

Societal responses to synthetic biology applications
*Understanding changing public attitudes to emerging
agrifood technologies*

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Overview

- Risk communication in the risk analysis process
- The importance of consumer risk perceptions
- An overview of public attitudes to GM technologies
- Gene editing of animals- a case study
- Is synthetic biology different?
- Conclusions



Risk Communication in the Risk Analysis Process



Risk assessment is the process that is used to quantitatively or qualitatively estimate and characterize risk.

Risk management is the weighing and selecting of options and implementing controls as appropriate to assure an appropriate level of protection.

Risk communication is the exchange of information and opinions concerning risk and risk-related factors among risk assessors, risk managers, consumers and other interested parties.

Differences between expert and citizen perceptions of risk

Risk = Toxicity X Exposure

- **Experts**

- Rely on technical risk assessments
- Use scientific argumentation which does not take account of socio-economic impacts
- In theory, balance risk against benefits (but it is not always clear how socio-economic benefits, or even technical benefits, are assessed).



- **Public**

- Use their risk perceptions to make judgements about risk
- Require risk communication to take account of their concerns as well as technical risk estimates
- Emotional (or affective) responses
- Moral and ethical assessments
- Trust in regulators and information



Technology adoption

How does risk perception influence societal acceptance of novel and potentially beneficial emerging technologies?



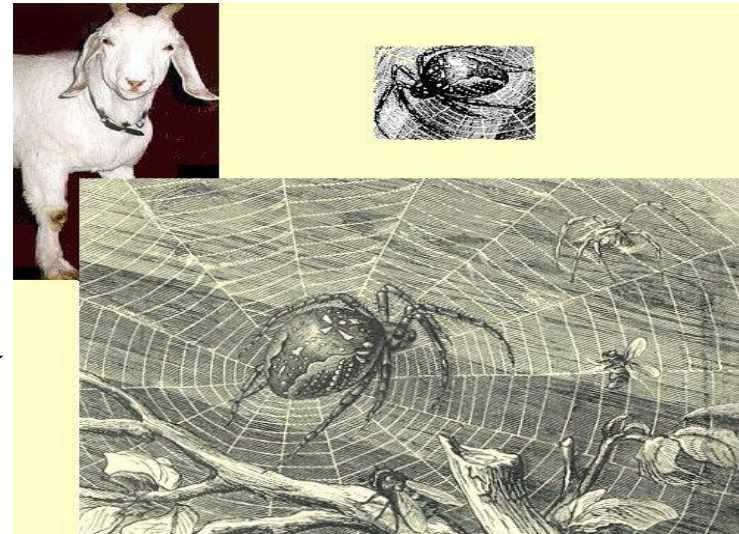
Novel applications GM animals and improved food security



Lactoferrin production
(Herman the Bull)



Aquabounty Salmon



The goat that produces spider silk in its milk (used for fabrics)

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The Observer
Medical research

This article is more than **3 years old**

Scientists deploy GM sheep in fight to treat Huntington's disease

Transgenic flock brought to UK for research into incurable brain condition, which affects more than 6,700 people in the country

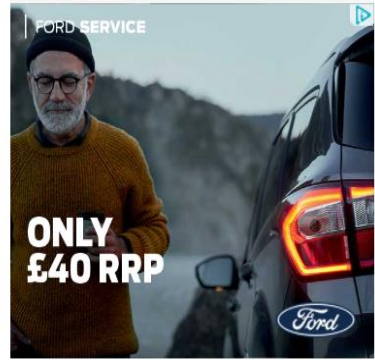
Robin McKie *Observer science editor*

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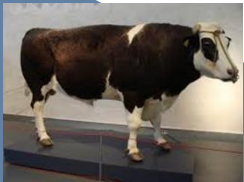
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Jenny Morton, a professor of neurobiology at Cambridge University, with transgenic sheep imported from New

Results of meta-analysis – consumer attitudes to GM Foods

- ***Plant-related or “general” applications*** were more **acceptable** than *animal-related* applications.
- **Pharmaceutical production** more acceptable than **food applications**
- Risk perceptions (associated with both plants and animals) were greater in **Europe** than **North America** and **Asia**.
- Benefit perceptions were greater in **North America** and **Asia** than **Europe**.
- Moral concerns higher in **North America** and **Asia** compared to **Europe**
- ***Risk and benefit perceptions*** increased with time **everywhere**
- Potential to continue to ***map changes*** in perceptions and attitude of data added to the data base



Frewer, L. J., van der Lans, I. A., Fischer, A. R., Reinders, M. J., Menozzi, D., Zhang, X., & Zimmermann, K. L. (2013). Public perceptions of agri-food applications of genetic modification—a systematic review and meta-analysis. *Trends in Food Science & Technology*, 30(2), 142-152.

