University of New England

Introduction to Breeding and Genetics

Lecture1

GENE 251 / 351

School of Environment and Rural Science (Genetics)

GENE 251 / 351

- **Unit Objectives**
  - to introduce students to applied genetics
  - basic understanding in plant and animal breeding
  - be aware of new technologies affecting these disciplines

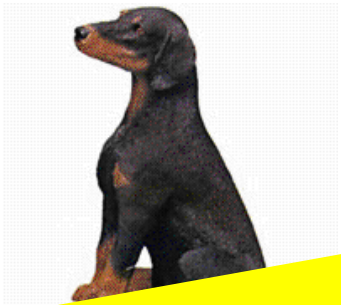
- **Teaching Outcomes**
  - demonstrate an understanding of applied genetics
  - show an understanding of applications of animal and plant breeding
  - demonstrate awareness of new technologies affecting these disciplines

Animal and Plant Breeding

- Refers to genetic change – with aim to improve
  - (breeding not simply as ‘reproduction’)

- Mainly based on quantitative genetics
  - Measurement of traits
  - Polygenic model

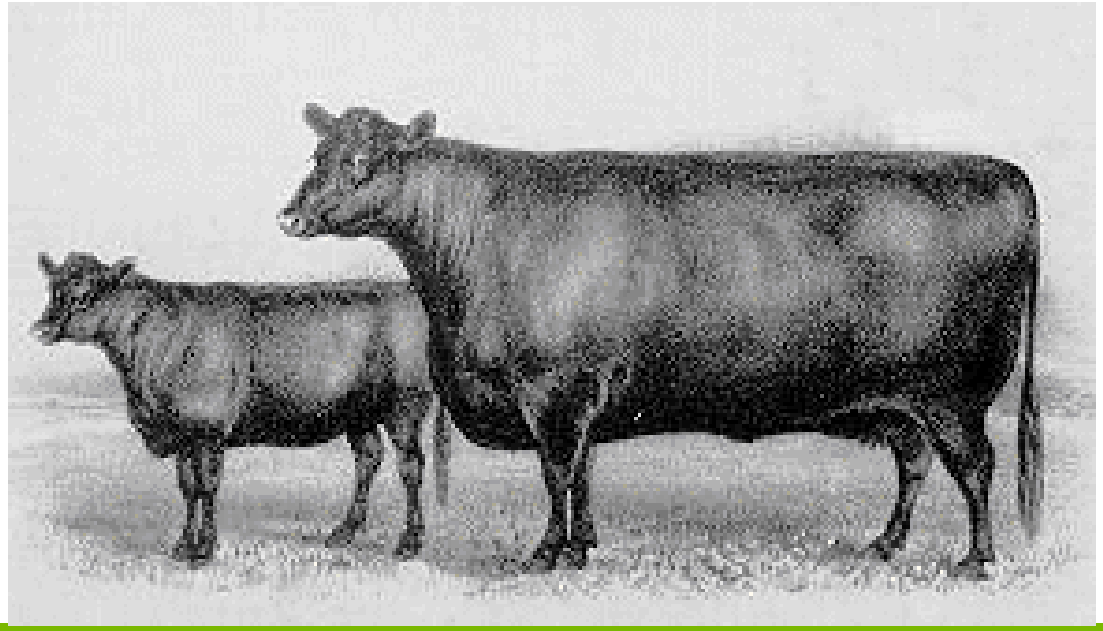
Don’t underestimate the power of genetics !



