The future of alternative proteins: Implications for the meat industry and farmland use

December 2021
Introduction

Objective

To develop insights and an outlook on the alternative protein market 1) as an investment opportunity and 2) a path to reduce deforestation. The content of this report determines the opportunity to invest in alternative protein supply chain as there is potential for revenue growth and strong partnerships in the future.
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**Investment highlights**

**Objective:** To develop insights and an outlook on the alternative protein market 1) as an investment opportunity and 2) a path to reduce deforestation. The content of this report determines the opportunity to invest in alternative protein supply chain as there is potential for revenue growth and strong partnerships in the future.

**What is the market outlook?**

- **The demand for alternative protein is permanent and is expected to continue growing at a baseline of 5% - 7% for US, EU and China and 3.6% globally by 2030.** This will translate to 11 million tons of global consumption of plant-based meat by 2030. This is a market of US$20.6 billion in the key markets and still a small portion the global animal-based meat market valued at US$1.5 trillion in 2020.

- **Primary drivers of the demand growth are attributed to shifting consumer preferences towards healthy and environmentally friendly food and meat products.** The plant-based meat market specifically appeals to the niche flexitarian market that aims to reduce their meat intake and not eliminate it. Approximately 14% of the population of the 28 most populated countries identifies as flexitarian; that is 830 million consumers. The flexitarian demographic alone could consume up to 14 million MT of plant-based meat products if all constraints are removed. For this reason, overcoming barriers of desired taste, texture and price will be imperative to consider for the industry entrants.

- **A good mix of product varieties offered that are closely comparable to already successful product (i.e., animal-based protein) and available through retailers and food service channels will help with growing this market.** Retail strategies that include placement of product have already proven to increase consumer trial and acceptance of plant-based products. In the US, plant-based sales has increased by 43% from 2018-2020.

- **Plant-based meat has the potential to compete with animal-based meat as the ingredient costs are cheaper** and with scaling of processing technology, plant-based products will be able to reduce the 40% price premium.

- **Alternative protein industry is a climate-friendly investment** as inputs needed to produce animal-based products demand large farmlands and infrastructure to grow meat and animal feed. Whereas, plant-based meat, for example, will require 47-71% less land for each ton of meat compared with 1 ton of animal-based meat. With increasing consumption of plant-based products, land-use change leading to deforestation can be reduced however other factors (e.g., regulatory land measures) also are needed to have a larger impact on reducing deforestation.
Investment highlights

Who is already investing?

• **Alternative protein industry has raised US$5.9 billion in investments as of 2020**, spanning over plant-based companies, cell-based meat companies and fermentation technologies.

• **Investor profiles include food and agricultural companies, non-profit organizations and foundations, government funds and venture capitalists.** Strategies include,
  > Direct investments in plant-based meat companies (e.g., Beyond Meat) or key suppliers (e.g., Puris pea protein)
  > Partnerships and acquisition with plant-based food development companies.
  > Food and agricultural companies, specifically, are investing in introducing own product line using existing meat processing facilities.

Where can you invest?

• **To create a sustainable food system and meet the growing demand of alternative proteins, investments are needed across the supply chain.** A list of investment opportunities and current investors are added in the report in “Investment Implications” section.
  > Pea protein ingredient manufacturers
  > Innovative protein companies/startups
  > Production technology and R&D institutions
  > Texturizing capacity
  > Production plants
Background & recent developments
Section summary

• This section aims to provide insights on the following,

  > A background on animal-based protein industry that can potentially lose market share to the growing alternative protein industry in the future. The loss of market share will remain relatively small as the alternative protein industry is competing with a market that is significantly mature and will grow up to 16 times the current size of alternative protein market in the next 10 years.

  > An estimation of market share of alternative protein industry as of 2020 and its important segments, including plant-based, cell-based and other protein sources such as vegetables, insects and microalgae. The alternative protein market share varies by product segmentation (e.g., plant-based meat market share is about 1-2%) and is growing in key consumer economies such as the US, Europe and China.

  > The segmentation of demand for type of alternative product to indicate growth points of the market. Within plant-based meat segment, beef, chicken and pork products account for about 70% of the demand structure. As an implication of growing demand, consumption of animal-based products will vary by country as macroeconomic factors such as income will determine cost-effectiveness of alternative products.

  > A timeline of history and recent developments of plant-based protein companies and major meat companies entering the alternative protein industry and introducing their own plant-based product lines. Accelerated development, in terms of investment and new products, is noted in the last five years.
Animal-based proteins: What is at stake?

- The global animal-based protein market produces about 800 million tonnes of proteins valued at US$1.5 trillion. Of the broader protein market, beef, pork and broiler meat account for 33% and more than 60% of meat protein is produced and consumed outside the EU and North America.

- Over the last 10 years, broiler meat production has been the most dynamic species with a global CAGR of 2.6%. With a 31% market share, Asia is the dominant producing region in 2020.

- For the next 20 years the baseline meat protein demand, excluding the growth of alternative meats which would substitute animal meat proteins, is as follows.
  > Broiler meat production is expected to grow at CAGR of 1.8%; Asia will be the most dynamic region with a 2.0% CAGR.
  > Pork meat production has been impacted in 2019 and 2020 by the ASF (African Swine Fever), especially in Asia. For the next 20 years, pork meat production growth will be driven by Asia and Central and South America.
  > Bovine meat production is mainly driven by North and Latin America with a combined market share of 52% in 2020. Production growth will be driven Asia and Central and South America.

- Milk production is the largest in Asia and Europe with a combined share of 62% in 2020. For the next 20 years, milk and dairy products are projected to grow more than other agricultural commodities. The growth also will be driven by consumers in Asia and Europe.

- Alternative proteins are competing with an industry that is significantly mature and will continue to grow in the next 10 years; for perspective meat demand (excluding milk) will expand by about 17 million tonnes by 2030 in a high case scenario; this growth alone represents 16 times the current size of the alternative meat market.
Alternative proteins market segments

- Alternative proteins products that are direct substitutes for animal-based protein (meat & dairy) are valued at US$29.4 billion from primary markets in North America, Europe and Asia. While vegetable proteins (e.g., tofu) are considered matured demand, the currently popular and growing plant-based food categories are plant-based dairy and meat at 10-15% and 1-2% of total global protein markets, respectively.

- For the purpose of this report, alternative proteins are categorized as the following, but only plant-based meat and cell-based proteins are studied in greater detail in this report:

  > Plant-based dairy: An alternative dairy source for consumers made from vegetables and/or tree nuts such as almonds, soy, and oats, etc. While plant-based dairy can include egg substitutes, mayonnaise and dressings, etc., plant-based milk is considered a dominant product of the plant-based dairy category. In the US, plant-based milk was about 35% of the retail sales value of the total plant-based food market in 2019.

  > Plant-based meat: Made from vegetable proteins such as soy or pea protein, plant-based meat has increasingly become a popular alternative protein source for meat as it imitates the taste and texture of real meat and aims to directly substitute meat consumption.

  > Cell-based meat: Also known as “lab grown meat,” more than 50 companies worldwide are now working on producing meat made from real animal cells grown in cultivators but, at the moment, such meat is only available in Singapore.

  > Vegetable protein: Vegetable-based products such as tofu, beans and legumes are considered primary sources of protein specifically for vegetarians and vegans. This is a mature market primarily driven by vegetarians.

  > Insect protein: In many parts of the world, insects (e.g., crickets) are consumed as a source of protein and there are new ventures looking to expand insect protein for food and animal feed.

  > Microalgae protein: Microalgae-based solutions deliver non-GMO alternative protein concentrates and isolates with amino acid profiles rivalling animal-based proteins.
Demand structure of alternative proteins

Background

• Alternative meat products are seen as direct substitutes for beef, pork, and poultry products with the largest market for beef substitutes followed by chicken.

• Differentiation of beef, chicken, and pork products are made with seasonings and the primary plant protein ingredient. For example, most plant-based beef contains soybean or pea protein along with “heme” which is an ingredient that gives the product a meat-like flavor, whereas plant-based chicken products may contain more wheat protein to give it a chicken-like texture.

• These products are produced to be direct substitutes of value-added products such as chicken nuggets, bratwurst sausages, burger patties, and links, etc.

Implications

Animal based meat and milk consumption

• Meat and milk consumption in higher income countries will stagnate as alternatives gain market share. In developing and middle-income economies, meat and milk consumption will continue to grow as animal-derived products are still more cost effective and the potential health and animal welfare benefits of alternatives are not as highly valued by consumers.

Cattle herd numbers

• Cattle herd numbers in countries experiencing rapid economic growth will rise while mature economy cattle herd numbers will remain constant as alternatives gain slight overall market share.
Recent developments in alternative protein market saw the major meat companies entering the market

Recent entry and investment from the major global meat companies into plant-based proteins validates the potential of alternative meat; that is, it is no longer seen as a niche or small segment of consumers (vegetarians and vegans), but rather a growth market that reaches across a widespread range of consumers who have not have previously sought out alternative meat products.

The market response from the major global brands was also observed in the plant-based dairy segment where the world’s largest dairy product producers, such as Danone, Chobani, Nestle, Unilever, and Saputo, have entered the plant-based dairy space and now they compete with the initial new entrants such as Califia Farms, Oatly, Perfect Day, and Kite Hill who produced almond, oat, and soy milk for many years before the major brands entered the market.

