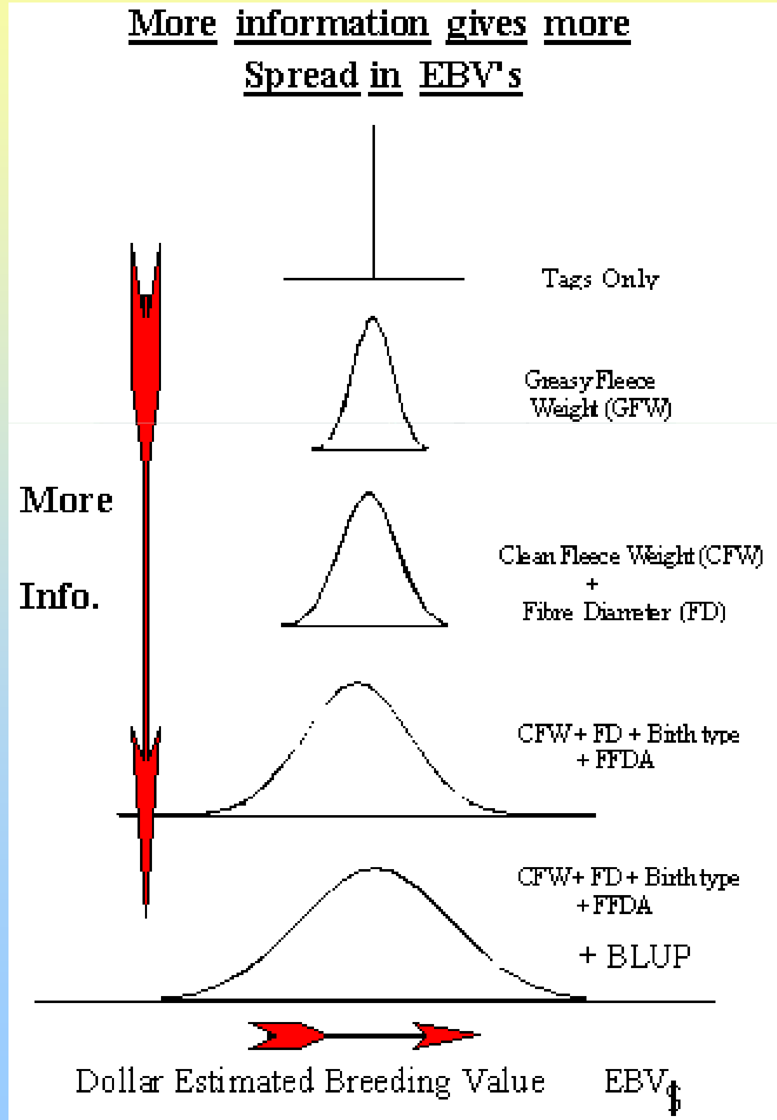
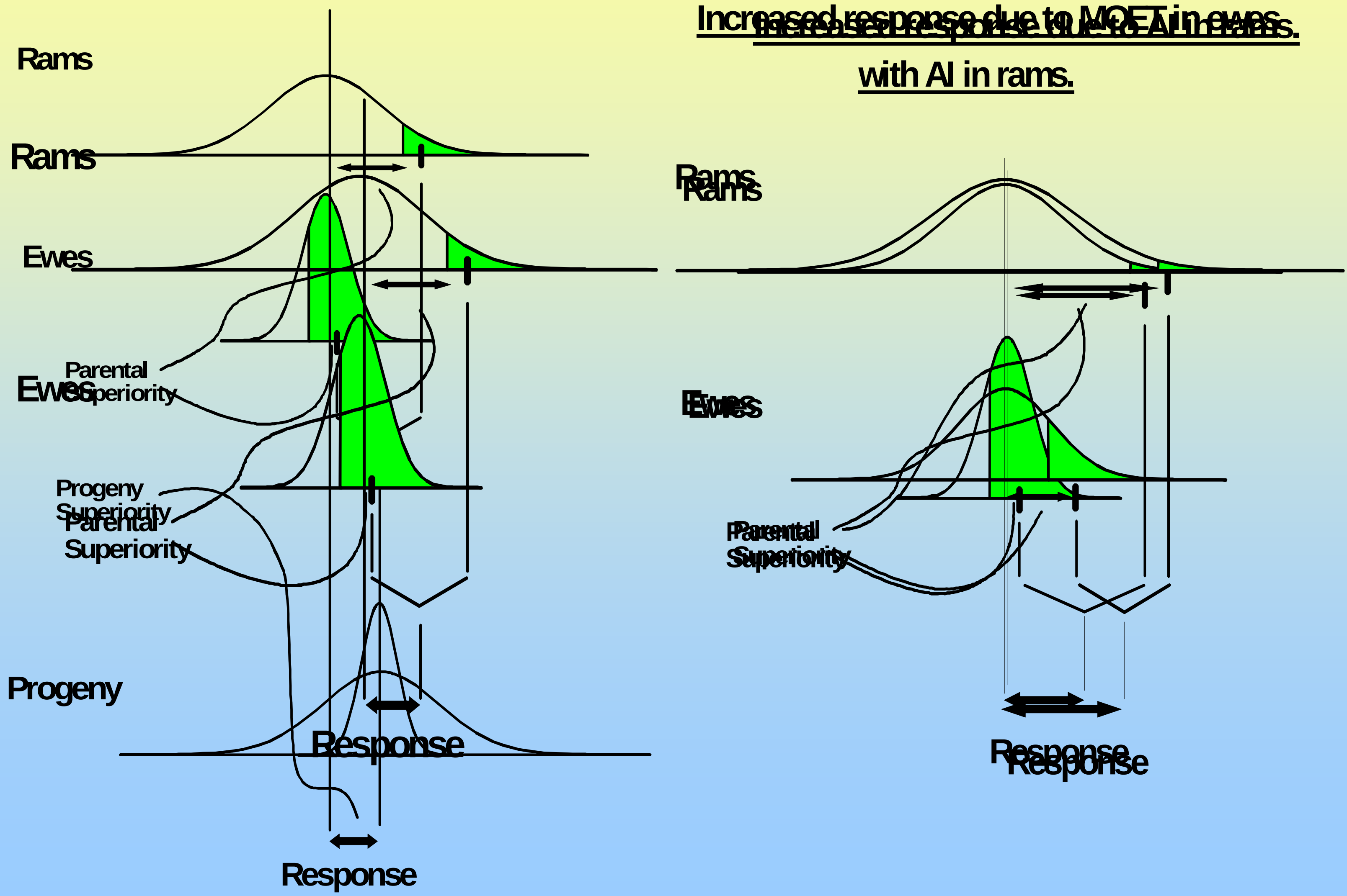
Reproductive technologies

