Optimizing Breeding Programs

COST-BENEFIT

Armidale Animal Breeding Summer Course 2014

Cost - Benefit of breeding programs

<u>Cost</u> of breeding programs for genetic improvement

Fixed costs (logistics, scientists etc. etc.)

Cost related to breeding strategy
- cost of phenotyping
- cost of genotyping
- cost of reproduction

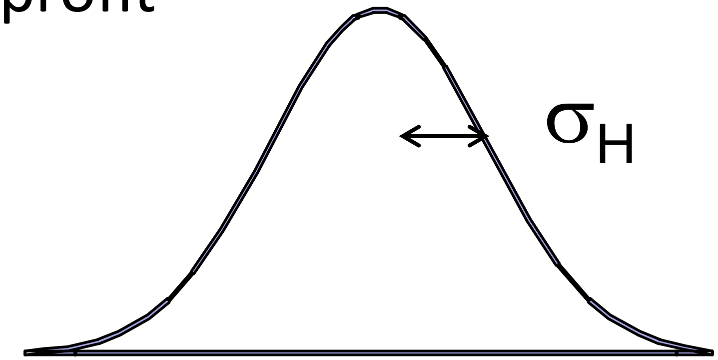
<u>Benefits</u>

Benefit of more genetic gain
Market share

Benefits of genetic gain

- Assuming the benefit is expressed by the breeding objective (economic values of trait improvement

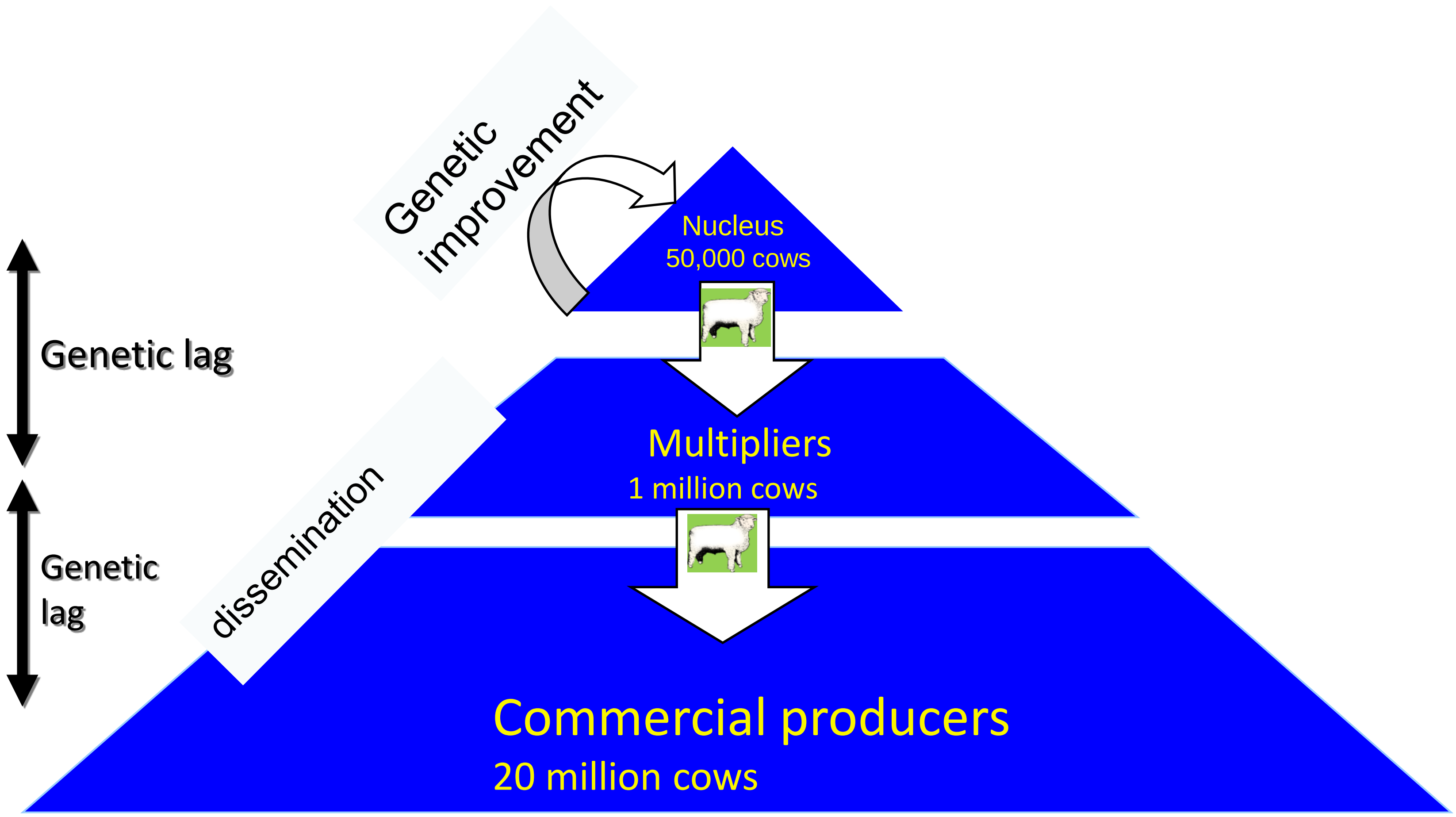
- Variation in breeding objective is variation in genetic merit for profit



