Evolution of Genetic Improvement Practices in Domestic Animal Populations

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Characterization of Genetic Improvement Programs

Genetic Evaluations in Time: Past, Present, Future

Role of Universities, Government Institutions, Private Industry

Final Thoughts

Characterization of Genetic Improvement Programs

- Population
- Traits
- Genetic and Environmental Effects
- Data Collection and Maintenance
- Genetic Evaluation Models
- Computational Procedures
- Selection
- Mating Strategies

Population

- Domestic Animal Populations
  (Cattle, Sheep, Swine)
- Number and Type of Subpopulations
  (Unibreed, Multibreed)
- Reproductive Rates and Procedures
  (NS, AI, ET; Generation Interval)

Complete Multibreed Population

UFL Angus-Brahman Multibreed Herd

Composed of purebred and crossbred animals that interbreed

Angus
¾ A ¼ B
½ A ½ B
¼ A ¾ B
Brahman
Brangus

Sires mated to dams of all breed groups

Angus-Brahman Multibreed Herd

12 years of data (1989-2001)

153 sires (12 to 42 per BG)
1124 dams (113 to 293 per BG)
2910 calves (143 to 951 per BG)

Numbers of Sires

	BGS					
BGD	A	.75 A	.50A	.25A	B	Br
A	27	9	15	17	26	26
.75 A	20	12	15	15	27	20
.50A	27	11	15	17	31	29
.25A	20	9	13	13	24	16
B	19	11	13	16	42	21
Br	19	8	13	15	21	31

Numbers of Dams

	BGS					
BGD	A	.75 A	.50A	.25A	B	Br
A	110	43	75	42	55	32
.75 A	28	26	39	25	38	15
.50A	42	30	59	36	49	29
.25A	88	36	69	40	54	33
B	86	45	90	48	258	33
Br	95	38	101	41	52	127

Numbers of Calves

	BGS					
BGD	A	.75 A	.50A	.25A	B	Br
A	200	31	48	107	101	128
.75 A	50	28	38	46	51	50
.50A	98	44	79	93	114	164
.25A	51	28	40	52	60	47
B	65	43	52	62	495	61
Br	40	15	32	36	38	223

Incomplete Multibreed Population

Sanmartinero-Brahman Multibreed Herd

Sanmartinero
Colombian Criollo Breed
Beef - Dairy

Number of Sires

	BGS		
BGD	Sanmar	½S½B	Brahman
Sanmar	88	0	14
½S½B	14	10	18
¾S¼B	14	0	0
Brahman	41	1	22

Number of Dams

	BGS		
BGD	Sanmar	½S½B	Brahman
Sanmar	410	0	80
½S½B	39	68	75
¾S¼B	29	0	0
Brahman	75	1	110

Number of Calves

	BGS		
BGD	Sanmar	½S½B	Brahman
Sanmar	1309	0	147
½S½B	92	242	242
¾S¼B	88	0	0
Brahman	264	1	371

Incomplete Multibreed Population

DPO Multibreed Population

Holstein, Native, Brahman, Red Sindhi, Sahiwal, Jersey, Red Dane

Bos taurus - Bos indicus

Holstein - Other

(Native, Brahman, Red Sindhi, Sahiwal, Jersey, Red Dane)

Numbers of Sires

	BGS	
BGD	H	(.63-.99)H
(.8-1.0)H	78	4
(.6-.79)H	103	6
(.4-.59)H	76	5
(.2-.39)H	17	2
(0-.19)H	14	1

Numbers of Dams

	BGS	
BGD	H	(.63-.99)H
(.8-1.0)H	115	9
(.6-.79)H	168	12
(.4-.59)H	92	7
(.2-.39)H	15	2
(0-.19)H	15	2

Numbers of Daughters

	BGS	
BGD	H	(.63-.99)H
(.8-1.0)H	127	9
(.6-.79)H	178	12
(.4-.59)H	106	7
(.2-.39)H	17	2
(0-.19)H	15	2

Traits and Effects

Number and Type of Selection Traits

(continuous, categorical, biological, synthetic)

Genetic and Environmental Effects

Additive

Direct

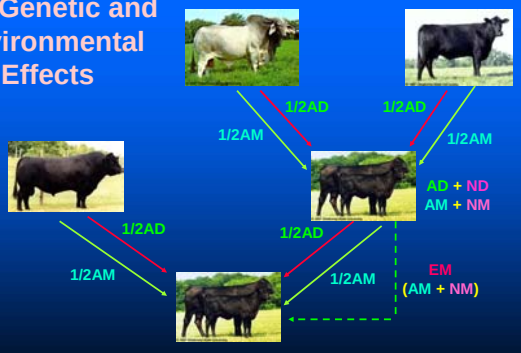
Intrabreed

Nonadditive

Maternal

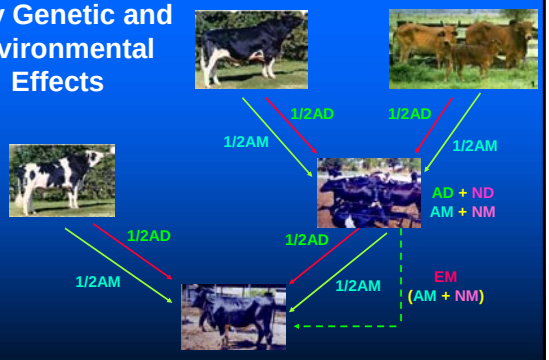
Interbreed

Beef Genetic and Environmental Effects



(AD + ND) + (AM +NM) + ED (AD + ND) + EM (AM + NM)

