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# Alternative Proteins: Exploring the Asian appetite and conservation potential



Authored by

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# Foreword

Since establishing the Impact Advisory and Finance (IAF) Department in October 2017, we have published a number of thought leadership pieces sharing perspectives on the rapidly developing sustainable finance market.



At Credit Suisse, we are committed to mobilising capital towards investments which can help tackle the world's critical challenges. From our long history in creating and supporting microfinance investments to our structuring of products that have channelled capital to such sectors as financial inclusion, education, healthcare and conservation, we continuously seek to identify and facilitate investment opportunities across the Sustainable Development Goals while seeking to generate market returns for our investors. The burgeoning field of alternative protein is just one of those sectors – one that shows great promise from an investment point of view and that has the possibility to make a meaningful difference in climate change and in feeding a future planet of 11 billion people.

Transforming global food systems and land use to feed our growing population while staying within the planet's boundaries is one of the biggest challenges the world faces. It will not only require unprecedented levels of innovation but also a large capital base to support associated investments. In a recent report outlining the Ten Critical Transitions to Transform Food and Land Use, it was established that diversifying sources of protein represents over USD 240 billion investment opportunity.

At the core of the expanding market of alternative proteins is the promise that the world's hunger for protein can be met while moving away from the low feed efficiency and environmental footprint of our current livestock dependent system. According to a recent FAIRR report, 80% of the Amazon forests cleared since 2014 have been occupied by cattle. The link between animal protein and some of the world's most serious environmental degradation makes a compelling case for urgent action. While price competitiveness, consumer acceptance, and regulatory approvals remain challenges to be met, the conservation benefits have a strong appeal for both activist consumers and impact investors.

The trend for alternative proteins as a food choice was, until recently, confined to upscale markets. However, the recent adoption by mass market fast food chains have amplified the potential for mainstream consumption. A strong testament of the investment potential in redesigning the way we produce and consume meat was the successful Beyond Meat IPO in mid-2019. Credit Suisse was a proud underwriter bringing this first pure play plant-based protein producer public, a giant leap forward.

Looking ahead, a question looming before us is to what extent Asia, the region with the strongest growth in meat consumption, will incorporate alternative protein into its diet. While the region will be key to living up to its conservation prospects, established alternative protein players have had minimal impact in disrupting traditional meat consumption habits to date. This certainly does not have to be the case going forward and if the trends in other markets are a barometer, it is only a matter of time before consumers and producers change the equation.

Credit Suisse has engaged Asia Research and Engagement to assess the land use saving potential if alternative protein were to substitute a portion of meat consumption in the region to help support the case for Asia's food producers and how consumer adoption in Asia can make a substantial positive environmental impact at an individual level. We trust you will enjoy exploring the new frontiers of the alternative protein market and hope that Credit Suisse has given you 'food for thought' to consider the theme as part of an investment objective to "Generate returns. Sustainably".

**Marisa Drew**  
CEO, Impact Advisory and Finance  
(IAF) Department

# Executive summary

Recent breakthroughs in plant-based proteins coupled with increasing awareness and interest in environmental issues has led to rapid growth in demand for “alternative proteins”. Alternative proteins have the potential to address rising environmental, health and animal welfare concerns. These food innovators claim to require fewer resources, land and water, to deliver a comparable culinary experience to farmed meat, while providing similar nutritional value.

Two separate methodologies were used to estimate the potential land savings. Approximately 8 million km<sup>2</sup> of land might be saved by 2030, equivalent to the landmass of Australia, when land savings are estimated based on the projected growth of global alternative proteins market. However, when estimating land savings at a more granular level based on the number of meals replaced, the estimated land savings falls to 3 million km<sup>2</sup>, or equivalent to the landmass of India. This rises to just under 4 million km<sup>2</sup> if Asia adopts alternative proteins at a rate that is higher than the expected global adoption rate.

In order for the potential to be realised, alternative proteins will need to satiate the demand where the hunger for meat is strongest. In other words, it will need to whet the appetites of the Asian consumer. This report explores the variety of alternative proteins. Of the four major types of alternative proteins commonly discussed; plant-based, microbial-based, insect and cultivated meat, only cultivated meat is yet to be commercially available.

It then seeks to quantify the potential land that can be saved if the world adopts alternative proteins in place of meat.

As Asia grows wealthier, Asians are preparing fewer meals at home, which means that food services companies will play a critical role in the adoption of alternative proteins. There might be stronger uptake of alternative proteins in the near term if they are incorporated into Asian dishes, but in the longer term, Asia is likely to readily take to alternative proteins as Asian youth become increasingly conscious of the impact of their food choices. Alternative proteins may even transition to become part of the everyday Asian diet as lifestyle trends and the image around adopting alternative proteins becomes increasingly positive, an effort that is aided as more Asian celebrities endorse this lifestyle.

## Scope

This report focuses on the land conservation potential associated to the growth of the alternative proteins market. It does not look at other potential benefits including how the product could help meet global nutrition gaps.

In addition, while we recognize that the resource saving potential involves more than just land, this publication focuses on land use as land plays a critical role in water cycles and carbon sequestration.

This is of particular importance in view of the critical role that land-based solutions can play in climate mitigation, including addressing emissions related to the agriculture sector.

Finally, we acknowledge innovation currently taking place in other parts of the diet such as seafood and dairy, but this report focuses on meat in view of its large environmental impact.

# Getting to alternative proteins

Alternative proteins are trending these days – Google searches for alternative protein products have seen significant growth in 2019. Alternative protein product launches by fast food chains have been met by enthusiastic responses. By most measures, interest in these products is only set to grow. But what exactly are alternative proteins?

Food has taken on many different roles through our history. It has been used to heal us, tell our stories and we are now beginning to recognize its strong link to the health of our planet. Specifically, the problems arising from meat consumption. Meat demand has steadily grown around the world as more people are lifted out of poverty and are growing wealthier. The trend of increasing wealth being correlated with increasing meat demand has held firm across cultures. What was once a luxury is now an everyday item for growing numbers of people around the world.

Agribusinesses have responded to this demand in two ways. One is to continually breed animals that grow bigger and faster, and the other is to simply grow more of them to meet that demand. This has led to massive populations of farm animals; the Food and Agriculture Organisation (FAO) estimates that approximately 330 million head of cattle, 1 billion head of sheep and goats, 1.5 billion head of pigs and 66 billion chickens are slaughtered each year, and that's just to meet current demand.

Collectively, all animals reared for consumption, including land to grow their feed, require an estimated 32.1 million km<sup>2</sup> to grow; land area approximately equivalent to the size of Africa.

Many species are approaching the biological limits for how large and how quickly they can grow. Modern broiler chickens, or chickens grown for meat, still take 21 days to hatch but that's where the similarities with their wild cousins end. After hatching, they typically grow to around 5.5 pounds (2.5kg) or approximately twice the size of wild chickens, taking an average of only 48 days to reach that size. Just 50 years ago, broiler chickens took 81 days to reach the same weight. According to some studies, the capacity to grow these chickens any faster or bigger is now very limited.

The concern over how our food choices negatively impacts the environment was initially expressed through the choices that people made about what they would, and more importantly would not eat. Some people chose to avoid consuming meat for ethical reasons. Beef and lamb in particular were shunned due to the strain their production caused on the environment, not least due to the harmful effects of methane emissions caused by the digestive processes of ruminant animals. Encouraging simple abstinence from eating these meats has not delivered the impact necessary to return our resource use to sustainable levels as overall demand for meat continues to grow. We are now beginning to write a new chapter with food. We increasingly look at how we produce our food, on top of what we choose to eat, as a solution to many of the world's environmental and social problems.

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# What is alternative about alternative proteins?