### Development in alternative protein products

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tr>
<td>1975</td>
<td>Morning Star Farms introduced soy-based meat in US grocery stores</td>
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<tr>
<td>1999</td>
<td>Kellogg’s acquired Morningstar Farms &amp; owns its plant-based business</td>
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<tr>
<td>2009</td>
<td>Acquired plant-based brand Boca Burger Kraft</td>
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<td>2013</td>
<td>Mosa Meat - A Dutch company introduced world’s first lab grown meat</td>
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<td>2016</td>
<td>Impossible Foods launched its first plant-based product directly competing with Beyond Meat</td>
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<tr>
<td>2019</td>
<td>JBS launched soy-based burger in Brazil through its brand SEARA</td>
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<tr>
<td>2020</td>
<td>JBS, Cargill launch plant-based meat brands in US</td>
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<tr>
<td>2020</td>
<td>Food &amp; meat giants Tyson’s, Smithfield, Hormel, Nestle &amp; Kroger launch their own plant-based brands</td>
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Since mid-2019, development of alternative meats market accelerated

**Plant-based meat**
- Meat giant JBS entered into the plant-based meat arena via a new subsidiary – Boulder, CO-based Planterra Foods, OZO brands. The acquisition was announced in October 2020 and their product lines have been reaching retailers across the US.
- Other large meat companies also have previously entered the alternative protein industry. Tyson and Perdue launched their entry into the alternative meat space in June 2019, Hormel in September 2019, Smithfield in October 2019, and Cargill in February 2020.
- Canadian packaged meats company Maple Leaf Foods announced an investment of more than $400 million for two massive plant-based protein manufacturing facilities. Combined, they will comprise almost 350,000 square feet of manufacturing space in Indiana.
- Impossible Foods has received approximately $1.4 billion in funding and pressure is building to go public in order to raise more capital.
- Beyond Meat went public in May 2019 at an initial IPO price of $46 per share, which then peaked at a price of $234.90 in July 2019. Since the stock market largely recovered after the COVID-19 induced pullback in early 2020, Beyond Meat’s stock price has been trading above $90 per share, although there has been a downward trend over the second half of 2021. Prior to going public, Beyond Meat raised $122 million in 10 rounds of funding.
- California based Upside Foods (formerly Memphis Meats) and Netherlands based Mosa Meats have raised $181 million and $96 million in funding, making them the two largest players in the lab-grown cultured meat division of alternative proteins.
- Traditional venture capital firms and celebrities are a large investors in alternative meat production companies. For example, Impossible Foods has received investments from Serena Williams, Katy Perry, and Bill Gates. Gates has also invested in Upside Foods.

**Cell-based meat**
- Israeli company Future Meat Technologies managed to make a chicken breast from real chicken cells cultured in a bioreactor for $7.50 per pound — a fraction of the $300,000 price tag when lab grown meat was introduced in 2013.
- In March 2021, Singapore-based food tech company Sophie’s Bionutrients unveiled the world’s first plant-based burger patty made from microalgae.
- For more detailed information on role of food and agricultural companies in alternative protein market, please reference SECTION: INVESTMENT THESIS.
Outlook for alternative meat
Section summary

This section aims to provide insights on the following,

> A background on the organic food industry and its growth pattern in the past 10-15 years.
   Like the alternative protein market, the organic food market is targeted to consumers that would pay premium prices for a higher quality and healthier products. So, the organic industry is a key learning industry for the alternative protein players.

> An outlook on growth of plant-based and cell-based meat market as of 2030 segmented into global growth and growth in key economies i.e., US, Europe and China. The outlook is further divided into three following scenarios that are explained in further detail in the section.

   – In baseline scenario, IHS Markit estimates market share of plant-based meat to range from 4.8% to 7.6% by 2030 depending on the economy. Globally, the market share is estimated to be at 3.6% by 2030.

   – In high growth scenario, IHS Markit estimates market share of plant-based meat to range from 7.5% to 11.6% by 2030 depending on the economy. Globally, the market share is estimated to be at 5.7% by 2030.

   – In low growth scenario, IHS Markit estimates market share of plant-based meat to range from 0.9% to 2.3% by 2030 depending on the economy. Globally, the market share is estimated to be at 0.68% by 2030.
Organic industry: A lesson for alternative proteins growth

• The organic livestock industry serves as an example of a targeted protein market’s growth over time and is a good proxy for alternative protein industry.

• Like the alternative protein market, consumers are willing to pay a price premium for organic products, often motivated by health concerns or a perception of higher product quality. Younger and wealthier consumers show a higher amount of interest in purchasing organic products.

• While organic product sales receive a premium over conventional, the costs of inputs are priced at a similar or even higher premium, thus creating margins that are often narrower than conventional farming.

• Organic milk cows, beef cows, and hogs have not shown growth since 2008. However, the organic poultry has shown rapid growth. Market share of organic meats in US grew from 0.5% in 2008 to 1.2% in 2019 whereas market share of organic milk dropped from 2.2% in 2008 to 1.8% in 2019 in the US. In the EU, roughly 4% of milk is organic and the EU hopes to increase this share but there are obstacles to an increase including the costs to transition from traditional to organic agriculture. EU organic egg share has increased from 3% in 2010 to 6% in 2020.

• Despite the growth in organic livestock populations, organic still makes up a relatively small portion of total US livestock, reaching a peak of 1.2% in 2019. The portion of European livestock that is organic is slightly higher than the US, showing an upward trend to a peak of 1.8% in 2019.
IHS Markit outlook on plant-based meat market

- The United States, Europe and China are key economies for the growth of plant-based meat market as consumer preference shifts towards healthier and environmentally friendly meat options in these regions. These countries are the largest consumer of animal-based protein and have income levels to substitute animal-based protein for plant-based options. For this reason, the outlook scenarios are segmented according to these regions and “others” to give a global perspective. Specialty products by large global companies in other countries (e.g., JBS in Brazil) will also mobilize growth globally.

Three scenarios are evaluated in this report and defined as follows,

- **Baseline Scenario:** With emerging technologies and increased competition, in baseline scenario the market share of plant-based meat consumption in US will be 7.1%, in Europe will be 7.6%, and China will be 4.8% by 2030. The baseline scenario assumes the current plan of expansion by plant-based giants (Beyond Meat and Impossible Foods) globally and achieving cost competitiveness with scaled production. The constraint of insufficient supply and investments in plant proteins and technology to improve protein level and diversify plant protein source will hinder growth.

- **High Growth Scenario:** In a high growth scenario, the market share of plant-based meat consumption in US, Europe and China will be 10.9%, 11.6% and 7.9% by 2030, respectively. In this scenario, the industry will not face any financial constraints, higher cost competitiveness, better nutritional value and significant growth in consumer acceptance as seen in 2020 due to COVID-19 increasing animal-based protein prices. Other countries will also start to adopt plant-based movement and global market share will increase up to 5.7%.

- **Low Growth Scenario:** In a low growth scenario, the market share of plant-based meat consumption in US is 2.25%, in Europe 2.06%, and China 0.68% by 2030. In this scenario, the industry will face similar challenges as faced by the organic market in this region. This would include large price disparity, high cost of production and lower consumer acceptance.
IHS Markit outlook on plant-based meat market (cont.)

- The market share of plant-based meat by 2030 is evaluated based on volume. The value of plant-based proteins is 40% higher than animal-based protein. Market share represents combined beef, poultry and pork consumption for each region/country.

- Current market share (2021) of plant-based meat consumption in the US is 0.84%, in the EU at 0.78%, and China at 0.36%. Global market share is at 0.4% as “others” are included that brings down the market share.

- Europe will grow faster than the US as the growth is also driven by the push for decarbonization through the New Green Deal in Europe.

- China’s growth rate will remain moderately lower than US and Europe. Although similar acceleration in plant-based growth will be noted, the growth of animal-based protein is faster than the EU and the US in the forecast period.

![Graph showing plant-based meat market share growth from 2020 to 2030 by region and scenario.](image-url)
IHS Markit outlook on cell-based meat

- Cell-based meat intends to mimic meat from animals, such as cattle and poultry by producing cultured meat using live animal cells. Naturally, the process is expensive and not fully commercialized as it is still in development stages. As of May 2021, there is only one cultured meat product available on the market at a restaurant in Singapore.

- Cell-based meat industry is still facing the following issues,
  > **Scalability** – Scalability is still an issue for other companies as the bioreactor technologies and input needed to grow the live cells are still expensive. This increased cost of production is hindering any cost effectiveness.
  > **Consumer Acceptance** – Consumers may not be accepting of the price, taste and texture of cell-based meat, which will make it difficult for cell-based meat to meet increasing protein demand. Consumers and producers used to traditional farming have been known to raise concerns over cell-based proteins. There has also been uncertainty of where religions stand on cell-based proteins, such as whether it can be considered Kosher or Halal.
  > **Regulatory restrictions** – Labeling of cell-based proteins falls under various regulations according to a region. For example, in the US, EU and Australia, the authorities will take a pre-market authorization approach through legal inspections, whereas in China and Brazil, cultured meat will be less regulated than other regions. This will affect consumer adoption.

- Two scenarios are created for cell-based meat considering growth with current constraints and growth with lower constraints that will enable cell-based meat to compete with animal-based premium cuts.
  > Cell-based proteins will become 0.3% of the global protein market by 2030, if it cannot achieve price parity and continue with lower consumer adoption.
  > Cell-based proteins will become 0.6% of the global protein market by 2030, if the cost of production is lowered drastically, which is already happening (e.g., Mosa Meats has brought down the price of a single burger patty from $300,000 per pound to $10 per pound.). Consumer adoption and regulation will remain a consideration as the market is too new to evaluate these constraints.
Market drivers & growth constraints
Section summary

This section aims to provide insights on the following,

- **A deep dive into demand drivers that are crucial for the growth of alternative protein industry today.** For each driver, a discussion on barriers to entry is also included to indicate challenges faced by the alternative protein industry. These drivers include:
  
  > Growth driven by the increasing number of flexitarians, a niche demographic that substitutes meat products for plant-based on certain days for health or environmental reasons.
  
  > New consumer trials in plant-based products in the past few years have become trendy and showcase increasing interest in plant-based products.
  
  > Growth in sales driven by smart retail strategies such as product placement with animal-based meats, proper signage and merchandising strategies such as retailers offering their own line of plant-based products at value prices.
  