AI and MOET

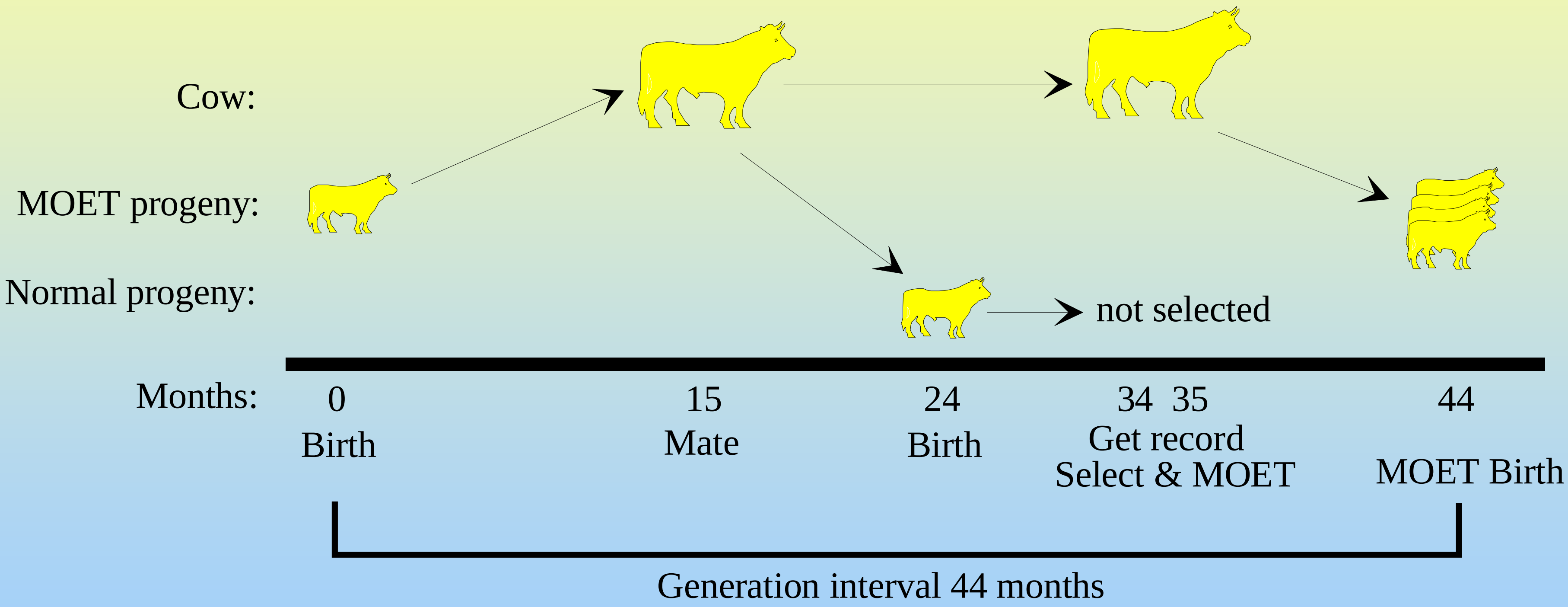
- Increased selection intensity
- Reduced generation interval
- Increased accuracy of EBV's



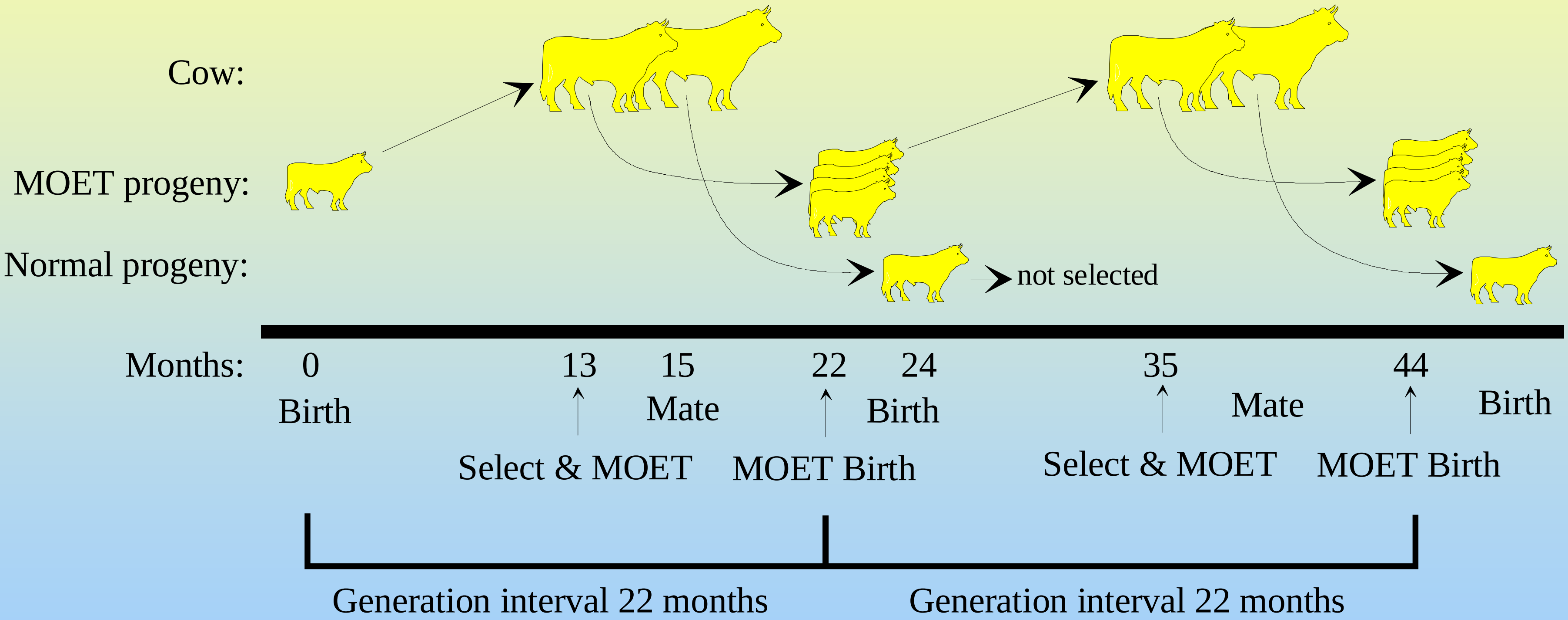
Increased intensity and accuracy ...



Adult dairy MOET scheme



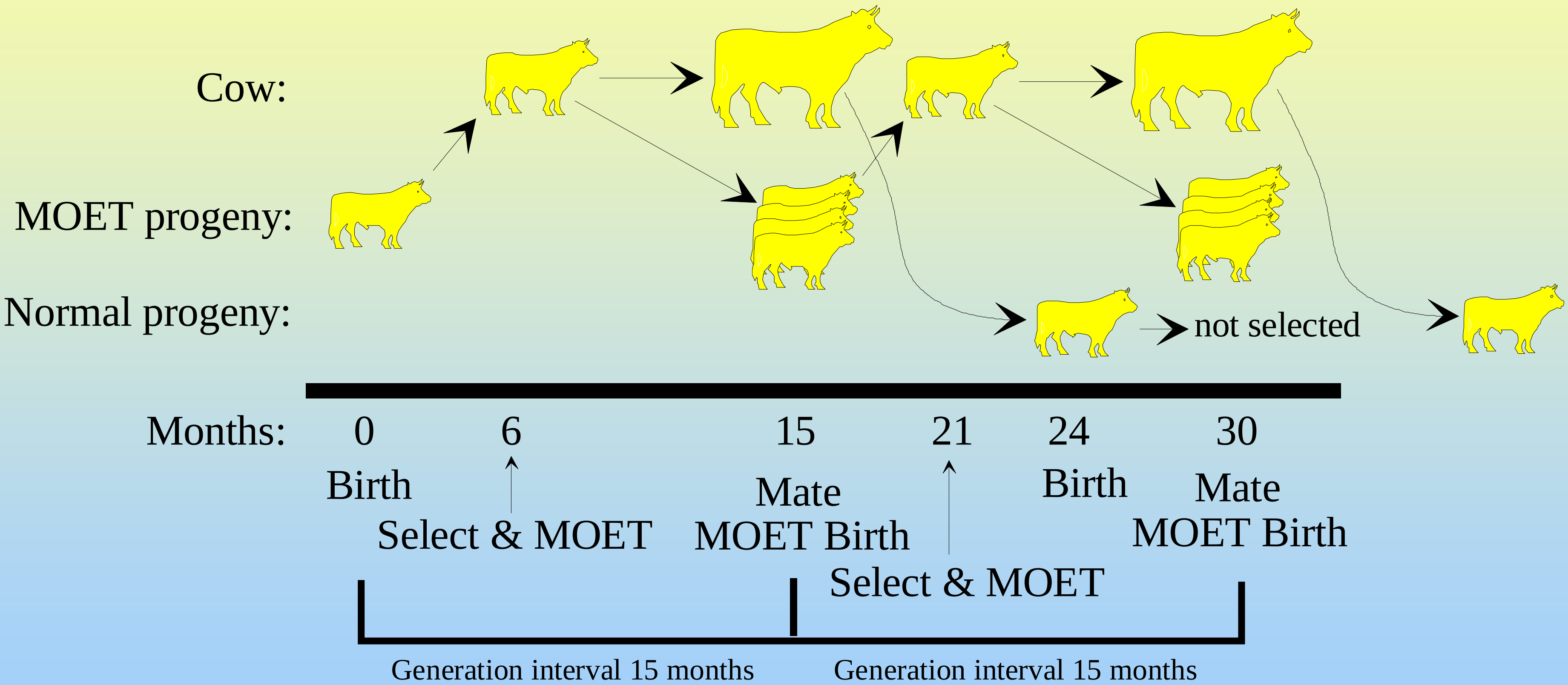
Juvenile dairy MOET scheme



Oocyte harvesting and *IVF* in Australia:

