

Global status and opportunities of animal biotechnology for food and agriculture



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Webinar on Animal Biotechnology Opportunities and Regulations in the Philippines

29th September 2022



Animal biotech plays an important role in research and development



Australian Centre for Disease Preparedness



Recombinetics, 2016



Shanghai Institute, 2018

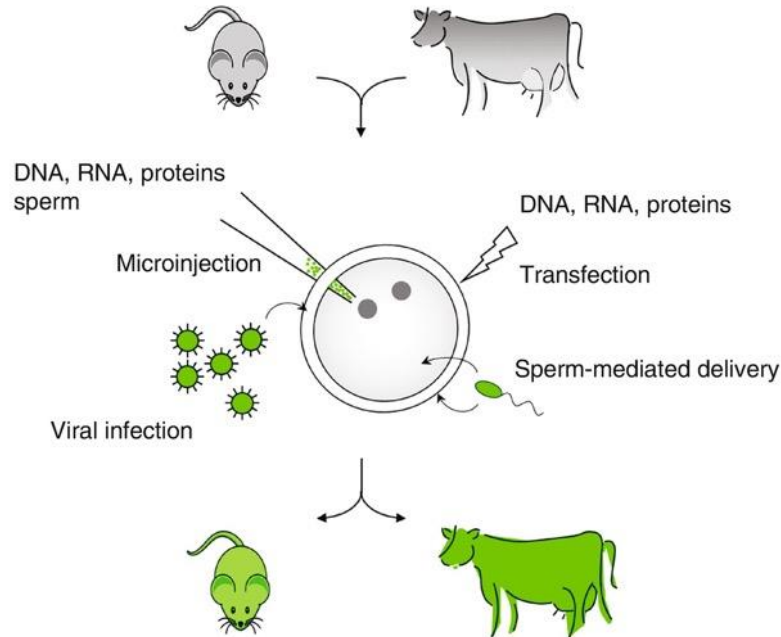


Xinjiang Academy of Zootechnical Science, 2016

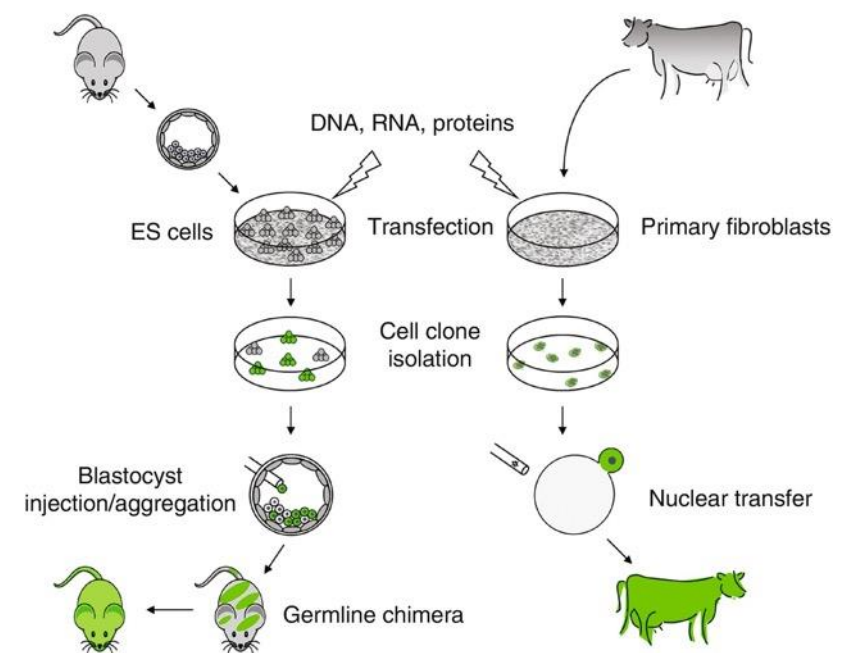


Approaches for genetic engineering

Embryo-mediated



Cell-mediated



- Advantage of a relative high efficiency for the embryos to develop into live transgenic founder animals.
- Disadvantage of this approach lies in the lack of total control of when and what modification is introduced. Can lead to mosaic animals

- Advantages-sex selection, characterised modification before generating animals. Can avoid mosaics and produce multiple founders
- Disadvantage-Cloning step leading to other issues

The great challenge

- ✓ **Provide genetic improvement of food animals to meet human demand → without compromising animal well-being and the environment**
- **What do we want?**
 - Food equality
- **How do we get it?**
 - Using new technologies to change paradigms
- **How much does it cost?**
 - Social uncertainty, political agendas, patents/IP, & regulatory approvals
 - Universal access

What is commercially available?

