

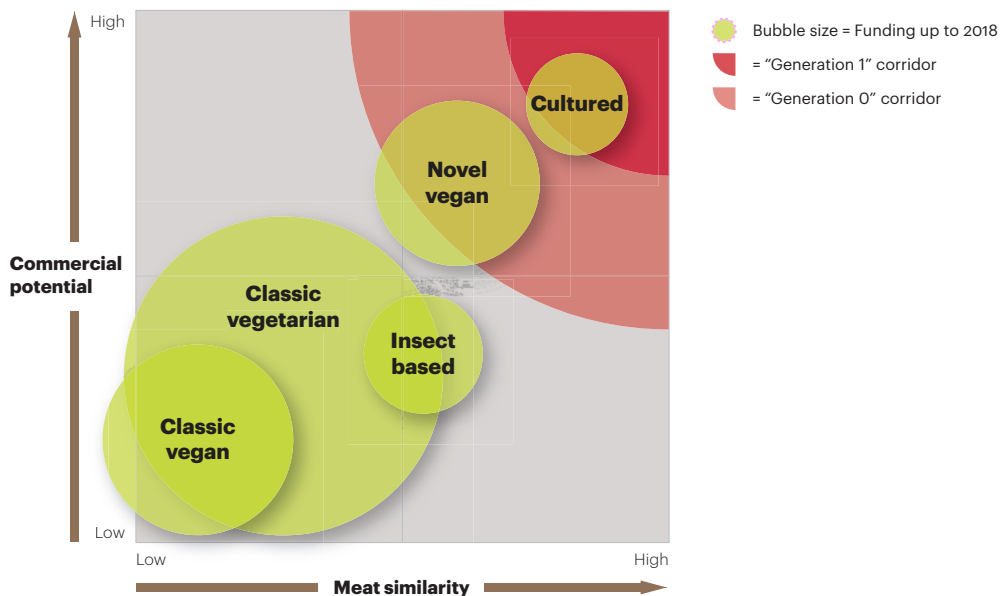
How Will Cultured Meat and Meat Alternatives Disrupt the Agricultural and Food Industry?



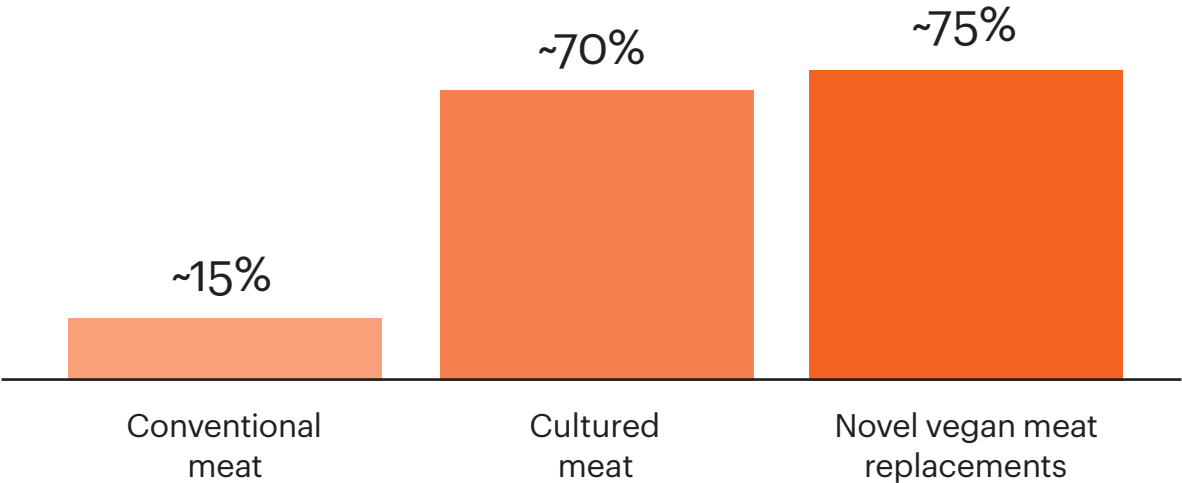
Global meat market (producing feed and meat):
1,000 billion US dollars in 2018

Novel vegan meat replacements and **cultured meat** have the potential to disrupt the meat industry.

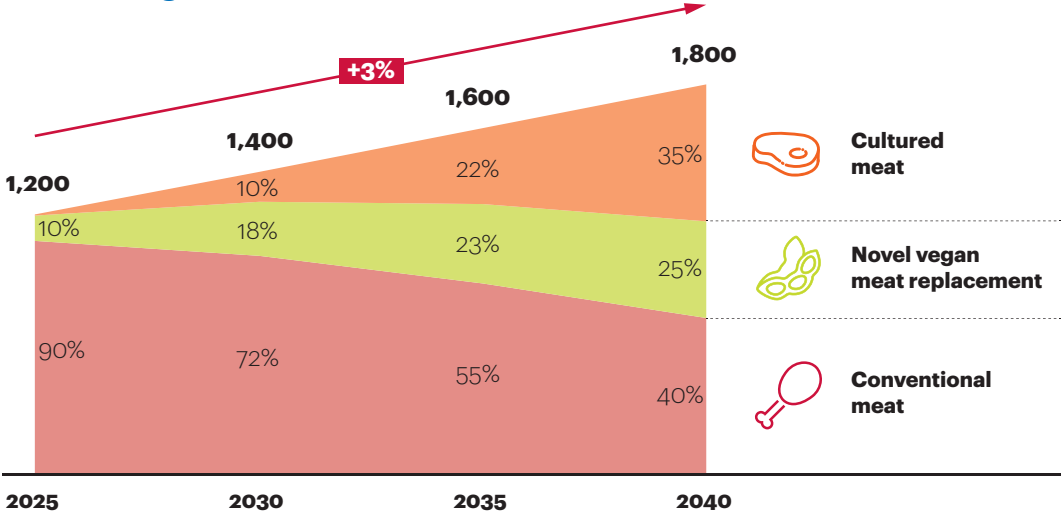
Overview on cultured meat and meat alternatives



Conversion rate of plant calories to meat and meat alternative calories



Global meat market forecast (in \$ bn, global)



Cell- and fermentation-based technology companies will leverage their intellectual property **to cover as much animal products as possible.**

