

Heritable Genomic Modification in Food Animals *An Australian Perspective* *A solution for a big problem in the egg layer industry?*

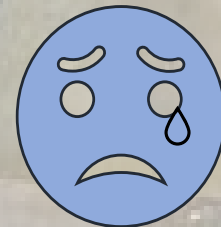
Dr Mark Tizard *from the CSIRO Genome Engineering Team*

Australian Centre for Disease Preparedness (ACDP)

Previously known as the Australian Animal Health Laboratory (AAHL)

A KEY ETHICAL DILEMMA AND POTENTIAL WELFARE ISSUE

- ~20 million male chicks culled in Australia every year
- ~300 million male chicks culled in the US every year
- ~7 billion male chicks culled globally every year
- Industry needs a solution



OTHER CHALLENGES DRIVING THE SEARCH FOR A SOLUTION:

- Carbon footprint of food production
- Sustainability of food supply (low value waste → food)

 frontiers | Frontiers in Animal Science

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Biotechnological fixes and the Big Three urgent moral challenges facing the global livestock industry

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THE POTENTIAL TO IMPROVE THIS *WELFARE, ETHICS AND SUSTAINABILITY* ISSUE

CURRENT GLOBAL PRACTICE



DAY 21

INCUBATION, HATCH, MANUAL
SEXING, REMOVAL & CULL

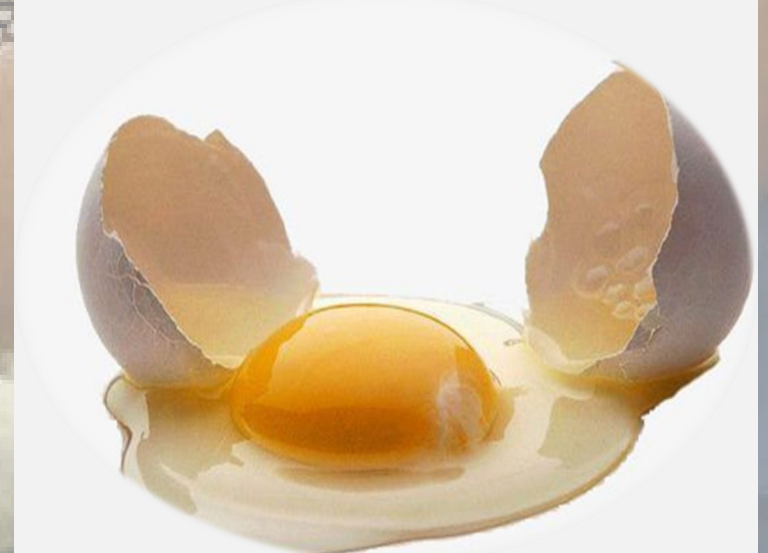
NEW TECHNOLOGY IN EUROPE



DAY ~ 9

INCUBATION, SAMPLING, ANALYSIS,
REASSORTMENT, REMOVAL & CULL

MARKER SORTING – POINT OF LAY



DAY 0

DETECTION, REMOVAL
(NO INCUBATION, NO GROWTH, NO CULL)