Dairy Genetic and Environmental Effects



(AD + ND) + (AM +NM) + ED (AD + ND) + EM (AM + NM)

Data Collection and Maintenance

- Data for Current and Future Traits
- Data on All Effects Related to All Traits
- Complete Pedigree (Animals, Sires, Dams)
- Breed Identification and Breed Composition (Animals, Sires, Dams)
- Date1, {Measurements1}, …

Chart of Genetic Effects

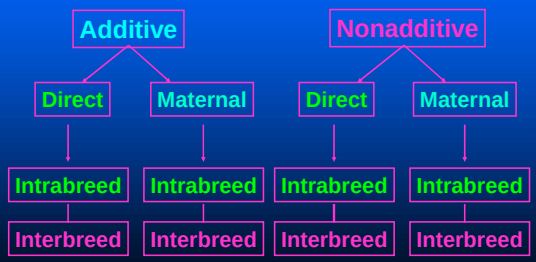
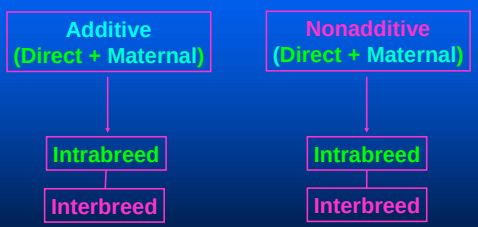


Chart of Environmental Effects



Multibreed Model

- Record
- Multibreed Contemporary Group
  Age Dam-Sex Calf-Dam Group
- Sire Group and Mgs Group
  (A, N, D, M)
- Sire and Mgs
  (A, N, D, M)
- Residual

Computational Procedures

Population Size

Small
Large

Type of Trait

Categorical
Continuous
Biological
Synthetic

Direct

Iterative

Systemic
(Systems Analysis)

Multibreed Genetic Evaluations

Angus-Brahman – USA (1998, 2002)
Growth Traits (Pre & Postweaning)
Carcass Traits
Romosinuano-Brahman – Colombia (1998)
Growth Traits (Pre & Postweaning)
Sanmartinero-Brahman – Colombia (1999)
Growth Traits (Pre & Postweaning)
Holstein-Other, BT-BI – Thailand (2002)
Dairy Traits (Milk Yield, Fat Yield, Fat %)

Selection and Mating Strategies

Selection

Unitrait
Multitrait

Mating Strategies

Unibreed
Multibreed

Multitrait
(Index)

Unibreed

Multibreed
(Upgrading)
(Rotational Crossbreeding)

Genetic Evaluations in Time

Past

Present

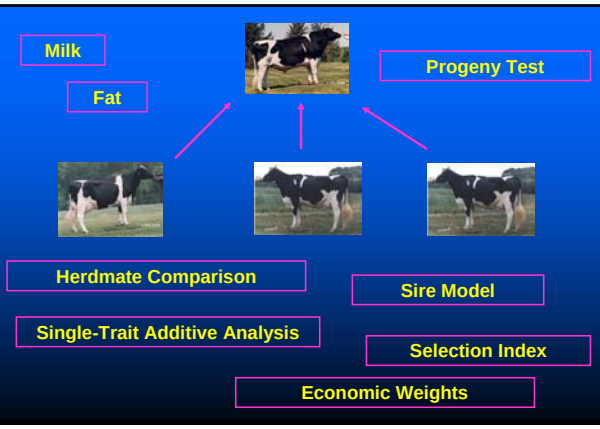
Future

Past Genetic Evaluations

Unibreed

Unitrait
Multitrait
(Selection Index)