Selection on phenotype

Traditional (historical) Breeding

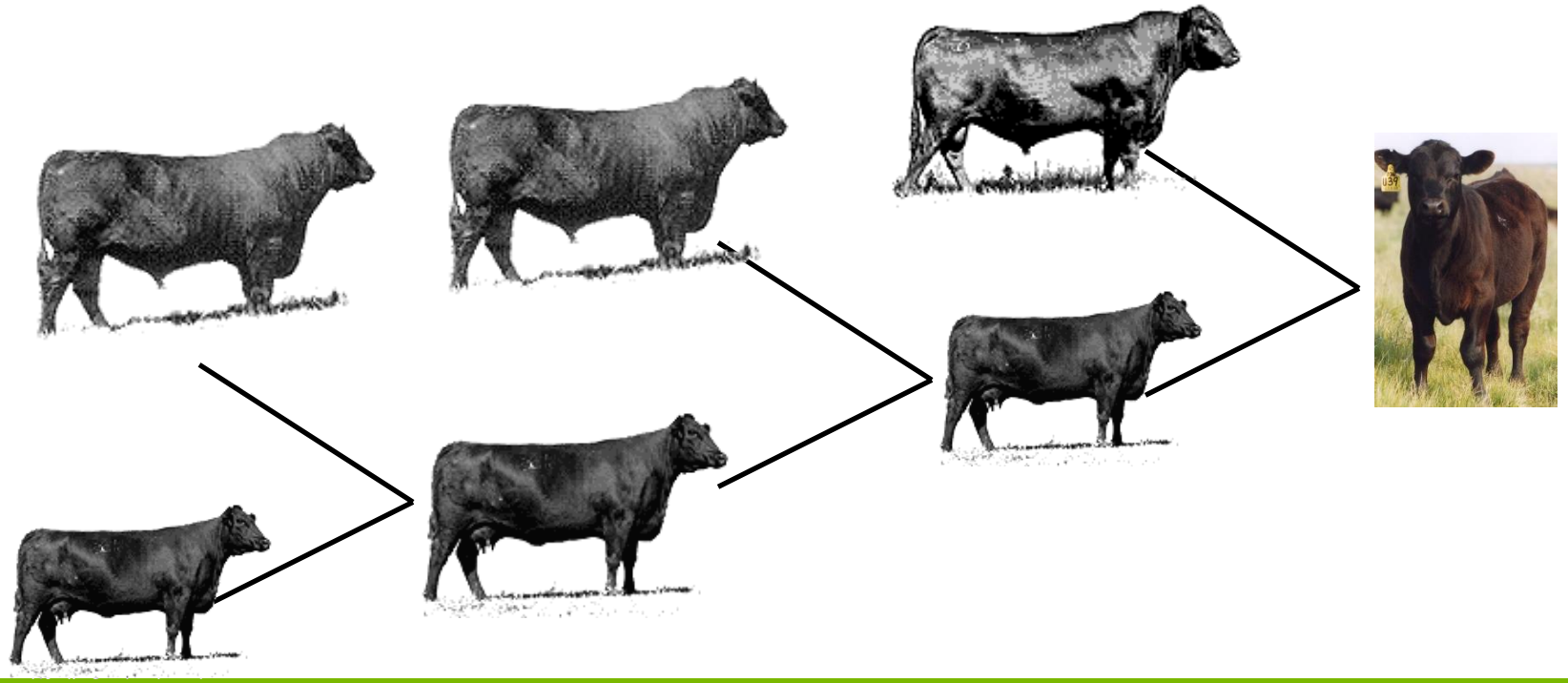
- Gradual (but dramatic) genetic change over long time periods (100's years) via observation and selective breeding



Slide from Peter Parnell (Angus Assoc)

Traditional (historical) Breeding

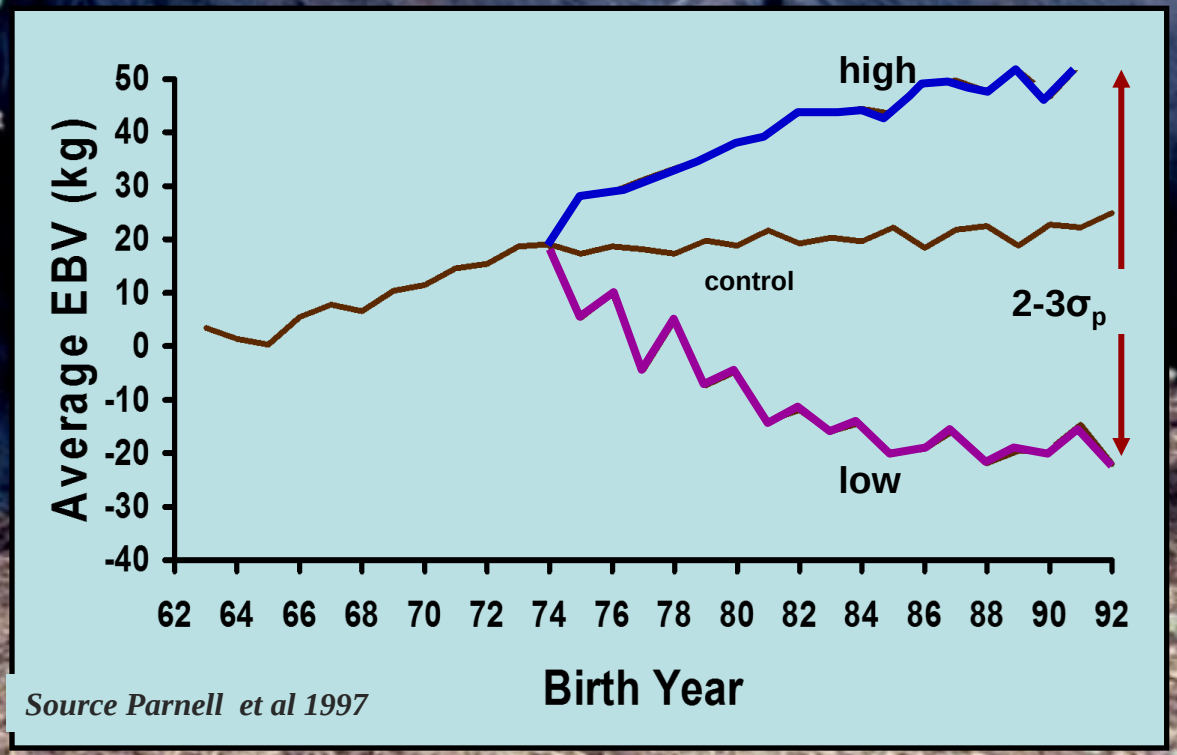
- Use of Pedigree Information
  - things could get complicated



