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Sutardja Center

for Entrepreneurship & Technology

Berkeley Engineering

Saving the Planet The Market for Sustainable Meat Alternatives

Abstract

Meat production will be unsustainable by 2050 at current and projected rates of consumption due to high resource intensity and destructive cost. This opens a large market for nutritious protein alternatives which can provide comparable taste, texture, and nutrition density.

This paper looks at the impacts of industrialized meat production and population demands to estimate the inflection point by which meat-rich diets become unsustainable. We also evaluate the total available market for meat alternatives, current players, barriers to entry, and opportunities for future innovation.

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Authors

Indira Joshi / *Director, Samsung*

Seetharam Param / *Sr Director R&D, VMware, Inc*

Irene / *Technical Lead & Manager, Google, Inc*

Milind Gadre / *Director R&D, VMware, Inc*

Berkeley
UNIVERSITY OF CALIFORNIA

Sutardja Center for Entrepreneurship & Technology
2150 Shattuck Ave 11th Floor, Berkeley, CA 94704 || scet.berkeley.edu

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Overview

Meat production will be unsustainable by 2050 at current and projected rates of consumption due to high resource intensity and destructive cost. This opens a large market for nutritious protein alternatives which can provide comparable taste, texture, and nutrition density.

This paper looks at the impacts of industrialized meat production and population demands to estimate the inflection point by which meat-rich diets become unsustainable. We also evaluate the total available market for meat alternatives, current players, barriers to entry, and opportunities for future innovation.

Impacts of Meat Production

Carbon Footprint

Agriculture is one of the primary drivers of climate change, estimated globally at 14%-15% of all greenhouse gas (GHG) emissions, half of which is generated directly by livestock.¹ If we consider both direct and indirect emissions from livestock, many articles cite this as comparable to or exceeding the emissions impact of the global transportation sector.

“It turns out that producing half a pound of hamburger for someone's lunch a patty of meat the size of two decks of cards releases as much greenhouse gas into the atmosphere as driving a 3,000-pound car nearly 10 miles.”

-Scientific American²

Livestock produce significant amounts of methane as a natural byproduct of digestion. Referred to as enteric fermentation, this process accounts for 40% of all methane emissions from agriculture.³ In the ten years between 2001 and 2011 alone, emissions from enteric fermentation increased 11%.⁴ Manure management and farming application generate an additional 25.9%.⁵

¹ <http://www.theguardian.com/environment/2014/jul/21/giving-up-beef-reduce-carbon-footprint-more-than-cars>

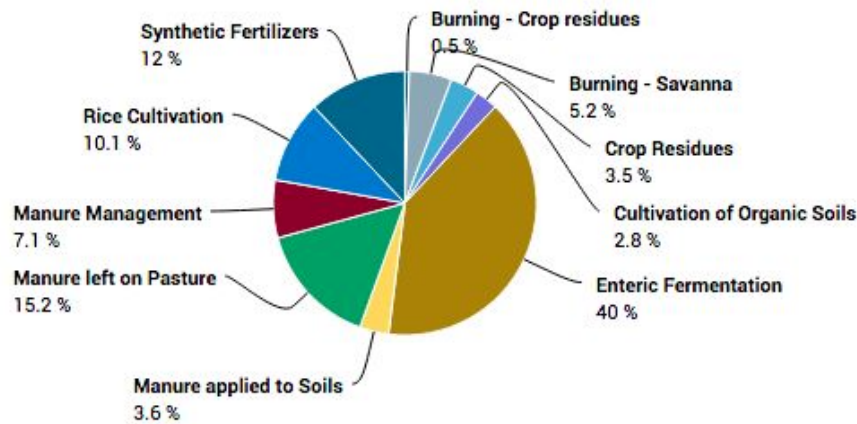
² <http://www.scientificamerican.com/article/the-greenhouse-hamburger/>

³ http://faostat3.fao.org/browse/G1/*E

⁴ <http://www.fao.org/news/story/en/item/216137/icode/>

⁵ http://faostat3.fao.org/browse/G1/*E

Emissions by sector Average 1990 - 2012



Also notably, 72% of all livestock emissions is generated by cattle.⁶ Sources estimate the production of red meat to dwarf all other livestock on environmental impact, with cattle utilizing 28 times more land and 11 times more water than swine or chicken. Compared to staples such as potatoes, wheat, and rice, the impact of beef per calorie is even more extreme, requiring 160 times more land and producing 11 times more greenhouse gases.⁷

To generate an emissions measurement based on dietary choice, a 2014 British study on the environmental impact of diet concluded that dietary GHG emissions in self-selected meat-eaters are approximately twice as high as those in vegans.⁸ The study ran across 2,041 vegans, 15,751 vegetarians, 8,123 fish-eaters and 29,589 meat-eaters and adjusted for gender and age. The findings estimate that meat-rich diets, defined as more than 100g per day, ran the equivalent of 7.2kg of carbon dioxide emissions. In contrast, both vegetarian and fish-eating diets equated to 3.8kg of CO₂ per day, while vegan diets produced only 2.9kg.

Thus all studies make the case that significant reductions in meat consumption would lead to significant reductions in GHG emissions. In particular, changes in both livestock management and dietary choice offer strong opportunities. On the supply side, crop management practices such as improved waste and fertilizer management offer the greatest reduction potential at relatively low costs. Better management of grazing land, such as rotating usage, altering forage composition,

⁶ http://faostat3.fao.org/browse/G1/*E

⁷ <http://www.theguardian.com/environment/2014/jul/21/giving-up-beef-reduce-carbon-footprint-more-than-cars>

⁸ <http://link.springer.com/article/10.1007%2Fs10584-014-1169-1>

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and restoring degraded lands are also important.⁹ On the dietary side, shifting away from meat and especially beef consumption offers the greatest potential for reducing emissions.