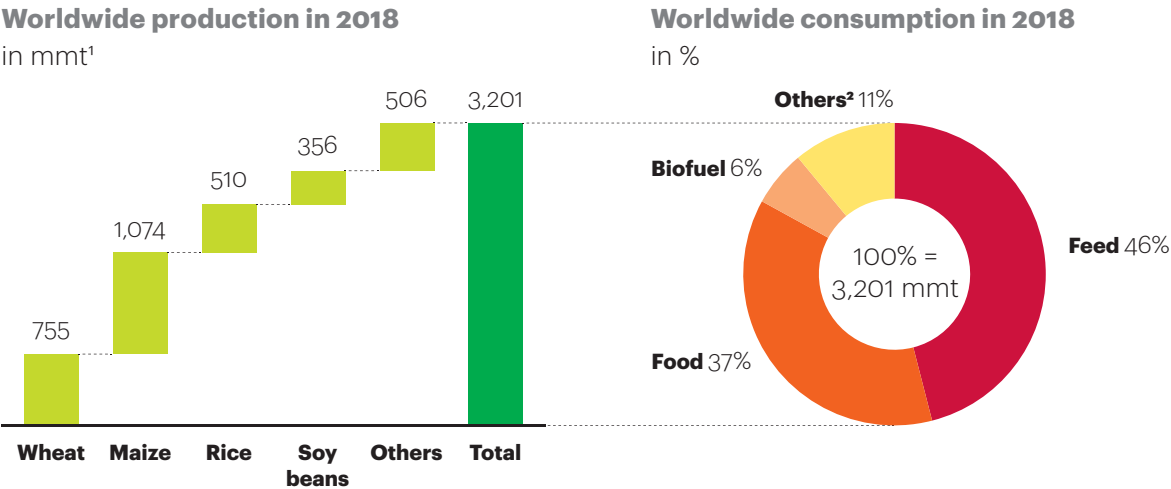
A number of meat alternatives are evolving, each with the potential to disrupt the multi-billion-dollar global meat industry. The essential questions, however, are which of those new products have the most disruption potential, what are the resulting shifts within the value chain, and who will benefit most? Based on our work in the global agriculture, food, and meat industry, we shed some light on the major disruptive trends and provide a trigger point to redirect the strategies of companies affected.

Globally, Meat Is a Huge Business and Will Grow Further

Global population—which was around 7.6 billion in 2018—is projected to increase to around 10 billion in 2050. To sustain all these people, a massive amount of food is required. However, according to the Food and Agriculture Organization of the United Nations (FAO), nearly half of the worldwide harvest is required to feed the livestock population, which consists of about 1.4 billion bovines, 1 billion pigs, 20 billion poultry, and 1.9 billion sheep, lamb, and goats (see figure 1). Agricultural production directly for human consumption accounts for just 37 percent, representing the second largest harvest consumption block (ahead of biofuel, industrial production, and others). Thus, most of the harvest is fed to animals to produce meat, which finally is consumed by humans. In the following elaborations, the term “meat” refers to bovine, pig, poultry, sheep, lamb, and goat meat but does not include game or seafood (for example, fish and crustaceans).

Reliable data are difficult to obtain, but according to the American Oil Chemists’ Society (AOCS) and our own field research, it takes about 7 kg of grain in dry weight to produce 1 kg of live weight for bovine in feedlots, around 4 kg of grain in dry weight per 1 kg of live weight for

Figure 1
Livestock feed consumes a large fraction of the total harvest



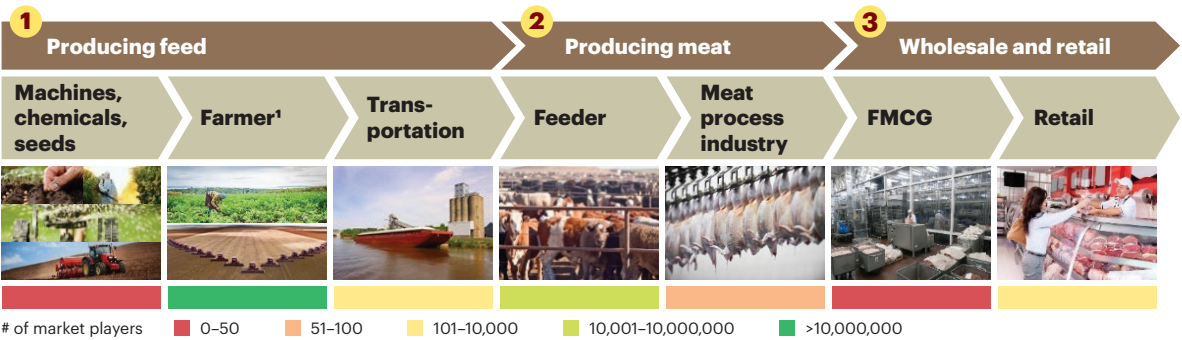
¹ mmt = million metric tons
² Others = industry consumption and deterioration
Sources: OECD, FAO; A.T. Kearney analysis

pigs, and for poultry it is just over 2 kg in dry weight. However, as this is live weight and not meat, all byproducts—which account for about 40 percent of live weight—must be subtracted.¹ Hence, in the example of poultry, around 3 kg of grain are required to produce 1 kg of meat.² Bearing in mind that meat has on average the same calories per kg as a mix of wheat, maize, rice, and soy beans, the conversion of the 46 percent of worldwide feed production into meat adds less than 7 percent to worldwide available food calories.³ This in turn implies that 44 percent of today’s global agricultural production (37 percent plus 7 percent) would be enough to feed most humans.

It is worthwhile to note that a plant-based diet would not only provide the same calories but also have the same nutritional value if crops are chosen accordingly to have enough protein. Hence, we could feed around twice as many humans with today’s global harvest if we did not feed livestock but rather consumed the yield ourselves. Based on the current worldwide population of 7.6 billion humans, we would have food for an additional 7 billion people. This number would increase even further if less of the harvest ended up in biofuel and industrial use or if waste could be reduced.

Given the enormous global harvest needed to feed our livestock, the size and impact of the global meat industry should not come as a surprise. Ultimately, the meat chain is part of the global food chain, which has an estimated value of 10 percent of global GDP or \$8.8 trillion for 2018 in absolute numbers. Figure 2 shows the entire meat value chain, which is characterized by production and processing steps, retail, and a strong linkage with the agricultural industry.

