How Game-Changing is Alternative Food Production?

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BEYOND MEAT®

The Guardian

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

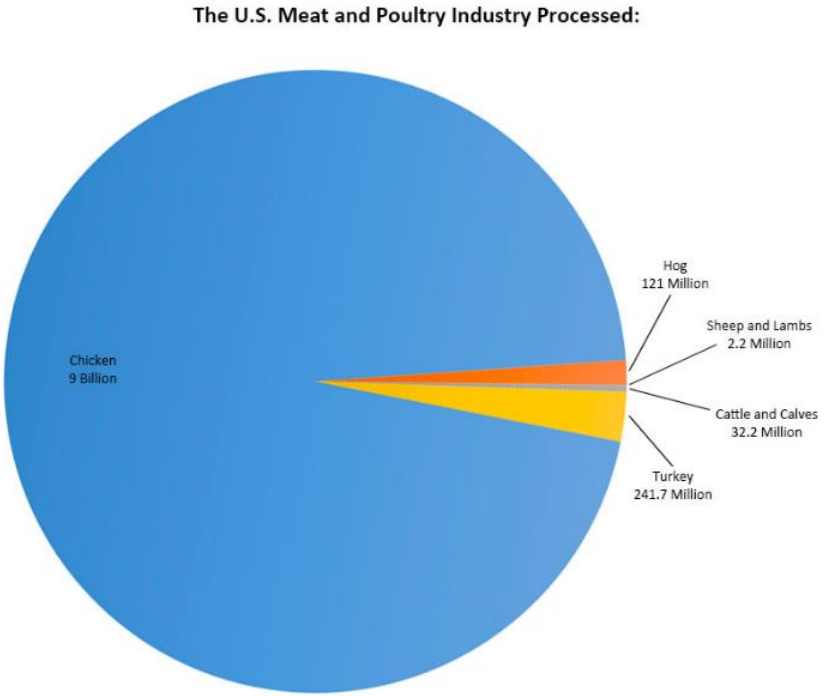
Outline

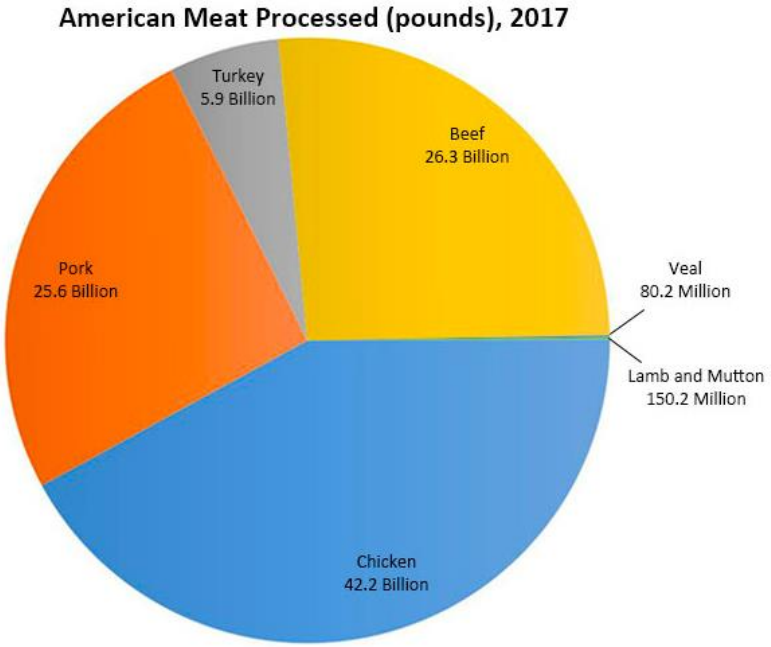
- Meat in America and its discontent
  - Environment, Labor, Ethics, Technology
- The emergence of meat alternatives
  - A brief history and definitions
- Alternative 1: Plant-based meat alternatives
  - State of the industry
  - Comparative LCA and value chain analysis
  - Game-changing impacts on the 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.*"