Health Implications

A 2011 study by the National Antimicrobial Resistance Monitoring System, a joint collaboration between the FDA, CDC, U.S. Department of Agriculture reports that contaminated meat and poultry infect 3.6 million annually, killing at least 1,000.¹⁰

In the 1920 store-bought meat sampled, antibiotic-resistant strains of salmonella and *Campylobacter* were found in 81% of ground turkey, 69% of pork chops, 55% of ground beef, and 39% of chicken wings, breasts and thighs. In total, 62% of samples tested positive for antibiotic-resistant strains of *Enterococcus*, indicating prior contact with fecal matter.¹¹

Additionally, there is some evidence that Alzheimer's and mad cow disease are related. The practice of feeding rendered cattle meat and chicken feces to living cattle opens the doorway to prions which are understood to cause mad cow disease. Eating beef from cattle that have been fed rendered cattle meat transfers these prions into the human bloodstream.¹²

Pollution

Pollution from meat production comes from the following sources

- Livestock are typically fed corn, soybean meal and other grains which have to first be grown using large amounts of fertilizer, fuel, pesticides, water and land. EWG estimates that growing livestock feed in the U.S. alone requires 167 million pounds of pesticides and 17 billion pounds of nitrogen fertilizer each year across some 149 million acres of cropland. The process generates copious amounts of nitrous oxide, a greenhouse gas 300 times more potent than carbon dioxide, while the output of methane—another potent greenhouse gas—from cattle is estimated to generate some 20 percent of overall U.S. methane emissions¹³. Livestock production accounts for 9% of carbon dioxide and 37% of methane gas emissions worldwide.

⁹ <http://www.wri.org/blog/2014/05/everything-you-need-know-about-agricultural-emissions>

¹⁰ <http://www.ewg.org/meateatersguide/superbugs/>

¹¹ <http://www.ewg.org/meateatersguide/superbugs/>

¹² <http://www.npr.org/templates/story/story.php?storyId=101145687>

¹³ <http://www.scientificamerican.com/article/meat-and-environment/>

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- Destruction of forests - Up to 91% of Amazon destruction is for livestock or livestock feed¹⁴. Why is this important?
 - The trees of the Amazon contain 90–140 billion tons of carbon equivalent to approximately 9–14 decades of current global, annual, human induced carbon emissions. Beyond its role as a giant, somewhat leaky reservoir of carbon, the Amazon is home to one out of every five mammal, fish, bird and tree species in the world. Less recognized, perhaps, is the role of the Amazon in the global energy and water balance. Approximately eight trillion tons of water evaporate from Amazon forests each year, with important influences on global atmospheric circulation. The remainder of the rainfall entering this enormous basin flows into the Atlantic Ocean—15–20% of the worldwide continental freshwater runoff to the oceans.¹⁵
- CAFO manure has contaminated drinking water in many rural areas, caused fish kills, and contributed to oxygen-depleted “dead zones” (areas devoid of valuable marine life) in the Gulf of Mexico, the Chesapeake Bay, and elsewhere. Ammonia in manure contributes to air pollution that causes respiratory disease and acid rain. Leakage under liquid manure storage “lagoons” pollutes groundwater with harmful nitrogen and pathogens, and some lagoons have even experienced catastrophic failures, sending tens of millions of gallons of untreated waste into streams and estuaries, killing millions of fish¹⁶.
 - The American Society of Agricultural Engineers provides an estimate of 540 million metric tons of dry weight excreta per annum (American Society of Agricultural Engineers, 2005)¹⁷.
- In the US, 80% of antibiotics usage is for animal farming. Between 30 and 90% of the dosage is excreted and flows directly into the environment.

In the US, animal farming is estimated to account for 55% of soil and sediment erosion, 37% of nationwide pesticide usage, 80% of antibiotic usage, and more than 30% of the total nitrogen and phosphorus loading to national drinking water resources.

The following diagrams are from “Environmental Impact of Industrial Farm Animal Production” - A Report of the Pew Commission on Industrial Farm Animal Production¹⁸.

¹⁴ [Causes of Deforestation of the Amazon Rainforest -- World Bank 2004](#)

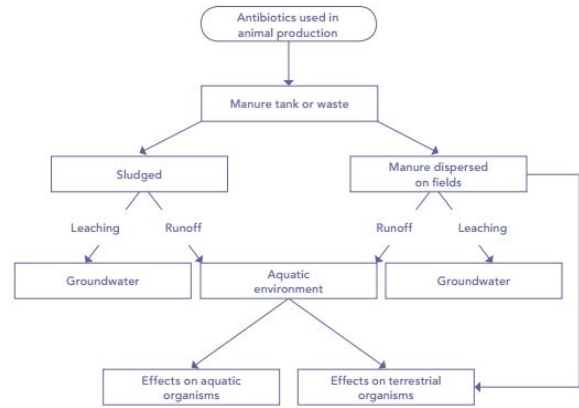
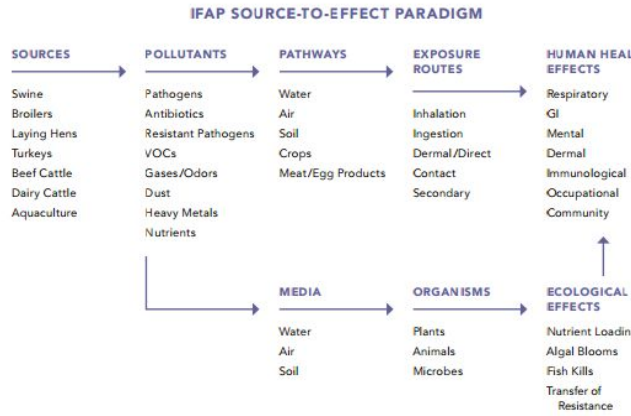
¹⁵ <http://rstb.royalsocietypublishing.org/content/363/1498/1737>

¹⁶ https://www.organicconsumers.org/sites/default/files/hidden_costs_of_cafos.pdf