Additive Genetic Effects

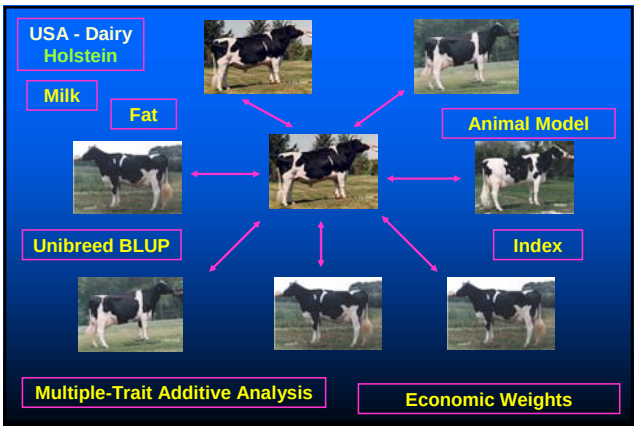


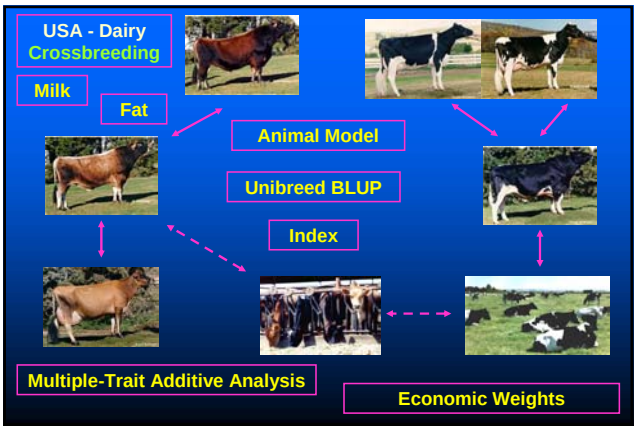
Present Genetic Evaluations

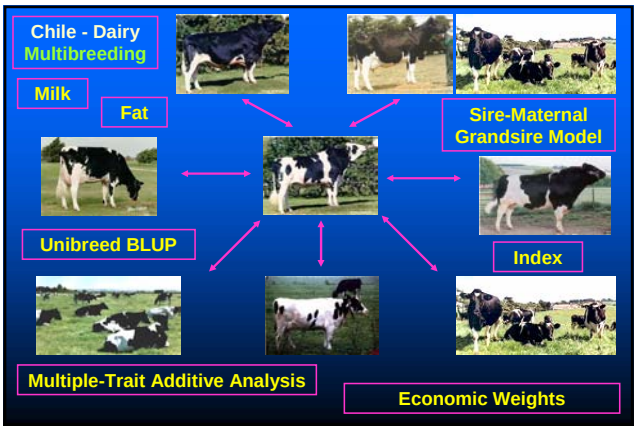
Unibreed
Multibreed

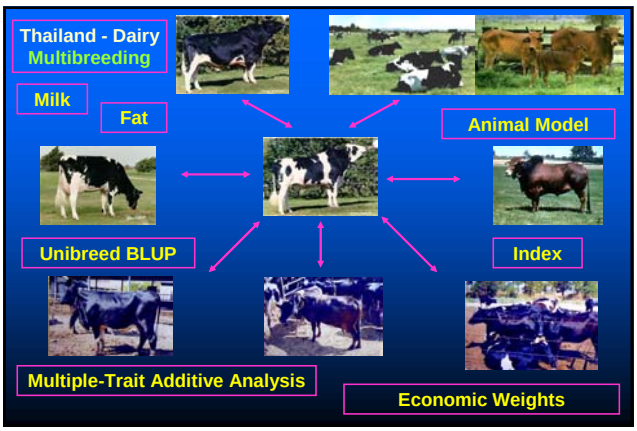
Multitrait
Quantitative Trait Loci (QTL)
(BLUP, Bayesian Methods)

Additive and Nonadditive Genetic Effects
(Interbreed)









