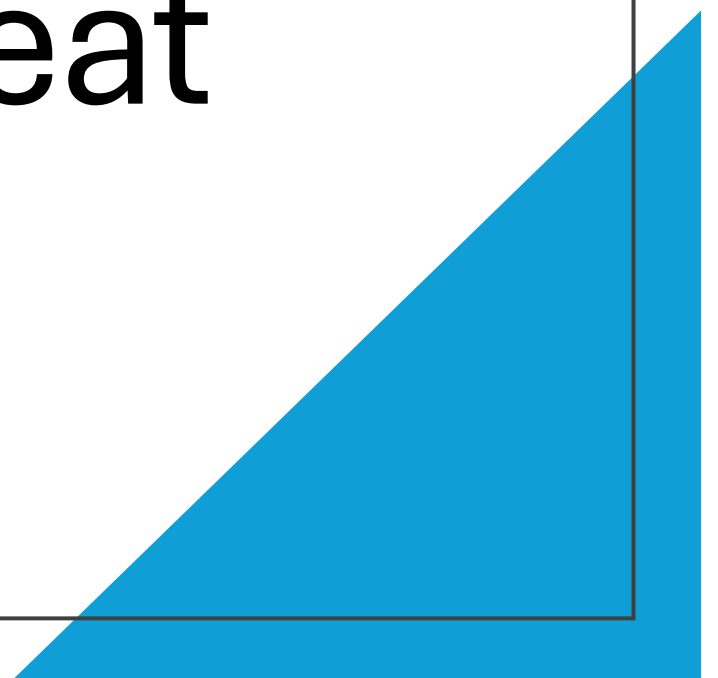


Plant-based and Animal cell-based approaches for production of meat