Difference between best and worst is about 6 σ_H

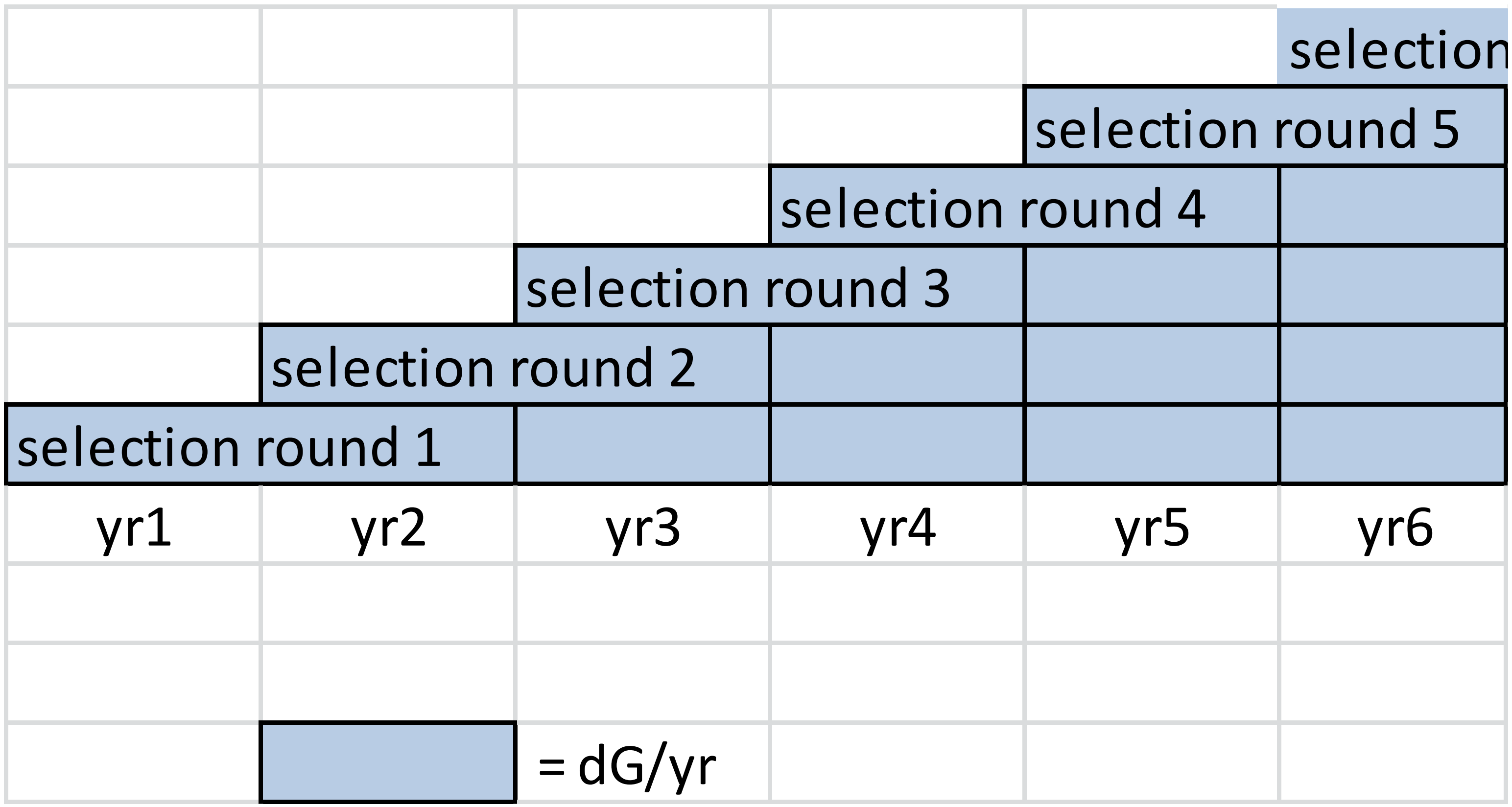
Benefits of genetic gain

- Benefit is transmitted is multiplied over many animals



Benefits of genetic gain

- Benefit is cumulative



Benefits of genetic gain

Benefit is

- Cumulative
- Multiplied over many

Benefits can be expected to be large

- But:
  - Are they achieved?
  - Who gets the benefit?
    - Breeders, Producer? Retail? Consumer?

Economic value of genetic improvement

- Value difference between two bulls
- Value of selecting better bulls
    - Bulls sold to Commercial
    - Bulls used in Stud
- Value of genetic improvement – whole herd

Two Commercial Bulls

	EBV YWT
Bull 1: Kevin	+10 kg
Bull 2: Tony	+15 kg

Nr Progeny:	100
Value of 1 kg YWT	$4
Difference in progeny	2.5 kg

Difference in value: as commercial bulls	5*$4	* 100	* 0.5
	Selection Difference	Nr of Progeny	Expression per progeny

= $1000.-

Two Commercial Bulls

	$Index
Bull 1: Kevin	+190
Bull 2: Tony	+180

Nr Progeny: 100

Difference in progeny $5

Difference in value: as commercial bulls	$10	* 100	* 0.5
	Selection Difference	Nr of Progeny	Expression per progeny

= $500.-

Selecting Better Bulls

		$Index
Average of 100 rams sold:	With Genomics	+182
	No Genomics	+180

Nr Progeny: 100 per bull

Difference in progeny $1.0

Difference in value:	$2	* 100	* 0.5
as commercial bulls	Selection Difference	Nr of Progeny	Expression per progeny

= $100.- * 100 rams = $10,000.

une

So principles are

Value of a superior bull

= Selection Difference * Nr.Progeny * expressions per progeny

We look at all expressions in <u>commercial</u> progeny

To evaluate benefit we need to predict

- the extra Selection Difference we can get

  this will depend a lot on extra accuracy

- the number of expressions

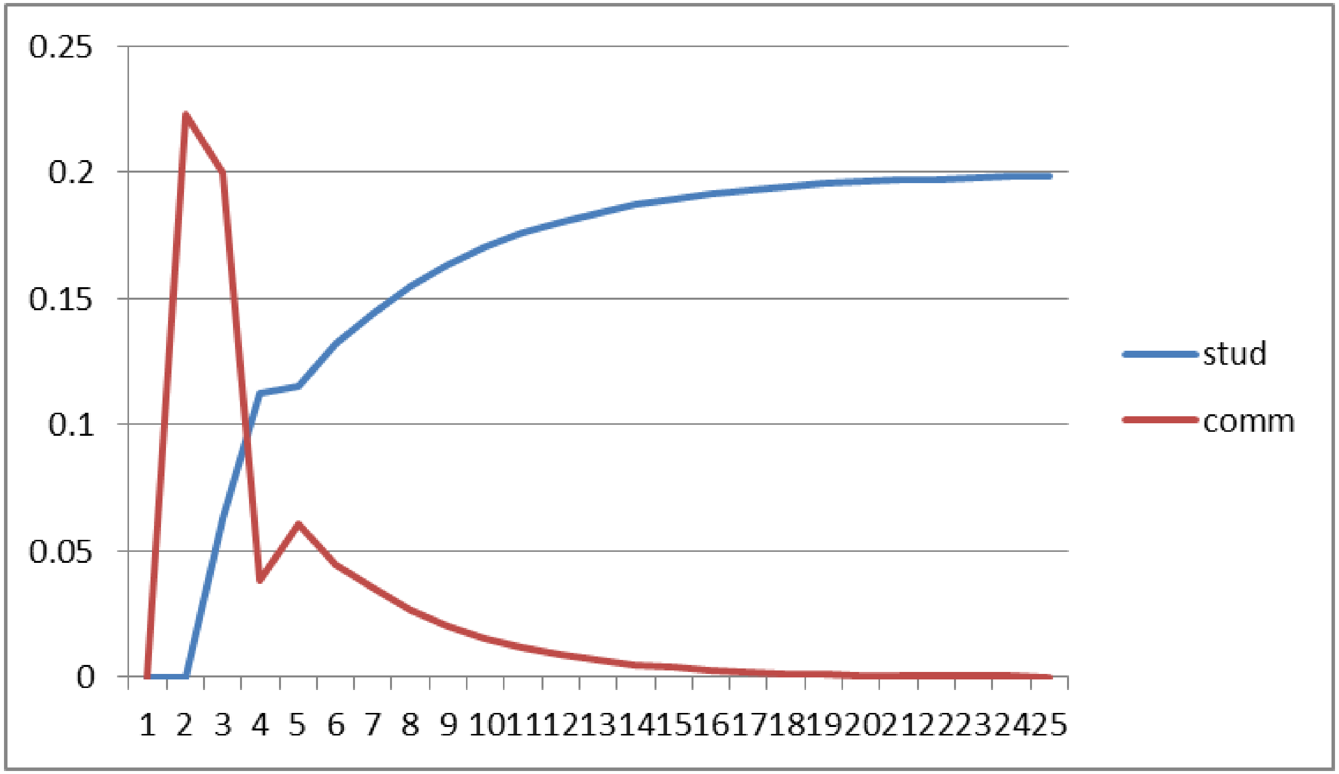
How about selection of stud bulls?