DPO Multibreed Population

Dairy Traits

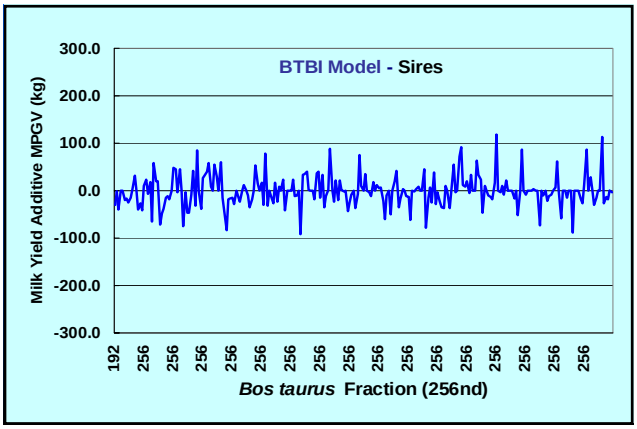
Milk Yield
Fat Yield
Fat %

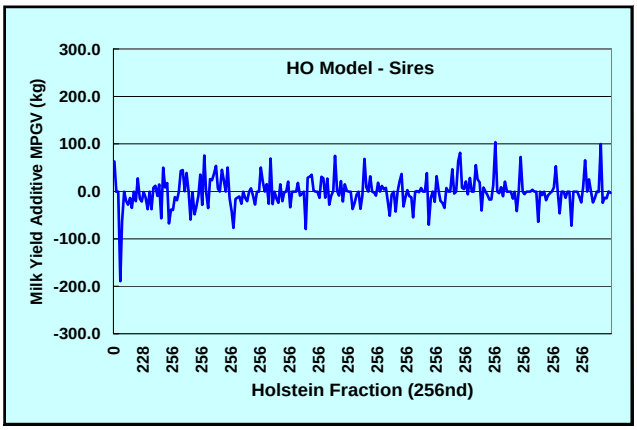
Bos taurus
Bos indicus

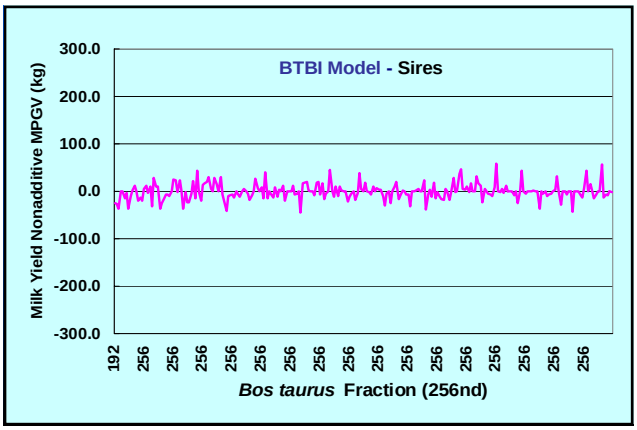
Holstein
Other
(Native, Brahman, Red Sindhi, Sahiwal, Jersey, Red Dane)

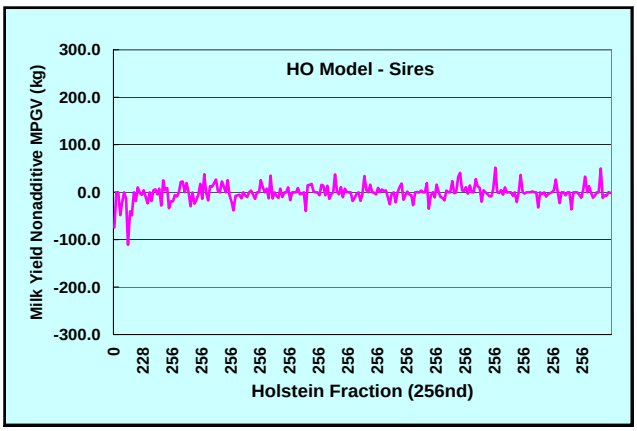
DPO Multibreed Genetic Predictions

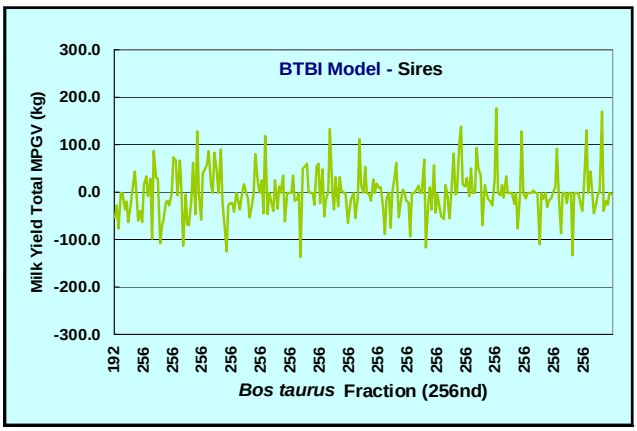
MEPD	Direct (D)
Additive (A)	AD
Nonadditive (N)	ND
Total (T=A+N)	TD