¹⁷ http://www.ncifap.org/images/212-4_envimpact_tc_final.pdf

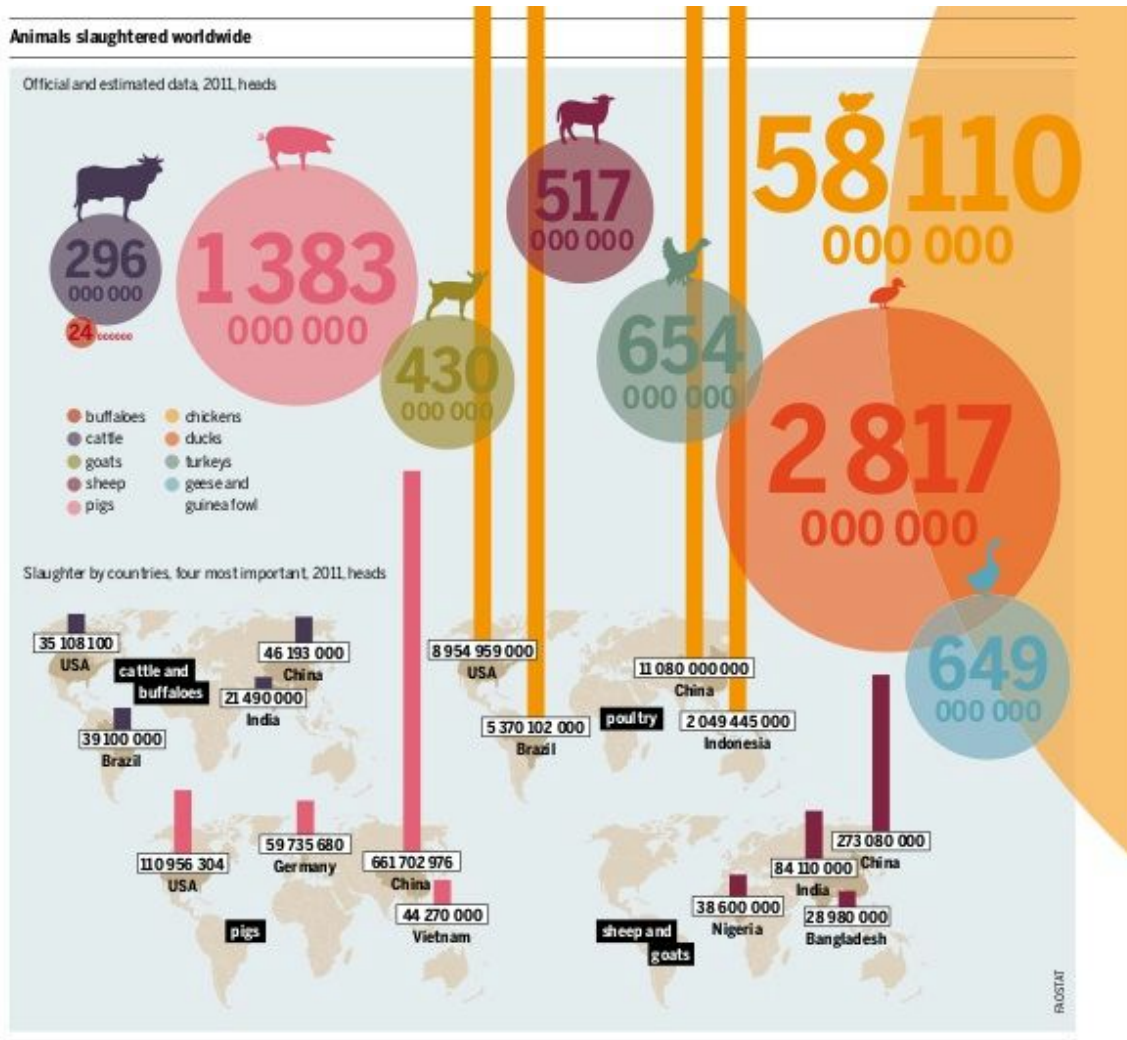
¹⁸ http://www.ncifap.org/images/212-4_envimpact_tc_final.pdf

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Ethics

More than 56 billion farmed animals are slaughtered annually, many of which go through immense pain in the process.



“Chick culling is the culling of newly hatched male chickens for which breeders have no use. In an industrial egg-producing facility, about half of the newly hatched chicks will be male and would grow up to be roosters, which do not lay eggs and therefore provide no incentive for the breeder to preserve. Most of the male chicks are usually killed shortly after hatching.”

-Wikipedia¹⁹

“All dairy cows eventually end up at slaughter. The abuse wreaked upon the bodies of female dairy cows is so intense that the dairy industry also is a huge source of downed cows. Cows referred to as downed cows are so sick and/or injured that

¹⁹ http://en.wikipedia.org/wiki/Chick_culling

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they are unable to walk or even stand, hence the title 'downed'. Downed cows are routinely dragged or pushed with bulldozers in an attempt to move them to slaughter. Dairy cows are not given any food, water, or protection from the elements during their inevitable journey to the slaughterhouse. Prior to being hung up by their back legs and bled to death, dairy cows are supposed to be rendered unconscious, as stipulated by the federal Humane Slaughter Act.²⁰ However, this 'stunning' which is usually done by a mechanical blow to the head, is terribly imprecise. As a result, conscious cows are often hung upside down, kicking and struggling, while a slaughterhouse worker makes another attempt to render them unconscious. Eventually, the animals' throats will be sliced, whether or not they are unconscious."

-<http://mspca.org/>

Questions

The ethical issues fall into one or more of the following concerns -

- Is it ethical to grow and kill sentient beings for our needs especially when alternatives are available?
- Even if we grow and kill animals for our needs, is it ethical to subject sentient beings to lifetimes of extreme pain and suffering?
- Is it ethical to divert 40%+ of our global agricultural output towards meat production (which only a small percent of the population can benefit from) when close to a billion people still do not get enough to eat?
- Is it ethical to destroy so much of the environment to support what amounts to lifestyle choices?

Government Subsidies

In most of the countries, the meat industry gets more subsidies from the government than the fruit and vegetable industries though the same governments recommend their citizens to eat more vegetables and fruits.

The U.S government spends \$38 billion each year to subsidize the meat and dairy industries, but only 0.04 percent of that (i.e., \$17 million) each year to subsidize fruits and vegetables. A \$5 Big Mac would cost \$13 if the retail price included hidden expenses that meat producers offload onto society. A pound of hamburger will cost \$30 without any government subsidies.