Value of a superior bull

= Selection Difference * Nr.Progeny * expression per progeny

Progeny in commercial, so for a stud bulls
these are actually
grand progeny,
great grand progeny, etc

(allele) frequency of one unit of superiority as expressed in commercial herd



The fate of superiority from commercial bull vs a stud bull

Noting that a commercial bull also transmits the superiority from a stud bull ?!

GENEFLOW

males to males	females to males
males to females	females to females

Donors of genes

Recipients of genes

	Sires of Nucleus					Dams of Nucleus									
P matrix	1	2	3	4	5	1	2	3	4	5	6	7	8	9	10
1	0	0.5	0	0	0	0	0.166667	0.166667	0.166667	0	0	0	0	0	0
2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
1	0	0.5	0	0	0	0	0.166667	0.166667	0.166667	0	0	0	0	0	0
2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

GENEFLOW

Donors of genes

Recipients of genes

Sn<Sn	Sn<Dn	Sn<Sc	Sn<Cm	Sn<Cf	Sn	Sires of Nucleus
Dn<Sn	Dn<Dn	Sf<Sc	Dn<Cm	Dn<Cf	Dn	Dams of Nucleus
Sc<Sn	Sc<Dn	Sc<Sc	Sc<Cm	Sc<Cf	Sc	Stud born males to sire commercial
Cm<Sn	Cm<Dn	Cm<Sc	Cm<Cm	Cm<Cf	Cm	Commercial born males
Cf<Sn	Cf<Dn	Cf<Sc	Cf<Cm	Cf<Cf	Cf	Commercial born females

GENEFLOW

Donors of genes

Recipients of genes

donors of genes

		Sires of Nucleus					Dams of Nucleus										Stud born males to sire commercial					Commercial born males					Commercial born females									
	P matrix	1	2	3	4	5	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	6	7	8	9	10
recipients of genes	1	0	0.5	0	0	0	0	0.166667	0.166667	0.166667	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0.5	0	0	0	0	0.166667	0.166667	0.166667	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0.5	0	0	0	0	0.166667	0.166667	0.166667	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0.166667	0.166667	0.166667	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	0.166667	0.166667	0.166667	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

P = matrix describing transmission of genes

GENEFLOW

- R = a matrix defining gene transmission of some superiority (or particular allele)

- Q= a matrix describing aging

	Sires of Nucleus					Dams of Nucleus			
P matrix	1	2	3	4	5	1	2	3	4
1	0	0.5	0	0	0	0	0.166667	0.166667	0.166667
2	1	0	0	0	0	0	0	0	0
3	0	1	0	0	0	0	0	0	0
4	0	0	1	0	0	0	0	0	0
5	0	0	0	1	0	0	0	0	0
1	0	0	0	0.5	0	0	0.166667	0.166667	0.166667