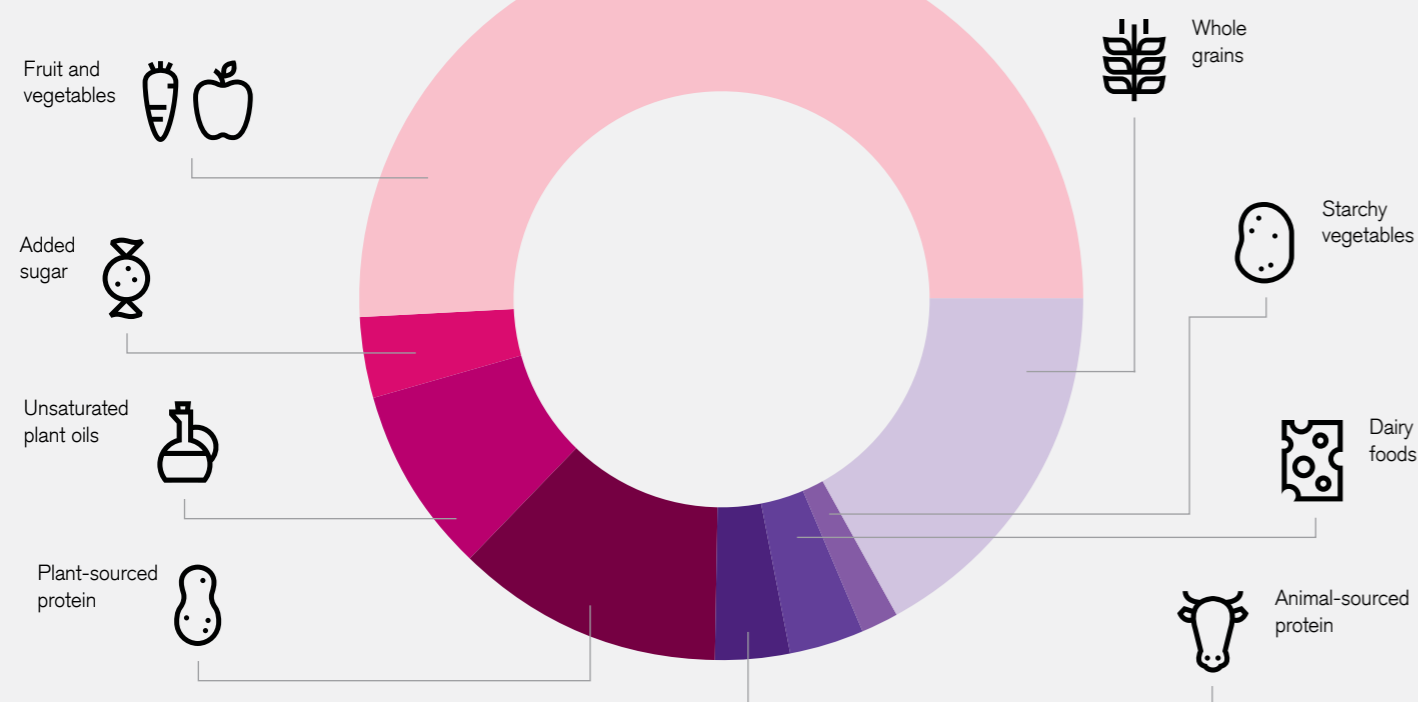
Alternative proteins are trending these days – Google searches for alternative protein products have seen significant growth in 2019. Alternative protein product launches by fast food chains have been met by enthusiastic responses. By most measures, interest in these products is only set to grow. But what exactly are alternative proteins?

Proteins have largely been synonymous with meat in the consumers' minds, but alternative proteins are seeking to change that. Alternative proteins is a catch-all term used to describe a class of products that share a single principle, to provide people with protein from a source other than a live animal. The sources for these proteins span a wide spectrum, with more familiar sources such as plants and mushrooms on one end, to exotic sources such as insects and cell cultures at the other.

Most products under this category also seek to deliver protein through a product that replicates the flavours and textures of meat. Some even try to replicate how the meat behaves during both cooking and consumption.

“**Alternative proteins are not just seeking to replace nutritional content through alternative sources, it's about redefining what we eat through providing an all-encompassing sensory experience.**”

## A sustainable diet The planetary health plate



In 2019, the EAT Lancet Commission quantitatively described a universal healthy reference diet, addressing the need to feed a growing global population while also defining sustainable food systems that will minimize damage to our planet. While a small amount of meat is still on the plate, the Commission's finding showed that developed countries would need to cut meat consumption by 80% and developing countries by 50%.

Source: EAT Foundation

# Why did we start playing with our food?

Meat substitutes are not new. The concept of creating a meat substitute with similar textures and flavours has a long and storied history, stretching back far longer than most people realise.

Early attempts at recreating meat were largely driven by religious concerns. In medieval Europe, the observance of Lent led to the use of almonds and grapes in place of mincemeat. Cooks would chop the almonds and grapes, then spice them appropriately to recreate the textures and flavours of mincemeat in dishes. Diced bread and gingerbread were also popular among cooks for recreating the look and texture of roast meats.

Similarly, Buddhist monks in ancient China created meat dishes out of soy and vegetables because of the vegetarian dietary laws of Buddhism. These dishes were created to cater to visitors and benefactors of the temples and monasteries. The mock meats allowed them to continue eating dishes that were familiar to them whilst remaining aligned with the dietary restrictions of their hosts. Religious chefs were at the forefront of mock meat innovation, and the quality of these mock meats were determined largely by the skill of the chef preparing them.

Modern meat analogues for the masses can trace their history back to the 19th century. John Harvey Kellogg, of corn flakes fame, developed meat analogue products as part of his quest to create a healthy diet. Kellogg primarily used nuts to create his meat analogue products and sold them to the public through his company, the Sanitas Nut Food Company founded in 1889. Kellogg himself was inspired by the vegetarian practices of Sylvester Graham, of Graham cracker fame. However, Kellogg's products reportedly looked like meat but did not resemble meat in taste or texture, and tasted largely of peanut butter. This did not stop the products from becoming very popular as they fed demand created by a movement towards healthier foods.

The latest round of innovation in the alternative protein space has been driven by both environmental and animal welfare concerns, two of the greatest concerns of the rising conscious consumerism movement, which seeks to reduce the negative impact of their purchasing decisions.

Current dietary consumption trends risk depleting natural resources while exacerbating climate change through greenhouse gas emissions. The EAT Lancet Commission recommends a healthy planetary diet consists of no more than 6% of daily protein intake to be from animal-based sources. This has led to the creation of products that seek to satisfy culinary demands while reducing environmental impact. Alternative protein products have the added benefit of reducing consumers' concerns around animal welfare and reducing the exposure of both animals and humans to antibiotics that may be used in farming.

The effort placed into replicating the textures and flavours of meat is a nod to the modern lifestyles that people lead. Consumers demand familiarity and convenience in their meat replacements, which also need to be healthy and environmentally friendly. Food technology companies are rising to the challenge.

# The menu

## Overview of current alternative protein products

The variety of meat replacements available on the market has widened considerably in recent years. Gone are the days when the meat-free burger options were limited to tofu and veggie patties. These days, while the more traditional options such as tofu, tempeh and seitan-based products are still available, other more exotic options such as jackfruit are starting to become more widely accepted. There is also an increase of processed alternative protein products where various ingredients are combined to create a product that resembles traditional meat without directly being derived from live animals.

“**Given the explosion in conscious consumerism, one of the common threads linking alternative protein products is that they seek to produce scalable protein sources that are less resource intensive to produce than meat.**”

The growing selection of alternative protein products generally fall within four categories, based on their source of protein. They are plant-based, microbial-based, insects and cultured meat.

Each source of alternative proteins faces different hurdles on the path to becoming a mainstream choice for consumers. Cost is naturally a hurdle and taste is another, though technology is allowing companies to advance on both those fronts. The various sources also need to cross the “uncanny valley of meat”; the unease or discomfort that people feel when presented with a nearly exact replica of meat but one that falls short of being convincing. It is analogous to the concept of the uncanny valley, a term first coined by roboticist Masahiro Mori in 1970 to describe the unease that people feel when encountering anthropomorphic robotic figures. Each type of alternative proteins needs to overcome their respective hurdles. Some have made more progress than others.



## Plant-based

Plant-based meat analogues have possibly the longest culinary histories of the four types of alternative proteins. Nuts, fruits and soy-based ingredients have been used by chefs to mimic the look, texture and at times, flavour of meat in various dishes. That innovation has now progressed from the kitchen to the lab. Food technology companies are now trying to recreate the molecular composition of meat using plant-based sources, all in an effort to produce products that look, cook and taste like meat.

Plant-based alternative proteins are created by extracting protein concentrates from plants. Binders, plant-based fats, nutrients and flavouring agents are added, and the entire mixture is shaped into the end product. They generally take approximately one week to manufacture; considerably faster than the 18 months it takes to rear a cow. They also tend to use a lot less land and water per pound of product to produce and emit considerably fewer greenhouse gases.

Currently, the major plant-based products are pitched as alternatives to ground beef or ground pork and can be used in recipes that require either type of meat. They are available in ground meat format or pre-shaped into patties or sausages. When formed into a patty and grilled, the beef-replacement products have sizzled and “bled” in ways that are similar to beef. After cooking, these products have been reported to be “juicy” and “tender”, words more commonly used to describe meat rather than vegetables or even other veggie burgers. These textural enhancements have helped to reframe the perception that plant-based alternative proteins are gastronomically inferior to meat.

The products have generally been well received by consumers, with some commenting that it is difficult to distinguish the taste and texture of the alternative proteins from beef. Plant-based options are currently commercially available and are priced slightly higher than their respective benchmark meats. A growing number of fast food chains, restaurants and grocery stores have added plant-based products to their offerings.

Start-ups in this space have attracted an increasing amount of capital, with US-based start-ups raising USD 535 million in 2018 alone. July 2019 also saw the IPO of the first plant-based protein manufacturer, raising USD 240 million with their shares rising over 700% in the weeks following their listing. Four plant-based start-ups were also acquired by more established food companies in 2018.

## Microbial-based

Microorganisms such as microalgae or fungi provide the protein for these products. Microbials are grown in large scale-culture systems. They are then harvested, dried and the proteins extracted from them. These proteins are then mixed with binders and flavouring agents to produce the end product.

