

A pair of blue-handled scissors is positioned over the word 'Genome' in the title, symbolizing genome editing.

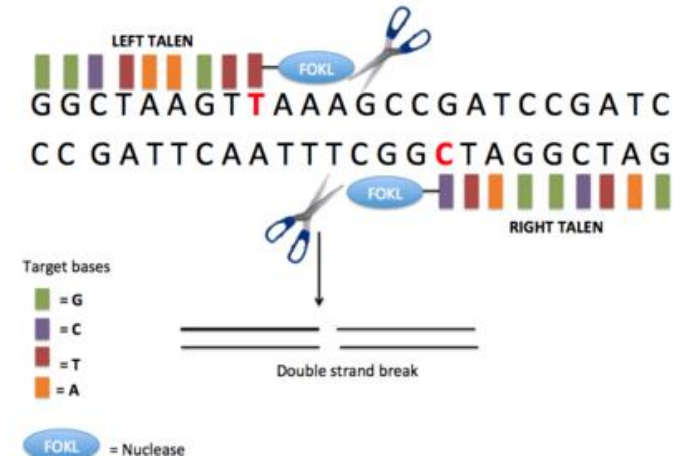
# Genome editing



NÖK, Rättvik, 23 July, 2018, Susanne Eriksson, SLU, Uppsala

# What is gene/genome editing?

- A type of genetic engineering in which DNA is inserted, deleted, modified or replaced in the genome.
- Engineered nucleases (enzymes) cut DNA at desired locations.
- The cell repairs the DNA, resulting in targeted mutations ('edits').
- Examples of engineered nucleases: zinc finger nucleases, TALENs, and the (CRISPR/Cas9) system.



# Is genome editing GM?

- Classification not clear yet: GMO or not, HUGE impacts on the regulatory framework.
- Difference that genome editing does not leave foreign DNA (from other species).
- Precision and efficiency improved much since first GM animals in mid-1980s.

*Herman the Bull (1990-2004): the first GM farm animal, with a human genetic variant for the protein lactoferrin.*



# Remember: Traditional selection can also result in big changes...



- We utilize new mutations (or mutations in low frequency).

# Why is genome editing of interest for breeding?

- To introduce new genetic variants from other breeds requires crossbreeding and backcrossing for generations
  - risk of losing genetic progress.
- Imagine changing only one trait in existing population:
  - to improve nutritional value of product, or production efficiency, or animal health, or “repair” genetic defects, or ..

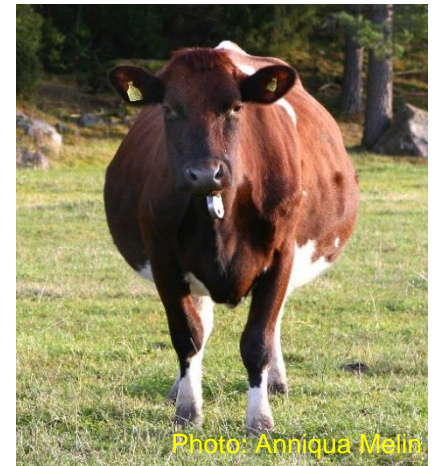
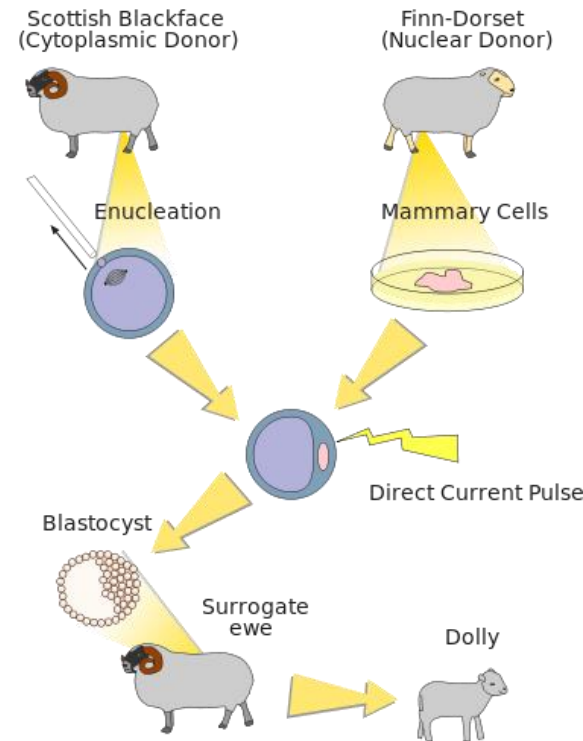


Photo: Annika Melin



# Genome editing requires advanced assisted reproduction techniques

- Somatic Cell Nuclear Transfer (“Dolly”-96)
  - high losses of embryos, low viability of newborn offspring...
- Micro-injections of zygotes alternative, but SCNT still important.
- Impose ethical considerations in itself.
- Need to become more efficient (>90% of embryos may be lost).
- Chinese and Korean companies claim to be able to produce hundreds of cloned embryos/day.



# Why is genome editing not in use already?

- No large scale breeding programmes with genome editing of farm animals in action (yet), strict regulatory framework.
- To become quickly adopted and implemented, novel technologies must be suitable for daily use, benefit the breeding program, be cost efficient and be ACCEPTED BY SOCIETY (Simianer, 2016)
- Still lack complete understanding of complex traits and interactions. (Certain applications more straightforward?)