TACKLING THE ISSUE

BIG IMPROVEMENTS ACHIEVED

POTENTIAL COMPLETE SOLUTION

MALE CULLING ILLEGAL IN GERMANY AND FRANCE: RESPEGGT and IN OVO first to market



<https://www.respeggt.com>

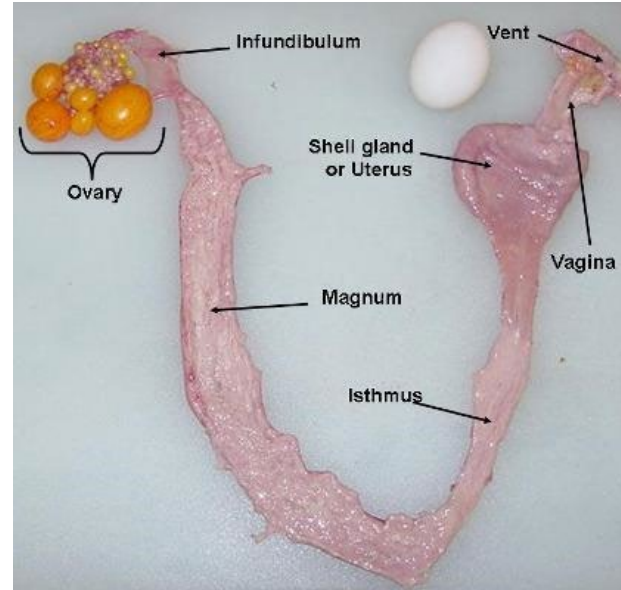


<https://inovo.nl>

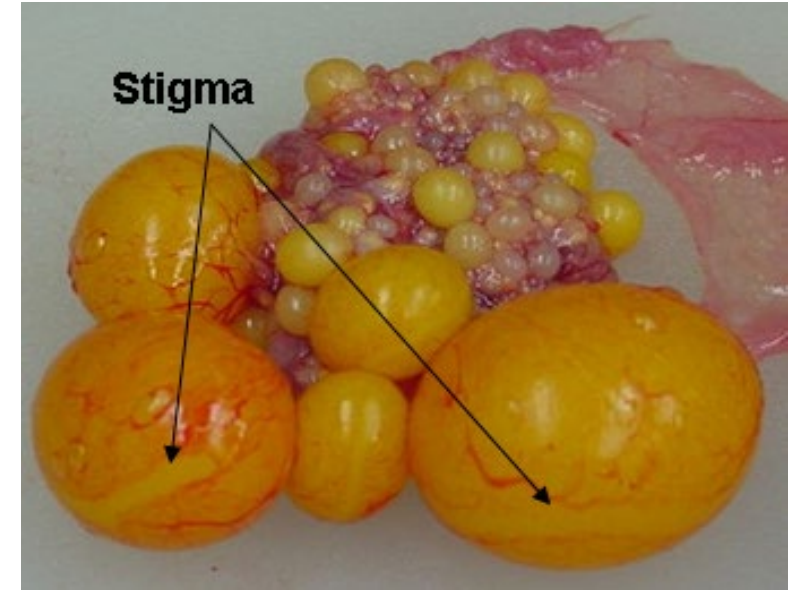
GENE EDITING & PRECISION GENOME ENGINEERING IN ANIMALS



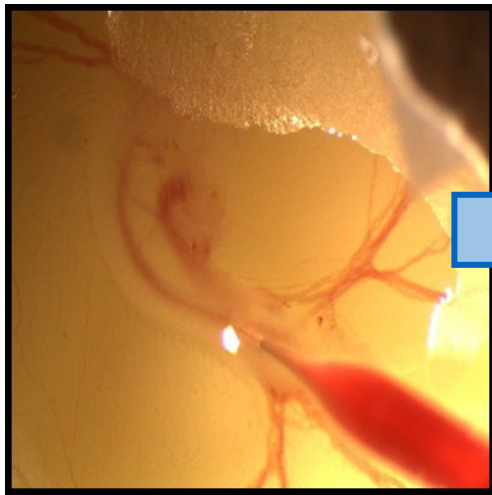
- Gene editing in mammalian species is performed on freshly fertilized eggs – *in vitro*



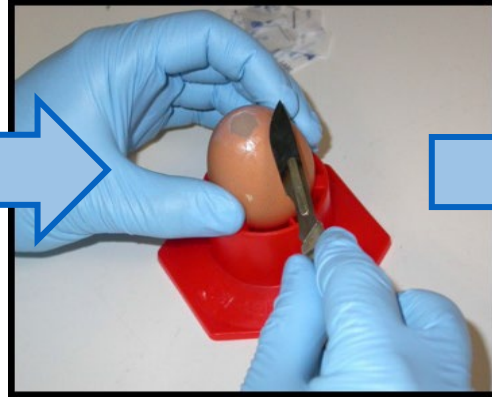
- Avian reproduction presents quite different challenges.
- The ovum is intimately associated with the yolk and is fertilized at the top of the reproductive tract.
- **Alternative approaches are required.**