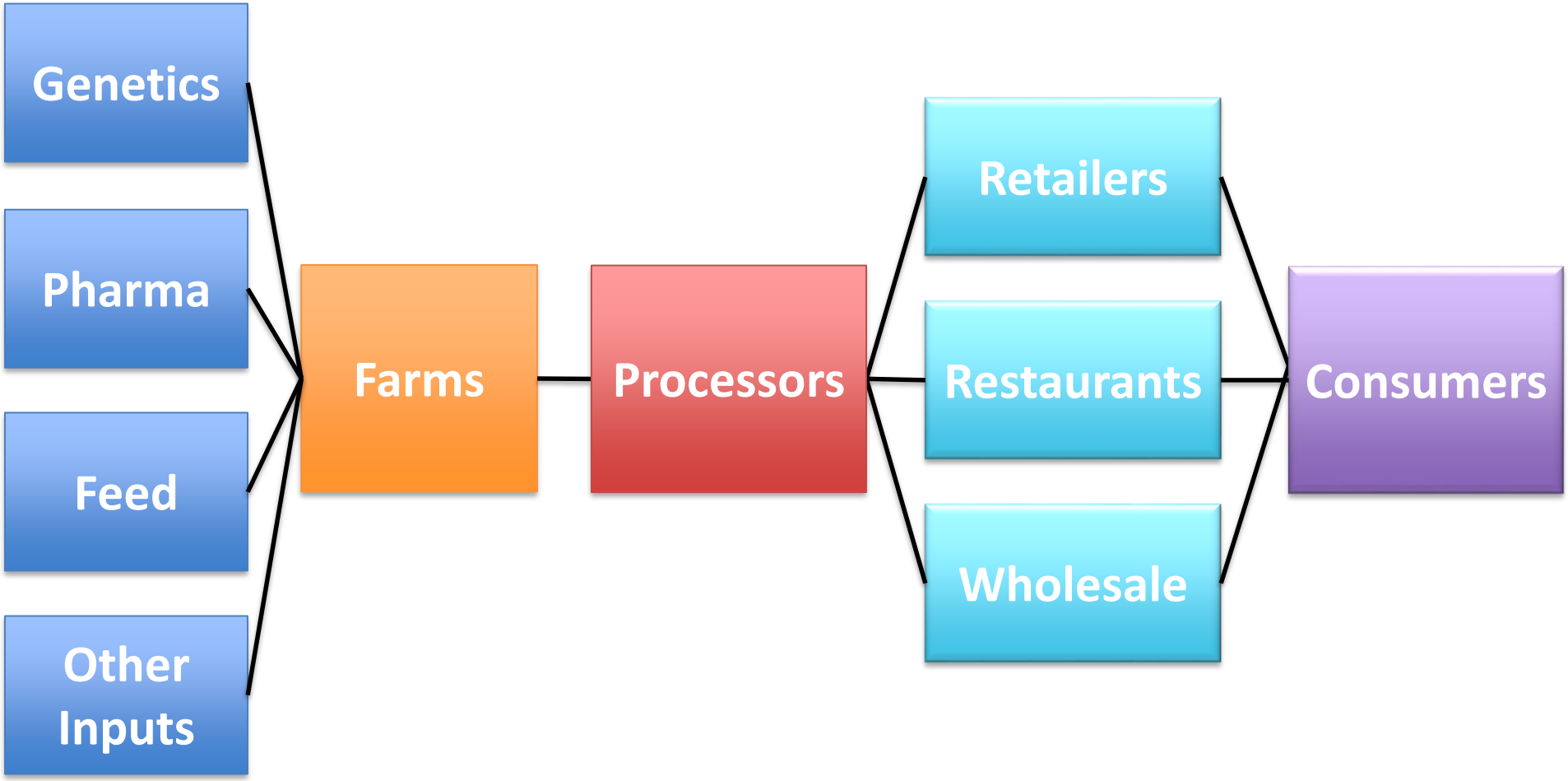
- Roger Horowitz

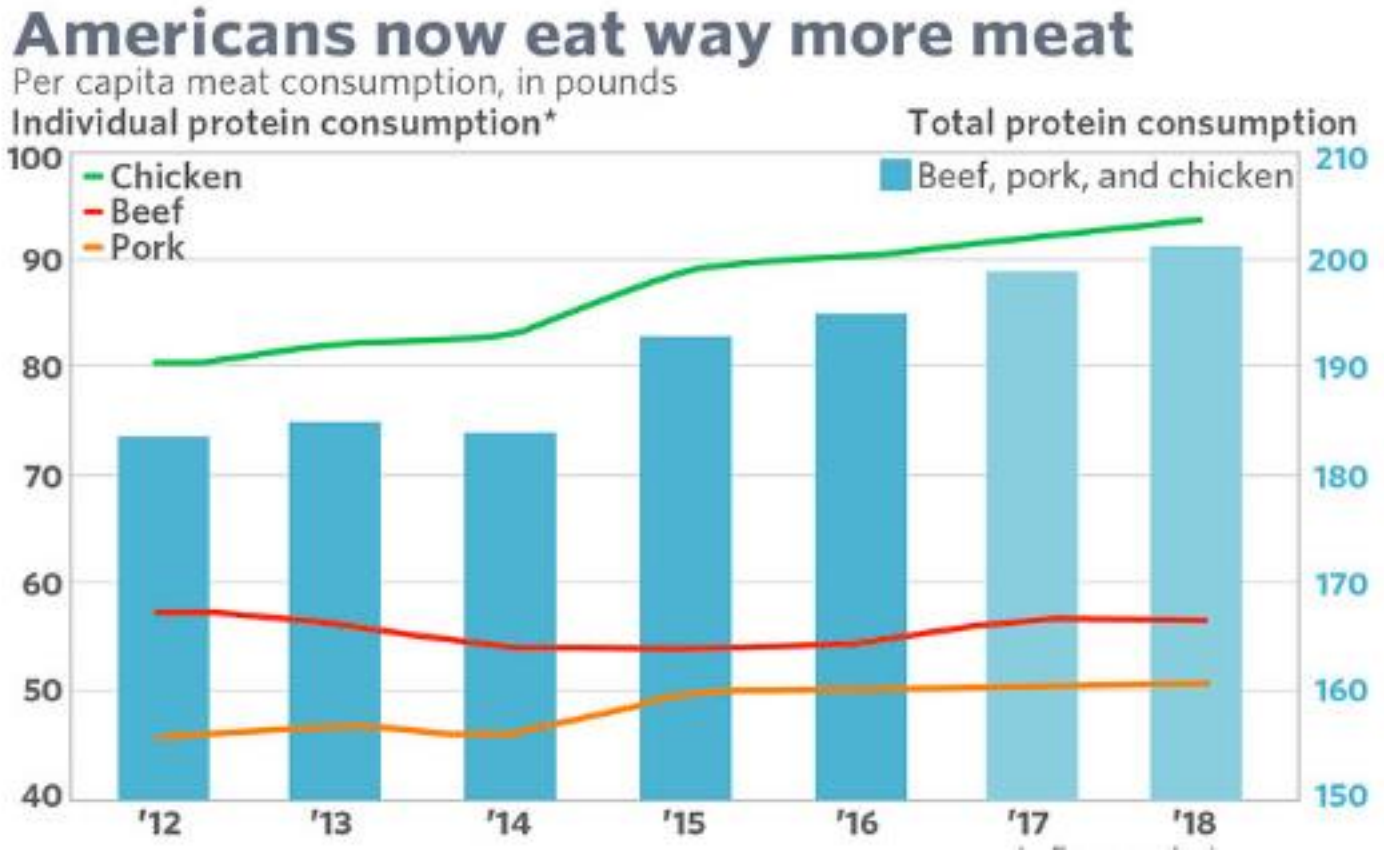




Source: NAMI (2017)