AquaAdvantage® Salmon



GloFish®



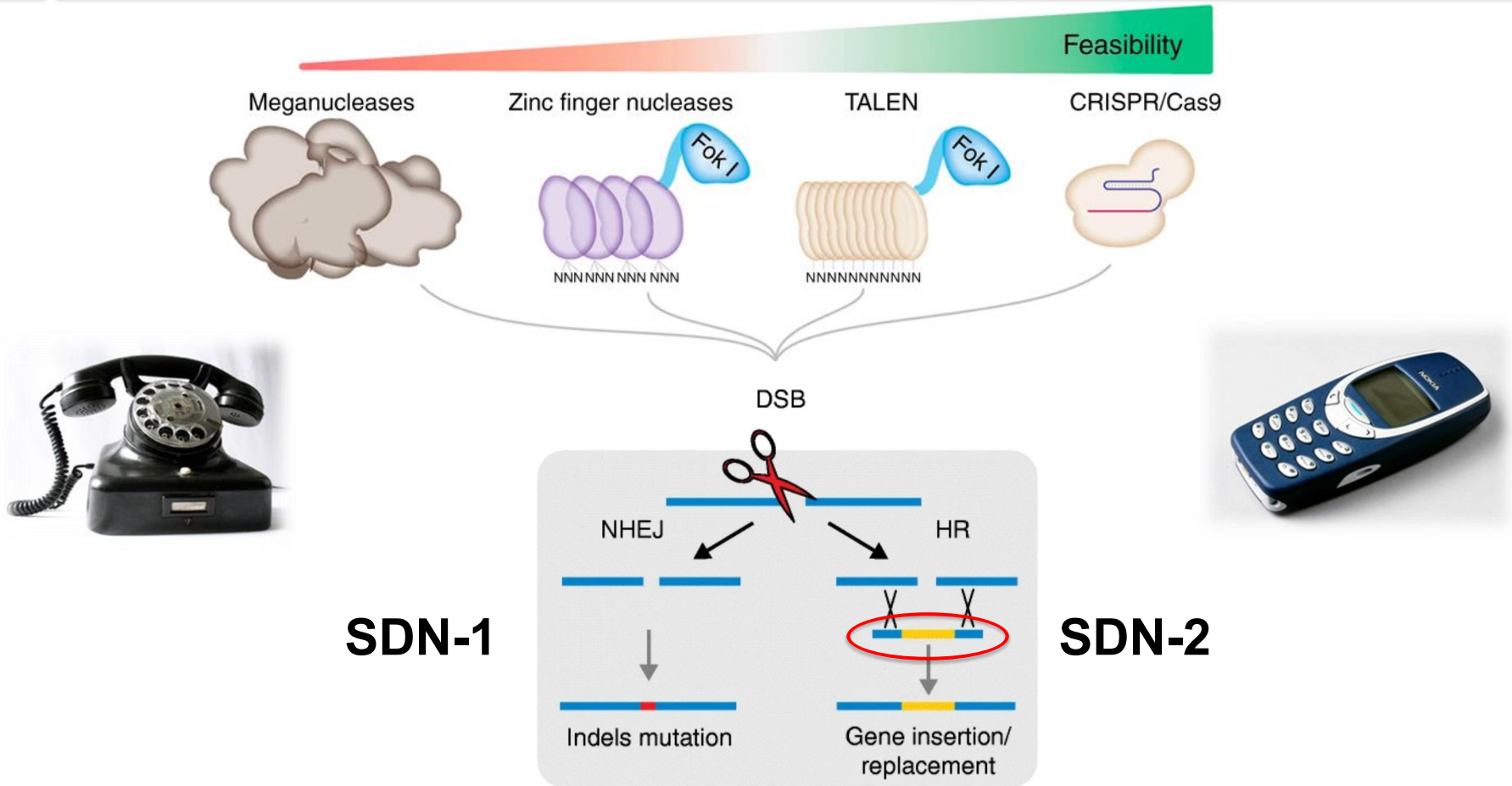
Photo: AquaBounty.com



Limited GE animals.....

A new opportunity for animals....

