Health and welfare in genetically high producing dairy cows and its economical implications

Pascal A. Oltenacu

Cornell University, USA

Tartu, Estonia
June 17-21

XIII ISAH Congress 2007

Terminology

- Adaptation ⇒ when an animal or breed has the ability to survive, produce and reproduce within a specific environment at an acceptable (adequate) level.
- A long productive life, resistance to diseases and good fertility are important adaptive traits.

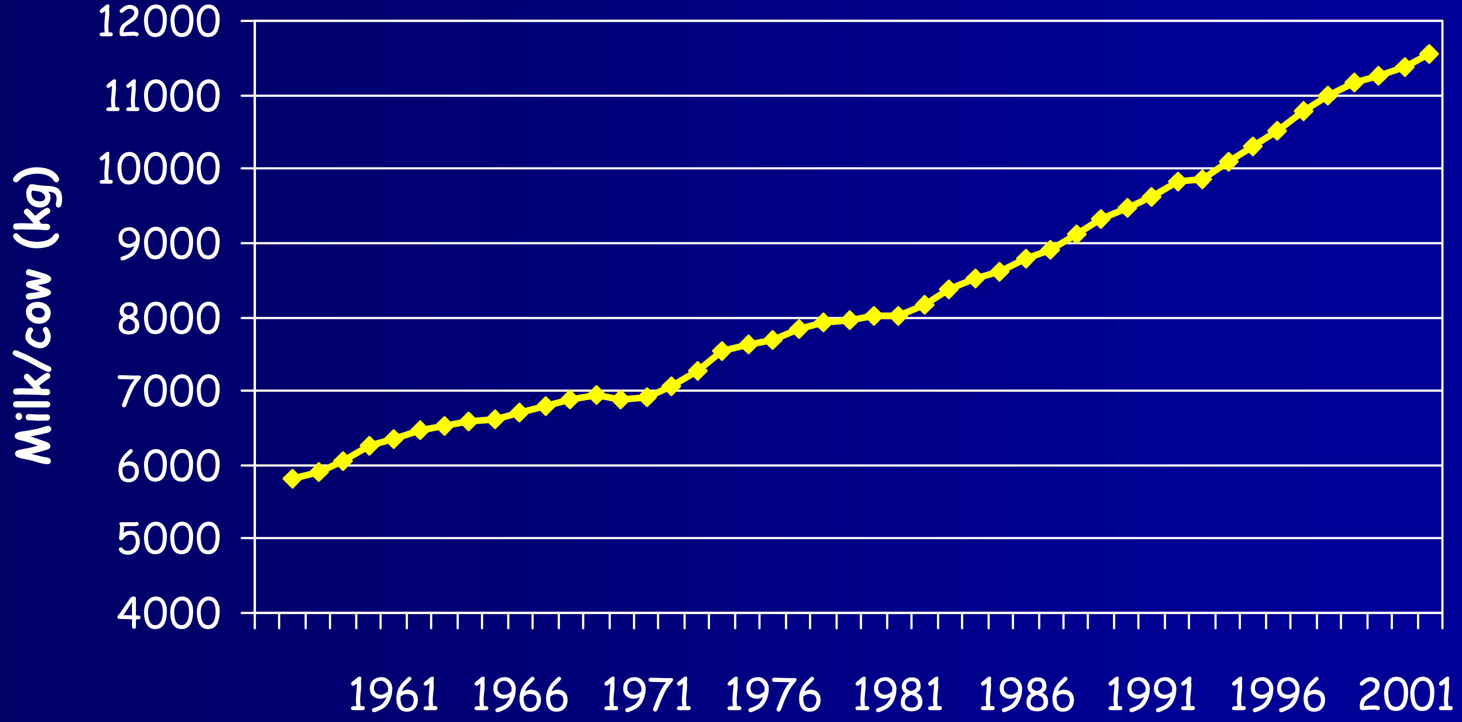
Hohenboken et al.,2005

Adaptability of modern dairy cow

- In the last 100 years we have made great progress in understanding the biology of the dairy cows. We also used that knowledge to increase milk production by developing more effective selection programs, better management and more intensive production systems

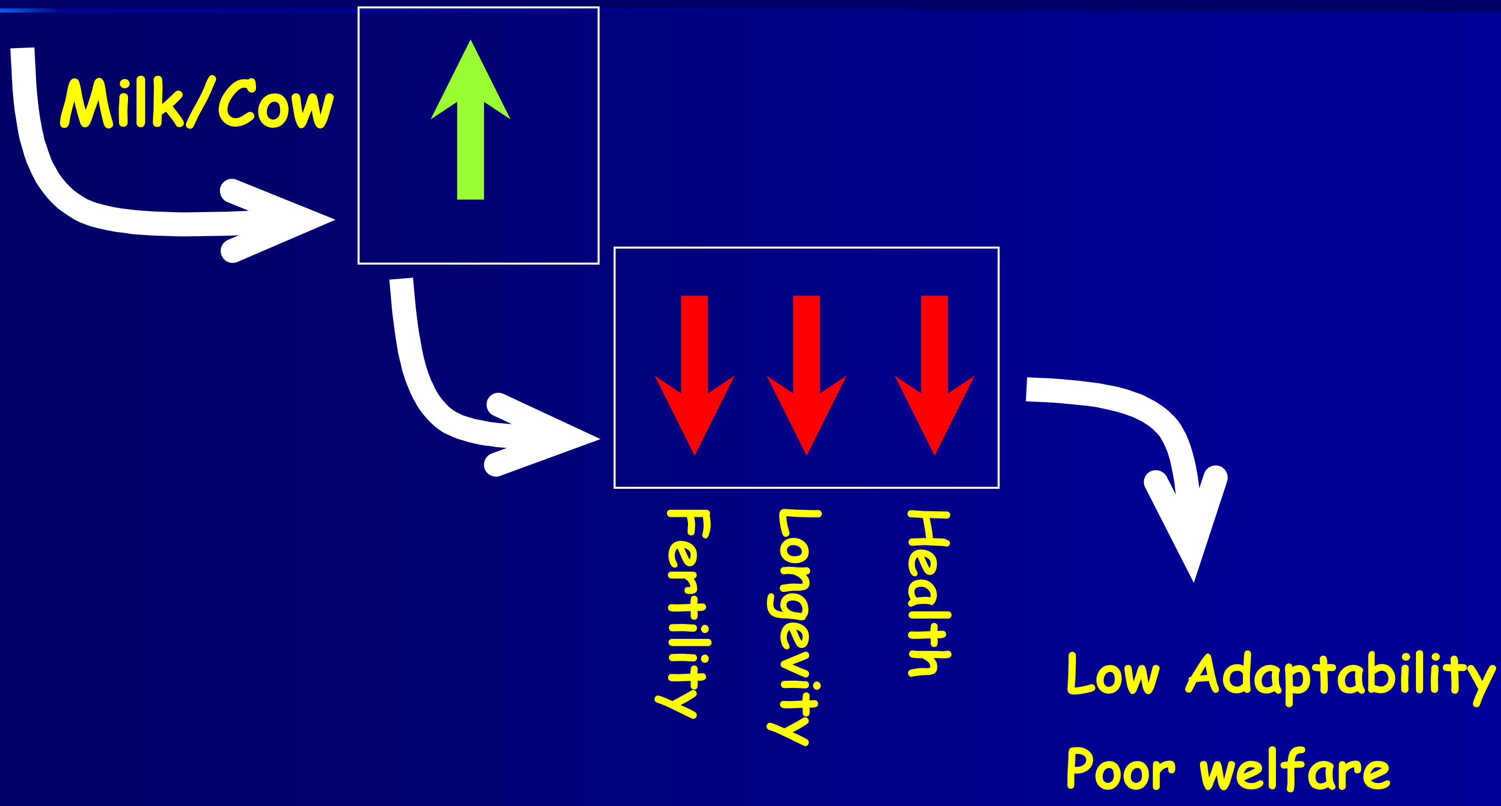
- Is the adaptability of the modern dairy cow changing? If so, how and why?