Figure 2
The global meat value chain consists of seven steps organized in three sections



¹ Farmers cultivating at least five hectares
 Sources: OECD, FAO, Zion Market Research, Meat Atlas, Grand View Research; A.T. Kearney analysis

1 Producing feed. To grow plants, several agricultural input factors such as equipment and machinery, seeds, fertilizer, and agrochemicals are required. These inputs come from a highly consolidated global industry with only a handful of big players. In the agriculturally developed world around 30 million professional farmers produced animal feed at a farm-gate value of around \$600 billion in 2018.⁴ This only considers the yield which is consumed by livestock.

¹ In the western world byproducts not only include bones and skin but also organs and meat parts such as liver, pork belly, or tripe, which are not in high demand by consumers.
² According to industry experts, the conversion rate from grain to meat for poultry can be improved from 3.0 to 1.8 kg of grain for 1 kg of meat, but this holds true only for optimized industrial livestock farming conditions.
³ “Feed production” refers to crop yields from arable land; pasture land is not considered here.

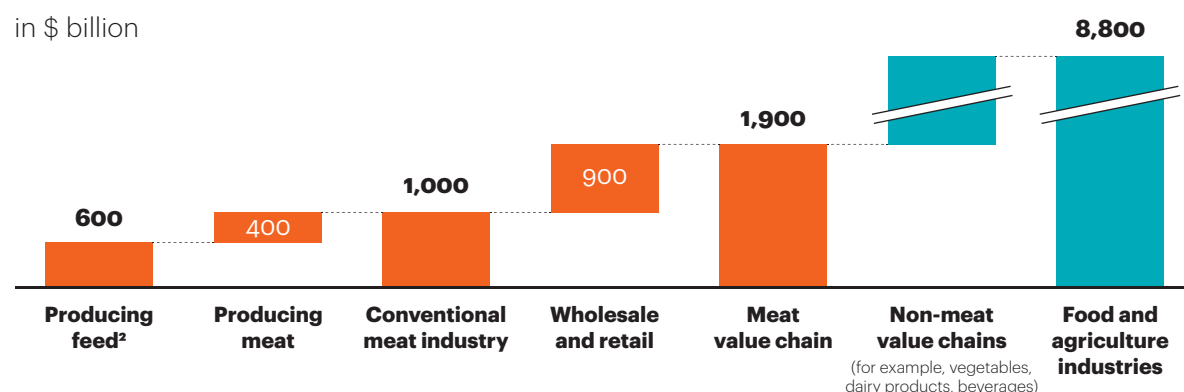
2 Producing meat. First, feeders grow and fatten livestock, and then the animals are slaughtered and processed to meat products. The value-add in this part of the value chain was around \$400 billion in 2018. Players in this step on the feeder side are counted in millions, with some corporations sticking out (for example, Five Rivers Cattle Feeding, LLC in Colorado or “hog hotels” for pigs operated by Guangxi Yangxiang Co., Ltd.). The meat processing industry at the next step is rather highly consolidated; dominant players include JBS, Tyson Foods, Cargill, BRF, Nippon Meat Packers, and Smithfield Foods.

Not feeding livestock but consuming the yield ourselves would provide enough food to nourish the global human population beyond 2050.

3 Wholesale and retail. Meat and meat-containing products are further processed by fast-moving consumer goods companies (FMCG) or are directly sent to retailers to be sold to the end-consumer. The value add in this step was around \$900 billion in 2018.

Even though the total meat value chain has a size of around \$1,900 billion, meat replacements will primarily disrupt the agricultural and conventional meat industry with a total value of around \$1,000 billion (see figure 3). FMCG and retailers sell end products, be it meat or meat replacements, to end-consumers and are less affected—if at all—by new products and changing customer behavior. Therefore, the focus of this paper is to highlight the potential disruption within the first two sections of the meat value chain (producing feed and producing meat).

Figure 3
The current global meat value chain has a size of around \$1,900 billion¹



¹ Numbers are rounded to hundred billions.

² Only the fraction relevant for meat production is taken into account.

Sources: OECD, FAO, Zion Market Research, Meat Atlas, World Bank, Grand View Research; A.T. Kearney analysis

⁴ These are solely farmers cultivating at least five hectares. When considering smallholder farmers as well, the total number increases to around half a billion.

Solutions for Increasing the Efficiency of Conventional Meat Production Have Been Almost Exhausted

The global agriculture and meat industry faces enormous challenges to meet the growing global meat demand while transforming to a more sustainable meat system.

Land challenge. In a world where arable land is shrinking due to global warming and sprawling cities and can only be expanded at the cost of losing valuable natural habitats such as rain forests, it's hard to justify expanding acreage used to produce feed. In addition, the total number of people will increase by about 2.5 billion in the next 32 years. Both effects—shrinking arable land and rising human population—lead to a worldwide reduction from 0.38 hectare per capita in 1970 to around 0.15 hectare per capita in 2050. The availability of fresh water, particularly in dry and less rain intense areas, is another challenge to maintaining fertile land. According to FAO and Aquastat, global agriculture today already uses around 70 percent of “blue” water.⁵ This is hardly sustainable, as evidenced by the many water-stressed areas around the world.

Intensification challenge. A further intensification of agricultural production is reaching its limits—the downsides of the current industrialized farming practices are already clearly visible. For example, resistances to modern agrochemicals are on the rise, soil compaction poses problems, and soil erosion is an issue. The reduction of biodiversity in intensively cropped areas is increasingly coming onto the radar of stakeholders and decision-makers. Regulation of agrochemicals is expected to get stricter in all geographies.

Livestock challenge. Moving from field to feedlot, additional challenges of conventional meat production surface, from antibiotic use to zero-tolerance for animal harm. The use of antibiotics to avoid livestock epidemics will cause antibiotic resistance of humans resulting in major health risks. Finally, scandals involving feces—and the handling of those scandals by the meat industry—have contributed to consumers losing their appetite for factory-farmed meat. More and more people are against the industrialized slaughtering of their fellow creatures; “non-slaughtered” is appealing to many people already. Industrialized meat production faces an image problem and the large-scale livestock industry is viewed by many as an unnecessary evil.

All predominant innovations, including digitalization, simply increase efficiency of conventional production methods and won't overcome global agricultural and food challenges.

