The History of Animal Genetic Improvement "101"

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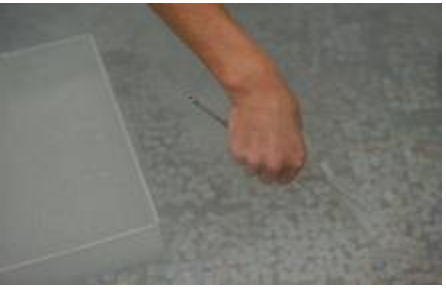
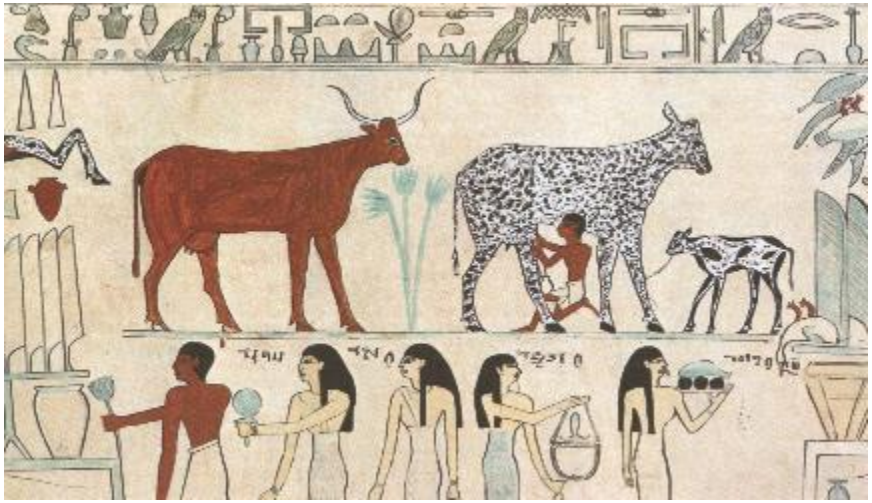


Forward-Looking Statements

Some of the statements made in this presentation are forward-looking statements. These forward-looking statements are based upon our current expectations and projections about future events and generally relate to our plans, objectives and expectations for the development of our business. Although management believes that the plans and objectives reflected in or suggested by these forward-looking statements are reasonable, all forward-looking statements involve risks and uncertainties and actual future results may be materially different from the plans, objectives and expectations expressed in this presentation. All information in this presentation is as of the date marked on the cover page, and Trans Ova Genetics undertakes no duty to update this information unless required by law.

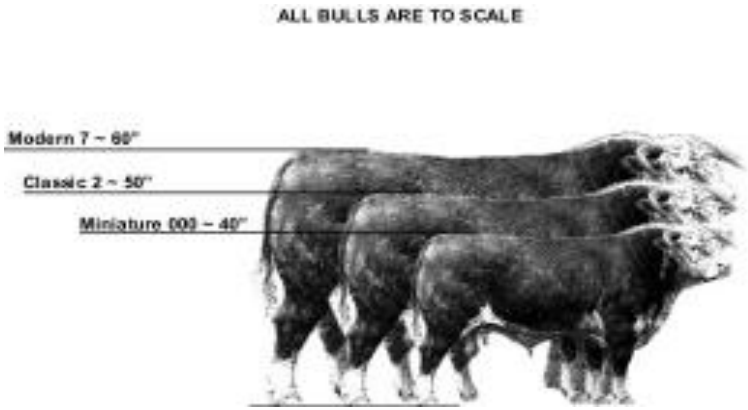
Genetic Selection – Animal Breeding

- **Been going on for thousands of years**
- **Has accelerated dramatically last 100 yrs**
- **Massive progress in the last 50 yrs**
- **Extremely organized systems of genetic improvement in the livestock sectors**



Selection Information – Genetic Process

- Visual appraisal
- Pedigree information
- Performance data
- Genetic merit values & accuracy
- Genomic/DNA markers enhanced genetic merit values
- Future technologies