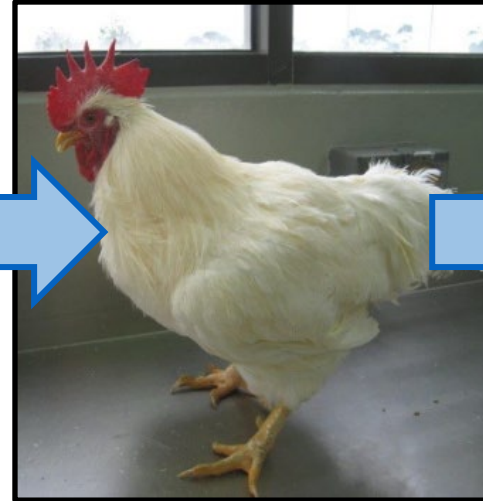
INTEGRATING THE MARKER GENE INTO THE CHICKEN GENOME



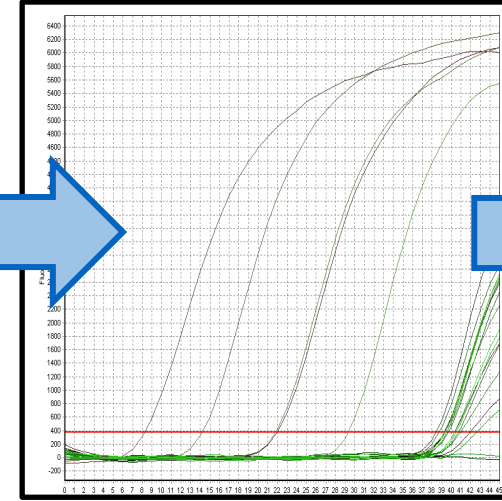
Inject 50 eggs



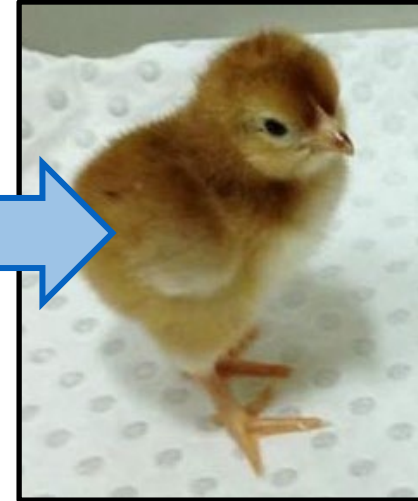
Seal & Incubate
Hatch 25 eggs



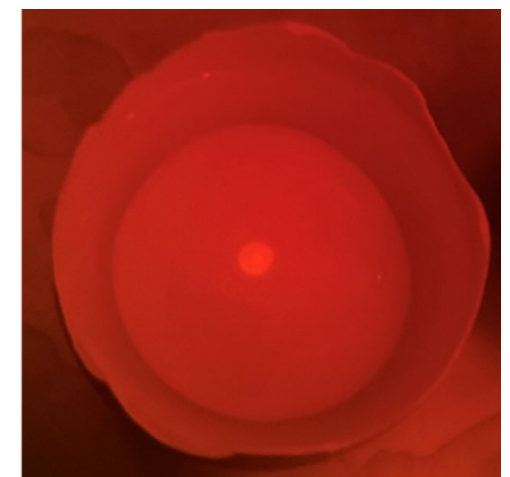
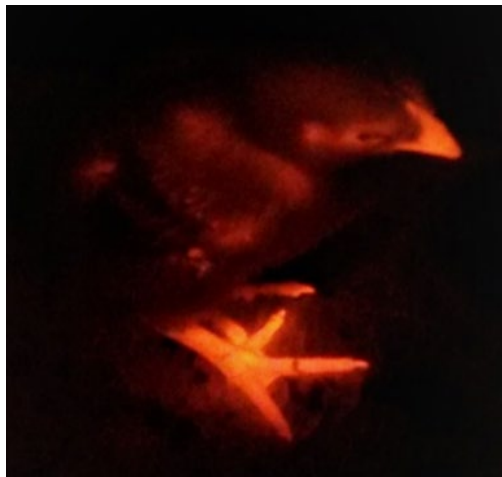
Grow 10 males
to maturity: G0



