



Genome editing for poultry production challenges

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Biotechnology and
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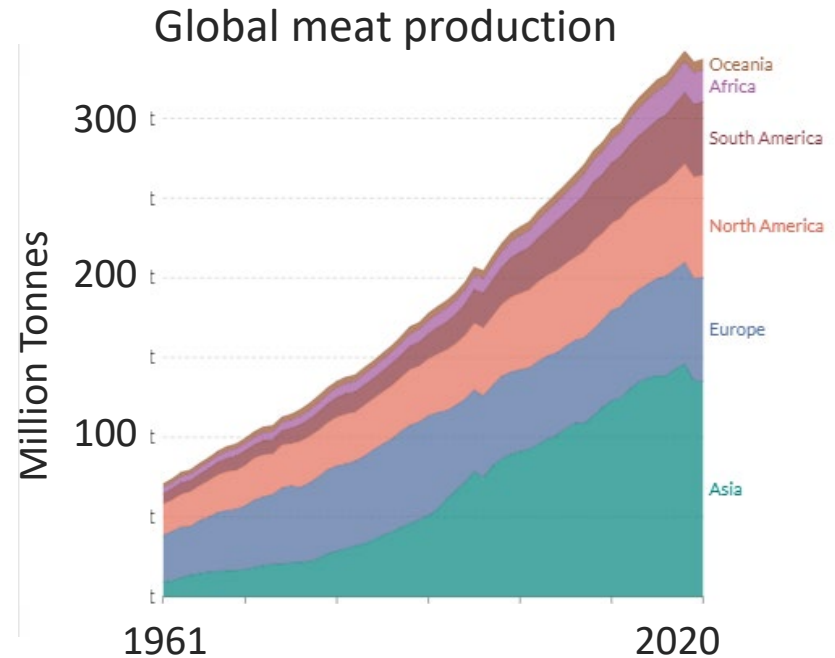
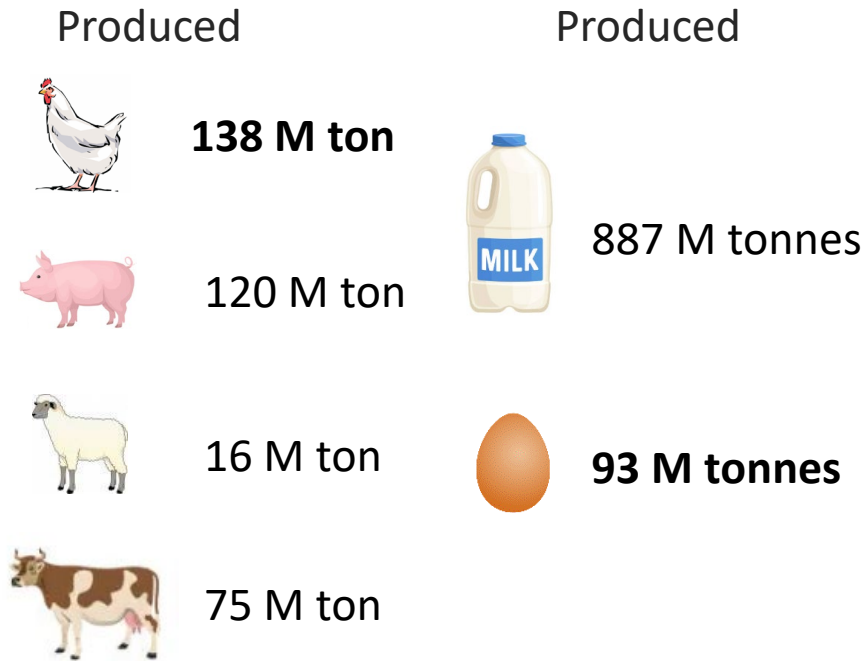
Why is chicken important?