Change in milk yield/cow in Holstein cows (Northeast US; 1957-2002)

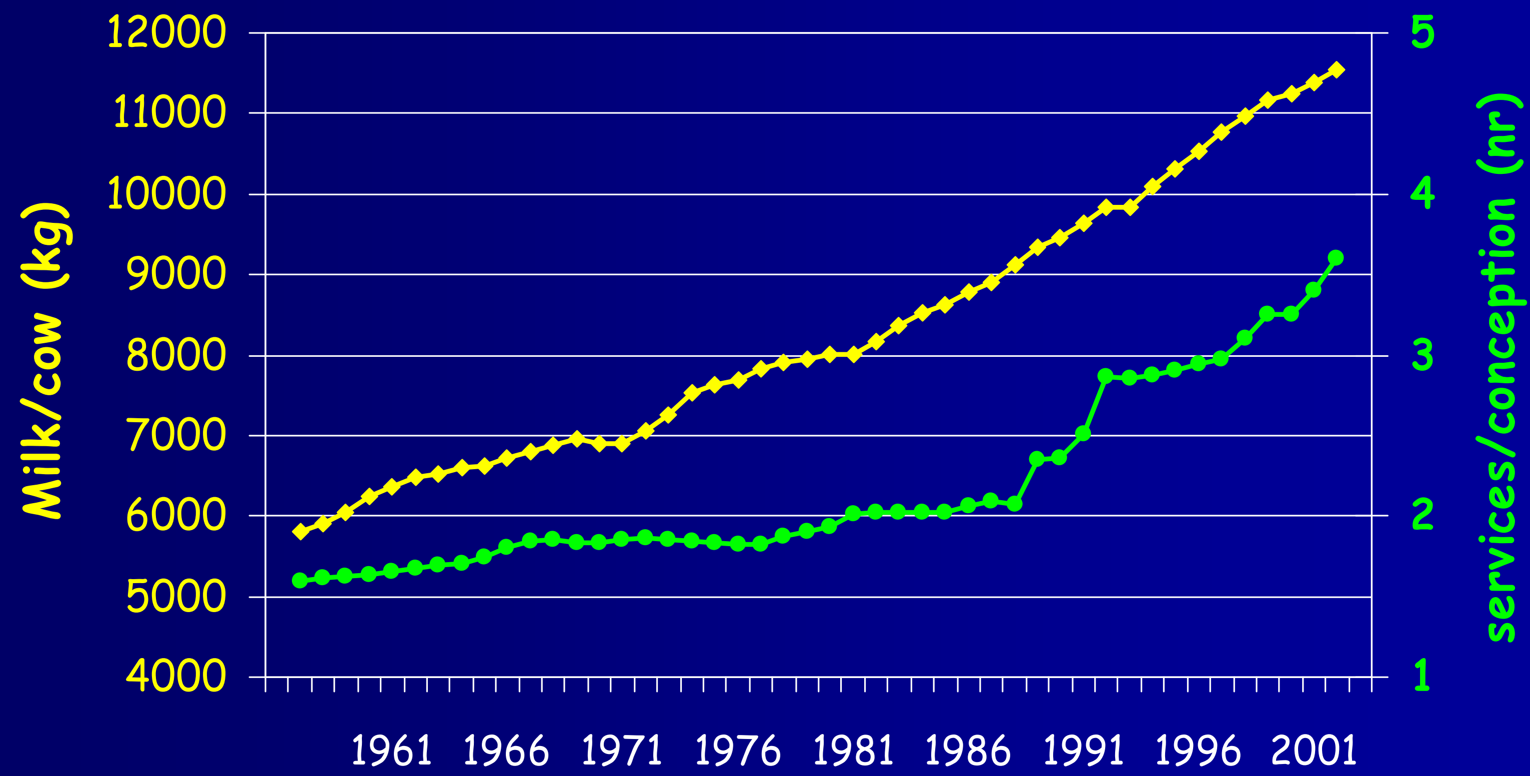


USDA-NASS, 2003

Should high yield/cow be of concern?

