

LAB-GROWN MEAT: THE FUTURE OF FOOD AND NATURAL RESOURCE MANAGEMENT

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INTRODUCTION

With a greater knowledge of what are called hormones, i.e., the chemical messengers in our blood, it will be possible to control growth. We shall escape the absurdity of growing a whole chicken in order to eat the breast or wing, by growing these parts separately under a suitable medium.¹

Approximately 10 percent of the Earth's population does not have enough food to lead a healthy life.² However, this is not due to food scarcity.³ In fact, the world has already produced enough food to feed 10 billion people—the projected population for 2050.⁴ The reality is that a significant portion of mass-produced grains go to animal feedlots.⁵ This trend of diverting valuable food sources to animal feedlots in order to support our increasing consumption of meat is significantly impacting the state of our ecosystems.⁶ For example, 30 percent of Earth's ice-free land and 8 percent of its freshwater resources are used for raising livestock.⁷ Meat production also creates 18 percent of global greenhouse gas emissions, which is substantially more than global transportation emissions.⁸ Specifically, one study found that “34% of the greenhouse gas emissions related to livestock production are due to deforestation [from clearing land], 25% are methane emissions from enteric fermentation of ruminants, and 31% of the emissions are related to manure management.”⁹ Data clearly demonstrates that increasing levels of greenhouse gases from modern

¹ Winston Churchill, *Fifty Years Hence*, POPULAR MECHANICS (Mar. 1932), reprinted in http://rolandanderson.se/Winston_Churchill/Fifty_Years_Hence.php.

² *Hunger Statistics*, FOOD AID FOUND., <http://www.foodaidfoundation.org/world-hunger-statistics.html> (last visited Oct. 27, 2017).

³ Eric H. Gimenez, *We Already Grow Enough Food For 10 Billion People—and Still Can't End Hunger*, HUFFINGTON POST (May 2, 2012, 10:19 AM), https://www.huffingtonpost.com/eric-holt-gimenez/world-hunger_b_1463429.html.

⁴ *Id.*

⁵ *Id.*

⁶ Hanna L. Tuomisto & M. Joost Teixeira de Mattos, *Environmental Impacts of Cultured Meat Production*, 45 ENVTL. SCI. TECH. 6117, 6117 (2011).

⁷ *Id.*

⁸ *Id.*

⁹ *Id.*

meat production exacerbate our planet's already warming climate.¹⁰ Climate change will bring with it an increase in pests, weeds, diseases, and extreme weather events.¹¹ This is extremely worrisome because these externalities will put additional pressure on agriculture production and further exacerbate global poverty and hunger.¹²

With the world's population projected to reach approximately 10 billion in 2050, we urgently need to rethink how we have designed our food system and how we utilize food resources.¹³ The United States wields significant power in the global economy due to its role as a major importer and exporter of food products.¹⁴ If the United States were to shift toward more sustainable sources of protein, other countries would likely follow suit. Thus, Part II of this Comment discusses the current state of meat production in the United States, and Part III explores the alternatives to these methods. The discussion in Part III provides insights into the U.S. government's use of incentives and subsidies to promote livestock production and explains the impact these subsidies and incentives have on both the individual and environmental health of our nation. Part IV argues that by shifting away from traditional meat production, the United States could more efficiently use land and resources and could reduce greenhouse gas emissions. Part IV also makes recommendations on addressing public perception and aversion to farmed-meat alternatives. Parts IV and V conclude by arguing that the production of lab-grown meat is the foremost solution to meeting our future health and environmental

¹⁰ Tuomisto, *supra* note 6; Fiona Harvey, *Eat less meat to avoid dangerous global warming, scientists say*, GUARDIAN (March 21, 2016, 3:00 PM), <https://www.theguardian.com/environment/2016/mar/21/eat-less-meat-vegetarianism-dangerous-global-warming>.

¹¹ U.S. Global Change Research Program, *Agriculture*, NAT'L CLIMATE ASSESSMENT, <http://nca2014.globalchange.gov/report/sectors/agriculture> (last visited Oct. 3, 2017) [hereinafter *Global Change, Agriculture*]; *see also* Health Impacts: Climate Human Health, NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES, https://www.niehs.nih.gov/research/programs/geh/climatechange/health_impacts/index.cfm (last visited Oct. 3, 2017).

¹² *Global Change, Agriculture, supra* note 11.

¹³ *World population projected to reach 9.8 billion in 2050, and 11.2 billion in 2100*, UNITED NATIONS DEP'T OF ECON. & SOCIAL AFFAIRS, <https://www.un.org/development/desa/en/news/population/world-population-prospects-2017.html> (last visited June 21, 2017).

¹⁴ *See generally Agricultural Trade*, U.S. DEP'T OF AGRIC., <https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/agricultural-trade/> (last visited Dec. 13, 2017).

resource needs and by analyzing how the U.S. government could promote and regulate the mass production of lab-grown meat to meet these needs.

I. MEAT PRODUCTION IN THE UNITED STATES

A. Background

1. Beef

The United States is the world's largest beef producer and importer.¹⁵ Interestingly, beef has not always been a significant part of the American diet.¹⁶ Before the Civil War, cattle were primarily used for butter, milk, and hides.¹⁷ Wild game accounted for most meat consumption.¹⁸ After the Civil War, Americans moved West and brought cattle along in lieu of traditional food crops that were more difficult to cultivate in arid climates.¹⁹ Cattle grazed on native grasses and were moved to feedlots through cattle drives.²⁰ After gaining significant weight at the feedlots, cattle were transported to the Midwest by train to be slaughtered.²¹ The resulting beef was subsequently shipped east on refrigerator cars to areas where most Americans lived.²²

Industrialization radically changed the beef production process with a result similar to the impact that mechanization and efficiency had on the Ford Model T production line.²³ Increased use of feedlots and unsanitary conditions gave rise to the need for antibiotics to keep

¹⁵ *Animal Production*, U.S. DEP'T OF AGRIC., <https://www.usda.gov/topics/animals/animal-production> (last visited Oct. 27, 2017).

¹⁶ Bravodeluxe, *The History of Beef*, HANKERING FOR HISTORY (Jan. 11, 2013), <https://hankeringforhistory.com/the-history-of-beef/>.

¹⁷ *Id.*

¹⁸ *Id.*

¹⁹ *Id.*

²⁰ *Id.*

²¹ *Id.*

²² *Id.*

²³ *Id.*

the cattle alive.²⁴ Bioengineering flourished as incentives for synthetic growth hormones, and steroids use increased to satisfy the growing demand for beef output per head of cattle.²⁵ In 2016, approximately 30 million cows were slaughtered in the United States, producing 25 billion pounds of beef.²⁶ Although beef consumption has experienced an overall negative trend in the last 40 years,²⁷ in recent years, American beef consumption has been on the rise.²⁸ The average American consumed approximately 56 pounds of beef in 2016, an increase from the 54 pounds of beef per person consumed in 2015.²⁹ Because of this increased consumption, in 2017, one farm of 2,500 cows produces as much waste as a city with approximately 411,000 inhabitants.³⁰

2. *Chicken*

Poultry production in the United States is expected to grow over the next several years due to increasing demand, domestically and abroad, for low-cost, healthy meat products.³¹ The steady increase in chicken consumption started in the 1920s with the development of the broiler, a chicken specifically raised for its meat.³² By 1926, the first broiler house was built with a capacity for 10,000 birds.³³ In the 1940s,

²⁴ Bravodeluxe, *supra* note 16.

²⁵ *Id.*

²⁶ *Beef Industry Statistics*, NAT'L CATTLEMEN'S BEEF ASS'N, <http://www.beefusa.org/beefindustrystatistics.aspx> (last visited Oct. 27, 2017).

