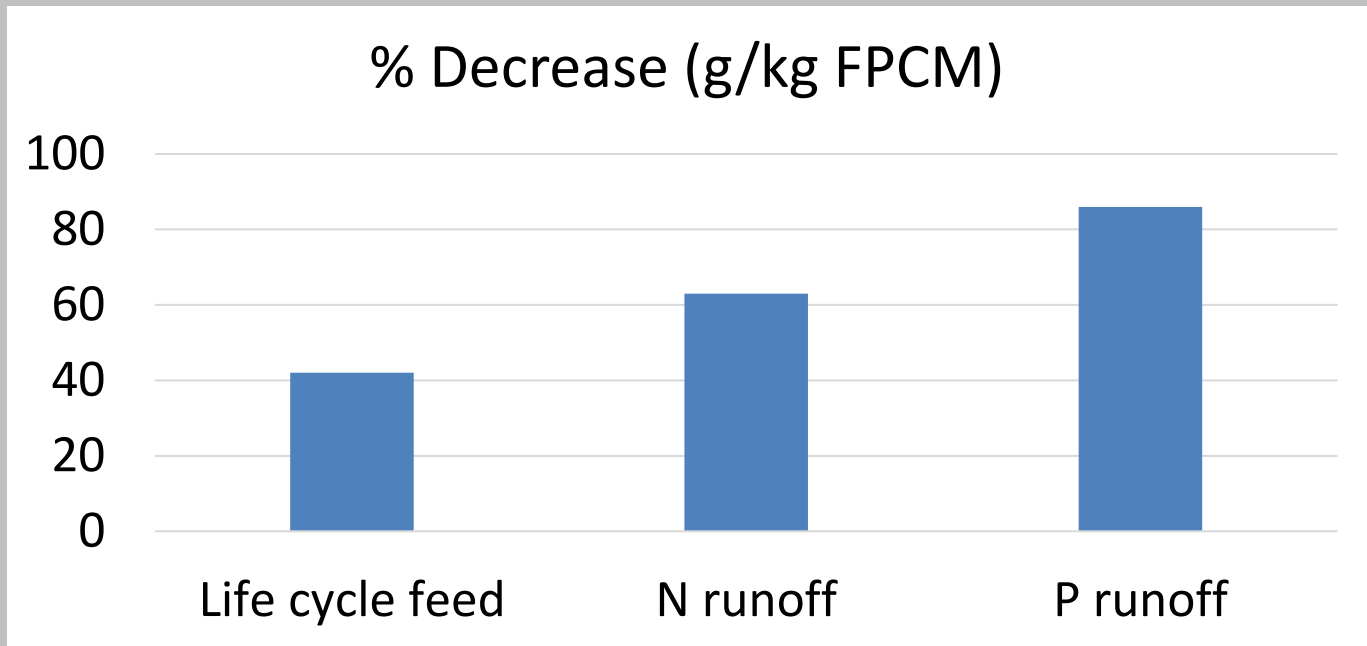
Fifty years of environmental progress for United States dairy farms

C. A. Rotz,[1]* D. Beegle,[2] J. K. Bernard,[3] A. Leytem,[4] G. Feyereisen,[5] R. Hagevoort,[6] J. Harrison,[7] G. Aksland,[8] and G. Thoma[9]





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Effects of genetic and environmental trends from 1970 to 2020 on farm efficiency estimated with a whole-farm modeling system

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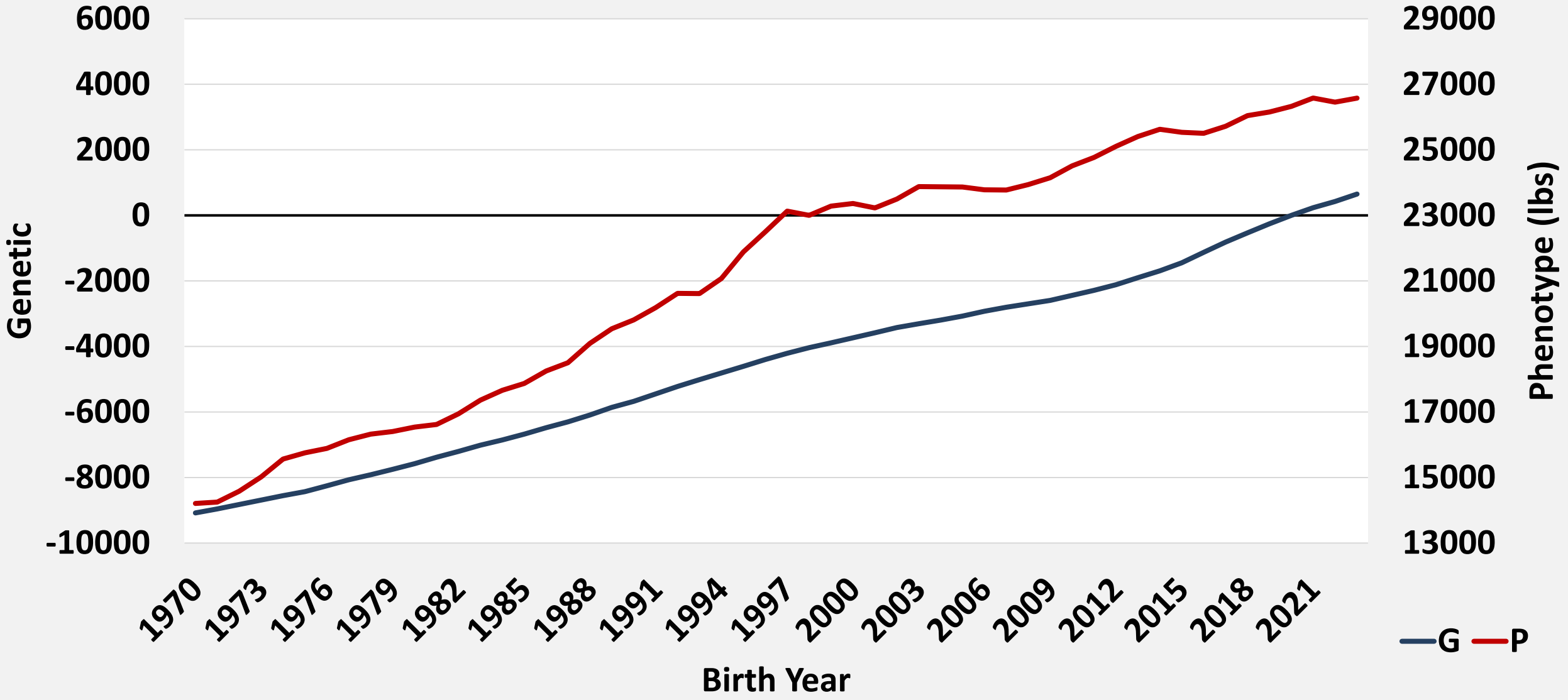
- Factors driving in efficiency
- Genetic change in individual traits v. expectations from $NM.

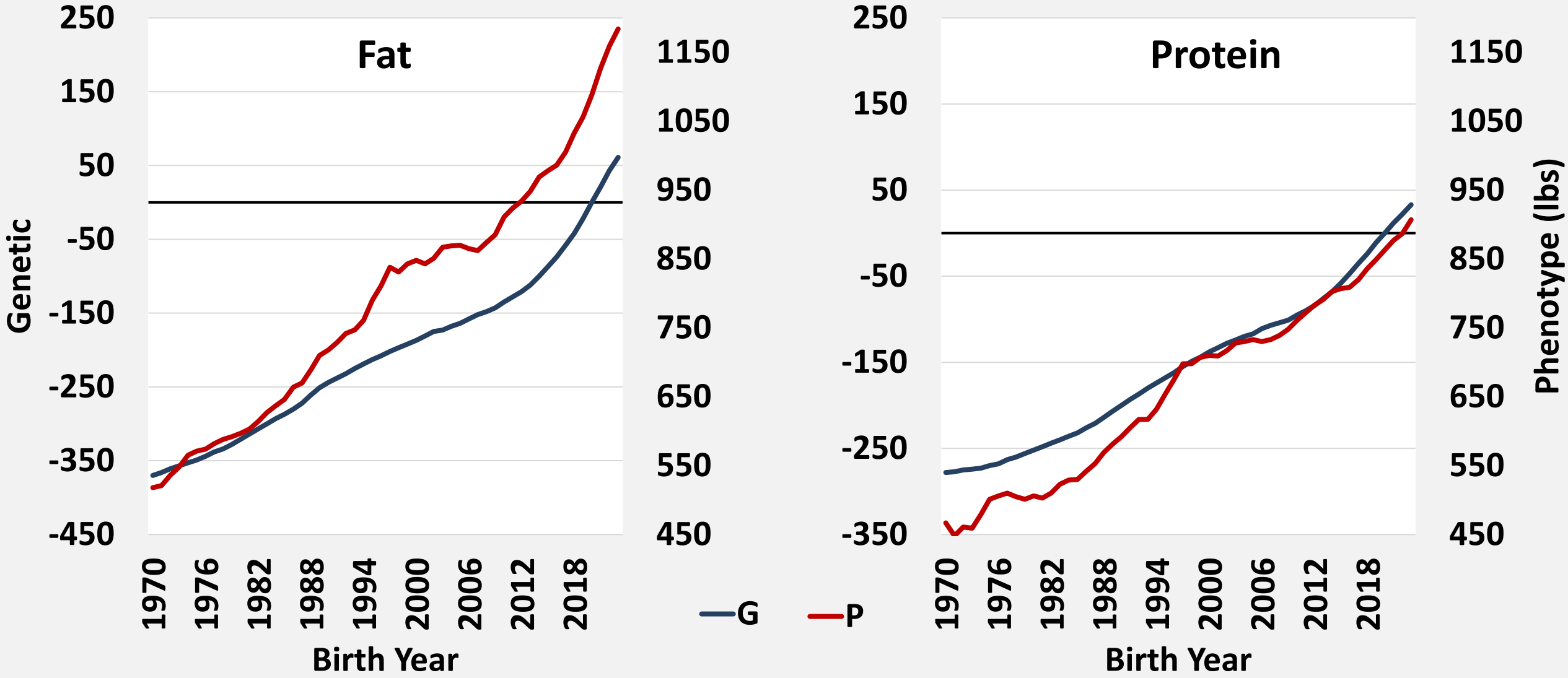
Topics

- **Genetic & phenotypic trends**
- **Integrated Farm System Model**
  - Efficiency gains
- **Efficiency gains & $NM**
- **Butter fat problem?**