The conventional meat value chain



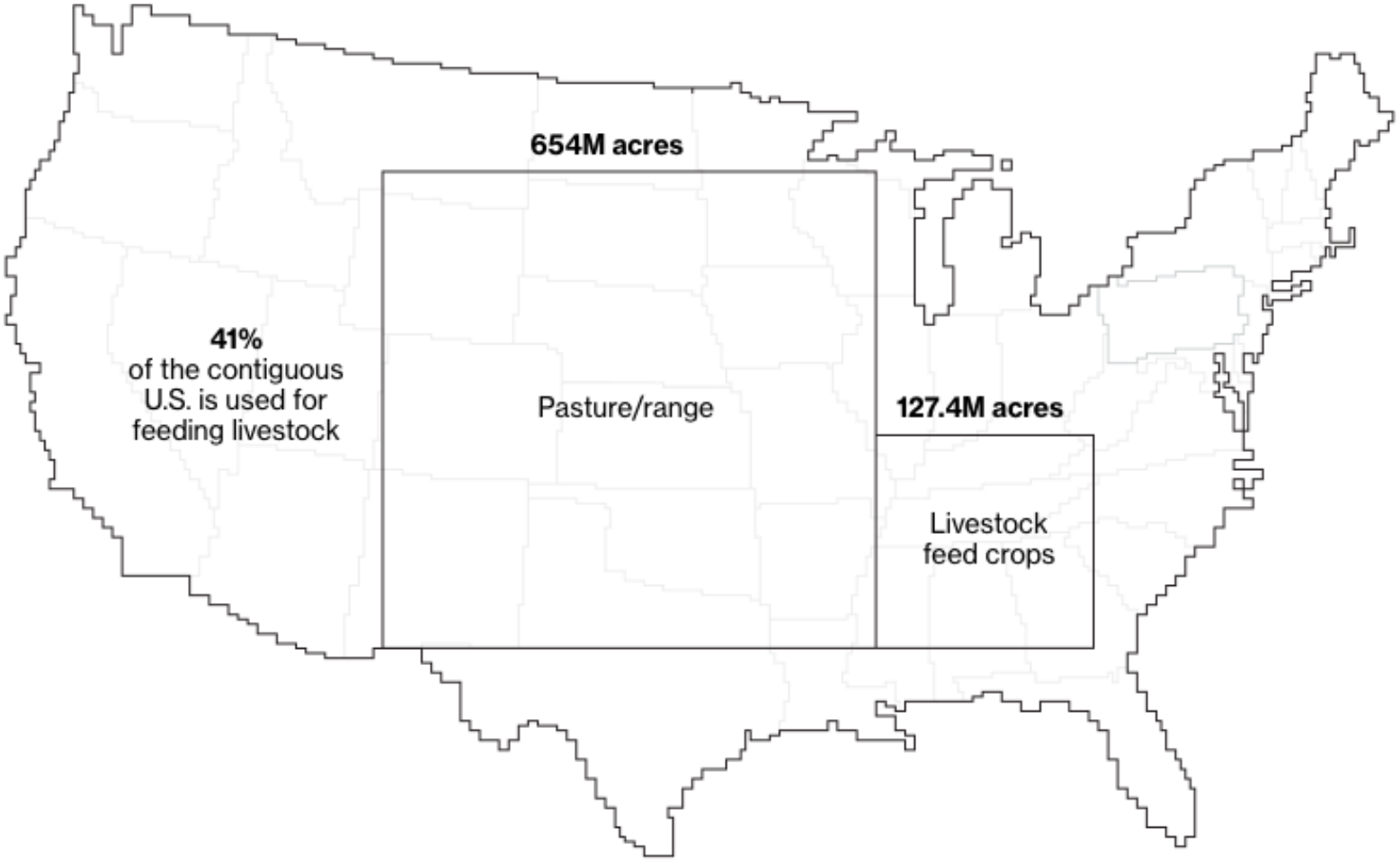


Source: Marketwatch (2016)

Effects & Externalities

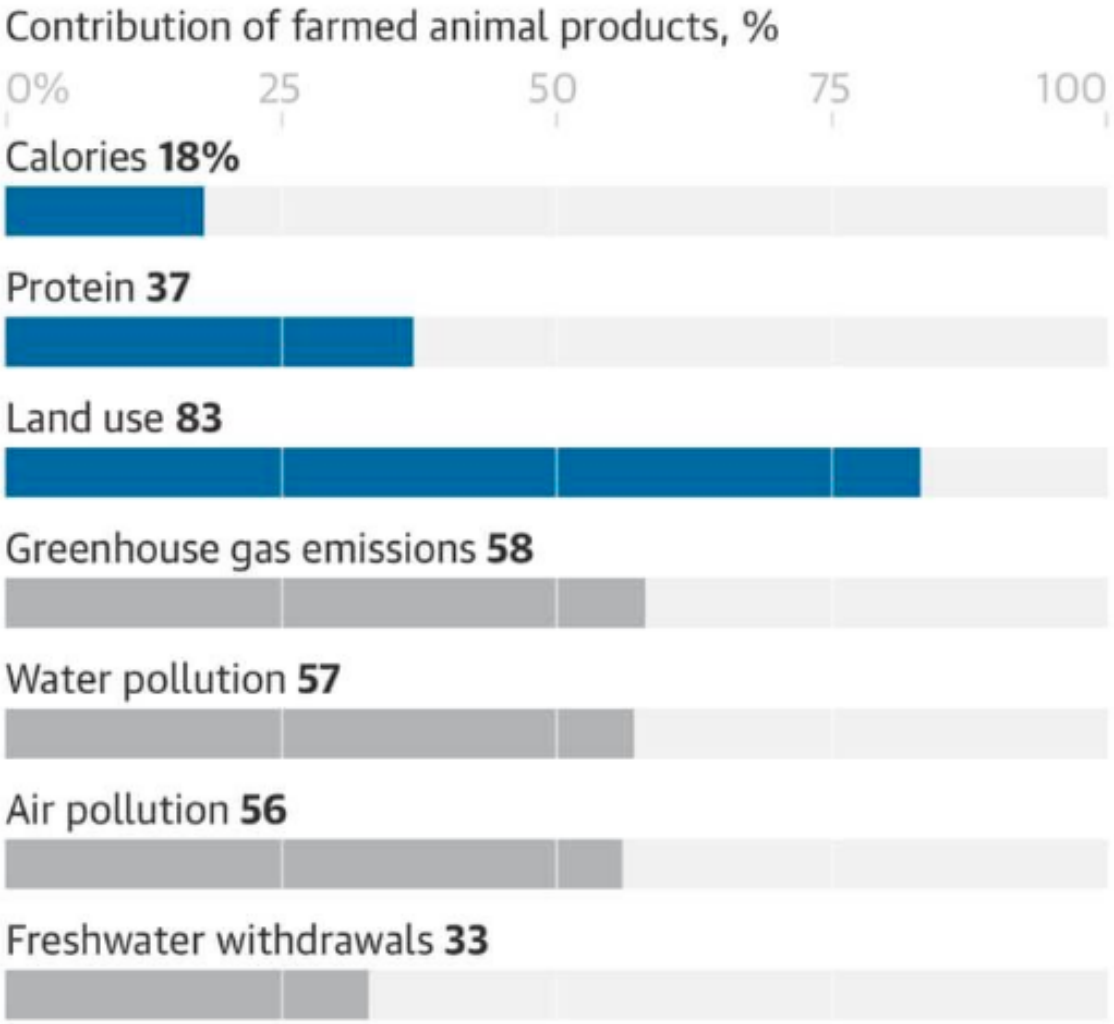
- Land use
- GHG emissions
- Water use and contamination
- Limits to efficiency

- Public and political concern about:
  - Labor relations
  - Business practice & monopsony
- Animal welfare



Source: Bloomberg (2018)