- P = matrix describing transmission of genes
  - P=R+Q

$$m_t = P\ m_{t-1} + Rn_{t-1}$$

- m vector of allele frequency in each age class

- n vector to describe inserting allele or superiority

GENEFLOW

g1	g2	g3	g4	g5	g6	g7	g8	g9	g10	g11	g12	g13	g14	g15	g16	g17	g18	g19	g20	g21	g22	g23	g24	g25
0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718	0.189324	0.208962	0.192477	0.206315	0.194699	0.20445	0.196265
1	0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718	0.189324	0.208962	0.192477	0.206315	0.194699	0.20445
0	1	0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718	0.189324	0.208962	0.192477	0.206315	0.194699
0	0	1	0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718	0.189324	0.208962	0.192477	0.206315
0	0	0	1	0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718	0.189324	0.208962	0.192477
0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718	0.189324	0.208962	0.192477	0.206315	0.194699	0.20445	0.196265
0	0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718	0.189324	0.208962	0.192477	0.206315	0.194699	0.20445
0	0	0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718	0.189324	0.208962	0.192477	0.206315	0.194699
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0	0	0	0	0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718	0.189324	0.208962	0.192477
0	0	0	0	0	0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718	0.189324	0.208962
0	0	0	0	0	0	0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718	0.189324
0	0	0	0	0	0	0	0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718
0	0	0	0	0	0	0	0	0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849
0	0	0	0	0	0	0	0	0	0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805
0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718	0.189324	0.208962	0.192477	0.206315	0.194699	0.20445	0.196265
0	0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718	0.189324	0.208962	0.192477	0.206315	0.194699	0.20445
0	0	0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718	0.189324	0.208962	0.192477	0.206315	0.194699
0	0	0	0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718	0.189324	0.208962	0.192477	0.206315
0	0	0	0	0	0.5	0	0.333333	0.083333	0.305556	0.111111	0.273148	0.138889	0.251543	0.156636	0.236368	0.169496	0.225609	0.178498	0.21805	0.184849	0.212718	0.189324	0.208962	0.192477
0	0	0	0.25	0	0.208333	0.083333	0.229167	0.104167	0.22338	0.138889	0.218557	0.156057	0.214989	0.170332	0.211072	0.179479	0.208424	0.185905	0.206188	0.190297	0.204567	0.193304	0.203333	0.195378
0	0	0	0	0.25	0	0.208333	0.083333	0.229167	0.104167	0.22338	0.138889	0.218557	0.156057	0.214989	0.170332	0.211072	0.179479	0.208424	0.185905	0.206188	0.190297	0.204567	0.193304	0.203333
0	0	0	0	0	0.25	0	0.208333	0.083333	0.229167	0.104167	0.22338	0.138889	0.218557	0.156057	0.214989	0.170332	0.211072	0.179479	0.208424	0.185905	0.206188	0.190297	0.204567	0.193304
0	0	0	0	0	0	0.25	0	0.208333	0.083333	0.229167	0.104167	0.22338	0.138889	0.218557	0.156057	0.214989	0.170332	0.211072						
0	0	0	0	0	0	0	0.25	0	0.208333	0.083333	0.229167	0.104167	0.22338	0.138889	0.218557	0.156057	0.214989	0.170332						
0	0	0	0.25	0	0.208333	0.083333	0.229167	0.104167	0.22338	0.138889	0.218557	0.156057	0.214989	0.170332	0.211072	0.179479	0.208424	0.185905						
0	0	0	0	0.25	0	0.208333	0.083333	0.229167	0.104167	0.22338	0.138889	0.218557	0.156057	0.214989	0.170332	0.211072	0.179479	0.208424						
0	0	0	0	0	0.25	0	0.208333	0.083333	0.229167	0.104167	0.22338	0.138889	0.218557	0.156057	0.214989	0.170332	0.211072	0.179479						
0	0	0	0	0	0	0.25	0	0.208333	0.083333	0.229167	0.104167	0.22338	0.138889	0.218557	0.156057	0.214989	0.170332	0.211072						
0	0	0	0	0	0	0	0.25	0	0.208333	0.083333	0.229167	0.104167	0.22338	0.138889	0.218557	0.156057	0.214989	0.170332						
0	0	0	0	0	0	0	0	0.25	0	0.208333	0.083333	0.229167	0.104167	0.22338	0.138889	0.218557	0.156057	0.214989						
0	0	0	0	0	0	0	0	0	0.25	0	0.208333	0.083333	0.229167	0.104167	0.22338	0.138889	0.218557	0.156057						
0	0	0	0	0	0	0	0	0	0	0.25	0	0.208333	0.083333	0.229167	0.104167	0.22338	0.138889	0.218557						
0	0	0	0	0	0	0	0	0	0	0	0.25	0	0.208333	0.083333	0.229167	0.104167	0.22338	0.138889						
0	0	0	0	0	0	0	0	0	0	0	0	0.25	0	0.208333	0.083333	0.229167	0.104167	0.22338						

0.185905	0.206188	0.190297
0.208424	0.185905	0.206188
0.179479	0.208424	0.185905
0.211072	0.179479	0.208424
0.170332	0.211072	0.179479
0.214989	0.170332	0.211072

Allele frequency in the limit, from on ‘insertion’ of superiority (or an allele) = $1/(L_m + L_f)$

Geneflow mainly useful for initial part of an action, otherwise can use Rendel and Robertson