  > Market externalities such as income levels drives the growth in alternative protein products as they remain at premium prices. Hence, more growth is noted in higher income countries such as the US, Europe and China.
  
  > Current market disruptions such as COVID-19 impacted the animal-based meat supply chain, causing shortages. Due to this, a higher growth in plant-based sales is noted as consumers tried substitutes for the first time in absence of animal-based products.
  
  > Environmental awareness is causing shifts in consumer behavior and consequently the demand for products that can be associated with lower carbon emissions such as plant-based meat is increasing.

- **A deep dive into supply drivers that are crucial to meet the growing demand of alternative protein industry.** These drivers include:
  
  > Investment strategies by key players in the market through fundraising, partnerships, acquisitions or introducing their own product line. The key players vary from food and agricultural companies to non-profit organizations and financial institutions looking for climate-friendly investments.
  
  > Partnerships between plant-based protein companies such as Beyond Meat and Impossible Foods with large food retailers is driving up the reach to mass audience and driving up the supply.
Demand driver: Plant-based analog products growth driven by the flexitarian diet

- Plant-based food companies are not just marketing to vegetarians and vegans, but also target flexitarians (semi-vegetarians) and omnivores as key markets. The following consumer behavior and preferential diets will drive growth of plant-based protein markets in different ways:
  - **Flexitarian:** This is a key market that plant-based companies should be targeting to grow rapidly. A more health-conscious consumer segment, flexitarians intentionally replace meat on some days of the week (e.g., Meatless Mondays). An increased adoption by flexitarians will reduce demand for traditional meat as they are willing to replace animal-based protein if alternative proteins are more accessible and achieve desired taste.
  - **Vegetarians/Vegans:** As of 2020, vegetarians and vegans are only 5% and 3% of the global population, respectively. While it is a key market for plant-based proteins, adoption by this segment only will not create significant growth for plant-based companies.
  - **Omnivores:** The omnivore market, one of the most common diets globally, will remain harder to penetrate as globally six out of 10 people would still not go for plant-based meat alternatives, according to recent market studies.
  - **Pescatarians:** As plant-based fish & seafood is a novel product, the demand is yet to establish for fish substitutes. However, this segment may be open to non-seafood imitating plant-based meats.

- Some global consumer studies and retail data indicates the growth of plant-based food product purchases specifically by flexitarians:
  - A 2020 IPSOS study surveyed 6,000 flexitarians around the world and established that about 60% of flexitarians are already heavy buyers of plant-based meat. This segment of flexitarians are driven by health and environmental consciousness but not at the expense of the taste. The remainder are not heavy buyers yet because they care about convenience and price.
  - Another recent (2020) Good Food Institute study found that 63% of the plant-based meat buyers in the supermarket also bought animal-based meat at the same time. This is an indication of diversified buying driven by a flexitarian diet or current peaked interest.

- **Barrier to driver:** If alternative proteins do not achieve price parity, desired taste, texture and nutritional quality, the flexitarian market will select vegetarian options over alternative proteins.

“Flexitarians are looking for meat and dairy analog products directly substituting animal-based meat, unlike vegetarians/vegans that consider non-analog products as functional replacement of animal protein”
Demand driver: New consumer trials and interest driving current sales growth

- Interest in plant-based meat and dairy spiked in recent years with top searches from North America, Australia and Singapore. This corresponds with the increasing sales of plant-based meat and dairy products as reported by Good Food Institute. Interest in lab grown meat spiked in 2013-14 when a Dutch university introduced lab grown meat, however, this segment is yet to be commercialized at retail stores.

- The US alone saw a 43% increase in plant-based food sales from 2018-2020 compared with food retail sales that only grew at 17% in the same time period. The highest sales was in the refrigerated category with plant-based meat placed next to animal-based meat indicating consumer interest in analog products.

- Key Takeaway: Plant-based proteins may still be a small market but has growing interest, especially by flexitarians. In some diets, it can reduce animal-based protein demand as plant-based proteins become cheaper, accessible and achieve desired taste and texture. However, the surge in current sales can be primarily a result of current curiosity and may taper off in following years if price and taste parity is not achieved.

- Barrier to driver: Alternative proteins still only directly competes with ground meat and burgers; the ultimate growth will be when competing with whole cuts, which can be achieved by commercializing cell-based protein. A peak in sales is associated with new consumer trails, however, if repeat customers do not increase at the same rate as recent years, the demand will reduce.

![Google trends interest over time](source: IHS Markit, Google)

![Growth in plant-based foods retail sales vs. food retail sales in US](source: Good Food Institute, 2020)
Demand driver: Sales growth driven by retail and merchandising strategies

Common retail strategies that are adopted by large food retailers such as Whole Foods, Walmart etc. include:

**Product placement:** Consumers tend to compare plant-based and traditional protein products; hence shelving products together is a successful merchandising strategy. A recent study from Kroger and the Plant Based Foods Association placed a three-foot plant-based section in the meat aisle. Thus, plant-based meat sales rose by 23% compared with control stores.

**Offer private label products:** Walmart, Kroger, Whole Foods have also started to offer products under their private labels such as “Great Value” that compete with other expanding brands.

**Plant-based food added to food services:** Whole Foods offers plant-based meat in their hot bar. By adding options to food services, retailers are creating demand for alternative protein products.

**Proper signage:** Signage that clearly labels plant-based products placed in the animal-based shelves communicates the alternative nature well to consumers who are interested in eating less or sustainable meat.

**E-commerce merchandising:** Availability of a product through e-commerce helps drive demand as many consumers are avid online shoppers. Retailers that will continue to advertise products on their website are facilitating demand growth in sales.

**Barrier to driver:** Animal-based protein producers are already pushing back on labeling plant-based products as “meat” or “milk.” Without prohibitive regulation, alternative protein growth may face hinderance due to this industry push back.
The meat industry consists of a complex supply chain that can cause market instability if disrupted. Alternative protein markets, being a true substitute of this industry, are also subject to similar risks and externalities.

Typically, higher income regions consume more meat although there can be cultural differences that account for variation as well. Since meat consumption correlates with income, if incomes in lower income countries do not rise, alternative protein consumption would be hindered since alternative proteins are priced similarly to meat.

Barrier to driver: Alternative meat needs to offset negative externalities of current animal protein industry. If prices remain higher than other protein products, it will be difficult for alternative proteins to grow in global markets.
Demand driver: COVID-19 impact on alternative protein sales growth

• Supply chain disruptions as seen during COVID-19, which caused meat processing plant closures, impacted the demand for alternative proteins. In this case, the externality was positive for alternative proteins because meat products were scarce and priced higher than usual. As a result, sales for alternative proteins increased in 2020.

• According to Nielsen, the average year-over-year sales increase for fresh conventional meat each of the first seven months of 2020 was 23% while it was an astounding 150% for fresh plant-based meat alternatives.

• On the other hand, closures in food service due to COVID-19 reduced sales of both animal- and plant-based protein at restaurants and events. Beyond meat reported in its 2020 annual report that their usual sales mix of retail and food service went from 50:50 to 90:10 in 2020 as restaurants, hotels, stadiums, universities and other food service customers closed or otherwise restricted service.

• **Barrier to driver:** Alternative meat needs to offset negative externalities of the current animal protein industry. If prices remain higher than other protein products, it will be difficult for alternative proteins to grow in global markets.

![Impact of COVID-19 on conventional vs. plant based retail sales in 2020, US](source: IHS Markit © 2021 IHS Markit)
 Demand driver: Consumer demand for zero carbon products

Vegetable proteins, such as soybean and peas, used in alternative meat products produce significantly less greenhouse gas emissions than traditional meat products, especially cattle products.

Total emissions from livestock globally represent about 65% of total agricultural emissions. This does not include the carbon footprint of animal feed. Studies also show that if cattle emissions were isolated as a country, it would rank as the third highest emitting country after China and United States. Hence, the environmental impact has caused public opinion to shift against animal agriculture.

Consequently, eliminating animal-derived protein from the global food system would save $1.6 trillion in environmental costs by 2050. Environmental awareness is a key driver for the growth of alternative proteins in the future.

Barrier to driver: Environmentally conscious consumers demand proteins that are marketed as sustainable. However, lower GHG is not the only indicator of sustainability. As an example, demand for almond milk dropped as research showed high water use was needed for relatively little output, which was rendered unsustainable. Alternative proteins will have to maintain sustainable procedures that can be costly.

“A vegan diet is the single biggest way to reduce one’s impact on the planet—far larger than cutting down on flights or buying an electric car” – A study by Oxford University
Supply driver: Investment strategies increasing productivity

- Over the past 10 years, capital invested in plant-based food companies has increased raising up to US$5.9 billion in total investments. In 2020, there was a record-breaking investment with over US$3 billion invested in cultured meat, egg, and dairy companies. Investment strategies adopted by large food and beverage companies can create improvements in productivity and increased efficiency of alternative protein supply chains.

- Investments and manufacturing by food and beverage companies: Top food processing and protein companies are playing an active role in the alternative protein supply chain through investments or acquisitions. For example, in addition to introducing their own product lines, companies like Cargill and Tyson Foods are supporting competing alternative protein companies like Beyond Meat & Upside Foods etc. However, creating their own product lines while investing in other plant-based food companies can create conflict of interest. For example, Tysons sold its share from Beyond Meat as the investment relationship was affected by Tyson introducing its own product line.

- Demand for climate-friendly investments by non-food and agricultural companies: Other notable investors in alternative protein market that are not distinctly in the food sector are the Bill and Melinda Gates Foundation, Richard Branson, Temasek Holdings, and Black Rock Capital.

- Government grants and financing: Some governments have invested in plant-based food and ingredient products through funding alternative protein products for commercialization. The government of Canada announced a $100 million investment in the plant-based meat sector in 2020 whereas a $7.8-million investment is allocated by the German government.