²⁰ http://en.wikipedia.org/wiki/Humane_Slaughter_Act



The above chart shows how much the OECD countries provide the subsidies for the meat industry. In total this amounted to \$53B in 2012.²¹

Without the hefty subsidies the meat industry can't make profit with the current prices. In a way the governments spend our tax money to promote the meat eating habit among the people. If the governments reduce or stop these subsidies the meat consumption will be greatly reduced.

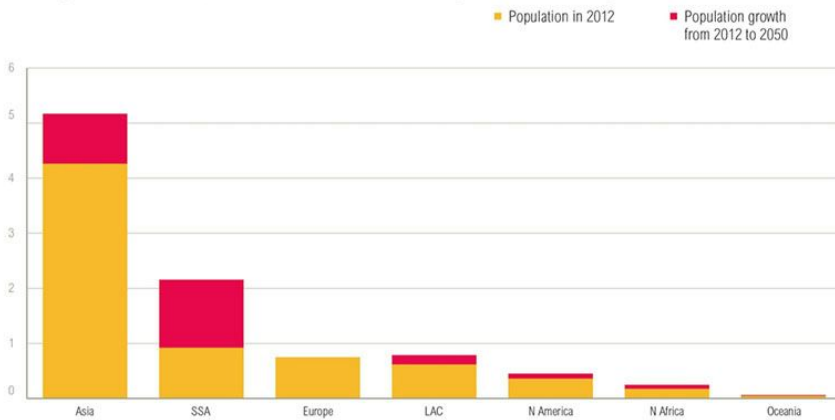
Inflection Point

While not too many people are aware of this, the current capacity of the planet cannot support our current or projected rates of demand for food and water. The world's population is projected to grow from about 7 billion in 2012 to 9.6 billion people in 2050.²² More than half of this growth

²¹ <http://www.eating-better.org/blog/34/an-atlas-of-meat.html>

²² <http://www.wri.org/publication/creating-sustainable-food-future-interim-findings>

Projected Population Growth (in billions)



Note: "SSA" = Sub-Saharan Africa, including Sudan. "LAC" = Latin America and Caribbean. "N America" = North America. "N Africa" = Rest of Africa.



Sources: <http://ow.ly/rpFMN>

will occur in sub-Saharan Africa, a region where one-quarter of the population is currently undernourished.

In addition to population growth, world’s per capita meat and milk consumption is also growing—especially in China and India—and is projected to remain high in the European Union, North America, Brazil, and Russia. These foods are more resource-intensive to produce than plant-based diets. India has the highest growth estimates - the estimated change in livestock is 94% while the growth in calories consumed from beef and mutton is expected to be 138%. Taking into account a growing population and shifting diets, the world will need to produce 69 percent more food calories in 2050 than we did in 2006.

Global Consumption of Meat and Milk Products

REGION	LIVESTOCK (KCAL/PERSON/DAY)			BEEF AND MUTTON (KCAL/PERSON/DAY)		
	2006	2050	% CHANGE	2006	2050	% CHANGE
European Union	864	925	7%	80	75	-6%
Canada & USA	907	887	-2%	117	95	-19%
China	561	820	46%	41	89	116%
Brazil	606	803	33%	151	173	15%
Former Soviet Union	601	768	28%	118	156	32%
Other OECD	529	674	27%	64	84	31%
Latin America (ex. Brazil)	475	628	32%	59	86	45%
Middle East and North Africa	303	416	37%	59	86	45%
Asia (ex. China, India)	233	400	72%	24	43	79%
India	184	357	94%	8	19	138%
Sub-Saharan Africa	144	185	29%	41	51	26%
World	413	506	23%	50	65	30%

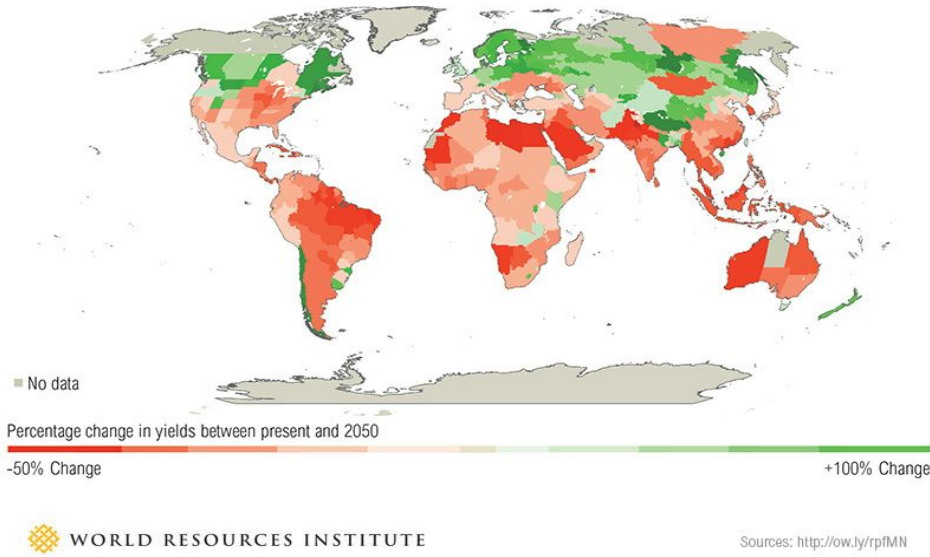
But we can't just produce more food in the same way as today—we also must reduce food's environmental impact. Agriculture currently contributes nearly one-quarter of global greenhouse gas emissions, uses 37 percent of land mass (excluding Antarctica), and accounts for 70 percent of all freshwater withdrawn from rivers, lakes, and aquifers.

Linearly extrapolating to 2050, these numbers would be 63% of land mass, and 118% of all freshwater! Even with simple math, this is clearly not even feasible.

This picture is further complicated by climate change! Climate change is expected to negatively impact crop yields, particularly in the hungriest parts of the world, such as sub-Saharan Africa.