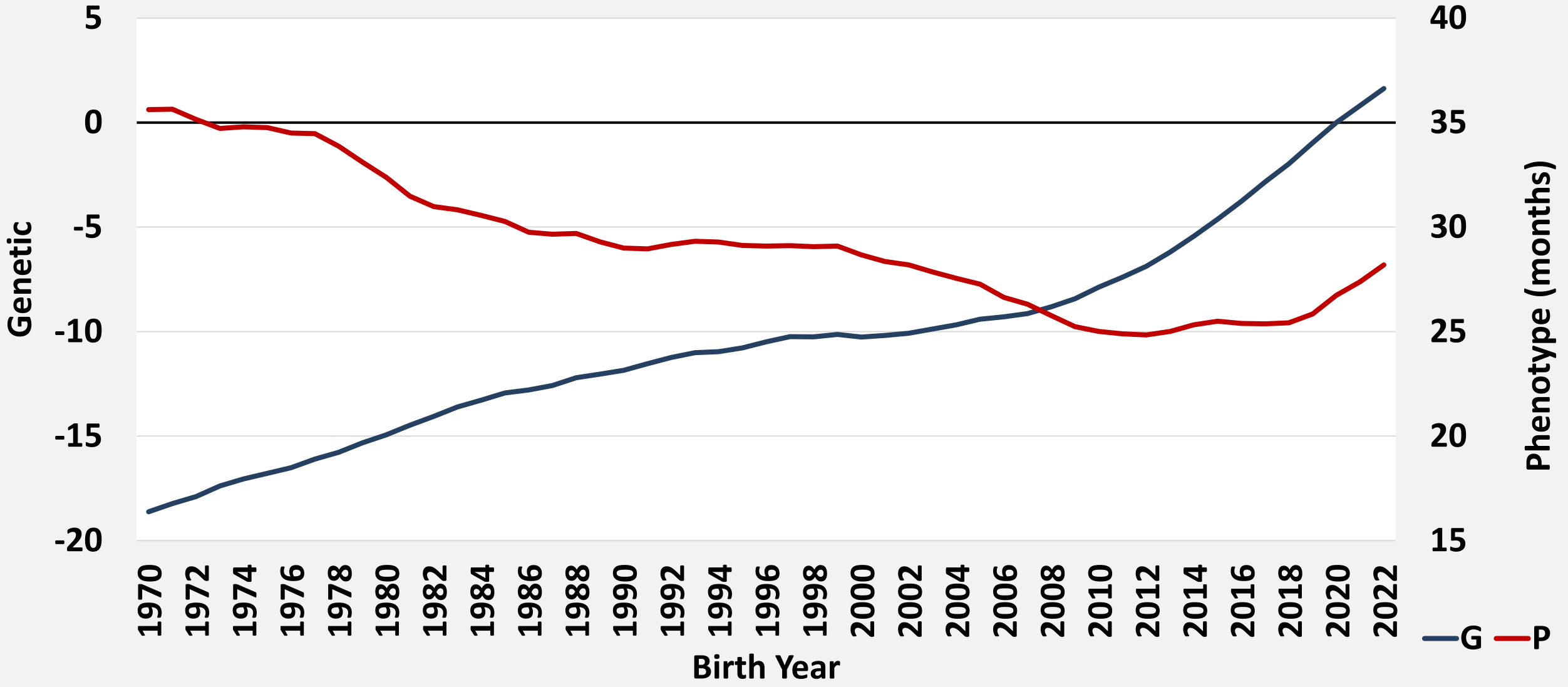
Milk: P = G + E


6000
4000
2000
0
-2000
-4000
-6000
-8000
-10000
Genetic
29000
27000
25000
23000
21000
19000
17000
15000
13000
Phenotype (lbs)
1970
1973
1976
1979
1982
1985
1988
1991
1994
1997
2000
2003
2006
2009
2012
2015
2018
2021
Birth Year
G
P