Attitudes of UK citizens to Gene editing applied to animals

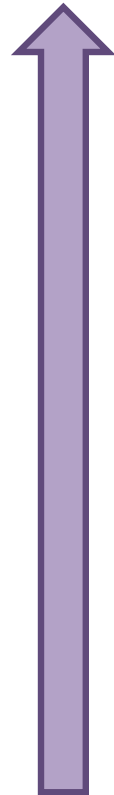
- Five focus groups
 - 4 in the city of Newcastle (UK)
 - 1 in rural Northumberland
- Range of ages and SE classes
- Thematic analysis (nVivo) applied to the results



Francis Z. Naab, David Coles, Ellen Goddard, Lynn J. Frewer (in preparation). Public perceptions regarding the use of genomic technologies in breeding farm animals: a qualitative study.

Ranking of different genomic technologies applied to animal production

Most negative



- Gene drives
- GM foods

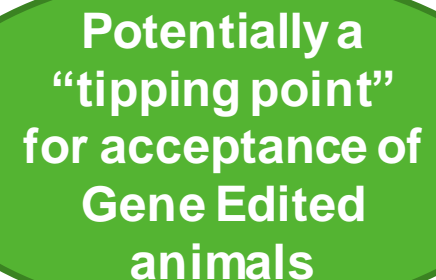
- Gene editing
- Conservation genomics

- Accelerated breeding (no cisgenics or transgenics)
- Traditional breeding

Most positive

Priorities and Concerns expressed very similar when considering both GM and gene editing

- Very similar when considering all genomic technologies applied to animal production systems
- *Issue is the degree of concern...*
 - Perceived unnaturalness”
 - “Telos”
 - Alternative approaches?
 - Animal welfare
 - Ethical concern
 - Dis-enhancement
 - General disquiet
- Motivation for applying breeding technologies
 - **Financial gain**
 - **Improved animal health**
 - **Reduced negative environmental impacts**
 - **Human health**



Potentially a
“tipping point”
for acceptance of
Gene Edited
animals

Naab et al (*ibid*)

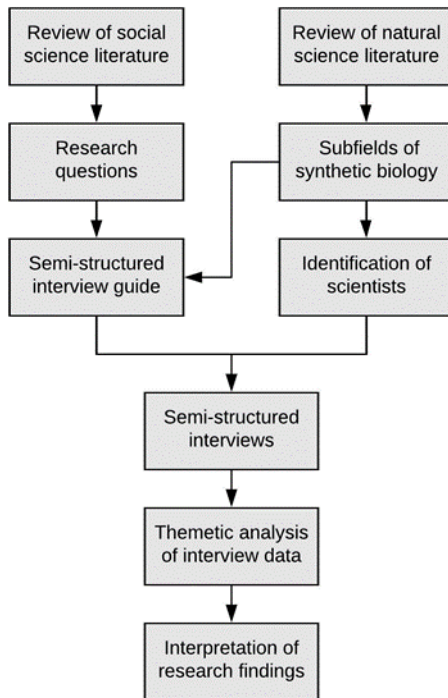
Synthetic Biology in Agriculture



Definitions

- “Applying the engineering paradigm of systems design to biological systems in order to produce predictable and robust systems with novel functionalities that do not exist in nature” (The European Commission, 2005, p. 10).
- “The design and construction of new biological parts, devices, and systems, and the redesign of existing, natural biological systems for useful purposes” (Springer Nature, 2019).
- “The design and construction of novel artificial biological pathways, organisms and devices, or the redesign of existing natural biological systems” (The Royal Academy of Engineering, 2009, p. 13).

What do European and Chinese scientists think the public will think about synthetic biology in agriculture?



- Chinese (n=9) and EU (n=13) scientists in depth interviews
- Both Chinese and EU scientists regarded SB as being high-benefit, low-risk and ethically acceptable, and predicted its rejection by the general public
- Public rejection attributed to the public's knowledge deficit and irrationality.
- The “deficit model” of science communication endorsed.
- European scientists unaware of the emphasis on responsible research and innovation (RRI) and the “multi-actor” approach in EU research projects.