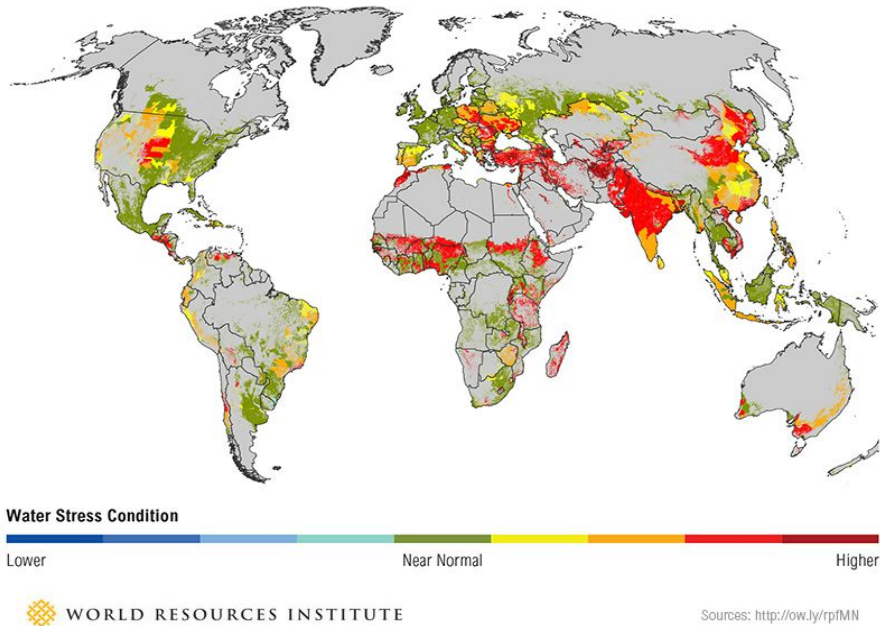
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Most studies now project adverse impacts on crop yields due to climate change (3°C warmer world)



Growing water use and rising temperatures are expected to further increase water stress in many agricultural areas by 2025.

Water stress will increase in many agricultural areas by 2025 due to growing water use and higher temperatures (based on IPCC scenario A1B)



Solutions

The biggest intervention people could make towards reducing their carbon footprints would not be to abandon cars, but to eat significantly less red meat.²³

1. Beef is the least efficient source of calories and protein, generating six times more greenhouse gas emissions per unit of protein than pork, chicken, and egg production. Shifting just 20 percent of the anticipated future global consumption of beef to other meats, fish, or dairy could spare hundreds of millions of hectares of forest and savannah.
2. Shift to meat alternatives - by producing foods with the protein density of meat directly from plants.

“If all the grain currently fed to livestock in the United States were consumed directly by people, the number of people who could be fed would be nearly 800 million,” reports ecologist David Pimentel of Cornell University’s College of Agriculture and Life Sciences. He adds that the seven billion livestock in the U.S. consume five times as much grain as is consumed directly by the entire U.S. population.

Estimated Market Size for Meat Alternatives

This report estimates the market for meat alternatives to be between \$5-10B. A couple of different approaches were taken to estimate the market for meat alternatives:

- Conversion of existing market for meat products to plant based products.²⁴
- Projecting growth of existing market for meat alternatives

A parallel could be drawn to the growth of renewable energy versus fossil fuels. The environmental impacts of carbon based fuels resulted in policy changes that encouraged investments in renewables and several new markets opened up (e.g. cars, batteries, etc). In 2013, more renewables capacity was added than conventional²⁵ and renewables will lead world power growth²⁶. In fact, some food manufacturers petitioned Congress to tackle climate change on Oct 01, 2015²⁷. We could see the same market explosion with meat alternatives.

²³ [Giving up beef will reduce carbon footprint more than cars - The Guardian](#)

²⁴ <http://tinyurl.com/m85ydgj>

²⁵ <http://tinyurl.com/k6urudg>

²⁶ <http://tinyurl.com/nkfehgw>

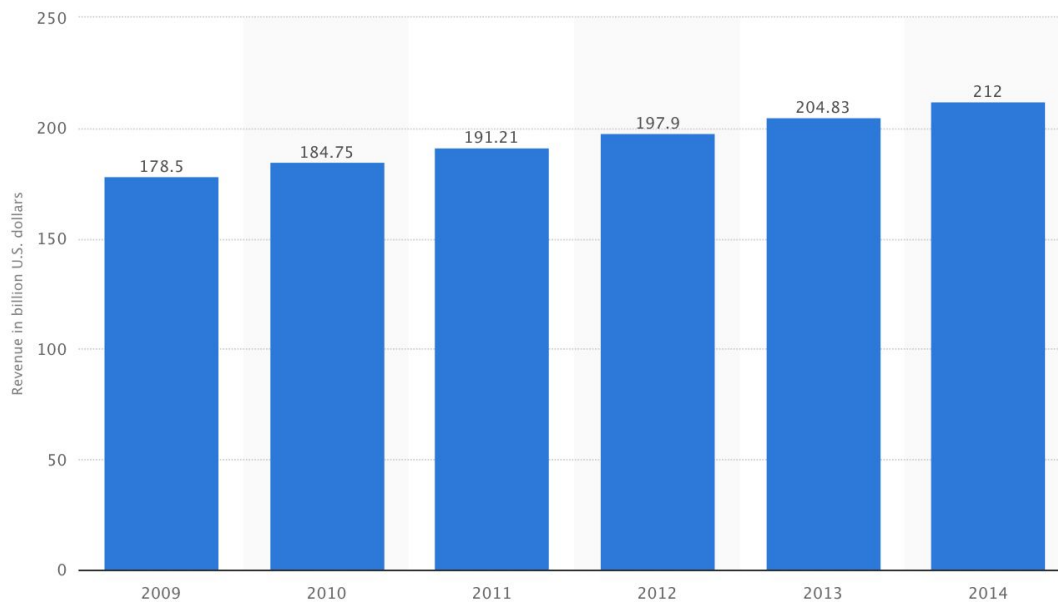
²⁷ <http://thinkprogress.org/climate/2015/10/01/3708023/food-industry-climate-change-congress/>

Existing Market for Meat Products

The revenues of meat, beef and poultry processing have steadily increase at a 3% CAGR from 2009 to 2014²⁸. This represents a mature market. If we assume 5-10% conversion of this market to meat alternatives we arrive at a market estimate of 10-20 B\$.