Algae-based proteins are usually grown in ponds, which means that they can be grown on barren land. Depending on the species of algae used, they can be grown without freshwater, and any water used to grow them can be recycled. They also grow rapidly all year round, allowing algae farmers to harvest them several times a week as opposed to once or twice per growing season. Algae are rich in protein and in Omega fatty acids, endowing them with very high levels of nutritional productivity per unit of land used.

Fungi-based proteins, also known as mycoproteins, tend to be grown in fermenters, through a process not dissimilar to how beer is brewed. The mycoproteins are then harvested and processed, before binders and flavourings are added. This mixture is then shaped and frozen, to allow meat-like textures to develop.

Microbial-based proteins are positioned similarly to plant-based proteins but are generally not available in ground meat format. The microbial products tend to be offered as sausages, nuggets or in other ready-to-cook forms. At least one company has taken a different approach and mixed algae with seaweed and kelp to create a shrimp substitute.

Despite being on the market for longer than recent plant-based alternatives, mycoprotein products and companies have not achieved a similar level of media attention. Whilst mycoprotein products might not have generated as much fanfare as plant-based products, at least one major fast food chain is trialling a mycoprotein product for wider release.

Algae-based products are relatively newer and less commercially available. Mycoprotein and algae-based start-ups as a whole have not attracted as much attention from investors in recent times as their plant-based or even cultivated meat competitors. However, one mycoprotein start-up still managed to raise USD 23 million and a large meat company invested an undisclosed amount into an algae-based start-up that makes shrimps substitutes using algae.

## Insects

Certain cultures have a deep history of incorporating insects within their cuisines. For example, whole insects are available via street food vendors or local eateries in parts of Thailand, Laos or China. As these cultures modernize, insect-eating has been gradually relegated to the fringes and they are now primarily regarded as delicacies. Insects are undergoing a renaissance at the moment; they are now once again being considered as a potential protein source for the future.

Of all the categories of alternative proteins, insects likely have the easiest production system to understand. The insects can either be grown in farms with little need for large land areas or harvested from the wild. They tend not to require much in terms of resources to grow, nor do they emit large quantities of greenhouse gasses. They can either be eaten whole or crushed and added into other food products, and the entire insect can be eaten.

Unlike the other alternative proteins, insect-based food companies have not attempted to create products that visually resemble meat. Some insects may taste like meat while others, according to some consumers, have distinctive yet delicious flavours. For example, termites have been described to taste like bacon, while crickets are said to taste like hazelnuts. Insects are generally crunchy if eaten whole, so some might argue they are texturally similar to crispy bacon or fried chicken.

Insect-based food products are commercially available. However, insects face a mixed reception outside of cultures that have traditionally eaten them. Insects have had a growing acceptance as snacks in some markets, depending on how they are presented. As the market for insects for human consumption remains niche, ticket sizes are significantly smaller for start-ups in this space, ranging from USD 20,000 to USD 5 million.

## Cultivated Meats

Cultivated meats represent the cutting edge of food technology in developing an alternative protein. Cultivated (also known as cultured, cell-based or environmentally-friendly) meats are an attempt to harness recent scientific discoveries to grow only the parts of meat that are consumed, without growing the entire animal. Stem cells are extracted from a live animal then grown in a nutrient rich culture within a bioreactor. The cells replicate, and form either muscles, fat or connective tissue. These are then used to recreate the meat of the animal from which the stem cells were originally harvested.

Cultivated meats should come closest to animal-based proteins because they are built using largely the same components. As such, there should be little to no difference in basic taste. However, the goal of recreating cuts of meat as opposed to ground meat using current technology is proving to be elusive. This is because a simple cut of meat that we are familiar with is actually composed of different types of muscle cells, connective tissue, and fat layered together in a structurally complex matrix. The combination and interplay of these components affect the taste and texture of the meat. This has resulted in early prototypes looking paler and tasting blander than the animal-based version of the meat.

Current methods for growing cultivated meats from stem cells generally result in the muscle cells, connective tissues and fats growing separately from each other. These separate components are then combined to reproduce the cuts of meat. Cultivated meat companies have so far found it difficult to structure the components in ways resembling actual cuts of meat. One of the latest approaches is to use cellulose structures within which the meat cells grow, and the result is a tartare-like sheet of “steak”.

The environmental impact of producing cultivated meats is not yet quantified, as methods used to produce them are still more experimental than ready for mass production. And while cultivated meats have seen phenomenal reductions in the cost of production in a very short period of time, from USD 325,000 for a regular beef patty in 2013 to USD 11 per patty or around USD 37 per pound in 2019, it is still significantly more expensive than the cost of wholesale beef which costs just USD 2.80 per pound. The primary reason for the high cost is the nutrient rich culture that the cells grow in.

Should cultivated meat companies be able to overcome the cost hurdles, they will then need to overcome the psychological resistance that a not insignificant number of people have expressed towards the concept of cultivated meat. Of the four categories of alternative proteins, cultivated meats need to navigate the longest path through the uncanny valley of meat due to the sheer novelty of the product. However, a number of analysts believe that the market for cultivated meats will be potentially larger than that for plant-based alternative proteins if all these hurdles can be overcome. Cultivated meat start-ups globally attracted a total of USD 73 million in 2018, primarily in seed funding, though at least two companies have successfully closed their Series A rounds. Deal count in 2018 has also risen by 169% over 2017 figures, with 22 completed deals.



# The interplay of global demand for meat and land use



## Looking forward to meat platters in 2030

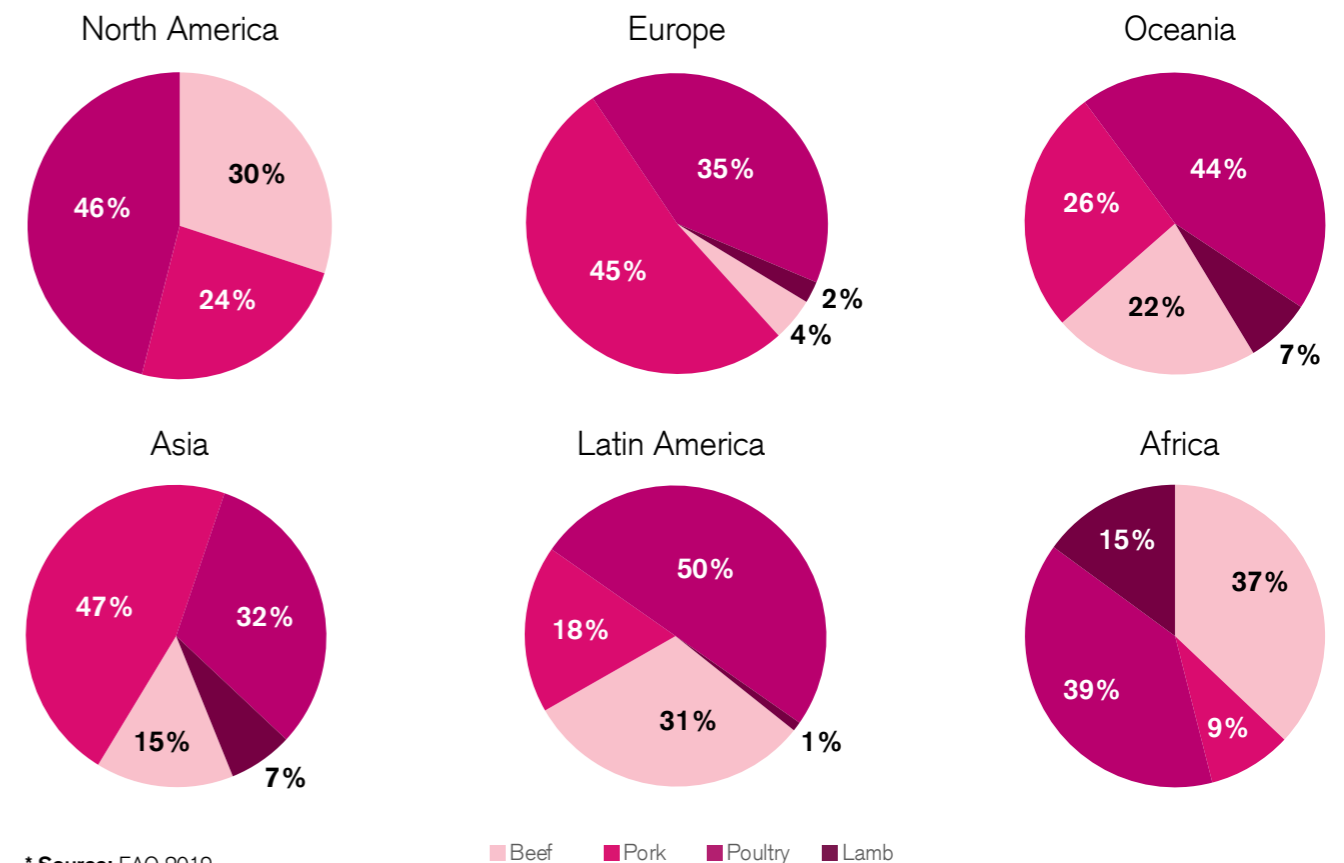
The resource needs to satisfy meat demand depend on a range of factors including: the type of meat consumed; the amount of meat consumed per person; and the number of people eating meat.