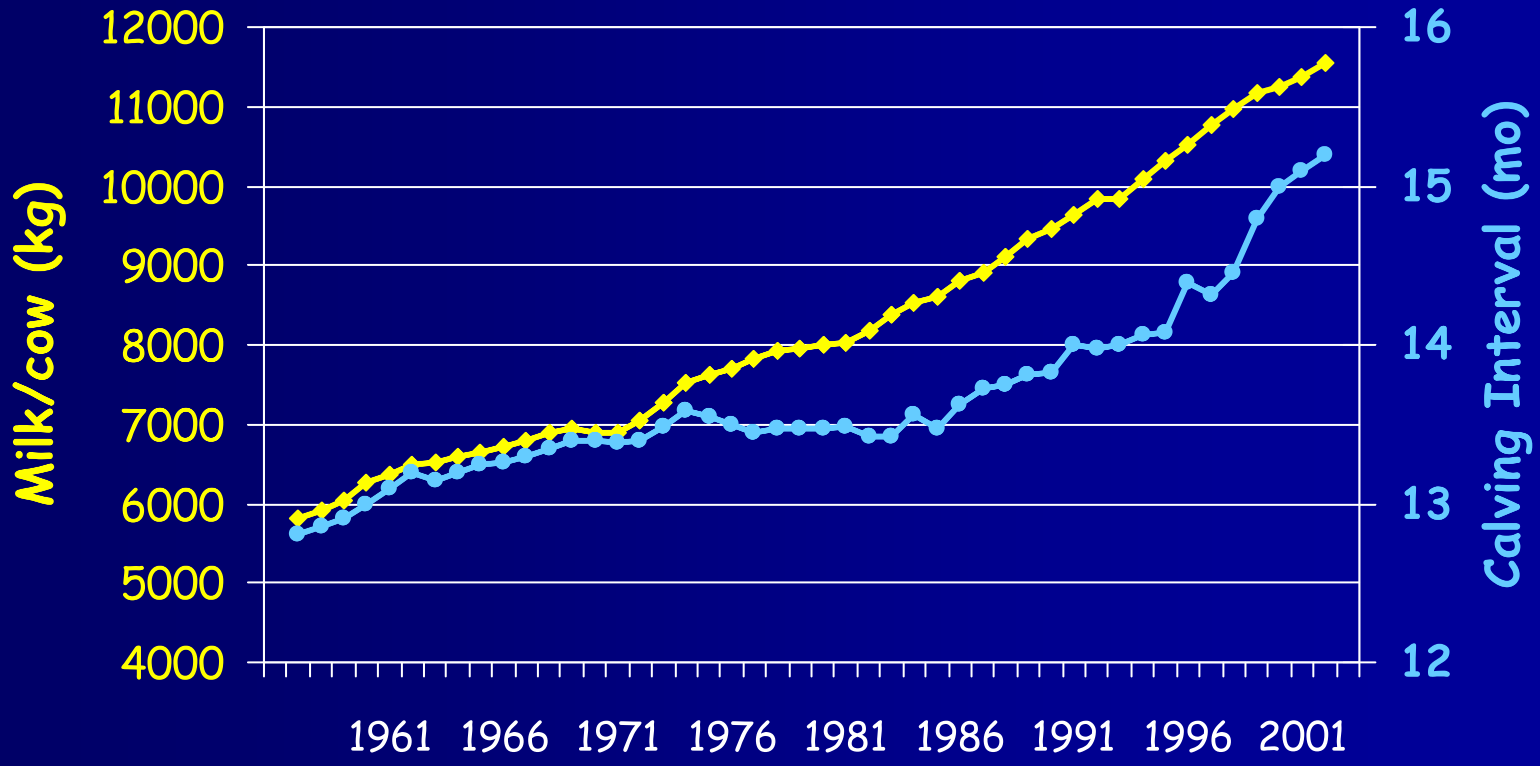


Changes in milk yield/cow and services per conception in Holstein cows (Northeast US; 1957-2002)



USDA-NASS, 2003

Changes in milk yield/cow and calving interval in Holstein cows (Northeast US; 1957-2002)



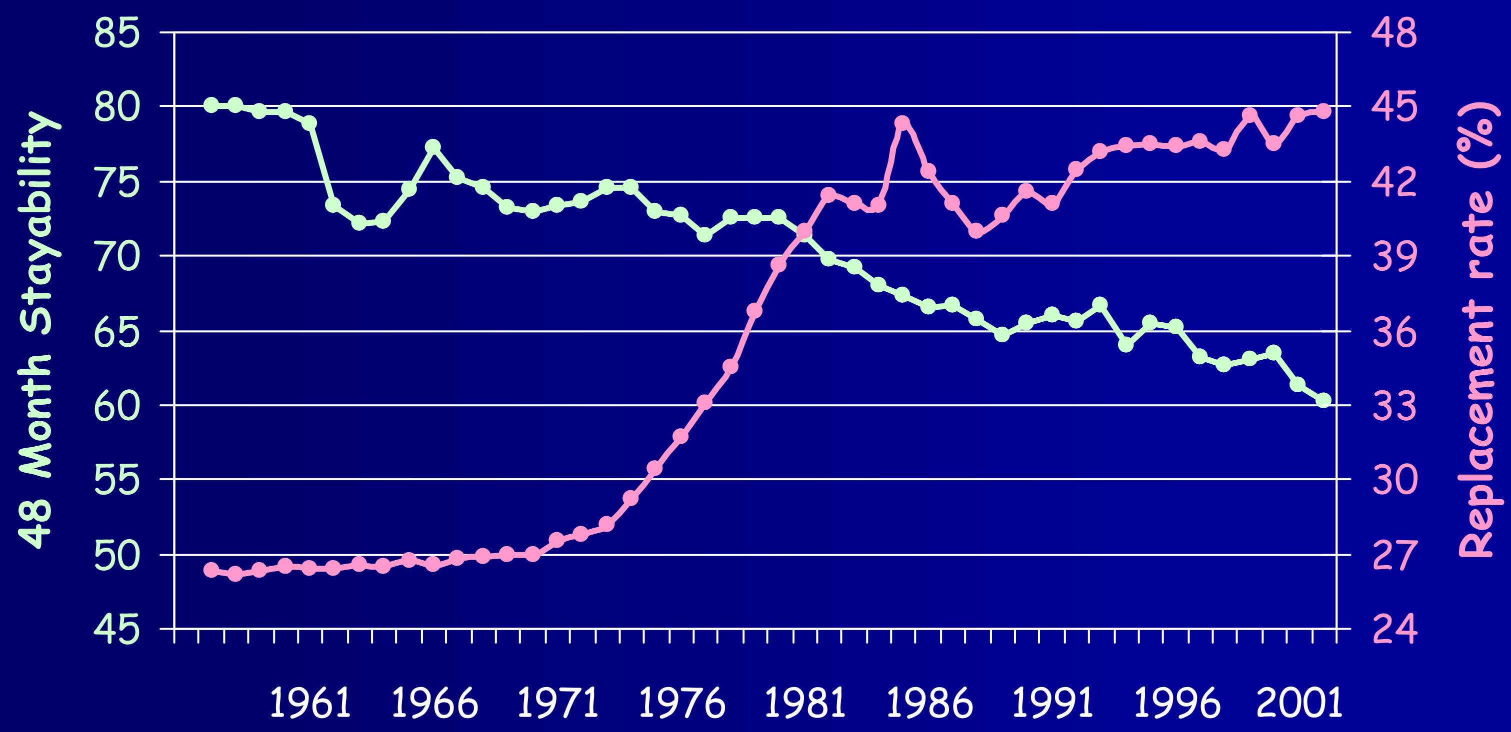
USDA-NASS, 2003

Estrous Cyclicity in Dairy Cows

Item	Type of Dairy Cow	
	Traditional	Modern
No. of cycles	463	448
Normal Cyclical Pattern (%)	79	53*
Long interval to 1st ovul. (%)	7	21*
Temp. cessation of cycle (%)	3	3
Long luteal phase (%)	3	20*
Short cycle (%)	4	0.5
Other (%)	4	2.5

Roche, 2000

Changes in replacement rate and 48 month stayability in Holstein cows (Northeast US; 1957-2002)



Cows Culled (%) by reason

Culling reason	Primary (%)	Secondary (%)
Reproduction	27	10
Mastitis	22	5
Udder, Feet/Legs	16	8
Death	13	
Low Production	8	13
Other	14	12