Select males:
PCR screen semen

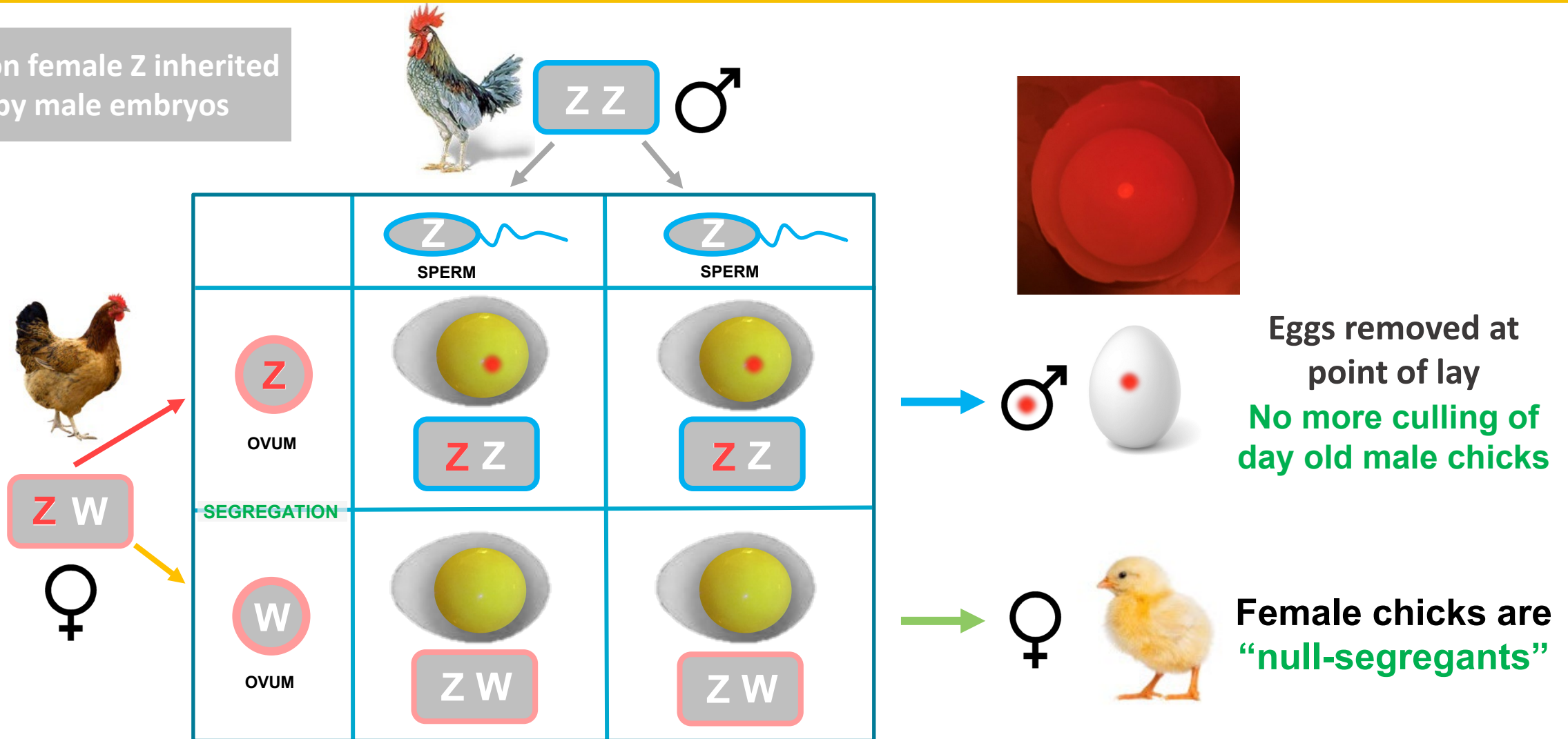


Screen 50 hatchlings
for fully transgenic



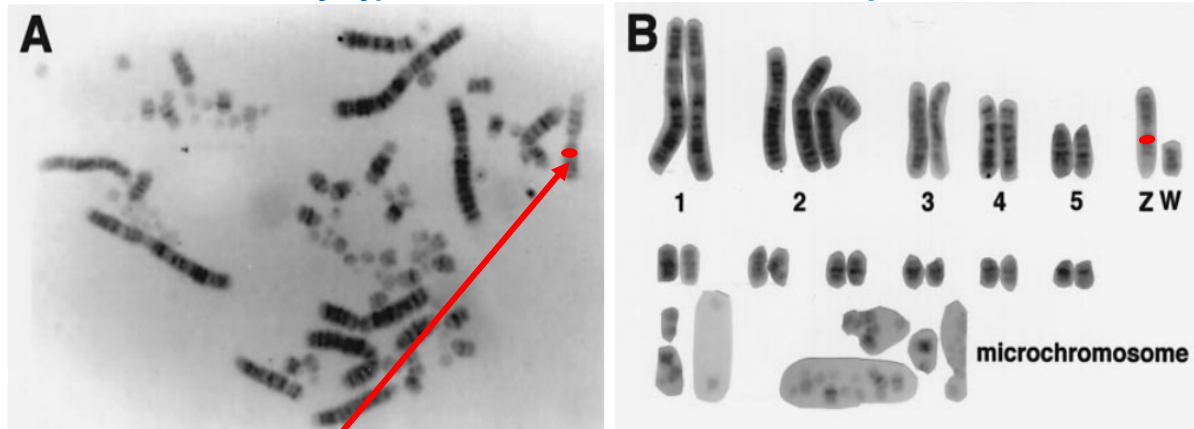
SEGREGATION OF SEX CHROMOSOMES AS OVUM AND SPERM ARE FORMED