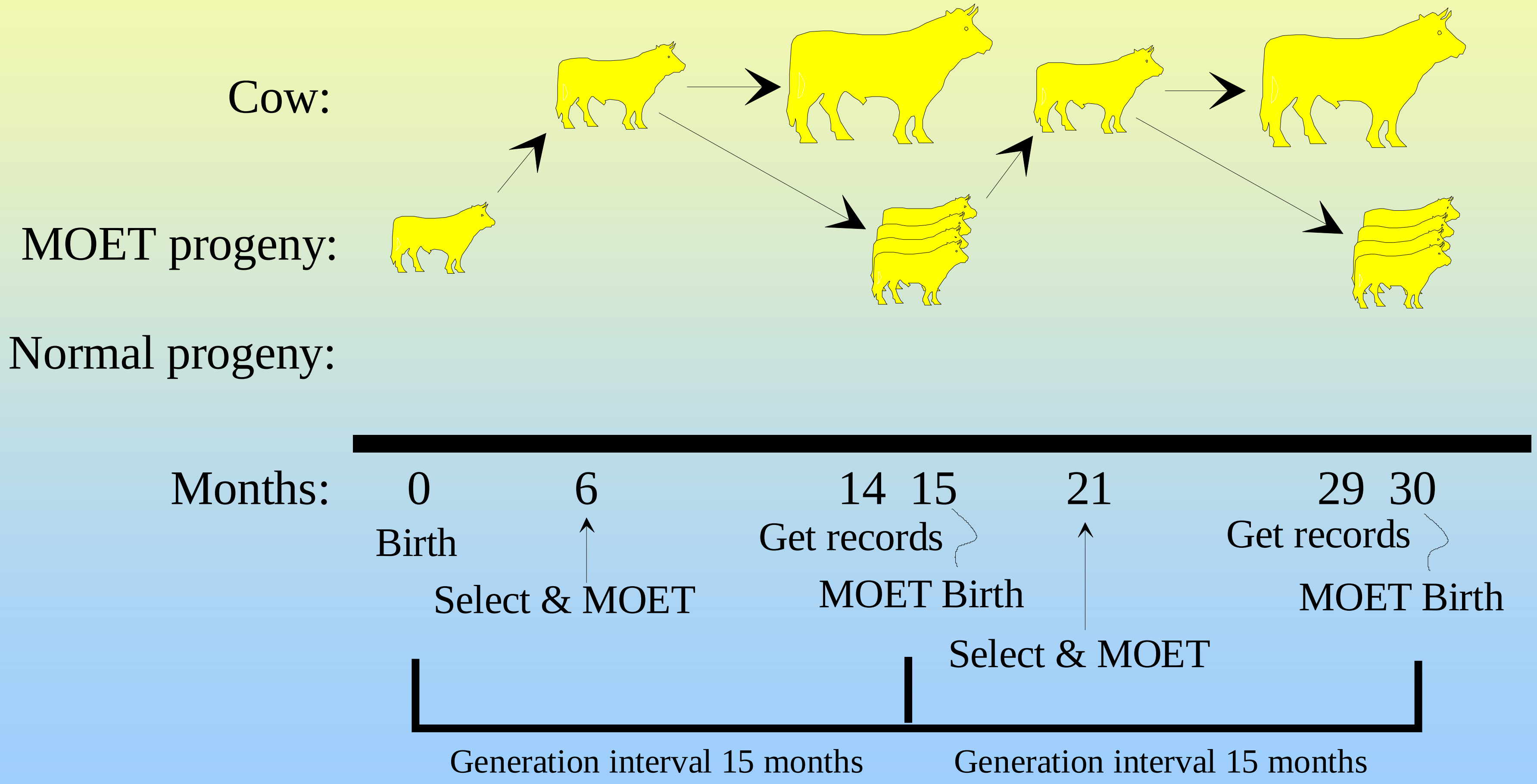
- 26 lambs born from one 13-week old lamb in 1998.
- Over 400 JIVET lambs produced at SARDI (2½ yrs to Nov 2000)
- 2000: 8 JIVET companies in Australia
- 450 Oocytes from one 6-week lamb (Oct 2000)

Even more juvenile dairy MOET...

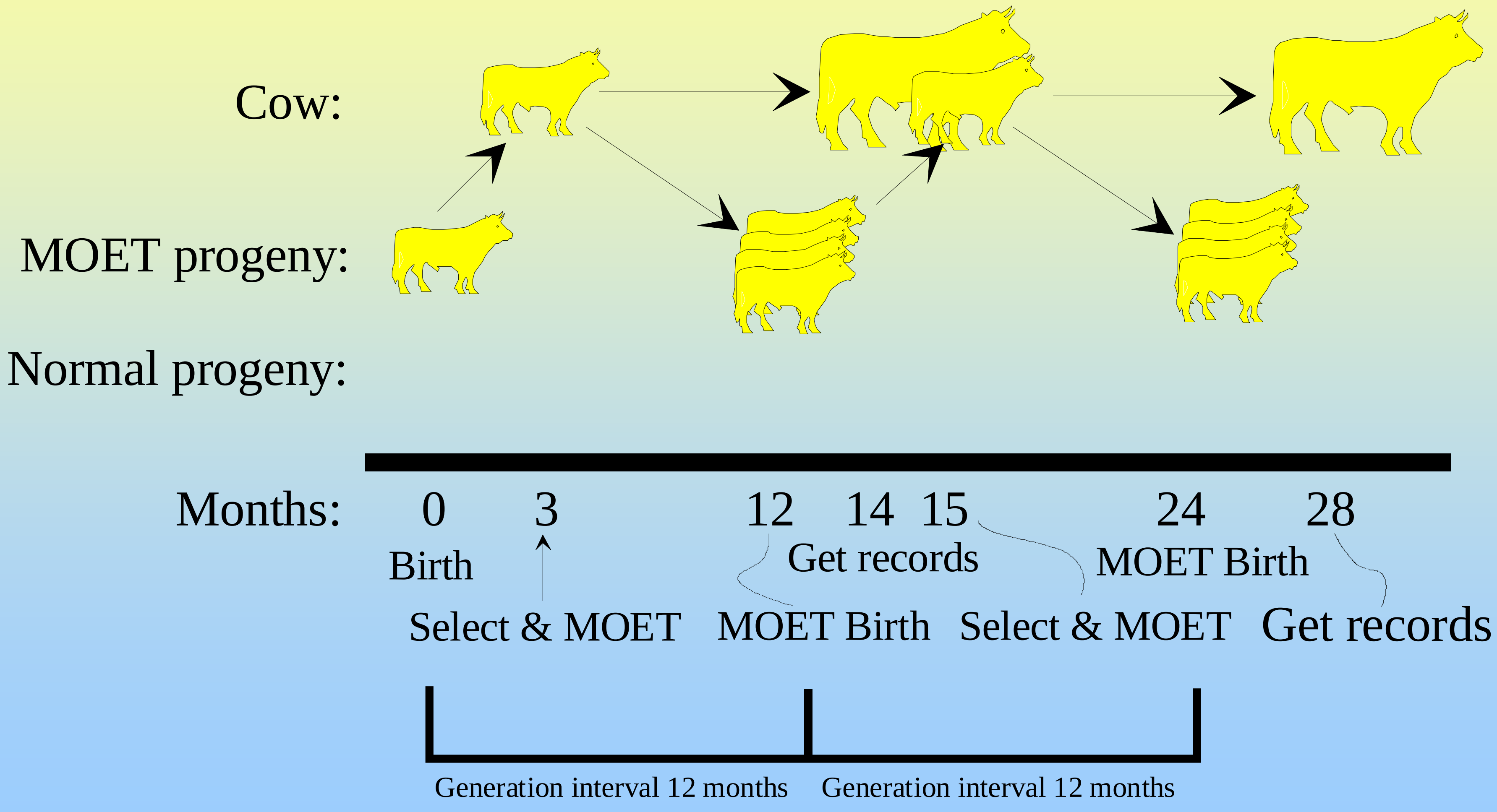


Note that this is a bad design - EBV from grandparents!