Genome editing for precision

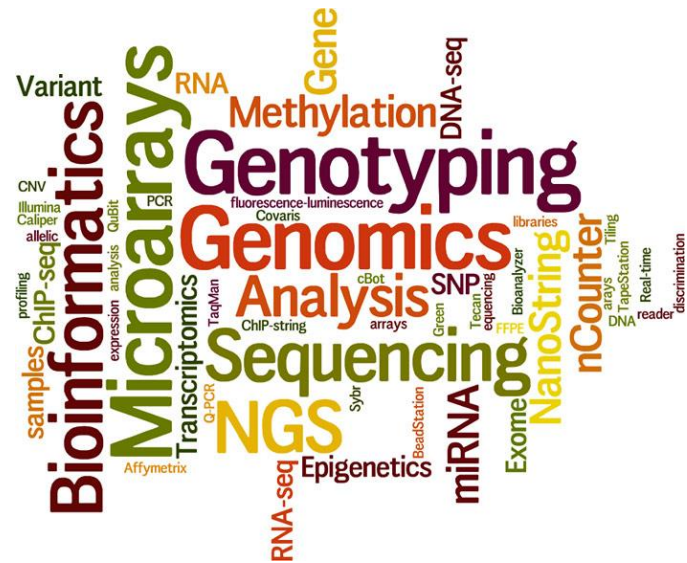


Adli, M. The CRISPR tool kit for genome editing and beyond. *Nat Commun* **9**, 1911 (2018). <https://doi.org/10.1038/s41467-018-04252-2>
 Zhang, Y., Massel, K., Godwin, I.D. *et al.* Applications and potential of genome editing in crop improvement. *Genome Biol* **19**, 210 (2018). <https://doi.org/10.1186/s13059-018-1586-y>

New gene technology techniques

- "genome editing", "gene editing", "genome engineering", "New Breeding Techniques (NBTs)", "Precision Breeding Techniques (PBTs)", or "Precision Breeding Innovations (PBIs), Plant Breeding Innovation (PBI)" "Genome editing", gene editing, "genome engineering", "New Improvement Techniques (NTM)", "Precision Improvement Techniques (TMP)", or "Innovations for Precision Improvement (IMP), Innovation of the Plant Improvement (IMV)"
- All of them are examples of **manipulation of genomes**, but in many cases they are **different from GMOs**.
- These techniques are **complex to explain**.

Deciding on what to edit?



Variation between locally adapted and purpose bred populations

An opportunity for genetic improvement

Beef



Milk



Value added



Regional Adaptations



Disease Resilience



Potential opportunities



Beef and Dairy

- Bovine tuberculosis resistance
- Foot-and-mouth disease virus resistance
- Pest resistance—Trypanosoma
- Improved thermotolerance
- Increased genetic diversity



Swine

- Porcine Reproductive Respiratory Syndrome resistance
- Foot-and-mouth disease virus resistance
- Piglet nutrition enhancement
- Castration procedure prevention
- Increased genetic diversity



Aquaculture

- Disease resistance
- Reduced antibiotic use
- Sea lice resistance
- Increased growth rates
- Castration procedure prevention
- Increased genetic diversity

Genome Editing for disease resistance

Pigs that are Resistant to Incurable Disease
Developed at University of Missouri

Discovery about PRRS virus could save swine industry hundreds of millions of dollars; Exclusive deal signed with global leader in animal genetics

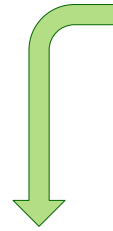
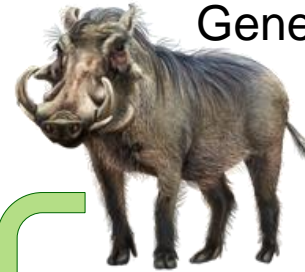
PRRSv costs
US pork industry
\$1.8 M/day

annually. Now, a team of researchers from the University of Missouri, Kansas State University and Iowa State University have developed pigs that are not harmed by the disease.