- Agricultural venture capitalists: GlassWall Syndicate, Unovis, Green Monday, Lever VC are examples of investors that have targeted their investments, research and outputs specifically towards the alternative protein industry.

- Barrier to driver: The scale needed to bring ingredient supply constraints to meet demand spikes for vegetable-based has not yet been coupled with increased supply capacity, leading to price volatility. Another barrier that investors may face is cumbersome processes to regulate alternative products. For example, Mosa Meat, a company that is taking a leading role in reducing production cost of cell-based meat by 65 times, is still seeking to work with European regulators to get approval for its products.

“Incumbent meat processors are investing in alternative protein markets AND/OR introducing their own plant-based product line”
Supply driver: Partnerships with fast food and wholesale distribution channels

- During 2019 and 2020, fast food companies announced partnerships with the two big plant-based giants, Impossible Foods and Beyond Meat.

- This strategy allows for mass distribution and a high probability of consumer acceptance of plant-based options by appealing to value-minded consumers that would like to have the option to decrease meat consumption.

- **Barrier to driver:** Burger King and Tim Hortons are examples of falling sales of plant-based meat options as their options did not appeal to consumers at its dollar value. Since fast food distribution channels cater mostly to value minded customers, the premium price may not allow for a boost in acceptance in this segment. The plant-based industry will have to achieve price parity to appeal to a mass audience.

### Company Name | Role in the alternative protein market | Partnered with
--- | --- | ---
Subway • In September 2019, it began offering plant-based meatball subs at 685 participating restaurants across the US and Canada. | Beyond Meat
McDonalds • In September 2019, it started testing a plant-based burger (P.L.T.) at locations in Canada. | Beyond Meat
Starbucks • In 2017, it began selling the Lentils & Vegetable Protein Bowl with Brown Rice. In the UK, it offers a plant-based burrito and vegan mac and cheese. • In 2021, more than 200 locations in UAE and Kuwait added Beyond Meat sandwiches. | Own Brand & Beyond Meat
Burger King • The Impossible Whopper went nationwide in the US in summer 2019. • Partnering with “The Vegetarian Butcher” to roll out plant-based burgers in UK and select locations in China. | Impossible Foods, The Vegetarian Butcher
Dunkin’ Donuts • On November 6, 2019, it rolled out a sausage breakfast sandwich made with Beyond Meat sausage to all Dunkin’ restaurants across the US. | Beyond Meat
KFC • In June 2020, it launched a plant-based version of fried chicken made from Beyond Meat in California. • Beyond Meat is also sold at select KFC outlets in few Chinese cities. | Beyond Meat
Tim Hortons • Introduced a breakfast sandwich made with Beyond Meat’s meatless sausage and burger in July 2020 but disappeared by January 2021. | Beyond Meat
Pizza Hut • Beyond Meat is sold at select Pizza Hut outlets in a few Chinese cities. | Beyond Meat
Taco Bell • Beyond Meat sold at select Taco Bell outlets in a few Chinese cities. | Beyond Meat
Disney • In 2020, it announced its partnership with Impossible Foods. Disney World offers Impossible meat options at many of its own food vendors now accelerating demand | Impossible Foods & Beyond Meat
Conventional vs alternative proteins prices
Section summary

This section aims to provide insights on the following,

• **An analysis of lowering animal-based prices** in the last 40 years. As the market matures and technology evolves, the animal-based meat products have seen significant efficiencies, making it harder for alternative protein products to compete at a premium price.

• **A comparison of animal-based meat and plant-based meat production costs.** The input costs of plant-based meat is significantly lower than animal-based meat, but the premium prices lie in processing as plant-based meat facilities are still new and experimental and will need to scale to achieve efficiencies similar to animal-based meat processing facilities.

• **A comparison of animal-based meat and plant-based meat retail prices.** In regard to US retail, where plant-based meat market is growing, the products analyzed are priced at 40% premium that can be prohibitive for some demographics.

• **Summarized strategies of how alternative protein market can achieve price parity.** As significant cost lies in processing, scaling and integration of the supply chain will reduce per unit production costs, translating to lower retail prices. Fluctuation in animal-based meat products, as seen during COVID-19, will also reduce the price gap between plant-based and animal-based meat. Lastly, technological changes and innovation in efficient production, and new ingredients, etc. can help achieve price parity.
Lowered prices of animal-based meat in last 40 years

- Lower prices and higher incomes have driven and continue to drive meat consumption. Animal agriculture is also heavily subsidized by the federal government in the US.

- Beef retail prices show a distinct u-shaped pattern in which prices declined from 1980 before reaching a peak low in 1998, at which point they began to rise again.

- Pork retail prices have stayed in the $3.50- to $5-per-pound price range with pork prices remaining around the $4-per-pound mark in 2021 dollars since 1992.

- Broiler retail prices have shown a consistent decline over the past 40 years, one of the key reasons behind increased chicken consumption in the US.

- **Key takeaway:** meat prices have stayed relatively low. Consumers of meat are unlikely to be drawn to alternative proteins strictly on a price basis, indicating there is a need for the other key drivers of alternative proteins to resonate with consumers.

![US Retail Meat Prices in 2021 Dollars](image-url)
Comparative cost of production

The cost of producing alternative meats and animal-based meats do not differ a lot on downstream activities, which includes packaging, distribution, and sales. The spread lies primarily in upstream processes and inputs.

- **Input costs:** In the animal-based protein value chain, the cost of production comprises the price of animal feed, capital costs such as land for housing, veterinary and livestock supply costs, farm labor, marketing, and energy costs. Whereas, in the plant-based protein value chain, the input cost of plant protein (e.g., soybean, peas, and wheat) and binding agents (e.g., oil and water) is fairly cheap. The price spread between the two value chains will differ based on region (see example analysis on next slide). Cell-based protein companies purchase live tissue and cell-multiplying agents (e.g., Fetal Bovine Serum) that can be costly.

- **Processing costs:** Slaughterhouses and processing facilities for animal meat are massively commercialized and concentrated where some large incumbent meat processors such as JBS, Tysons, Smithfield, and Hormel take large shares. However, plant-based protein processing is still new and experimental, not integrated and costs more. This is where the 40% premium of plant-based retail price lies. Cell-based protein is even higher because of non-commercialized use of new technology (e.g., bioreactors).
Ingredient input cost: Animal-based versus plant-based

- Production processes of alternative meat and traditional meat are different and hard to compare. In a complex beef supply chain in the US, a calf grows and is weaned off from cow/calf operation to a backgrounder/stocker operation where it will stay on pasture until it is moved on to a feedlot to achieve marketable weight for the slaughterhouses and meat processing facilities. Some cow/calf operations are also backgrounders, which means that the cost of production in this case can be lower.

- For the purpose of initial comparison, below we outline input costs to grow a beef cow in cow/calf operation in Nebraska before it moves to the next stages versus input costs for plant-based burger before it goes into processing. Please note that the mass composition of plant-based burger includes 55% water, which is not included in the cost here.

- Based on an initial input comparison, plant-based inputs are $1.52 cheaper per pound than inputs needed per cow in a cow/calf operation based in Nebraska. This does not include the rest of the value chain indicating that plant-based meat can compete with animal-based meat due to cheaper input prices. Additional live cattle prices in Nebraska for meatpackers ranged from $1.03 to $1.25 per pound in 2019,* which are still lower than what would be needed as an input for plant-based meat. The premium lies in the processing where plant-based meat companies are still trying to scale up production and create an integrated value chain.

---

### Input cost for a beef cow at a cow/calf operation in Nebraska

<table>
<thead>
<tr>
<th>Input</th>
<th>Cost per cow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed Costs (includes bulls, 2 yr. olds &amp; replacement heifers)</td>
<td>$659</td>
</tr>
<tr>
<td>Veterinary Medicines + Equipment</td>
<td>$120</td>
</tr>
<tr>
<td>Labor</td>
<td>$100</td>
</tr>
<tr>
<td>Ownership Costs</td>
<td>$125</td>
</tr>
<tr>
<td>Net Cost Per Cow</td>
<td>$1,004</td>
</tr>
</tbody>
</table>

**Cost of input for a beef cow sold at avg. 550 lb** $1.83

---

### Input cost for a soy-based burger

<table>
<thead>
<tr>
<th>Input</th>
<th>Price per lb ($US/lb)</th>
<th>Amount needed to produce 1 lb of plant based meat (lb.)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybeans</td>
<td>$0.16</td>
<td>0.42</td>
<td>$0.07</td>
</tr>
<tr>
<td>Canola oil</td>
<td>$0.40</td>
<td>0.31</td>
<td>$0.12</td>
</tr>
<tr>
<td>Wheat flour</td>
<td>$0.15</td>
<td>0.14</td>
<td>$0.02</td>
</tr>
</tbody>
</table>

**Cost of input for 1 lb of plant based burger** $0.21

---

* 2020 prices were affected due to COVID-19 so 2019 prices is a better representation of live cattle prices
Retail beef pricing comparison – Plant-based vs. animal-based

The average price of plant-based meat is approximately US$0.56 per ounce and traditional beef is US$0.44 per ounce. The spread can vary due to fluctuating animal-based meat market prices.