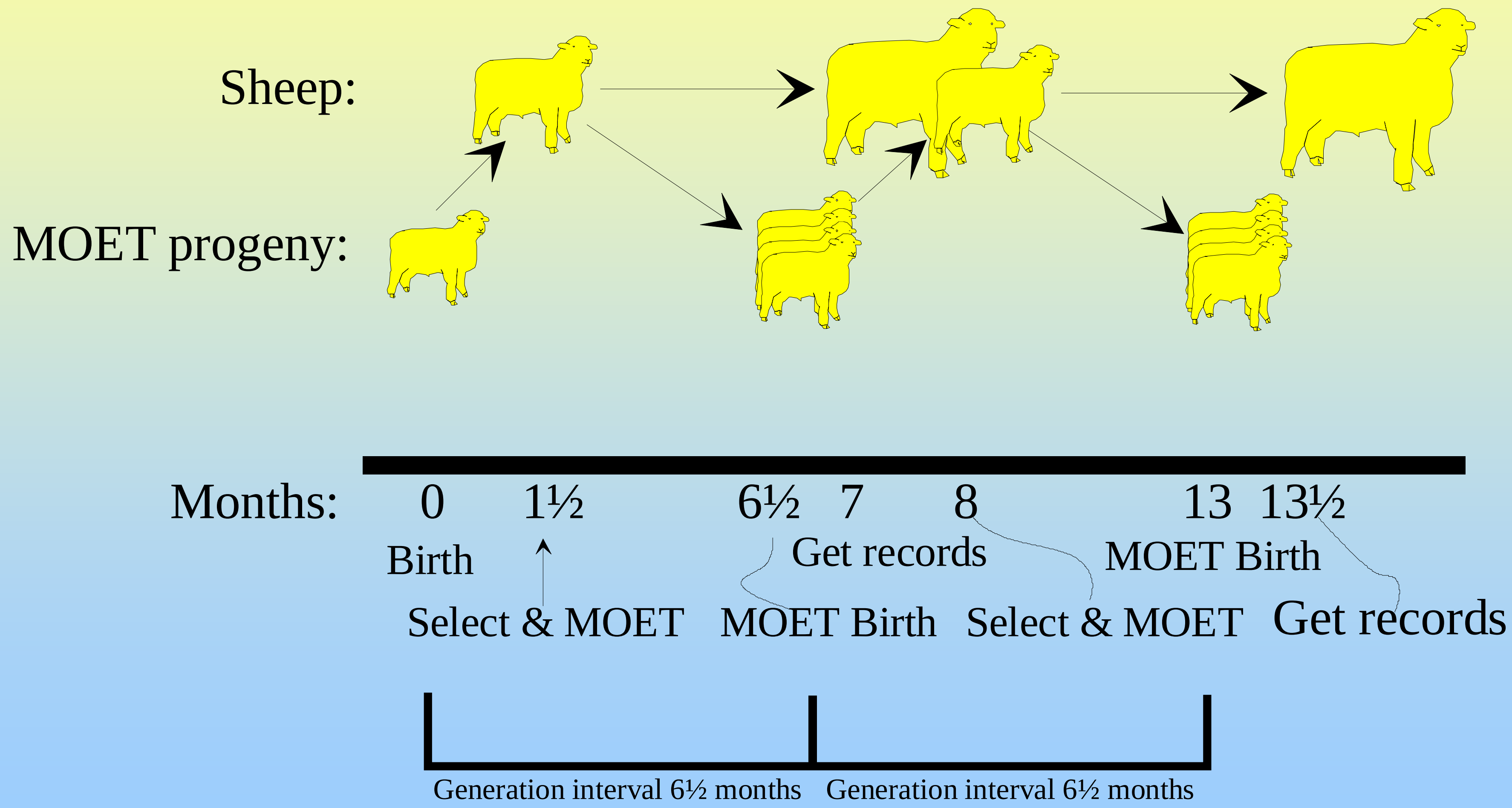
Juvenile beef MOET



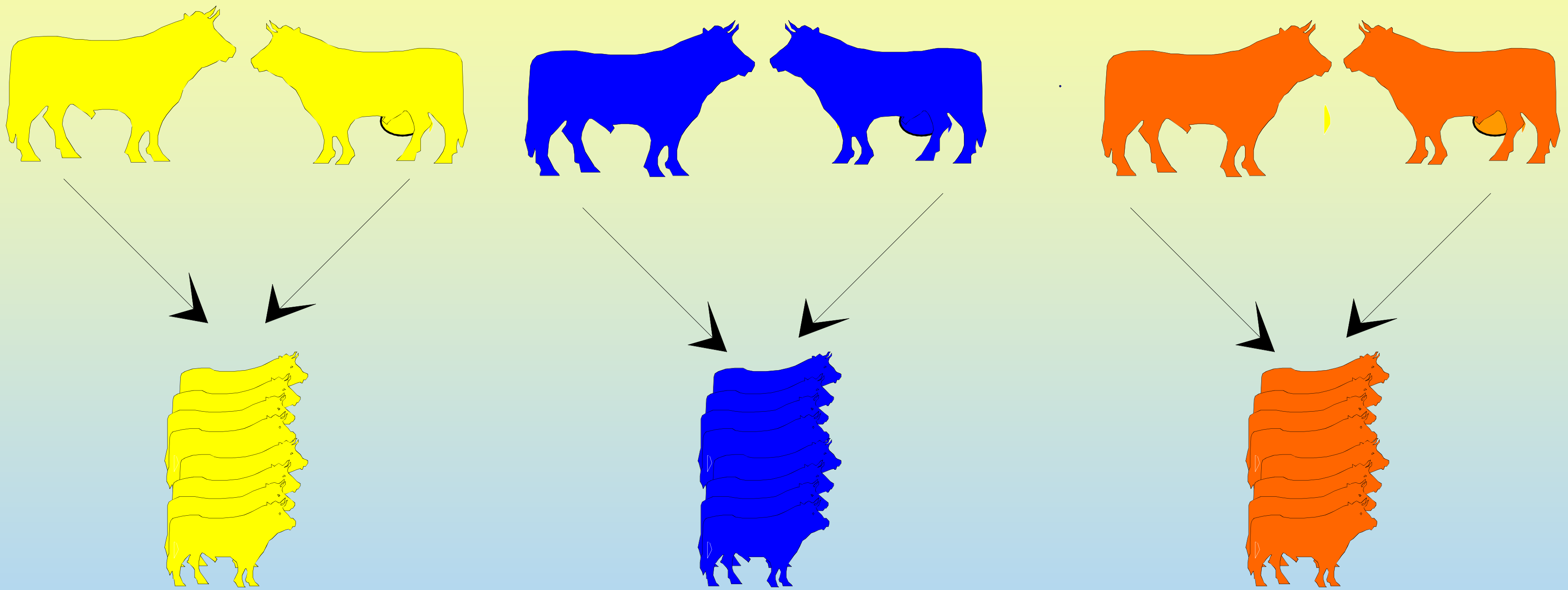
Even more juvenile beef MOET



Juvenile sheep MOET



Between versus within family selection



<u>No own information</u> (performance or genotype):