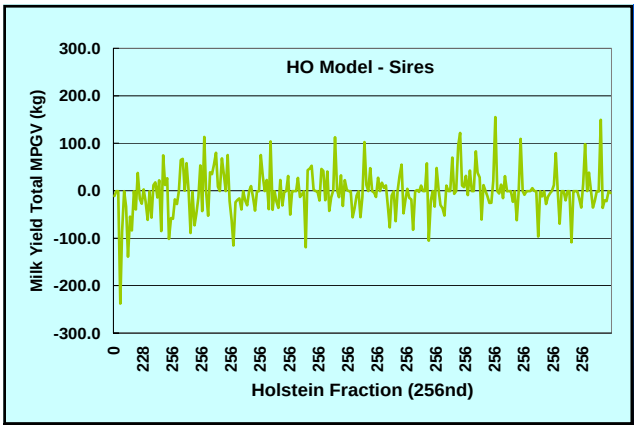


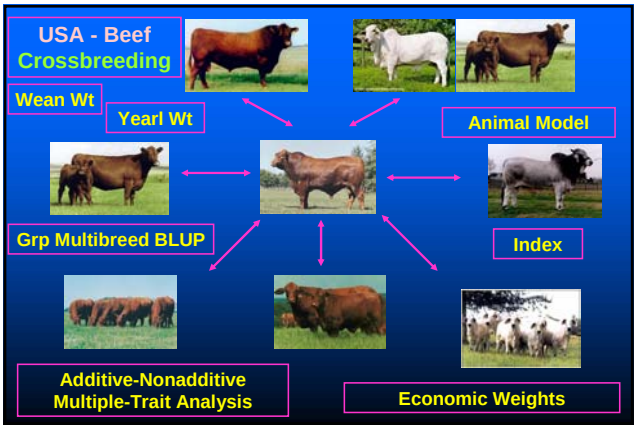












Angus-Brahman Multibreed Herd

Growth Traits

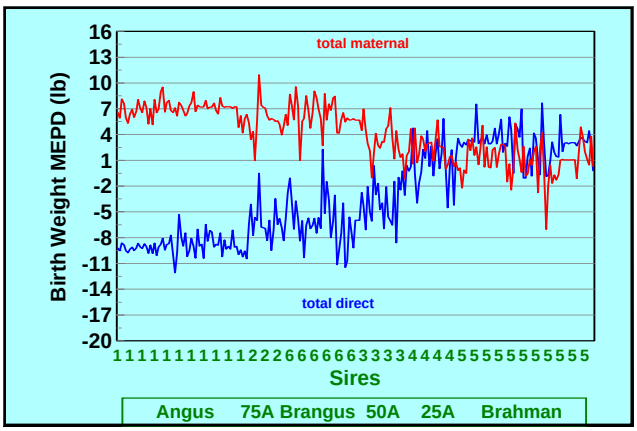
Birth Weight
Weaning Weight
550-day Weight

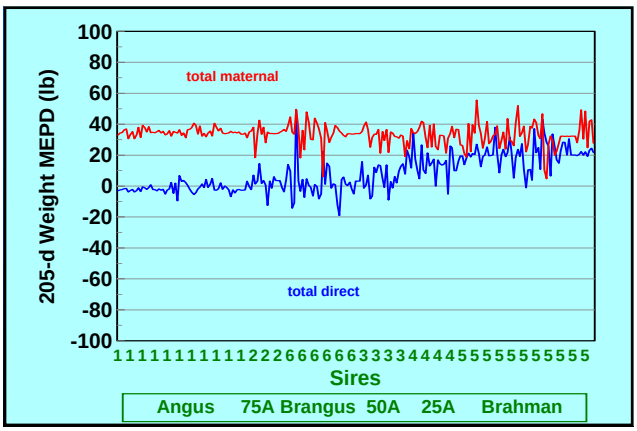
Carcass Traits

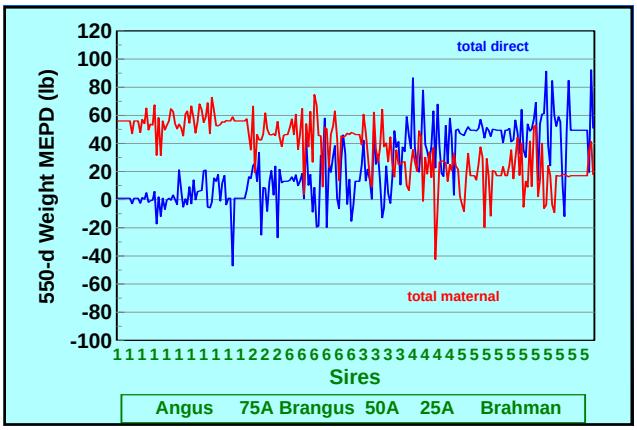
Hot Carcass Wt
Ribeye Area
Marbling
Tenderness

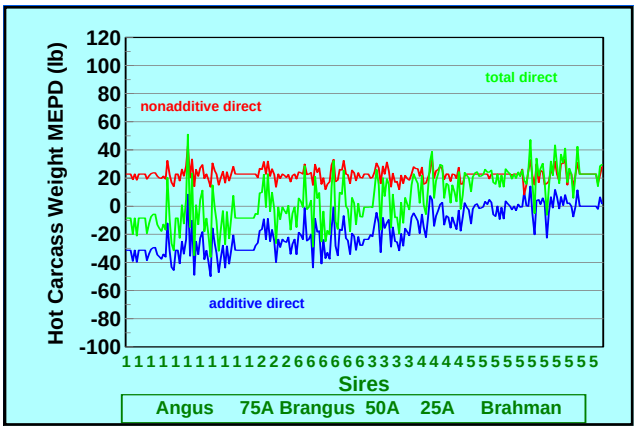
Multibreed Genetic Predictions

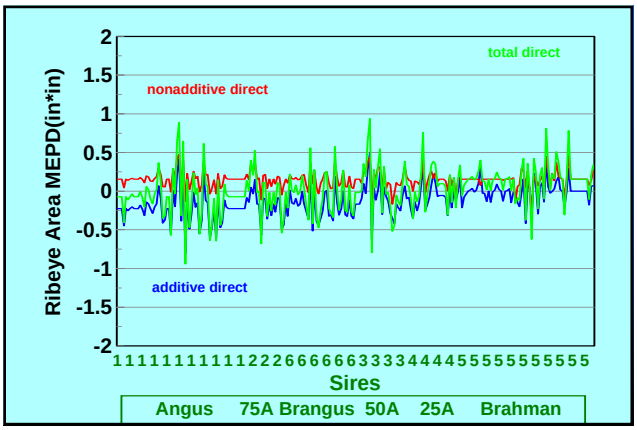
MEPD	Direct (D)	Maternal (M)
Additive (A)	AD	AM
Nonadditive (N)	ND	NM
Total (T=A+N)	TD	TM