**Plant-based meat burger patties**
- Beyond Meat Beyond Burger $0.67/Ounce
- Field Roast Vegan Field Burger $0.66/Ounce
- Gardein Ultimate Plant-Based Burger $0.62/Ounce
- Good and Gather Frozen Plant Based Meatless Beef-Style Patties $0.36/Ounce
- Morningstar Veggie Grillers Original $0.49/Ounce

**Beef burger patties**
- Good & Gather 80/20 Grassfed Burger Patties $0.42/Ounce
- Good & Gather All Natural 85/15 Beef Patties $0.42/Ounce
- Good & Gathered Beef Patties $0.42/Ounce
- Bubba Burger Angus Beef Chuck Patties $0.41/Ounce

Source: Target
Note: NYC Prices Used
Retail poultry pricing comparison – Plant-based vs. animal-based

The average price of plant-based meat poultry is approximately US$0.54/ounce and for traditional is US$0.33/ounce. **Hence, it can still cost up to 40% more to buy plant-based meat options.**

### Plant-based poultry meat

- **Tofurky Organic Vegan Plant-Based Hickory Smoked Deli Slices**
  - $0.67/Ounce

- **Raised & Rooted Alt-Protein Frozen Nuggets**
  - $0.62/Ounce

- **Morningstar Farms Veggie Frozen Meal Starters Chik’n Strips**
  - $0.38/Ounce

- **Good and Gather Frozen Plant Based Meatless Chick’n Tenders**
  - $0.47/Ounce

### Animal-based poultry meat

- **Oscar Mayer Deli Fresh Sliced Oven Roasted Turkey Breast**
  - $0.39/Ounce

- **Good & Gather Crispy Chicken Breast Strips**
  - $0.33/Ounce

- **Tyson All Natural Crispy Chicken Strips**
  - $0.34/Ounce

- **Tyson Air Fried Chicken Nuggets**
  - $0.27/Ounce

Source: Target
Note: NYC Prices Used
How will alternative protein products achieve price parity?

In the long term, scaling up operations will bring cost efficiencies that help both plant and cell-based meat. Cultured meat companies are seeking a path to affordability by producing at commercial scale. Investors in the sector expect production costs to fall steeply in next few years.

- **Supply Chain Integration:** Beyond Meat is targeting price parity with real meat in at least one of its product categories by 2024. The company is aiming to develop fully integrated production facilities to reduce labor and logistics costs. Based on Securities and Exchange Commission filings, Beyond Meat’s cost of production has already fallen from $4.50 per pound in mid-2019 to $3.50 per pound in mid-2020. In 2020, Beyond Meat made significant investments in operation capabilities and infrastructure. In the US, they moved to scale up integrated production at a recently acquired facility in Pennsylvania. They applied the same model of integrated production across the world in Jiaxing, China, where a new facility is designed with end-to-end capabilities. In the EU, they are nearing commercial production at their own facility in Enschede, Netherlands, which will establish their first extrusion capabilities in continental Europe. At the same time, they will continue to work closely with partner, Zandbergen World's Finest Meat, in the Netherlands at their wholly-dedicated Beyond Meat facility.

- **Scale-up production:** Impossible Foods has reduced its retail price twice in the last 18 months and one of the drivers is generating product at scale that helps with reducing cost of production. Mosa Meat, a cell-based protein company, estimated that the price could be $80 per kilogram if they are able to reach large-scale production. This would mean that a five-ounce burger would cost slightly more than $11.

- **Fluctuation in conventional meat prices:** The rise in US beef prices over the past year has also helped reduce the price premium over real meat patties. Impossible’s patty price was cut to $11 per pound compared with the average US beef patty price of $5 calculated by the US Department of Agriculture. The average retail price for Beyond Meat’s burgers has fallen to about $9 per pound, down from roughly $12 at the time of the company’s 2019 stock market debut, according to Bank of America.

- **Reduce input costs:** The key to reducing the cost of production for cultured meat is to reduce the price of the “feed” that provides the basic nutrients that allow the cells to proliferate. The industry started using expensive fetal bovine serum used in the biotech and pharmaceutical industries but is now focused on producing its own cheaper plant-based versions.

- **New technology utilization:** The key to reducing the cost of production for cultured meat is to reduce the price of the “feed” that provides the basic nutrients allowing the cells to proliferate. The Israeli-based company, Future Meat Technologies, has found ways to cut costs by creating a bioreactor that effectively removes impurities and makes the feed cheaper. This will reduce output costs for cell-based meat and achieve cost parity with conventional meat.

“This ultimately, what will drive market penetration, is taste, texture and price”
Investment implications
Section summary

This section aims to provide insights on the following,

• **Provide findings from an investment case study on Beyond Meat, one of the first public plant-based meat company.** Similar to technology investments, plant-based protein opportunities should be seen as a long-term investment as the revenue growth on the top line showcases increasing efficiencies whereas the bottom line (net profit) remains negative.

• **The role of food and agricultural companies that are also rapidly entering the alternative protein market and ramping up interest in the market.** The participation strategy includes,
  > Introducing their own product lines using existing processing facilities
  > Investing in plant-based supply chain, for example, pea protein companies
  > Partnering with other food and agricultural plant-based companies to achieve efficiencies

• **Provide a list of potential corporate ventures that develops the current alternative protein value chain for interested investors.** The companies disclosed in this list is not exhaustive but are researched to be growing plant-based or cell-based companies/startups that are innovative and may seek opportunities to grow market cap through investments.
An investment case study: Beyond meat

• Being one of the first publicly traded plant-based meat companies, Beyond Meat is a good proxy to understand the potential financial health of a pure plant-based meat company. Pioneering in a fairly new industry, Beyond Meat has seen more growth in top line (revenues) rather than bottom (net profit), which is similar to tech companies and early movers in the market. The firm needs to capitalize on its early mover advantage and penetrate as much of the market as possible.

• From year-on-year financial statements, Beyond Meat is operating at a bottom-line loss. However, investors should note the gross margin and operating expense to revenue ratio that declined quite a bit in the past five years indicating minimized expenses relative to revenue. Investing in and scaling of production facilities as well as partnerships with large retail distributors has increased revenue.

• As has been established, Beyond Meat is chasing top line growth rather than profitability. It already has a lot of competition from plant-based rivals like Boca Foods, Field Roast Grain Meat Co., Gardein, Impossible Foods, Lightlife, Morningstar Farms, and Tofurky. Established brands are also implementing their plant-based products, including Nestle, Unilever, and most supermarkets. In addition, Beyond Meat wants to compete against traditional meat products and plans to undercut the price of traditional meat through at least one product by 2025.

• **Key Takeaway:** Establishing an alternative protein supply chain will require significant investments and will be a suitable long-term investment as opposed to a short-term one. The market is still adjusting and is at a high right now due to consumer trials and trends. It must adjust to seasonality, consumer acceptance, increased competition and availability of inventory to meet the demand.

<table>
<thead>
<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Net Revenues</td>
<td>$16,182</td>
<td>$32,581</td>
<td>$87,934</td>
<td>$297,897</td>
<td>$406,785</td>
</tr>
<tr>
<td>Cost of Goods Sold</td>
<td>$22,494</td>
<td>$34,772</td>
<td>$70,360</td>
<td>$198,141</td>
<td>$284,510</td>
</tr>
<tr>
<td>Gross Profit</td>
<td>$(6,312)</td>
<td>$(2,191)</td>
<td>$17,574</td>
<td>$99,756</td>
<td>$122,275</td>
</tr>
<tr>
<td>Gross Margin Ratio</td>
<td>-39%</td>
<td>-7%</td>
<td>20%</td>
<td>33%</td>
<td>30%</td>
</tr>
<tr>
<td>Total Operating Expenses</td>
<td>$18,454</td>
<td>$26,374</td>
<td>$45,563</td>
<td>$100,245</td>
<td>$171,620</td>
</tr>
<tr>
<td>Operating Exp. To Revenue Ratio</td>
<td>114%</td>
<td>81%</td>
<td>52%</td>
<td>34%</td>
<td>42%</td>
</tr>
<tr>
<td>Total Other Expense</td>
<td>$(380.00)</td>
<td>$(1,814.00)</td>
<td>$(1,896.00)</td>
<td>$(11,945.00)</td>
<td>$(3,335.00)</td>
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<tr>
<td>Total Expense</td>
<td>$18,074.00</td>
<td>$24,560.00</td>
<td>$43,667.00</td>
<td>$88,300.00</td>
<td>$168,285.00</td>
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<tr>
<td>Net loss</td>
<td>$(25,146.00)</td>
<td>$(30,379.00)</td>
<td>$(29,885.00)</td>
<td>$(12,434.00)</td>
<td>$(52,680.00)</td>
</tr>
</tbody>
</table>

Amounts are in thousand US dollars
Role of food & agricultural companies in alternative protein space

- Top agricultural and food processing companies are capitalizing on the plant-based meat trend by investing in product development and introducing their own brands; as well as partnering with existing plant-based companies and/or developing technology to cover any input gaps that may cause undersupply (e.g., high protein seeds).

- While food and agricultural companies are eagerly investing in alternative protein companies, they are also entering the market by introducing their own product lines, especially meat processors. This has created a challenge in the past as it can be considered a conflict of interest. For example, Tyson withdrew investment from Beyond Meat once it started its own plant-based product line, Raised & Rooted. Therefore, investments from F&A companies have a higher risk profile.

- In addition to most top meat processors that have already entered the market, food retailers and consumer packaged goods (CPG) companies are next in line in developing and launching plant-based products under their brand names. On the other hand, agricultural input companies are primarily partnering with other companies to supply ingredients needed to keep up with the increasing demand of plant-based products instead of introducing own plant-based brands.

- Agricultural companies are investing in research and development within organizations to innovate and solve complex challenges presented by the plant-based industry such as a shortage of plant protein products. These companies also include grain traders that will especially be affected by increase in plant-based meat sales as significant revenue comes from producing animal feed for livestock.

- Large investments by agricultural companies in production facilities set up in US, Canada and Europe are indicative of accelerated growth in plant-based sales in the future as capacity increases.

- The next slide maps out food and agricultural companies from different stages of the supply chain investing in or producing their own plant-based products.
Where in the supply chain are investments needed?

To create a sustainable food system and meet the growing demand of alternative proteins, investments are needed across the supply chain as identified below.