⁵ Freshwater can be differentiated as “green” and “blue” water. While “green” water is rain falling on the Earth's surface and being absorbed by plants, “blue” water is in lakes, rivers, groundwater, and glaciers.

To this point, the agriculture and meat industries have, for the most part, tried to address their challenges by further increasing efficiency of the conventional production methods. Digital farming—cropping regimes that are very much tailored to the needs of individual small plots on the field—can contribute to an increase in agricultural production as it will help lift yields by around 20–30 percent without increasing agricultural inputs. In meat production, optimization of input–output relation (conversion rate) by, for instance, substituting fish meal with protein-rich insect meal as well as increasing automation via digital tools can play a major role. Digital can help improve growth of the animals through more optimized feeding regimes, reducing the amount of feed needed to reach slaughter weight by up to 10 percent.

However, improving efficiency of conventional methods is not enough in the long run to cope with the pressing challenges of our food system. In addition, all the above-mentioned solution approaches have one aspect in common: they do not disrupt the conventional method to produce meat but rather incrementally improve it. In the following sections, meat replacements are presented which have the potential to disrupt the agricultural and meat industries.

New Meat Products and Market Players Are Evolving

Instead of further optimizing the conventional meat production, several companies focus on inventing new products to replace conventional produced meat. These products range from plant-based meat alternatives and insect-based meat replacements to cultured meat. As many companies with slightly different product offerings have emerged, the list of new products and brands is long and growing. Nevertheless, the following five product classes can be differentiated:

Classic vegan meat replacements. These products have existed for several years and are mainly based on tofu, seitan, mushrooms, or jackfruit without any animal ingredients such as egg, gelatin, or milk. The main disadvantage of these classic vegan products is their sensory profile, which is unlike meat and thus these products don't appeal to average consumers. Hence, they have historically been sold in a niche mainly to vegan and ethically motivated consumers.

Classic vegetarian meat replacements. Classic vegetarian meat replacements have been in the portfolio of most large meat producers and retailers for several years. In addition to plant-based ingredients, these products also contain animal ingredients such as egg or gelatin. Hence, livestock is still required to produce them on a large scale. Also, their sensory profile is unlike meat making them relatively unattractive to the average end-consumer.

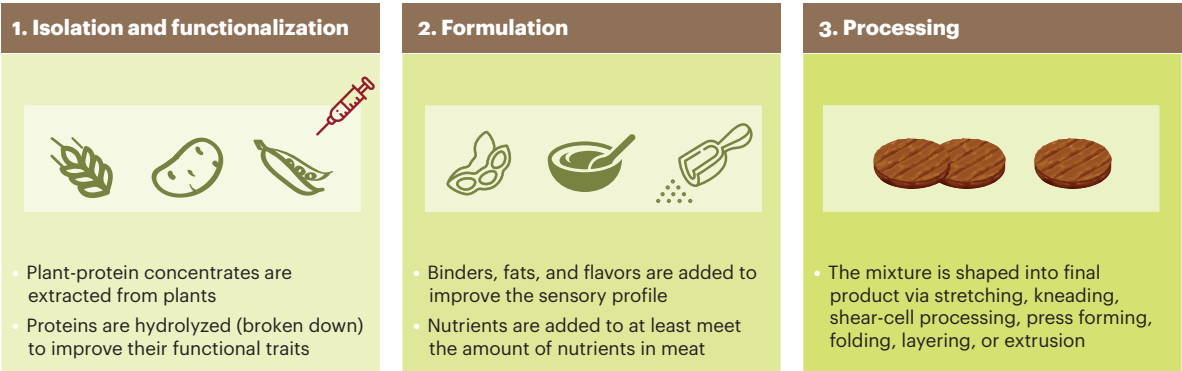
Insect-based meat replacements. These products are made of insect protein, mainly from mealworms and crickets. Some companies sell fried crickets and others process insects into burger patties or meatballs. The main advantage of insects is the superior conversion of energy and protein compared to conventional meat. However, while insect-based meal has enormous potential as food for livestock or for industrial food processing, insect-based meat replacements for human consumption represent a niche mainly due to their lack of an adequate sensory profile and negative consumer perception of insects as a food source in most Western countries.

Novel vegan meat replacements. No animal ingredients are required as these products are completely made of plant-based inputs (see figure 4). Nevertheless, their sensory profile gets a lot closer to meat than classic vegan meat replacements. The main reason for the improved sensory profile is a sophisticated production process with the use of hemoglobin and binders, extracted via fermentation from plants, which imitates the sensory profile of meat and even blood to complete the meat-like experience. Start-ups in this field, such as Impossible Foods, Just, and Beyond Meat, evolved around 2010 and have received substantial financing (totaling around \$900 million up to 2018). Their products are already available in restaurants and supermarkets in several countries.

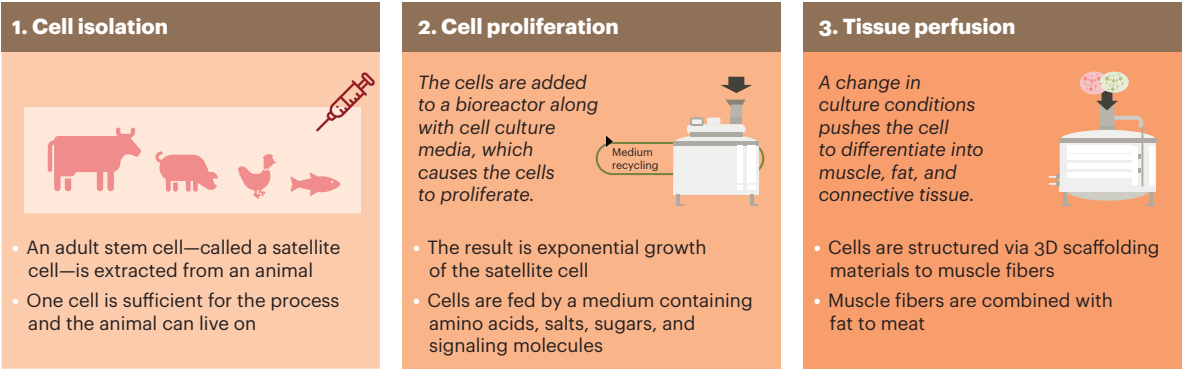
Cultured meat. This type of meat, also referred to as clean meat, cell-based meat, or slaughter-free meat, has evolved in recent years and represents meat that is created through exponential cell growth in bioreactors. In the first step a cell is extracted from a living animal, then the cell is fed with a media to proliferate, and finally the resulting muscle and fat cells are structured in 3D scaffolding materials to meat. The result is meat which is identical to conventionally produced meat. While several of the first start-ups in this field have done public and private tastings of various prototypes, no commercial products are sold yet.