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

Diet scenario	Tech scenario	Loss and waste scenario	GHG emissions			Cropland use			Bluewater use			Nitrogen application			Phosphorus application		
			SSP2	SSP1	SSP3	SSP2	SSP1	SSP3	SSP2	SSP1	SSP3	SSP2	SSP1	SSP3	SSP2	SSP1	SSP3
Baseline	Baseline	Baseline	4	4	4	4	4	4	3	3	3	4	4	4	4	4	4
		Waste/2	4	4	4	4	4	4	3	3	3	4	4	4	4	4	4
		Waste/4	4	4	4	4	4	4	3	3	3	4	4	4	4	4	4
	Tech	Baseline	4	4	4	4	4	4	3	3	3	4	4	4	4	4	4
		Waste/2	4	4	4	3	3	3	2	2	2	4	4	4	4	4	4
		Waste/4	4	4	4	2	2	2	2	2	2	4	4	4	4	4	4
	Tech+	Baseline	4	4	4	3	3	3	3	3	3	3	3	3	2	2	2
		Waste/2	4	4	4	2	2	2	2	2	2	3	3	3	2	2	2
		Waste/4	4	4	4	1	1	1	2	2	2	3	3	3	2	2	2
Guidelines	Baseline	Baseline	4	4	4	4	4	4	3	3	3	4	4	4	4	4	4
		Waste/2	4	4	4	4	4	4	3	3	3	4	4	4	4	4	4
		Waste/4	4	4	4	4	3	4	3	3	3	3	3	3	4	4	4
	Tech	Baseline	4	4	4	3	3	3	3	2	3	4	4	4	4	4	4
		Waste/2	4	4	4	2	2	2	2	2	2	4	3	4	4	4	4
		Waste/4	4	4	4	2	1	2	2	2	2	3	3	3	4	3	4
	Tech+	Baseline	4	4	4	2	2	2	3	2	3	3	3	3	2	2	2
		Waste/2	4	4	4	1	1	1	2	2	2	3	3	3	2	2	2
		Waste/4	4	3	4	1	1	1	2	2	2	3	3	3	2	2	2
Flexitarian	Baseline	Baseline	3	2	3	4	4	4	3	3	3	4	4	4	4	4	4
		Waste/2	1	1	2	4	4	4	3	3	3	3	3	3	4	4	4
		Waste/4	1	1	1	4	3	4	3	2	3	3	3	3	3	3	3
	Tech	Baseline	2	1	2	3	3	3	2	2	3	4	4	4	4	4	4
		Waste/2	1	1	1	2	2	2	2	2	2	3	3	3	4	4	4
		Waste/4	1	1	1	1	1	2	2	2	2	3	3	3	3	2	3
	Tech+	Baseline	1	1	2	2	2	2	2	2	3	3	3	3	2	2	2
		Waste/2	1	1	1	1	1	1	2	2	2	3	2	3	2	2	2
		Waste/4	1	1	1	1	1	1	2	2	2	2	2	2	2	1	2

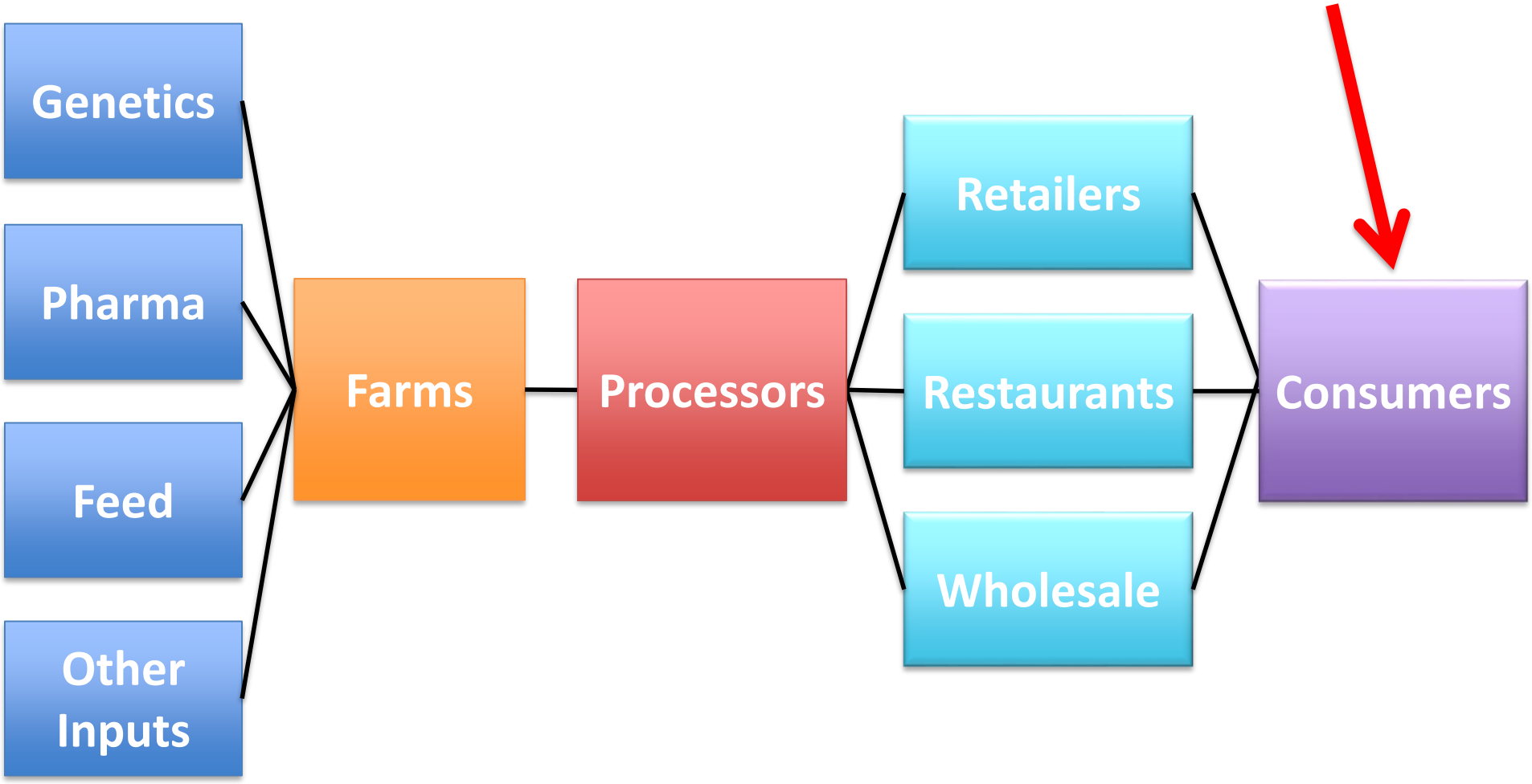
Springmann et al. (2018) “Options for keeping the food system within environmental limits.” *Nature*. Vol. 562. pp. 519-252