Animals slaughtered globally in 2020

1.7 million camels
24 million water buffalo
293 million **cattle**
398 million goats
518 million sheep
633 million turkeys
1.1 billion rabbits
1.5 billion **pigs**
3.3 billion ducks

70 billion chickens

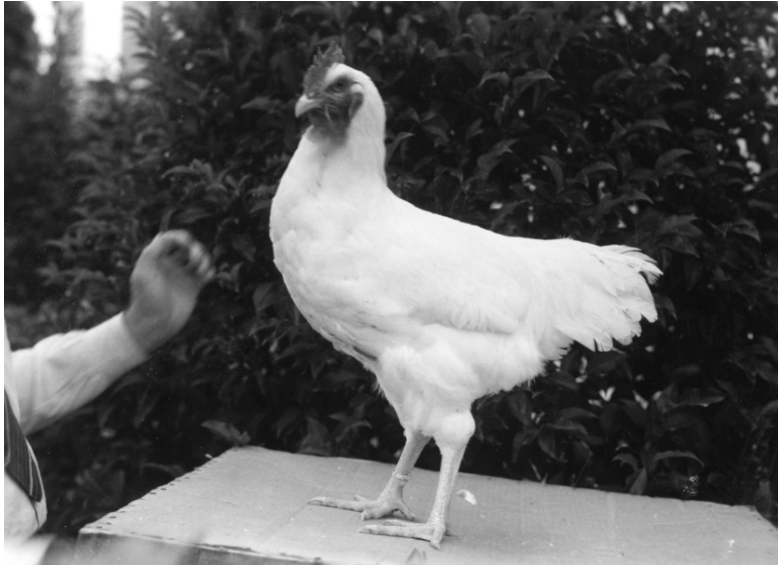
The global scale of animal production is vast



- Demand for meat & animal products has soared in recent decades, 1/5 of all global protein production
- Anticipated to increase by **50% by 2050** owing to population growth
- Significant impacts on the climate, environment & biodiversity
- Mitigates hunger, malnutrition & poverty in low- & middle-income countries

Achievements of animal breeding

1950



330kg meat per tonne of feed

2014



590 kg meat per tonne of feed

+79% improvement

The genetics of 1950 would require 80 million hectares of land to meet global poultry meat demand, the genetics of 2014 required only 45 million hectares

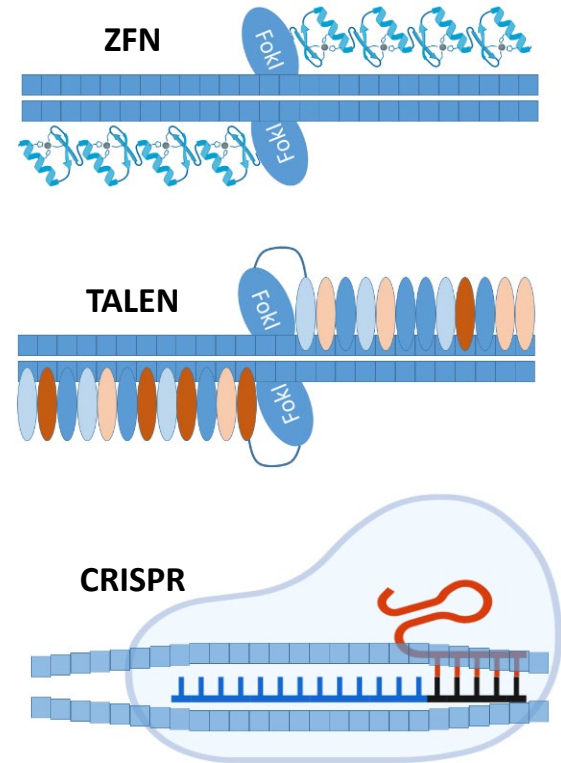
Source: <http://ourworldindata.org/data/food-agriculture/land-use-in-agriculture>