The Toolbox

In Vitro Fertilization

Genetic Resources

Sorted Semen

ViaGen Cloning Technology

Embryo Transfer

Biomedical

Artificial Insemination

Precision Breeding

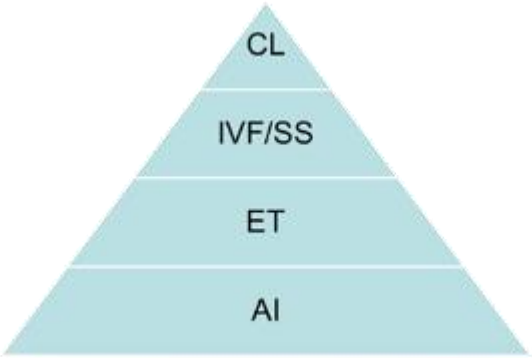
Gene Editing

Animal Husbandry

Genetic Selection & Technology

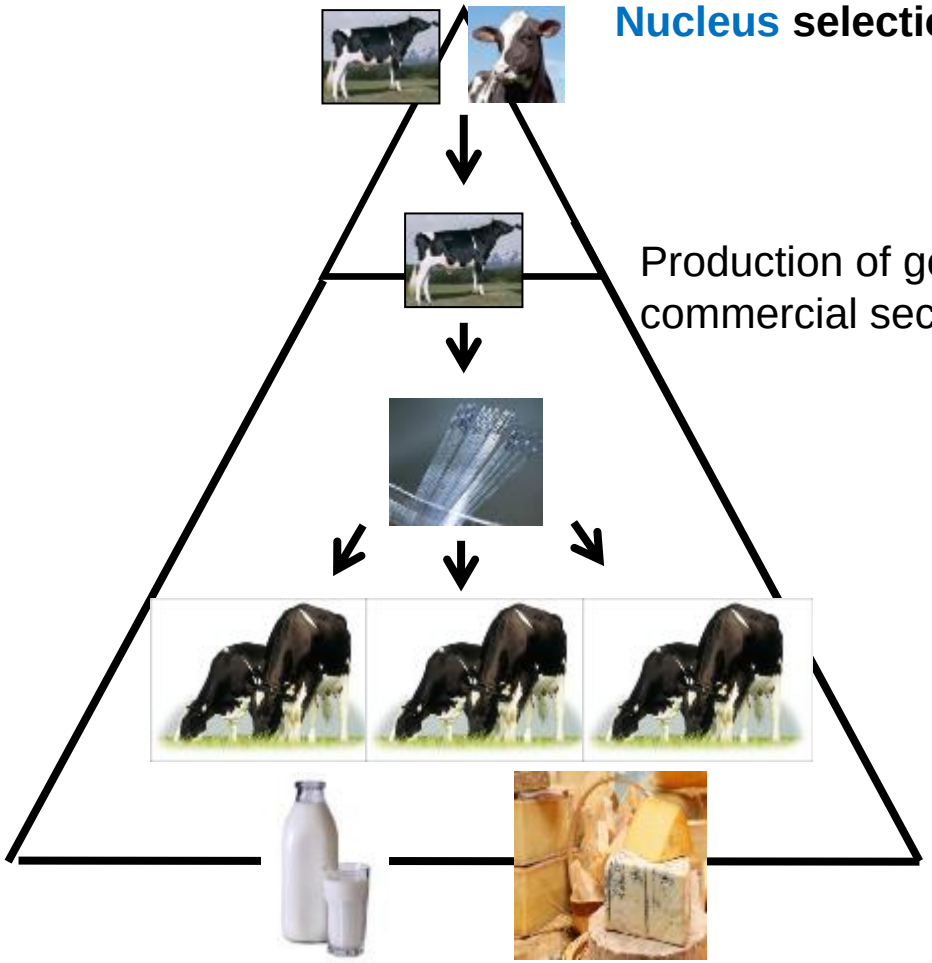
Genetic Gain= **acc** x genetic variation x **intensity**
generation interval

AI started in 1950's
ET started in 1970's
IVF started in 1990's
Cloning started in late 1990's (Dolly)
SS started in 2000's