This report focuses purely on the land use impact of meat. In other words, how much land is needed to produce meat now and in future in different scenarios. The report focuses exclusively on land use as land plays a critical role in the world's ecosystem. Land use changes can adversely impact water cycles and greenhouse gas emissions, as well as biodiversity.

To build our models, we have relied on the data provided by the Food and Agriculture Organization (FAO), an agency of the United Nations focusing on agriculture in the world, as well as a study by the University of Oxford and the Swiss agricultural research institute, Agroscope.

While people's diets can and do change, given religious and cultural preferences, our model assumes that preferences for specific types of meats over others is likely to remain constant over time in each region.

Snapshot of meat consumption by type of meat per continent in 2018\*

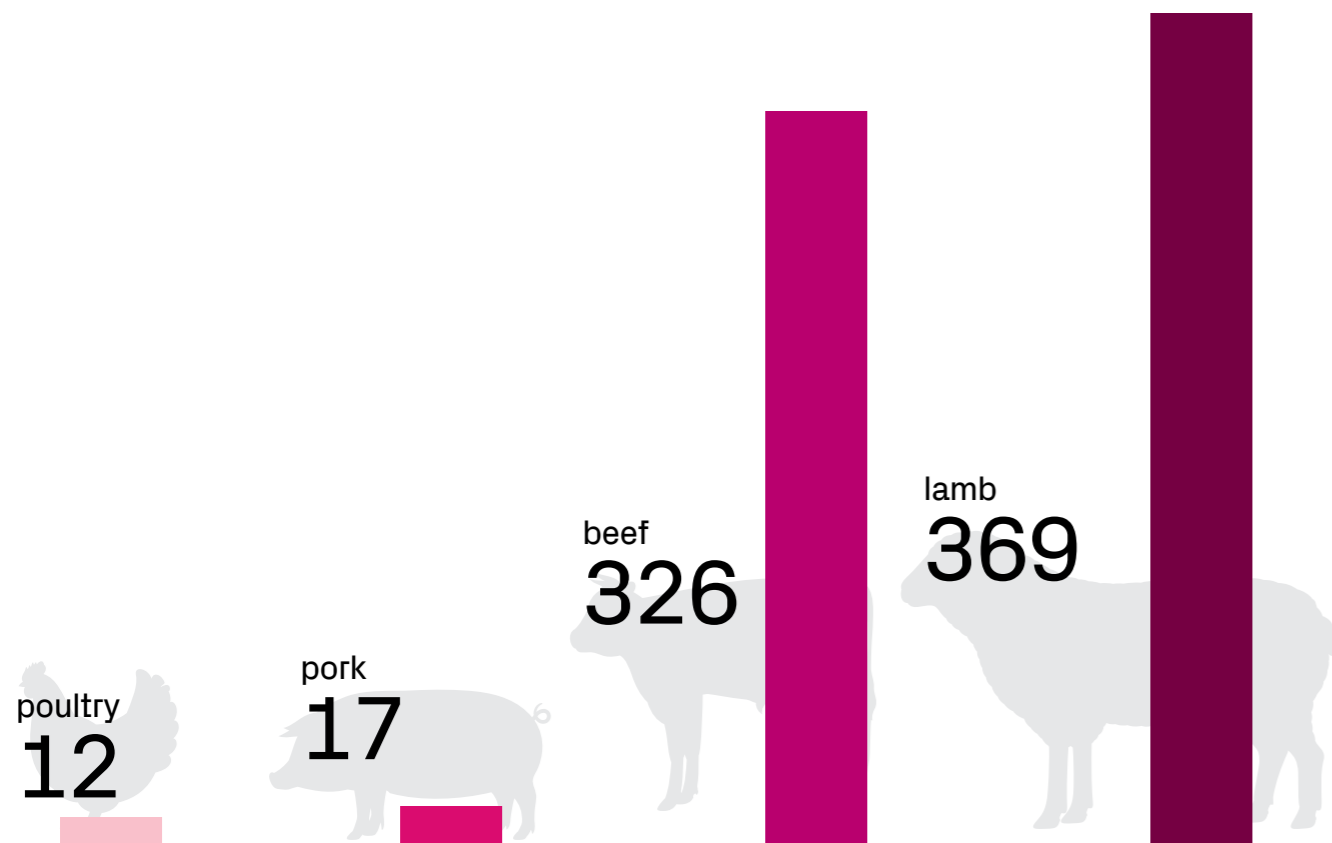


The world generally eats four main types of meat: beef, lamb, pork and chicken. It will probably come as no surprise that the most popular type of meat around the world is chicken. It is everywhere and after all, almost everything “tastes like chicken”.

Differences in meat consumption between the continents generally come down to a choice between beef and pork, which is strongly influenced by religion.

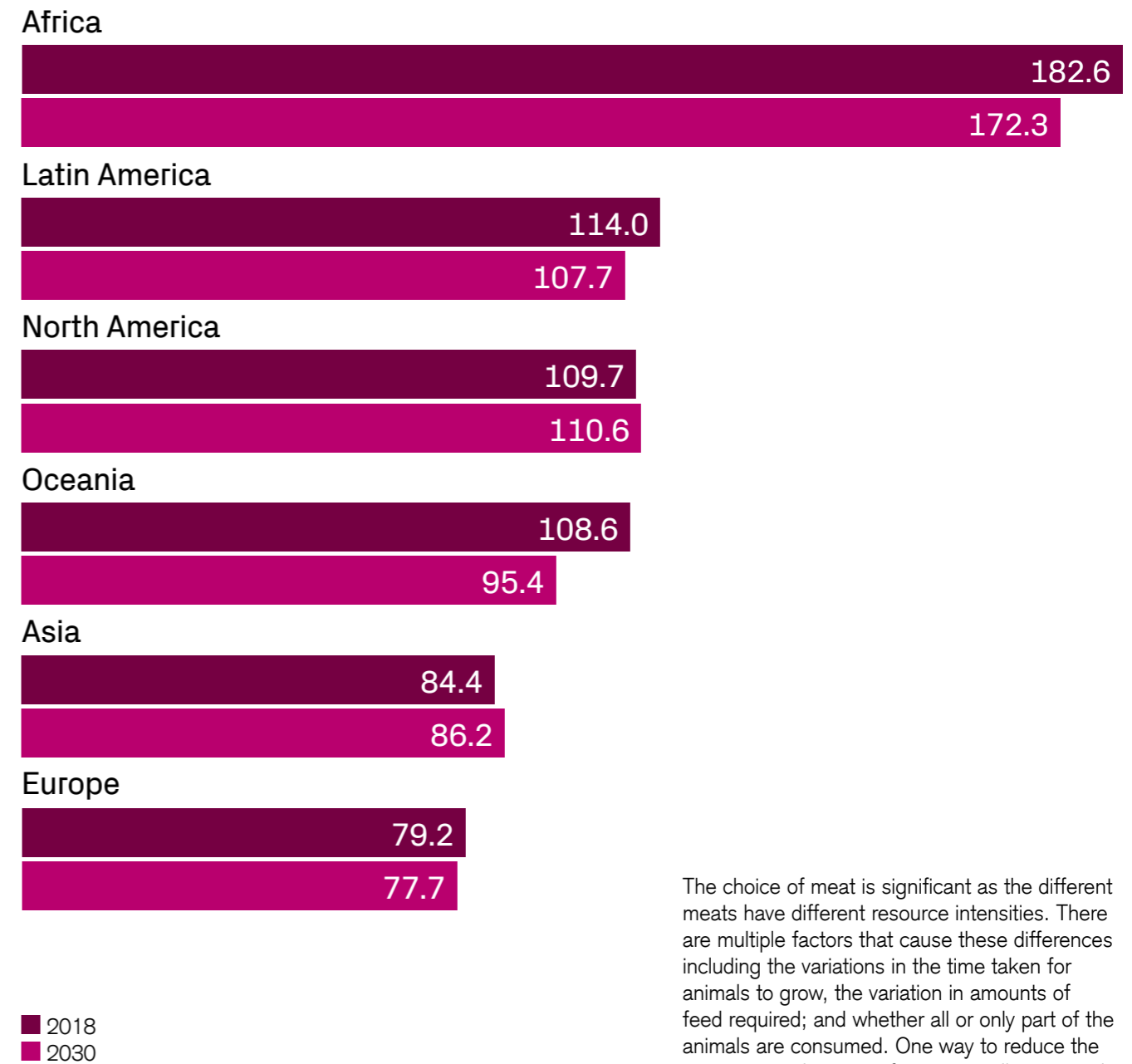
Asia’s relatively low consumption of beef is driven in part by its large Buddhist and Hindu population, two dominant religions in Asia that strongly discourage the consumption of beef. Similarly, Africa’s low consumption of pork is down to its large Muslim population.