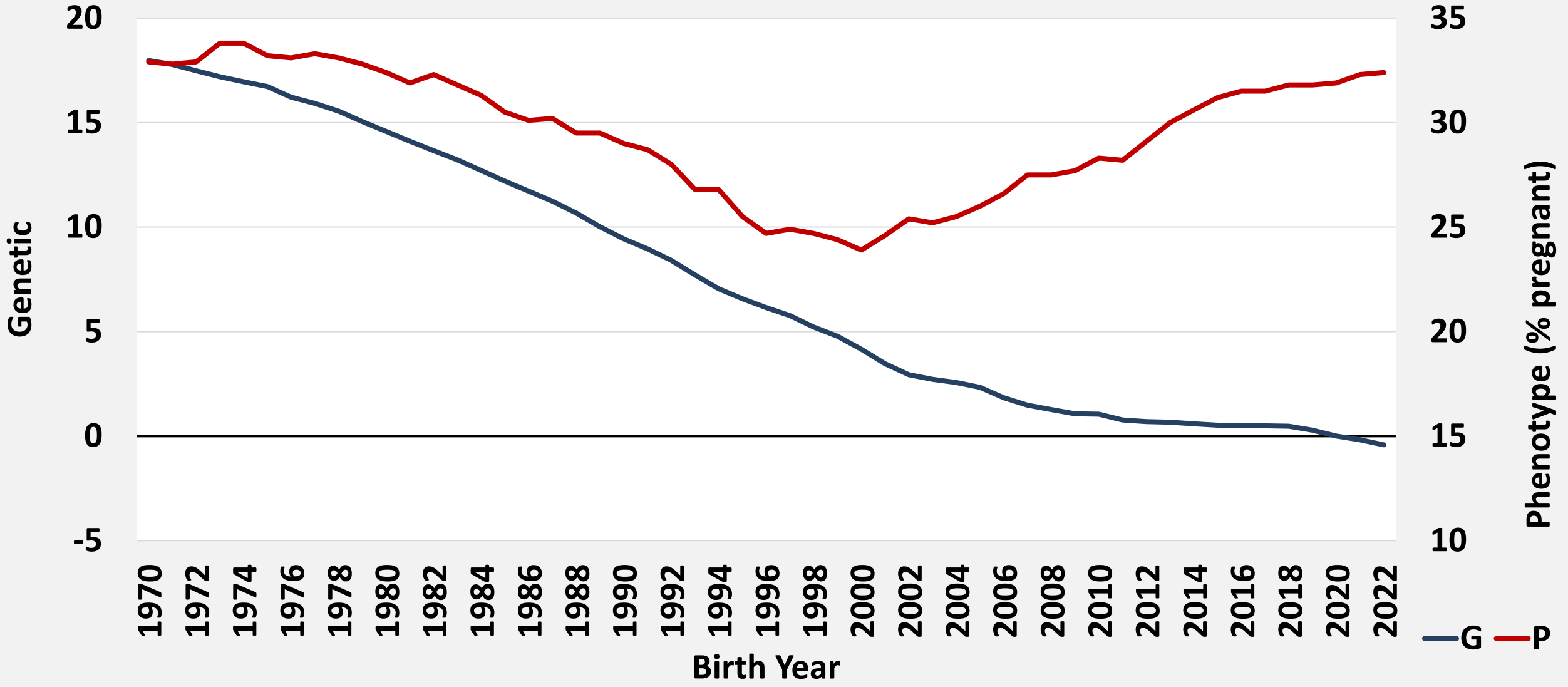
Fat and Protein



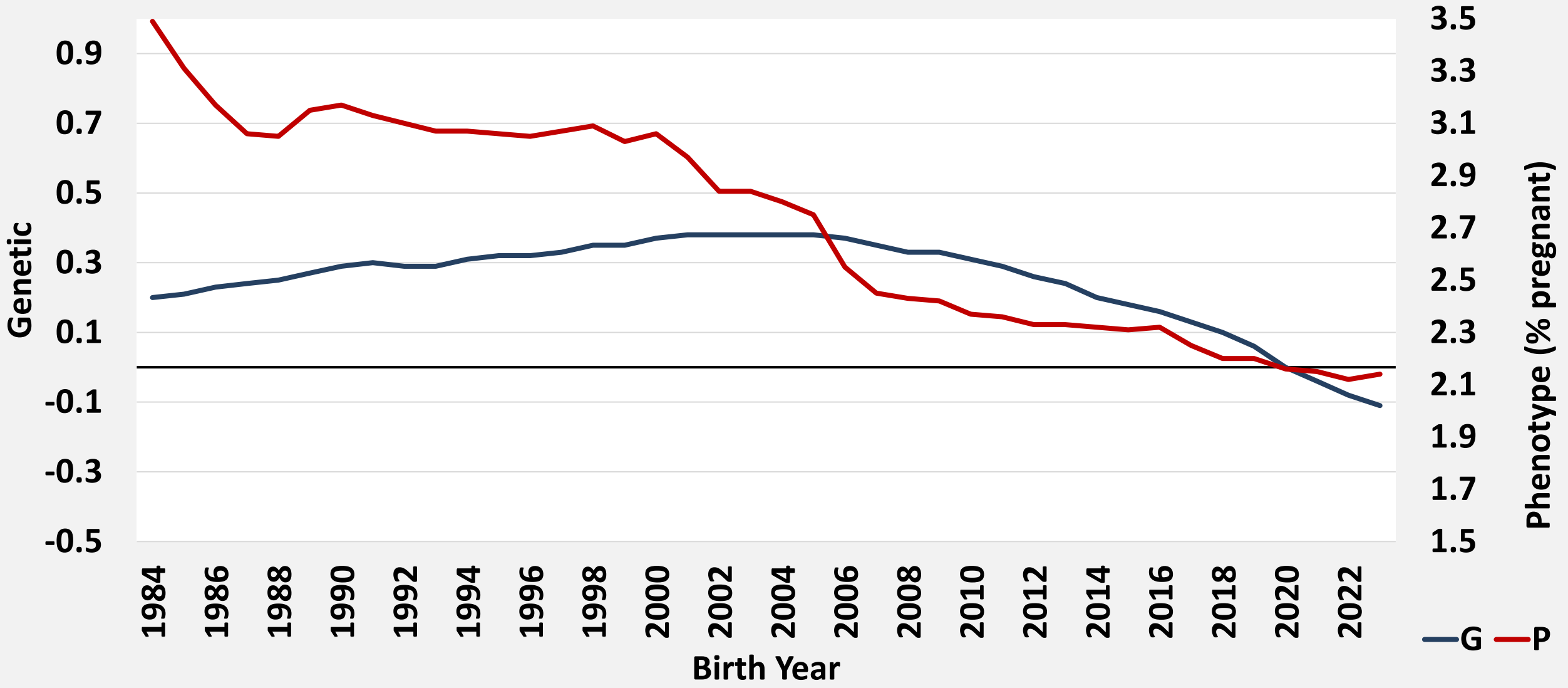
Productive Life



Daughter Pregnancy Rate



Somatic Cell Score



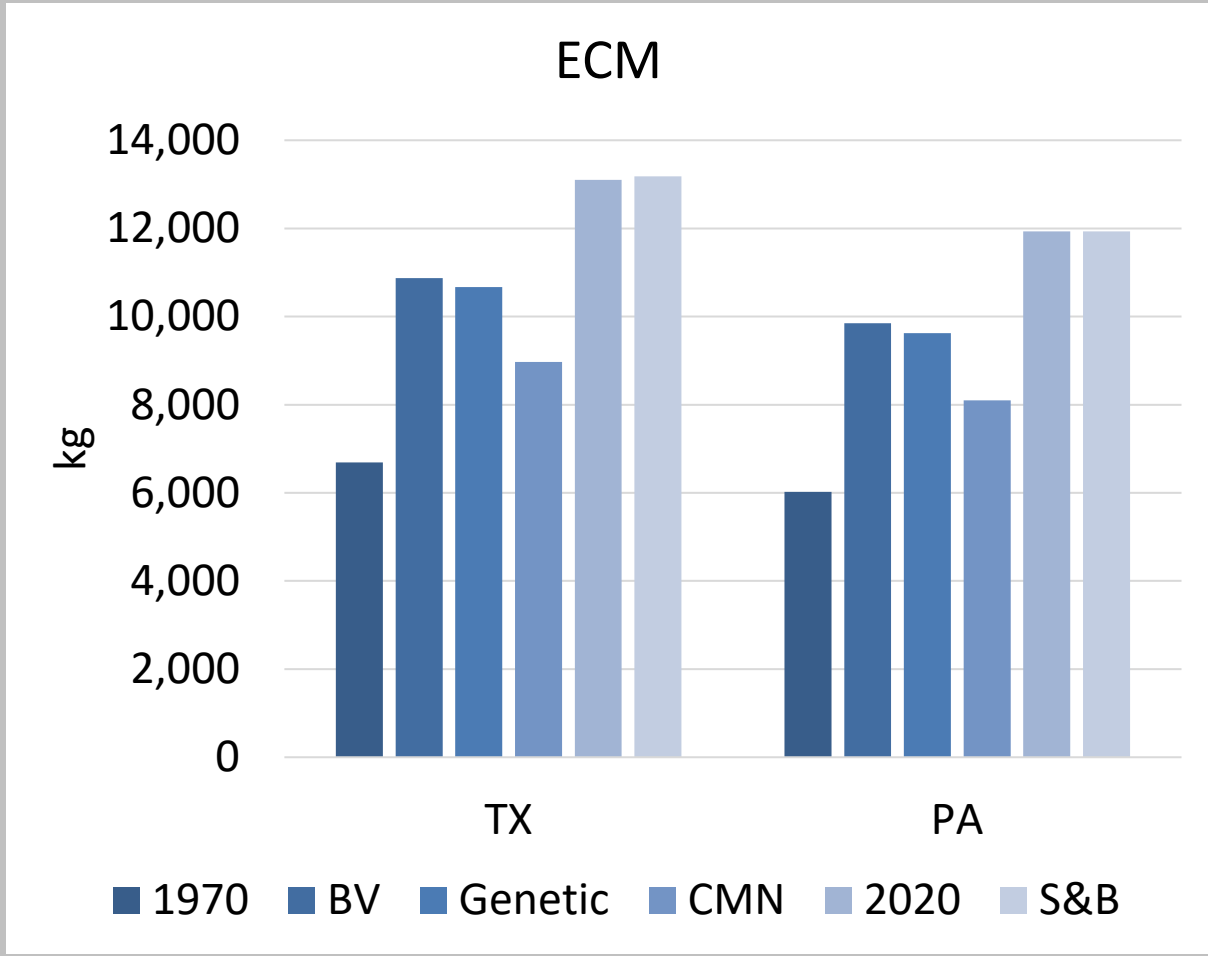
IFSM: Cow and Crop Yields

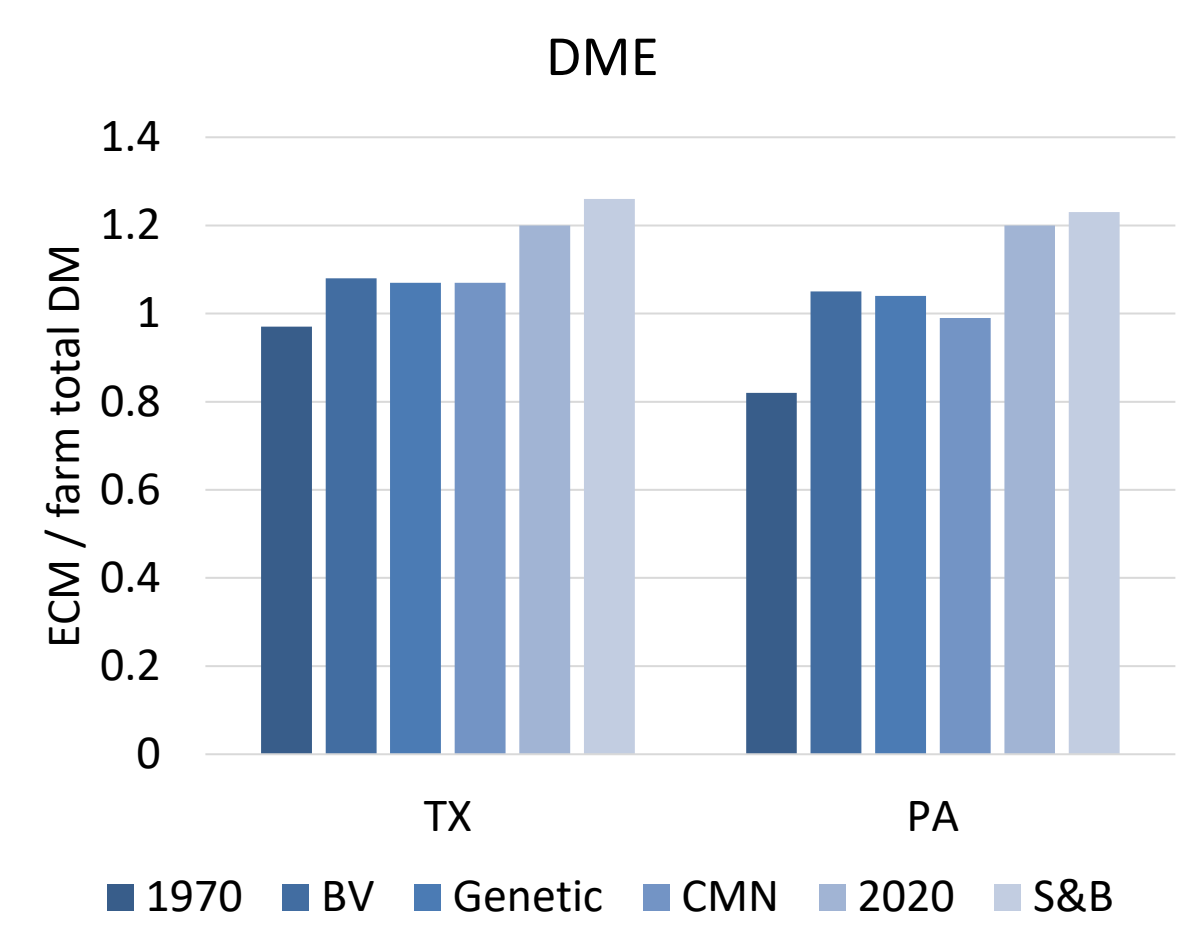
- **Cow trends**
  - Genetic, nutrition & management, inbreeding
  - Yields, replacements rates, fertility, body size, health treatments
  - Economic values based on $NM
- **Crop trends**
  - Genetics and management, CO_2 fertilization
  - Land required to grow forage and energy
  - Protein supplements purchased
- **Economic efficiency v profitability**

Systems

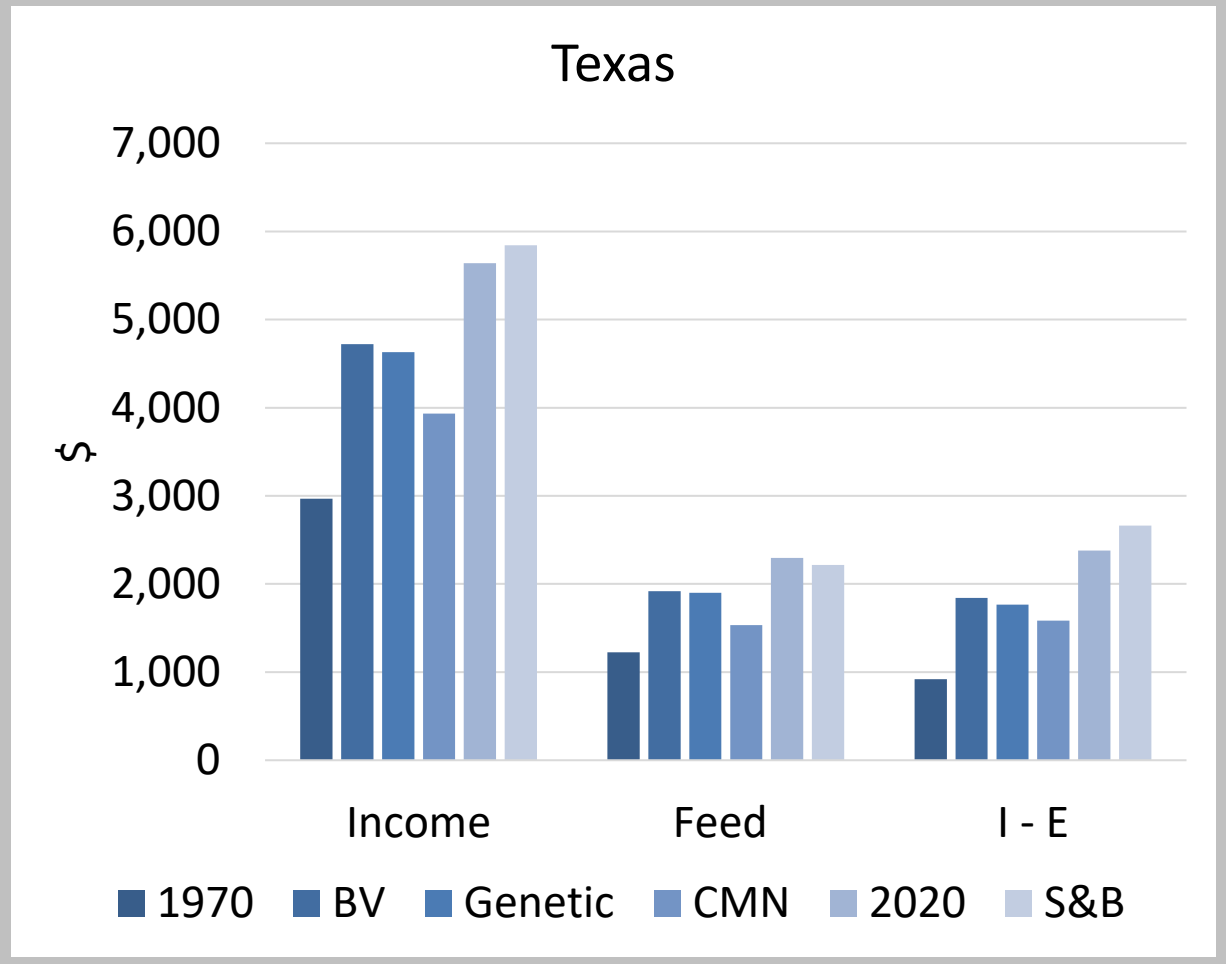
- **Farms**
  - 50 cow PA herd with grazing, 7,000 cow TX herd
- **Scenarios**
  - Base: 1970 expectation levels
  - Breeding value
  - Genetic: BV + inbreeding
  - CMN: Cow management and nutrition
  - 2020: Genetic + CMN
  - S&B: 2020 + sexed + beef semen
- **CO_2 fertilization**
  - High and low estimates applied to 2020 scenarios