Hierarchy of ART

Today's Industry- Flow of Genetic improvement



Nucleus selection lines/populations-

Production of genetic product for the commercial sector – **Multiplier**

Genetic targets

Commercial production of product

Genetic Improvement- Poultry

Growth rate

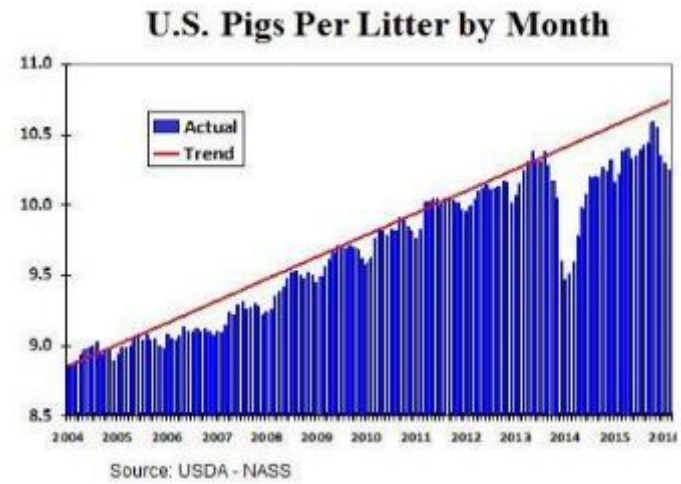
- 85-90% increase

Havenstein et al., 2003. Poultry Science 82, 1500-1508

Pork Production

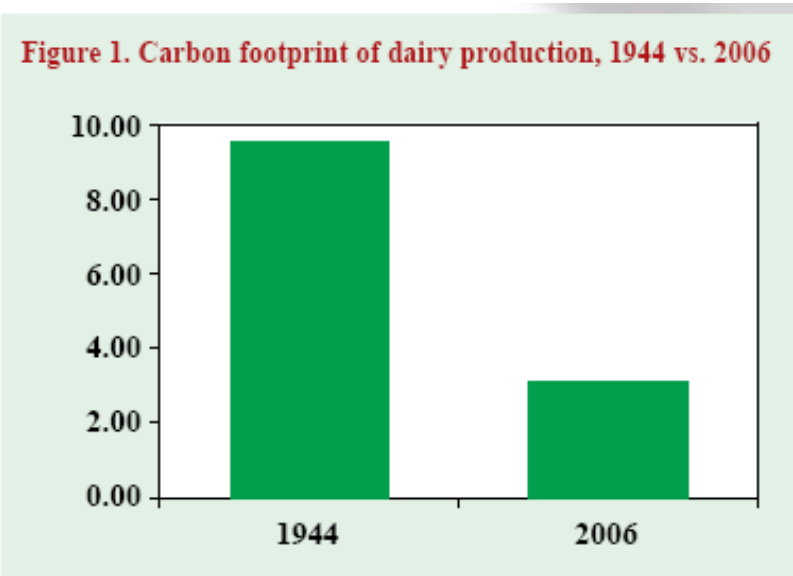
1959 it took 8 pigs to produce 1000 lbs of pork, today it only takes 5 pigs

	1950s	Today
• Litter size weaned	5-7	10-11
• Pigs weaned/sow/year	10-15	20-25
• Market weight, lb	200-225	275-290
• Days to market	180	165
• Feed efficiency (feed/gain)	3.50	2.75



https://www.uky.edu/Ag/AnimalSciences/instruction/2009.pdf

Dairy



lb CO_2 per lb Milk

1940s

- **25 M cows 4500 lbs per lactation**

2008

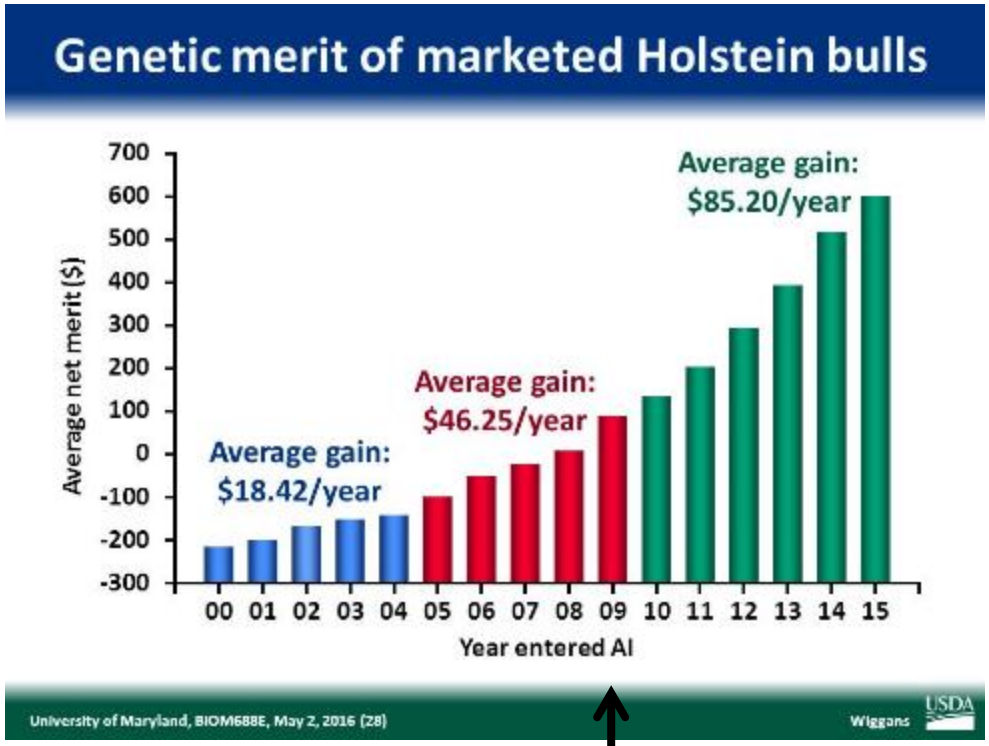
- **9.2 M cows 22,000 lbs per lactation**