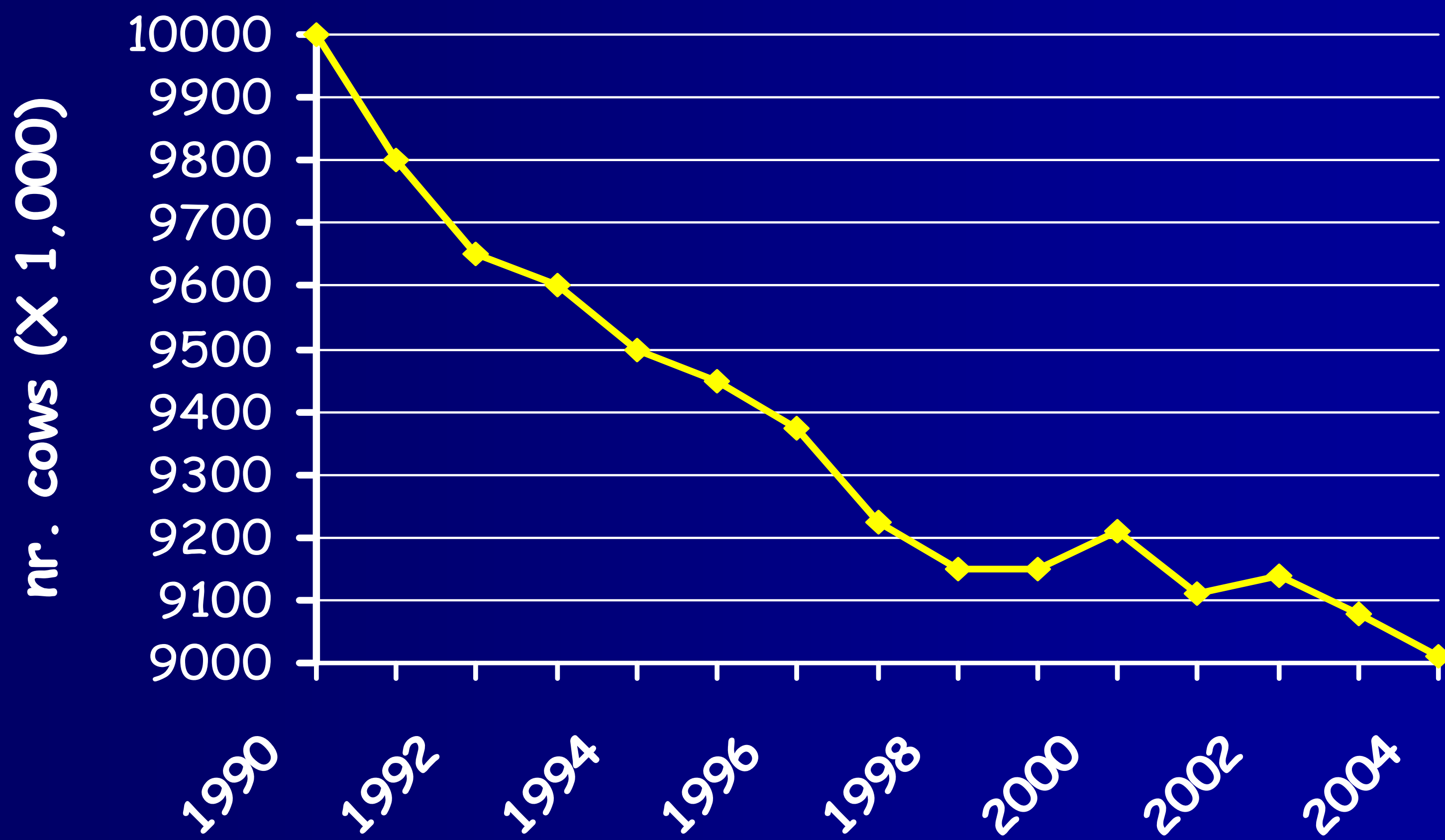
Oltenacu et al., 1998

Reasons for declining adaptability and welfare of dairy cows (i)

- Dairy production systems are rapidly changing, predominantly in the direction of greater intensification
- Consequently, dairy herd environments are changing more rapidly than dairy populations can adapt to these changes through natural selection

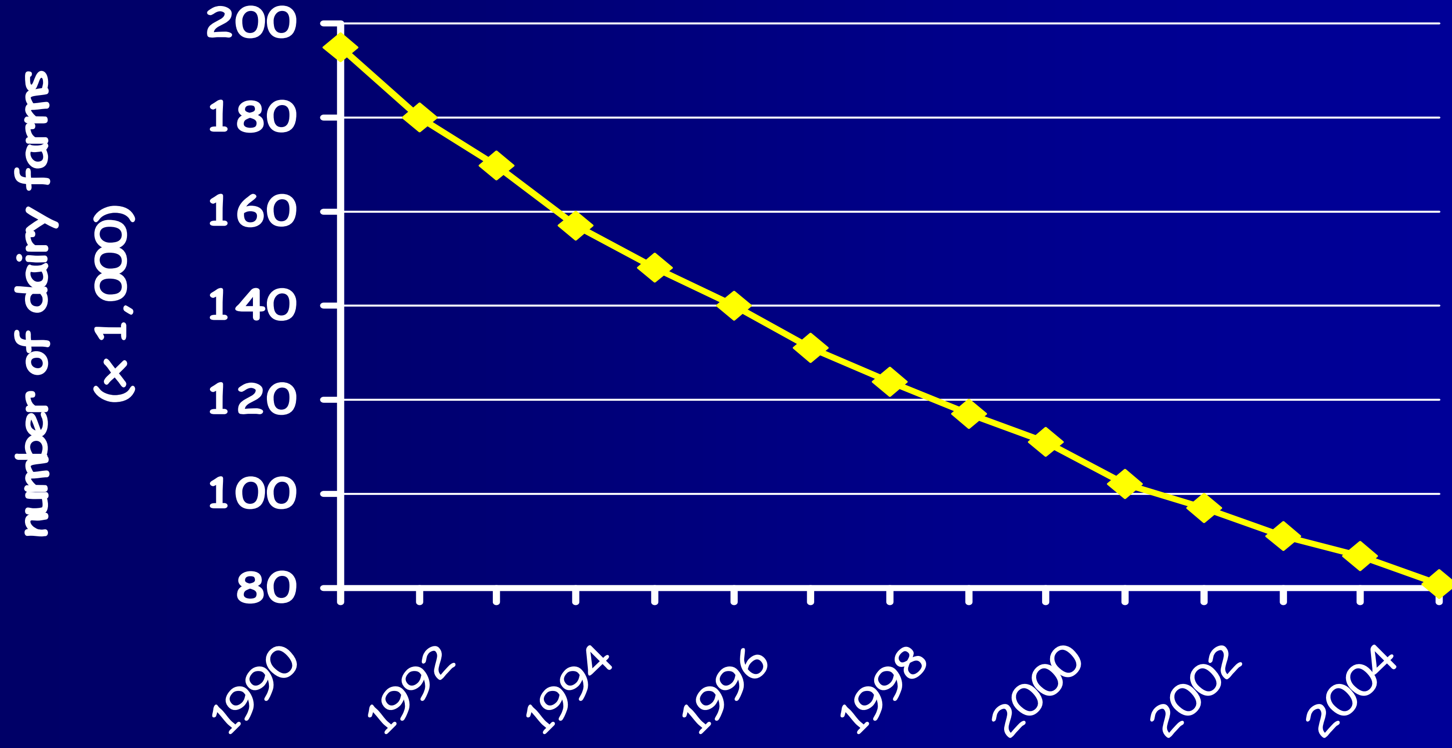
Number of Dairy Cows

United States (1990 - 2004)