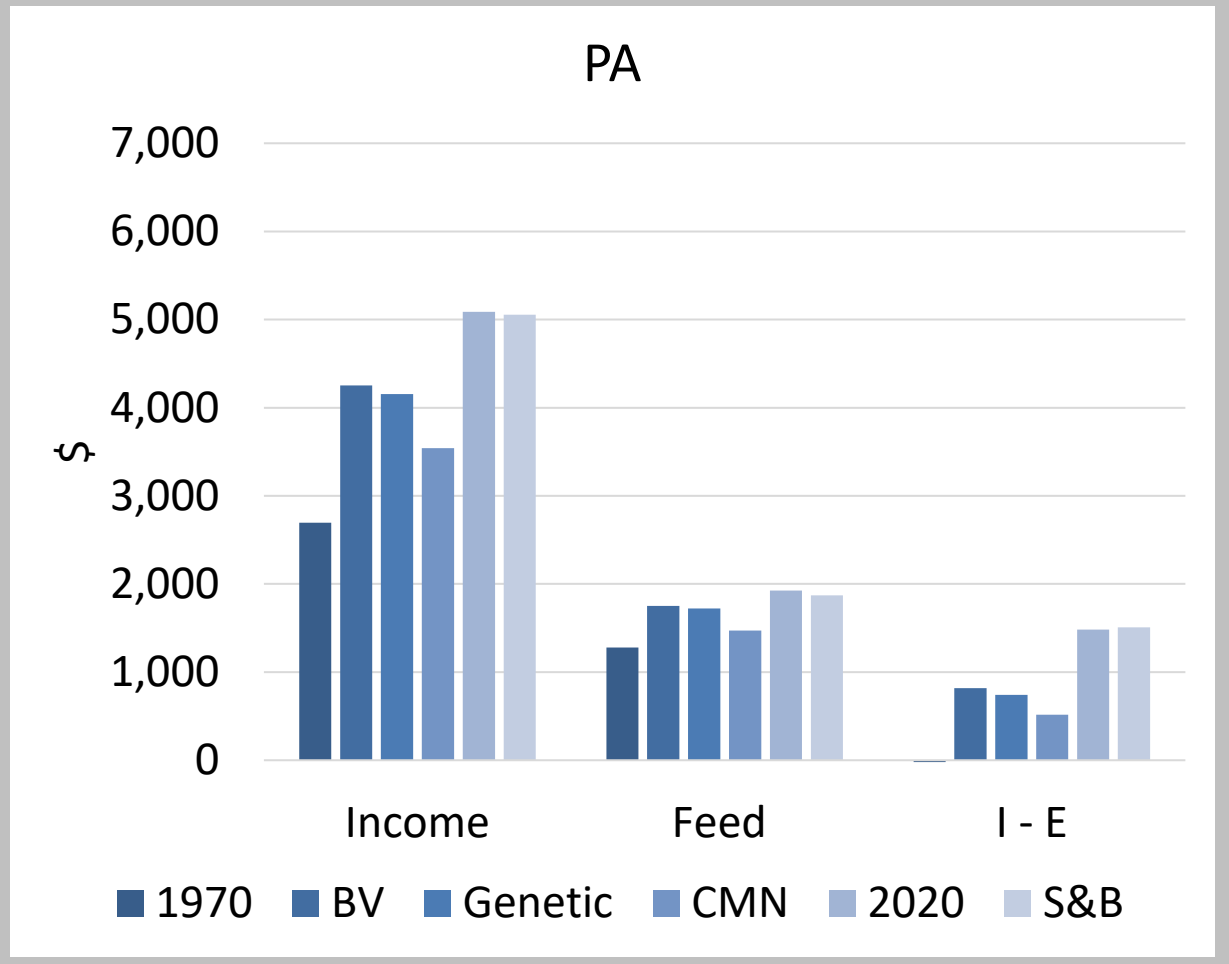
Yield and Efficiency



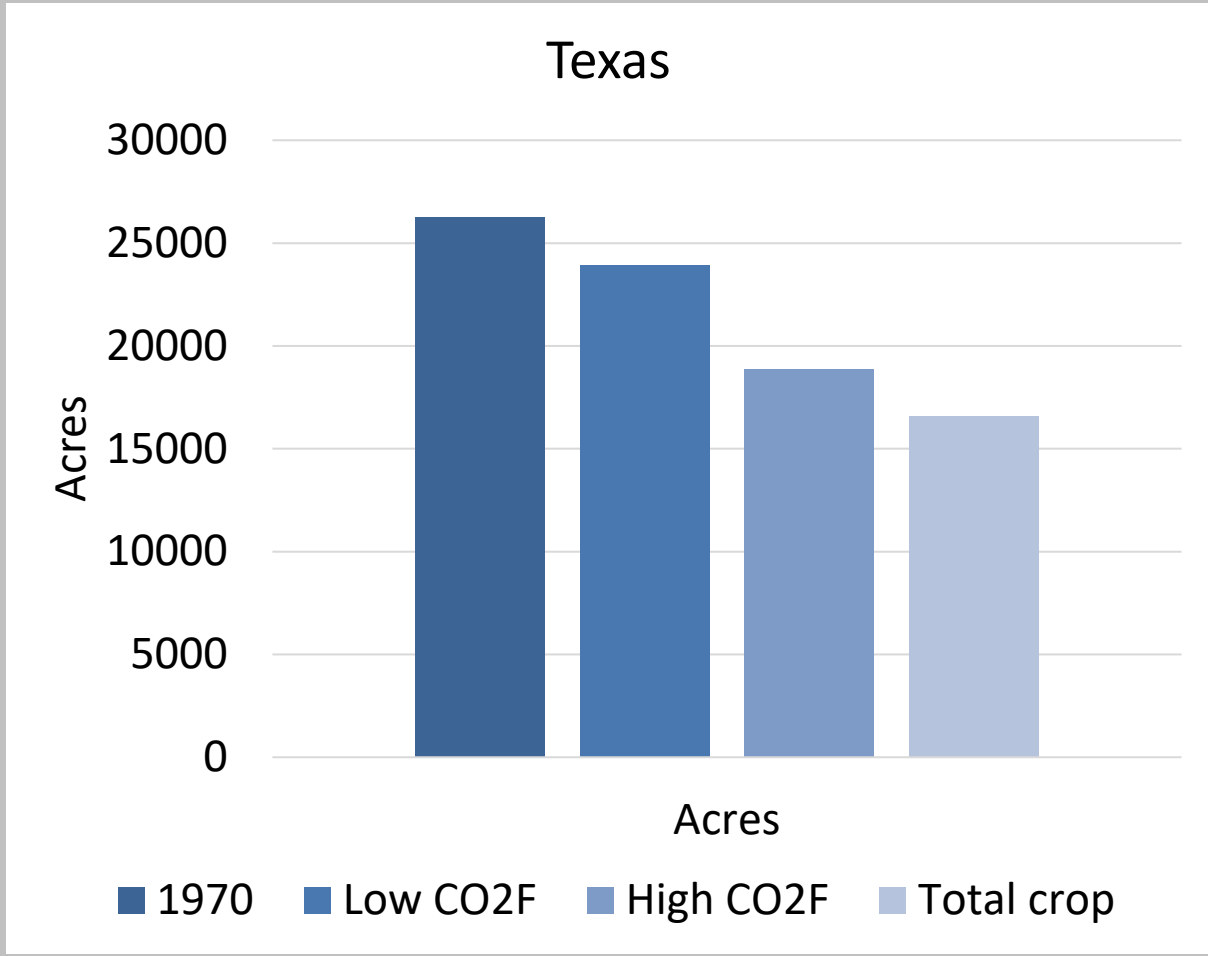


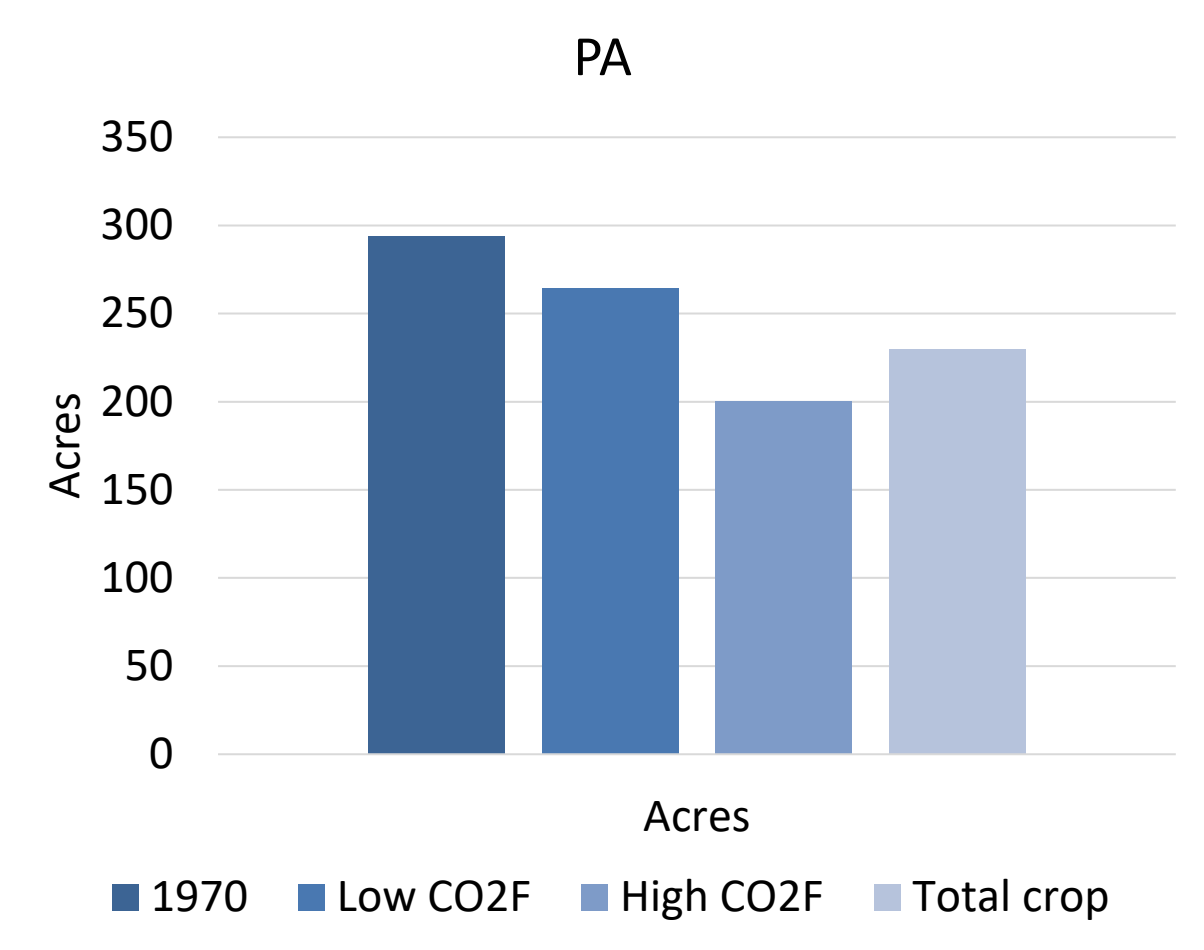
Income and Expenses



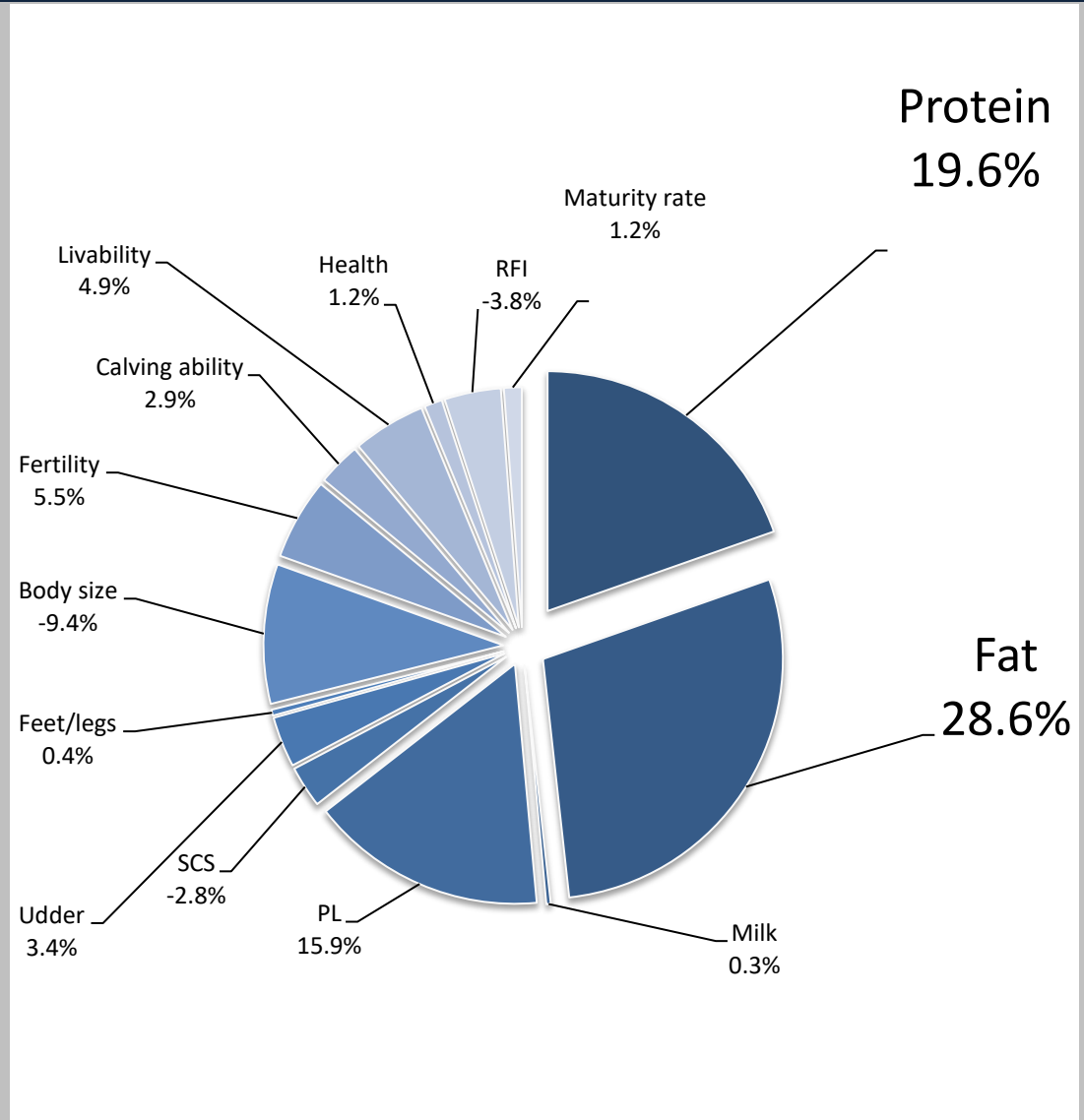


CO2 Fertilization





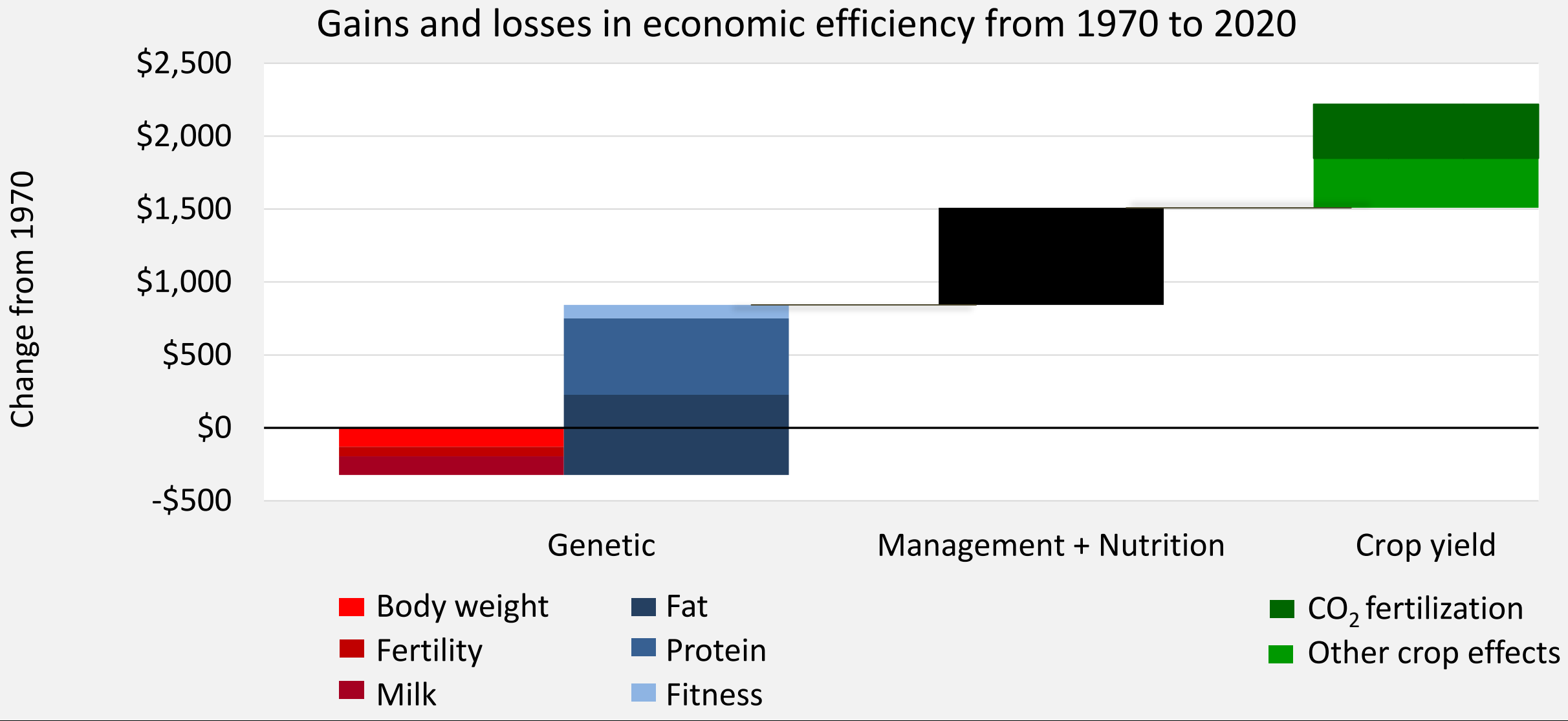
2021 $NM Relative Emphasis