❖ **2.7 fold reduction in cow numbers**
❖ **4.9 fold milk yield per cow increase**

1940 cows required 4.5 times more land and produced 2.6 times more Methane.

Genetic Gain – Recent technology additions

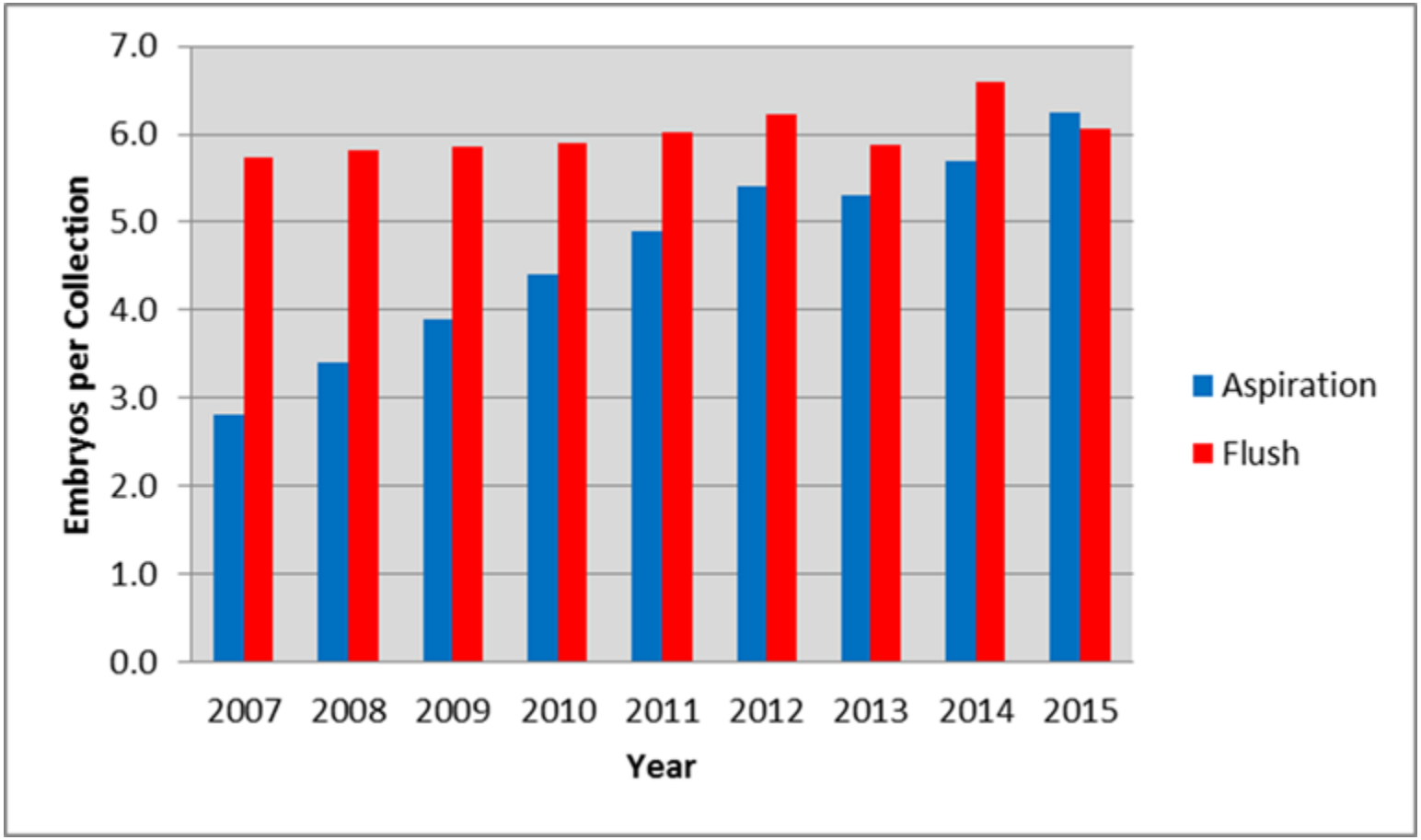
Genomic/DNA enhanced genetic evaluations