Revenue of meat, beef & poultry processing (NAICS 31161) in the United States from 2009 to 2014 (in billion U.S. dollars)

This statistic displays annual revenue figures of the meat, beef & poultry processing industry in the United States from 2009 to 2014. In 2010, the revenue of meat, beef & poultry processing in the U.S. totaled to about 185 billion U.S. dollars.



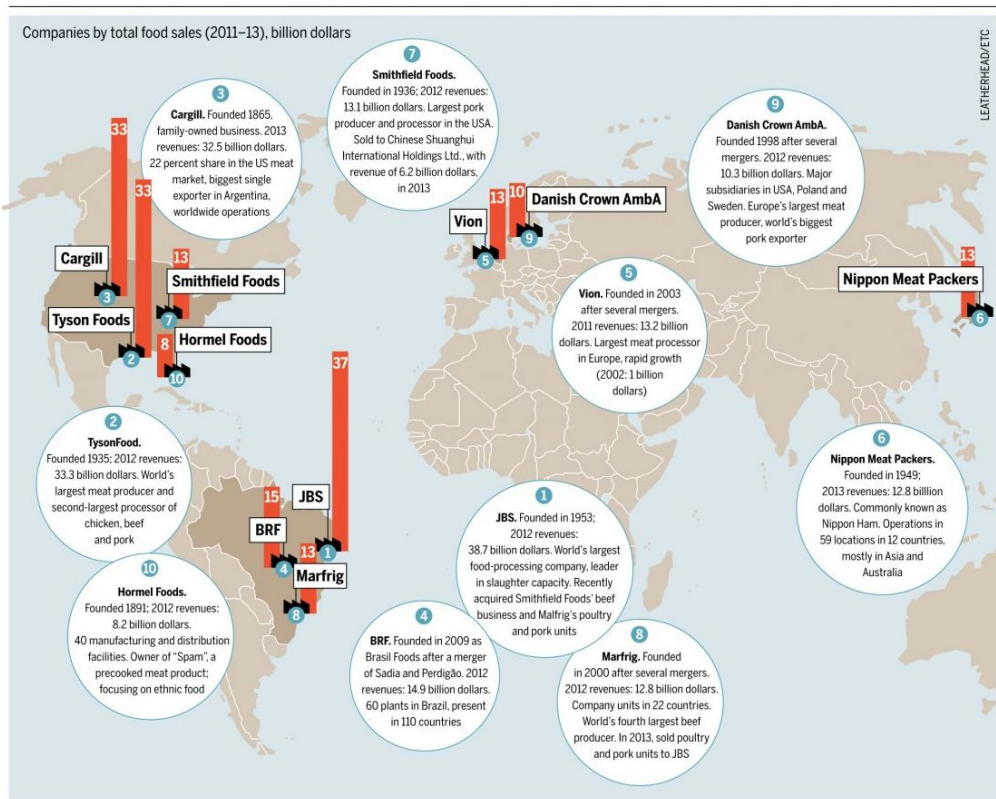
The world wide meat industry is dominated by just 10 firms with ~\$200B in sales annually²⁹. Given the high levels of government subsidy (e.g. US \$22B, OECD \$53B) the industry is susceptible to disruption by both policy changes and individual choice. Furthermore, climate driven disruptions (e.g. in feed supply) could lead to a shock that further drives the market for alternatives³⁰.

²⁸ [Revenue of meat, beef & poultry processing around the world](#)

²⁹ https://www.boell.de/sites/default/files/meat_atlas2014_kommentierbar.pdf

³⁰ <http://www.wri.org/blog/2013/12/global-food-challenge-explained-18-graphics>

The Top Ten of the international meat industry



Factors in Market Conversion

- People looking to eat less meat for health reasons, including weight, diabetes and heart disease management.
- Cost of meat production increasing driving less demand
- More awareness of environmental impacts of meat production and processing
- More affluence in regions of the world which are already primarily vegetarian will lead to these demographics looking for high quality plant based protein (e.g India)
- Sports nutrition (explosion in protein bars sales and offerings)
- Ethical concerns driving people to re-examine the impacts of their dietary choices

Existing Market for Meat Alternatives

The existing global meat alternatives market is expected to reach USD 5.17 Billion by 2020 at a CAGR of 6.4% from 2015 to 2020³¹. The market has been segmented on the basis of type into:

- Tofu & tofu ingredients
- Tempeh
- TVP (a highly nutritious and versatile soy product, that takes on flavor easily)
- Seitan (derived from the protein portion of wheat. It stands in for meat in many recipes)
- Quorn (a fungus-based ferment used in food production as a meat substitute.)
- Other soy-products (miso, yaso, & natto)
- Others (lupin, pea-protein, risofu, and vales).

The soy-based segment accounted for a ~68% market share in the global meat substitutes market in 2014. The market for tofu & tofu ingredients is projected to witness the highest growth as a result of increasing awareness about the health benefits of soybean.

Leading players in the meat substitutes market include:

- Amy's Kitchen (U.S.),
- Beyond Meat (U.S.),
- Sonic Biochem Extractions Limited (India)
- MGP Ingredients (U.S.)
- Garden Protein International Inc. (Canada).