A changing food paradigm and changing strategies

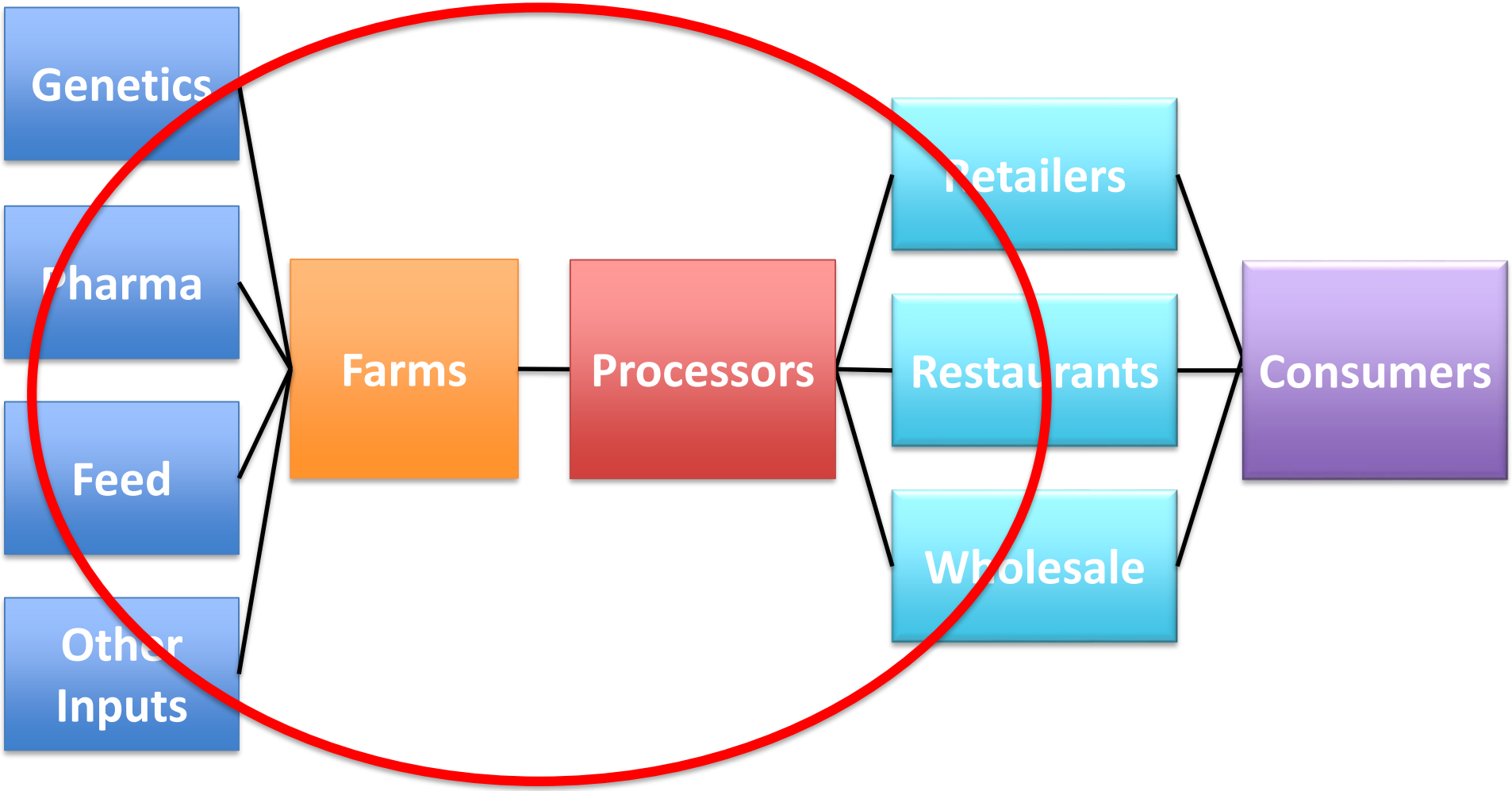
- Increasing push for a move toward a plant-based diet
- … but ongoing public intransigence ...
- Shift from values-based appeals to individuals and to production of animal product analogs and alternatives goods aimed at mass market

Part 2: Plant-Based Meat Alternatives

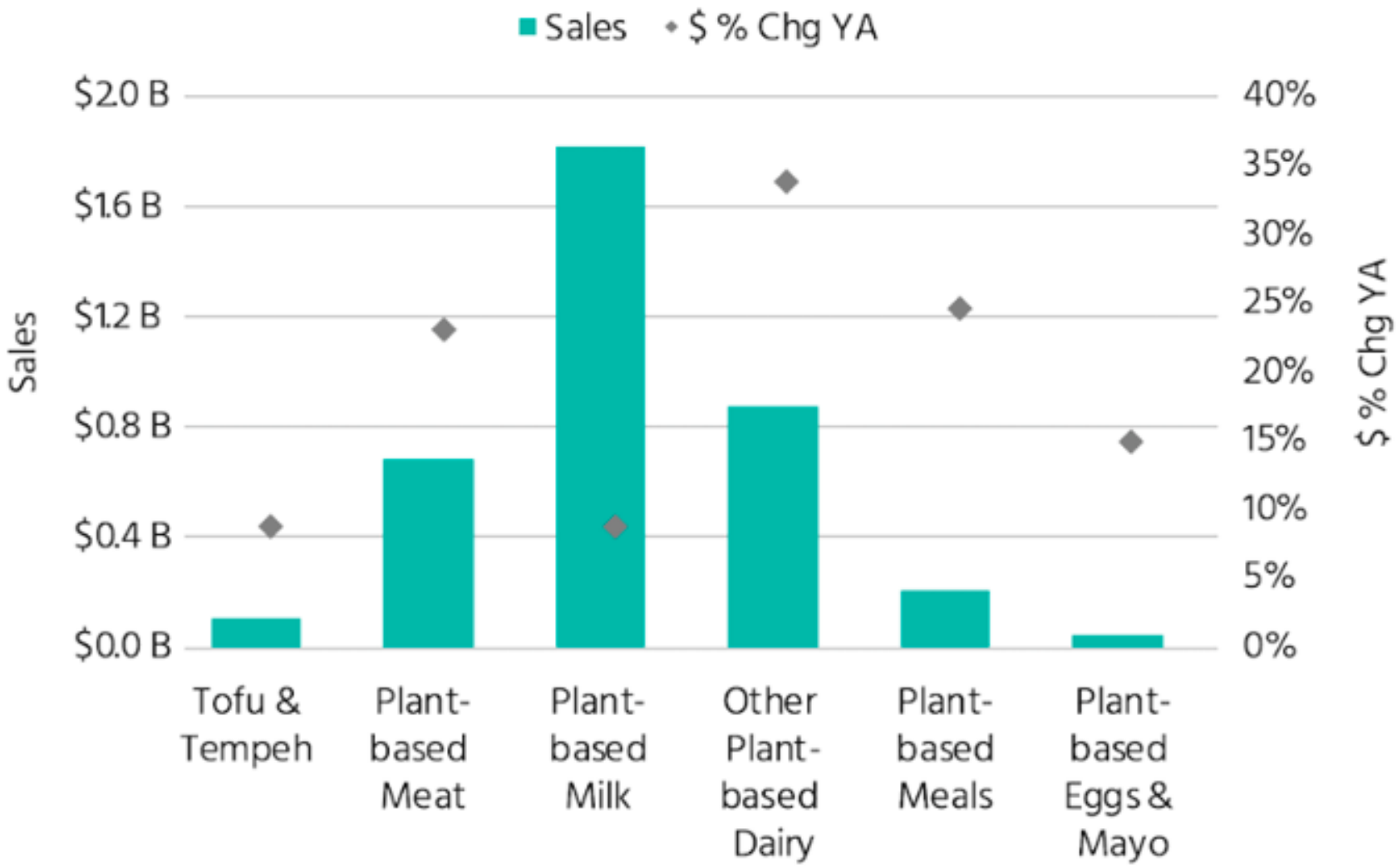
“Traditional interventions”