Slide from Peter Parnell (Angus Assoc)

Selection experiments: Trangie growth research

How much change can we achieve in 20 years of selection?



Source Parnell et al 1997

Courtesy: Peter Parnell

Animal breeding in a nutshell

Where to go? — Breeding objectives

How to get there? — Quantitative genetics

- Measurement of Traits: Which traits, Which animals? Pedigree and DNA testing
- Genetic Evaluation: Prediction of Breeding Value
- Reproductive technology? AI. MOET, JIVET, sexing

Tools and Investment

Getting there — Implementation

- Predicting and comparing alternative strategies
- Decision making: Mate Selection, Merit, Trait emphasis, Inbreeding

Where to go?
Breeding objectives

To increase growth and muscle, and decrease fat

To conserve a rare species

How to get there?
Selection

- Which animals to select?
- We are interested in the *GENES* responsible for good muscling, than the good muscling itself

- Need measurement
  - Correct for non-genetic effects
  - Consider family information (pedigree)

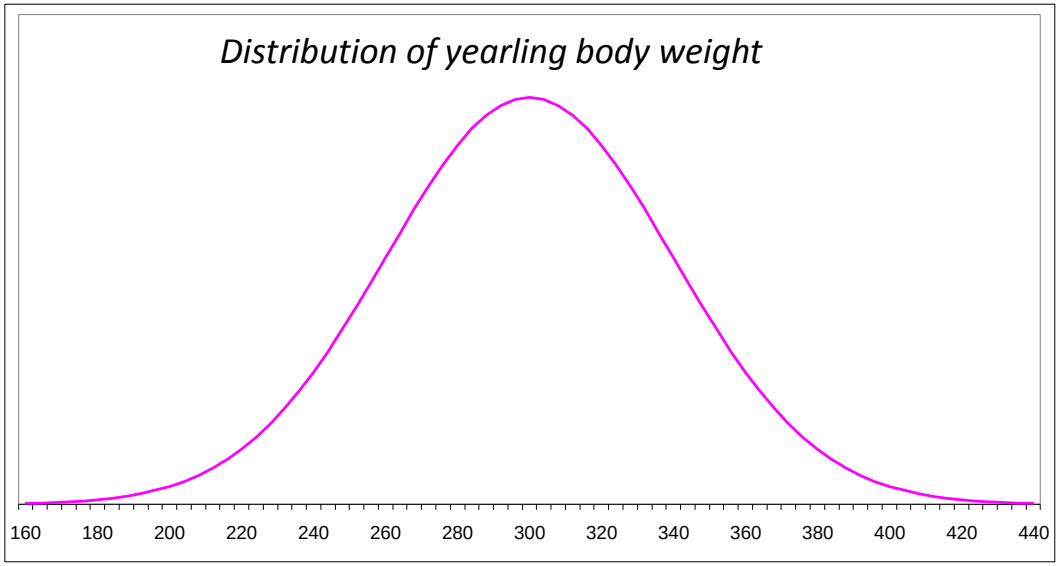
Genetic Evaluation

- Breed from the best only, select accurately, breed from young animals, not all from the same family

Selection

How much improvement is possible?