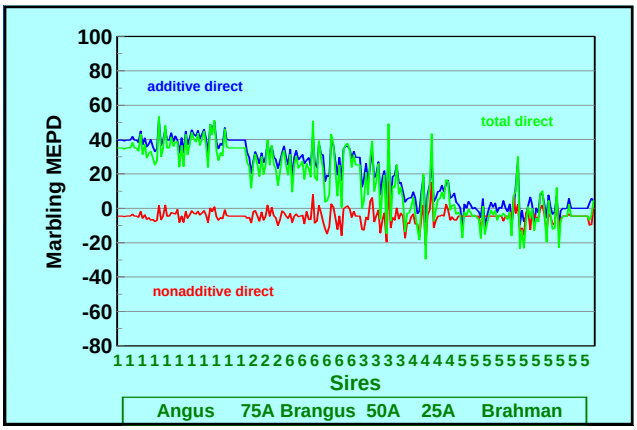


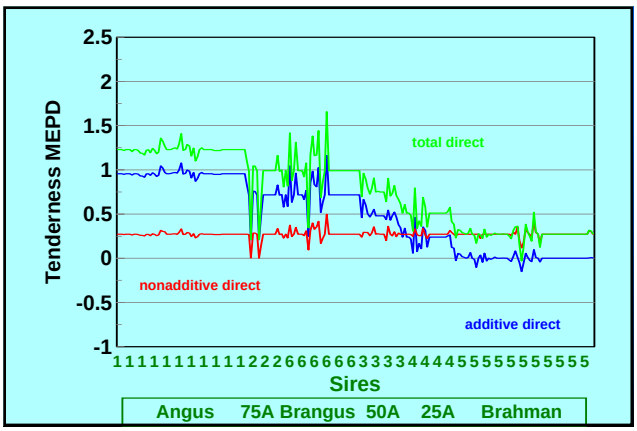






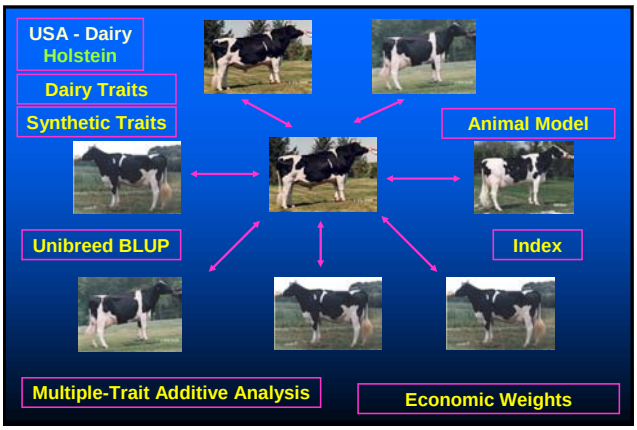


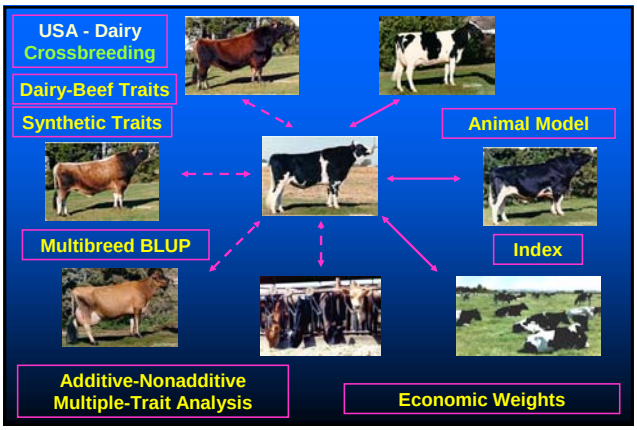


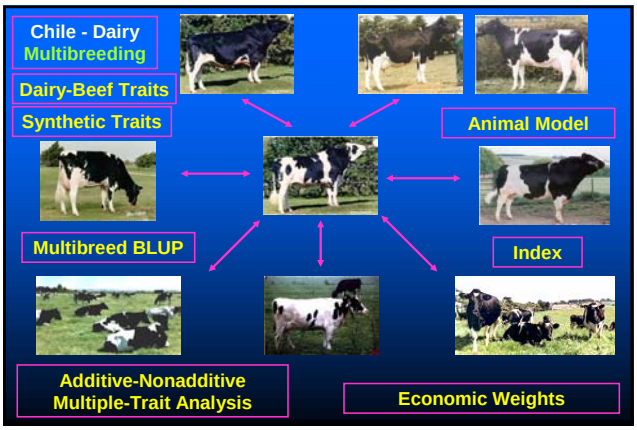


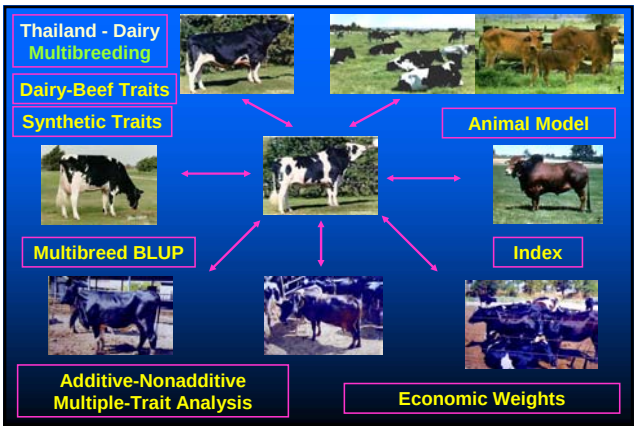
Future Genetic Evaluations

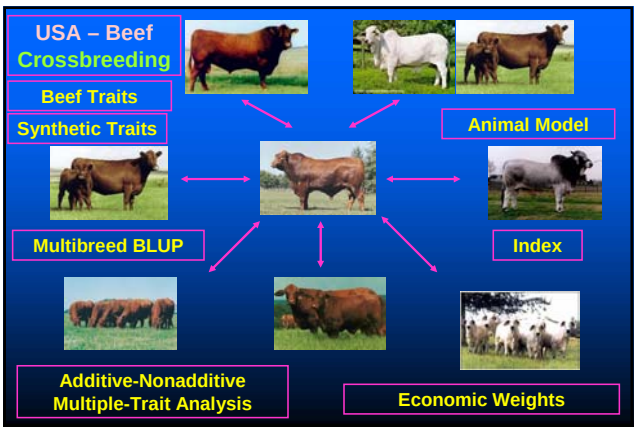
- Multitrait
- Discrete
- Continuous
- Unibreed
- Multibreed
- Economic Traits
- Quantitative Trait Loci
- Actual Genes
- Gene Combinations
- Synthetic Traits
- Additive and Nonadditive Genetic Effects (Intrabreed and Interbreed)

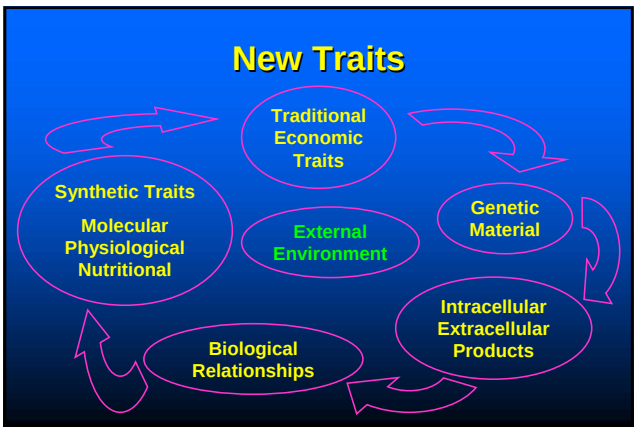

USA - Dairy
Holstein
Dairy Traits
Synthetic Traits
Animal Model
Unibreed BLUP
Index
Multiple-Trait Additive Analysis
Economic Weights