²⁷ Carrie R. Daniel, *Trends in meat consumption in the United States*, 14 PUB. HEALTH NUTRITION 575, 580 (2011).

²⁸ Zlati Meyer, *Beef is back on the grill and its sales are heating up, too*, USA TODAY (July 5, 2017, 11:23 AM), <https://www.usatoday.com/story/money/2017/07/03/americans-eat-more-beef-and-meat-trend-thats-expected-continue/435331001/>.

²⁹ *Id.*

³⁰ *What Happens to Animal Waste?*, FOODPRINT, <https://foodprint.org/issues/what-happens-to-animal-waste/?cid=906> (last visited June 10, 2019).

³¹ *Animal Production*, *supra* note 15.

³² *U.S. Chicken Industry History*, NAT'L CHICKEN COUNCIL, <http://www.nationalchickencouncil.org/about-the-industry/history/> (last visited Oct. 27, 2017) [hereinafter *U.S. Chicken*, NAT'L CHICKEN COUNCIL].

³³ *Id.*

vertical integration took hold so that a single company controlled every stage of production.³⁴ In 1949, the United States Department of Agriculture (“USDA”) initiated a voluntary grading program to assure consumers of the quality of the chicken; this program became mandatory in 1959.³⁵ Since the 1970s, the broiler industry has implemented technology for automation and mechanization, genetic improvements, and disease eradication programs.³⁶ Today, most chickens are raised in high-density sheds without access to the outdoors.³⁷ Additionally, the typical broiler house of 22,000 chickens produces the same amount of phosphorus as the sewage from a community of 6,000 people.³⁸

In the United States, chicken consumption surpassed pork consumption in 1985 and beef consumption in 1992.³⁹ In 2017, Americans consumed nearly twice as much chicken as pork or beef—89 pounds of chicken per person annually as opposed to 54 pounds-per-person of beef and 50 pounds-per-person of pork.⁴⁰ Total annual per capita poultry consumption is forecasted to be 109.2 pounds by 2018.⁴¹

³⁴ *Id.*

³⁵ *Id.*

³⁶ *Id.*

³⁷ See generally J.H. Leibler et al., *Epizootics in Industrial Livestock Production: Preventable Gaps in Biosecurity and Biocontainment*, 64 ZOOZOSES AND PUB. HEALTH 137, 138 (2016) (discussing the health impact of high-density poultry and hog livestock production).

³⁸ *Animal Manure Management*, U.S. DEP’T OF AGRIC., https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/technical/nra/rca/?cid=nrcs143_014211 (last visited Nov. 7, 2017).

³⁹ See *U.S. Chicken*, NAT’L CHICKEN COUNCIL, *supra* note 32.

⁴⁰ Joseph Erbentraut, *Americans Are Eating More Meat, But Not For The Reasons You Might Think*, HUFFINGTON POST (Aug. 19, 2016, 1:38 PM), https://www.huffingtonpost.com/entry/us-meat-consumption-chicken-oversupply_us_57b7188fe4b03d513687e091.

⁴¹ *Per Capita Consumption of Poultry and Livestock, 1965 to Estimated 2018*, in *Pounds*, NAT’L CHICKEN COUNCIL, <http://www.nationalchickencouncil.org/about-the-industry/statistics/per-capita-consumption-of-poultry-and-livestock-1965-to-estimated-2012-in-pounds/> (last visited Oct. 27, 2017) (citing the USDA) [hereinafter *Per Capital Consumption*, NAT’L CHICKEN COUNCIL].

3. *Pork*

Pigs were first commercially processed in Cincinnati.⁴² By the mid-1800s, Cincinnati led the nation in pig processing.⁴³ With the invention of the refrigerated railroad car in 1887, pig farming underwent a revolution.⁴⁴ After 1887, slaughterhouses and production centers could be grouped together because the processed meat could be shipped safely, as opposed to shipping live hogs.⁴⁵ The entire pork industry soon relocated to the Upper Midwest where the majority of grain was grown.⁴⁶ Today, 97 percent of pigs are raised in high-density barns and are given a significant amount of antibiotics.⁴⁷

The United States is the world's second-largest pork producer and also ranks second both as an importing and exporting country of pork.⁴⁸ The average American in 2017 consumed about 50 pounds of pork, compared to the approximately 45 pounds consumed by the average American in 2014.⁴⁹ This steady increase is expected to continue in the coming years.⁵⁰ This increase in consumption of pork will translate into an increase in waste: a pig produces about four times as much solid waste as an average person.⁵¹ A typical hog farm of 5,000 pigs is equal to a small city of 20,000 people with no sewage treatment plant.⁵²

⁴² Mick Vann, *A History of Pigs in America*, AUSTIN CHRON. (Apr. 10, 2009), <https://www.austinchronicle.com/food/2009-04-10/764573/>.

⁴³ *Id.*

⁴⁴ *Id.*

⁴⁵ *Id.*

⁴⁶ *Id.*

⁴⁷ Lynne R. Kasper, *Inside the factory farm, where 97% of U.S. pigs are raised*, SPLENDID TABLE (May 6, 2015), <https://www.splendidtable.org/story/inside-the-factory-farm-where-97-of-us-pigs-are-raised>; see generally Leibler, *supra* note 37.

⁴⁸ *Animal Production*, *supra* note 15.

⁴⁹ *Per Capital Consumption*, NAT'L CHICKEN COUNCIL, *supra* note 41.

⁵⁰ *Id.*

⁵¹ Polly Walker et al., *Public health implications of meat production and consumption*, 8 PUB. HEALTH NUTRITION 348, 351 (2005).

⁵² *Id.*

4. Fish

Commercial fishing is distinct from any terrestrial animal food source for many reasons.⁵³ First, there are significant issues with lack of knowledge (i.e., the size of fish stocks and what constitutes a sustainable population); second, competing jurisdictional claims between nations cause issues with this migrating food source; third, competing interests between recreational and commercial fishers influence regulation of fisheries; and fourth, scarcity as the depletion of fish stocks affects the availability of fish as a commercial food source.⁵⁴ In the 19th century, many thought that fish stocks were inexhaustible.⁵⁵ However, by the 1950s, many fishermen recognized that there were too many boats pursuing too few fish.⁵⁶ This reality is still prevalent today.⁵⁷

In 2015, the average American consumed 15.5 pounds of fish and shellfish for the year.⁵⁸ This makes the United States the second-largest consumer of fish behind China and ahead of Japan.⁵⁹ Interestingly, even though humans are rapidly depleting many fish stocks,⁶⁰ the average American does not eat the total recommended amount of seafood per year, according to *Dietary Guidelines for Americans* and the supporting USDA MyPlate.⁶¹

⁵³ See Oliver A. Houck, *On the Law of Biodiversity and Ecosystem Management*, 81 MINN. L. REV. 869, 945–48 (1997); see also JAMES RASBAND ET AL., NATURAL RESOURCES LAW AND POLICY, 508–09 (Robert C. Clark et al. eds., 3d ed. 2016).

⁵⁴ See Rasband, *supra* note 53, at 517.

⁵⁵ *Id.*

⁵⁶ *Id.*

⁵⁷ *Id.*

⁵⁸ Clare Leschin-Hoar, *Hey, Looks Like Americans Are Finally Eating More Fish*, NPR (Oct. 31, 2016, 7:00 AM), <http://www.npr.org/sections/thesalt/2016/10/31/499780982/hey-looks-like-americans-are-finally-eating-more-fish>.

⁵⁹ *Id.*

⁶⁰ See Rasband, *supra* note 53, at 517.