“Innovation”-based interventions



Source: Fast Company (2018); see also Heller & Keoleian (2018)



Source: Nielsen xAOC + WFM, 52 weeks ending 8/11/18.

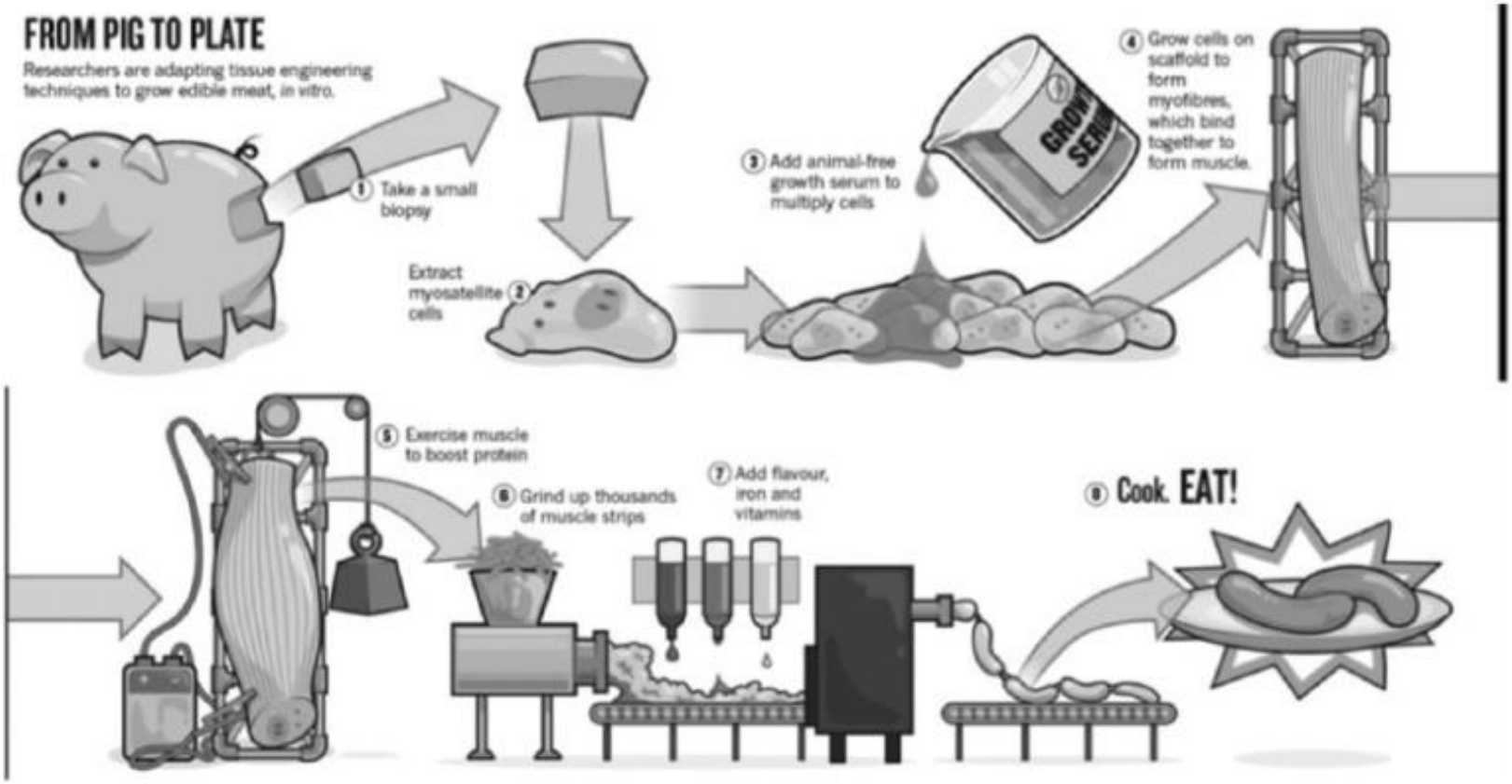
Some points to note

- 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."