### Land use by type of meat (m<sup>2</sup>/kg)



Source: Poore 2018

### Land use profile of meat consumed, by continent (m<sup>2</sup>/kg).



Source: Poore 2018, FAO 2019, ARE

The choice of meat is significant as the different meats have different resource intensities. There are multiple factors that cause these differences including the variations in the time taken for animals to grow, the variation in amounts of feed required; and whether all or only part of the animals are consumed. One way to reduce the environmental impact of meat overall is to simply replace highly resource intensive with lower resource intensive options.

We used the meat preferences of each continent to determine the proportion assigned to each type of meat, and from that the amount of land required to grow meat for each continent's meat diet profile.

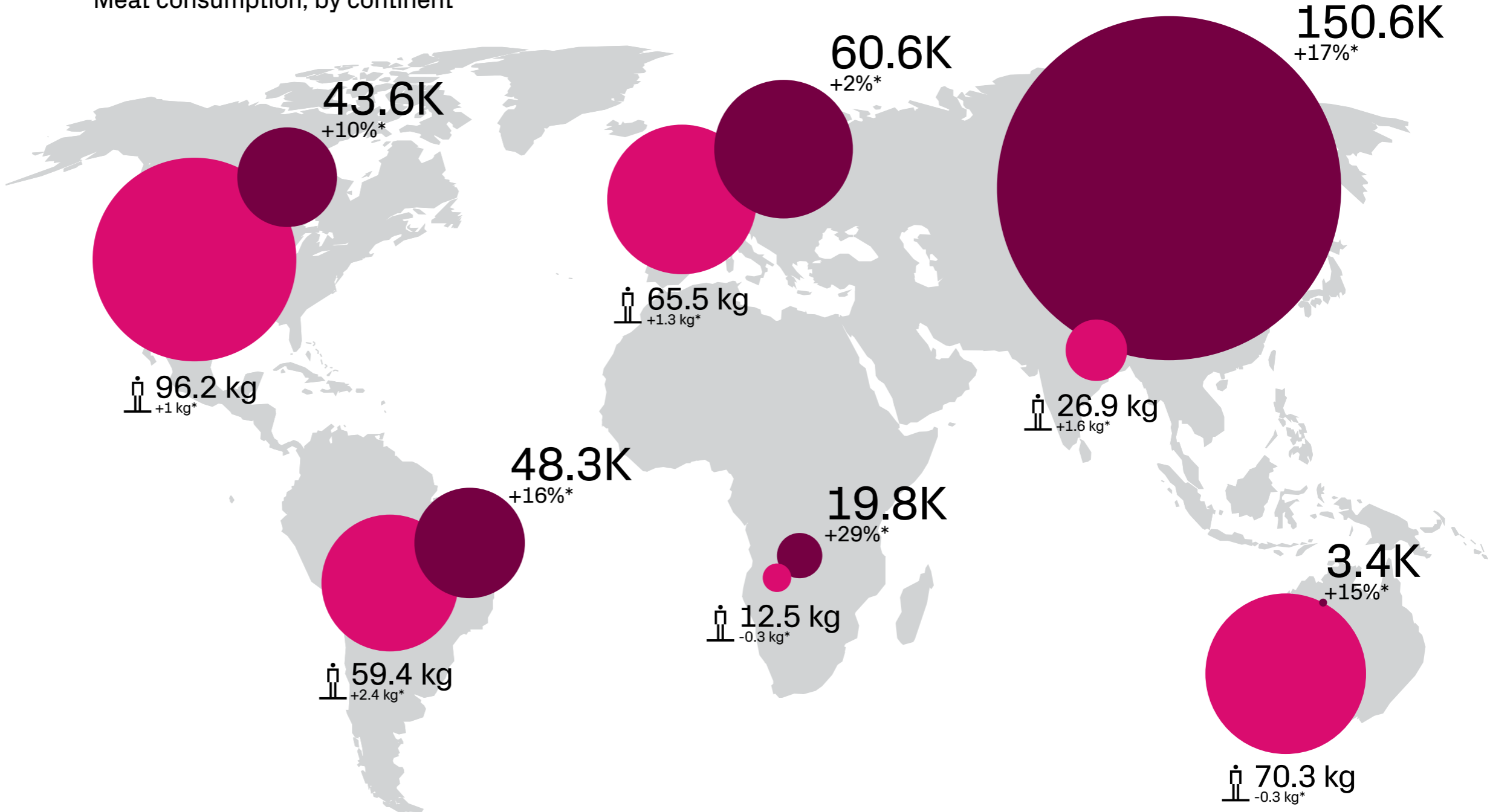
The meat consumption preferences per continent naturally affect the amount of land required to feed that demand. The shift away from beef and lamb, two of the most resource intensive meats, has led to Europe having the lowest land use profile of all the continents. Asia's land use profile is fairly similar, due to historically higher consumption of pork relative to beef and lamb, particularly in China.

Nonetheless, Asia's higher land use profile relative to Europe is due to the consumption of beef and lamb, meat choices influenced by Islam, another dominant religion in Asia. Likewise, Africa's preference for beef and lamb, influenced by religious dietary restrictions explains why their land use profile is double the global average.

The amount of meat a person consumes is heavily influenced by the amount of meat used in the cuisines that they eat. The dishes consumed in Asia and Africa on a daily basis generally do not contain large amounts of meat, and this is reflected in the low per capita figures provided by the FAO. There are concerns that per capita meat demand from Asia would grow as Asians became increasingly wealthier. While per capita meat consumption in Asia has grown and is predicted to continue growing, as Asians favour dishes with more meat, their meat consumption patterns have not converged with Western patterns.

While the FAO does not expect the amount of meat that each person consumes to change significantly from 2018 to 2030, meat consumption is still expected to continue growing globally for the next decade, with developing countries accounting for the majority of the growth. The growth is expected to be driven primarily by population growth. The majority of global population growth is expected to come from three regions, Asia, Africa and Latin America. Correspondingly, those three regions are expected to have the largest growth in meat demand.

Meat consumption, by continent



- Aggregate meat consumption by continent (kt), 2018
- Meat consumption per capita, per year (kg), 2018

\* Forecast for 2030

# How much land do we need to grow all of this?

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In calculating the amount of land required, we have made a number of assumptions. The resource use profile for producing each meat type was held steady over time. There are competing factors that might change the future land use coefficient for traditional meat production. On the one hand, concerns around animal welfare will likely increase land requirements to address concerns around intensive animal farming for meat production such as for pork and chicken. On the other hand, the concerns around achieving higher areal yield of crops have driven research and development into alternative animal feeds, some of which reduce the amount of land required for production. These range from mealworms and other insects to algae and seaweed.

While nutritionally these alternatives are likely to be able to substitute for the current soymeal and commeal feedstock, the longer-term viability of some of these products are questioned. One large food flavouring company revealed that they had to flavour the insects for fish feed, as the fish refused to consume them otherwise.

The sustainability impacts are also mixed. While land use savings could be achieved, when viewed through the energy-food-water-climate nexus, studies also show that the energy use and CO<sup>2</sup> emissions impacts of these alternatives is highly sensitive to the type of inputs available. Low carbon energy, carbon capture systems and waste nutrient streams all need to be available to achieve sustainability across a range of critical factors. Given the global concern of several planetary boundaries, it is difficult to predict whether these alternatives can be scaled.

# Where is the land going to come from?

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Two thirds of the world's surface is covered by water, and of the remaining one third, 70% of it is habitable land. Just under 50% of habitable land is covered by forests and shrubs, self-contained cities of nature that we are endeavouring to protect. In comparison, while we only use a tiny portion (1%) of habitable land area for all of our cities, urban areas and infrastructure, some estimates show we are presently using half of all habitable land to grow the food that we consume. Of this land used to grow food, close to 80% is being used to rear the animals that feed our appetite for meat.

Changing precipitation and temperature patterns means that the supply of quality agricultural land is dwindling. Research by the University of Minnesota shows that farming regions are already experiencing the effects of these changes through lower crop yields in Europe, Southern Africa and Australia. However, not all crop yields are adversely affected. Crop yields in Latin America have seen some improvement as a result of the changing conditions.

Political instability also potentially reduces the land available for agriculture. Arable lands in the Middle East, North Africa and Sub-Saharan Africa are particularly vulnerable due to increasing political instability and conflict in those regions. Conflict generally leads to declining agricultural output as farmers abandon high yielding croplands and relocate to safer, but less fertile lands. Access to labour is also compromised during periods of conflict.

Deforestation has historically been the easy way out in terms of expanding the area to produce food, but there is an increasing recognition of the holistic costs of deforestation, particularly with increasing recognition of the adverse biodiversity and climate change implications. In short, the planetary boundaries for land system change are rapidly being approached. And while the FAO, the OECD, and other organisations and academics continue to model and study our agricultural land use, what is clear is that we need to start working within our limits and fast.