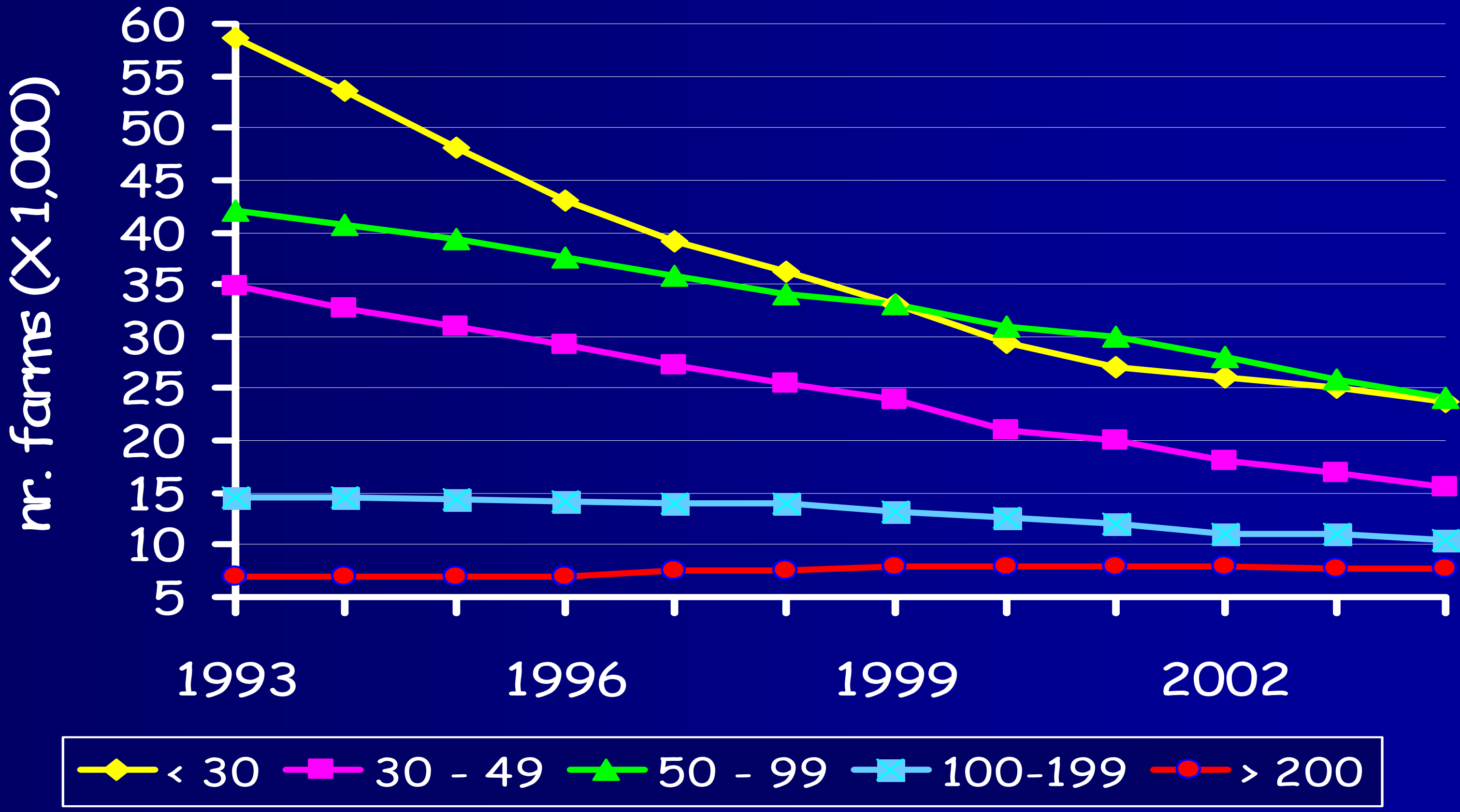
Number of Dairy Farms

United States (1990 to 2004)



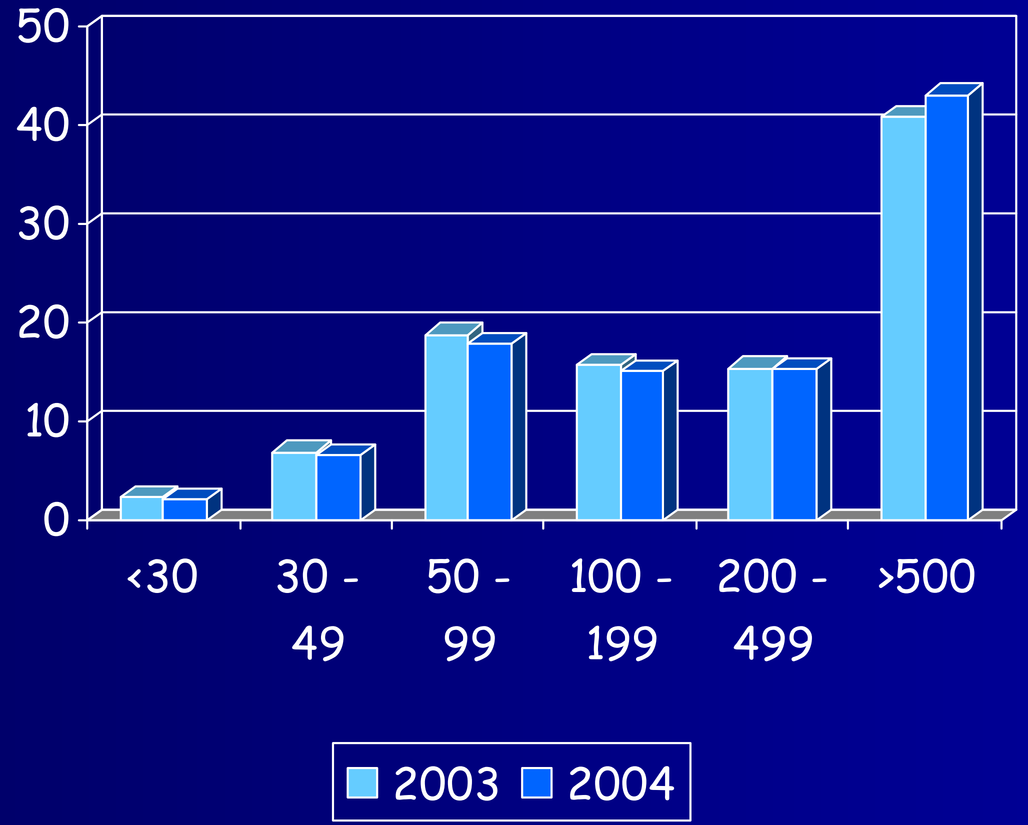
USDA-NASS; 2005

Number of Dairy Farms by herd size (1993 to 2004)