- **Pea protein ingredient manufacturers**: Pea protein is expected to lead the alternative protein market in the short term along with soybeans, but it will face more challenges that will need investments. Beyond Meat has said the price of its ingredients is volatile, partly because the yellow pea needed is primarily only grown in Canada and Europe. This means there can be fierce competition to procure the product in the first place and, if either one of those key farming regions suffer a bad season or are hit by a weather event, supply could tighten significantly. In the past few years, the industry witnessed a limited supply of pea protein also caused by a shortage of production capacities and doubling pea protein prices. Specialty ingredient companies like Roquette had to secure investments to build processing plants while ADM announced its own facility that could supply to the increasing pea protein demand. Investments in processing facilities will encourage a consistent supply of pea protein which is considered a high-end product with margins lower than soy-based products.

- **Innovative protein companies/startups**: Plant-based meat is criticized for not meeting the protein demand as much as animal-based meat. To overcome this challenge, investments in protein innovation is necessary. Especially technologies like CRISPR or computational breeding. Roquette invested in Equinom Ltd., an Israel-based seed breeding company that is developing new pea varieties with higher pea content. About 60% of the by-product of peas is pea starch, which is not usable in pea-protein based meat. Companies that will face increased demand of pea protein driven by plant-based meat will need to consider partnerships within industries that can use both pea protein and starch will make pea protein more competitive in the market.

- **Production technology and R&D institutions**: Cell-based proteins will be seen as a good substitute for plant-based meat that still lacks proteins and amino acids that are essential for human health. The largest hinderance for cell-based protein commercializing into mass market is the unavailability of fermentation and extraction technologies at a large scale. While some companies like Mosa Meats are claiming to bring down the price of cell-based protein using cheaper input ingredients, the industry must overcome major technological challenges before it can hope to become price competitive with conventional animal meat.

- **Texturizing capacity**: According to some consumer surveys, proper texturization of plant-based meat remains a bottleneck in industry growth. Experimentation of texturizing technologies can be costly and is capital intensive. Investments in perfecting texture of plant-based meat can accelerate growth in alternative meat industry because of higher consumer acceptance.

- **Production plants**: There is significant headroom for consumer-packaged goods (CPG) companies and food manufacturers in the alternative protein market, however, absence of production capabilities is a challenge. For CPG companies and food manufacturers to increase market share in the plant-based segment over the long term, they must invest in capabilities required to develop and manufacture these products. At the moment, a barrier to entry in alternative space for plant-based companies (e.g., Impossible, Beyond) is the development of a supply chain, which is a large investment. Partnerships with incumbent meat processors and food manufacturers can leverage production and create economies of scale.
### Role of food & agricultural companies in alternative protein space (cont.)

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Role in the alternative protein market</th>
<th>Started own plant-based brand?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Meat Processors</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Cargill  | • A $100-million Investment in Puris, an ingredient company, that provides pea protein to Beyond Meat.  
• A $12-million Investment in Memphis Meats to create cell-based protein.  
• KFC trialed plant-based chicken nuggets in China using Cargill’s meat.  
• Partner with Dutch startup, Bflike in a 50-50 joint venture to bring next generation meat and fish alternatives to market. | Yes |
| Tyson | • Tyson held a 5% share in Beyond Meat until 2019 for $13 million.  
• Investment in Memphis Meats to create cell-based protein.  
• Investment in fermentation companies focused on alternative proteins. | Yes |
| JBS | • Launched a line of plant-based burgers—the “Incredible Burger”—in Brazil under the Seara brand in May 2019.  
• Invested in a fully-funded plant-based protein startup in Boulder County called “The PowerPlants Company.” | Yes |
| SYSCO | • Is a Beyond Burger distributor  
• Since 2018 has offered plant-based meatballs, patties, and ground bulk through their Sysco Simply brand. Is also a Beyond Burger distributor. | No |
| Smithfield  | • In August 2019, it launched the Pure Farmland brand with eight initial products, including plant-based burgers, meatballs, breakfast patties, and vegan cheese. | Yes |
| Hormel  | • In March 2019, its Applegate brand launched a blended burger product, made from meat and mushrooms.  
• In September 2019, Hormel launched the Happy Little Plants brand under its Cultivated Foods umbrella.  
• The flagship product at this point is a ground meat alternative. | Yes |
| Marfrig | • Producing plant-based burger for Brazil market using soy products from ADM. | Yes |
| Conagra | • In partnership with Pinnacle Foods, a $10.9-billion acquisition of Gardein that offers a large variety of plant-based meat products. | Yes |
| Perdue Farms | • In June 2019, it launched Chicken Plus, a line of “vegetable-enhanced” foods including chicken nuggets. | Yes |
| OSI Group | • In July 2019, it signed a co-manufacturing collaboration with Impossible Foods to produce Impossible Burgers at multiple OSI plants. | Yes |
| Vion Food Group | • Invested $18 million in production line investments for meat-free products in 2020. | Yes |
| Tönnies | • Tried to create plant-based products in 2018 but sales did not go well. Production capacity will be doubled in 2021 to try again. | Yes |
| Danish Crown | • Started a fully plant-based range in 2019. | Yes |
| Hanegal A/S | • Produces organic meat but has committed to make 85% of its product portfolio plant based by 2030. | No |
## Role of food & agricultural companies in alternative protein space (cont.)

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Role in the alternative protein market</th>
<th>Started own plant-based brand?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consumer Packaged Goods (CPG) Companies</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kellogg’s</td>
<td>• Investment in fermentation companies focused on alternative proteins.</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>• Investment of $43 million in a Morningstar Farms manufacturing, the plant-based arm of the company in US.</td>
<td></td>
</tr>
<tr>
<td>Nestle</td>
<td>• A $5-billion acquisition of Sweet Earth that produces vegetable protein products to Nestle’s own product line.</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>• Partnership with Burcon and Merit, companies that provide high-quality vegetable protein ingredients to Nestle.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Partnering with Chinese retailers to carry Nestle plant-based products and announced a plant-based production facility in Tianjin, China.</td>
<td></td>
</tr>
<tr>
<td>Danone</td>
<td>• A $10-million investment in Laird Superfood, a creator of plant-based food products</td>
<td>No</td>
</tr>
<tr>
<td>Unilever</td>
<td>• Acquired &quot;The Vegetarian Butcher&quot; that sells plant-based meat in over 17 countries in over 4000 outlets. The Vegetarian Butcher partners with Burger King in UK and China to roll out Vegan Royale and Plant-based burgers in select locations.</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>• Invested $100 million in Foods Innovation Center, Hive, Netherlands, to formulate next generation of meat and dairy alternatives.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Partnered with Algenuity, a algae production company to create new type of microalgae for future alternative protein that would include microalgae ingredients.</td>
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<tr>
<td></td>
<td>• Aim to have 50% of Knorr’s portfolio to be plant based by 2025.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Pledged to build a $1-billion plant-based meat and dairy business within the next five to seven years, launching a number of plant-based products.</td>
<td></td>
</tr>
<tr>
<td>Kraft</td>
<td>• One of the first plant-based alternatives, Kraft started own subsidiary, Boca Foods Company, that manufactures soy-based meat alternatives in 2000. Despite being the first mover, Kraft struggled to gain traction as it did not brand the company for the plant-based movement until 2018.</td>
<td>Yes</td>
</tr>
<tr>
<td>PepsiCo</td>
<td>• Will be partnering with Beyond Meat to develop plant-based snack products.</td>
<td>No</td>
</tr>
<tr>
<td><strong>Agricultural Input Processors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bunge</td>
<td>• A $30-million equity investment in Burcon and Merit for a 25% stake. Burcon and Merit provide high quality plant proteins. Through this partnership, Bunge will also supply the companies with key inputs (e.g., canola).</td>
<td>No</td>
</tr>
<tr>
<td>ADM</td>
<td>• Announced partnership with Marfrig Global Foods, a Brazilian company that produces beef. The join venture will be called “PlantPlus Foods” and will sell meat-alternatives in South America.</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>• Announced a new position in the company known as “Director of Flexitarian solutions” to focus on developing products for food companies who are targeting plant-based diets. ADM has also expanded its plant protein team of scientists and repurpose animal feed plant in Rotterdam to produce soy products.</td>
<td></td>
</tr>
<tr>
<td>Corteva</td>
<td>• Corteva has discussed expanding into research or small acquisitions in vegetable seeds to meet the increasing demand for plant-based proteins</td>
<td>No</td>
</tr>
<tr>
<td>Louis Dreyfus</td>
<td>• Invested $31 million in Good Catch seafood which is the owner of Gathered Foods, plant-based protein company.</td>
<td>No</td>
</tr>
</tbody>
</table>
### Role of food & agricultural companies in alternative protein space (cont.)

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Role in the alternative protein market</th>
<th>Started own plant-based brand?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Food Retailers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walmart</td>
<td>• Walmart started its own plant version of meat under the Great Value brand while selling other large brands at its stores.</td>
<td>Yes</td>
</tr>
<tr>
<td>Alibaba</td>
<td>• China’s largest retailer Alibaba started to sell Beyond Burger patties in Shanghai through the its HEMA grocery store chain in 2020.</td>
<td>No</td>
</tr>
<tr>
<td>ALDI</td>
<td>• ALDI debuted Earth Grown brand under plant-based options in 2018 and was widely accepted by ALDI regular customers.</td>
<td>Yes</td>
</tr>
<tr>
<td>TESCO</td>
<td>• Released 76 own brand vegan products in UK under their brand known as Wicked Kitchen and have sold 10 million units in 2 years of business.</td>
<td>Yes</td>
</tr>
<tr>
<td>Kroger</td>
<td>• Created Simple Truth plant-based product line in 2020 that has exceeded $1 billion in annual sales in 2020.</td>
<td>Yes</td>
</tr>
<tr>
<td>Co-op</td>
<td>• Co-op launched “Gro,” its line of 35 meat free products in UK across its stores.</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Potential corporate ventures

- Within the supply chain, investment in alternative protein companies should lie between ingredients (soy, pea protein companies), technology (fermentation and cell-based technologies) and the food processing company that commercializes the product in the market.