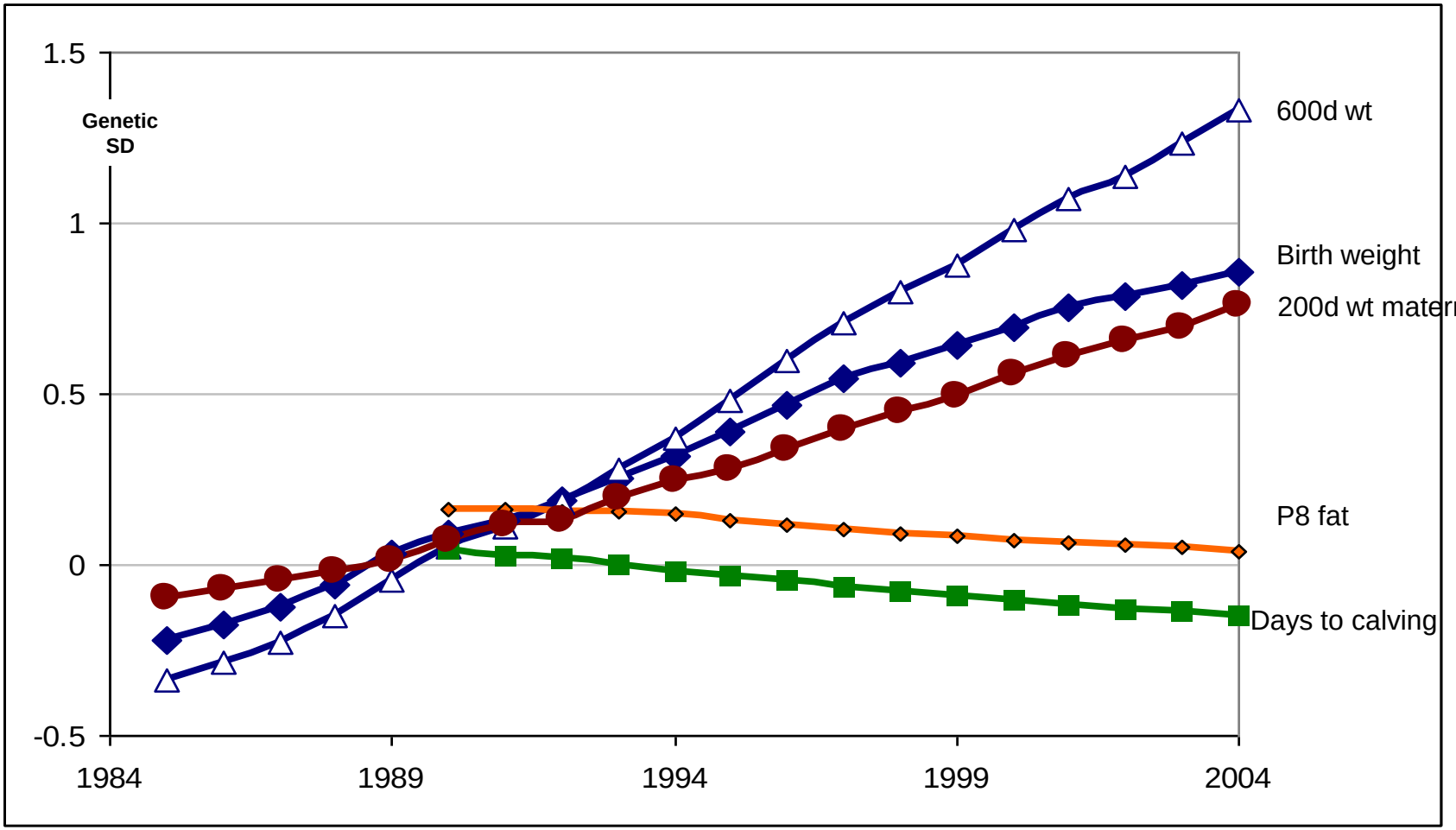
- Variation is Key



- Breeding Program
  - Selection Intensity
  - Selection Accuracy
  - Generation Interval

- Multiple Traits
  - Correlations
    - Favourable or unfavourable?
  - Balance between traits

Changing different traits - beef cattle



Changing different traits - sheep

- Realized 10 year change in merinos (Merinoselect)-

			Before Mean	Genetic Change	After Mean	%
Meat						
	Yearling weight	kg	50.0	0.5	55.0	10%
Wool						
	Adult clean fleece weight	kg	4.0	0.03	4.30	8%
	Adult mean fibre diameter	mic	18.0	-0.03	17.7	-2%
Repro						
	Number of lambs weaned	nlw	0.800	0.0024	0.824	3%
Parasites						
	Yearling worm egg count	cubert	8.0	-0.01	7.9	-2%

Is all potential is realized?