USDA-NASS; 2005

US Dairy Cows Inventory
Percent by herd size, 2003-2004

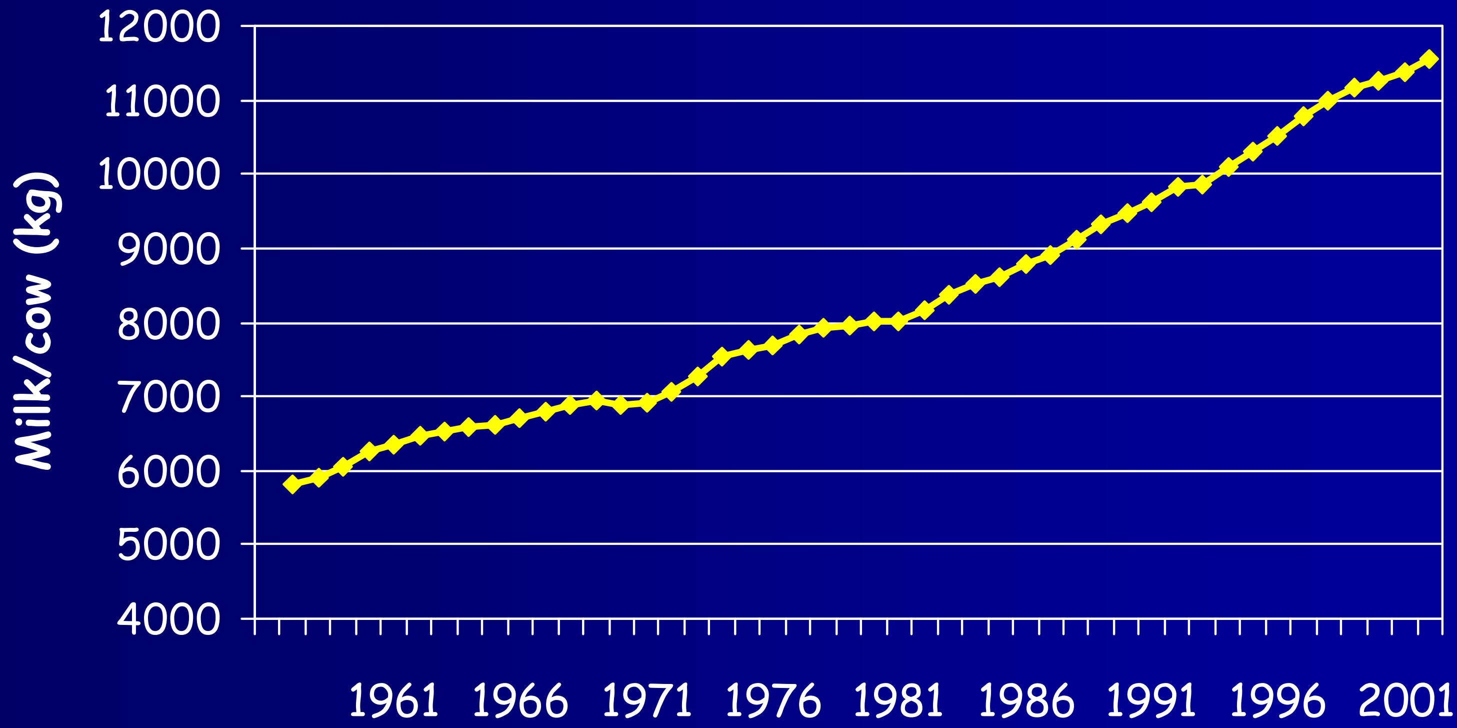


USDA-NASS; 2005

Selection in dairy cattle: Breeding objectives

- Primary goal: Increase milk, fat and protein yields
- Secondary goal: Improve type, particularly "dairy form"
- Fitness traits (fertility, health, longevity) were ignored
  - Low heritability
  - Can be effectively controlled through management

Change in milk yield/cow in Holstein cows (Northeast US; 1957-2002)



USDA-NASS, 2003

Genetics:
milk yield ⇨ reproductive traits

Genetic correlations are negative and large:

- First Service Conception Rate
  - **R_g = -.41** (Oltenacu et al., 1991)
  - **R_g = -.53** (Lindhe and Oltenacu, 2001)
- Days Open
  - **R_g = .53 to .68** (Dematawewa and Berger, 1998)
- Services per Conception
  - **R_g = .45 to .63** (Dematawewa and Berger, 1998)
- Interval to Commencement of Luteal Activity
  - **R_g = .48 to .65** (Veerkamp et all., 2000)

Genetics:
milk yield ⇨ health disorders

The genetic correlations between milk yield and LIR of production diseases are unfavorable and large:

- mastitis = (0.15-0.68)
- lameness = (0.24-0.48)
- ketosis = (0.26-0.65)
- ovarian cyst = (0.23-0.42)

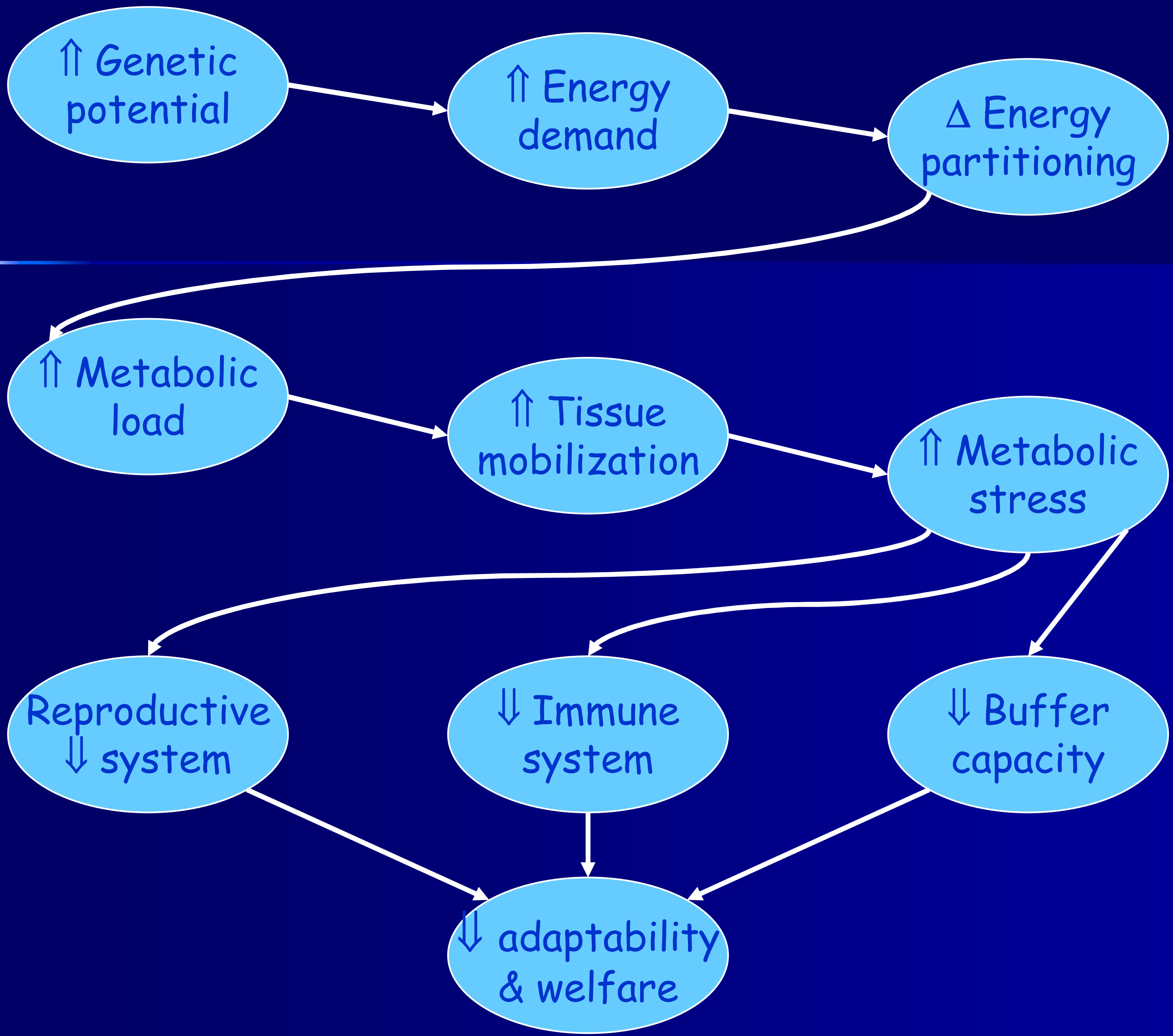
Ingvartsen et al., 2003

High production and metabolic stress

- Dairy cows experience a negative energy balance (NEB) in the early 1/3 of their lactation period
- NEB = the total energetic burden of lactation that is met by mobilization of body reserves ⇨ metabolic load (ML)
- Metabolic stress (MS) = "that amount of NEB which cannot be sustained, such that some other energetic processes (general health, reproduction, etc.) must be down regulated