USA - Dairy
Crossbreeding
Dairy-Beef Traits
Synthetic Traits
Animal Model
Multibreed BLUP
Index
Additive-Nonadditive
Multiple-Trait Analysis
Economic Weights

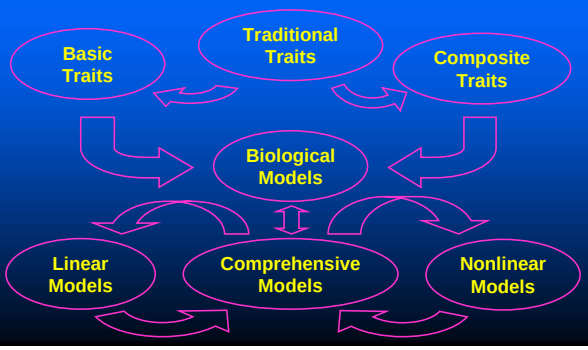

Chile - Dairy
Multibreeding
Dairy-Beef Traits
Synthetic Traits
Animal Model
Multibreed BLUP
Index
Additive-Nonadditive
Multiple-Trait Analysis
Economic Weights


Thailand - Dairy
Multibreeding
Dairy-Beef Traits
Synthetic Traits
Animal Model
Multibreed BLUP
Index
Additive-Nonadditive
Multiple-Trait Analysis
Economic Weights

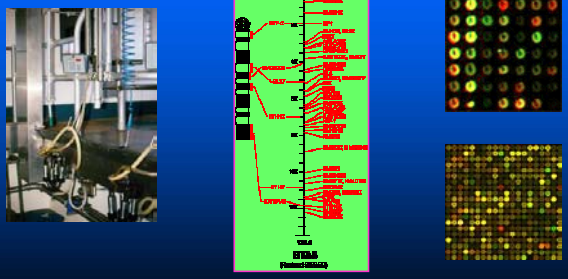

USA – Beef
Crossbreeding
Beef Traits
Synthetic Traits
Animal Model
Multibreed BLUP
Index
Additive-Nonadditive
Multiple-Trait Analysis
Economic Weights