How genome editing technologies can address global poultry challenges



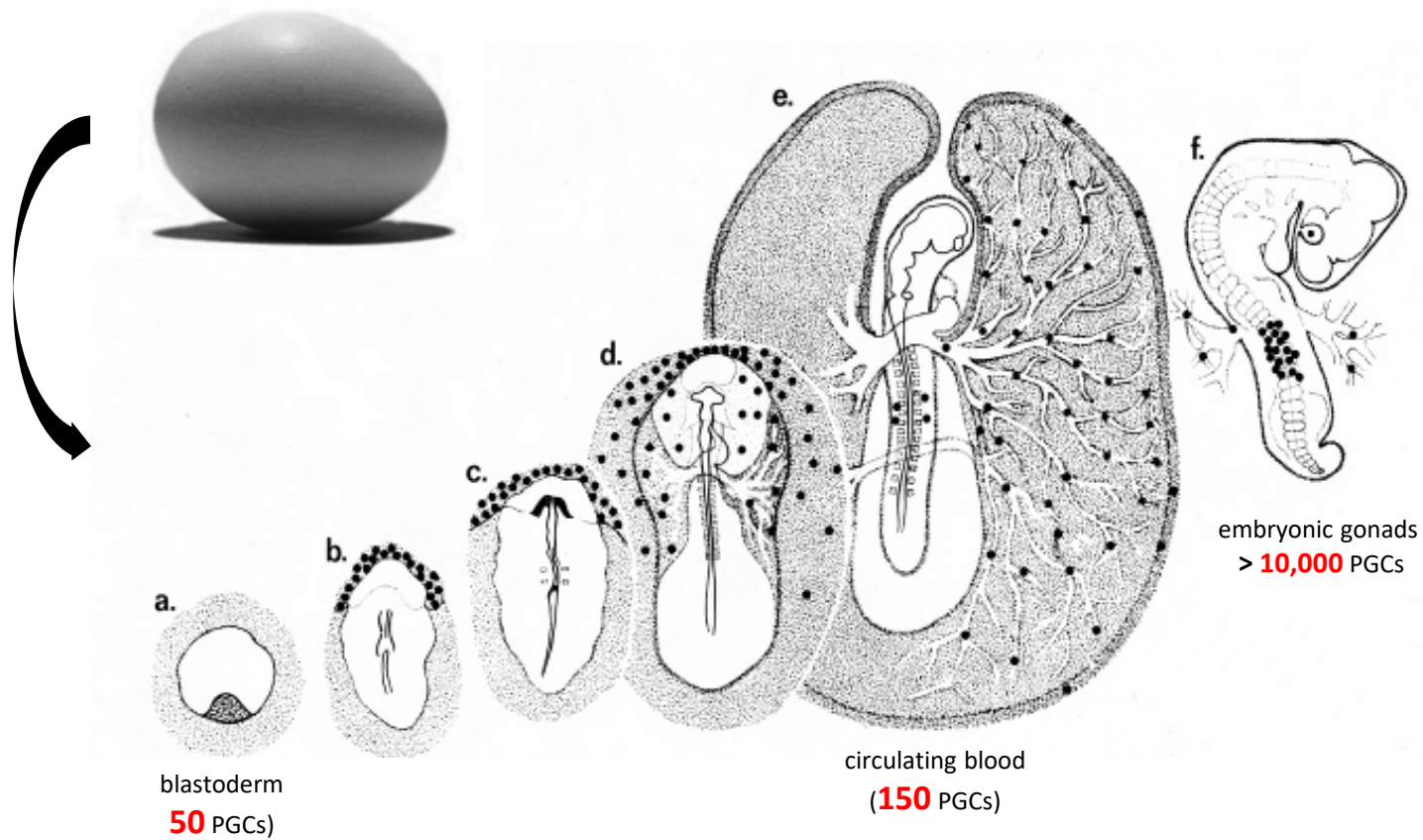
- Sustainable protein production to achieve global food security
- Mitigating negative impacts of poultry farming
- Reducing the burden of poultry diseases
- Reducing zoonoses (extremely important for chicken and waterfowl)
- Combatting antimicrobial resistance, eliminating microbial use
- Enhancing the welfare of farmed animals
- Conserving genetic diversity

How we edit livestock genomes



More accurate than you parents

Chicken reproductive cells can be modified *in ovo* or *in vitro*



Chicken primordial Germ Cells (PGCs) can be culture in vitro and are germline competent

- PGCs are the lineage restricted embryonic precursors of the gametes (sperm and eggs)
- Diploid and migratory



Using sterile males and female chimeras to create homozygous edited chickens



ths

Maeve Ballantyne



National Centre
for the Replacement
Refinement & Reduction
of Animals in Research



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Genome editing can have two major impacts on poultry:

Rapid transfer of genetics between unproductive animals to productive 'elite' animals

Introduction of NEW genetic changes that can create a novel beneficial trait in animals

Improving chickens for farmers and consumers



Increased productivity with lower GHG

Increased or 'Novel' disease resistance

Eliminate the hatching and culling of the wrong sex chicken

Genome editing using CRISPR/Cas9 carried in adenovirus to increase meat yield of unproductive 'breeds'

Myostatin 'knockout'