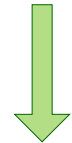
(Deletion)

Warthog Immune Gene



African Swine Fever Resistant Pig

Baboon ApoL-I Gene



Complete Protection from Trypanosomes

Animal Welfare is of great concern to the public



Naturally Hornless (Polled) Commercial Partnership Acceligen with Semex




NUTRITION & HEALTH

Feedstuffs

Recombinetics, Semex form
alliance to improve cattle well-
being



real agriculture 
Gene editing allows for polled dairy genetics
without the production drag



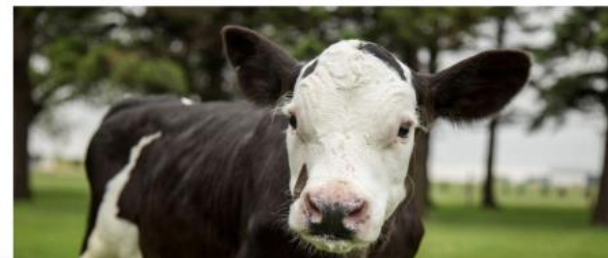
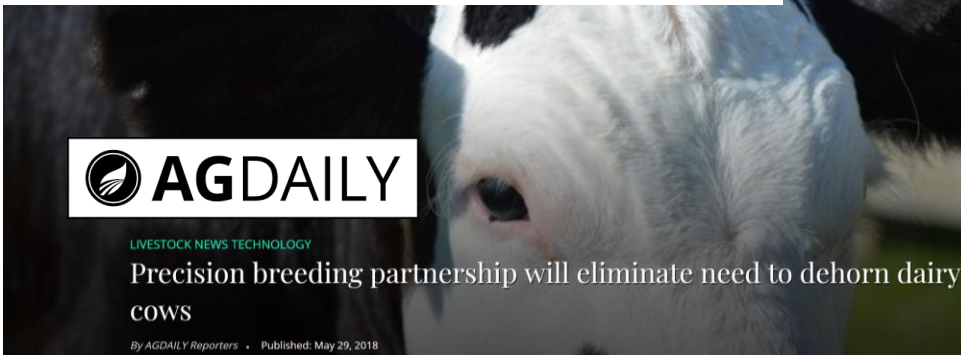
October 12

This Genetics Company Is
Editing Horns Off Milk Cows

- Recombinetics says its genetically edited Holsteins are ready to milk, but FDA rules are in flux.

By Adam Piore

**Bloomberg
Businessweek**





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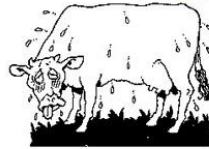
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Heat Stress-A Big Problem

THE COST OF HEAT STRESS IN CATTLE



Less Productivity

- Loss of acid/base balance
Depressed appetite
- Slower growth
- Indigestibility
- Less protein and fat
- Loss of body weight
- Inferior carcass quality
overfat downgrades

Increase in Metabolic Disorders and Treatment Costs of

- Milk fever
- Acetonaemia
- Udder oedema

Lost Fertility

- Mainly due to lowered circulatory progesterone

Increased Mortalities

- Reduced conception rate
- More anoestrous cows
- Fall in embryo survival rate
- Reduced post-natal survival
- More Metritis
- More Uterine Prolapse
- Premature and small calves (slowed embryonic growth)

Resistance to Infectious Disease

Caused by suppression of the immune system (lowered serum immunoglobulin).

- Spread of intercurrent
- Respiratory and
 - Gastro-enteritic infections
 - Mastitis