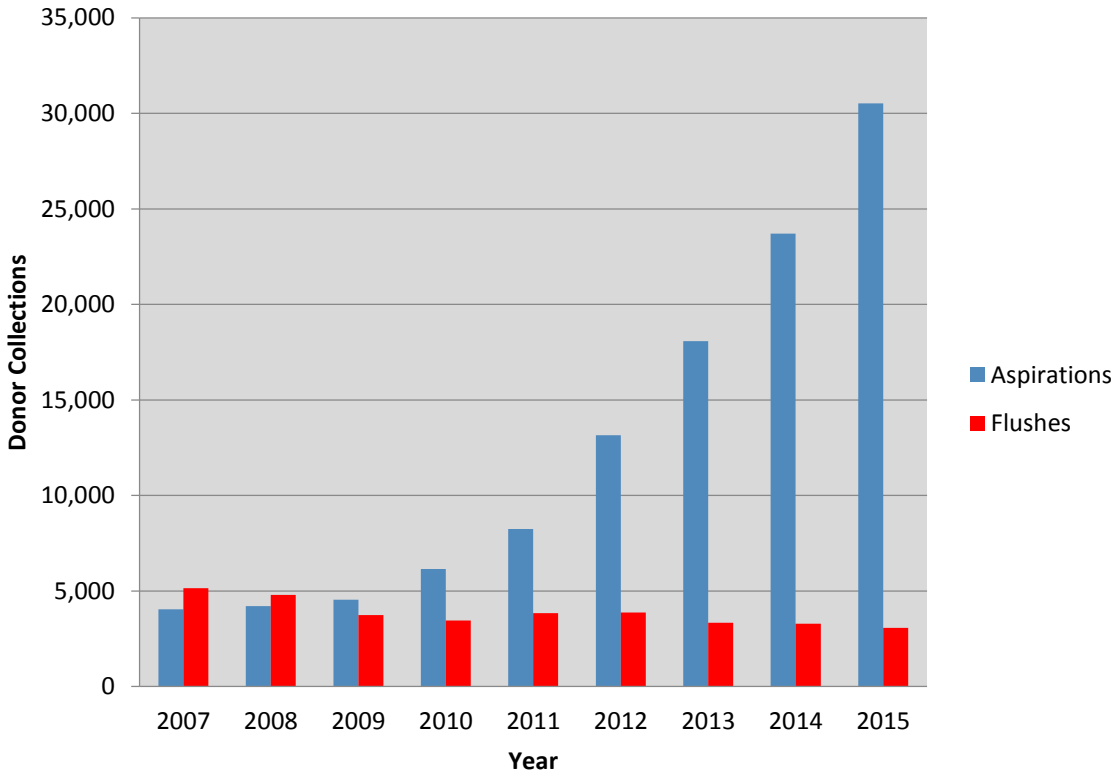
- **1.47 million dairy animals genotyped since 2009 worldwide**
- **1.16 million U.S. dairy animals genotyped since 2009**