Figure 4
The production processes for novel vegan meat replacement and cultured meat are quite different

Process to create novel vegan meat replacement



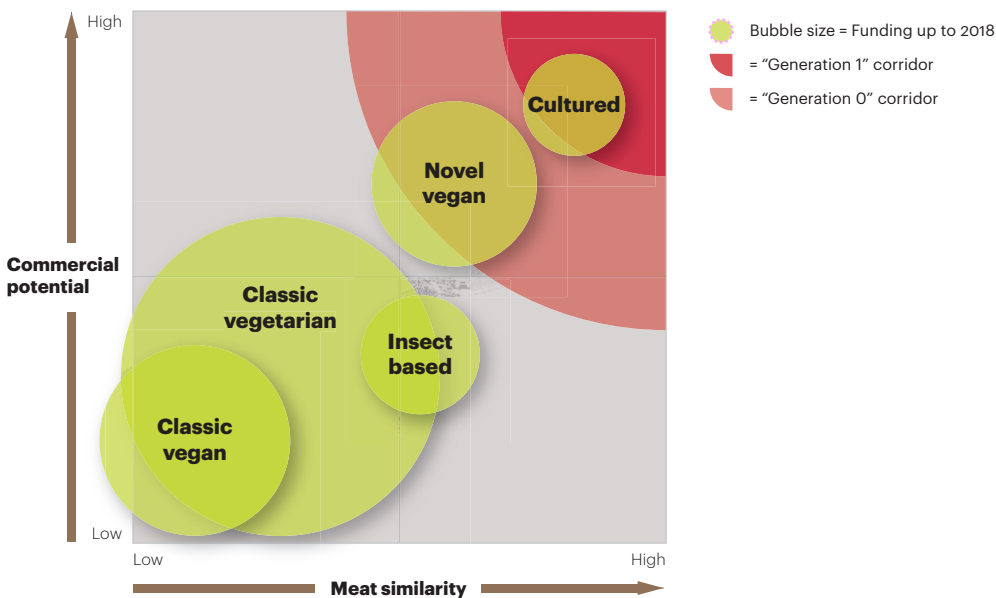
Process to create cultured meat



Sources: Good Food Institute, Impossible Foods; A.T. Kearney analysis

The total market for plant-based meat alternative products was around \$4.6 billion in 2018, with a growth projection of 20 to 30 percent per year (depending on region) for the next several years. As this represents a small fraction of the \$1,000 billion global meat market, a lot of upside potential remains. In figure 5, all five product classes are plotted based on three dimensions—meat similarity, commercial potential, and total funding. Meat similarity is defined by the degree to which the sensory profile and mix of nutrients and vitamins match that of meat. Commercial potential represents the addressable market share, the expected growth, and the competitiveness in terms of price within the next decade, which is estimated based on expert interviews. Funding is defined as the total amount of financial resources that was raised up to 2018.

Figure 5
Meat similarity drives the commercial potential



Sources: A.T. Kearney analysis

According to industry experts, classic vegan and vegetarian meat replacements as well as insect-based meat alternatives are less likely to grow beyond the current vegan and vegetarian trend as they lack the sensory profile to convince average consumers. Thus, their commercial potential is limited to the nature and size of the corresponding consumer type (for example, vegan, vegetarian, and ethical attitude and standards). In contrast, novel vegan meat replacements and cultured meat have the potential to disrupt the \$1,000 billion conventional meat industry. This is in line with industry experts often referring to novel vegan meat replacements as “Generation 0” and cultured meat as “Generation 1.” The names emphasize their novelty and potential but also the different pace of product development and market penetration. According to most industry experts, novel vegan meat replacements are more relevant in the transition phase toward cultured meat, whereas the latter will be most relevant in the long term. The predicted triumph of cultured meat is based on the compatibility of sustainability and a tailor-made nutrition through meat products, from low to premium quality, able to satisfy the diverse consumer types and preferences.

Driven by advances in biotechnology, cultured meat and novel vegan meat replacements are becoming harbingers of much larger changes across the whole food value chain.

These major changes in the global meat market will be driven by the further development and industrialization of biotechnological processes in the food industry. Within a few years, the emerging market and technology leaders in the field of novel vegan and cultured meat replacement have become an integral part of prestigious start-up spots such as California, Israel, and the Netherlands. These start-ups already exert an attraction and glamour on young top graduates in their countries, similar to that expected from Google, Tesla, or Apple. Figure 6 illustrates a snapshot of the most relevant and promising companies in both fields as well as the corresponding global funding up to 2018.

Figure 6
The meat replacement industry is attractive for venture capital

Selected cultured meat companies

<i>Appleton Meats</i>	<i>Biofood</i>	<i>Memphis Meats</i>	\$50 million in global funding up to 2018 
<i>biftec.co</i>	<i>New Age Meats</i>	<i>Integriculture</i>	
<i>FM</i>	<i>Meatable</i>	<i>mosa meat</i>	
<i>Mission Barns</i>	<i>Balletic Foods</i>	<i>Hs Higher Steaks</i>	
<i>avant</i>	<i>Aleph Farms</i>	<i>JUST</i>	
<i>Kiran</i>	<i>SuperMeat</i>		

Established novel vegan meat replacement brands

<i>Ojah</i>	<i>Sunfed</i>	\$900 million in global funding up to 2018 
<i>Field Roast</i>	<i>Like Meat</i>	
<i>Beyond Meat</i>	<i>JUST</i>	
<i>IMPOSSIBLE</i>	<i>right {treat}</i>	
<i>Moving Mountains</i>	<i>No Evil</i>	

Source: A.T. Kearney analysis

Next to venture capital funds and national funds (for example, China's national fund), it is large corporations such as Cargill, Tyson, Merck, Google, UBS, and PHW Group that have already invested in these companies. In addition to their financial support, most large corporations bring along agriculture-, biotechnology-, and food-related knowledge and often act as suppliers or customers for these start-ups.