# Example: Genome editing to dispense with dehorning

- Likely candidate for application??
- Dehorning animal welfare issue
- Naturally polled Holstein bulls exist
  - possible to breed for without editing, but lower genetic level and more inbred.
- Genome editing short-cut?
  - Celtic origin allele (e.g. Angus)



Photo: Gngarra

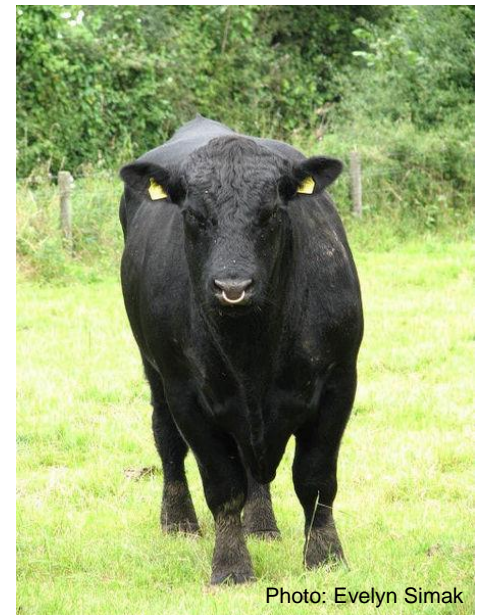
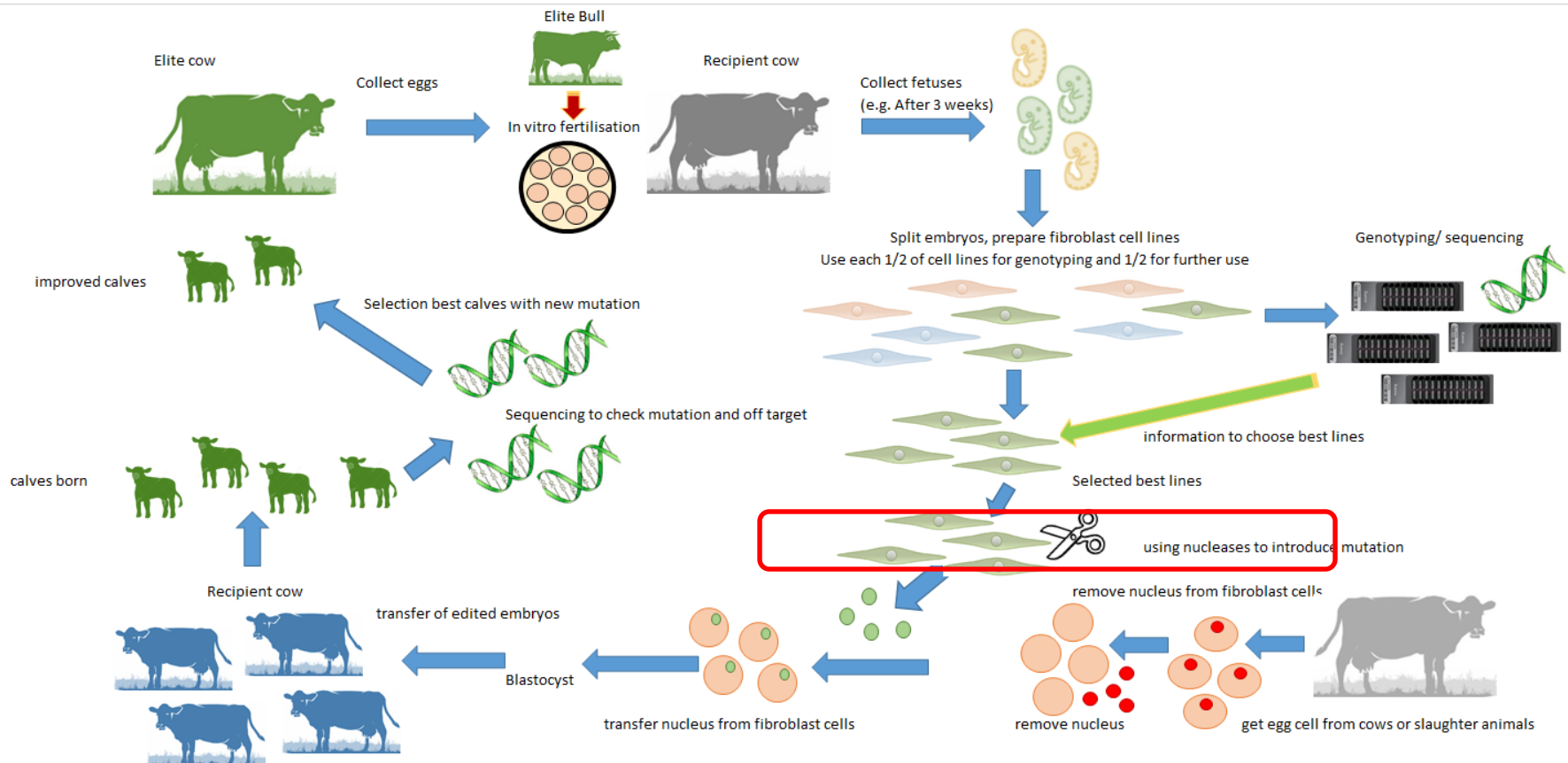


Photo: Evelyn Simak



# Breeding schemes incorporating genome editing?

- Genomic selection of in vitro produced embryos already proposed – genome editing not that big step?



# Context sensitivity

- Not using genome editing also needs ethical considerations!
- Societal acceptance case specific?
- Need to be discussed within relevant context: By researchers, breeding companies and farmers' organizations. Not only by other parts of society.
- Need for ethical boards as a (voluntary) help?



# Time will tell..

“We tend to overestimate the effect of a technology in the short run and underestimate the effect in the long run” (Amara’s law)

## Bill Gates invests \$40 million to create a ‘super cow’

By Holly Christodoulou, The Sun

January 29, 2018 | 11:49am | Updated

GLOBAL OPPORTUNITY

**Bill Gates says it would be a “tragedy” not to take advantage of CRISPR gene-editing**