- The following list is a list of prominent corporate ventures in the alternative protein market spanning from ingredient to technologies. This list is not exhaustive.

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Type</th>
<th>Direct Substitution for</th>
<th>Region of Operations</th>
<th>Overview</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Beef</td>
<td>Pork</td>
<td>Poultry</td>
</tr>
<tr>
<td>Beyond Meat</td>
<td>Plant-based meat</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Impossible Foods</td>
<td>Plant-based meat</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Upside Foods (Formerly known as Memphis Meats)</td>
<td>Cell-based meat</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Mosa Meat</td>
<td>Cell-based meat</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Before the Butcher</td>
<td>Plant-based meat</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GOOD Meat/Eat Just</td>
<td>Cell-based meat/Plant-based eggs</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V Bites</td>
<td>Plant-based technology</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Quorn</td>
<td>Plant-based technology</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Company Name</td>
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<td>Direct Substitution for</td>
<td>Region of Operations</td>
<td>Overview</td>
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</tr>
<tr>
<td>Future Meat Technologies</td>
<td>Cell-based meat</td>
<td>x</td>
<td>Middle East</td>
<td>Israeli cell-based meat company founded in 2018 with $40 million in funding. Known to be able to produce its products without the use of animal serum or genetic modification and opened the first industrial cultured meat production facility.</td>
</tr>
<tr>
<td>Aleph Farms</td>
<td>Cell-based meat</td>
<td>x</td>
<td>Middle East</td>
<td>Israeli cell-based meat producer with $236 million in funding, which is known for its cell-based steak imitation.</td>
</tr>
<tr>
<td>Nature’s Find</td>
<td>Plant-based meat</td>
<td>x</td>
<td>N. America</td>
<td>Startup with more than $500 in funding that produces alternative protein products with fungus-based ingredients, including imitation breakfast sausage and cream cheese.</td>
</tr>
<tr>
<td>Maple Leaf Foods (Greenleaf Foods/Field Roast/Lightlife Foods)</td>
<td>Plant-based meat</td>
<td>x x x x x</td>
<td>Global</td>
<td>In 2017, Maple Leaf Foods purchased Field Roast for $120 million and Lightlife Foods for $140 million. The brands are available through Maple Leaf’s Greenleaf Foods and have various plant-based meat and cheese options available.</td>
</tr>
<tr>
<td>Ingredion</td>
<td>Protein Ingredients</td>
<td>x</td>
<td>Global</td>
<td>Ingredient company with billions in revenue annually which provides the building blocks for alternative meat products through various starches and proteins.</td>
</tr>
<tr>
<td>The Very Good Food Company/The Very Good Butchers</td>
<td>Plant-based technology</td>
<td>x</td>
<td>N. America</td>
<td>Publicly traded Canadian plant-based meat and cheese company which appeared on the television show Dragons’ Den. Relatively small with less than $5 million of revenue in 2020 but growing.</td>
</tr>
<tr>
<td>Oatly</td>
<td>Plant-based dairy</td>
<td>x</td>
<td>Europe</td>
<td>Swedish producer of oat milk and other oat-based dairy products, $240 million in startup funding and publicly traded with annual revenue of $421 million in 2020.</td>
</tr>
<tr>
<td>Calyst</td>
<td>Plant-based technology</td>
<td>x</td>
<td>N. America</td>
<td>Provide a hemp-based alternative protein that can be used for alternative meat, startup with $61 million of funding and publicly traded.</td>
</tr>
<tr>
<td>Ecovative Design</td>
<td>Plant-based technology</td>
<td>x</td>
<td>N. America</td>
<td>Use mycelium from mushrooms to make various products including alternative bacon variety, startup with $90 million of funding.</td>
</tr>
<tr>
<td>Burcon NutraScience Corporation</td>
<td>Plant-based technology</td>
<td>x x x x x x</td>
<td>N. America</td>
<td>Canadian startup with around $10 million of funding that produces canola and pea proteins used for formulation of alternative proteins, publicly traded.</td>
</tr>
</tbody>
</table>
## Potential corporate ventures (cont.)

<table>
<thead>
<tr>
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<td></td>
<td></td>
<td>Beef</td>
<td>Pork</td>
<td>Poultry</td>
</tr>
<tr>
<td>Equinom</td>
<td>Plant-based technology</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>MycoTechnology</td>
<td>Plant-based technology</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>TerViva</td>
<td>Plant-based technology</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Roquette</td>
<td>Plant-based technology</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>ENOUGH</td>
<td>Plant-based technology</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Good Dot</td>
<td>Plant-based meat</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>InnovoPro</td>
<td>Plant-based technology</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutriati</td>
<td>Plant-based technology</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>ENOUGH</td>
<td>Plant-based technology</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Good Dot</td>
<td>Plant-based meat</td>
<td>x</td>
<td>x</td>
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</tr>
</thead>
<tbody>
<tr>
<td><strong>Zhenmeat</strong></td>
<td>Plant-based meat</td>
<td>x</td>
<td>Asia</td>
<td>Chinese plant-based meat company founded in 2017, lightly funded as of yet but looking for to grow. Its products closely align with Chinese culinary tastes.</td>
</tr>
<tr>
<td><strong>Starfield</strong></td>
<td>Plant-based meat</td>
<td>x</td>
<td>Asia</td>
<td>Chinese startup founded in 2019 that creates plant-based meats from plant sources including seaweed protein. Significantly more funding than its Chinese startup competitor Zhenmeat at around $25 million.</td>
</tr>
<tr>
<td><strong>Whole Perfect Food</strong></td>
<td>Plant-based meat</td>
<td>x</td>
<td>Asia</td>
<td>Chinese plant-based meat company that has been in the business of alternative proteins for more than 20 years. Annual revenue is approximately $40 million.</td>
</tr>
</tbody>
</table>
Can alternative proteins become a solution to deforestation?
Section summary

This section aims to provide insights on the following,

- **Impact of changing diets on land-use change.** Taking the US as an example, if consumers were to shift from current diet that includes meat and non-meat consumers to a completely meatless diet, a 42% reduction will be seen in land used to grow crops for animal feed and meat. This includes some land that will be converted to grow crops for increased plant-based diets.

- **Substitution of land by animal species** indicating the type of impact emerging from the demand structure was discussed in the “Background and Recent Developments” section. For example, one ton of plant-based meat requires 71% less land than animal-based beef. Whereas one ton of plant-based meat will need 63% less land than animal-based pork. The variation displays the higher input costs as discussed in the section of “Price Analysis.”

- **Substitution of crop use** using soybeans as an example that indicates the lower use of soybeans to produce plant-based meat versus animal-based meat. The substitution is also a function of the species as some species such as pork has a higher inclusion rate of soybean meal in its feed ration when compared to beef. Soybeans used in animal feed for pork is 75% more than soybeans used in producing plant-based meat. But soybean use in animal feed for cattle is 34% lower than plant-based meat, indicating the importance of diversifying plant protein crops.

- **Deforestation trends in Brazil** that are correlated to agricultural activities such as beef ranching. The alternative protein industry may alleviate the illegal deforestation in important forest areas in Brazil and elsewhere and can become a solution to reducing deforestation. However, the industry is too small to make a significant impact yet.
Impact of global diets on land-use change: US case study

About half of the land used to grow major crops (i.e., barley, corn, wheat, soybean, sorghum) in the US goes towards animal feed consumption driven by current animal-based protein diets. Here, we estimate the impact of global diets on land-use change as human consumption starts to substitute animal-based protein with plant-based protein.

As plant-based proteins reach price parity and achieve quality, the reducing animal-based meat and dairy consumption will decrease the amount of land needed to grow grains for human consumption and other uses by 42%. It should be noted that protein replacement will require the land freed from animal feed growing to be added back to grow more crops for human consumption to meet their protein needs.

| Land use change to grow crops (barley, corn, wheat, soybean, sorghum) by diet in US |
|---------------------------------|---------------------------------|
| **Current diet**                | ![Graph showing land use change] |
| **No animal-based beef consumption (except beef from dairy)** | ![Graph showing land use change] |
| **No-animal based meat consumption** | ![Graph showing land use change] |
| **Only plant-based diet**       | ![Graph showing land use change] |

Source: IHS Markit © 2021 IHS Markit

Land used to grow major crops will be reduced by 42% if everyone adopted a plant-based diet.
Substitution of land

To understand substitution of land to grow animal feed for one ton of beef versus plant ingredients for one ton of plant-based beef, one needs to look at the ingredient composition of plant-based proteins.

**Plant based meat** comprises of 55% water where the remaining 45% comes from plant-based ingredients such as soybeans or peas for protein; vegetable oil (e.g., canola) for oil, and wheat flour for binder. Land needed to grow animal feed to produce one ton of animal-based meat is an average of 62% more land to produce than land needed to grow the same amount of plant-based “meat.”

**Plant based milk** comprises of 90% water and 10% of ingredients that vary from soybean, almond, cashews etc. to produce the milk. Land needed to grow animal feed to produce one gallon of cow’s milk is an average of 94% more land to produce than land needed to grow the same amount of plant-based “milk.”

It should be noted that land needed to grow beef will vary by country as some countries like the US produce more grain-fed beef, whereas other countries grow grass-fed, which means land is mostly used for pasture and grazing.
Substitution of crop

Considering soybeans as a primary comparative crop used in both animal feed and plant protein, the substitution will vary by animal species.

Animals in the US are mostly grain-fed and currently the US holds a larger share of alternative meat industry, therefore, the analysis here is based on US consumption data.