⁶¹ Linda Kantor, *Americans' Seafood Consumption Below Recommendations*, AMBER WAVES (Oct. 3, 2016), <https://www.ers.usda.gov/amber-waves/2016/october/americans-seafood-consumption-below-recommendations/>.

B. Government Involvement in the Expansion of the Modern Meat Industry

Over the years, the U.S. government has been a significant player in the expansion of the meat production industry through subsidies and assistance programs.⁶² The USDA provides direct support to the livestock industry in the form of disaster assistance.⁶³ The Livestock Forage Program (“LFP”) provides compensation to livestock producers that have lost grazing land due to fire or drought.⁶⁴ The Livestock Indemnity Program (“LIP”) is a second program that provides benefits to producers when livestock deaths occur due to adverse weather or by animals that were reintroduced by the federal government.⁶⁵ A third program, the Emergency Assistance for Livestock, Honeybees, and Farm-Raised Fish (“ELAP”), covers loss of livestock due to conditions not covered by LFP and LIP, such as disease, blizzards, or wildfires.⁶⁶ The federal government also has an Emergency Loan Program that provides loans that can be used to help producers recover from mortalities caused by natural disasters or quarantine.⁶⁷

Additionally, the federal government supports the meat production industry through purchase programs.⁶⁸ Agricultural products are bought by the USDA for distribution through the National School Lunch Program; the Special Supplemental Nutrition Program for Women, Infants and Children (“WIC”); and The

⁶² See generally Paul Schwennesen, “Big Meat” and Big Government, PROP. & ENV’T RES. CTR. (Feb. 14, 2011), <https://www.perc.org/articles/big-meat-and-big-government> (arguing that the U.S. government has over-subsidized the meat industry).

⁶³ *Disaster Assistance Programs*, U.S. DEPT OF AGRIC., FARM SERV. AGENCY (Oct. 27, 2017), <https://www.fsa.usda.gov/programs-and-services/disaster-assistance-program/index>.

⁶⁴ *Id.*

⁶⁵ *Id.*

⁶⁶ *Id.*

⁶⁷ *Id.*

⁶⁸ *Agriculture and Health Policies in Conflict: How Food Subsidies Tax Our Health*, PHYSICIANS COMM. FOR RESPONSIBLE MED. (Oct. 3, 2017), <https://web.archive.org/web/20180529034800/https://www.pcrm.org/health/reports/agriculture-and-health-policies-unhealthy-foods> [hereinafter PCRM, *Agriculture*].

Emergency Food Assistance Program (“TEFAP”).⁶⁹ The USDA donates other purchased commodities to food banks, soup kitchens, and various institutions.⁷⁰ The federal government has indicated that these purchases also help to stabilize prices in agricultural commodity markets by balancing supply and demand.⁷¹ In 2009, the USDA spent at least \$793 million on pork, poultry, beef, eggs, and fish.⁷² The USDA also made “emergency” purchases amounting to \$319.5 million to relieve farm surpluses, largely from the poultry and pork industries.⁷³

Subsidies in the fishing industries are problematic because they contribute to overcapacity by artificially making it cheaper for fishermen to stay in business.⁷⁴ In other words, the U.S. government’s subsidy programs exacerbate the problem of having too many fisherman and not enough fish.⁷⁵ One program, the Capital Construction Fund, provides tax-free accounts for the construction and repair of boats.⁷⁶ Another, the Fishing Vessel Obligation Guarantee Program, promises long-term credit for fishing facilities and boats.⁷⁷ In 42 overfished areas, federal aid amounted to nearly \$840 million from 1994 through 2013.⁷⁸

These subsidy programs illustrate that the government has not been averse to playing a significant role in the food that Americans consume.⁷⁹ But perhaps it is time for the U.S. government to use its power in the food production sector to support environmentally

⁶⁹ *Id.*

⁷⁰ *Id.*

⁷¹ *Selling Food to USDA*, U.S. DEP’T OF AGRIC., <https://www.ams.usda.gov/selling-food> (last visited June 10, 2019); *What is the Agricultural Marketing Service?*, THE ORGANIC INTEGRITY Q. (U.S. Dep’t of Agric.), Dec. 2013, at 3.

⁷² PCRMA, *Agriculture*, *supra* note 68.

⁷³ *Id.*

⁷⁴ See Rasband, *supra* note 53, at 519.

⁷⁵ *Id.*

⁷⁶ *Id.*

⁷⁷ *Id.*

⁷⁸ *Id.*

⁷⁹ See generally *Selling Food to USDA*, *supra* note 71.

sustainable and healthful food production processes, such as lab-grown meat.

C. Environmental Impacts & the Associated Health Issues Related to Modern Meat Production

As stated in the Introduction *supra* Part I, there are numerous negative environmental impacts associated with the production of meat.⁸⁰ In short, it significantly increases the amount of greenhouse gases produced worldwide, exacerbating the warming of our planet.⁸¹ An often less-discussed consequence of meat production is the effect it has on the quality of fresh water resources in the United States.⁸² Unlike human waste, animal waste is not required by law to be treated before being disposed.⁸³ This lack of treatment is at odds with the fact that animal feeding operations annually produce approximately 100 times more manure than the human waste treated at wastewater plants.⁸⁴ Additionally, the Clean Water Act (“CWA”) does not require a permit for non-point source pollution.⁸⁵ The CWA defines the term “point source” as “any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged.”⁸⁶ The CWA also excludes agriculture storm-water discharges from the definition of a “point source.”⁸⁷ Thus, as long as livestock manure is not directly going into

⁸⁰ Lucas Reijnders & Sam Soret, *Quantification of the environmental impact of different dietary protein choices*, 78 AM. J. CLINICAL NUTRITION 664S, 664S (2003).

⁸¹ Tuomisto, *supra* note 6.

⁸² See generally Mary J. Angelo et al., *Chapter 9: Agriculture and the Clean Water Act*, in FOOD, AGRIC. & ENVTL LAW (ELI Press, 2013); see also Renee Cho, *How Hamburgers Pollute Our Water*, COLUMBIA UNIV. EARTH INST. BLOG (Oct. 25, 2015), <http://blogs.ei.columbia.edu/2010/10/25/how-hamburgers-pollute-our-water/>.

⁸³ See FOODPRINT, *supra* note 30.

⁸⁴ See *id.*

⁸⁵ See *Concerned Area Residents for the Env't v. Southview Farm*, 34 F.3d 114, 117 (2d Cir. 1994).

⁸⁶ 33 U.S.C.S. § 1362 (LEXIS through Pub. L. No. 116-19).

⁸⁷ See *Concerned Area Residents for the Env't*, 34 F.3d at 120.

water streams, the waste produced by livestock is not otherwise regulated by the government.⁸⁸ This lack of regulation is troublesome because animal waste pollutes our finite fresh water resources and can have significant detrimental effects on human health.⁸⁹

Specifically, waste runoff from livestock cultivation can result in gastrointestinal tract distress in humans when they drink contaminated surface water or groundwater.⁹⁰ The pathogens may also cause skin, eye, and ear infections simply from contact.⁹¹ Perhaps more disturbing is the significant amount of antibiotics and other pharmaceuticals that are present in livestock waste.⁹² These antibiotics are increasing the antibiotic resistance of microbial populations and naturally occurring pathogens.⁹³ In turn, there is an increased probability that human pathogens will acquire antibiotic resistance.⁹⁴ Additionally, the exposure to low levels of pharmaceuticals in drinking water could have acute negative health effects.⁹⁵

II. ALTERNATIVES TO MODERN MEAT PRODUCTION

Many Americans are shifting their diets away from traditional meat.⁹⁶ For example, one study found that the prevalence of vegetarianism and veganism specifically for health reasons in the United States rose to approximately two percent in 2012—an 18.8

⁸⁸ *Id.* at 122.