Marker on female Z inherited only by male embryos



Characterisation of the modified chicken genome

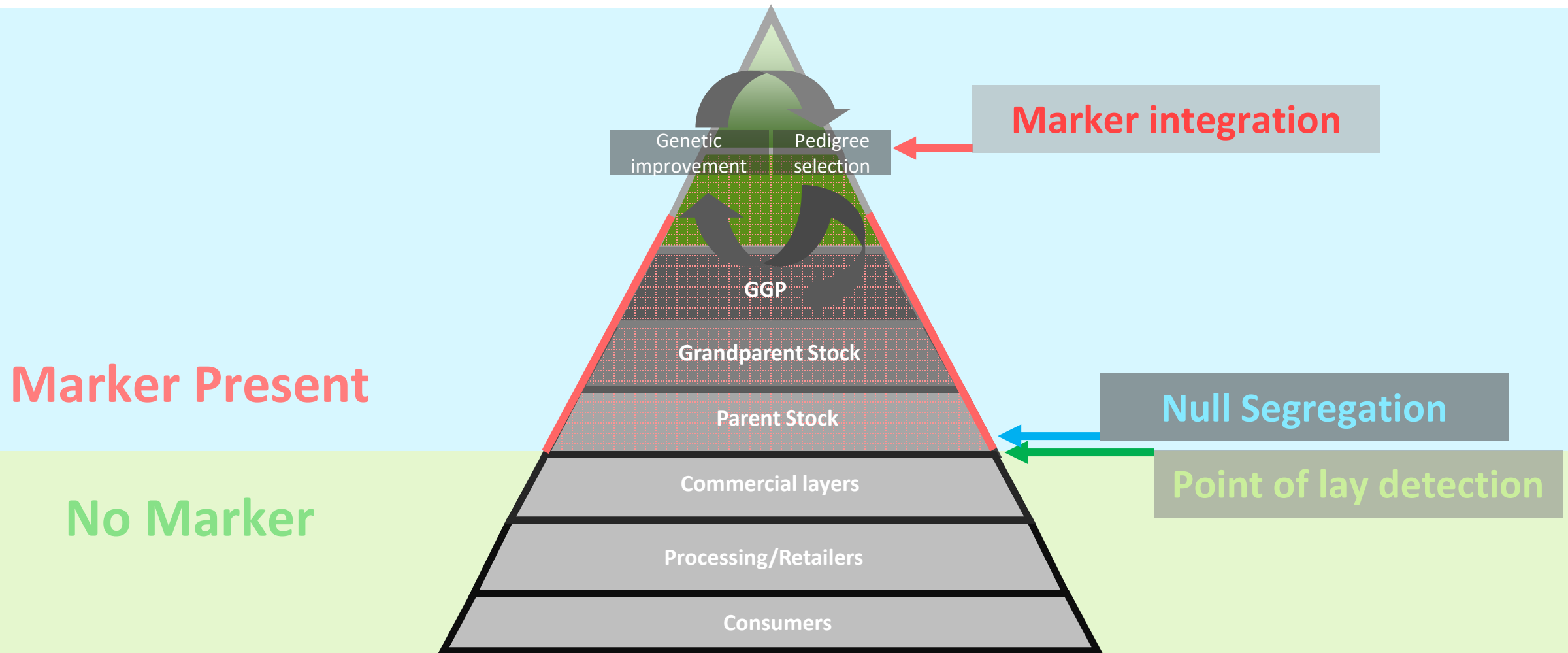
DT40 cell karyotype *From: Sonoda et al. (1998) EMBO J. 17 : 598-608*