Cell- and fermentation-based technology companies will leverage their intellectual property to cover as much animal products as possible.

Besides the presented meat-producing companies, several companies are focusing on novel plant-based and cultured seafood, leather, silk, egg white, milk, gelatin, and even horn. As the structures of cultured milk, egg white, gelatin, and leather are not as complex as meat, these products might hit the market even earlier than cultured meat. Some of these companies, such as cultured leather producer Modern Meadow, have already attracted multimillion-dollar funding as they look to bring their products on the market within the next few years. In the case of Modern Meadow, the chemical company Evonik helps to scale up the production and to make the leather available to designers of luxury goods.

Which Product Will Win in the Future Meat Market?

To assess whether one of the new products—the novel vegan meat replacements or cultured meat or even both—will disrupt the conventional meat industry, we compare the two products to conventional meat based on eight essential criteria.

Input materials. The inputs for conventional and novel vegan meat are relatively similar as they consist mainly of energy, water, and several arable crops (for example, wheat, potatoes, soy, and coconut oil). In contrast, the material input for cultured meat is a nutritious media which mainly consists of amino acids and glucose to feed cells. The inputs for the nutritious media can be extracted via hydrolyzation from a large variety of biomass, including livestock byproducts and several types of plants. According to industry experts, the best plants for the media production are soy, peas, corn, and red sugar beets. While glucose and amino acids are relatively cheap, the signaling molecules which stimulate cells to differentiate are currently very expensive. It is therefore not surprising that many research and development initiatives are aimed at further reducing this crucial cost block.

The conversion rates for cultured meat and novel vegan meat replacements are more than 4 times higher than for conventional meat.

Conversion rate. The conversion of grain in dry weight to meat with similar amounts of calories per kg is around 15 percent over all meat types as most of the energy input in livestock is lost to keep the body temperature constant, to create byproducts (for example, hair and organs), and for excretion of excrements.⁶ If meat byproducts are considered as edible meat, the conversion rate of grain to live weight is 23 percent. As most of the byproducts are currently used by industry or agriculture, it is reasonable to include them to present a comprehensive picture as novel vegan meat replacements and cultured meat don't create these byproducts when producing meat.

Compared to conventional meat, cultured meat needs significantly less material input and water to create the same amount of meat. According to our field research, around 1.5 kg of soy, peas, maize, and red sugar beets is required to produce 1 kg of cultured meat leading to a conversion rate of around 70 percent.⁷ As the technologies and production methods evolve, this conversion rate should improve. In addition, the cell-based technology can be applied to produce several livestock byproducts such as gelatin, leather, and blood to fulfill the needs of industry customers.

For novel vegan meat replacements, around 1.3 kg of arable crops are required to produce 1 kg of plant-based meat leading to a conversion rate of around 75 percent.⁸ Nevertheless, plant-based meat has the same nutritional profile as meat. Furthermore, significantly less water and energy are required compared to conventional meat production.

It can be stated that, on the one hand, the conversion rate of conventional meat can no longer be substantially improved and, on the other hand, lags far behind meat replacement products.

Cell- and fermentation based approaches in food industries will pave the way for a tailor-made as well as animal mimetic nutrition culture.

⁶ The calculation is based on the arithmetic average of the conversion rates of bovine, pig, and poultry (see page 4 of this article) as well as considering byproducts (non-edible meat) by 40 percent.

⁷ Based on expert interviews and A.T. Kearney analysis.

⁸ Based on expert interviews and A.T. Kearney analysis.

Product features. Cultured and novel vegan meat replacements have some key advantages in terms of product design such as the opportunity to customize the muscle-fat-nutrient ratio of the meat (for example, replacing fatty acids with omega and adding nutrients). Also, the shelf-life is longer, and less cooling is required for transportation since no bacteria (including salmonella or E. coli) foster the degradation process. Additionally, the new products don't have epidemic risks (for example, mad cow disease or bird flu) as they are part of a production process which is subject to strong quality management requirements. This circumstance will lead to a much higher security in meat supply chains. In addition, cultured meat still has the properties of real meat.

Scalability. Novel vegan meat replacements can be produced at scale and are already sold to end-consumers. In contrast, cultured meat products are not available on the market yet and production is at a very low scale as the type of cells, animal-free media, and bioreactors must be further improved and streamlined. Nevertheless, the upscale potential is enormous since these methods require significantly less arable land and water. According to industry experts, the technology to produce at scale will be ready by 2021. Based on current scaling effects, the US price for 100 g of conventional ground beef in retail stores is \$0.80. In contrast, novel vegan food replacement companies sold their 100 g burger patty for \$2.50 and cultured meat companies produced at \$80 per 100 g in 2018 (with a forecast to cut costs below \$4 per 100 g within the next 12 years).⁹ According to industry experts, the production costs of cultured meat can be even further decreased.

Consumer acceptance. Novel vegan meat replacements are marketable due to the trend toward semi-vegetarianism and their sophisticated sensory profile. Interestingly, this also applies to cultured meat. In recent surveys, most respondents in Western countries are willing to taste cultured meat and half of them are willing to buy it regularly. Similar studies show that people in India and China are particularly interested in cultured meat. Crucial for consumer acceptance is to educate society to point out the benefits of cultured meat.

Ethics and sustainability. Both meat alternatives have the potential to overcome most ethical and ecological agricultural challenges as no animal harm and significantly less livestock, land, and "blue" water is required. However, energy consumption in the form of heating and cooling is currently very high (though it is expected to decrease significantly over the next decade). According to industry experts, energy savings of more than 80 percent can be achieved when producing on a large scale with optimized bioreactors.