Selection based on parent average

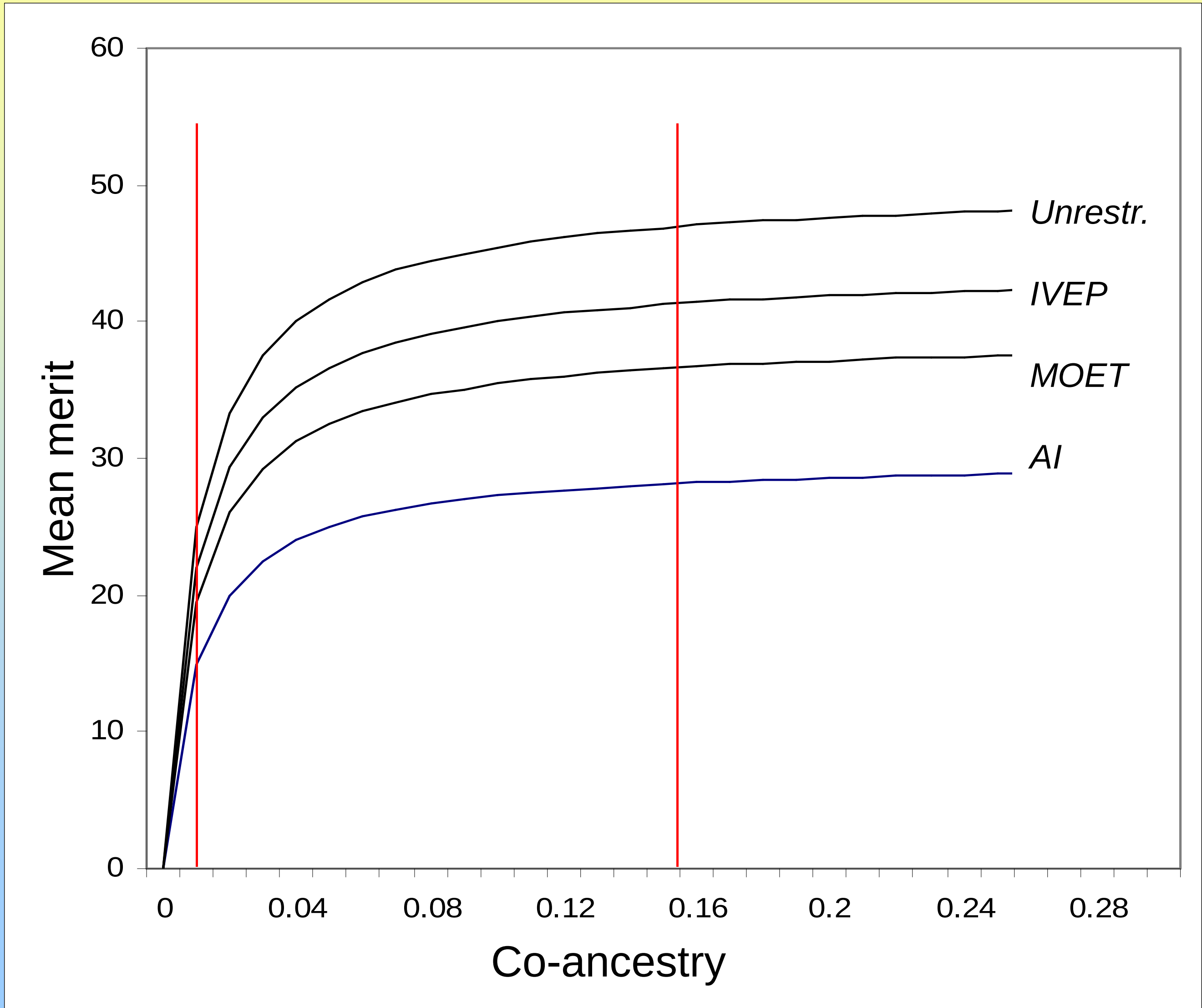
More between-family selection - ***more inbreeding***

Genetic gain versus genetic diversity

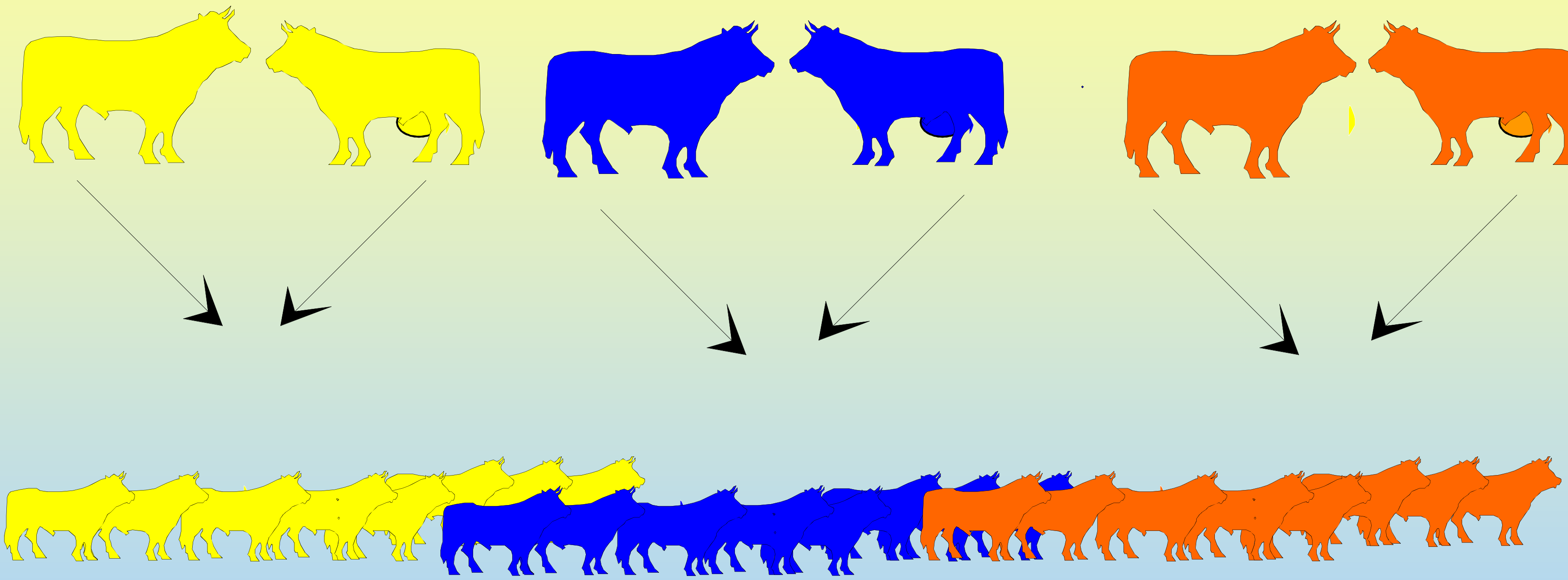
- Sustainable breeding programs require optimal selection balancing genetic gain and genetic diversity

- Potential short term benefits from reproductive technologies are inhibited by the need to maintain diversity

The balance between increased merit and inbreeding



Between versus within family selection



<u>Own information</u> (performance or genotype):

More variation within families

More within-family selection – ***less inbreeding***

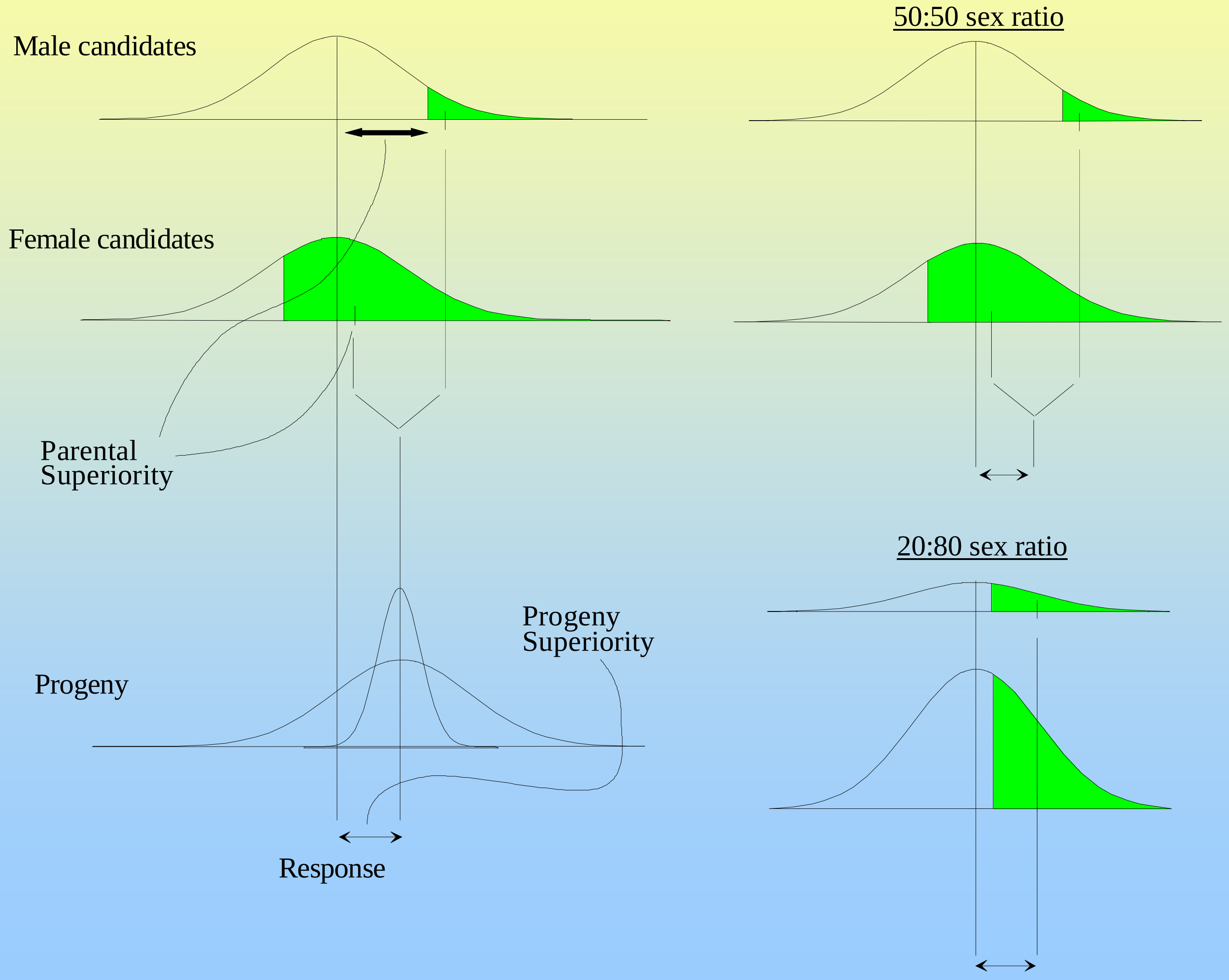
MAS combined with reproductive technologies