- **Beef and veal**: Considering that animal feed for beef cattle is mostly corn in the US, the use of soybeans is 34% lower in animal feed when compared to the use of soybean in one ton of plant-based meat. It will take 0.4 pound of soybeans to produce one pound of beef product. Whereas for a one pound of plant-based meat, it will take 0.55 pound of soybeans. This identifies the importance of diversifying plant proteins such as peas.

- **Hogs**: Unlike beef, plant-based pork products require 75% less soybean as an ingredient compared to animal-based pork. It will take 1.4 pound of soybean to produce one pound of pork whereas, for plant-based it will take 0.37 pound to produce one pound of plant-based pork products.

- **Chickens**: Chickens do not require a large volume of feed to grow which is why the differential is smaller than hogs. Plant-based chicken products required 37% less soybeans as an ingredient compared to broiler meat. It will take 1.29 pounds of soybeans to produce one pound of broiler meat, whereas, for plant-based option, it will take 0.63 pound to produce one pound of plant-based chicken products. Some plant-based chicken products are also created from wheat, which is consumed in low quantities in animal feed in the US. In that case, the crop amount needed for plant-based may be higher than animal-based protein.

Based on the region, this chart reveals the importance of diversifying plant protein ingredients that can a 100% substitute animal feed some of which are already commercializing in the market such as pea protein. Having said that, a different set of challenges can occur.
Brazil case study: Current deforestation trends

- Currently, illegal ranchers in the Amazon are identified as the main reason for deforestation caused by beef production. But it has been reduced as companies are now actively tracking for any illegal suppliers. For example, JBS, the largest global meat company in Brazil, monitors 100% of its direct cattle suppliers for illegal Amazon deforestation and is leveraging blockchain technology to monitor the suppliers of its suppliers.

- The states of Mato Grosso and Acre saw the largest decline in deforestation as foreign investments aided afforestation in the state. The funds helped to continue forest monitoring and enforcement activities in the states. The state of Para has been constantly deforested and is said to be driven by illegal ranching as the state exports significant amount of live cattle from Brazil.

- The Forest Code introduced as a regulation in 1965 in Brazil requires landowners in the Amazon to maintain about 80% of their land under natural vegetation. However, despite having seen a major decline in the 2000s, deforestation rates in the Brazilian Amazon have skyrocketed since Jair Bolsonaro assumed the presidency in January 2019. Under his government, funding for forest conservation and environmental law enforcement has been cut.

Deforestation in Cerrado:

- Despite the decline in deforestation, Cerrado deforestation in 2020 totaled 734,010 hectares, an increase of 13.2% versus 2019. Deforestation on private lands accounted for 66.7%, while public lands made up 19.2%. The remaining deforestation occurred on lands that hold no legal designation.

- Chain Reaction Research estimates that 28.3% of the total Cerrado deforestation was linked to soy expansion.
Brazil case study: Role of agribusinesses in deforestation in Cerrado

• Prominent soy producing companies like SLC Agricola and JLL Holdings that have trading relationships with Cargill, Bunge, ADM, Louis Dreyfus Company and Cofco, were responsible for 53% of the soy related expansion.

• Beef companies that have pledged to limit deforestation and only source from sustainable ranchers are still causing deforestation in Cerrado. For example, suppliers in Cerrado that produce cattle for JBS caused 1,500 hectares of deforestation in 2020.

• Food retailers such as Carrefour, Casino Group and Carrefour were also identified to the cause some deforestation in biome due to direct sourcing beef from suppliers in the area. These food retailers own the largest share of beef retail sales in Brazil.

• Some of the companies have pledged to limit deforestation through carbon pledges, however, the companies continue to clear land specifically for soybean production and beef cattle production.
IHS Markit outlook: How will increase in alternative protein affect land-use change?

IHS Markit estimates that in base case scenario, the alternative protein market will grow up to 5-7% market share of total meat consumption in key meat consuming countries i.e., China, the US and European countries. This would mean 17.5% lower demand of animal feed and land used to grow one pound of each animal protein species (beef, pork, chicken, and turkey). Just in the US where a lot of land is used to grow animal feed and meat, this translates to savings of 8.6 million hectares of land that used to go into animal feed production. This land area does not include land outside of US that grows feed to export to the US. Below we illustrate what this change will mean for countries like Brazil where deforestation is an issue.

- **Lower feed prices:** With an increase in alternative proteins, price of major feed crops like soybeans and corn will fall. This will also impact prices in feed-exporting countries like Brazil that will be affected by lower meat consumption and will convert land to other uses. The conversion from land for feed will occur mostly as a result of falling export demand. Domestic demand of animal feed in Brazil is lower as only 10-15% of the beef cattle is grain-fed while the rest are pasture-fed.

- **Lower illegal deforestation:** In Brazil, ranchers that were illegally occupying forest land and caused deforestation will reduce due to falling meat prices. Whereas, in the US, less profitable areas producing cattle (e.g., Northern Great Plains) will reduce land use for cattle growing and may convert to conservation land.

- **Increased land-use change:** With lower feed prices, land available from feed grain production can be moved towards conservation or pastureland. However, some land will be added back to grow the same crop to meet alternative protein demand (e.g., soybeans, peas, and wheat).

- **Alleviate pressure on fisheries:** The development and commercialization of plant-based and cultivated seafood will alleviate pressure on wild fisheries and aquaculture systems. The current aquaculture system is facing a slowed rate of growth coupled with increasing demand, creating a supply-demand gap. In addition to narrowing the gap, there will be improvement in water quality and reduction in ocean degradation.

The above scenario isolates other factors that will impact how land-use is changed. These are as follows,

- If the alternative protein market is growing in the US, but other large meat consuming economies (e.g., China) are increasing their animal-based protein consumption, US farmers still will grow grain for feed and export as it is more profitable than land-use change. Hence no displacement will be caused in feed grain land.

- Without increased protein level of plants, more land may end up being used to grow more crops to satisfy the calorific value.

- Although large food companies are developing their own brands, they will still struggle to compete with Beyond Meat and Impossible Foods as consumer perception of traditional meat companies may not change with their shifting preferences.
Are alternative proteins a solution to reduce deforestation?

Yes, but alternative proteins will not become a significant or the only solution to reduce deforestation for the following reasons:

- **Conversion of ranching land to soybean cultivation in Brazil:** Soybeans are considered a top ingredient along with pea protein for alternative protein growth. The cycle of land use change in Brazil starts with cleared forests used for pastureland and grazing is often used later for cultivation of soybeans. Although most soybeans are grown for animal feed, unless companies producing alternative protein do not diversify the plant protein profile, alternative protein growth will not be a crucial solution to reduce deforestation.

- **Global companies are investing mainly for economic reasons:** Companies like Cargill and Bunge that are investing and manufacturing their own plant-based products also have strong trading relationships with companies such as SLC Agricola that are responsible for causing deforestation in Cerrado for soybean expansion. This is an indication that while alternative proteins market is growing, the industry is growing due to economic reasons, not necessarily to address environmental issues, per se.

- **Lack of prohibitive policies:** Although the Forest Code and regulations and Brazil do not allow deforestation, illegal ranching is considered one of the primary reasons for deforestation in Brazil. This indicates a lack of implementation of regulation through land audits.

- **Growth constraints to alternative protein market:** Consumer acceptance will increase with lower price, desired texture, taste, and nutritional value. Until that is achieved, consumers will continue to buy animal-based protein offsetting any chance of reducing deforestation. Another constraint for alternative protein market is strong competition from animal-based protein. As animal-based protein is a successful product and becomes cheaper, ranchers will continue to deforest land when they can. Other growing industries such as biofuel demand for animal fats will continue to increase the production of animals.
About IHS Markit
IHS Markit (NYSE: INFO) is a world leader in critical information, analytics and solutions for the major industries and markets that drive economies worldwide. IHS Markit has been providing comprehensive information and expert independent analysis and insight to clients for more than 50 years, enabling critical business decisions with speed and confidence. IHS Markit has more than 50,000 key business and government customers, including 85 percent of the Fortune Global 500 and the world’s leading financial institutions. Headquartered in London, IHS Markit is committed to sustainable, profitable growth.

IHS Markit brings together nearly 2,000 consultants, researchers and economists in 150 countries across multiple industries. These interconnected capabilities within the IHS Markit umbrella allow us to provide timely, insightful and expert information, analysis and advice.

We bring a unique combination of breadth and depth of expertise, with extensive industry data and expertise along the entire agribusiness value chain drawing on the vast knowledge accumulated by our legacy brands, including Informa Agribusiness Intelligence, Fertecon, IEG Vantage, Phillips McDougall, F.O. Licht, Doyle Trading Consultants, and FNP.
About IHS Markit Agribusiness

Our Agribusiness Consulting solutions provide the cutting-edge research and forecasts necessary to gain a competitive edge. We offer over 200 agribusiness experts based in Asia, Europe, North America and South America, analysts and researchers who are well respected throughout the industry for their deep-rooted analysis and forecasts. The value that IHS Markit agribusiness can now offer has been extended by connecting agribusiness clients with the vast resource of insight and expertise that exists across IHS Markit including energy (including biofuels), supply chain, automotive, country risk and economics.

This heritage enables us to offer an unparalleled depth of understanding in all our consultancy work, providing our clients with unique perspectives on the opportunities for their business.

For more information, please contact the project team,

Juan Sacoto, Executive Director, Agribusiness Consulting, juan.sacoto@ihsmarkit.com
Sana Khan, Consultant, Agribusiness Consulting, sana.khan@ihsmarkit.com
Steve Wolf, Consultant, Agribusiness Consulting, steve.wolf@ihsmarkit.com
Tom Scott, Vice President, Agribusiness Consulting, tom.p.scott@ihsmarkit.com
Ryland Maltsbarger, Economics Associate Director, Client Advisory and Development, ryland.maltsbarger@ihsmarkit.com