⁸⁹ JoAnn Burkholder et al., *Impacts of Waste from Concentrated Animal Feeding Operations on Water Quality*, 115 ENVTL. HEALTH PERSPECTIVE 308, 308 (2007).

⁹⁰ *Id.* at 310.

⁹¹ *Id.*

⁹² *Id.*

⁹³ *Id.* at 309.

⁹⁴ J. L. Martinez, *Environmental pollution by antibiotics and by antibiotic resistance determinants*, 157 ENVTL. POLLUTION 2893, 2899 (Nov. 2009); Giorgia Guglielmi, *Are antibiotics turning livestock into superbug factories?*, SCIENCE (Sep. 28, 2017, 2:00 PM), <http://www.sciencemag.org/news/2017/09/are-antibiotics-turning-livestock-superbug-factories>.

⁹⁵ See Burkholder, *supra* note 89, at 310.

⁹⁶ See generally Holger Cramer et al., *Characteristics of Americans Choosing Vegetarian and Vegan Diets for Health Reasons*, 49 J. NUTRITION EDUC. BEHAVIOR 561, 561 (2017).

percent increase from 2002.⁹⁷ If this trend were to continue to rise to the point where Americans eventually do not consume any traditional meat, there would be a substantial reduction in the health and environmental impacts previously discussed.⁹⁸ Currently, approximately one-third of land-produced crops are dedicated to producing food for livestock.⁹⁹ If this percentage of land-produced crops transitioned to feeding humans, only about 10 to 20 percent of current pastureland would need to be converted to cropland.¹⁰⁰ The remaining pastureland could be restored to native habitats.¹⁰¹ The comparative impact of land utilization was illustrated in a study on environmentally relevant inputs for the production of 11 food items in which vegetarian and non-vegetarian diets differ.¹⁰² The study found that approximately 3 times more water, 2.5 times more energy, 13 times more fertilizer, and 1.4 times more pesticides were used to produce the 11 non-vegetarian items in the study.¹⁰³ A different study found that, by simply taking into account fossil fuel consumption, the production of one calorie from milk requires 14 fuel calories, and the production of one calorie from beef requires 40 calories of fuel, compared to the 2.2 calories of fossil fuels needed to produce one calorie of grain.¹⁰⁴ This study effectively demonstrates how “a greater consumption of animal products translates to a greater impact on the environment.”¹⁰⁵ As a society, it is essential to consider alternatives to the modern meat industry, or “it will be almost impossible to feed coming generations on the same diet which we now have in Western

⁹⁷ *Id.* at 564.

⁹⁸ See generally Harold J. Marlow et al., *Diet and the environment: does what you eat matter?*, 89 AM. J. CLINICAL NUTRITION 1699S, 1699S (2009).

⁹⁹ Rachel Nuwer, *What would happen if the world suddenly went vegetarian?*, BBC (Sep. 27, 2016), <http://www.bbc.com/future/story/20160926-what-would-happen-if-the-world-suddenly-went-vegetarian>.

¹⁰⁰ *Id.*

¹⁰¹ *Id.*

¹⁰² Marlow, *supra* note 98, at 1701S.

¹⁰³ *Id.*

¹⁰⁴ L. Baroni et al., *Evaluating the Environmental Impacts of Various Dietary Patterns Combined with Different Food Production Systems*, 61 EUR. J. CLINICAL NUTRITION 279, 282 (2007).

¹⁰⁵ *Id.*

Europe and in North America.”¹⁰⁶ In particular, the meat industry must increase production by approximately 50 to 73 percent in order to feed the projected population in 2050 with a “business as usual” food systems model.¹⁰⁷ One solution to this problem is to have the world’s population go completely vegetarian; however, a more diverse food system that includes lab-grown meat with fruits, vegetables, and grains is arguably a better option, as discussed below.

A. Plant-Based Substitutes

There are more plant-based meat alternatives available now than in any other time in history.¹⁰⁸ An individual can walk into her local Walmart or Target and easily find a variety of options to meet her animal-free tastes.¹⁰⁹ Consumers are demanding healthier and more environmentally friendly options, which is causing many producers, including highly influential ones, to take note.¹¹⁰ For instance, Bill Gates, Leonardo DiCaprio, and Twitter co-founders Biz Stone and Evan Williams have all invested significant capital in Beyond Meat.¹¹¹ Interestingly, Tyson Foods, the largest U.S. meat company by sales, has also invested in the company.¹¹² Beyond Meat uses a blend of soy and pea protein isolates, fiber, and several other ingredients to create its popular vegan meat products.¹¹³

¹⁰⁶ *Id.* at 285.

¹⁰⁷ Sarah P. F. Bonny et al., *Artificial meat and the Future of the meat Industry*, 57 *ANIMAL PROD. SCI.* 2216, 2216 (2017).

¹⁰⁸ See generally *Vegan Meat Brands That Are Changing Everything*, PEOPLE FOR THE ETHICAL TREATMENT OF ANIMALS, <https://www.peta.org/living/food/meat-replacements/> (last visited June 10, 2019).

¹⁰⁹ *Id.*

¹¹⁰ *Id.*

¹¹¹ Leanna Garfield, *Leonardo DiCaprio just invested in the Bill Gates-backed veggie burger that ‘bleeds’ like beef—here’s how it tastes*, *BUS. INSIDER* (Oct. 17, 2017, 2:19 PM), <http://www.businessinsider.com/review-leonardo-dicaprio-beyond-meat-veggie-plant-burger-2017-10>.

¹¹² Patrick McGroarty & Jacob Bunge, *Tyson Foods Invests in Startup Beyond Meat*, *WALL ST. J.* (Oct. 12, 2016, 4:37 PM), <https://www.wsj.com/articles/tyson-foods-invests-in-startup-beyond-meat-1476140287>.

¹¹³ Alton Brown, *Alton Brown on the End of Meat as We Know It*, *WIRED* (Sept. 17, 2013, 6:33 AM), <https://www.wired.com/2013/09/fakemeat/>.

Another largely successful plant-based meat company, Impossible Foods, strives to deliver burgers that smell, taste, look, and even feel like ground beef.¹¹⁴ The Impossible Burger mimics real meat using a gas chromatography mass spectrometry system.¹¹⁵ The mass spectrometer heats a sample of beef to release particular aromas and then breaks down the different compounds responsible for that aroma.¹¹⁶ The burger is made from potato protein to allow the burger to hold water, coconut (as a fat substitute), and soy leghemoglobin (for the meat taste).¹¹⁷ Although not available in grocery stores, this “meat” patty is available at over 200 restaurants around the country.¹¹⁸

A different company, New Wave Foods, has created a plant-based replacement for the most commonly consumed seafood product in the United States—shrimp.¹¹⁹ Using algae and plants, they have created a shrimp product that is antibiotic free.¹²⁰ Currently, New Wave Foods sells only to food-service operators in California and New York.¹²¹ In late 2018, their shrimp products will be available in select markets nationwide.¹²²

Although there are a multitude of options that come close to the authentic experience of eating meat, most Americans still prefer the real deal.¹²³ Thus, it seems unlikely that a majority of Americans will

¹¹⁴ Matt Simon, *The Impossible Burger: Inside the Strange Science of the Fake Meat That ‘Bleeds’*, WIRED (Sept. 20, 2017, 11:00 AM), <https://www.wired.com/story/the-impossible-burger/>.

¹¹⁵ *Id.*

¹¹⁶ *Id.*

¹¹⁷ *Id.*

¹¹⁸ See IMPOSSIBLE FOODS, <https://impossiblefoods.com/locations/> (last visited Nov. 6, 2017).

¹¹⁹ See NEW WAVE FOODS, <http://www.newwavefoods.com> (last visited Nov. 6, 2017).