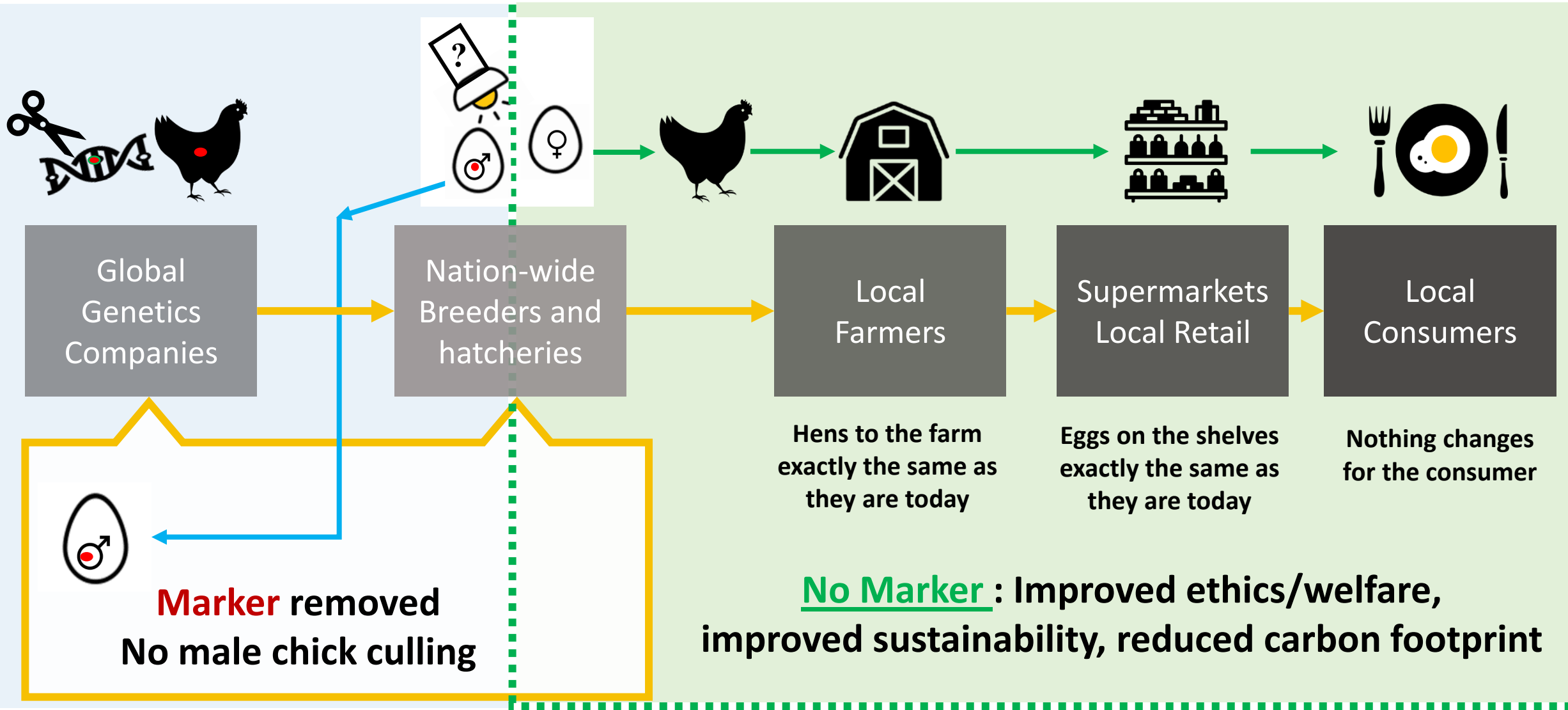
- **Tol2** integration – Z chromosome selection (post integration)
- Normal healthy growth of the chicken through embryonic development and adulthood
- Whole genome sequencing and anchor-targeted sequencing