Cumulative Discounted Expressions CDE

Value (V) in year t is worth now V.c where $c=1/(1+d)^t$

d = discount rate

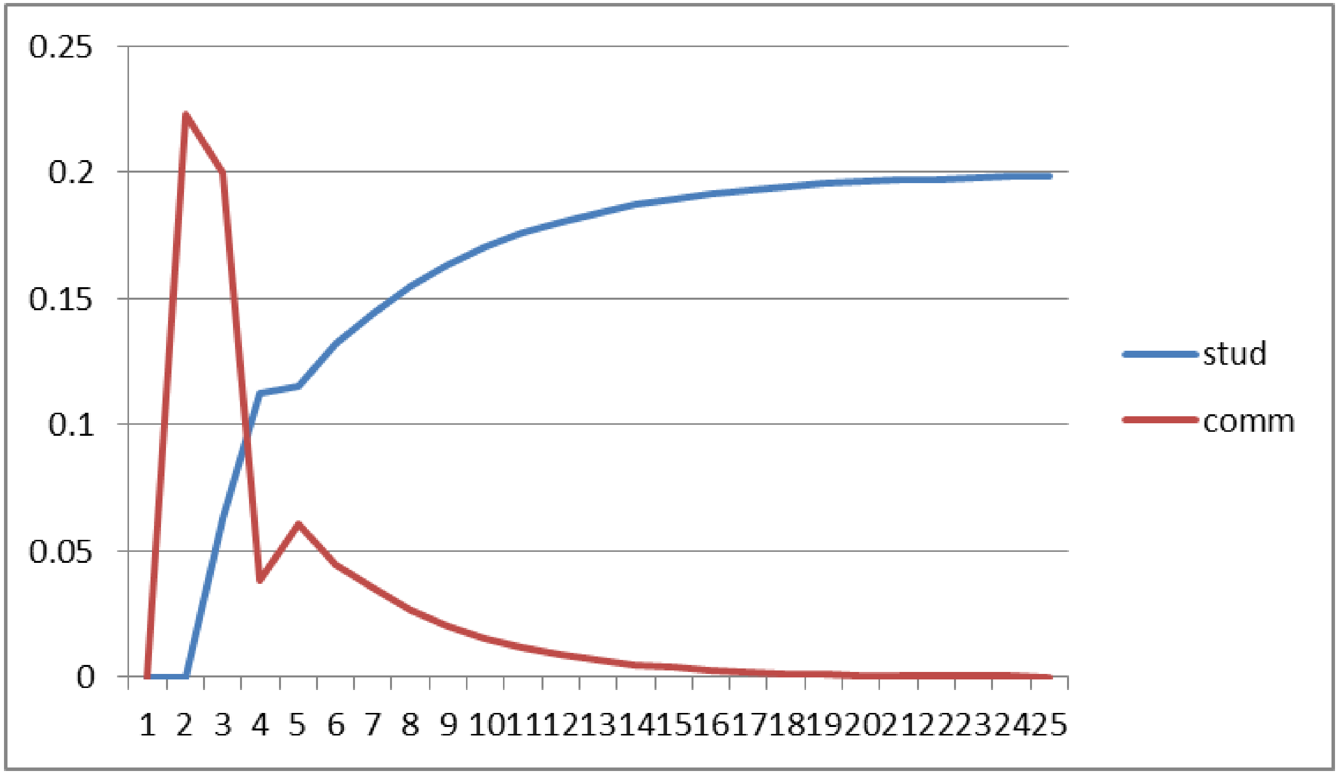
c = discount factor

Expression in age class i in year t is $m(i)_t = E_{it}$

Net Present Value of Sum of expression over 25 years

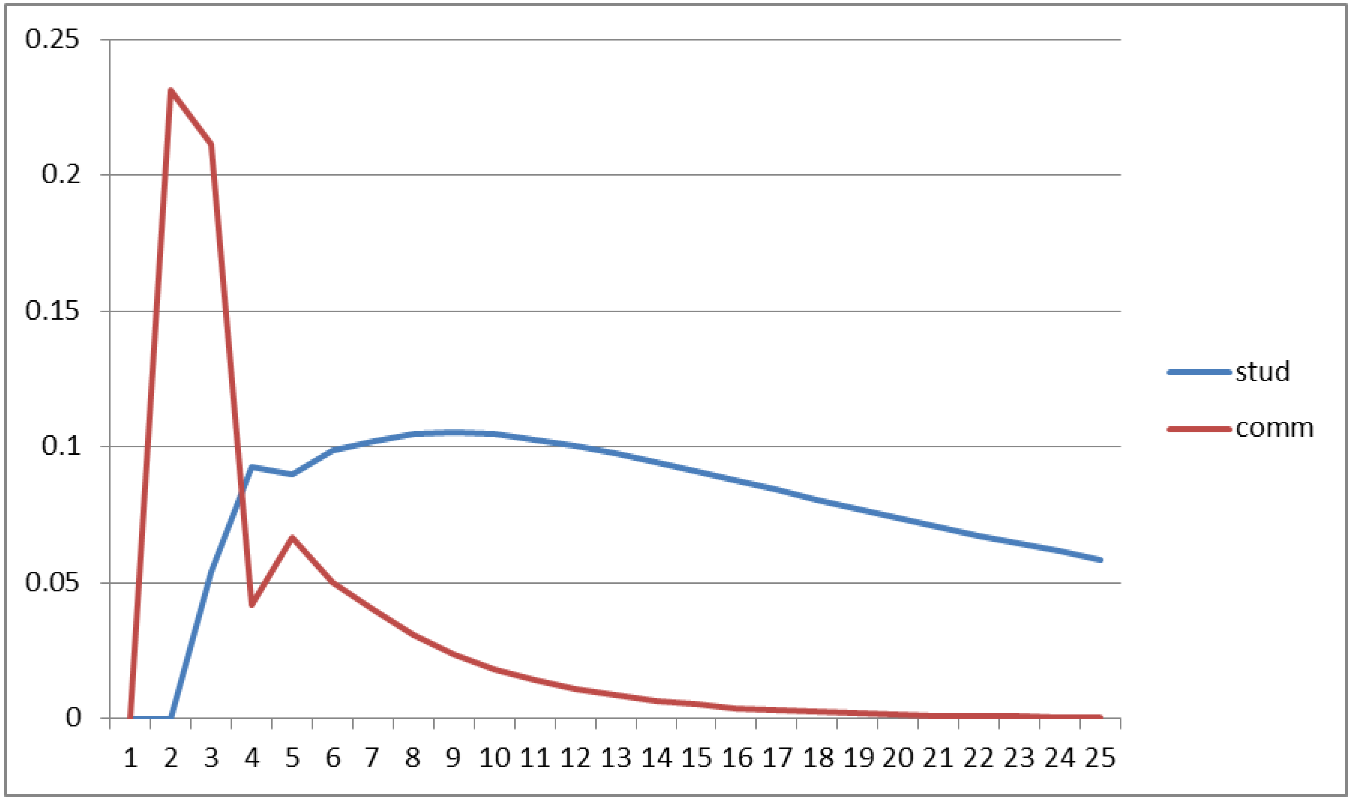
$$CDE = \sum_{t=1}^{25} \sum_{i=1}^{nac} E_{it} c_t$$

(allele) frequency of one unit of superiority as expressed in commercial herd



Discount rate	CDE comm bulls	CDE stud sires
0	0.99	3.93
0.05	0.78	1.96
0.08	0.68	1.37

(allele) frequency of one unit of superiority as expressed in commercial herd



Discount rate	CDE comm bulls	CDE stud sires
0	0.99	3.93
0.05	0.78	1.96
0.08	0.68	1.37

Value of selecting Stud Sires and Comm bulls

Value of a superior bull

CDE

= Selection Difference * Nr.Progeny * expression per progeny

Comm bull	+ 1.4	100	0.55	= $ 77
Stud Sire	+ 3.0	400	1.35	= $ 1,620

Herd structure

Nr Cows Commercial Herd	12,000		
Comm Dams/sire	50		
Comm Sire replacem. rate	0.33333		
Comm Weaning rate	1		
Nr new rams needed for comm herd/yr	80		
Nr lifetime Progeny per commercial sire		150	150 prog/comm bull
Prop. Stud.Males sold as breeding bull	20%		
Stud weaning rate	1		
Stud dams/sire	40		
Nr stud breeding cows	800		
Nr. Of stud sires	20		
Nr of comm bulls sold per year	80		
Nr of commercial bulls sold per Stud male	4		
progeny receiving genes from a stud male		600	600prog/stud bull

Value of selecting Stud Sires and Comm Bulls

Value of a superior sire = Selection Difference * Nr.Progeny * CDE

- Selection differential within the cohort: “The result of one round of selection”

Breeding performance						
			SD of breeding Objective	10.82		
			Male Selection intensity	2.06		
			Female Selection intensity	0.2		
			Male Selection accuracy *without* genomics	0.358	increase	
			Male Selection accuracy *with* genomics	0.432	21%	
			Female Selection accuracy	0.358		
			Generation Interval Stud males	1.53		
			Gneration Interval stud females	2.97		
	approximaley	1.90	CDE stud sires	1.90		
			CDE flock sires	0.6		
				no GS	GS	
			Sire superiority	7.979534	9.628934	
			Dam Superiority	0.774712	0.774712	increase
			Rate of gain/year	1.945	2.312	19%