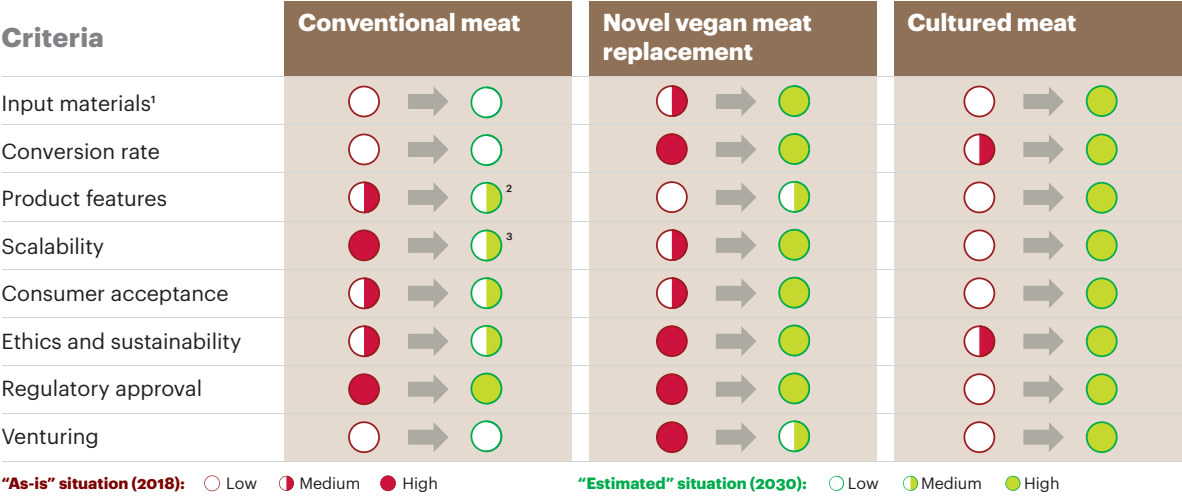
Regulatory approval. While novel vegan meat replacements don't face severe challenges with worldwide food authorities, cultured meat is at the beginning of a process to be accepted by most worldwide food regulators. In November 2018, the United States Department of Agriculture (USDA) and Food and Drug Administration (FDA) agreed to jointly regulate cultured meat, thereby providing the first step for legal access to cultured meat worldwide.

Venturing. Through 2018, the worldwide funding of novel vegan meat replacement companies reached \$900 million. The funding of cultured meat companies has reached the \$50 million threshold. As most cultured meat companies were founded around 2016 or 2017, this mostly represents early stage investments. Furthermore, meat replacement start-ups receive great financial and media support by large corporations, governments, and celebrities, including Richard Branson, Sergey Brin, and Bill Gates. For this reason, an increasing number of venture capital funds and corporate investors are expected to invest significantly more in these companies within the next several years.

⁹ This price assessment applies only to the so-called muscle meat; the price of mechanically separated and mixed meat is of course even lower.

Figure 7 summarizes A.T. Kearney’s assessment of the essential product criteria of conventional meat, novel vegan meat replacements, and cultured meat, while differentiating between the as-is situation (2018) and the estimated situation in 2030. Mainly, conversion rate, additional product features, and ethics and sustainability aspects underline the disruptive potential of both new product classes.

Figure 7
Both novel vegan meat replacement and cultured meat have disruptive potential



¹ Input materials in terms of "availability"
² In addition to taste, shelf life and customization (for example, muscle-fat-nutrient ratio) have been taken into account.
³ The scalability of meat will decrease due to stronger hygiene regulations and higher quality standards on the part of consumers.
Source: A.T. Kearney analysis

With the advantages of novel vegan meat replacements and cultured meat over conventionally produced meat, it is only a matter of time before meat replacements capture a substantial market share. The agriculture and conventional meat industry will feel the impact first. Their steps in the value chain, which make up around \$1,000 billion, are at risk. The new market entrants will take their place, converting agricultural inputs into meat alternatives directly without the detour of raising and processing animals. New suppliers, especially in the chemical and biotechnology sector, will provide large-scale media ingredients, bioreactors, and scaffolding materials. The agriculture industry will experience a demand decrease to the degree that meat alternatives capture market share, as the better input-output ratio will reduce demand.

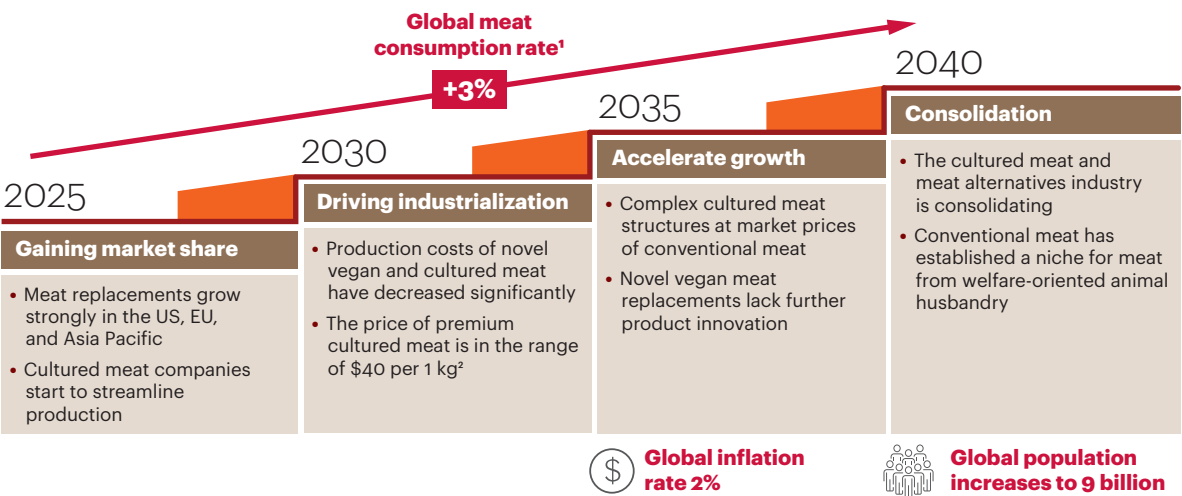
The Meat Industry Disruption Provides Vast Opportunities

At the current stage, it is hard to tell how fast the disruption will come about. However, one can already observe how wholesalers, retailers, and consumer goods companies are trying to find a lucrative starting position by purchasing exclusive distribution rights or through acquisition of start-ups (for example, Tesco bought distribution rights for the Beyond Meat Burger). Therefore, we have qualitatively forecasted the development of the meat market until 2040 based on reliable economic data as well as on our research and conversations with numerous experts in the field.