# What happens if we switch to alternative proteins?

One of the attributes of alternative proteins is their ability to potentially provide both the nutrients and culinary experience of meat without the resource intensity. The life cycle assessments of some leading alternative protein products have shown over 95% savings in land and water inputs, as well as significant reductions in greenhouse gas emissions, relative to comparable meats.

## Current Projections

Alternative proteins have been attracting a lot of attention from investors. Most reports examined the issue from the perspective of market size and share of alternative proteins based on a projected total protein market size in the future. However, in order to estimate the land savings, we would need to estimate the proportion of the alternative proteins market that is replacing the traditional meat market.

Most reports view the adoption of alternative proteins to be a two-staged process, an initial period with a slow growth rate followed by a relatively higher growth rate after hitting an inflection point. This is largely consistent with the adoption of other foods.

The two-staged growth process means that most of the land conservation potential of alternative proteins will only start to be realised after adoption rates move through the inflection point.

Of all the reports examined, only AT Kearney's projections provided us with sufficient detail to estimate the volume of alternative proteins that will be consumed. Their report provides an estimate of the size of both the plant-based alternative proteins and cultivated meat markets, relative to the conventional meat market in 2025 and 2030, providing different growth rates for both types of alternative proteins. They estimate that the alternative proteins market will be worth USD 120 billion in 2025, capturing 10% of the combined conventional meat and alternative proteins markets. The size of the alternative proteins market is expected to rise to USD 392 billion in 2030, accounting for 28% of the combined market.

In keeping with the two-staged adoption process, the majority of the land savings occur after 2025. A land area of approximately the size of Brazil, approximately 8.3 million km<sup>2</sup>, would be saved if the world switches to alternative proteins in line with AT Kearney's estimates. One of the critical assumptions we use to determine this is that 70% of the alternative proteins demand comes from meat eaters, while the remaining 30% comes from vegans and vegetarians. In other words, 70% of the alternative protein volume consumed displaces meat.

One of the first critical factors in hitting the inflection point in 2025 is achieving price parity with the comparable product – traditional meats. According to the FAO, average beef prices in 2019 are around USD 4.2 per kg, pork prices are around USD 1.40 per kg and chicken costs just USD 1.50 per kg. Using these figures as a baseline assumption for 2018 to 2030, the challenge is to determine when the alternative proteins could reach price parity.

Based on available research, cost-efficient methods of producing plant-based meats are already available. Currently available products are also close to price parity, plant-based beef burgers costs around USD 14, just USD 3 pricier than comparable beef burgers. We expect price parity will be reached in 2020 or soon after. For cultivated meats, we used a logarithmic interpolation based on cost data from 2013 to 2019, and producer expectations of prices to 2021. The results show cultivated meat could reach cost parity with traditional meats as early as 2022, and some industry players have alluded that its costs could drop below traditional meat price soon after.

Source	Current Plant-based Market Size [USD billion] (2018/2019)	Future Market Size [USD billion]	Ending period	Implied CAGR
A.T. Kearney	4.6	450	2040	23.2%
Barclays	14	140	2029	25.9%
FAIRR	19.5	100	2034	11.5%
Jefferies' Base Case	14	240	2040	12.0%
Jefferies' Best Case	14	470	2040	15.0%
Jefferies' Worst Case	14	90	2040	7.0%
UBS	4.5	85	2030	27.7%

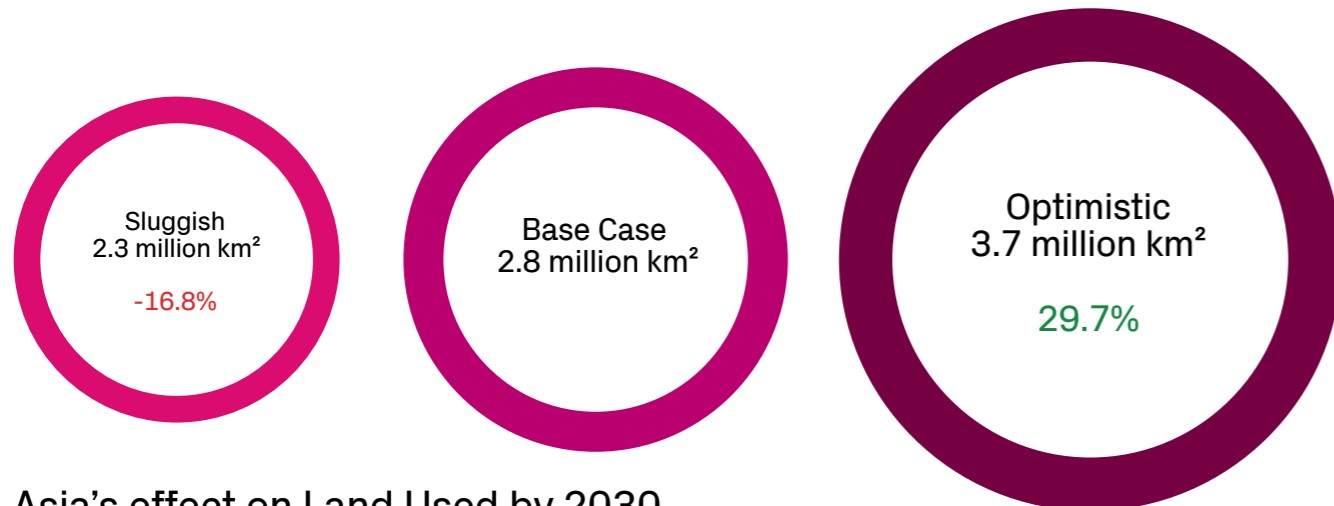
**Meal by meal**

Estimating the amount of land that can be conserved based on the size of the alternative proteins market provides us with a useful reference point. However, there are a wide range of factors that will affect the adoption of alternative proteins globally. The market sizing overview approach is unable to account for these nuances.

An alternative approach is to estimate the volume of meat and alternative proteins consumption based on reported intentions to replace meals with alternative proteins. The following table, on the next page, references the results of a 2019 survey of millennials in the US. The survey was conducted by Impossible Foods which inquired about the millennials' intended frequency of eating plant-based meats. 30% of respondents intended to replace meats with alternative proteins at least once a week, and more than 50% intending to make it a monthly affair.

We have assigned an initial percentage replacement rate based on the number of meals that are likely to be replaced by plant-based meats. Given the meat heavy diets for North America, Europe, Oceania and Latin America, and relatively early entrance of plant-based products, we assigned an initial replacement rate of 5.39%. This is between 4-5 meals a month of alternative protein.

“**The land conservation potential reflected here is based on consumers around the world replacing meat in 7.5 meals a month with alternative proteins by 2030.**”



**Asia's effect on Land Used by 2030**

**Additional land saved (km²)**



**Continental combined Land Use projections till 2030**



■ Land used to grow meat (incl feed)

Source: Poore 2018, FAO 2019, ARE

Reported Frequency	Replacement Rate	% of respondents
“Once a week or more often”	13.33% [equivalent to 3 meals a week]	30%
“At least once a month”	3.33% [equivalent to 3 meals a month]	40%
“Less than once a month”	0.56% [equivalent to 0.5 meals a month]	10%
“Never”	0%	20%
Calculated Weighted Replacement Rate		5.39%

Asia's initial replacement rate is 1.94% is lower due to the lack of availability of alternative protein products and lower consumer interest, while Africa's initial replacement rate is 0% as our research indicates that alternative protein products were only introduced to the South African market at the end of 2018.

We expect that replacement rates around the world will converge by 2030 to 8.33% due to a range of factors. Aside from the expected price parity as previously mentioned, we expect alternative protein products to be more readily available, and millennials and younger buyers will have incorporated the products into their diets. Africa will be the only exception, with a replacement rate of 3.33% due the significantly lower per capita meat consumption preferences. A typical African is expected to eat only 4.2 servings of meat per week, assuming they consumed 1 serving of meat per meal. A higher replacement rate would need to assume Africans are replacing almost all the meat they are consuming with alternative protein.

As Asia is expected to drive the majority of meat demand growth, we have created two more scenarios to explore the impact of Asia's future food choices. In the sluggish scenario, alternative proteins have not been as widely adopted in Asia by 2030 possibly due to the lack of suitable products catering to Asian taste buds. In this scenario, an Asian person is eating 4-5 meals of alternative protein a month. Conversely, the optimistic scenario is based on everyone in Asia having 3 meals a week with alternative proteins by 2030.

The effects of Asia's adoption rate on land conservation potential is quite pronounced. Should Asia take to alternative proteins, the estimated land savings are 30% higher than the Base Case scenario, bringing the estimated land savings up to 3.7 million km², or just under half the size of contiguous United States. Should Asia lag the world in adopting alternative proteins, the estimated land savings remains a sizeable 2.3 million km², just 17% less than the base scenario.



# Does it go well with rice

Putting alternative proteins into Asian bowls and plates

To realise the huge potential land savings, alternative proteins have to move from being a novelty product that consumers try once because of the hype, to a part of everyday life where the prefix alternative is dropped and the products become another food option providing proteins in the daily diet of Asians.