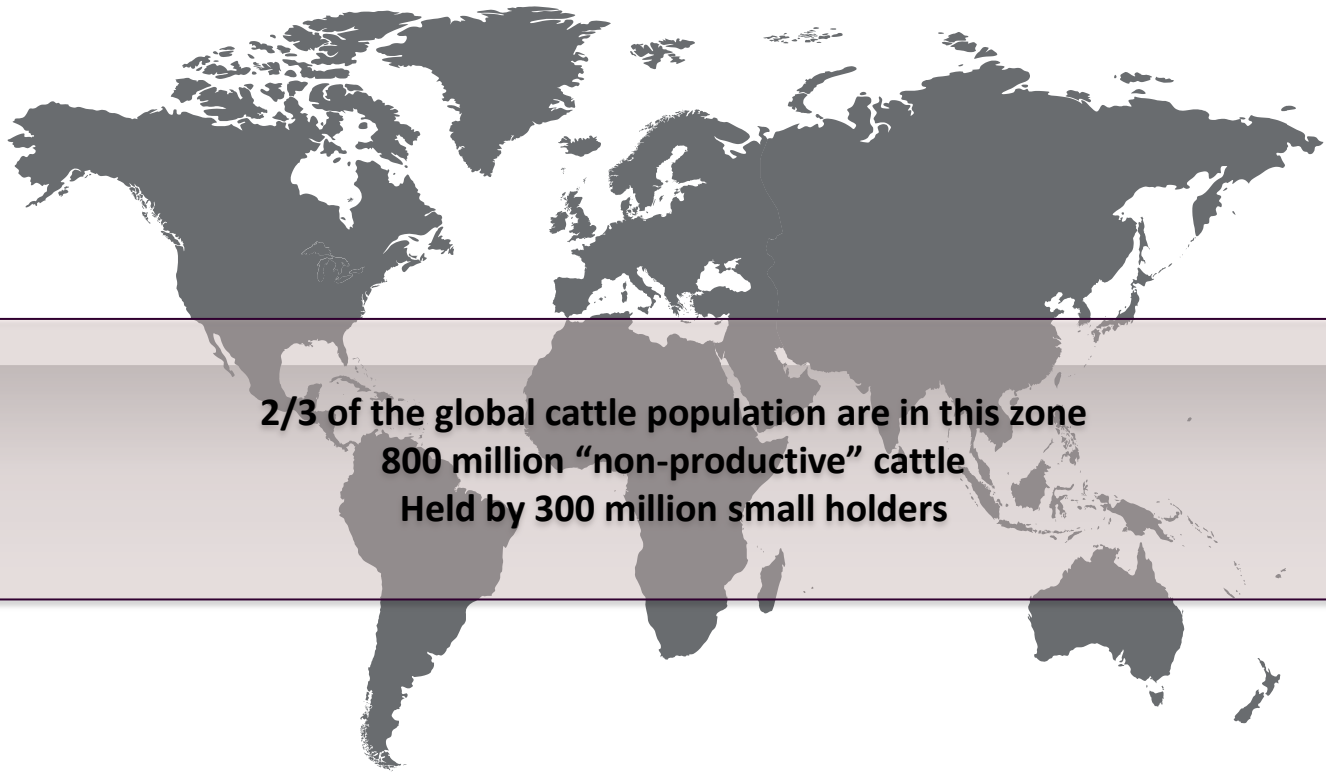
Add Capital Investment

- To provide
- Shade
 - Fans
 - Water sprinklers

THE COST OF HEAT STRESS IN CATTLE

Imported, non-adapted genetics is not a sustainable solution

Global Livestock Sector in the Tropics



2/3 of the global cattle population are in this zone
800 million “non-productive” cattle
Held by 300 million small holders

30% of the land

**\$1.4 Trillion
Global Market**

**1.3 billion employed Long
Value Chains**

53% GDP in IN

33% Ag GDP in EE

Some cattle are tolerant to heat



Castration-free Pigs

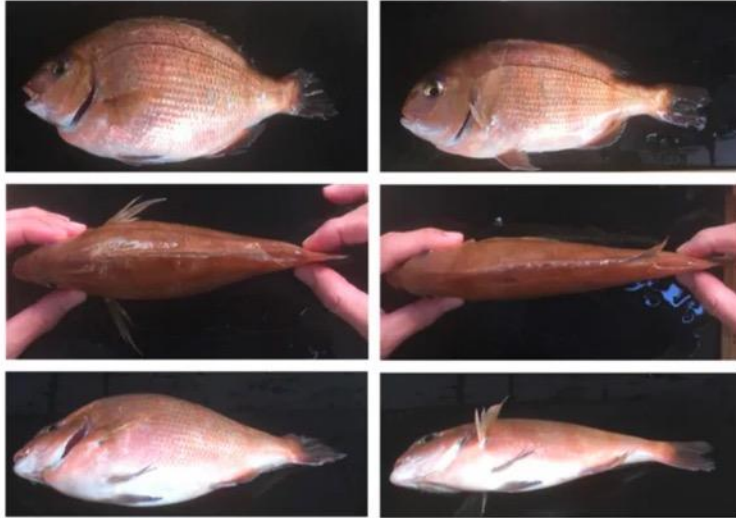
- Elimination of boar castration cost and value add worth >\$1B/yr in US alone
- The right thing to do



- ✓ Underdeveloped testes apparent in 6-12 month old males.
- ✓ No boar-taint odor or aggression
- ✓ GPR54 -/- males act like barrows (castrated boars).
- ✓ Proof of concept for genetic castration.
- ✓ Pre-commercialization study pending

Gene edited fish now on the market

Photo : Dr. Masato Kinoshita, Kyoto University
and Dr. Keitaro Kato, Kindai University



Gene-edited red sea bream (left) compared to unedited versions (right) (Oct 2021)



Gene-edited line of tilapia, FLT 01, has been exempted from GM regulation in Argentina (Dec 2018)

Courtesy of Regional Fish Institute Ltd.