Comparing geneflow with dG/year method

group	int	acc		Sup	L		dG/year
sires	2.1543	0.53		10.27622255	1.0		3.233294535
dams	0.7979	0.37		2.656955587	3.0		

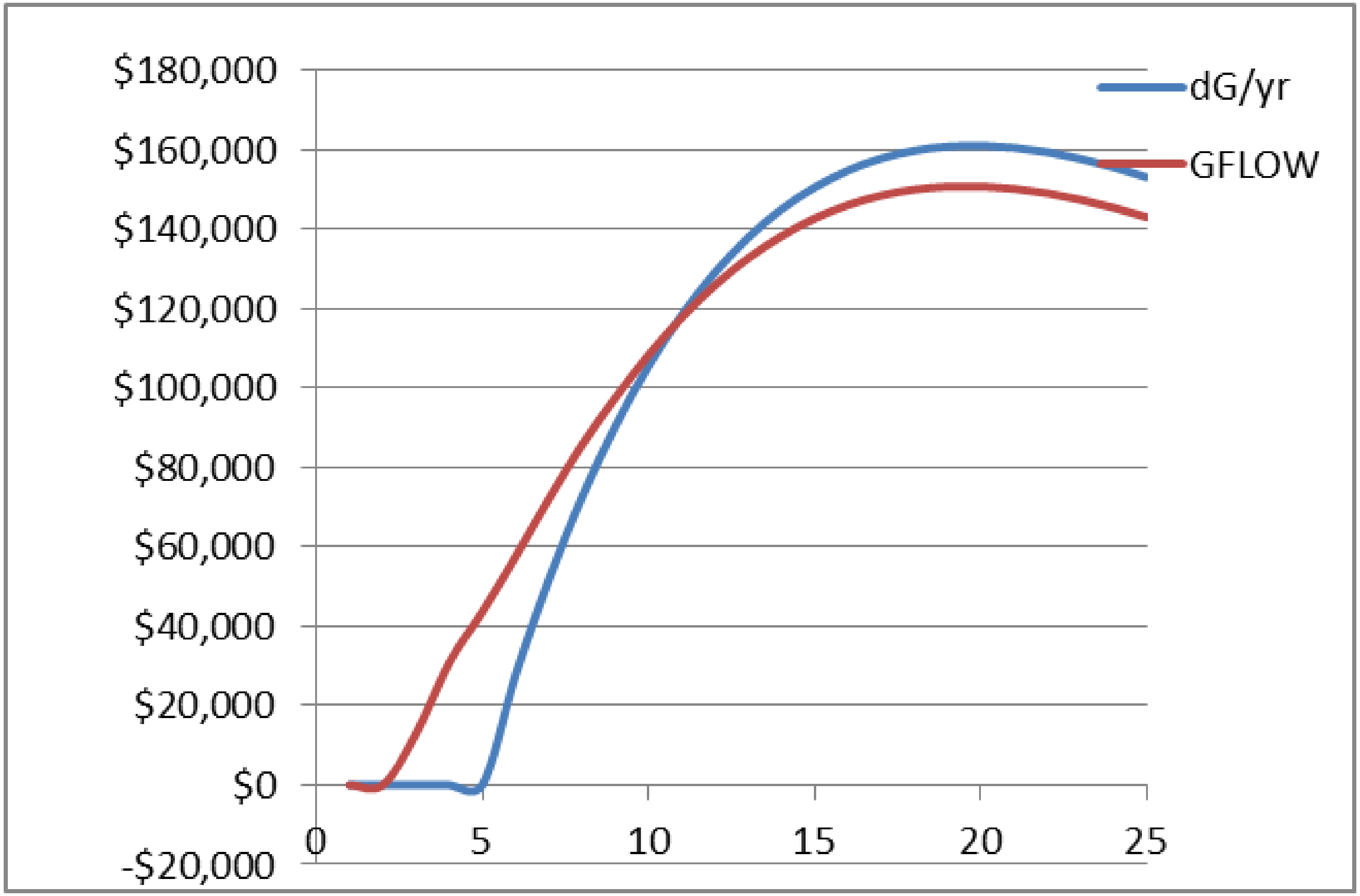
		Calculations based on dG/year				calculations based on GFLOW				
							sire	dam		
		dG/gen					selection	selection		
		3.23			dG/yr	superiority	10.2762	2.6570		GFLOW
year	disc fact	genetic mean	cum benefit	cost	disc retruns		Expr_SS	Expr_DS	cum benefit	disc retruns
1	1.000	0	$ -	$0	$0		0.000	0.000	$ -	$ -
2	0.935	0	$ -	$0	$0		0.000	0.000	$ -	$ -
3	0.873	0	$ -	$0	$0		0.119	0.000	$ 14,694	$ 12,834
4	0.816	0	$ -	$0	$0		0.174	0.048	$ 37,679	$ 30,757
5	0.763	0	$ -	$0	$0		0.131	0.105	$ 57,158	$ 43,606
6	0.713	$3.23	$ 38,800	$0	$27,664		0.157	0.128	$ 80,610	$ 57,474
7	0.666	$6.47	$ 77,599	$0	$51,708		0.185	0.149	$ 108,155	$ 72,068
8	0.623	$9.70	$ 116,399	$0	$72,487		0.196	0.165	$ 137,537	$ 85,651
9	0.582	$12.93	$ 155,198	$0	$90,327		0.197	0.178	$ 167,514	$ 97,494
10	0.544	$16.17	$ 193,998	$0	$105,522		0.206	0.190	$ 198,976	$ 108,230
11	0.508	$19.40	$ 232,797	$0	$118,342		0.213	0.199	$ 231,559	$ 117,713
12	0.475	$22.63	$ 271,597	$0	$129,034		0.217	0.206	$ 264,833	$ 125,820
13	0.444	$25.87	$ 310,396	$0	$137,820		0.220	0.211	$ 298,645	$ 132,602
14	0.415	$29.10	$ 349,196	$0	$144,904		0.223	0.216	$ 332,996	$ 138,182
15	0.388	$32.33	$ 387,995	$0	$150,471		0.225	0.220	$ 367,735	$ 142,614
16	0.362	$35.57	$ 426,795	$0	$154,690		0.227	0.222	$ 402,772	$ 145,983
17	0.339	$38.80	$ 465,594	$0	$157,713		0.228	0.225	$ 438,053	$ 148,384
18	0.317	$42.03	$ 504,394	$0	$159,678		0.229	0.226	$ 473,539	$ 149,910
19	0.296	$45.27	$ 543,193	$0	$160,711		0.230	0.228	$ 509,179	$ 150,648
20	0.277	$48.50	$ 581,993	$0	$160,926		0.231	0.229	$ 544,943	$ 150,681
21	0.258	$51.73	$ 620,793	$0	$160,425		0.231	0.230	$ 580,808	$ 150,092
22	0.242	$54.97	$ 659,592	$0	$159,300		0.232	0.231	$ 616,754	$ 148,954
23	0.226	$58.20	$ 698,392	$0	$157,636		0.232	0.231	$ 652,763	$ 147,337
24	0.211	$61.43	$ 737,191	$0	$155,508		0.232	0.232	$ 688,823	$ 145,305
25	0.197	$64.67	$ 775,991	$0	$152,984		0.233	0.232	$ 724,923	$ 142,916
				NPV	$2,607,849				NPV	$ 2,645,255