The alternative protein products currently making waves were designed to integrate into the daily diets of Americans. That is why while the products can be and are used in a variety of dishes, the most recognizable plant-based products are currently burgers. Although burgers are available in a growing number of Asian cities, they are not a core component of Asian diets.

The huge target populations make Asia's meat alternatives markets a very attractive economic prize, with China the crown jewel. As such, numerous alternative protein companies have developed or are developing products for Asian markets. However, Asia is also home to diverse populations with distinct identities and rich culinary heritages. This suggests that conquering Asia would mean the creation of products to cater to the wide variety of palates. Or does it?

Perhaps we can draw lessons from other foods that have caught on in Asia. From the rise of quintessential Asian foods such as instant ramen, to the ever-increasing popularity of coffee in a country with a millennia long history of drinking tea, there are a wide range of novel food products that have transformed local tastes. We asked a number of experts to share their views on how the story of alternative proteins might unfold in Asia.

# Cuisine: Asian

“  
The effort is worthwhile as a large food services provider we spoke to has noticed increased demand for alternative proteins when they are offered in Asian dishes.



## Flavour explosion

Asian cuisines have been influenced and shaped by centuries of trade, yet they have also developed distinctive culinary identities. For example, South Asian cuisines tend to be heavily spiced, with turmeric, cumin and ginger featuring heavily in the wide range of curries that are a South Asian trademark. East Asian cuisines generally use herbs and vegetables to flavour foods, as well as a wide variety of cooking techniques. Southeast Asian chefs have been influenced by both South and East Asian cuisines, but typically use different herbs and spices in their foods.

The diversity of Asian cuisines makes pinning down unifying elements a rather tricky affair. Looking across the various types of Asian cuisines, the one common staple food is rice. Rice is often the foundation upon which a meal is built. Another commonality across Asian cuisines is that meat rarely features as the centrepiece of most dishes. Meat is more often used to add texture and flavour to the dish.

## Alternative proteins for Asian palettes

The type of meat being replaced affects potential adoption rates. Food preferences are generally regarded by economists as being elastic; that people will respond to pricing signals and switch if the costs get too high. The outbreak of African Swine Fever has wiped out over half of the world's population of domesticated pigs in 2019, resulting in soaring prices. Yet despite pork prices having risen significantly, demand for pork in China remains firm. And while some Chinese have switched to using cheaper alternatives, the Chinese government had to intervene through releasing its frozen pork reserves and importing pork in order to satiate demand and maintain social harmony.

Regional differences in cuisines mean that they use meats in different ways. Dumplings stuffed with minced meat feature heavily in East Asian cuisines, while South Asian cuisines typically employ bite-sized chunks of meat stewed in spices

to form curries. The one thing that Asian chefs and home cooks have in common is that they prefer to spice their own meats. As such, alternative protein products that do not come pre-marinated may perform better than those that are sold pre-flavoured. They also need to be versatile enough to pair with the range of flavours of the different cuisines, a trait that allowed both instant noodles and chicken to become ubiquitous in Asia and around the world.

The range of flavours and cooking techniques also mean that chefs in Asia need to understand how alternative protein products interact with the herbs, spices and cooking techniques. David Yeung, CEO of the Green Monday group, an alternative protein food business, revealed that his company regularly engages with chefs to tweak Asian recipes to allow them to replace meat with alternative protein products. The effort is worthwhile as a large food services provider we spoke to has noticed increased demand for alternative proteins when they are offered in Asian dishes.



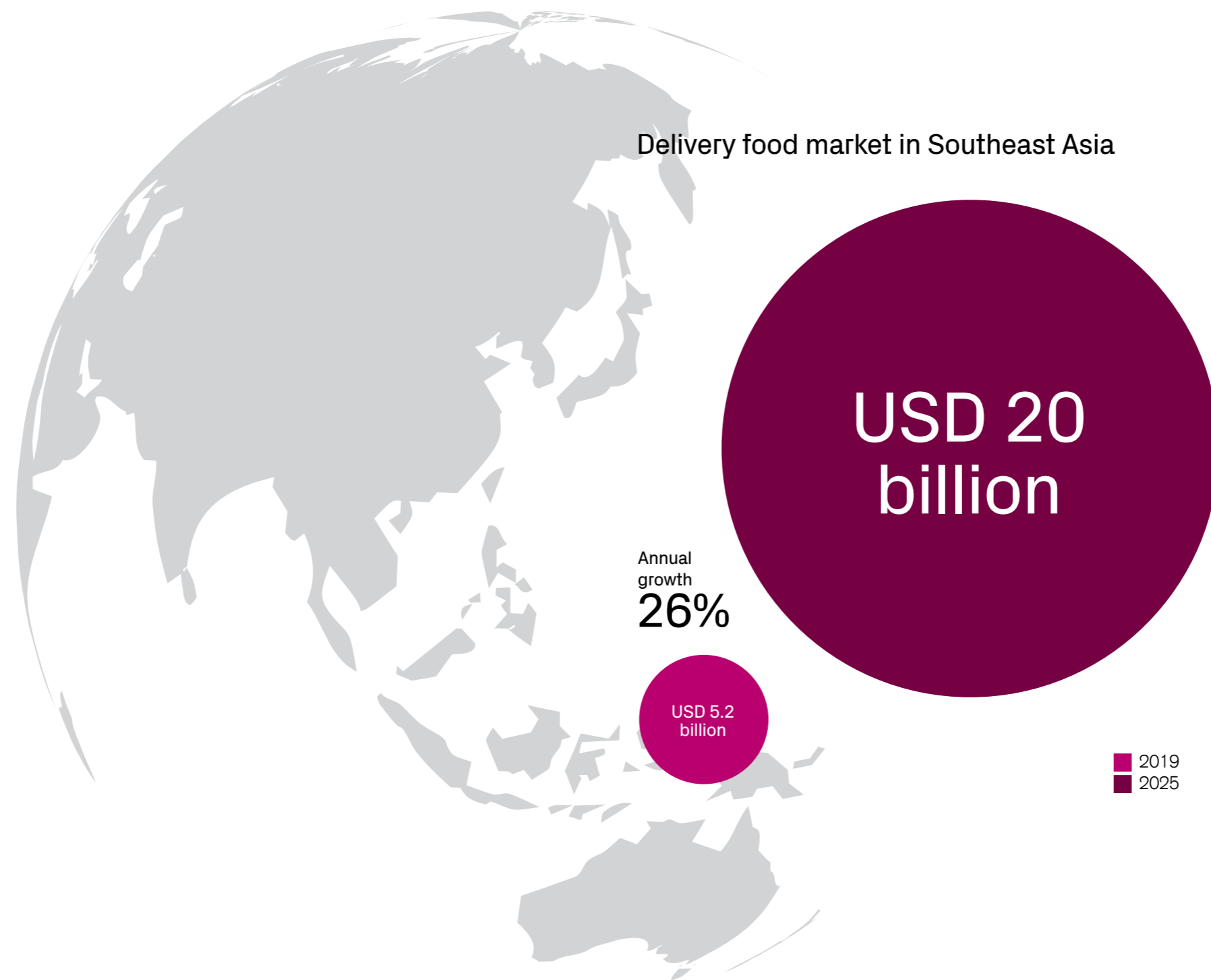
## Farm to door

Much of Asia is rapidly urbanising, and the changes in the way that Asians live is accompanied by the change in the way that Asians eat. The density of Asian cities coupled with affordable, tasty local food that is easily available has created a lifestyle where fewer Asians are choosing to prepare meals at home, particularly as Asian houses are getting smaller. Rather, as Asia develops and Asians gain more disposable income, they are choosing to dine out for the majority of their meals.

The advent of technology has also moved Asians further from the kitchen, with food delivery platforms bringing the wide variety of food options available straight to their workplace or their home with just a few quick taps on their smartphones. According to research performed by Daxue Consulting, a market research firm in China, the value of the online delivery food market in China has grown from USD 15 billion in 2015 to USD 35 billion in 2018. A joint study by Bain & Co, Google and Temasek Holdings also predicts that the value of the delivery food market in Southeast Asia will grow from USD 5.2 billion in 2019 to USD 20 billion in 2025.

“**These trends suggest that increasing the accessibility of alternative proteins products via food services providers will be critical to driving the adoption in Asia.**”

Manufacturers should cater more to food service providers than supermarkets when reaching out to consumers. And the products that they create need to be delicious in Asian dishes and will still stay delicious half an hour after being tossed around in hectic Asian traffic



## The cool factor

The youth are becoming increasingly aware of environmental issues and this awareness is being reflected in their choices. A food services company that provides catering in schools and workplaces across Asia that we spoke to revealed that the two demographics that have requested for more plant-based options are the young in schools and white-collar workers. The reason for their requests? Environmental impact and health concerns, two aspirational lifestyle values that are trending around the world.