The synthetic biology (SB) cases examined in the survey work

- SB yeasts for producing artificial milk



- Drought-resistant SB soybeans

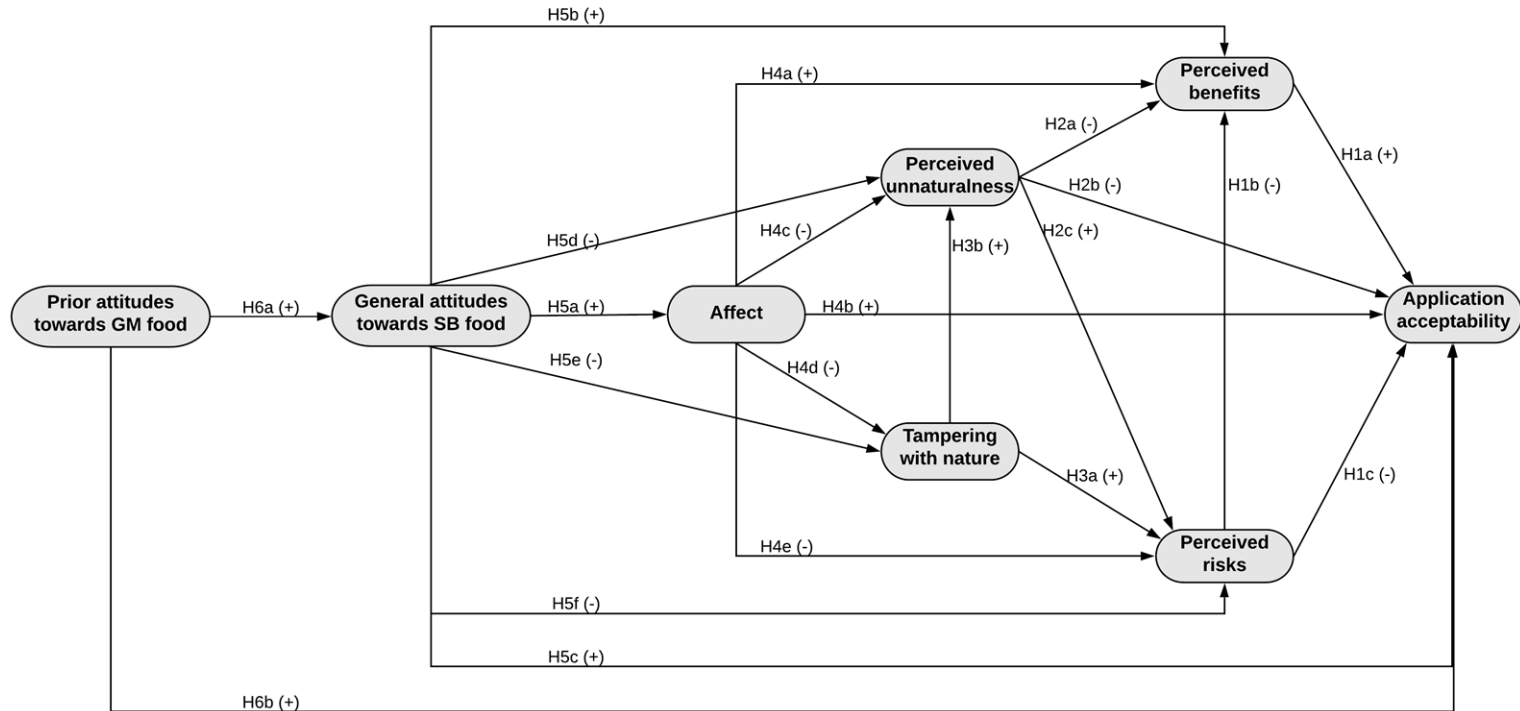


- SB pigs with strengthened immune systems



These are all SB applications under development

Do the public think in the same way? A survey of the Chinese public (n = 1330)



Jin, S., Dawson, I., Clark, B., Li, W., & Frewer, L. J. (2021). Chinese consumer perceptions of synthetic biology applied within the agri-food sector: Evidence for policy development. (Submitted)

Key results

- Synthetic Biology-based agrifood products are evaluated by the public on a case-by-case basis
 - Significant attitudinal differences across application types.
 - Confirmed in a comparative study on current attitudes to GM
 - Perceived unnaturalness reduced acceptance
 - Perceptions of tampering with nature had no effect
 - Risk-benefit communication *in itself* generates an affective response
 - Acts as a heuristic to shape attitudes.
 - The assumptions of the scientific experts are unfounded
 - Predicting public views requires social science research

Conclusions

- Attitudes to food technologies are not fixed
- Attitudes nuanced by context
- “Why is it being applied”
 - Risk-benefit communication
- Ethical concerns and perceived “unnaturalness” need to be taken into account#
- Risk communication in itself may generate an affective response, which acts as a “heuristic” to shape attitudes.
- We cannot assume that attitudes to GM foods is the “blueprint” for future attitude adoption