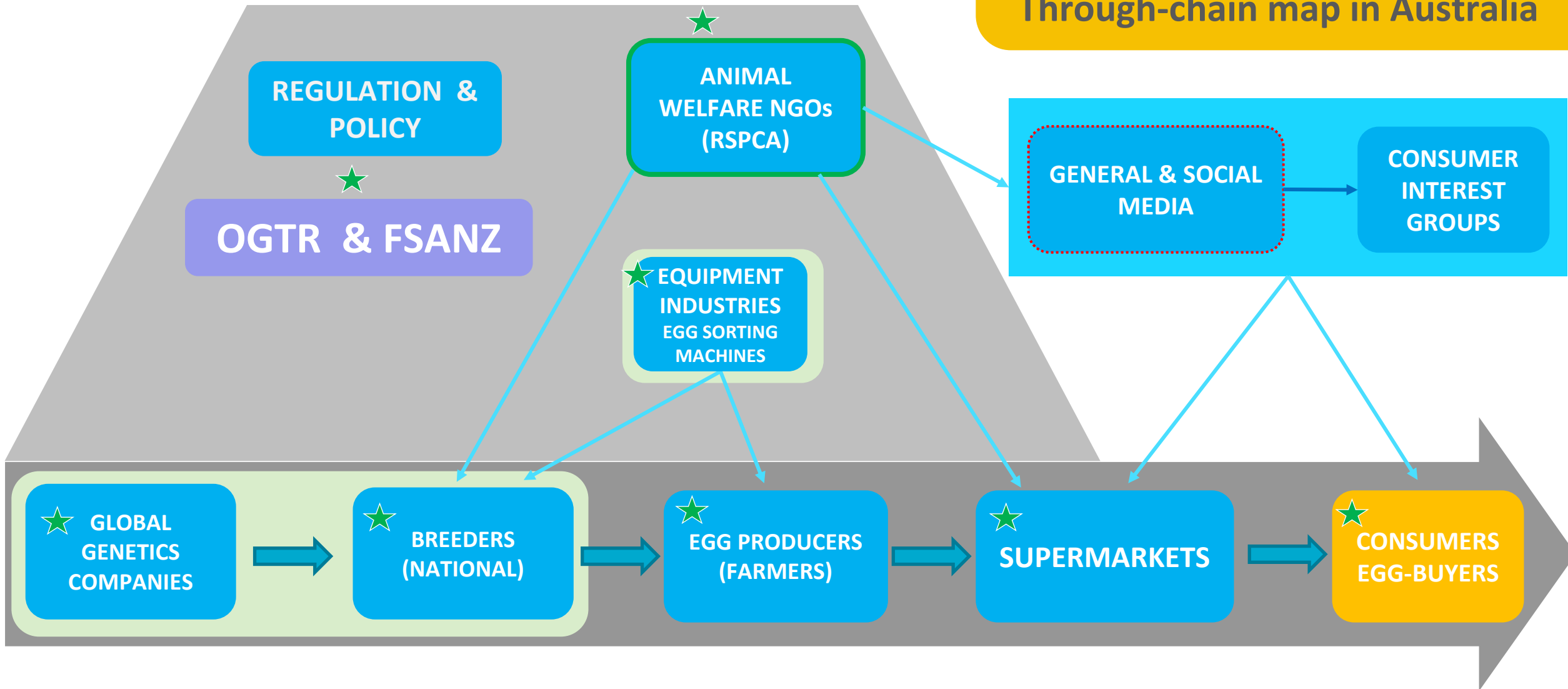


INTEGRATION INTO THE COMMERCIAL BREEDING PYRAMID



SEX SORTING – BENEFITTING THE ENTIRE SUPPLY CHAIN





★ Positive dialogue and engagement
Feedback received and incorporated

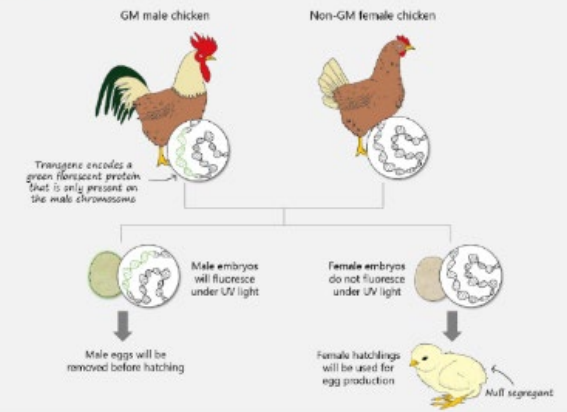
Would the egg on your plate be regulated as a safe food in Australia?

- The answer is... **yes** (*most likely**)
 - **Office of the Gene Technology Regulator (OGTR)**
 - Amended the Gene Technology Regulations in 2019 to make clear that a “**null-segregant**” is not a GMO
 - **Food Standards Australia New Zealand (FSANZ)**
 - Re-writing its food standard (1.5.2 *Food generated using gene technology*)
 - Making clear that food produced from “**null-segregant**” animals only requires an equivalence test (i.e. brief analysis to show an egg is an egg)
- * Of course, a final decision is pending completion of the project work and supply of suitable data to the two organisations



Box 4 | Sex selection in layer chickens

Male hatchlings of layer chickens are normally culled after hatching. A NBT could allow the detection and removal of male eggs before hatching. This technique will result in null segregant female hatchlings.



Would the egg on your plate be regulated as a safe food, globally?

- The answer is... **yes** (*most likely**)
- **Argentina – CONABIA**
 - initial consultation and discussion - positive
- **Brazil - CTNBio**