- Genotype testing provides within family information
- Exploiting this variation allows genetic gain without jeopardizing inbreeding

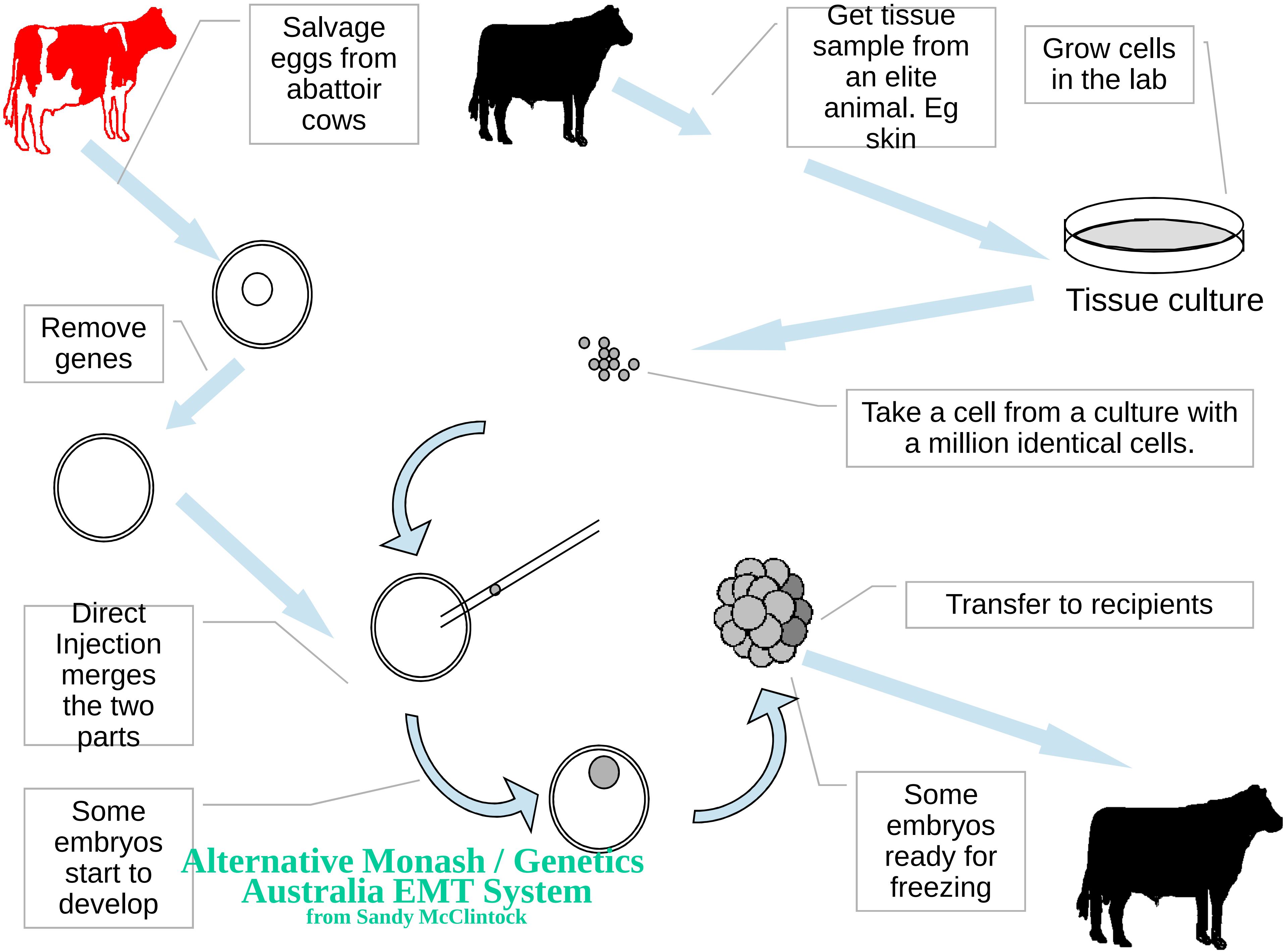
Sexing semen or embryos

- Ability to sex semen makes little difference to rates of genetc gain:
  - Usually less than 5% extra genetic gains
- However, effect on commercial production efficiency can be dramatic:
  - Eg. producing crossbred gilts in the pig industry.
  - Value in dairy is not high, due to ongoing harvesting – the producers of progeny are also the producers of milk.