Genetic progress in Sheep	Annual response ($ per ewe)		
	Potential	Realised *Since 2000*	Ratio (%)
Border Leicester	2.0	1.7	85
Merino	2.3	0.7	30
Terminals	1.8	2.0	111

Implementation in various industries

Use of quantitative genetics theory has been implemented in all major livestock species:

	Changes
– Very good use in intensive industries	
• dairy, chicken, pigs	large
– Good use in extensive industries	
• Meat sheep	substantial
• Beef cattle	smaller
• Wool sheep	very modest

Breeding by the numbers….
EBVs and indexes

Terminals - Top 150

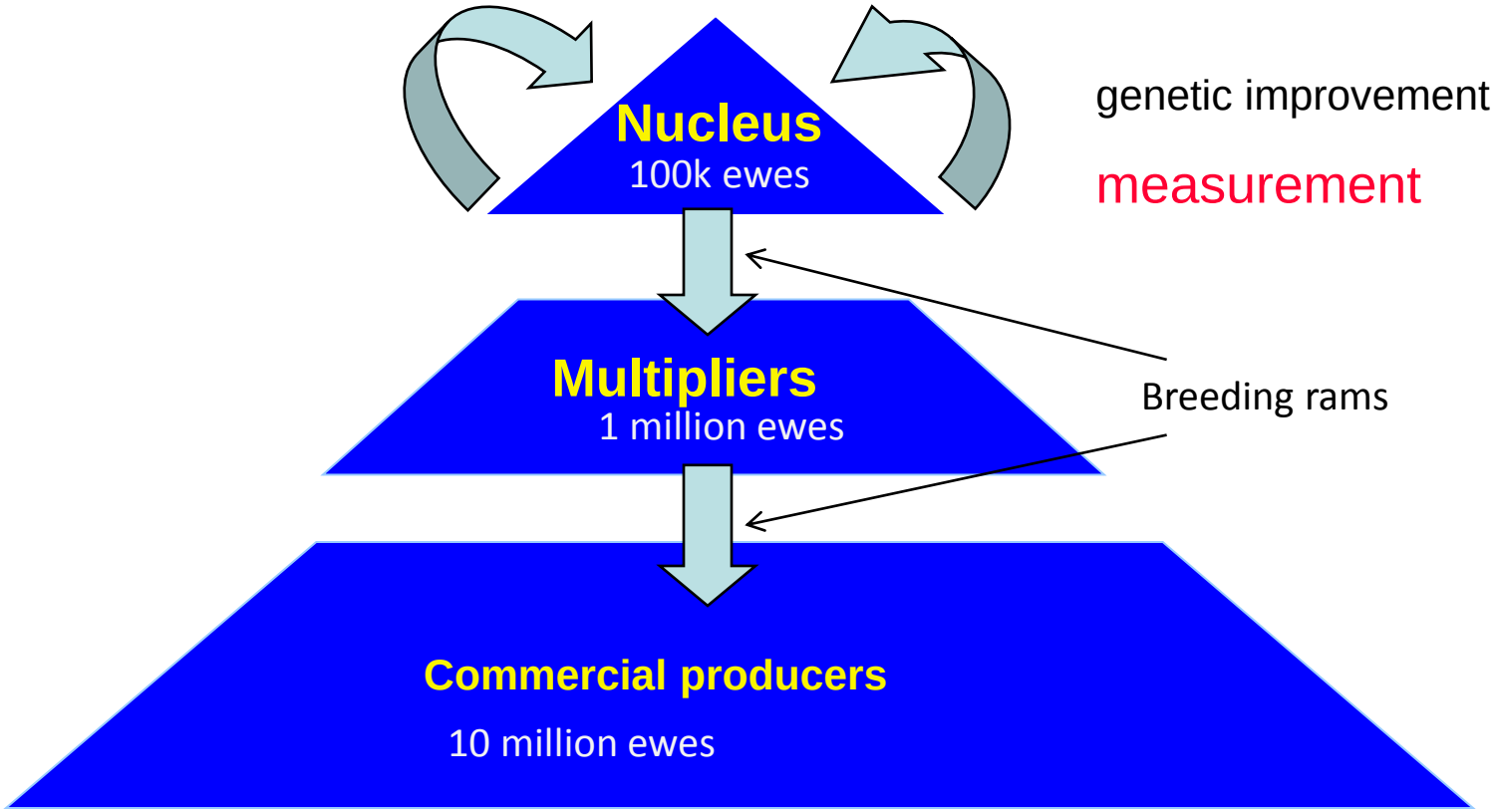
Analysis Date Friday, 15 June 2001

LAMBPLAN

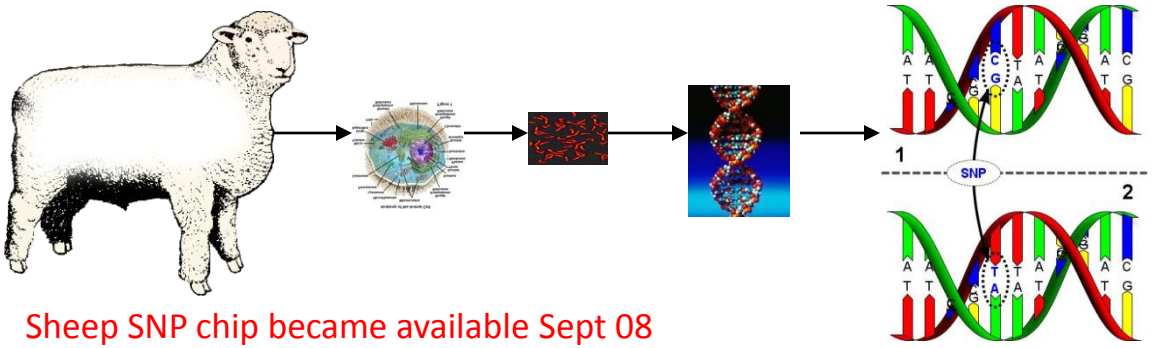
Sires

ID	Stud of breeding	Wwt	Pwwt	Ywt	Pfat	Pemd	Carcase +	Progeny	Inbreeding & Accuracies Coeff	Weight	Carcase	Sire	Sire of Dam
161972-1999-990196	HILLCROFT FARMS	5.46	14.95	14.94	-1.19	1.62	226.64	38	0.133	83	70	1619721998980093	1630001993930134
162368-1998-980211	KURRALEA	6.60	12.39	12.69	-0.89	2.50	215.20	1148		97	96	1623681994940260	8600401992920175
162204-1999-990453	BETHELREI	8.52	13.38	15.87	-1.18	1.11	211.75	224		93	89	8601221993930205	1619721995950289
161972-1998-980093	HILLCROFT FARMS	5.15	14.40	16.00	-1.08	0.25	207.51	12		80	74	1630001993930134	1603361992920349
161972-1998-980527	HILLCROFT FARMS	8.46	13.45	10.97	-1.66	-0.47	204.10	25		85	76	1619721996960091	1630001993930134
860122-1993-930205	OHIO	6.95	11.94	13.72	-1.60	0.49	203.76	1522		98	97	8601221992920200	8601221987870073
161143-1999-990204	DERRYNOCK	8.39	12.10	12.19	-0.49	2.19	203.60	38		82	76	1623681998980211	1640001993930411
160060-1996-960004	ANNA VILLA	8.56	14.90	16.18	-0.48	0.24	200.47	151		93	87	1632801992920016	1623541990900584