¹²⁰ *Id.*

¹²¹ *Id.*

¹²² NEW WAVE FOODS, *Where to Find Us*, <https://www.newwavefoods.com/where-to-find-us> (last visited Oct. 4, 2017).

¹²³ See Holley Simmons, *We tried meatless ‘Impossible Burger’ at two D.C. restaurants. Here’s what it tastes like.*, WASH. POST (Oct. 20, 2017), https://www.washingtonpost.com/news/going-out-guide/wp/2017/10/20/we-tried-impossible-burger-at-two-d-c-restaurants-heres-what-it-tastes-like/?utm_term=.d650e101f195.

shift their diet away from meat in the foreseeable future.¹²⁴ As mentioned previously, consumption of most major types of meat are on a positive upward trend.¹²⁵ Furthermore, plant-based meat products face their own set of unique challenges outside of public preference. These products still require land, water, and chemical products to be produced.¹²⁶ Viable land and fresh water will become more and more difficult to find with the changing climate of the planet.¹²⁷ Additionally, there is concern that the prevalence of monoculture¹²⁸ puts the planet at risk of losing major agricultural products because a lack of genetic diversity makes plants more susceptible to disease and pests.¹²⁹ Thus, it is arguably an imperfect solution to rely solely on plants for all of our food sources.¹³⁰

B. Lab-Grown Meat

In 2013, the world's first lab-grown burger was revealed by physiologist Mark Post and his team in the Netherlands.¹³¹ The burger was made by taking a handful of stem cells from a cow's shoulder, and over the course of three months, turning it into a patty containing

¹²⁴ See generally Carrie R. Daniel et al., *Trends in meat consumption in the USA*, 14 PUB. HEALTH NUTRITION 575, 577 (2010).

¹²⁵ *Id.*

¹²⁶ See generally Melia Robinson, *Inside the Bill Gates-backed startup on a mission to reinvent meat*, BUS. INSIDER (Oct. 12, 2016, 2:46 PM), <http://www.businessinsider.com/impossible-foods-meatless-burger-how-its-made-2016-10/#in-a-redwood-city-california-office-building-with-blacked-out-windows-scientists-foodies-and-silicon-valley-veterans-work-on-making-the-perfect-veggie-burger-1>.

¹²⁷ See Global Change, *Agriculture*, *supra* note 11.

¹²⁸ *Monoculture*, SCI. DAILY, <https://www.sciencedaily.com/terms/monoculture.htm> (last visited Oct. 4, 2018) (explaining that monoculture "describes the practice of relying on a very small number of genetic variants, or cultivars of a food crop for commercial agricultural").

¹²⁹ See generally Lori A. Thrupp, *Linking Agricultural Biodiversity and Food Security: The Valuable Role of Agrobiodiversity for Sustainable Agriculture*, 76 INT'L AFF. 265, 266 (2000). See also Myles Karp, *A Battle to Save the World's Favorite Treat: Chocolate*, N.Y. TIMES (Sep. 25, 2017), <https://www.nytimes.com/2017/09/25/science/cacao-fungus-chocolate.html>.

¹³⁰ See Thrupp, *supra* note 129.

¹³¹ *Meet 7 Startups Creating Lab-Grown Meat*, NANALYZE (Oct. 19, 2017), <https://www.nanalyze.com/2017/10/7-startups-lab-grown-meat/>.

20,000 individual muscle fibers.¹³² It was the most expensive burger ever made with a price tag of \$330,000, and it reportedly was not all that appetizing.¹³³ However, scientists have been hard at work to make artificial meat less expensive and better tasting.¹³⁴ Mark Post's team now has the burger priced down to \$11 per patty; nevertheless, they believe it will take another 10 years for the lab-grown meat to become commercially viable.¹³⁵

Other companies are exploring this technology as well.¹³⁶ San Francisco-based Memphis Meats has a menu of meatballs, chicken, and duck.¹³⁷ This startup begins with stem cells from a particular animal and grows muscle tissue in thin layers inside of bioreactors.¹³⁸ Memphis Meats is especially remarkable in that it has discovered a technical breakthrough in how it grows the meat. Most lab-grown meat relies on fetal bovine serum extracted from the blood of unborn calves.¹³⁹ Memphis Meats has developed a kill-free feed that will be used in all of their products in the next five years.¹⁴⁰ Bill Gates, Richard Branson, and even Cargill (one of the world's largest meat producers) have invested in Memphis Meats.¹⁴¹ However, their products are still far from being commercially viable.¹⁴² One pound of Memphis Meats' meatballs costs \$2,400 to produce.¹⁴³

¹³² Maddie Stone, *The Future Will Be Full of Lab Grown Meat*, GIZMODO (May 27, 2016, 3:20 PM), <https://gizmodo.com/the-future-will-be-full-of-lab-grown-meat-1720874704>.

¹³³ *Id.*

¹³⁴ *Id.*

¹³⁵ NANALYZE, *supra* note 131.

¹³⁶ *Id.*

¹³⁷ *Id.*

¹³⁸ *Id.*

¹³⁹ *Id.*

¹⁴⁰ *Id.*

¹⁴¹ Corby Kummer, *The Advantages of Test-Tube Tuna*, ATLANTIC (Sept. 14, 2017), <https://www.theatlantic.com/science/archive/2017/09/in-vitro-fish/539685/>.

¹⁴² *See id.*

¹⁴³ *Id.*

Brooklyn-based Finless Foods collects samples from marine animals to be cultured and grown in a brewery-like environment.¹⁴⁴ Their seafood will be free from ocean pollutants, such as plastics and mercury, and all other pollutants currently found in our seafood.¹⁴⁵ By 2019, Finless Foods plans to have a finished Bluefin tuna product.¹⁴⁶

Despite advances in technology over the years, lab-grown meat products face many challenges.¹⁴⁷ For one, it will take significant capital to build the infrastructure to produce lab-grown meat at a commercially-viable price.¹⁴⁸ Additionally, many object to the technology behind lab-grown meat.¹⁴⁹ Some communities view the lab-grown beef as unnatural and do not like the idea of scientists playing God.¹⁵⁰ Furthermore, many people do not like the idea of ranchers losing their jobs or the disappearance of the culture associated with ranching.¹⁵¹ Public perception is important for market demand, and one study has shown that while most people are willing to try lab-grown meat, only one-third were willing to “definitely or probably” eat it as a replacement for farmed-meat.¹⁵² It is also to be

¹⁴⁴ *Inside Finless Foods*, FINLESS FOODS, <https://www.finlessfoods.com/about/> (last visited Oct. 5, 2018); Amy Fleming, *Could lab-grown fish and meat feed the world – without killing a single animal?*, GUARDIAN (Sep. 20, 2017, 11:40 PM), <https://www.theguardian.com/lifeandstyle/2017/sep/20/lab-grown-meat-fish-feed-the-world-frankenmeat-startups>.

¹⁴⁵ See Kummer, *supra* note 141.

¹⁴⁶ Elaine Watson, *Cultured fish co Finless Foods aims to achieve price parity with Bluefin tuna by the end of 2019*, FOOD NAVIGATOR-USA (Dec. 21, 2017, 4:03 PM), <https://www.foodnavigator-usa.com/Article/2017/12/21/Finless-Foods-co-founder-talks-clean-meat-clean-fish-cultured-meat>.

¹⁴⁷ Zuhaib F. Bhat et al., *In Vitro Meat: A Future Animal-Free Harvest*, 57 CRITICAL REV. FOOD SCI. & NUTRITION 782, 786 (2017).

¹⁴⁸ *Id.* at 788.

¹⁴⁹ *Id.* at 787.