 - initial consultation and discussion - positive
- **Canada – Health Canada**
 - initial consultation and discussion - positive
- **Japan – National Agriculture and Food Research Organisation**
 - Ministry of Health, Labor and Welfare - early informal conversation - positive
- **USA – FDA CVM**
 - initial consultation and discussion - positive



*** Final decisions rest on presentation of appropriate data packages**



Partners in research

Published on June 30, 2022



New partnership to study innovative sex sorting technology for the egg laying industry

Hendrix Genetics is partnering with Australia's national science agency, CSIRO, to test the viability of an innovative point of lay sex sorting technology for the egg laying industry.

<https://www.hendrix-genetics.com/en/news/new-partnership-to-study-innovative-sex-sorting-technology-for-the-egg-laying-industry/>

CSIRO – Genome Engineering Team

GE Team

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 - [Terri O'Neil](#)
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 - Kristie Jenkins
 - Arjun Challagulla
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 - Bishwo Pokharel
 - Joseph Kolotelo
 - Brodie Morgan
 - Jessica Rice
 - David Rice
 - Kadir Batuk
 - Jayne Vella
 - Alexis Johns
-
- [Caitlin Cooper \(Hendrix Genetics\)](#)

Thank you for listening



I dream of a world where
chickens can cross the road
without having their motives
questioned