Selection for high milk yield and MS

- Selection for ⇑ yield also ⇑ feed intake
  - But, R_g (yield, feed intake) = 0.46 to 0.65
  - the gap between energy input and output in early lactation also increases
- Correlated response to selection for higher yield is ⇑ NEB and ⇑ body-tissue mobilization
- The decline in fertility and health is largely due to <u>excessive</u> tissue mobilization (MS) associated with the success of the genetic selection for increased milk yield


⇑ Genetic potential
⇑ Energy demand
Δ Energy partitioning
⇑ Metabolic load
⇑ Tissue mobilization
⇑ Metabolic stress
Reproductive ⇓ system
⇓ Immune system
⇓ Buffer capacity
⇓ adaptability & welfare

What should be done?

- More research, basic and applied, to understand and address the problem short and long term
- Two dimensional approach is required:
  - develop and implement management practices to minimize MS
  - develop and implement dairy cattle breeding programs aimed at preventing deterioration of adaptability and welfare (restoring?)

G*E Interaction
herd environment classification

Combination of herd mean (HM) and standard deviation (HSD) for mature equivalent milk

- high level is:

  upper 40% for HM and HSD

- low level is:

  lower 40% for HM and HSD

Castillo and Oltenacu, 2002

Heritabilities, genetic and phenotypic correlations for ME milk, SCS and CRFS

Class/trait	ME milk	SCS	CRFS
High environment			
ME milk	0.30	0.17	-0.32
SCS	-0.09	0.09	-0.14
CRFS	-0.17	-0.04	0.01
Low environment			
ME milk	0.22	0.28	-0.42
SCS	-0.05	0.11	-0.21
CRFS	-0.18	-0.04	0.02

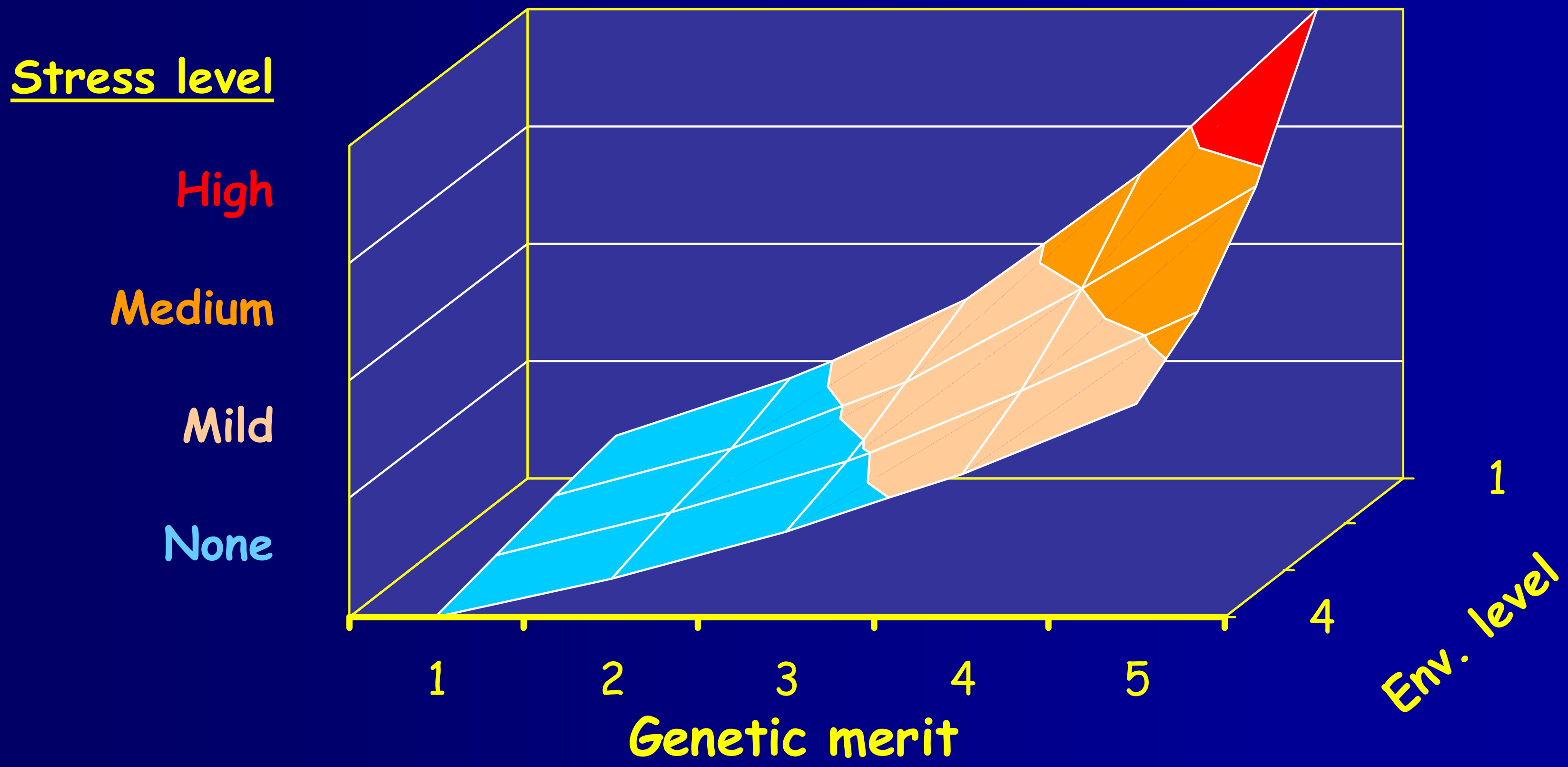
Castillo and Oltenacu, 2002

Expected correlated responses for 1,000 kg of ME Milk genetic gain

Environmental class	SCS	CRFS	Prot. kg	Fat kg
Low	0.176	-0.045	46.09	30.16
High	0.064	-0.016	49.92	37.15
Low/High	2.76	2.85	0.92	0.81

Castillo and Oltenacu, 2002

Level of metabolic stress as a function of cow's genetic merit (1-5) and quality of environment (1-4)



Conclusions

- Metabolic stress (excessive tissue mobilization) in genetically high producing cows is a major cause for declining adaptability
- Nutritional and reproductive practices to alleviate MS, though important, are only short term solutions
- A long-term sustainable solution is to place major selection emphasize on improving animals' ability to cope ⇨ adaptability and its components

"Genetic selection has not taken adequate account of the adaptability and welfare of cows. Current trends towards ever greater milk production should not be continued unless it can be insured that welfare is good. It is important to the dairy industry that welfare problems should be addressed before there is widespread condemnation of breeding and management practices."