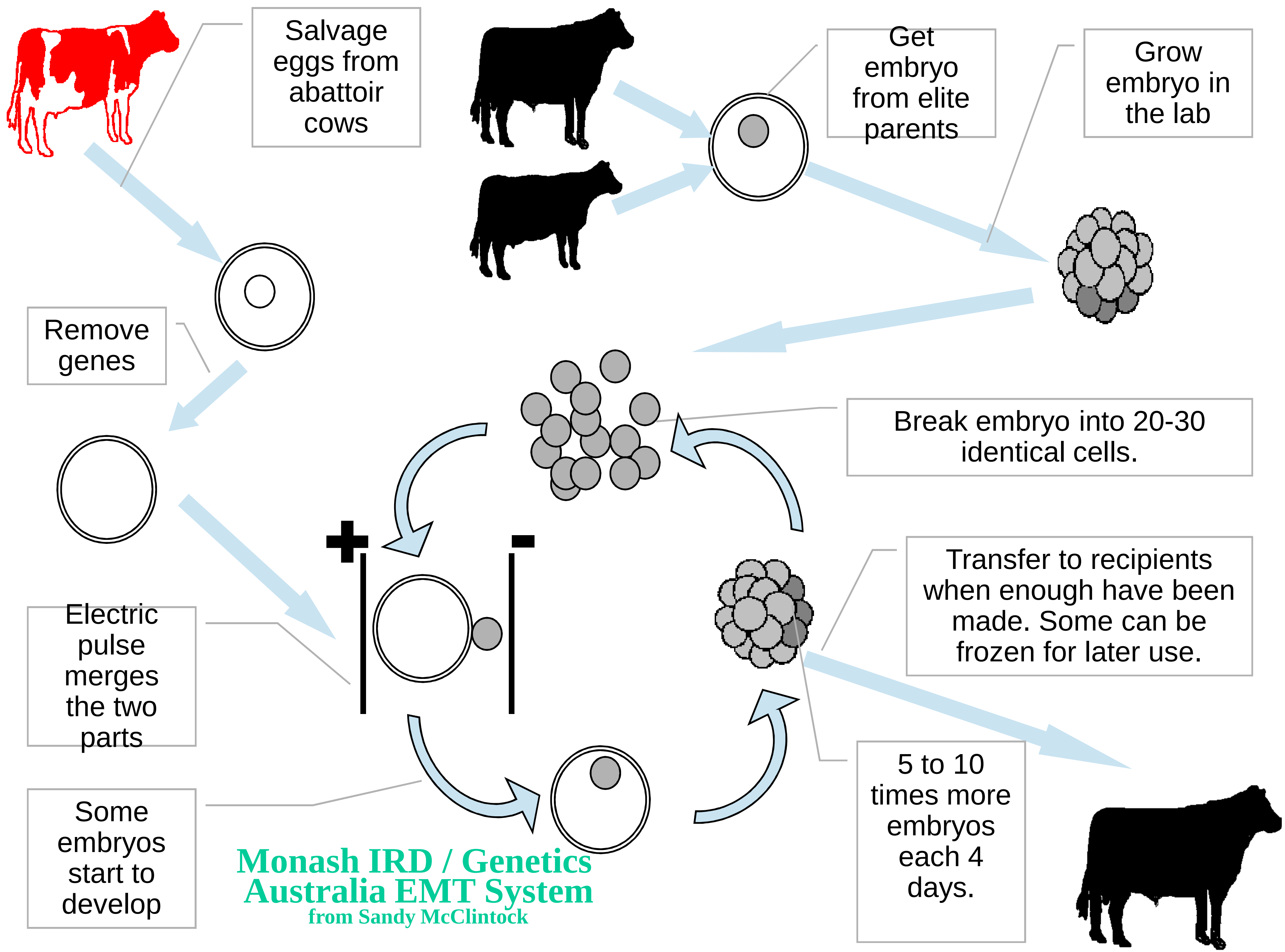
The value of semen sexing



Test with
"AGES" …



Salvage eggs from abattoir cows
Get tissue sample from an elite animal. Eg skin
Grow cells in the lab
Tissue culture
Remove genes
Take a cell from a culture with a million identical cells.
Transfer to recipients
Direct Injection merges the two parts
Some embryos start to develop
Some embryos ready for freezing
Alternative Monash / Genetics Australia EMT System
from Sandy McClintock


Salvage eggs from abattoir cows
Get embryo from elite parents
Grow embryo in the lab
Remove genes
Break embryo into 20-30 identical cells.
Transfer to recipients when enough have been made. Some can be frozen for later use.
Electric pulse merges the two parts
Some embryos start to develop
5 to 10 times more embryos each 4 days.
Monash IRD / Genetics Australia EMT System
from Sandy McClintock

Cloning in animals

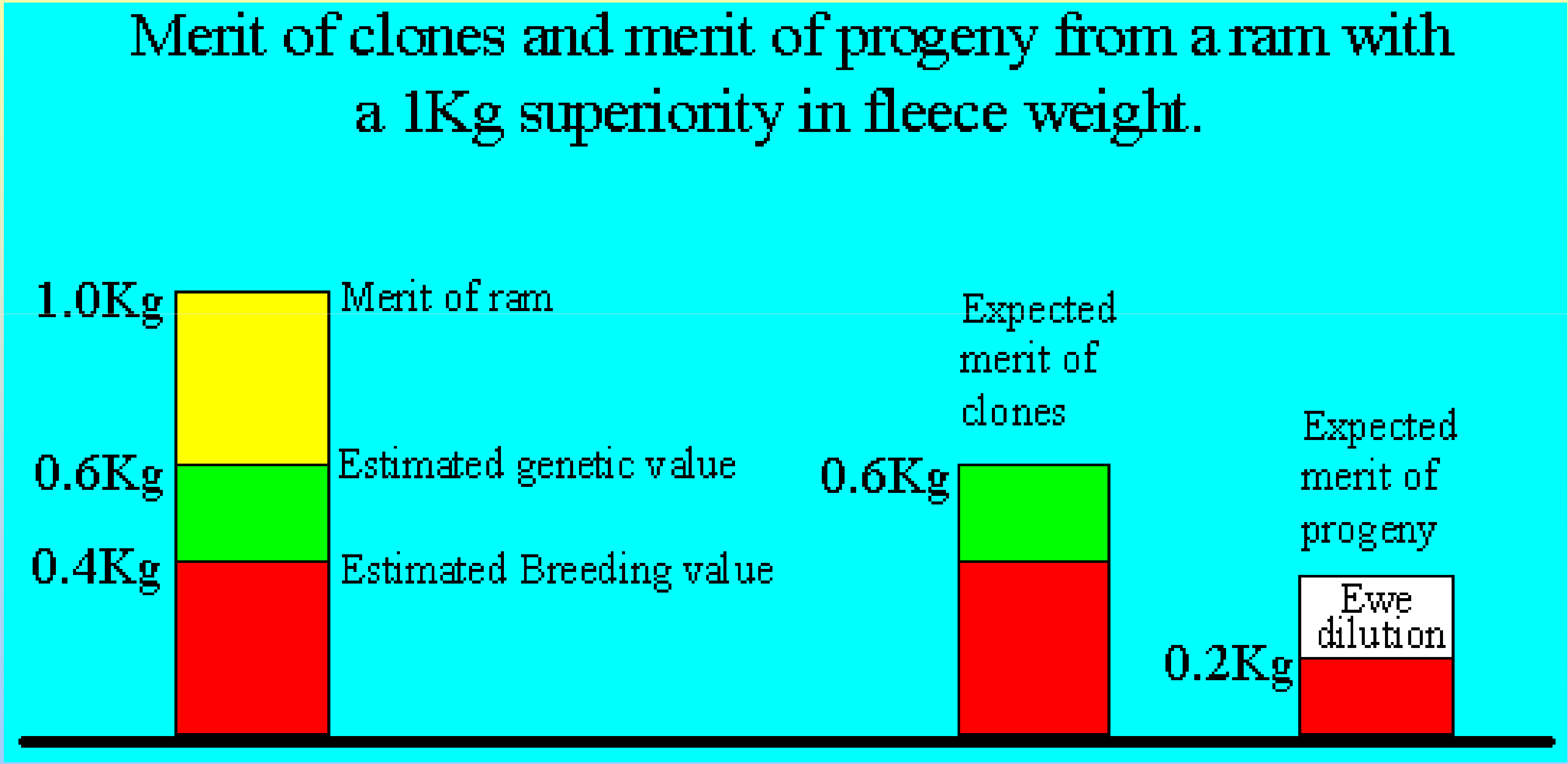
- Cloning from embryos, adults and cell lines.
  - Cell lines $\rightarrow$ easy genetic manipulation.
- Evaluate individuals via their clones ...
  - evaluations can be biased
  - fewer genetic individuals as candidates.
- Clone elite individuals for use in industry
  - eg. beef bulls for natural mating.

Genetic evaluation using clones

- **Breeding value**. This is ***the value of an animal's genes to its progeny***. For when we want to make judgements about breeding animals for generating progeny.

- **Genetic value**, or Genotypic value. This is ***the value of an animal's genes to itself***. For when we want to select animals to make clones of themselves to generate product to be harvested