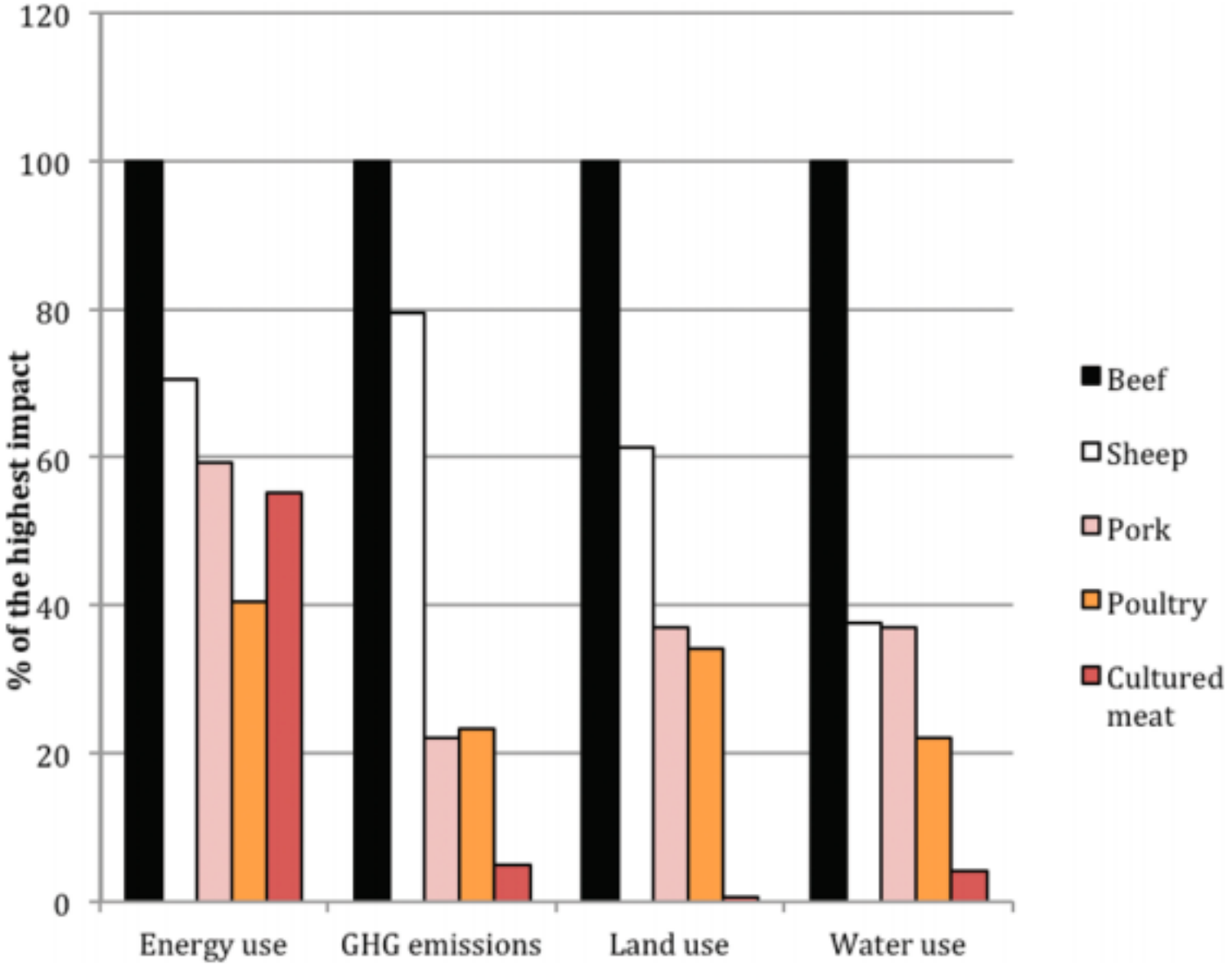
- Bruce Friedrich, Good Food Institute (GFI)

Part 3: Cellular Agriculture / “Clean Meat”

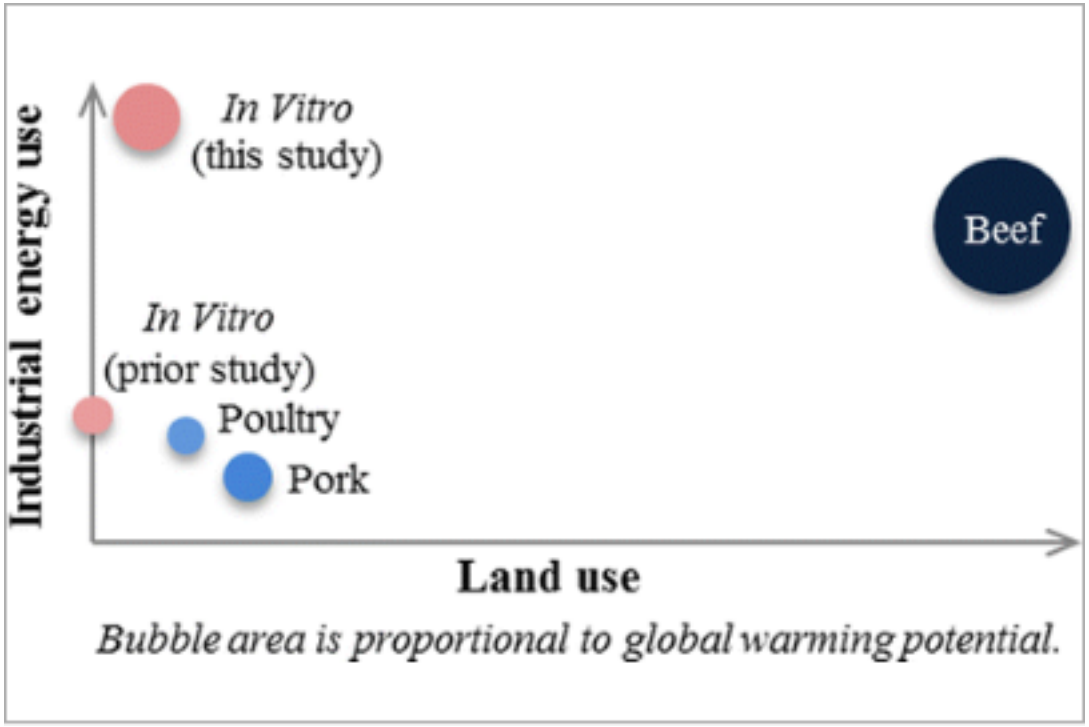

FROM PIG TO PLATE
Researchers are adapting tissue engineering techniques to grow edible meat, in vitro.
1 Take a small biopsy
Extract myosatellite cells 2
3 Add animal-free growth serum to multiply cells
4 Grow cells on scaffold to form myofibres, which bind together to form muscle.
5 Exercise muscle 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