Broom (2002)

Does ⬆ adaptability (or Welfare) pay?

We need to show that:

Improved adaptability ➡ Economically beneficial

We will focus on the effect of diseases on animal productivity

Incidence of Veterinary Diagnoses

Diagnosis	Lactational incidence risk SRB	Lactational incidence risk SLB
Dystoccia (DYST)	0.8	0.8
Stillbirth (STLB)	4.0	3.6
Retained Placenta (RTPL)	3.1	4.1
Metritis (METR)	1.6	2.2
Ketosis (KETS)	2.8	1.6
Cystic Ovaries (CYST)	4.3	2.0
Anestrus (SLHT)	4.3	3.9
Feet & leg (FEET)	2.3	3.0
Clinical Mastitis (MAST)	14.4	17.3

Emanuelson & Oltenacu, 1993

Economic cost of diseases

veterinary treatments
discarded milk
mortality
farmer's labor

Direct costs

Direct Costs of Diseases (in US $)

Disease	Vet trtm ($)	Farm labor ($)[1]	Milk disc. (kg)[2]	Direct costs ($)
DYST	100	40	0	140
STLB	0	75[3]	0	75
RTPL	50	30	150	125
METR	50	30	150	125
KETS	40	10	0	50
CYST	40	20	0	60
SLHT	40	20	0	60
FEET	20	10	0	30
MAST[C]	25	10	150	80
MAST[S]	0	0	0	0

1)Cost calculated as \$25/hour of labor; 2)Cost calculated as \$0.3/kg; 3)Value of dead calf;

Guard, 2000

Economic cost of diseases

veterinary treatments
discarded milk
mortality
farmer's labor

→ Direct costs

⇓ milk production
⇓ fertility
⇓ longevity

→ Opportunity costs

Opportunity Costs of Diseases (in US $)

Disease	Milk lost (kg)[1]	Calving interv. (days)[2]	Invol. culling ($)[3]	Opport. costs ($)[4]
DYST	300	10	75	190
STLB	0	10	50	75
RTPL	250	20	50	175
METR	250	20	50	175
KETS	250	10	0	100
CYST	150	40	140	285
SLHT	0	40	0	100
FEET	400	30	100	295
MAST[C]	400	0	140	260
MAST[S]	300	0	50	140

1)Cost $0.3/kg; 2)Cost $2.5/day open; 3)Cost(attributable risk)($760);
4)Includes cost of (Milk lost)+(Calving interval)+(Involuntary culling)

Strandberg & Oltenacu, 1989

Direct+Opportunity* Costs (in US $)

Disease	Per Disease Event: Treatment	Direct costs ($)	Opport. costs ($)	D+O costs ($)(2	In 100 Cow Herd(1: Treatment ($)	D+O costs ($)
DYST	100	140	190	330	80	264
STLB	0	75	75	150	0	600
RTPL	50	125	175	300	155	930
METR	50	125	175	300	80	480
KETS	40	50	100	150	112	420
CYST	40	60	285	345	172	1484
SLHT	40	60	100	160	172	688
FEET	20	30	295	325	46	748
MAST[C]	25	80	260	340	360	4896
MAST[S]	0	0	140	140	0	4032

Cost / cow / year: 12 145

1)Calculated as (LIR) × (D+O costs)

Economic cost of diseases

discarded milk
mortality
farmer's labor
→ Direct costs

⇓ milk production
⇓ fertility
⇑ risk culling
→ Opportunity costs

⇑ risk of other diseases
→ Indirect costs

Cows with DYST are at increased risk of:

- STLB (OR=13.7)
- RTPL (OR=7.8)
- METR (OR=7.4)
- MAST (OR=1.7)
- as well as KETS, CYST and SLHT

What is the "new" cost of DYST:

Treatment	$100	$140	$330
Farm labor	$ 40		
Milk lost	$ 90	$190	
Increased calving interval	$ 25		
Increased risk of culling	$ 75		
Risk of subsequent diseases	$196		
New Total cost	$526		

Oltenacu & Lindhe, 1990

Economic cost of diseases

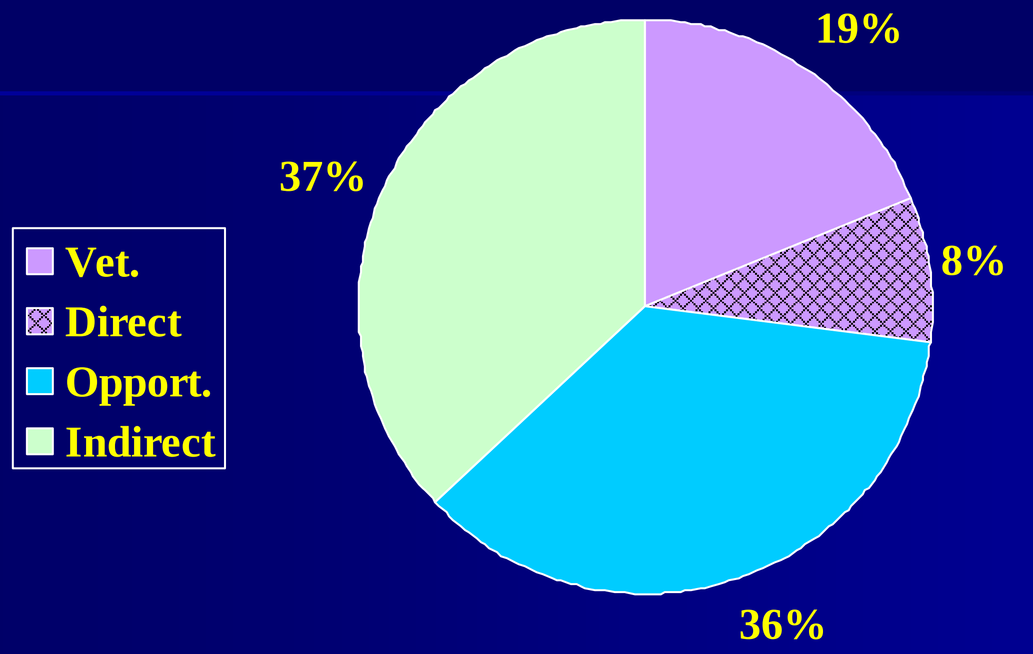
discarded milk
mortality
farmer's labor
→ Direct costs

⇓ milk production
⇓ fertility
⇑ risk culling
→ Opportunity costs

⇑ risk of other diseases
→ Indirect costs

⇓ animal welfare
⇓ trade, consumption
⇓ envt. pollution
⇑ societal acceptance
→ Hidden costs

Costs of Dystocia



Direct Costs + Opportunity Costs + Indirect costs + Hidden Costs = TOTAL COSTS

$140 + $190 + $196 + $???? = $526+????

Conclusions

The negative consequences of diseases are numerous, ranging from obvious to hidden and from immediate to remote.

Some consequences are easily translated into monetary values but many are not.

The magnitude of these consequences varies with intensity of production system, level of management, environment, etc.

Conclusions

When all impacts of diseases are properly accounted, costs of diseases are very high.

Preventing disease and improving resistance to diseases and other adaptability traits (fertility, longevity) is economically beneficial.

Genetic improvement of adaptability (welfare) is cumulative, permanent and is disseminated in the entire cow population.