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Case Study on New Technologies and Their Challenges

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Disclosures

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Feeding 10 billion people



We cannot continue with business as usual



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Adapted from OurWorldInData.org and based on UN FAO statistics 4

Children below 5 years Stunted - NFHS4



Sustainable food systems require radically rethinking meat – not incremental efficiency gains





Animal agriculture is "one of the most significant contributors to **the most serious environmental problems**, **at every scale** from local to global."

- Livestock's Long Shadow, 2006, UN FAO



40x more carbon dioxide per calorie of protein than lentils In their latest test, *Consumer Reports* found bacterial contamination on 97% of chicken. Drug resistant infections kill half a million people a year THE GUARDIAN Superbugs could cost the world \$100 trillion by 2050 The telegraph

Despite increasing awareness that eating animal meat is harmful, consumption continues to rise.



Global demand for meat is on the rise, despite increasing consumer awareness of its environmental burden



Source: Food and Agriculture organization of the United Nations, ESA Working Paper No. 12-03, p. 131



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Two solutions: plant-based meat and cell-based

meat



What is Plant-Based Meat?

Plant-based meat products are structured plant- or fungus-derived foods designed to replace animal-based meat either as stand-alone products or within recipes.







New technologies unlock opportunities to achieve functionality throughout production







Crop Analysis and Optimization

Develop plant crops with the **end application in mind (**functionality, taste, nutrition, ease of isolation).



Raw Material Sourcing and Optimization



Composition and Process Optimization



Establishing the correct mix of **ingredients and processes** to create the desired **taste**, **texture**, **smell**, and **structure**



Data will accelerate the next phase of plantbased meat



DATA COLLECTION AND ANALYSIS

- GENOTYPE • PHENOTYPE
- FUNCTIONALITY
- PROTEIN STRUCTURING • MACRONUTRIENTS
- CONSUMER PREFERENCE MICRONUTRIENTS
 - SOIL CONDITIONS



Two solutions: plant-based meat and cell-based meat



What is Cell-Based Meat?

Cell-based meat is genuine animal meat that can replicate the sensory and nutritional profile of conventionally produced meat because it's comprised of the same cell types arranged in the same threedimensional structure as animal muscle tissue.



Cell-Based Meat Production at Scale



World Firsts



^ 2013 Prof Mark Post World's First Cell-Based *Burger Patty*





< 2016 Memphis Meats World's First Cell-Based *Meatball*



^ 2017 Finless Foods World's First Cell-Based *Fish*

< 2017 Memphis Meats World's First Cell-Based Chicken & Duck



Cell line development



A **cell line** is a strain of animal cells that can be reproduced in cell culture (*in vitro*).



Cell culture media



Cell culture media is a nutrient broth that contains all of the vitamins, minerals, salts, energy sources, and amino acids cells need to grow.

It also contains signaling molecules called **growth factors**.



Cell culture media will be the main marginal cost driver



Scale, formulation optimization, and raw material supply will allow clean meat to be **cost competitive** with conventional meat

Scaffolding



Scaffolding provides a structure on which cells can attach, form complex 3D tissues, and **differentiate** and **mature** into their final cell type.



Scaffolds Are Widely Used In Cell Therapy



gfi.org_{Sadat-Shojai}, Mehdi. (2015).

Bioreactors



Bioreactors are the vessels in which cells **proliferate** (reproduce/divide) and mature. They provide circulation of the nutrients and gas exchange.



How saturated is the meat alternatives field?

What is the opportunity for exploratory research to translate into a revolutionary reality?

\$1.275 Billion Invested

in Plant-based and Cell-based Meat, Egg, and Dairy Companies





Meat alternative development is highly tractable.

Data: Global Trends in Renewable Energy 2012

India to be an epicentre of development in the sector

- Exploration of indigenous crops to diversify raw materials and specialty ingredients, including millets, moringa, etc
- Optimization of flavour profiles and product types to satisfy local demand, and nutritional parameters to target nutrition gaps
- Establishment of infrastructure for the scale-up of cell-based meat research project at Centre for Cellular and Molecular Biology Hyderabad, and Centre of Excellence in Cellular Agriculture at Institute of Chemical Technology Mumbai

Key takeaways

- New technologies are unlocking opportunities to develop the next generation of meat using more sustainable production methods.
- Two of the most promising solutions to meet growing global protein demand are plant-based meat and cell-based meat: using plant-based ingredients and animal cells as more sustainable inputs and units of production.
- While the alternative protein field has garnered buy-in from notable industry incumbents and investors, there is still substantial room for innovation to advance plant-based and cell-based meat products.