Figure 8 illustrates the cornerstones for the qualitative forecasting methodology, starting in 2025 with gaining substantial market shares in the US, Europe, and Asia Pacific, and ending with a consolidating cultured meat and novel vegan meat replacement industry. The following three elements of the model need to be highlighted as they play a fundamental role:

- 1. The meat market will grow at a low rate in the coming decades as global population growth takes place mostly in locations with low meat consumption such as India and African countries. Considering an average inflation rate of 2 percent, the meat market will grow at around 3 percent per year in the coming decades.
- 2. Novel vegan meat replacements will be most relevant in the transition phase toward cultured meat, whereas cultured meat will win in the long run. This is due to the fact that commercial competitiveness will gradually shift in favor of cultured meat over the next 15 years.
- 3. The consumer and legal acceptance of cultured meat will be a global phenomenon. This hypothesis is backed by several surveys in India, China, and the US as well as the global development toward “non-slaughtered” and resource-efficient products.

Figure 8
Global meat consumption: Qualitative forecasting is required as historical patterns cannot be applied



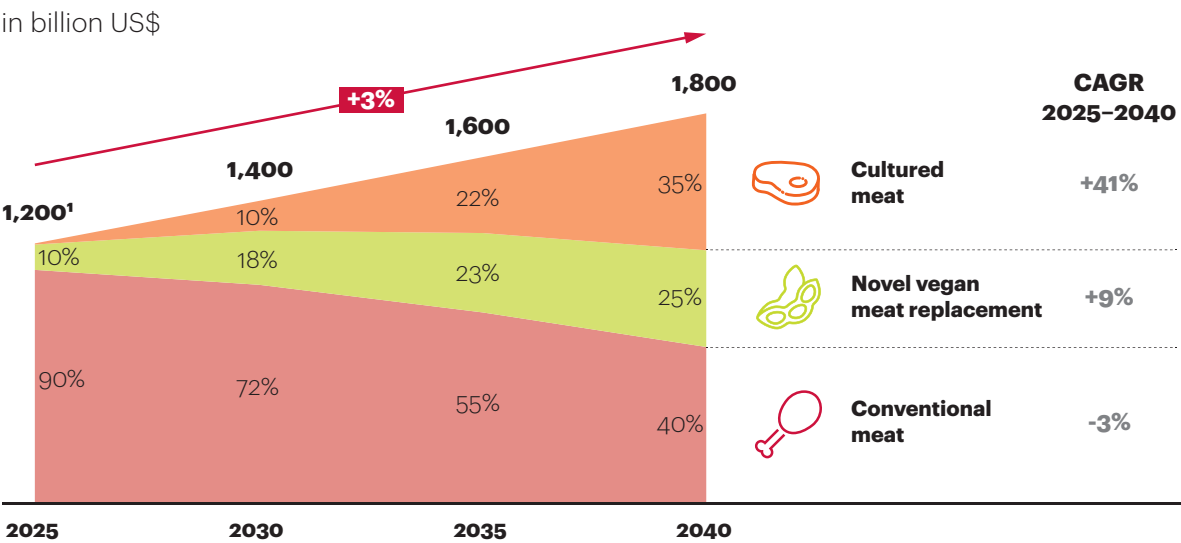
¹ The global meat consumption rate considers (1) changes in consumer behavior focusing on non-meat proteins and (2) centers of global population growth (low meat consumption countries due to cultural/religious affiliation).

² This price assessment applies only to the so-called muscle meat; the price of mechanically separated and mixed meat is of course even lower.

Sources: United Nations, World Bank, expert interviews; A.T. Kearney analysis

Based on A.T. Kearney analysis, around one-third of the global meat supply will be provided by these new technologies within the next 10 years (see figure 9). It is noteworthy that the demand for conventional meat declines by 3 percent despite a global increase in meat consumption of 3 percent per year. Novel vegan meat replacements will show a strong growth in the transition phase (until 2030), whereas cultured meat—with an annual growth rate of 41 percent per year—will outgrow novel vegan meat replacements between 2025 and 2040 due to technological advancements and consumer preferences.

Figure 9
Global meat consumption: By 2040, conventional meat supply will drop by more than 33%



¹ Numbers are rounded to hundred billions.
Sources: United Nations, World Bank, Expert interviews; A.T. Kearney analysis

Characteristic of the global meat market’s development will be that an evolution of global meat consumption (+3 percent per year) is accompanied by a disruption in the meat segments—the market share of conventional meat goes back massively in favor of cultured meat and meat replacements. Worthwhile to note is that new biotechnology methods will disrupt not only the meat industry but the complete food industry as products such as milk, egg white, gelatin, and fish can be created with similar technology.

Cultured meat will win in the long run. However, novel vegan meat replacements will be essential in the transition phase.

To become successful in the meat market in 2030 and beyond, an early investment is required as supply chains, production facilities, and distribution channels must be built up and adapted to the new market requirements. Another key factor will be how good and how fast a broad patent and brand portfolio on the subject of novel vegan meat replacements and cultured meat can be set up. While patenting plays a crucial role for the development of product characteristics, for manufacturing purposes as well as for expanding successively into adjacent food sectors, strong brands are particularly important for rapid and widespread distribution—especially as the product promise is focused on ethical, health, and wellness aspects.

In addition to the advantages and opportunities, several potential threats will result once the two new product classes provide a significant amount of worldwide meat production. One consideration is that the remaining livestock might not produce enough manure (to fertilize fields) or byproducts (for example, brain, skin, and horn) for the industry. On the one hand, the quantitative use of manure and synthetic fertilizers as well as their price mechanisms will adapt to the new market conditions and, on the other, efforts to replace animal byproducts with synthetic substitutes will increase. In any event, structural transformations in conventional meat production will become inevitable if the new products make up a significant proportion of the worldwide meat market.



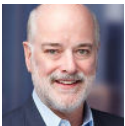
In 20 years, only 40% of global meat consumption will still come from conventional meat sources.

All in all, cultured meat and new meat replacement products are going to disrupt the \$1,000 billion conventional meat industry with all its supplier companies. This disruption is supported by a general shift toward consumption of non-meat proteins (for example, legumes and nuts) as a consequence of new lifestyle trends, all aimed at a more sustainable and healthier diet, as well as regulatory measures against conventional meat. Already today, we can observe the formation of a new customer segment made up of “passionate meat eaters” who take care of their diet but for whom a vegan or vegetarian diet is still not an option. In this context, the discussion about cultured meat as well as meat replacement products and how they can be produced in terms of large-scale batches at attractive prices may seem very technical and unemotional. This raises the question: How can we “integrate” biotechnologically engineered food products into our lives so that we feel familiar with them just like baking bread or brewing beer?

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