Observed Lifetime Trait Value

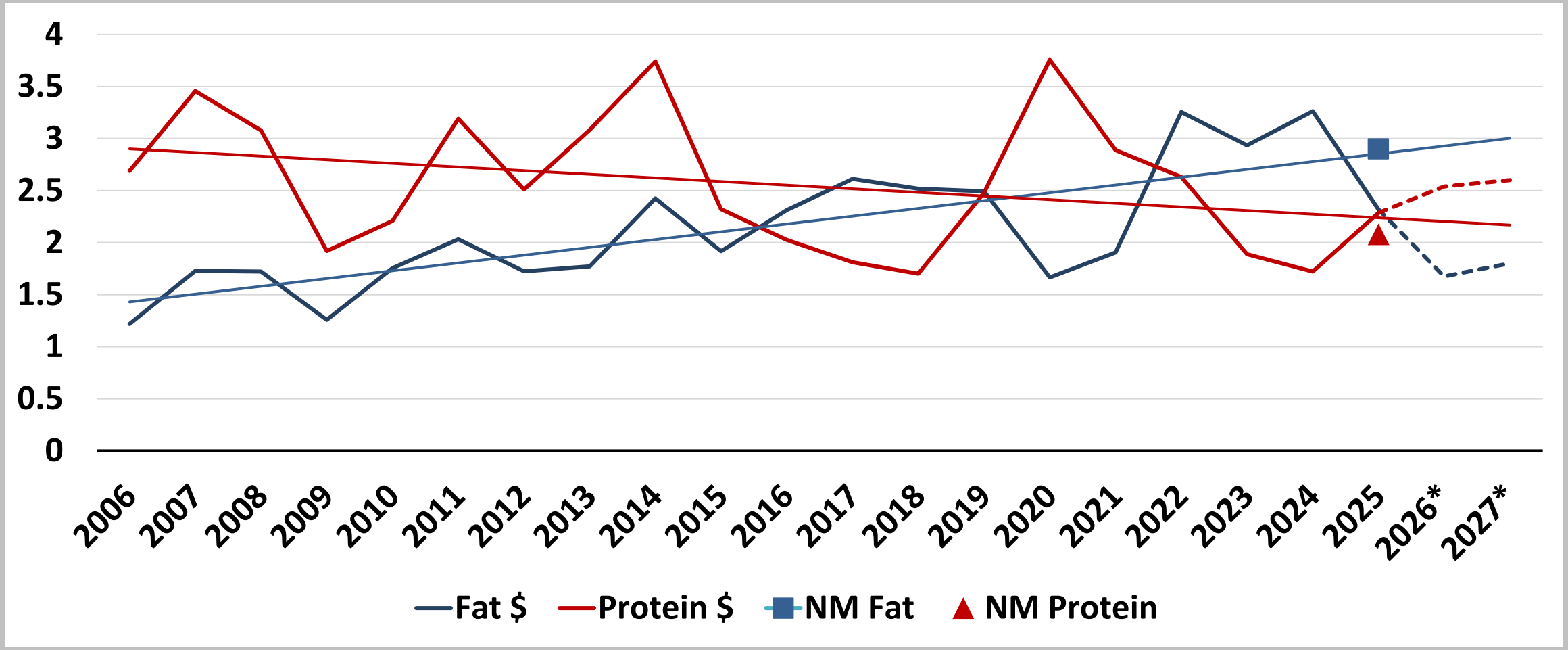
	Trend	$/lifetime	$NM
Milk	4,277	-0.08	0.004
Fat	168	8.78	9.21
Protein	129	10.96	10.29
BWC	11.3	-30.76	-45
Livability	-1.2	6.28	9.8
Productive Life (own)	18.5	6.4	34
Productive Life ($1,500)	18.5	17.2	34
Productive Life ($3,000)	18.5	36.85	34