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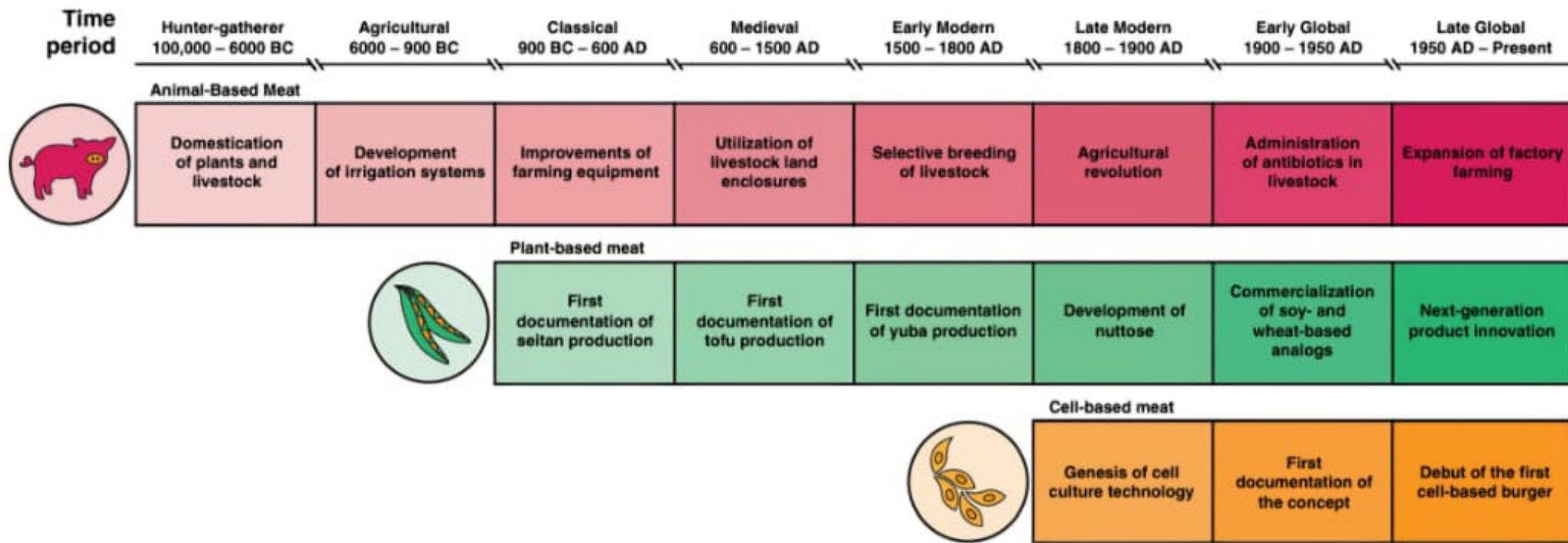
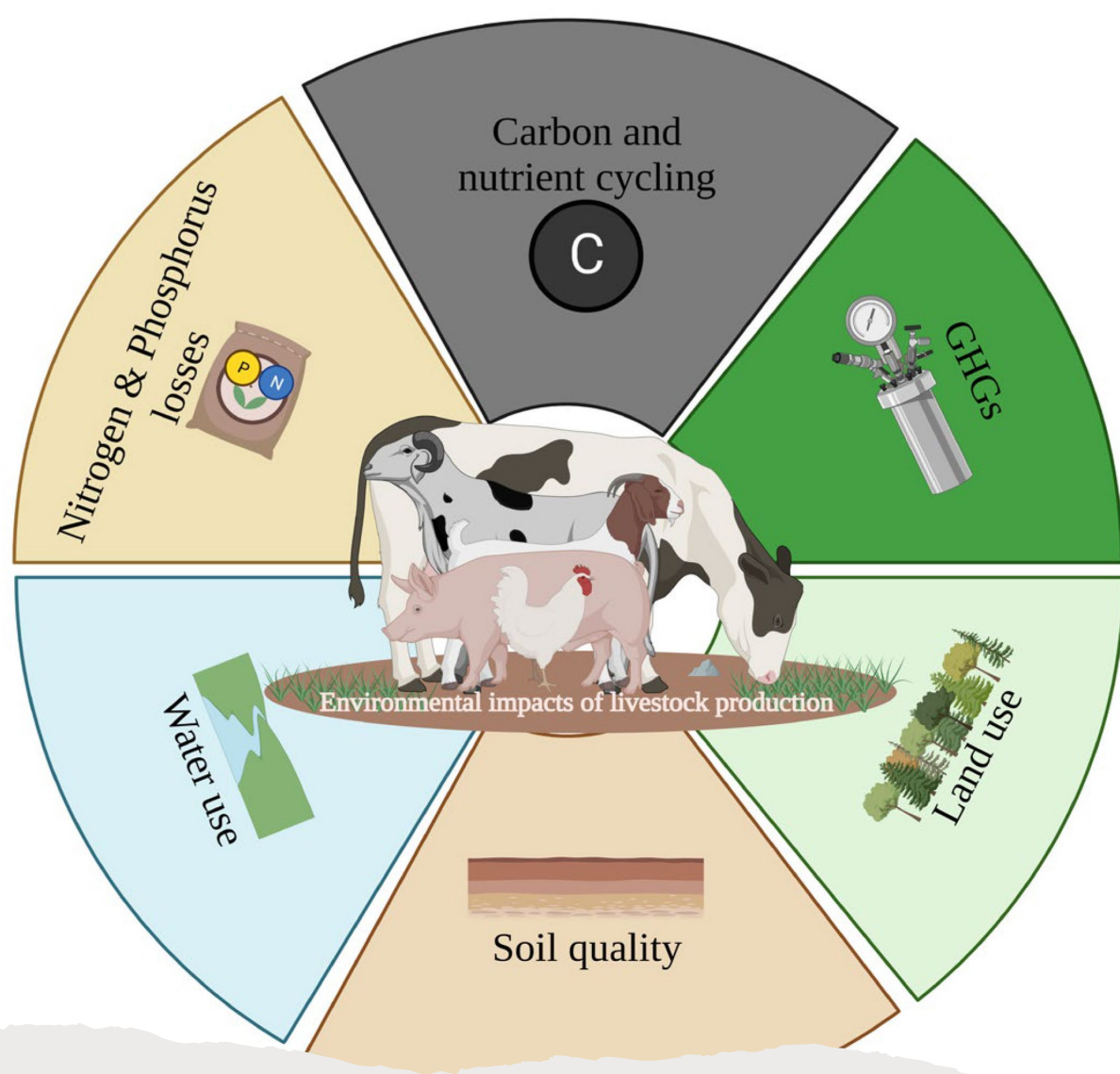


