

# Feeding 10 billion: Cultured meat as a sustainable protein source

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## INTRODUCTION

- Livestock meat production inefficiencies exacerbate global food insecurity and climate change as the global population approaches 10 billion.
- Cultured meat could be a viable protein alternative to address the concerns associated with conventional meat production.
- Cultured meat is produced by isolating stem cells from livestock muscle tissue, embryos, or induced somatic cells.
- Cells are placed in a bioreactor for amplification and proliferated utilizing specific media.

## HISTORICAL DEVELOPMENT

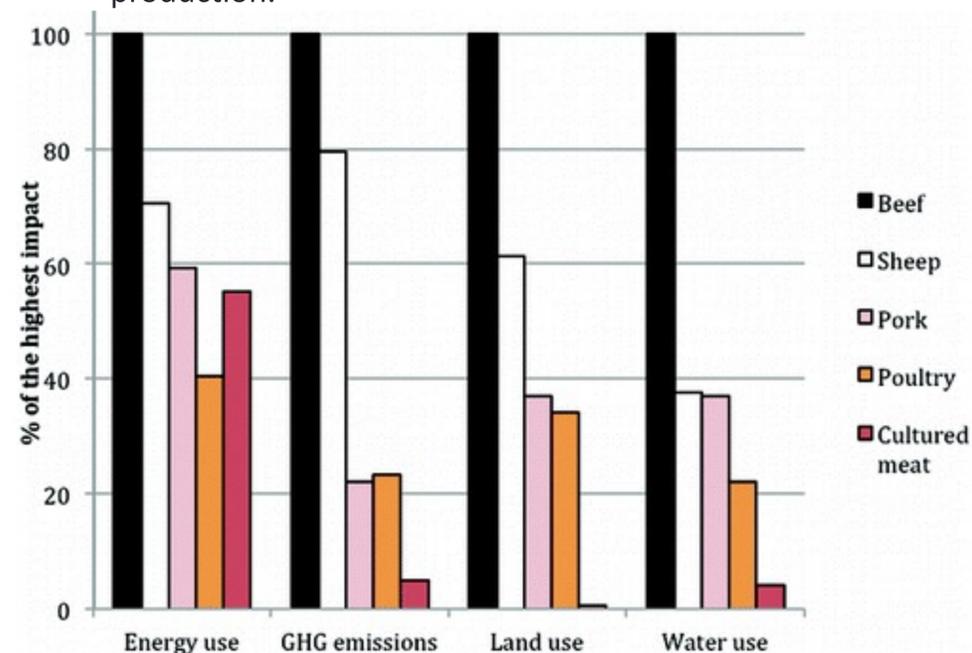
- An experiment funded by NASA brought cultured meat to the forefront of scientific research by producing edible *in vitro* fish filets for long space voyages.
- Methodologies derived from the NASA experiment resulted in the production and consumption of the first cultured beef burger in London in 2013.

## PRODUCTION OPTIMIZATION

- Researchers developed a cost-efficient 300m<sup>3</sup> air-lift bioreactor that addresses the demand for large scale meat production with the potential to supply enough meat for around 75,000 people.
- Inducing cell death within the culturing process emulates the texture and tenderization of conventional meat products.
- Lowering ambient oxygen levels alters the yellow tint of cultured meat tissues to mimic the pink and red tint observed in livestock meat products.

## ENVIRONMENTAL IMPACT

- Key metrics of environmental impact indicate potential benefits of cultured meat for sustainable protein production.



• Figure reprinted with permission from Tuomisto, H. L., & de Mattos, M. J. (2011). Environmental impacts of cultured meat production. *Environ Sci Technol*, 45(14), 6117-6123. <https://doi.org/10.1021/es200130u>. Copyright 2021 American Chemical Society

- Land requirements
  - Cultured meat production required 99% less land than conventional meat.
- Water usage
  - Production of 1000kg of cultured meat utilizes 82-96% less water than meat from conventionally raised beef, sheep, pork, and poultry.
- Energy requirements
  - Cultured meat was shown to require 7-45% less industrial energy than conventional meat systems apart from poultry.
  - Most of industrial energy input for cultured meat went towards media creation.
- GHG emissions
  - GHG emissions of cultured meat production are 78-97% lower than conventional meat.

## CONSUMER ACCEPTANCE

- Analysis of consumer demographics revealed statistically significant differences in willingness to try and accept cultured meat.
- Discrepant framings of cultured meat to potential consumers resulted in positive or negative associations.
- Increased familiarity with cultured meat may promote consumer acceptance.
- The association of cultured meat as “cleaner” meat could drive consumer acceptance.

## AREAS OF DISAGREEMENT

- Disagreement persists regarding the precise methods of quantifying environmental impacts.
- The impacts and potential benefits of cultured meat on a global scale remain hypothetical values based on the early-stage nature of the technology.
- Large scale production of cost-efficient cell culture media has yet to be developed and thus presents a limitation to global scalability.

## CONCLUSIONS AND RECOMMENDATIONS

- Long-term environmental impact analyses should be implemented to solidify the sustainability of cultured meat production practices.
- Limitations of cell culture media emphasize the need for the developments of cost and energy efficient media for cultured cell proliferation.
- Potential environmental and societal benefits of cultured meat are contingent on global consumer acceptance. Future research should center around mimicry of conventional meat products to promote consumer acceptance.