IFSM & Long-Term Drivers of Efficiency

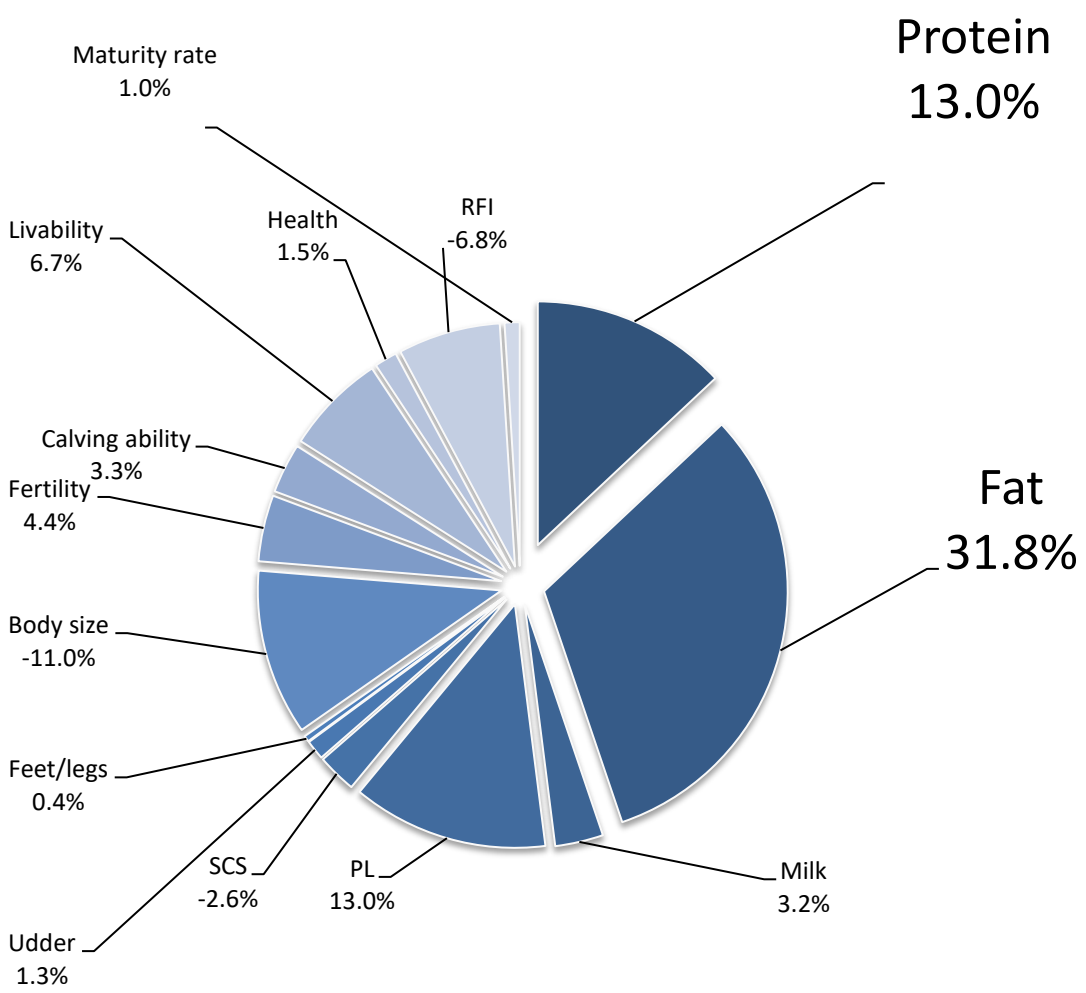


Do we have a fat problem?

Fat & Protein prices

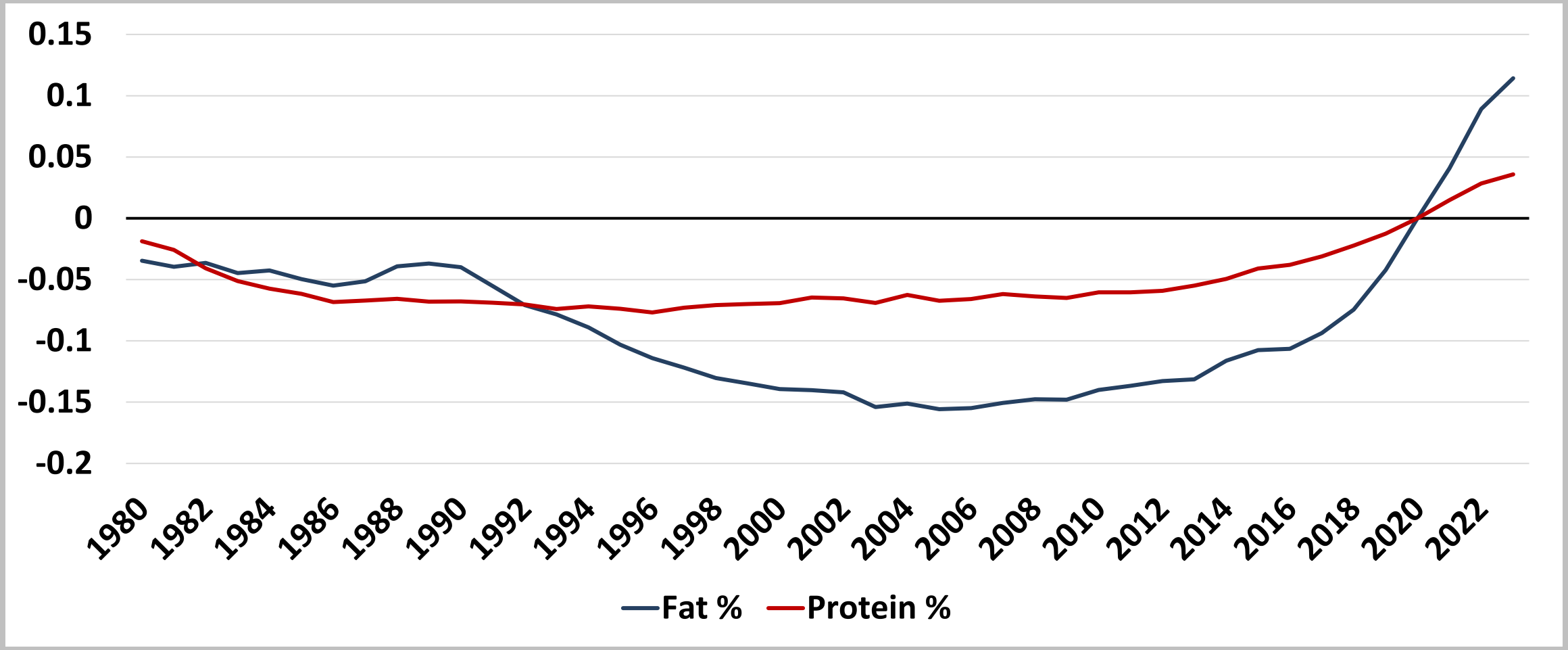


2025 $NM

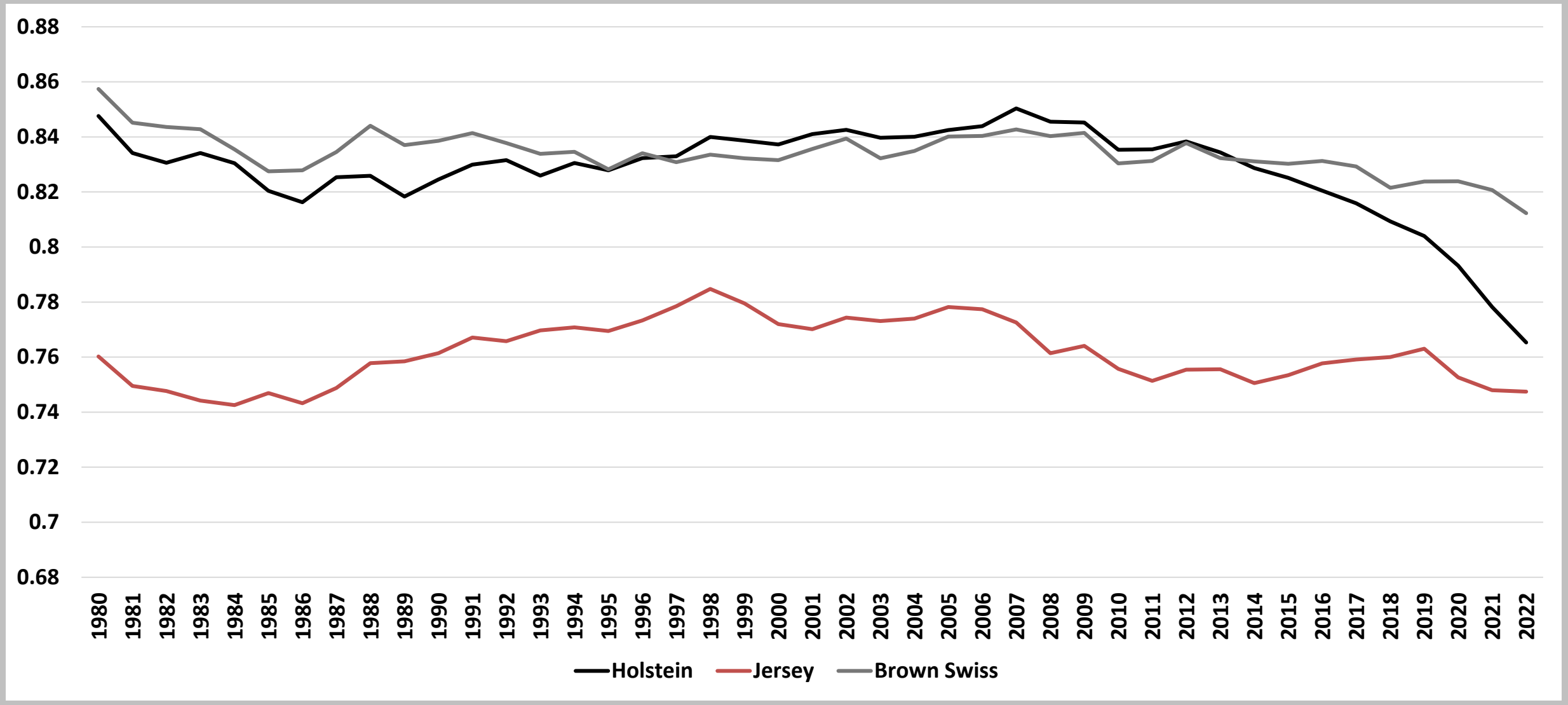


- **$ assumption**
  - Fat = %5.01
  - Protein = $3.33
- **PTA standard dev**
  - Fat = 24.88
  - Protein = 15.27
- **More variable traits are easier to change**
  - Factored into relative emphasis