¹⁵⁰ *Id.*

¹⁵¹ Bonnie Gardiner, *Would you eat lab-grown meat?*, YOUgov UK (March 23, 2012, 2:50 PM), <https://yougov.co.uk/news/2012/03/23/would-you-eat-lab-grown-meat/>.

¹⁵² Matti Wilks & Clive J. C. Phillips, *Attitudes to in vitro meat: A survey of potential consumers in the United States*, 12 PLOS ONE 1, 1 (2017).

expected that the agricultural industry will push back against any proposed regulations to support a lab-grown meat industry.¹⁵³

Notwithstanding the challenges facing the lab-grown meat industry, the potential benefits could make lab-grown meat the best solution to feed Earth's exponentially growing population.¹⁵⁴ Lab-grown meat can be manipulated to include more vitamins and less fat; thus, this "designer meat" can be used to help improve overall health.¹⁵⁵ An increase in protein and polyunsaturated fatty acids and a decrease in saturated fat would significantly reduce the risk of chronic diseases.¹⁵⁶ Additionally, exposure to arsenic, hormones, dioxins, and pesticides that are imbedded in conventional meat production would be substantially reduced.¹⁵⁷ Furthermore, lab-grown meat is incredibly efficient.¹⁵⁸ Only the tissue of the animal that is to be consumed by humans is grown.¹⁵⁹ Traditionally, 75 to 95 percent of feed given to livestock is lost because of metabolism and development of structures or tissue not eaten.¹⁶⁰ Moreover, lab-grown meat uses considerably less resources than conventional meat production and, thus, reduces the environmental footprint.¹⁶¹ Lab-grown meat facilities can be built vertically and close to cities, reducing land use, transportation costs, and food miles.¹⁶² Most importantly, the transition to lab-grown meat could reduce greenhouse gas emissions from raising livestock by as

¹⁵³ See generally Eliza Barclay, *Heck No Or Let's Go? Your Thoughts On Lab-Grown Meat*, NPR (Aug. 6, 2013, 4:49 PM), <http://www.npr.org/sections/thesalt/2013/08/06/209495866/heck-no-or-lets-go-your-thoughts-on-lab-grown-meat>.

¹⁵⁴ See Bhat, *supra* note 147, at 786–87; see also Trae Norton, *From the Lab to the Supermarket: In Vitro Meat as a Viable Alternative to Traditional Meat Production*, 11 J. FOOD L. & POL'Y 157, 162–63 (2015).

¹⁵⁵ See Bhat, *supra* note 147, at 786.

¹⁵⁶ Ginger Hultin, *Lab-Grown Meat: Exploring Potential Benefits and Challenges of Cellular Agriculture*, FOOD & NUTRITION (Feb. 27, 2017), <https://foodandnutrition.org/march-april-2017/lab-grown-meat-exploring-potential-benefits-challenges-cellular-agriculture/>.

¹⁵⁷ See Bhat, *supra* note 147, at 786.

¹⁵⁸ *Id.*

¹⁵⁹ *Id.*

¹⁶⁰ *Id.*

¹⁶¹ *Id.*

¹⁶² Jennifer Pirrone, *Lab Meat May Lead to Environmental Sustainability*, VEGAPROCITY (June 16, 2016), <https://vegaprocity.com/2016/06/lab-meat-lead-environmental-sustainability/>.

much as 90 percent, and the use of land and water resources by up to 80 percent.¹⁶³ Thus, the concerns associated with monoculture and the threat of crop failure due to our changing climate¹⁶⁴ call for greater investment and expansion of lab-grown meat. The U.S. government could play an important role in this shift toward a more food-secure world by setting an example of the different policy methods that could facilitate the expansion of lab-grown meat.

III. POLICY MECHANISMS FOR FACILITATING LAB-GROWN MEAT PRODUCTION AND REGULATION

A. How Lab-Grown Meat Could Be Promoted

1. *Information Campaigns*

As is common with new and complex technologies, a lack of understanding of an innovation may turn into distrust and rejection.¹⁶⁵ Therefore, providing comprehensive, yet easily understood, information to consumers about the benefits of lab-grown meat will be a vital tool in facilitating lab-grown meat production.¹⁶⁶ Currently, America's perception of lab-grown meat is not promising.¹⁶⁷ While many Americans are likely to try lab-grown meat, few believe it has the potential to replace farmed meat in their diet.¹⁶⁸ The main concerns of Americans regarding lab-grown meat are its high price and its lack

¹⁶³ See Bhat, *supra* note 147, at 786.

¹⁶⁴ Thrupp, *supra* note 129, at 265.

¹⁶⁵ EVERETT M. ROGERS, *DIFFUSION OF INNOVATIONS* 15 (3d ed. 1971) (describing how villagers in Los Molinos did not understand germ theory and, therefore, did not understand the reasons for boiling their drinking water).

¹⁶⁶ See Patrick D. Hopkins & Austin Dacey, *Vegetarian Meat: Could Technology Save Animals and Satisfy Meat Eaters?*, 21 J. AGRIC. ENVTL. ETHICS 579, 589 (2008) (describing how moral objections to in vitro meat could be overcome by demonstrating how it would lead to less animal suffering); see also Jane Switzer, *Would You Eat Test-Tube Meat?*, NAT'L POST (July 16, 2011), <http://news.nationalpost.com/2011/07/16/would-you-eat-test-tube-meat/> (discussing how common consumer misconceptions, such as in vitro foods being more unnatural than staple foods, can be remedied by proper marketing).

¹⁶⁷ See Wilks, *supra* note 152.

¹⁶⁸ *Id.*

of flavor and a perception of the product as unnatural.¹⁶⁹ There are several methods the government could use to counter these misguided beliefs. Each of these approaches will necessarily be opposed by the traditional meat industry; however, the manner in which to address this particular opposition is beyond the scope of this Comment.

a. Labeling

By labeling lab-grown meat products, the government could easily communicate relevant information to the consumer to foster a sense of trust and understanding.¹⁷⁰ Such a label could have a straightforward diagram explaining the process of nurturing the cells. Breaking down the science behind lab-grown meat into easily understood terms may allay consumers' fear of the product. Additionally, the label could list the ecological footprint of the process and compare it to the ecological footprint of conventional farm-raised meat. As Americans gain a better understanding of the anthropogenic impacts on the planet, the demand for more environmentally friendly products has increased.¹⁷¹ Thus, it is likely that the ecological footprint comparison would be effective. Furthermore, more Americans are becoming concerned with health and wellbeing.¹⁷² An inclusion of increased nutritional content of lab-grown meat may also be compelling information to the consumer.

The success of eco-labeling in other industries could serve as examples for the lab-grown meat industry.¹⁷³ For example, the "Dolphin-Safe" policy Star-Kist adopted for tuna in 1990 was widely successful in changing consumer preferences and demands while also

¹⁶⁹ *Id.*

¹⁷⁰ See generally Zachary Schneider, Comment, *In Vitro Meat: Space Travel, Cannibalism, and Federal Regulation*, 50 HOUS. L. REV. 991 (2013).

¹⁷¹ See *Business scramble to keep up with green product demand*, GREENBIZ (May 24, 2012, 6:00 AM), <https://www.greenbiz.com/blog/2012/05/24/businesses-scramble-keep-up-with-green-product-demand>.

¹⁷² See *American Adults are Choosing Healthier Foods, Consuming Healthier Diets*, U.S. DEP'T OF AGRIC. (Jan. 16, 2014), <https://www.usda.gov/media/press-releases/2014/01/16/american-adults-are-choosing-healthier-foods-consuming-healthier>.