The following charts show rapid growth of global mega regions. The demand from these areas will further drive the need for sustainably produced highly nutritious food.³²

³¹ <http://www.marketsandmarkets.com/PressReleases/meat-substitutes.asp>

³² <http://tinyurl.com/ntfg2me>



Meat Alternatives

Soy Alternatives

Value Proposition

Soy meat alternatives are generally composed of soy protein, wheat gluten, spices, dairy, and carbs. Soy is well regarded as a high-quality protein containing all essential amino acids needed for growth, B vitamins, iron, fatty acids, dietary fiber, omega 3s, and isoflavones.³³ Additionally,

³³ <http://www.soyfoods.org/soy-products/soy-fact-sheets/soy-meat-alternative-fact-sheet>

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soy is naturally cholesterol-free and low in saturated fat. Studies also show that choosing soy-based foods over animal fats may help lower LDL, or “bad” cholesterol, by 3%.³⁴

The more common forms of soy alternatives today are tempeh and textured soy protein. A staple of Indonesia, tempeh is a cake of cooked, fermented soybeans. It is optionally combined with legumes, grains, and seeds and is made by fermenting dehulled soybeans for 18-24 hours with a starter till a white mold binds the ingredients together. Good tempeh yields a firm, chewy texture with a mushroom or yeast flavor.³⁵

Most new soy-based foods entering the market today contain textured soy protein (TSP), which is at least 50% protein. TSP is highly versatile and made from soy flour, soy concentrate, or soy protein isolate. When re-hydrated, it resembles cooked ground beef or poultry. Flavored or unflavored, it can appear in chunks, slices, flakes, crumbles, or bits. Unflavored TSP has the additional benefit of low sodium.³⁶

Current Players

Company	Products	Other Information
Boca Foods	<ul style="list-style-type: none"> ● Boca Traditional ● Organic ● Natural Lines 	Subsidiary of Kraft Foods. No detailed market cap breakdown.
Hain Celestial Group, Inc.	<ul style="list-style-type: none"> ● Yves ● Carb Fit 	Market cap: \$4.77B ³⁷
Pulmuone Wildwood	<ul style="list-style-type: none"> ● Onederful Organic Tofu ● Monterey Gourmet ● Fit Patties 	Subsidiary of Pulmuone Holdings. No detailed market cap breakdown.
Worthington Foods, Inc.	<ul style="list-style-type: none"> ● MorningStar Farms ● Natural Touch ● Loma Linda products 	Subsidiary of Atlantic Natural Foods. No detailed market cap breakdown.

³⁴ <http://www.webmd.com/cholesterol-management/features/soy-and-cholesterol>

³⁵ <http://www.soyfoods.org/soy-products/soy-fact-sheets/soy-meat-alternative-fact-sheet>

³⁶ <http://www.soyfoods.org/soy-products/soy-fact-sheets/textured-soy-protein-fact-sheet>

³⁷ <http://finance.yahoo.com/q?s=HAIN>

Future Innovation

Soy itself has been a standalone staple of its own across cultures for generations, with a wide range of application.³⁸ The soy-based meat alternatives market is projected to reach \$5.17B by 2020.³⁹

Plant-Based Alternatives

Value Proposition

One of the biggest challenges in reducing the consumption of animal protein is that humans like the taste and texture of meat. Meat is an important part of the human culture across the world. In order to address this, several companies are working on products that mimic the taste, texture and nutrition profile of meat. These products are either proteins derived from plants but with the taste, texture and nutrition profile of meat, or they may be actual animal meat that is directly cultured in the lab. In this section, we will look at the companies that are producing products from plants that mimic the taste, texture and nutrition profile of meat.

Beyond Meat⁴⁰

Founded	2009
Funding	\$17M funding in 2 rounds ⁴¹
Availability	Products found in 7,500 stores, and will soon be in Walmart as well. Aiming to get its products on pizzas and in fast-food restaurants and is targeting the average consumer. ⁴²
Other Information	<ul style="list-style-type: none"> ● Interview by The Atlantic⁴³ ● Technology leaders have been fooled (Bill Gates blog⁴⁴)

³⁸ https://en.wikipedia.org/wiki/List_of_fermented_soy_products

³⁹ <http://www.marketsandmarkets.com/PressReleases/meat-substitutes.asp>

⁴⁰ <http://www.beyondmeat.com>

⁴¹ <https://www.crunchbase.com/organization/beyond-meat#/entity>

⁴² <http://www.nytimes.com/2015/09/20/opinion/sunday/nicholas-kristof-the-fake-meat-revolution.html>

⁴³ <http://www.theatlantic.com/video/index/411802/our-meatless-morrow/>

⁴⁴ <http://www.gatesnotes.com/About-Bill-Gates/Future-of-Food>

Impossible Foods⁴⁵

Founded	2011
Funding	\$183M in 2 Rounds from 5 Investors ⁴⁶
Availability	2016
Other Information	<ul style="list-style-type: none"> ● New generation of meats & cheeses from plants. ● Mission - to give people great taste and nutrition minus negative health & environmental impact.

Hampton Creek Foods⁴⁷

Founded	December 01, 2011
Funding	\$120M in 5 Rounds from 24 Investors ⁴⁸
Availability	Multiple locations
Other Information	<ul style="list-style-type: none"> ● Egg and Mayo replacements ● One time target of disinformation campaign by Egg Board⁴⁹

Lab Grown Meat

Value Proposition

The lab grown meat a.k.a cultured meat a.k.a. vitro meat is produced by taking a small amount of cells from a living animal and growing it into lumps of muscle tissue in the lab. Producing the synthetic meat is no longer in the realm of science fiction. A Dutch scientist, Dr. Mark Post from Maastricht University produced a beef patty using the lab grown meat and showed it to the work

⁴⁵ <http://impossiblefoods.com/>

⁴⁶ <https://www.crunchbase.com/organization/impossible-foods#/entity>

⁴⁷ <https://www.hamptoncreek.com/>

⁴⁸ <https://www.crunchbase.com/organization/hampton-creek-foods#/entity>

⁴⁹ <http://tinyurl.com/noa2wfv>

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at an event in London. It is just matter of time before someone opens up a commercial meat factory.



Photo Credit: David Parry / PA Wire

Modern Meadow⁵⁰

Founded	2014
Funding	\$11.2M in 3 Rounds from 9 Investors ⁵¹
Availability	N/A
Other Information	●

In the United States, New York-based Modern Meadow is developing cultured “steak chips”—something between a potato chip and a beef jerky that would be nutritionally superior to both.

⁵⁰ <http://www.modernmeadow.com/>

⁵¹ <https://www.crunchbase.com/organization/modern-meadow>

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Dr. Post says he also imagines commercial cultured meat “factories” opening up in developing countries in the near future, perhaps even in 10 years. “In essence, it’s a very simple technology, so it can be easily transplanted,” he says. “You don’t need a Ph.D. to grow cultured meat. In fact, it would be feasible to do it at home.”