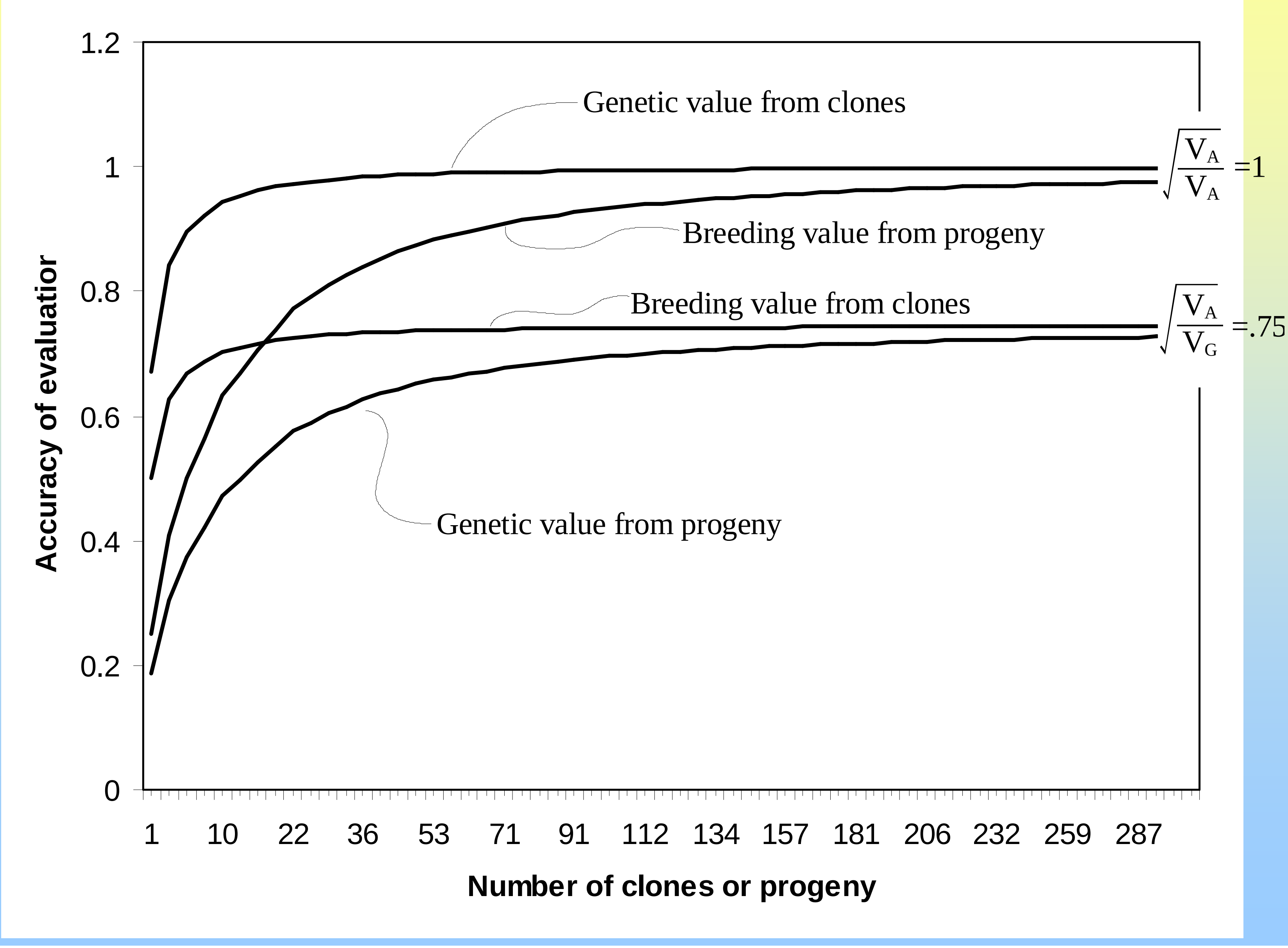
Clones versus progeny for direct use



Genetic evaluation using clones

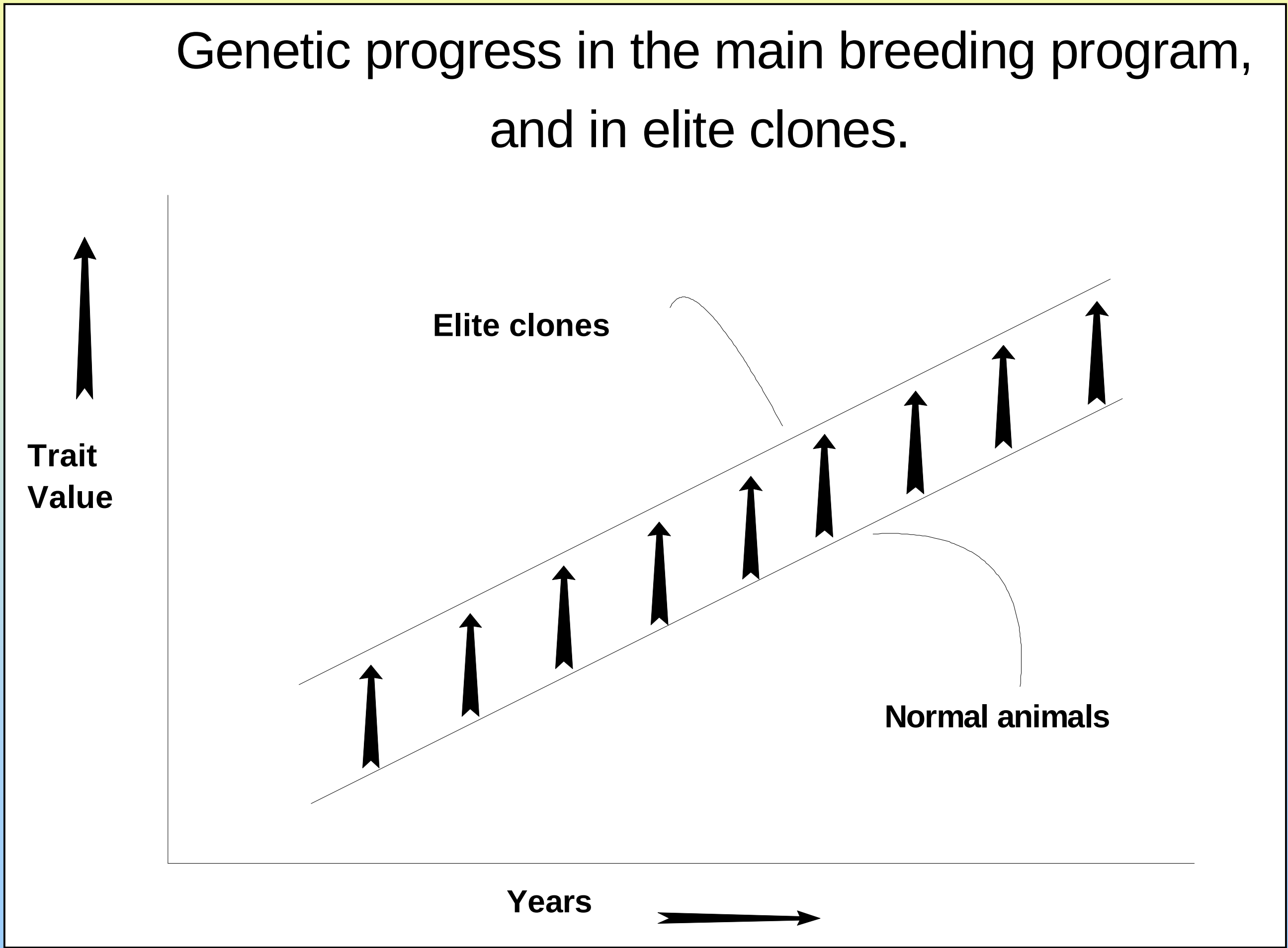
Data source	Accuracy of breeding value	Accuracy of genetic value
n progeny of each candidate	$\sqrt{\dfrac{¼V_A}{¼V_A + \dfrac{V_P - ¼V_A}{n}}}$	$\sqrt{\dfrac{¼V_A}{¼V_A + \dfrac{V_P - ¼V_A}{n}}} \times \sqrt{\dfrac{V_A}{V_G}}$
n clones of each candidate	$\sqrt{\dfrac{V_A}{V_G + \dfrac{V_P - V_G}{n}}}$	$\sqrt{\dfrac{V_G}{V_G + \dfrac{V_P - V_G}{n}}}$

Genetic evaluation using clones



Cloning

Impact on commercial production levels



Normal breeding program:

i = 1.4
h^2 = 0.4
L = 3.25 yrs.

Clone selection:

i = 3
H^2 = 0.6

Result: Today's elite clones are expected to be as good as normal animals born in just over 10 years' time.

Clones can give a more uniform product

Table 2. Predicted range of expression within a cohort for a trait with V_A/V_P = 0.25 and V_G/V_P = 0.45, relative to unrelated animals = 100%.

Cohort type	**Predicted range of trait expression**
Unrelated animals	100%
A sire family	96.8%
A full-sib family	90.8%
A clone family	74.2%

Controlled cell manipulations

Meiosis *in vitro* (*MIV*) ??

Use of genetic markers!

Summary Reproductive technologies

Usage in breeding industry

	Benefit to rate of genetic improvem.	Dairy	Beef	Sheep	Pigs
AI	++	+++	++	++	++
MOET	++	+++	++	+	
JIVET	+++	+			
Sexing	+	+	-	-	-
Cloning	-				

Reprod technol. In a breeding design context