161143-1999-990201	DERRYNOCK	5.43	11.83	11.14	-1.19	0.83	199.83	39		83	77	1623681998980211	1613151995950042
230034-1997-970904	BURWOOD	4.98	11.01	8.82	-2.27	-0.55	198.82	380	0.003	96	92	2300091994940171	2300341994940314
163677-2000-000140	FELIX	6.69	13.56	13.36	-0.59	0.61	197.98	56		70	63	1619721995950289	1600341994940020
160060-1997-970115	ANNA VILLA	6.30	14.47	11.69	-0.42	0.24	196.90	118		90	83	1600601996960004	1600601992920057
162204-1999-990394	BETHELREI	7.42	12.97	14.27	-1.03	0.14	196.85	24		82	74	8601221993930205	1622041996960579
161143-1999-990064	DERRYNOCK	5.10	11.20	10.10	-0.72	1.60	196.01	18		80	74	1623681998980211	1640001994940317
161972-1996-960020	HILLCROFT FARMS	5.32	12.96	10.66	-0.80	0.36	195.20	83		88	75	1630001993930134	
160185-1996-960001	JOLMA	6.19	10.29	10.42	-1.56	0.63	194.57	101		90	83	1630001993930134	1613151991910870
161235-1997-970830	POLLAMBI	7.10	10.69	10.35	-0.88	1.50	194.54	34		87	79	1700991993930002	1612351991910691
163677-1999-990307	FELIX	7.09	12.52	11.59	-1.29	-0.47	192.45	54		83	74	8601221993930205	1636771994940008
162368-1999-990290	KURRALEA	5.53	10.84	10.58	-0.62	1.59	192.11	68		69	62	1623681998980211	1630001993930160
860074-1995-950044	ADELONG	7.17	14.47	13.22	-0.80	-0.94	191.15	448		96	94	8600741993930189	
163000-1998-980575	RENE	7.59	12.01	13.06	-0.50	0.99	190.92	12		71	60	1623681994940260	8600371992920165
162368-1997-970443	KURRALEA	6.58	12.13	7.96	-1.00	0.08	190.69	178		88	83	1640001993930411	8600401992920175
160034-1999-991208	MOSSLEY	5.52	13.45	10.27	-0.53	0.04	190.41	17	0.003	78	70	1621001998980130	1600341994940171
161437-1999-990006	WARBURN	5.41	10.97	10.93	-1.21	0.37	190.26	14		73	65	1604621994940012	1640001993930411