¹⁷³ See generally Abhijit Banerjee & Barry D. Solomon, *Eco-labeling for energy efficiency and sustainability: a meta-evaluation of US programs*, 31 ENERGY POL'Y 109, 109.

fostering a sense of trust with a particular product.¹⁷⁴ As the largest tuna canner in the world, Star-Kist's decision to cease purchasing tuna caught by drift or gill nets, or captured in nets with dolphins, gave consumers the opportunity to choose an environmentally friendly option—and they did.¹⁷⁵ The label “no harm to dolphins” with a tiny blue dolphin over blue water became a symbol shoppers looked for, trusted, and expected, consequently shifting demand so that other tuna canners followed suit.¹⁷⁶ In the case of lab-grown meat, it appears likely that even a simple label of “no harm to animals or humans” could have a profound effect. Not only is lab-grown meat on the way to becoming completely kill-free, but it also does not harm humans like conventional meat does with greenhouse gas emissions and waste pollution.¹⁷⁷ Consumers would expect to see the “no harm to animals” phrase on lab-grown meat, but adding “or humans” to the label could force consumers to look at the harsh truth of the modern meat industry. The understanding that would come with this type of labeling would foster a trust in lab-grown meat over traditionally farmed meat because consumers would better understand the extent of harm stemming from traditional meat production compared to lab-grown meat.

b. Marketing

The U.S. government supports the marketing of products it finds important to the economy and human health.¹⁷⁸ For example, the USDA's Agricultural Marketing Service provides support to the dairy industry through its Dairy Program.¹⁷⁹ Thus, the government should

¹⁷⁴ See United Press International, *StarKist Adopts 'Dolphin-Safe' Policy on Tuna*, L.A. TIMES (April 12, 1990), http://articles.latimes.com/1990-04-12/business/fi-1772_1_starkist-tuna.

¹⁷⁵ *Id.*

¹⁷⁶ See generally Sharon Dowell, *Starkist Supports Dolphin Safety*, NEWS OK (July 4, 1990, 12:00 AM), <http://newsok.com/starkist-supports-dolphin-safety/article/2322959>.

¹⁷⁷ See generally NANALYZE, *supra* note 131.

¹⁷⁸ See generally *National Dairy Promotion & Research Board*, U.S. DEP'T OF AGRIC., AGRIC. MARKETING SERV., <https://www.ams.usda.gov/rules-regulations/research-promotion/dairy> (last visited Oct. 3, 2017).

¹⁷⁹ See *Dairy Program*, U.S. DEP'T OF AGRIC., AGRIC. MARKETING SERV., <https://www.ams.usda.gov/about-ams/programs-offices/dairy-program> (last visited Nov. 6, 2017).

support the marketing of lab-grown meat in a similar fashion. This support would include creating a program to grade the quality of lab-grown meat in order to provide buyers and sellers with an impartial evaluation of the product quality.¹⁸⁰ The program would also include a plan to provide information to small businesses in the production and processing of lab-grown meat.¹⁸¹ Additionally, the program would develop and finance general advertising to maintain and expand markets.¹⁸²

One aspect of the marketing should include information that addresses the possible health risks associated with consuming lab-grown meat. Public perception of lab-grown meat runs the risk of becoming analogous to that of genetically modified organisms ("GMOs"); thus, proper marketing will be vital to assuage any of these concerns.¹⁸³ Marketing must emphasize the fact that lab-grown meat is *not* a genetically modified food.¹⁸⁴ The cells in lab-grown meat are derived from the same stem cells that form muscle cells in cows.¹⁸⁵ However, it is true that while assumed to be at least as safe as regular beef, it will take years to know what the real impact of consuming lab-grown meat is on an individual human's health.¹⁸⁶ Still, as previously discussed, the fact that the meat can be made to contain more nutrients and would not have contaminants, such as arsenic or dangerous bacteria, may suggest that it is safer to eat than farm-raised meat.¹⁸⁷ An

¹⁸⁰ See generally *How to Apply for Service*, U.S. DEP'T OF AGRIC., AGRIC. MARKETING SERV., <https://www.ams.usda.gov/services/grading/request-service#dairy> (last visited Nov. 6, 2017).

¹⁸¹ See generally *Dairy Small Business Assistance*, U.S. DEP'T OF AGRIC., AGRIC. MARKETING SERV., <https://www.ams.usda.gov/services/dairy/sba> (last visited Nov. 6, 2017).

¹⁸² See generally *Fluid Milk Processors Promotion Board*, U.S. DEP'T OF AGRIC., AGRIC. MARKETING SERV., <https://www.ams.usda.gov/rules-regulations/research-promotion/fluid-milk> (last visited Nov. 6, 2017).

¹⁸³ See Stone, *supra* note 132.

¹⁸⁴ *Id.*

¹⁸⁵ Shirley S. Wang, *Scientists Cook Up Lab-Grown Beef*, WALL ST. J. (Aug. 5, 2013, 3:11 PM), <https://www.wsj.com/articles/SB10001424127887323420604578650194180347284>.

¹⁸⁶ *Id.*

¹⁸⁷ See Marta Zaraska, *Lab-grown meat is in your future, and it may be healthier than the real stuff*, WASH. POST: HEALTH & SCIENCE (May 2, 2016), <https://www.washingtonpost.com/national/health-science/lab-grown-meat-is-in-your-future-and-it-may-be-healthier-than-the->

example of smart marketing in this regard is illustrated by Memphis Meats.¹⁸⁸ To address the perception of “naturalness” and further distinguish its product from GMOs, Memphis Meats has already marketed its product as “clean meat” made at a “meat brewery.”¹⁸⁹

2. *Subsidies and Tax Incentives*

The U.S. government employs a multitude of mechanisms to support the development and growth of the economy.¹⁹⁰ The usual mechanisms are subsidies, which include direct grants, loans, research and development support, and tax incentives.¹⁹¹ Energy markets are an example of an area in which the government has intervened.¹⁹² The government has intervened in the past to develop public goods and maintain national security and defense.¹⁹³ The subsidies enacted encourage private individuals to invest in the public good and provide benefits to the American society at large.¹⁹⁴ Food security is just as important as national security, and the U.S. government must enact subsidies and give research and development support to lab-grown meat facilities. While this may be the first time for the U.S. government to provide financial support for lab-grown meat, precedent exists for a government to recognize the potential of lab-grown meat and support its development.¹⁹⁵ From 2005 to 2009, a Dutch government agency funded cultured meat research.¹⁹⁶ Furthermore, this would also not be

real-stuff/2016/05/02/aa893f34-e630-11e5-a6f3-21ccdbc5f74e_story.html?utm_term=.ee 1577
b4002b.

¹⁸⁸ Clint Rainey, *World's Largest Ground Beef Company Just Gave a Big Vote of Confidence to Lab-Grown Meat*, N.Y. MAG: GRUB STREET (Aug. 23, 2017), <http://www.grubstreet.com/2017/08/cargill-invests-future-in-memphis-meats-lab-grown-beef.html>.

¹⁸⁹ *Id.*

¹⁹⁰ Tracey M. Roberts, *Picking Winners and Losers: A Structural Examination of Tax Subsidies to the Energy Industry*, 41 COLUM. J. ENVTL. L. 63, 65 (2016).

¹⁹¹ *Id.*

¹⁹² *Id.* at 68–69.

¹⁹³ *Id.*

¹⁹⁴ *Id.*

¹⁹⁵ Isha Datar et al., *Mark Post's Cultured Beef*, NEW HARVEST (Nov. 3, 2015), http://www.new-harvest.org/mark_post_cultured_beef.