Global trends proliferate among the young through social media. Food trends are no different. Nithiya Laila, culinary anthropologist, observed that food trends started in cities such as New York or London are gradually adopted in large cosmopolitan Asian cities such as Bangkok, Shanghai and Singapore, before flowing through the rest of the region. Consciously flexitarian diets have been an emerging trend in the West, and it is beginning to take root in Asia. This trend coincides with the availability of alternative protein products in Asia.

The food trends create the hype that drive people to sample these products, but David Yeung observes that changes in lifestyle choices, particularly among the young are what will eventually move alternative proteins into the mainstream in Asia. While the young are increasingly aware of the environmental and ethical impact of their food, what can drive sustained changes in behaviour is the image that adopting an environmentally conscious lifestyle is socially desirable.

He quotes the success of Starbucks in China as a prime example of this phenomenon. China has a deep history and strong culture of tea drinking. However, when Starbucks entered the Chinese market, it created an image that projected an aspirational lifestyle, eventually leading to the proliferation of Italian coffees in China. The growing number of Asian celebrities adopting environmentally conscious lifestyles also helps in expanding this movement.

Further, as the market for alternative proteins in Asia grows, it appears likely that the vast majority of the demand will come from meat eaters. David Yeung observed that a significant number of vegans and vegetarians in Asia are driven by religious concerns and are generally not attracted to meat substitutes. Rather, Asians seeking to reduce meat consumption through adopting a flexitarian diet appear to be driving demand for alternative proteins at this early juncture.

# Conclusion

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The promise that alternative proteins may reduce the negative impact that our food system places on the environment appears plausible. The rate of adoption worldwide still hinges on a wide range of factors, but the trends are moving in a positive direction.

Globally, the growth of the conscious consumer as well as vast improvements in the quality of alternative protein products should continue to drive the growth of the market and the corresponding environmental benefits.

And if Asia takes to alternative proteins, the amount of land saved from the corresponding reduction in meat consumption will be potentially more significant. Early signs suggest that this is a realistic possibility. Adoption levels will initially be low due to the lack of availability of suitable alternative protein products at affordable mass-market prices, but this is unlikely to persist as a wave of Asian-based food tech start-ups are developing products for Asian consumers.

As these products become available, the rate of adoption of alternative proteins across the globe might keep pace with or might even exceed the most optimistic projections. When the alternative protein products are of sufficient quality and are competitively priced, there is no real reason why people won't incorporate them into their everyday diets.



# Appendix 1

## Land savings based on estimated size of market

In the report How Will Cultured Meat and Meat Alternatives Disrupt the Agricultural and Food Industry, AT Kearney provides an estimate of the size of the alternative proteins market in 2025, 2030, 2035 & 2040.

In its estimates, the alternative proteins market is broken down into plant-based and cultivated meat, that grow at different rates. The traditional meat market is expected to have no growth. The entire meat market, comprising of animal-based meats, plant-based alternative proteins and cultured meat, is estimated to grow at a 3% CAGR between 2018-2030. However, the growth rates are different for different segments of the meat market, as detailed in the table below.

	2018-2025 CAGR	2025-2030 CAGR
Traditional Meat Market	1.11%	-1.37%
Plant-based	56.97%	16%
Cultured meat	Reference data shows cultured meat has close to 0% market share at 2025, growing to 35% market share in 2040.  The market size for 2026-2030 are based on an interpolation from future market size growth.	

We then used FAO meat pricing data for the year of analysis to translate market values to volume. This is based on the assumption that plant-based meats and cultured meats reach price parity with traditional animal-based meats by or before 2025.

To account for demand from non-meat eaters, we have estimated that 70% of combined plant-based alternative proteins and cultured meat market will displace the same volume of meat in the traditional meat market. This is consistent with 2018 reports quoting Beyond Meat's executive chairman Seth Goldman.<sup>1</sup>

The land use profile of displaced meat is based on the global weighted average land use profile of meats. The volume of meat, alternative proteins and cultured meat in the year of analysis were then used to calculate the corresponding land use.

<sup>1</sup> <https://www.foodnavigator-usa.com/Article/2018/01/12/An-estimated-70-of-Beyond-Burger-fans-are-meat-eaters-not-vegans-vegetarians-says-Beyond-Meat>

# Appendix 2

## Land savings based on reported intention to replace meals with alternative protein

### Replacement methodology

Impossible Foods performed a survey on millennials in the US to gather their intention on their frequency of eating plant-based meats. We have turned that into a percentage replacement rate of 5.39% based on the number of meals that are likely to be replaced by plant-based meats<sup>2</sup>. We assumed that the replacement rate was based on 3 meals per day, for a total of 90 meals per month.

Frequency	% of respondents
"Once a week or more often"	30%
"At least once a month"	40%
"Less than once a month"	10%
"Never"	20%

### Assumed replacement rates

"Once a week or more often" = 13.33% [equivalent to 3 meals a week]  
 "At least once a month" = 3.33% [equivalent to 3 meals a month]  
 "Less than once a month" = 0.56% [equivalent to 0.5 meals a month]  
 "Never" = 0%

We created scenarios and assigned regional replacement rates for 2018 and 2030. The replacement rate for 2025 is then assumed as a straight-line interpolation. The Base Case Scenario is relatively optimistic and demonstrates that by 2030, plant-based alternative proteins are widely accepted and easily available everywhere but Africa.

### Base case scenario

	2018	2025*	2030
North America, Europe, Oceania, Latin America	5.39%	7.11%	8.33%
Asia	1.49%	5.76%	8.33%
Africa	0%	2.22%	3.33%
"Never"	20%		

Given the meat heavy diets for North America, Europe, Oceania and Latin America, and relatively early entrance of plant-based alternative protein products, we assigned similar replacement rates based on the Impossible Foods US millennials survey results.

\* The replacement rate for 2025 is assumed as a straight-line interpolation between 2018 and 2030.

The land use savings was calculated as the difference between the amount of land required for the year of analysis, less the amount of land required to produce the plant-based alternative proteins.

<sup>2</sup> Agfunder, 2019. The Investment Case for Alternative Protein.

### 2018 Asia – Base Case Scenario

While an alternative pork product entered the market in 2017 in Asia, the sentiment on consumer interest is not as widespread as in the US. On the other hand, given the long history of mock-meats, several studies have shown that in both China and India, there is less aversion to alternative protein. As such, the scenario models a population that is highly willing, but not actively looking to replace meals.

Frequency	% of respondents
“Once a week or more often”	0%
“At least once a month”	50%
“Less than once a month”	50%
“Never”	0%
Aggregate Replacement Rate for 2018 Asia	1.49%

### 2018 Africa – Base Case Scenario

Our research shows the products were only introduced to the South African market at the end of 2018. Given the lack of availability of plant-based alternative proteins, the African replacement rate is 0%.

### 2030 Global, ex-Africa – Base Case Scenario

In this scenario, alternative protein products are well accepted and readily available. The Asian market has caught up with the rest of the world. A significant part of the population are consuming alternative proteins on a regular basis. That would mean actively eating at places that serve the option. It is however, not yet ubiquitous.

Frequency	% of respondents
“Once a week or more often”	50%
“At least once a month”	50%
“Less than once a month”	0%
“Never”	0%
Aggregate Replacement Rate for 2030 Global, ex-Africa	8.77%

### 2030 Africa

Given that the per capita meat consumption for Africa at 2030 is still very low. In general, they eat 0.6 servings of meat (60g per serving) a day, compared to 1.3-3 servings of meat a day for the rest of the world<sup>3</sup>.

Frequency	% of respondents
“Once a week or more often”	0%
“At least once a month”	100%
“Less than once a month”	0%
“Never”	0%
Aggregate Replacement Rate for 2030 Africa	3.33%

How will Asia’s take-up rate change land use savings?

	2018	2030		
		Sluggish	Base Case	Optimistic
“Once a week or more often”	0%	30%	50%	100%
“At least once a month”	50%	40%	50%	0%
“Less than once a month”	50%	30%	0%	0%
“Never”	0%	0%	0%	0%
Aggregate Replacement Rate	1.49%	5.50%	8.33%	13.33%
(+)/(-) Land Use Savings		-17%	Base Case (2.8mil km <sup>2</sup> )	+30%

Sluggish Growth Scenario – Asians do not take to alternative proteins due to cost, taste profiles or other reasons. Only high conscious eaters will consume alternative proteins on a regular basis. Therefore, adoption rate is at 5.50% due to the low acceptance of alternative proteins by consumers or the lack of availability of alternative protein products.

Optimistic Growth – Alternative proteins are now readily available in the majority Asian markets and in almost every meat dish available in non-home dining. Because of the increased accessibility of alternative proteins, the adoption rate is increased as the number of meals with alternative proteins is expected to increase.

<sup>3</sup> Servings of meat per day is estimated based on FAO per capita consumption divided by the weight of meat in a common meal. In the US, the New York strip steak and a hamburger patty is used as a reference point. In Asia and Africa, the reference point is based on dietary recommendations of 60g per serving.

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