Before cultured meat can become easily accessible, however, Post says several challenges will need to be overcome. For starters, he has to find a much cheaper growth medium, one that wouldn’t be made of fetal bovine serum (from unborn cows). He is also working on the fat tissue and the protein composition of cultured meat—myoglobin in particular, which is important for the iron content and the red color of beef. And last but not least, Post is trying to scale up production by developing special tanks for growing the cells.

Creating cultured steaks, chops and other whole pieces of meat is a possibility for the distant future, but Post believes that in five to seven years consumers will be able to find cultured ground meat products on the shelves of high-end stores in places like Dubai or Silicon Valley in the United States. Such meats could be produced locally or in the Netherlands and would cost around \$30 to \$45 per pound, says Post, and should taste the same as a conventional high-quality burger.

Barriers To Entry

Culture

This is perhaps the most difficult to overcome. Meat has great cultural significance, not the least being that it is an aspirational food. When one comes out of poverty, one expects to eat more meat. Furthermore, not eating meat is considered to signify a loss of prestige or economic standing. Eating meat is also considered macho, and eating less of it is considered a sign of weakness.

However, just as the use of clean energy vehicles underwent a cultural transition (and is now considered a status symbol⁵²), attitudes towards meat eating can change.

Taste and Texture

It can be difficult to replace the taste and texture of meat. This in turn can make it harder for current meat eaters to switch to alternatively derived meat⁵³. However, all of the players in the meat alternative industry are working to replicate not only the taste and texture of meat, but its

⁵² <http://www.tesla.com>

⁵³ <http://www.nytimes.com/2015/09/20/opinion/sunday/nicholas-kristof-the-fake-meat-revolution.html>

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nutrition profile as well. This interview with the founder of Beyond Meat by The Atlantic magazine goes deeper into this topic⁵⁴.

Similarly Impossible Foods is working on plant based meat and cheese alternatives that look and taste like the real thing.



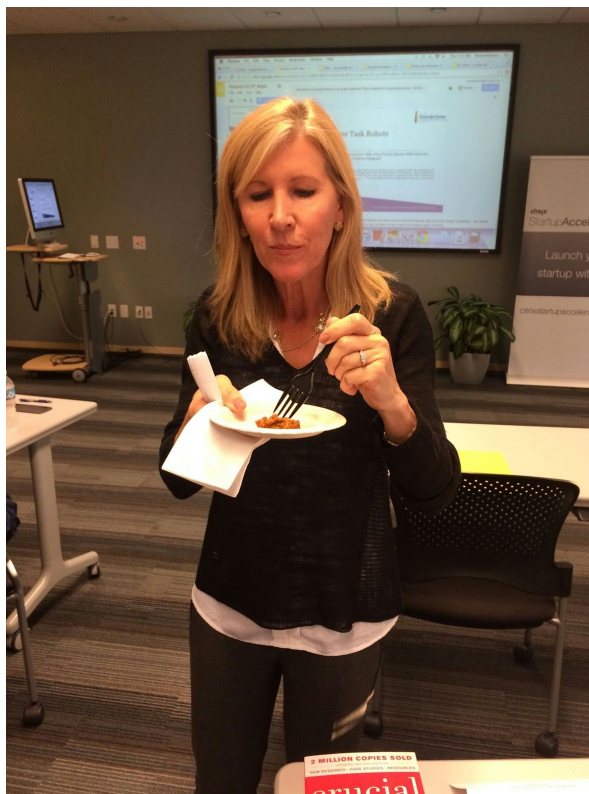
THE IMPOSSIBLE CHEESEBURGER

We love meat. We love cheese. And for thousands of years we have relied on animals to make them. Impossible Foods has found a better way. We use plants to make the best meats and cheeses you'll ever eat.

Finally - with lab grown meat, one can get actual meat - without it having come from animals.

These photos show Prof Sidhu and Jocelyn enjoying a helping of chicken tikka masala (made with Beyond Meat)!

⁵⁴ <http://www.theatlantic.com/video/index/411802/our-meatless-morrow/>



Political Roadblocks

The meat industry is a very powerful political lobby⁵⁵ and will do everything it can to prevent the rise of alternatives that could affect its economics. It has worked successfully to both lobby and financially support members of congress and the USDA to prevent changes in how the meat production facilities are inspected, as well as fighting changes to the food pyramid that could reduce the recommended daily allowances of meat⁵⁶.

Possible FDA Regulations

While there has not been any requirement to have the meat alternatives certified by the FDA, this may become an issue. This could be because of

- how the meat alternative is produced may trigger a review by the FDA

⁵⁵ <http://www.pbs.org/wgbh/pages/frontline/shows/meat/politics/>

⁵⁶ <http://tinyurl.com/ovh4t2u>

- unexpected health issues caused by any specific meat alternative

However, it is not likely that this could be a major barrier.

Conclusions

It is clear that meat production is unsustainable at current and projected rates of consumption due to its extremely high resource intensity and destructive cost. Researchers are clear that the one of the most effective ways to reduce the harmful effects of meat production is to eat less meat.

We believe that this opens a huge (\$5B-\$10B) market for nutritious protein alternatives which can provide comparable taste, texture, and nutrition density as animal meat.

Over the last 5+ years we have seen this thesis proven, with not just the increased number of companies working on and producing meat alternatives, but also via research in top universities and large investments from the venture capital community.

Much like the growth of the renewable energy market, we expect that there will soon be a tipping point⁵⁷ at which time the quantity of environmentally friendly, cruelty-free alternatives will surpass and overtake the production of animal meat.

The time to invest in meat alternatives is now. Now is a great time for both the portfolio and the planet.

⁵⁷ <http://tinyurl.com/k6urudg>, <http://tinyurl.com/qbzvtvn>



National rankings consistently place UC Berkeley's undergraduate and graduate programs among the world's best. Berkeley is home to top scholars in every discipline, accomplished writers and musicians, star athletes, and stellar scientists—all drawn to this public university by its rich opportunities for groundbreaking research, innovative thinking and creativity, and service to society.