160001-1998-980575	NEWBOLD	7.60	11.69	11.57	-0.26	1.48	189.97	89		87	75	1600011997970211	1640001993930411
160085-1998-980007	ALLENDALE	5.71	12.83	13.40	-0.12	1.00	189.76	65		89	83	1604621994940012	1603361991910163
163000-1993-930134	RENE	5.25	9.55	13.73	-1.52	0.65	189.72	1359	0.062	98	97	1630001991910075	1630001987870053
860482-1998-980065	CLARONDEN	5.90	9.96	8.49	-1.70	0.10	189.57	153		87	78	8600371996960003	8600371989890172
161972-1995-950289	HILLCROFT FARMS	5.74	9.65	11.84	-0.92	1.55	189.35	344		96	93	1630001993930134	1619721990900299

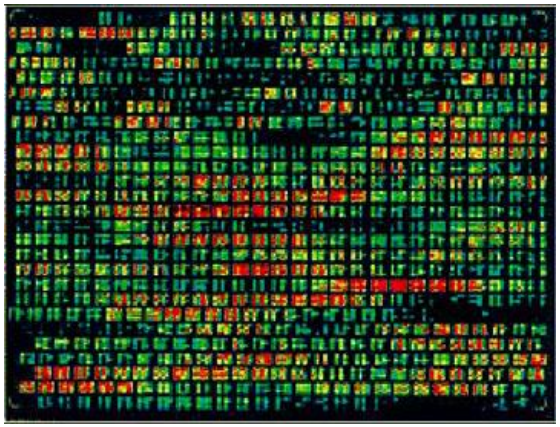
Breeding Program Design



The Genetic Revolution: Genomics



Sheep SNP chip became available Sept 08



SNP chip shows tens of thousands of DNA differences in one test for one individual --- very dense gene markers

This can be used to predict - breeding value
- phenotypes
to find - indiv. genes with large effect

Need quantitative genetic theory

- To predict breeding values
- Select the best individuals
- To predict outcomes of selection
  - genetic change
  - inbreeding

- To optimize breeding program decisions
  - multiple traits
  - improved merit versus inbreeding
  - crossbreeding

GENE 251 / 351 Plan

- Basis of genetics — Genes, inheritance
- Quantitative genetics — Variation, heritability, breeding value
- Selection Theory — Estimating breeding value
  Predicting changes to selection
  Correlated changes
  Multiple trait selection
- Genetic Markers, Genomic Selection
- Animal breeding programs — crossbreeding, reproductive technologies
  objectives, program structure
- Plant Breeding programs — breeding programs structure, gene markers