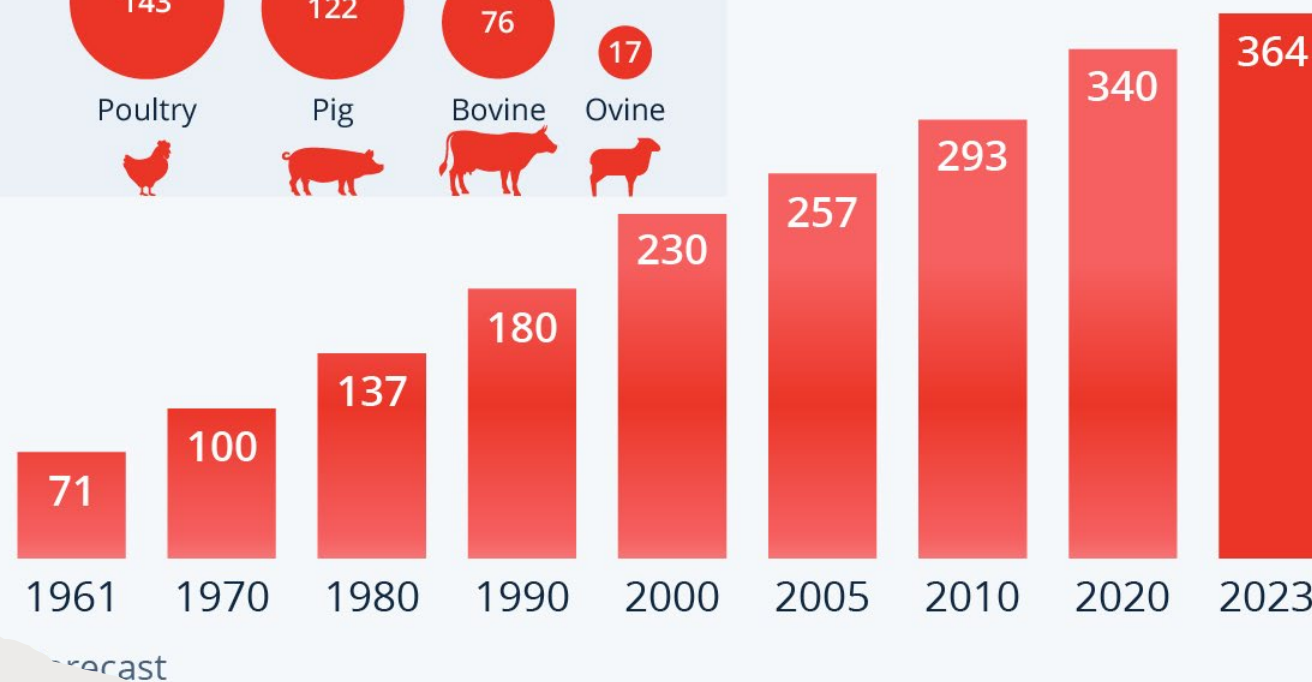
Fig. 1. The history and evolution of animal-, plant- and cell-based approaches to meat production. ^{13,87–93} Humans have consumed plant-based meat (2555 years ago) for only 0.098% of the time period for which their ancestors have consumed animal-based meat (2,600,000 years ago). Likewise, humans have eaten cell-based meat (7 years ago) for only 0.274% of the time period for which they have consumed plant-based meat.



The Growing Global Hunger For Meat

Worldwide annual production of meat
(in million tonnes - carcass weight equivalent)

Production by type in 2023*



INTRODUCTION

ALTERNATIVE FOR MEAT



Plant - based Meat

New Technology To Meet The
Conventional Meat Demand



Cell - based Meat

Meat Type Comparison

Aspect	Plant-based approach	Animal-based approach	Cell-based approach
Environmental impact	Lower greenhouse gas emissions, water usage, and land degradation; specific crops (e.g., nuts) can still be resource-intensive	High greenhouse gas emissions (14-51%), excessive water use (100x more than plants), and extensive land degradation	Significantly reduce resource use and environmental impacts, including energy, greenhouse gas emissions, land, and water use, compared to animal-based meat.
Production method	Proteins extracted from plants (e.g., soy, peas), mixed with nutrients, and processed to mimic meat texture using extrusion or 3D printing	Rearing and slaughtering livestock, requiring large-scale agriculture for feed and extensive land for grazing	Production involves isolating and culturing muscle and fat cells, formulating xeno-free culture media, developing scaffolds for cell growth, and designing bioreactors
Nutritional content	Offers fiber, low cholesterol, and fewer calories; fortified to meet dietary needs; potential nutrient loss in processing	High in protein, vitamin B12, and essential fats; associated with increased risks of heart disease and chronic conditions	The potential for customizable nutrition profiles through differentiated muscle and fat cells, media supplementation, and genetic modification

Aspect	Plant-based approach	Animal-based approach	Cell-based approach
Cost	Production costs higher due to processing; efforts ongoing to reduce costs and improve scalability	Generally lower cost due to industrial farming efficiencies, but external costs include environmental and health-related impacts	production costs ranging from \$11–\$520/kg in projections for large-scale production, influenced by factors like growth medium expenses
Consumer acceptance	Growing acceptance due to taste and sustainability improvements, but some resistance to perceived over-processing	Widely accepted; ingrained in culinary traditions and cultural preferences	Many consumers express concerns about its unnaturalness, safety, and taste, and studies indicate mixed reactions depending on how the product is framed and described
Ethical considerations	No direct harm to animals; aligns with ethical eating trends	Raises animal welfare concerns due to intensive farming and slaughter practices	Reducing reliance on intensive animal farming, though concerns remain regarding the use of animal-derived cells and fetal bovine serum, prompting the development of serum-free alternatives to enhance animal welfare.

Conclusion

Both **plant-based** and **cell-based meats** address critical **environmental, ethical, and health challenges** associated with traditional meat production. These **innovative alternatives** play a role in **reducing the environmental footprint** of global food systems, offering **sustainable** solutions to meet rising demands. While plant-based meats provide an **immediate option** with improved **environmental** and **health benefits**, cell-based meats hold the promise of **customizable nutrition** and a closer resemblance to traditional meat. The future of these alternatives depends on advancements in **technology, affordability, and consumer acceptance**, alongside supportive policies and education. The way for a **healthier, more sustainable, and ethical food future**.