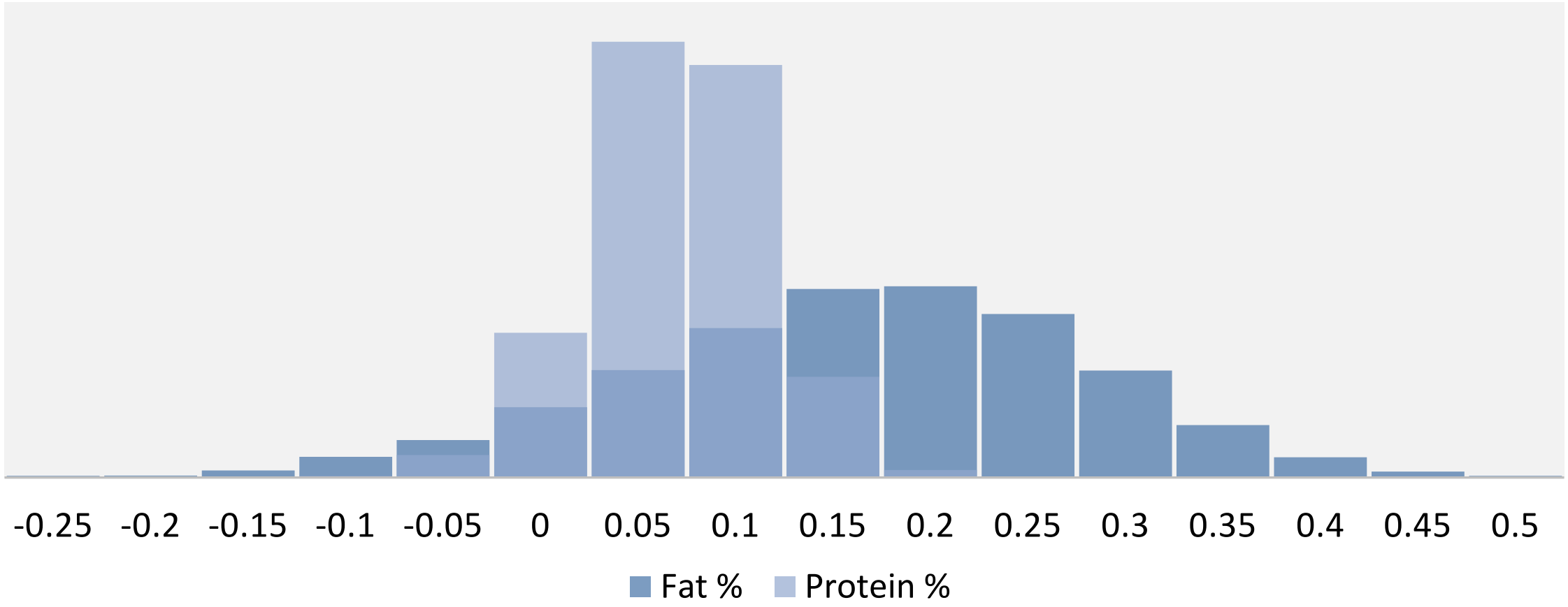
Genetic change in fat & protein %



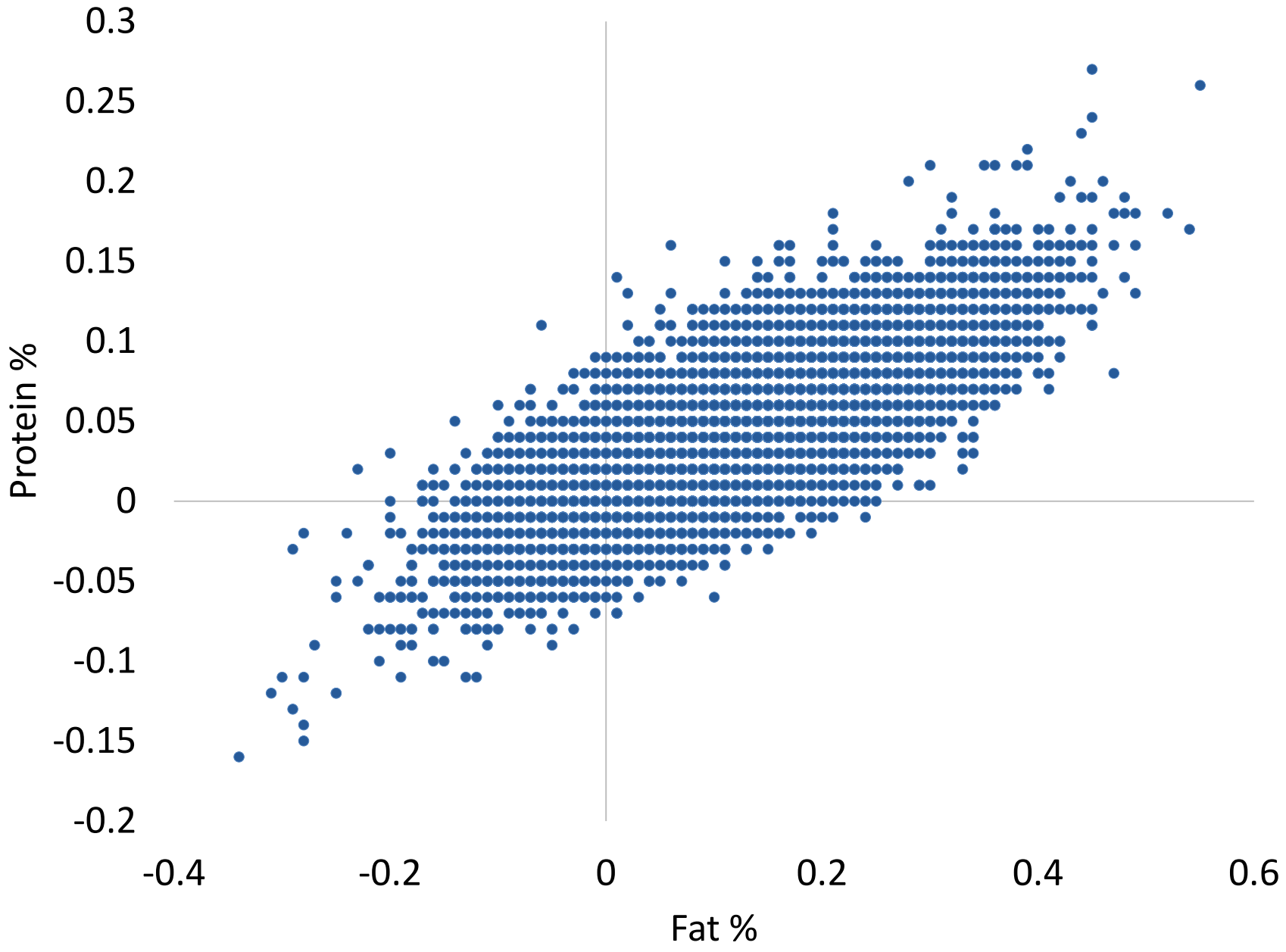
Protein:Fat ratio



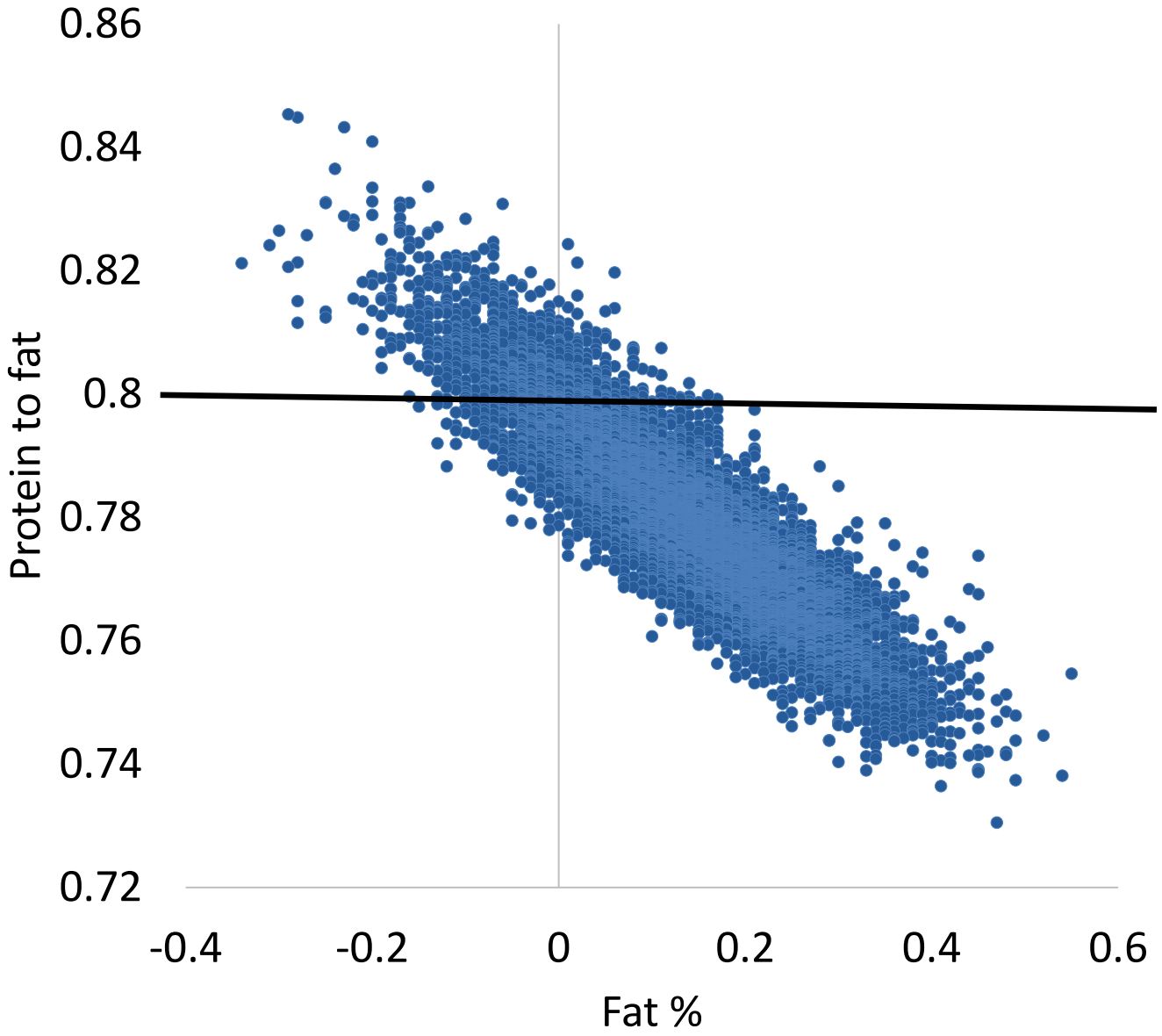
Distribution of PTA for fat and protein %