A 2-year-old genome-edited tiger puffer, top, and a conventional fish of the same species (Dec 2021)

Key messages

- Numerous GE and GEed targets have been identified and characterized for animals
- Many biomedical models are now generated using gene editing techniques
- Ornamental fish and high growth rate fish are the only products currently on the market
- There are significant opportunities for improved animal health and welfare, particularly in livestock
- Commercialization will depend on a clear pathway to market and an effective value capture model.

Are biotech products safe?

Health or environmental hazards associated with exposure to biotech products



Case-by-case assessment

Biosafety regulations and guidelines =Risk management



BIOSAFETY REGULATIONS

Since its inception, NBA has developed and continues to implement four biosafety regulations;

Environmental
release, 2011

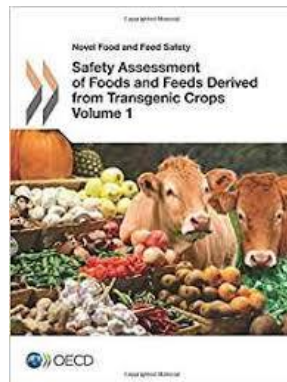
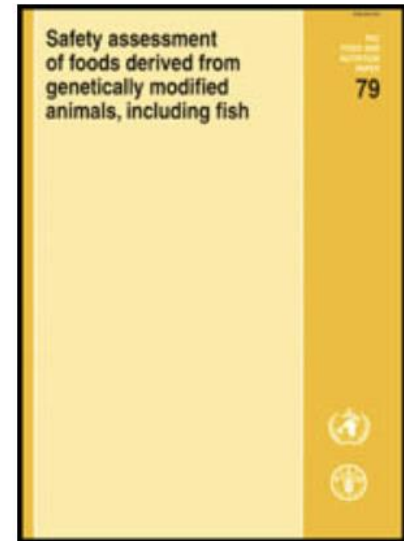
Export, import
and transit,
2011

Contained
use, 2011

Labeling
2012

The four regulations ensure;

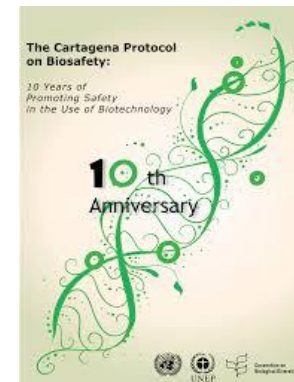
1. Research on genetic modification is done under appropriate experimental conditions
2. Open cultivation of genetically modified crops is safe for human health and the environment
3. Safe movement of genetically modified materials in and out of the country
4. Accurate consumer information and traceability of genetically modified products in the food supply chain