Expressed in 12,000 cows

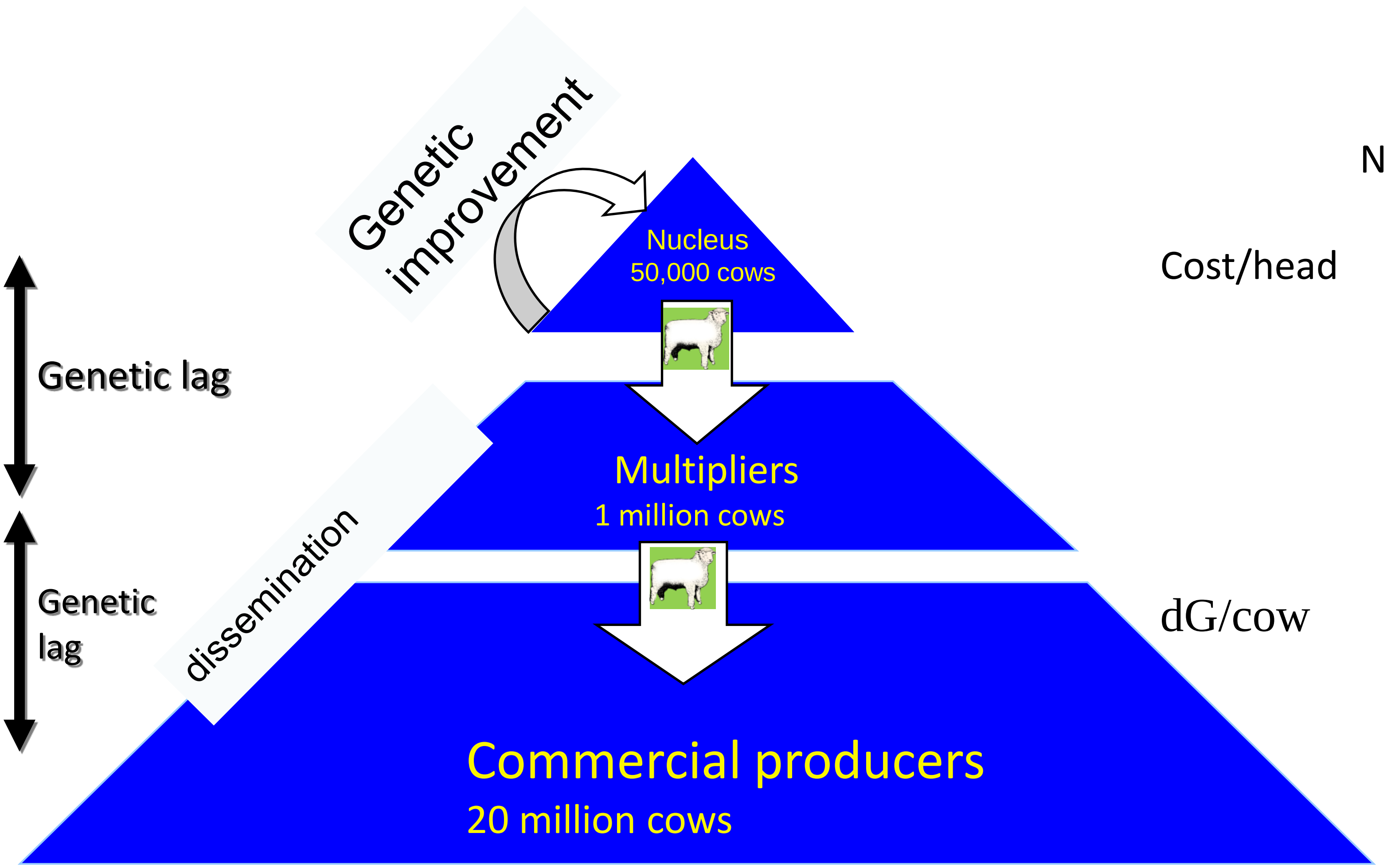
20 nucleus sires

i.e. 600 per sire

Comparing simply dG/yr vs GFLOW



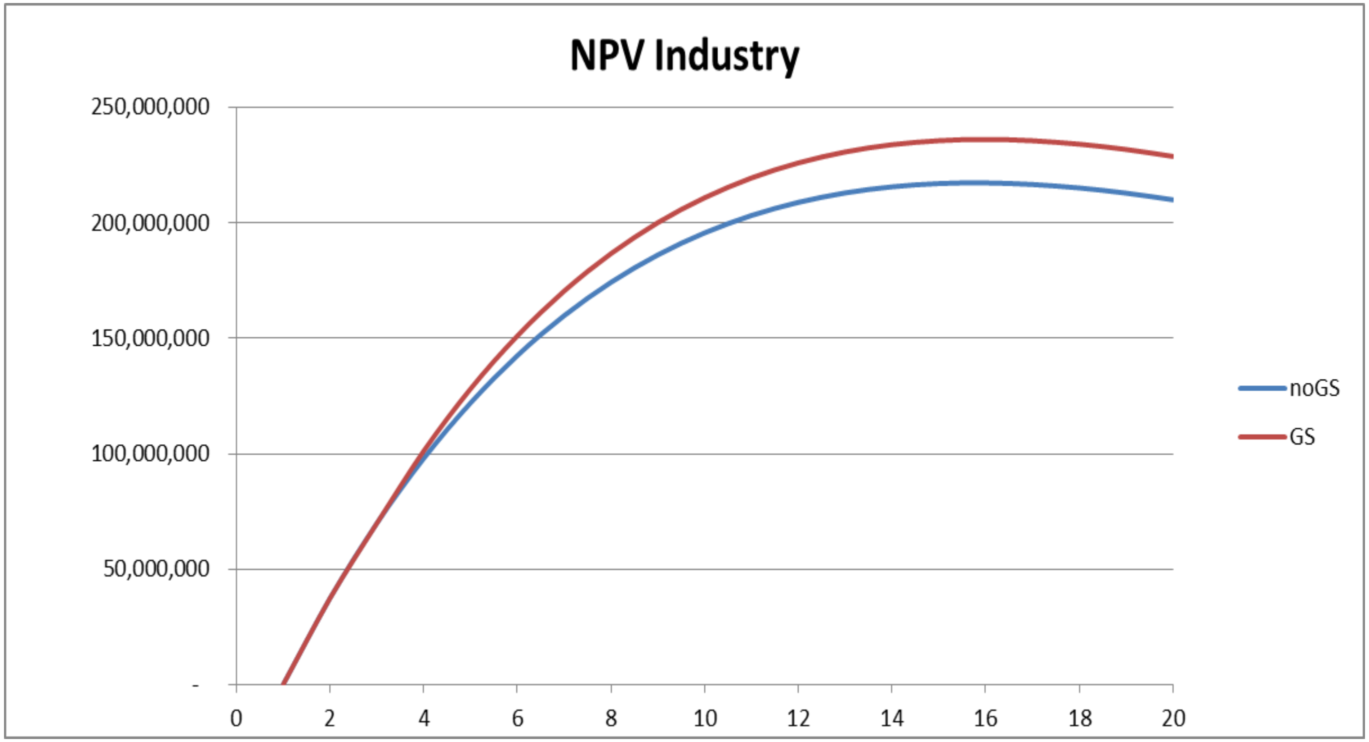
Cost - Benefit of breeding programs



	No GS	GS
Cost/head	$10	$60
dG/cow	$2	$2.2

Cost-Benefit industry wide

	No GS	GS
Cost	$0.5 M	$ 1.65 M
dG	$40 M	$ 44 M

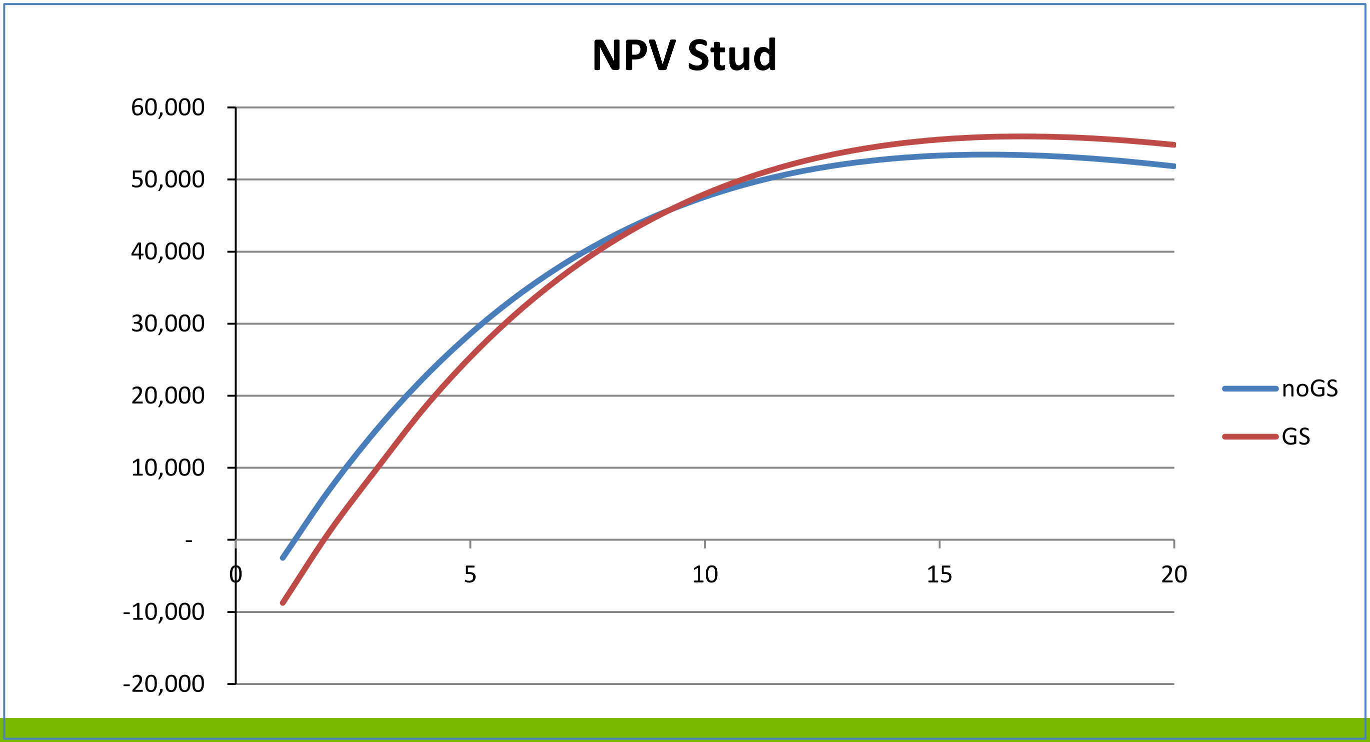


50k Nuc cows
20M Comm

3 tier benefit

Cost-Benefit Stud

	No GS	GS
Cost	$ 5 k	$17.5 k
dG	$20 k	$ 22 k



500 Nuc cows
10k Comm

2 tier benefit

Value of selecting Stud Sires and Comm Bulls

Value of a superior sire

= Selection Difference * Nr.Progeny * expression per progeny

	Selection Difference	Nr.Progeny	expression per progeny	Value	
Comm Bull	+ 1.4	100	0.55	= $ 77	
With Genomics	+1.6			= $ 88	+11
Stud Sire	+ 3.0	400	1.35	= $ 1,620	
With Genomics	+3.4			= $ 1,836	+216

Cost benefit analysis

- Extra benefit   120 * $11 + 30* $216 = $ 7,800
- If all young stud males tested: 600
- Break even: $13.00 per DNA test

summary

- Can calculate additional gain on a per bull basis, assuming returns in commercial progeny

- Those figures depend on
  - Additional accuracy
  - Age structure
  - Herd parameters such as weaning rate, mating rate, prop. Sold