How Game-Changing is Alternative Food Production?

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IMPOSSIBLE WHOPPER

100% WHOPPER 0% BEEF

NOW AVAILABLE NATIONWIDE!

Limited time only at participating restaurants. Patty made from plants.
We must change food production to save the world, says leaked report

A leaked draft of a report on climate change and land use, which is now ...
The new IPCC report emphasises that land will have to be managed ...

4 days ago
Outline

• Meat in America and its discontent
  – Environment, Labor, Ethics, Technology

• The emergence of meat alternatives
  – A brief history and definitions

• Alternative 1: Plant-based meat alternatives
  – State of the industry
  – Comparative LCA and value chain analysis
  – Game-changing impacts on the food system today and in the future

• Alternative 2: Cellular agriculture
  – More questions than answers
  – Potential trajectories of development: policy, regulation, and technology
  – Potential game-changing impacts on the food system in the future

• Concluding thoughts
  – Disruption vs. complementarity
  – Unanswered questions about public health, nutrition, and food access
Part 1: Meat and its Discontents
“Meat’s place at the center of the American diet has never been in doubt.”
- Roger Horowitz

Source: NAMI (2017)
The conventional meat value chain
Americans now eat way more meat

Per capita meat consumption, in pounds

Individual protein consumption:
- Chicken
- Beef
- Pork

Total protein consumption:
- Beef, pork, and chicken

Source: Marketwatch (2016)
Effects & Externalities

- Land use
- GHG emissions
- Water use and contamination
- Limits to efficiency

- Public and political concern about:
  - Labor relations
  - Business practice & monopsony
- Animal welfare
41% of the contiguous U.S. is used for feeding livestock.
More than 80% of farmland is used for livestock but it produces just 18% of food calories and 37% of protein.

Guardian Graphic | Source: Poore and Nemecek, Science
A changing food paradigm and changing strategies

• Increasing push for a move toward a plant-based diet

• ... but ongoing public intransigence ... 

• Shift from values-based appeals to individuals and to production of animal product analogs and alternatives goods aimed at mass market
Part 2: Plant-Based Meat Alternatives
“Traditional interventions”
“Innovation”-based interventions
The Future of Protein

1. Americans Love Hamburgers
   - Americans eat an estimated 50 billion burgers each year.
   - This raises a concern: Beef production uses a lot of natural resources.
   - BUT THERE'S A SOLUTION: By removing the animal from the equation, Beyond Meat is building a burger that's better for you and the planet.
   - IT'S MEAT MADE BETTER™

2. Who Says Meat Has to Come From Animals?
   - Meat is made up of four building blocks: protein, fat, trace minerals, and water. Beyond Meat finds these same building blocks in the plant kingdom to rebuild meat from the ground up without sacrificing on taste or texture. Building meat without the animal requires fewer resources, making it a much more efficient and sustainable process. Now that's food for thought!

   - **THE BEYOND BURGER**
     - Crops are grown for Beyond Burgers
   - **THE BEEF BURGER**
     - Crops are grown for animal feed

   - **BURGERS ARE MADE**
     - Heating, Cooling, Pressure
   - **COWS ARE FEED & RAISED**
     - Cows are... well... you know this step.

   - **BURGERS ARE MADE**
     - 99% Less
     - 93% Less
     - 90% Fewer
     - 46% Less
     - WATER
     - LAND
     - GREENHOUSE GAS EMISSIONS
     - ENERGY

3. A Burger with Benefits
   - A Life Cycle Analysis (LCA) conducted by the University of Michigan compared the environmental impact of The Beyond Burger to a ¼ lb U.S. Beef Burger.

   - The study concluded that The Beyond Burger uses significantly less water, less land, generates fewer Greenhouse Gas Emissions (GHG), and requires less energy than a beef burger: HOW MUCH LESS?

Source: Fast Company (2018); see also Heller & Keoleian (2018)
Source: Nielsen xAOC + WFM, 52 weeks ending 8/11/18.
Some points to note

• Most buyers of alternative meats (>70%) are not vegans/vegetarians
• Slots into “corporate food regime” (Broad 2018), meaning environmental benefits need not be accompanied by positive food justice or public health outcomes, BUT...
• Suggests a number of opportunities in agricultural production and research:
  – Move away from *some* monocrop agriculture *to* more varied plant stocks
  – Opportunities for cooperation between food science, public health groups, and farmers to work toward “food tech justice” (Broad 2018)
“... we want to make the best choices the default choices because the products are delicious, price competitive, and convenient.”

- Bruce Friedrich, Good Food Institute (GFI)
Part 3: Cellular Agriculture / “Clean Meat”
FROM PIG TO PLATE

Researchers are adapting tissue engineering techniques to grow edible meat, in vitro.

1. Take a small biopsy
2. Extract myosatellite cells
3. Add animal-free growth serum to multiply cells
4. Grow cells on scaffold to form myofibres, which bind together to form muscle.
5. Exercise muscle to boost protein
6. Grind up thousands of muscle strips
7. Add flavour, iron and vitamins
8. Cook. EAT!
The sales pitch

• 1-to-1 analog to conventional meat (no switching costs for consumers)
• Dramatically reduced ecological hoofprint
• More efficient/shorter value chain
• Global market for full animal replacement estimated at $1.6 trillion
• Slots into existing consumer end of value chain, appealing to major processors and pharma players already present in the market
Source: Tuomisto et al (2011)
Bubble area is proportional to global warming potential.

Potential role for incumbent processors

- Processors
- Slaughter
- Processing
- Distribution
Potential role for incumbent processors

- Processors
- Slaughter (crossed out)
- Processing
- Distribution
The problems

• We actually don’t know much about how this is going to develop or scale... or even if scaling is possible

• Some problems:
  – Growth medium
  – Bioreactors
  – Scaffolding

• Most funding is VC and IP development is private
Caution and possibility

• The promise is actually massively disruptive (in the Silicon Valley sense and the literal sense)
• We are theoretically talking about agriculture without the rural – meat as *food product*
• But what form will it take? Open question.
  – Funding
  – Research
  – Regulation
  – Consumer uptake
• *Public health effects and desirability understudied*
• *Effects on labor requirements and distribution*