Ducks



layer line



Quail

The first genome edited chicken disease resistant chicken

*Avian Leukosis Virus resistant chicken- a silver bullet
-a monogenic trait*



newscientist.com

CRISPR-edited chickens made resistant to a common virus

Heijnar lab

Avian influenza resistance
would be a major win for
poultry



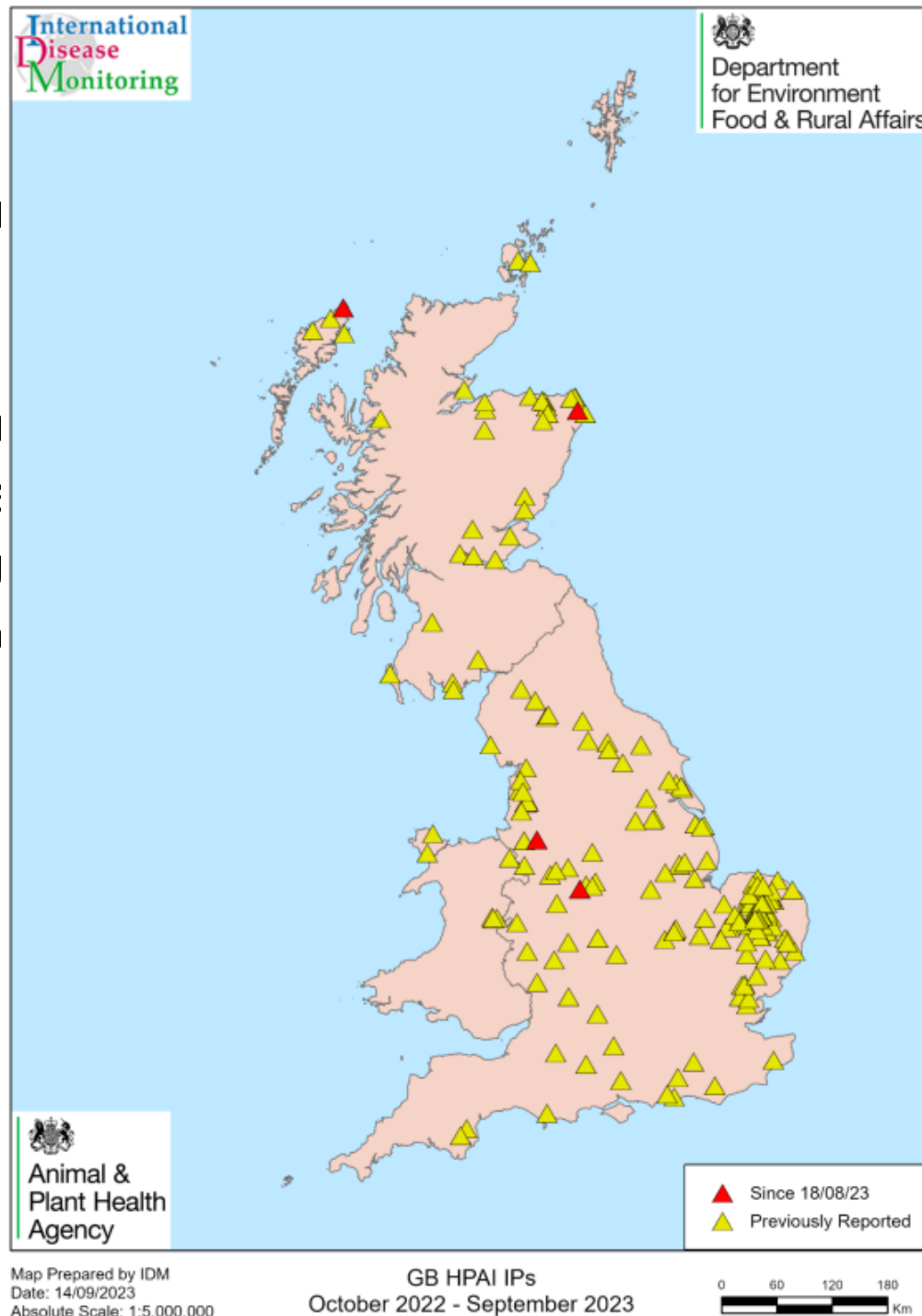
Preventing bird flu

- Major control/prevention is not full-proof:

- Strict biosecurity
- Poultry vaccination insufficient due to
- Epidemiological challenges
- Massive depopulation

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Avian influenza resistance
would be a major win for
poultry (and the world)

>chickens

- 100 commercial breeds
- 1400 local breeds

>farmers

- commercial
- village farmers

>consumers

- LMIC, HIC



Sex skewing of chicken eggs

Egg production only uses layer hens

29 million male chicks culled yearly in UK

260 million male chicks culled yearly in US

5-6.5 billion male chicks culled yearly

Thank You