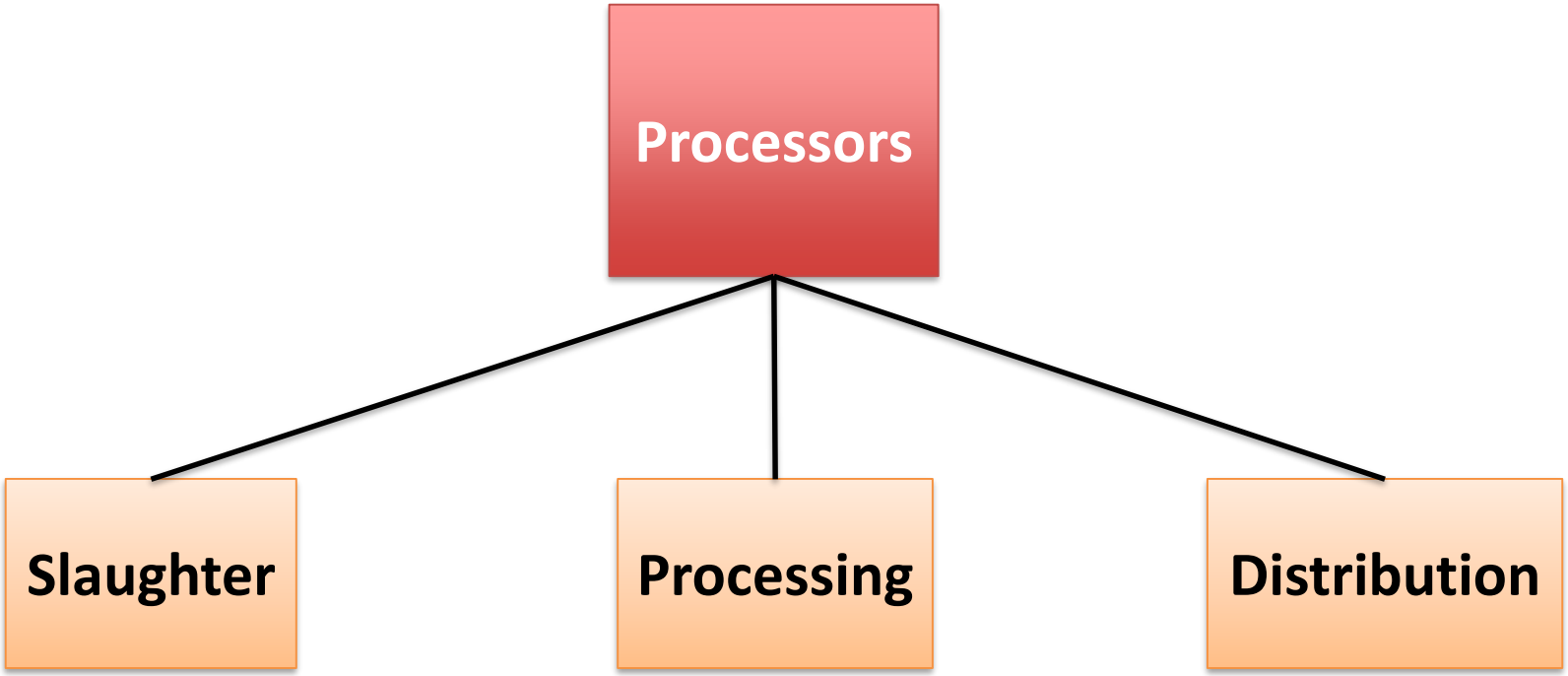


Source: Tuomisto et al (2011)



Source: Mattick et al (2015)

Potential role for incumbent processors



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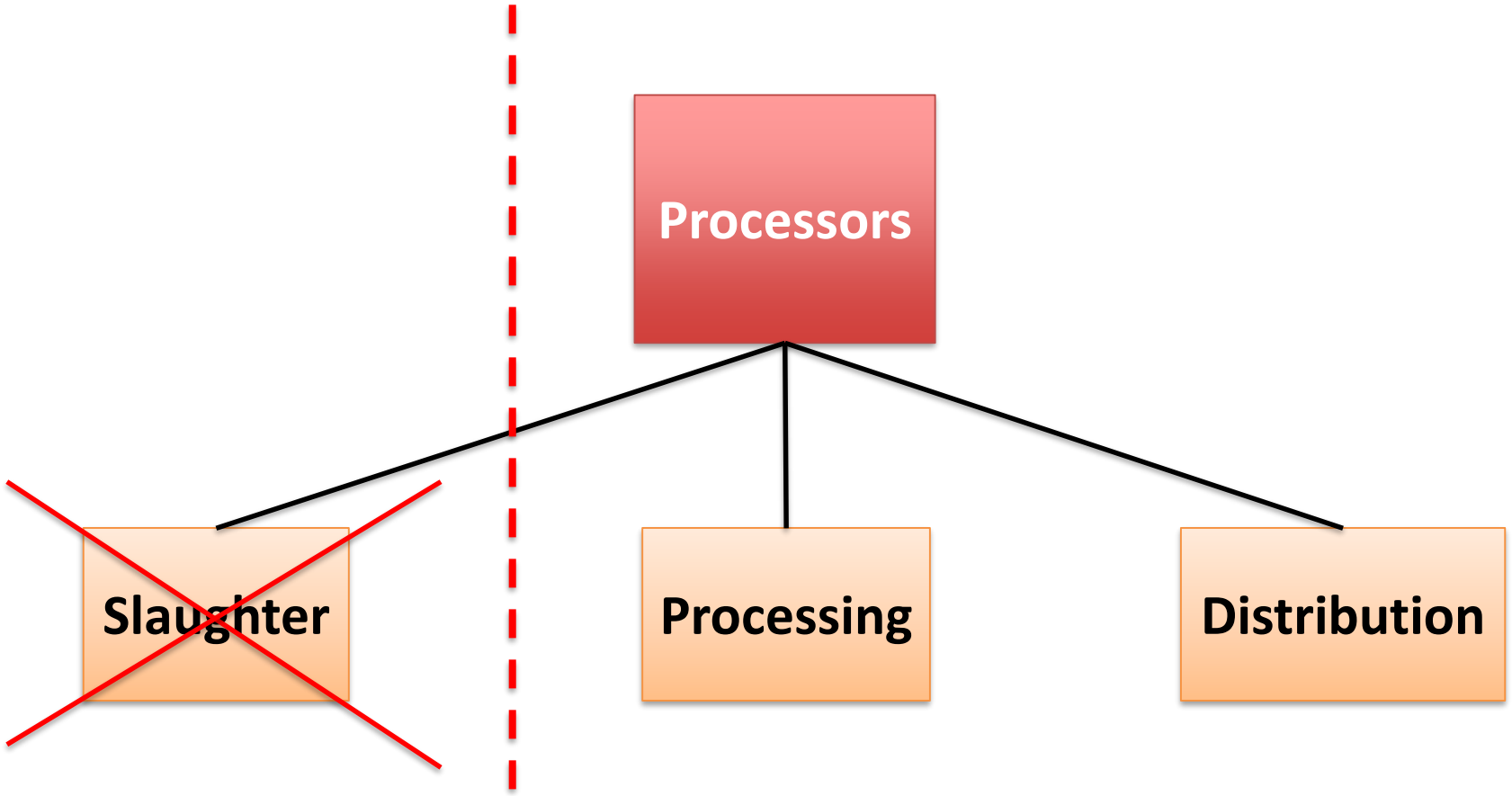

Source: GFI (2018)

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*

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