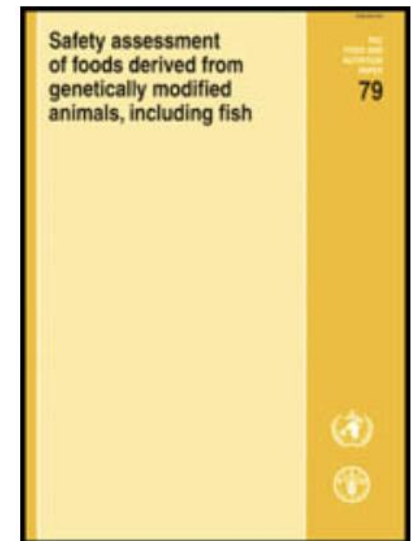
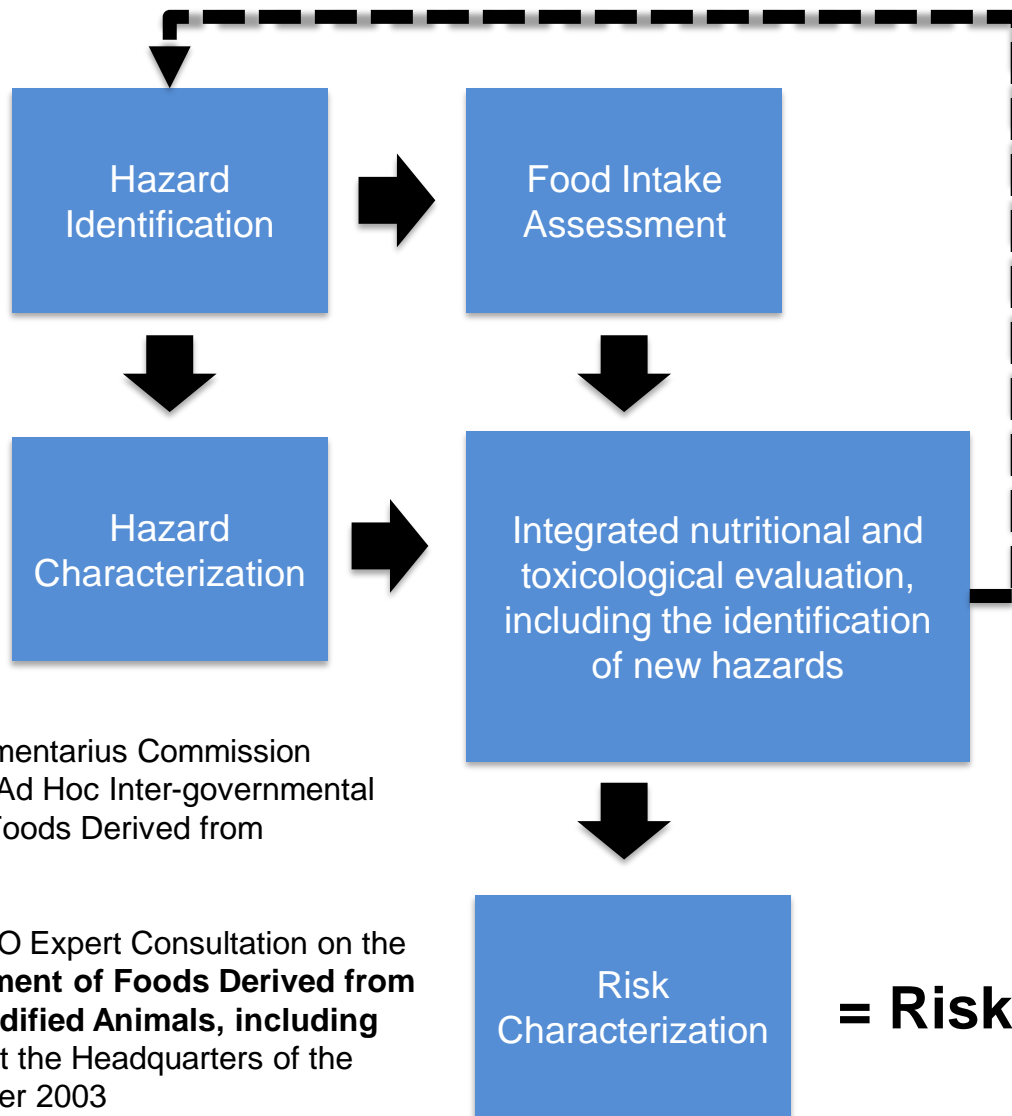
OECD AND RISK-SAFETY ASSESSMENT IN MODERN BIOTECHNOLOGY

COPI/MOP8 side-event, 8th December 2016, Cancun, Mexico

Presented by **Bertrand DAGALLIER** and **Takahiko NIKAIIDO**
OECD, Environment, Health and Safety Division
biosafety, novel food and feed safety



Biotech animal risk assessment



1999-Codex Alimentarius Commission established the Ad Hoc Inter-governmental Task Force on Foods Derived from Biotechnology

A joint FAO/WHO Expert Consultation on the **Safety Assessment of Foods Derived from Genetically Modified Animals, including Fish** was held at the Headquarters of the FAO in November 2003

= Risk level

Key messages

- Many countries have developed biosafety guidelines and regulations to assess the potential harm/risks associated with GM products
- The trigger for regulation is linked to the definition of a GMO
- What are the potential risks to people or the environment from gene editing animals?
- The regulation trigger is important—linked to the definition
- Many countries now using a simple decision tree to decide what requires regulation.

Concluding thoughts

- The role of biotechnology in agriculture continues to grow
- New technologies bring new challenges
- Environmental impacts and ‘product pull’ leading to consumer focused products
- Regulation is a key factor in success-managing potential risk to human health and the environment
- Definitions of a GMO provides the foundations for decisions on regulation–new breeding technologies
- Stewardship of products is pivotal in protecting markets and trade, particularly post approval / import/export
- There is still a balance between managing risk and innovation.



Thank You