First Genomic enhanced genetic evaluation 2009

IVF TOG and Genetic Gain

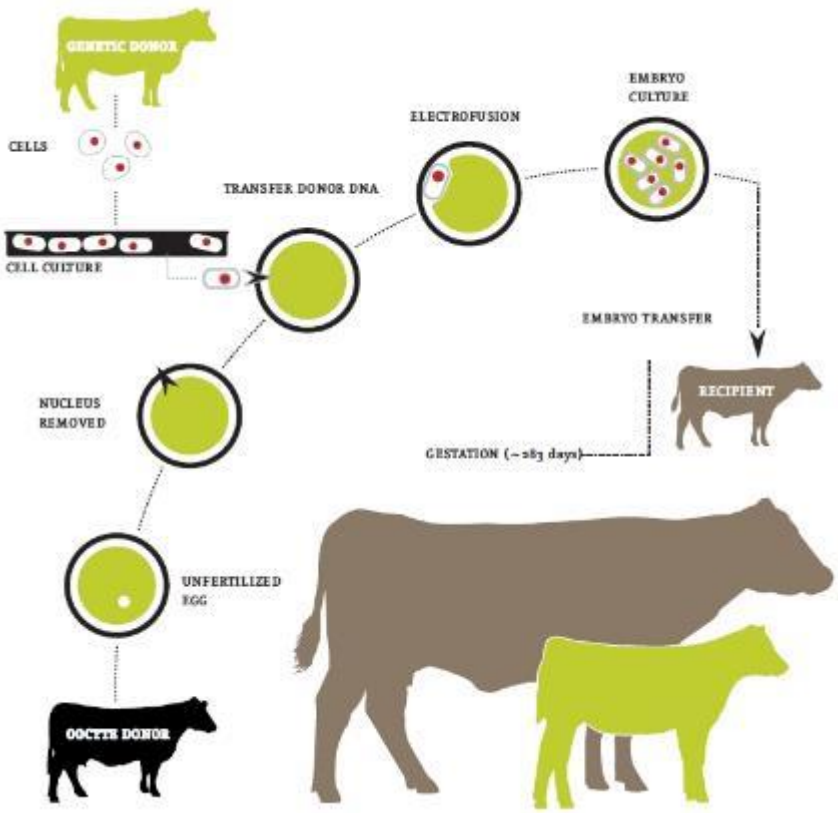


Growth of IVF at TOG and genetic gain dairy



Genetic Gain – Recent technology additions

- Cloning before Dolly 1996 –
  - Splitting embryos clones 1980's
  - Animal clones from embryonic cells 1984



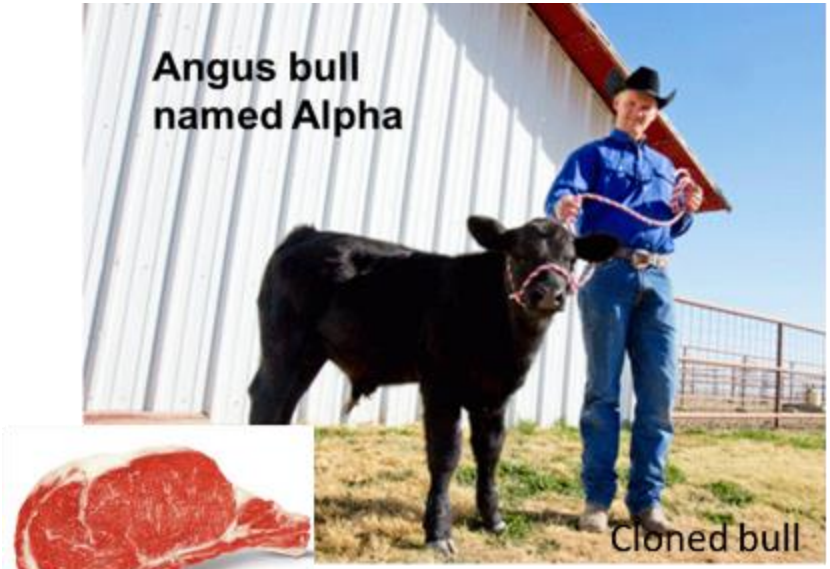
- **2008, the U.S Food and Drug Administration (FDA) Risk Assessment Published**