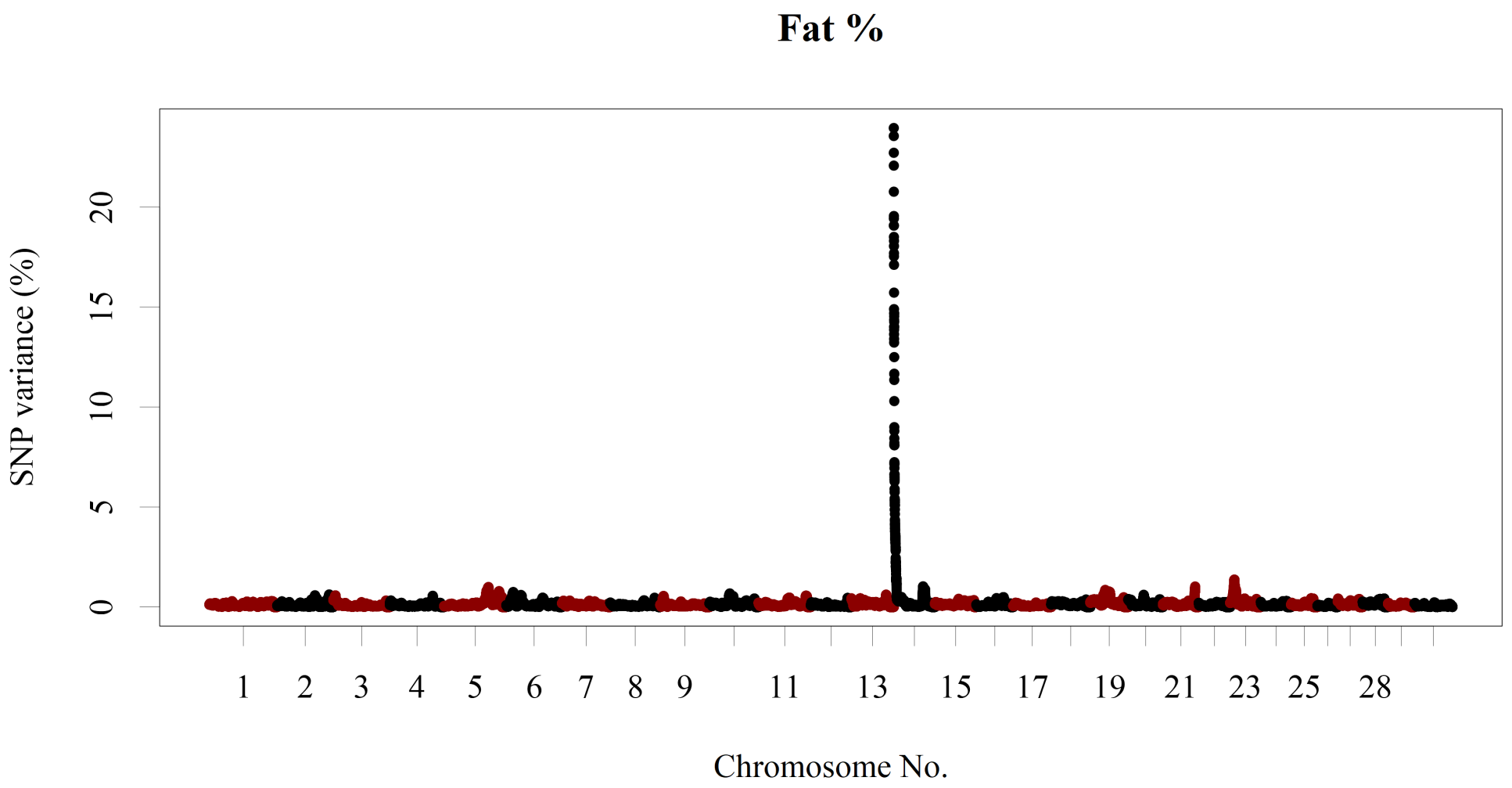
Fat % versus protein %



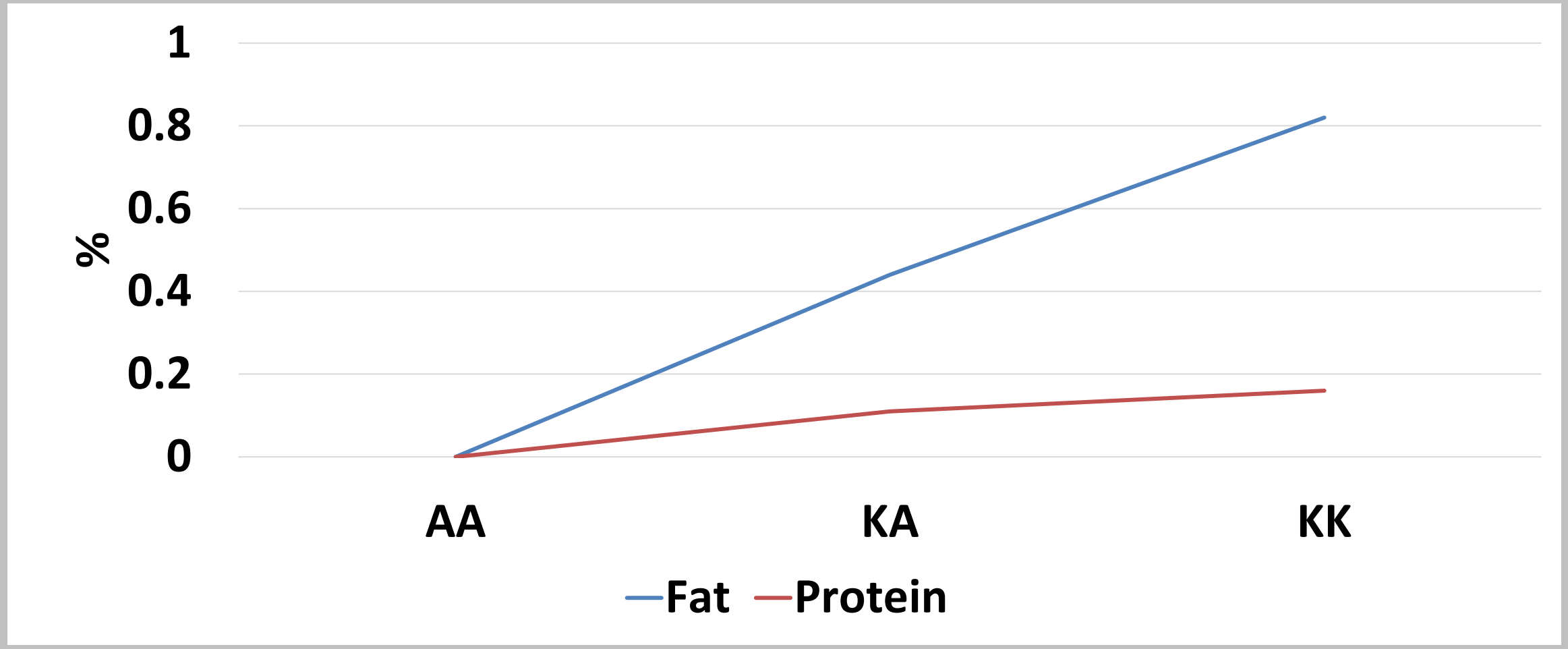
Protein to fat ratio versus PTA fat %



DNA marker effects

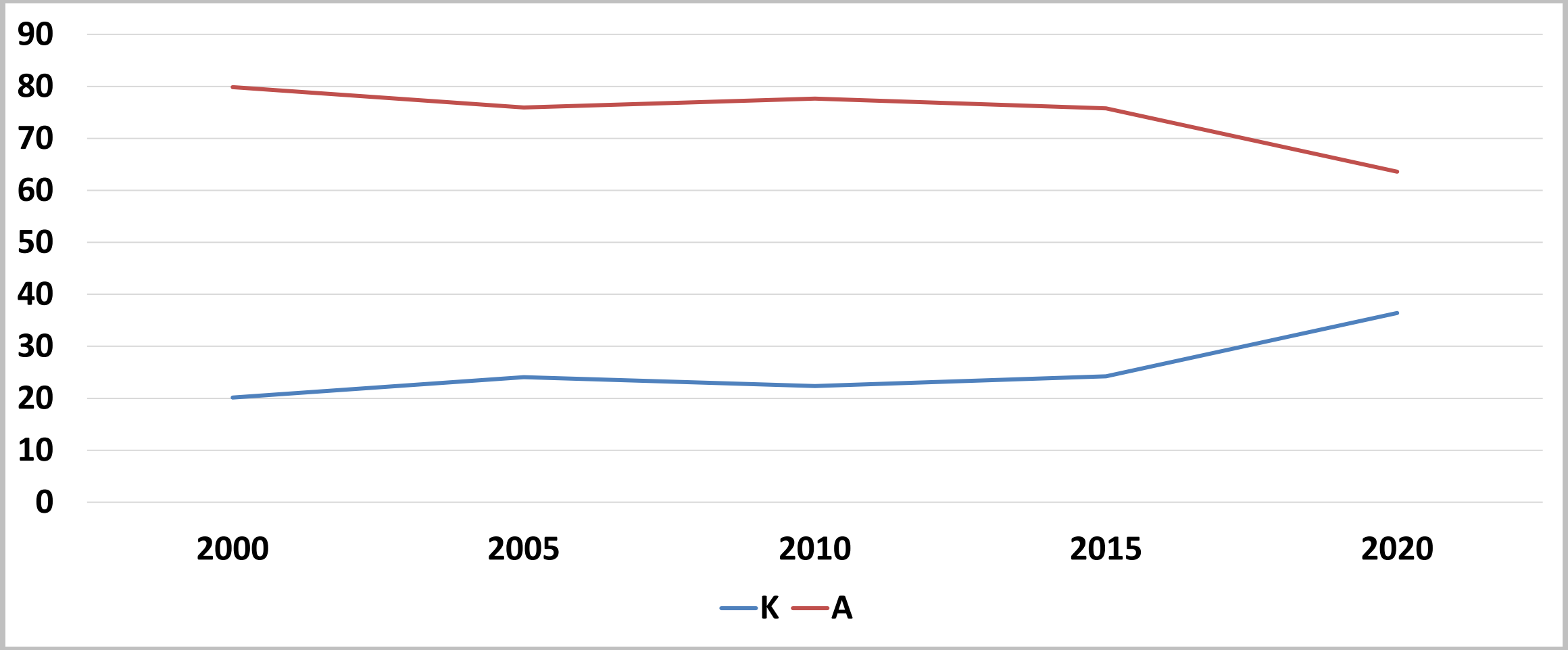


DGAT1 effect



https://genome.cshlp.org/content/12/2/222.full

Change in DGAT1 genotype



Protein & fat

- **Fat more variable than protein**
  - CFP largely driven by fat
  - Current economic selection indexes reward more variable traits
- **Difficult to increase protein without increasing fat more**
  - DGAT1 has much larger effect on fat
- **Will take time to unwind on the genetic side**
- **Crossing with higher relative protein breeds?**

Summary

- **Economic efficiency gains for dairy production are substantial**
- **Gains are multi-factorial**
  - Genetic and environmental
- **Whole farm modelling systems can be used to evaluate weights in selection indices**
  - Fat + protein breeding values big driver
  - Fat easier to change genetically