New Traits
Traditional
Economic
Traits
Synthetic Traits
Molecular
Physiological
Nutritional
External
Environment
Genetic
Material
Intracellular
Extracellular
Products
Biological
Relationships

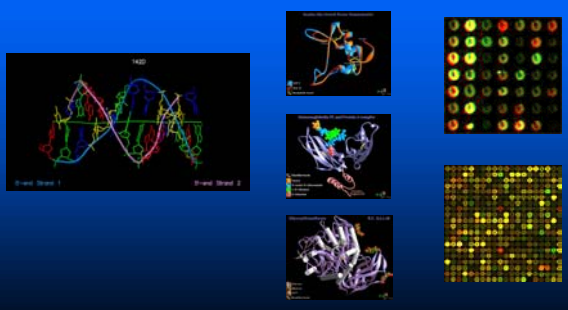
New Models



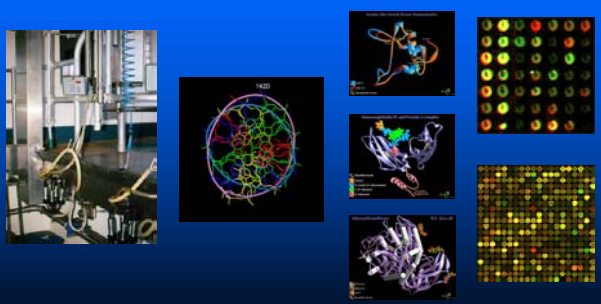
Current Research



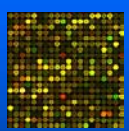
New Relationships



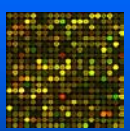
New Groups of Traits



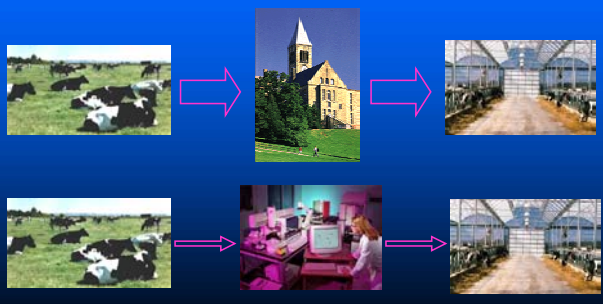
Subtraits Based on Gene Activity



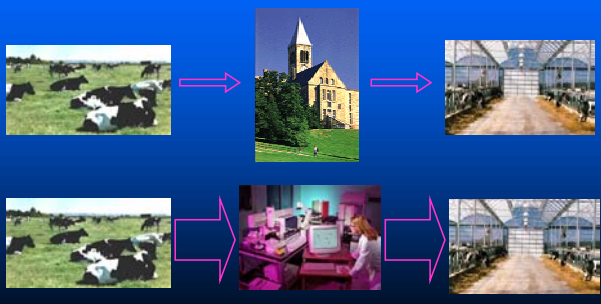
Subtraits Based on Gene Function



Current Flow of Information



Future Flow of Information



New Informatics Structure

Breed Associations

Private Companies

Universities

Large Number of Private Databases

Less Control over their Data ?

Less Access to Databases ?

New Research Structure

Expensive Research Projects (Equipment, Personnel)

Large Number of Simultaneous Measurements (Biochips)

Private Companies Will Collect Most of the Genetic Information ?

Role of Universities and Government Institutions ?

Role of Breed Associations and Private Industry ?

Role of Universities

Larger Integration with the Private Sector

Joint Basic and Applied Research Projects with the Private Sector

Participation in Joint Product Development and Commercialization with the Private Sector

Participate in Research Parks

Participate in National Research Committees

Role of Government Institutions

Support National Infrastructure and Agricultural Services

Support Research and Development Projects of National Interest

Support Development of Economically Viable Dairy and Beef Cattle Industries

Support the Development of New Technology and Development Programs

Role of Breed Associations

- Suppliers of Genetic Material
- Alliances with Private Companies
- Agreements with Universities
- Larger Investment in Research and Development
- Applied Research

Role of Private Industry

- Users and Suppliers of Genetic Material
- Vertical Integration (Poultry, Swine, Cattle)
- Cooperatives and Alliances
- Larger Investment in Research and Development
- Basic and Applied Research

Impact of Globalization

- International Companies
- International Projects in Research and Development
- International Databases
- Regional Agreements
- Larger Genetic Changes
- Larger Economic Benefits

Final Thoughts

Genetic Evaluation will change substantially in the future

- New Traits
- New Genetic-Statistical Methods
- New Population Structure
- New Data Structure
- New Economic Structure
- New Selection Goals