Genetic Gain – Recent technology additions

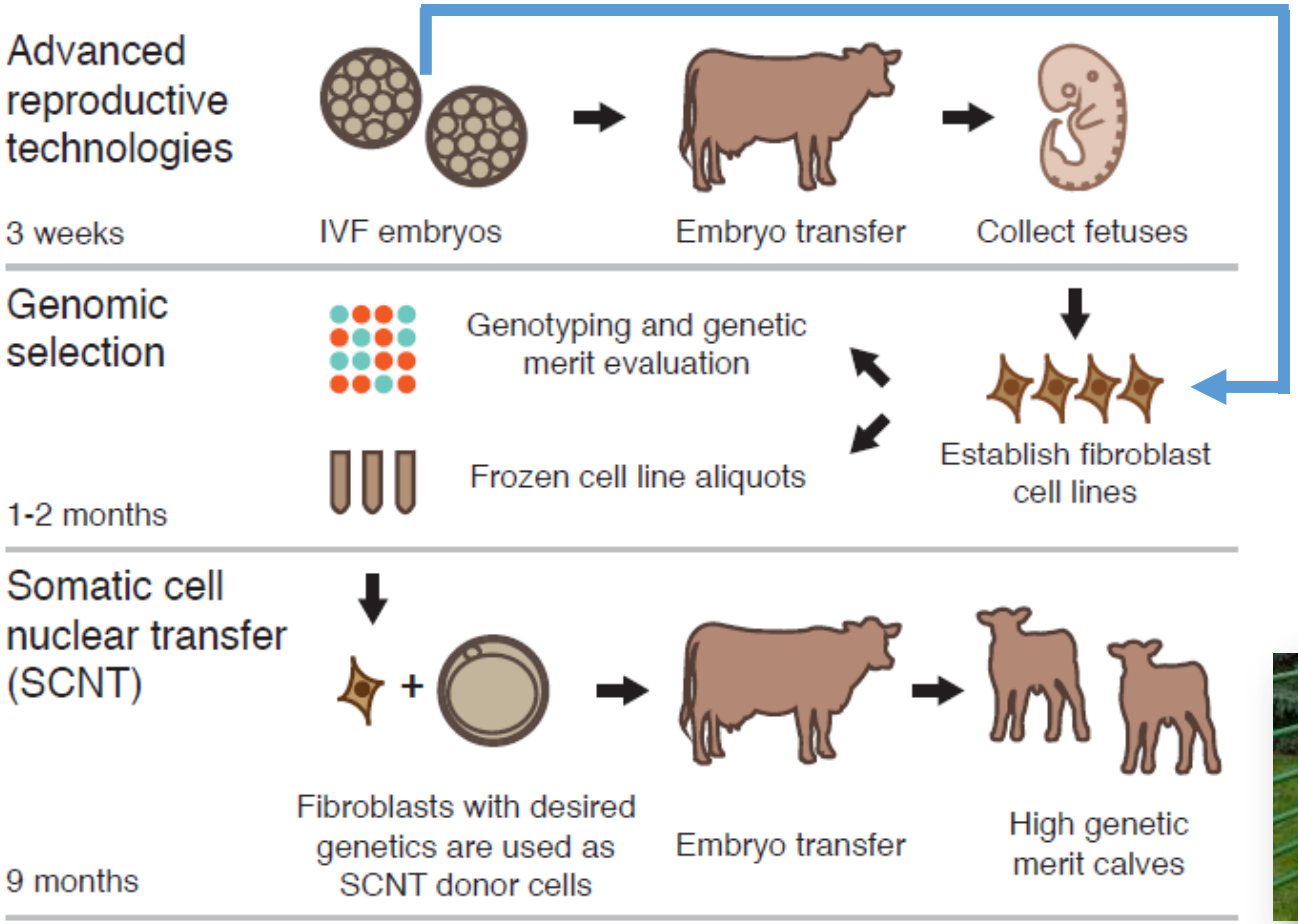
Cloning

Saving Superior Outlier Genetics

Extending Reach of Rare Genetics



Genetic Gain –
Combining IVF, genomic genetic evaluation & cloning



Fetal cell line selection
&
Embryo cell line selection

Traditional Animal Breeding

- **Novel natural occurring gene alleles segregating in population**
- **Traditional breeding will take 6-7 generations 15 yrs minimum**

Myostatin

Wagyu

f0  **x** 

Pied x Wagyu

↓

 f1

 **x**

↓

f2

f3

f4

f5

f6 

98% purebred Wagyu f6
Containing the Myo-P allele

<u>Backcrossing to produce purebred Wagyu with Myo-P allele.</u>

1) f2-f6 genetic test

2) Select females Myo-P

3) Backcross to Wagyu
- **Repeat process 6x**

Future of Animal Breeding – Adding tools

Myo-W/Myo-W

Elite Wagyu sire

1

2

3

Myo-P/Myo-P

4

Myo-W/Myo-W

5

Myo-P/Myo-W

1) Establish cell line

2) Edit Myostatin gene Piedmontese allele Myo-P/Myo-P

3) Use cloning to produce homozygous Myo-P/Myo-P Wagyu Bull

4) Mate bull with Wagyu females

5) Production of ideal 100% Wagyu progeny carrying a copy of the Myo-P allele - 3yrs

THANK YOU

QUESTIONS?

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