¹⁹⁶ *Id.*

the first time for the U.S. government to intervene in food production, as discussed in this Comment's section on government involvement in the expansion of the modern meat industry, *supra* Part II.B.¹⁹⁷

The federal government could also model a program for lab-grown beef after the energy industry's tax incentives. Similar to tax breaks given to businesses that install certain renewable energy technology,¹⁹⁸ the government could enact tax incentives to businesses that invest in or sell lab-grown meat products. Currently, the Internal Revenue Service, through the Consolidated Appropriations Act, administers the Business Energy Investment Tax Credit ("ITC").¹⁹⁹ The ITC gives a rebate of 30 percent for solar, fuel cells, and wind technologies to businesses.²⁰⁰ In short, if a business has installed a qualified renewable energy technology, then it can receive a reduction in tax liability of thirty percent of the cost of installing the product.²⁰¹ Mimicking this tax incentive for the production of lab-grown meat could involve a tax credit given to individuals who invest in the technology, or tax credits given to startup companies researching the technology, or even a tax credit given to restaurants that serve lab-grown meat. Any of these incentives would help facilitate the expansion of lab-grown meat until it becomes economically viable on its own. Just as renewable energy is on its way to becoming the most economically efficient source of energy, it is very likely that lab-grown meat will outperform farm-grown meat due to its efficiency and minimal externalities.²⁰² Lab-grown meat needs initial support from the government, so that the industry can continue to grow sustainably and Americans will be able to realize lab-grown meat's substantial benefits as soon as possible.

These tax incentives could promote and encourage the meat industry to invest more in lab-grown meat. Tyson and Cargill, as

¹⁹⁷ See Schwennesen, *supra* note 62.

¹⁹⁸ See Roberts, *supra* note 190, at 94.

¹⁹⁹ *Business Energy Investment Tax Credit (ITC)*, ENERGY.GOV, <https://energy.gov/savings/business-energy-investment-tax-credit-itc> (last visited Nov. 7, 2017).

²⁰⁰ *Id.*

²⁰¹ *Id.*

²⁰² See generally Bhat, *supra* note 147 (explaining that lab-grown meat is much more efficient than its counterpart).

discussed previously *supra* Parts III.A and III.B, respectively, have already recognized the potential of meat alternatives by investing in meat alternatives.²⁰³ Incentivizing further investment could mean less of a political battle between farm-raised and lab-grown meat and create the possibility for a smoother transition to lab-grown meat. Again, a comparison to the energy industry best illustrates the impact that government and private sector investment could have on the lab-grown meat industry.²⁰⁴ By enacting laws such as the Energy Policy Act of 2005, the U.S. government shifted federal incentives for energy production towards renewable energy, as opposed to nonrenewable.²⁰⁵ This shift has encouraged large energy companies to invest in renewable energies when they may have not otherwise.²⁰⁶ Thus, these companies are less likely to adamantly oppose the expansion of this type of energy. In other words, perhaps instead of being the enemy of lab-grown meat, the modern meat industry could become an ally, if the U.S. government gave them incentives to do so.

B. Regulatory Controls Needed After Implementation of Lab-Grown Meat

As production of lab-grown meat expands, an important consideration is how the industry could be regulated in order to protect consumers.²⁰⁷ A product such as lab-grown meat, since it is a food product, would likely fall under the oversight by the Food and Drug Administration (“FDA”) and the USDA.²⁰⁸ Thus, the doctrine of

²⁰³ See McGroarty, *supra* note 112.

²⁰⁴ See generally Anna Hirtenstein, *Big Oil Follows Silicon Valley Into Backing Green Energy Firms*, BLOOMBERG (Aug. 14, 2017, 11:00 PM), <https://www.bloomberg.com/news/articles/2017-08-15/big-oil-follows-silicon-valley-into-backing-green-energy-firms> (describing how private sector investments are supporting the renewable energy industry).

²⁰⁵ Lamar Smith, *Tax Subsidies For Renewables Now Far Outpaces Fossil Fuels*, REAL CLEAR ENERGY (April 28, 2017), http://www.realclearenergy.org/articles/2017/04/28/tax_subsidies_for_renewables_now_far_outpaces_fossil_fuels_110217.html.

²⁰⁶ See generally Kieran Cooke, *Exxon, Shell, Total, Statoil renew clean energy drive*, CLIMATE HOME NEWS (May 23, 2016, 9:47 AM), <http://www.climatechangenews.com/2016/05/23/exxon-shell-total-and-statoil-make-clean-energy-plays/>.

²⁰⁷ See Schneider, *supra* note 170.

²⁰⁸ *Id.*

substantial equivalence, the Food, Drug, and Cosmetics Act (“FDCA”), and the Wholesome Meat Act (“Meat Inspection Act”) would all apply to lab-grown meat.²⁰⁹ Under the doctrine of substantial equivalence, the government would test the product to determine whether it is substantially equivalent to its natural counterpart.²¹⁰ The FDCA allows the FDA to regulate food additives and also gives the government the power to identify and prevent “adulterated” foods from entering the country’s food supply.²¹¹ In association with the FDCA, the FDA also has the power to determine what food additives are considered Generally Recognized as Safe Food (“GRAS”) by having experts and scientists test the safety of the substance.²¹² The Meat Inspection Act gives the USDA the power to create regulations to ensure the sanitary conditions at meatpacking plants.²¹³ Thus, the USDA requires sterile and sanitary conditions for all surfaces and tools that may contact food, use of safe cleaning products, and cleanliness standards for workers.²¹⁴ These regulations, as applied to lab-grown meat, would provide a framework for its safe production because lab-grown meat is already much safer than its counterpart in terms of chemicals and contaminants.

CONCLUSION

Livestock production creates an estimated 32,564 million tons of carbon dioxide per year.²¹⁵ Additionally, the largely unregulated waste from livestock production is polluting our nation’s vulnerable water resources.²¹⁶ However, there are solutions available to halt these

²⁰⁹ *Id.*

²¹⁰ See Marianna Schauzu, *The Concept of Substantial Equivalence in Safety Assessment of Foods Derived from Genetically Modified Organisms*, 2 *AGBIOTECHNET* 1, 1 (2000).

²¹¹ See 21 U.S.C.S. § 348 (LEXIS through Pub. L. No. 116-19).

²¹² 21 C.F.R. § 170.30(a)–(b) (2019).

²¹³ 21 U.S.C.S. § 608 (LEXIS through Pub. L. No. 116-19).

²¹⁴ See 9 C.F.R. § 416.4(a)–(d) (2019).

²¹⁵ Kevin Schneider, Comment, *Concentrating on Healthy Feeding Operations: The National School Lunch Program, “Cultured Meat,” and the Path to a Sustainable Food Future*, 29 *FLA ST. U. J. LAND USE & ENVTL. L.* 145, 157 (2013).

²¹⁶ See *FOODPRINT*, *supra* note 30.

harmful activities and their associated externalities.²¹⁷ Plant-based meat alternatives and lab-grown meat have the power to mitigate global climate change and help clean up fresh water resources by reducing the number of livestock used in the meat industry.²¹⁸ Specifically, lab-grown meat would have significant benefits because of the substantial reduction of land and water required to produce it and because of the dangers of relying on agriculture alone.²¹⁹

However, political will and support by the U.S. government is needed in order to make this environmentally sustainable society a reality as quickly as possible. By supporting the dissemination of information about lab-grown meat through labeling and marketing, public perception would change, and acceptance and trust would be more likely. Furthermore, by implementing tax incentives and subsidies for businesses, the lab-grown meat industry would produce an economically viable product much faster than it would otherwise. By setting a positive example, the United States could lead the rest of the world to a more sustainable and environmentally healthy planet.

²¹⁷ See Norton, *supra* note 154.

²¹⁸ See generally Pirrone, *supra* note 162.

²¹⁹ See generally Thrupp, *supra* note 129; see also Bhat, *supra* note 147, at 786–87.