Vox

Where's the "Impossible Burger" of cheese?

Plant-based food has come a long way, but we still don't have a stretchy, melty cow-free cheese.

By Kenny Torrella | Jun 5, 2021, 8:00am EDT

Motif FoodWorks, a food technology startup in Boston, says it's developing plant-based cheese that stretches and melts like the real thing. | Courtesy of Motif FoodWorks

Two years ago, Beyond Meat became the first plant-based food startup to go public. Its shares surged **163 percent on its first day** and today it's valued at $9 billion, with shares now worth about five times their original value.

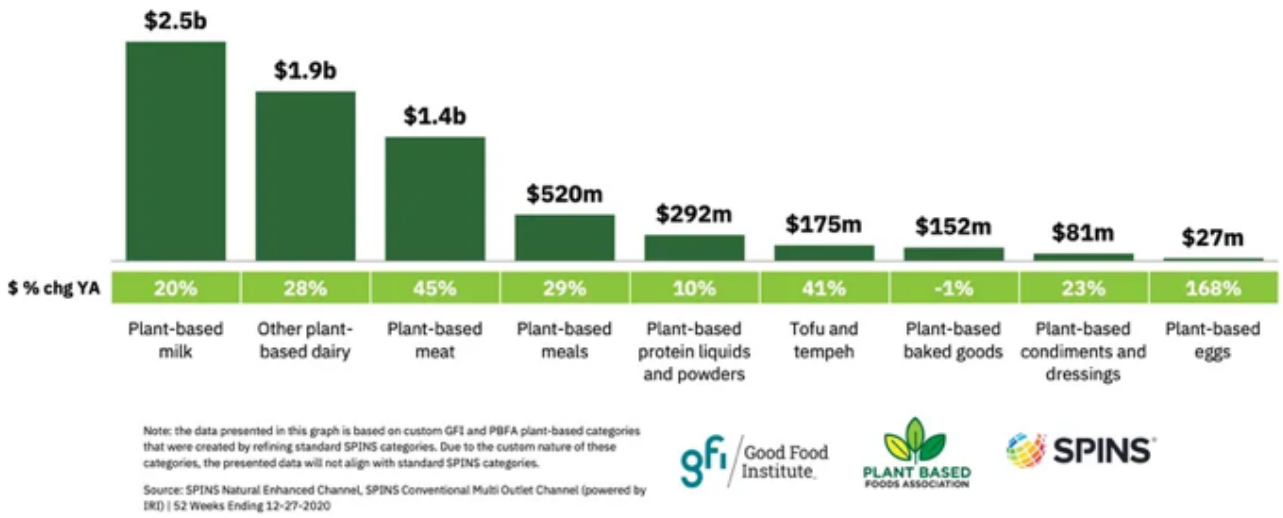
Since then, analysts have wondered which major plant-based food company would go public next. Late last month, they found out: Oatly, the Swedish maker of oat-based

milk, yogurt, and ice cream.

Oatly's stock didn't quite skyrocket like Beyond's, but by the end of the company's first day of trading, it was valued at about **$12 billion**. Now, Oatly is valued at $14 billion, over 50 percent more than Beyond's valuation of $9 billion. Though Beyond and other high-tech vegan meat producers get much more attention than companies that make plant-based milks, Oatly's valuation says a lot about the state of the plant-based food industry — namely, that plant-based milk has reached a point of maturation in the market that's even more advanced than plant-based meat.

According to a **report** recently published by the Plant-Based Foods Association and the Good Food Institute, two organizations that advocate for plant-based foods, plant-based milk alone accounts for **35 percent of the total plant-based foods market, worth $2.5 billion to plant-based meat's $1.4 billion**. Plant-based milks don't just dominate the plant-based food sector, they also take up a sizable portion of retail milk sales — 15 percent overall, and 45 percent in natural food stores.

Total U.S. plant-based food dollar sales and dollar sales growth by category, *2020*



Plant-based milk is the largest segment of the overall plant-based food industry. | SPINS, The Plant Based Foods Association, The Good Food Institute

Oatly's sudden rise since it came on the US market in 2016 has helped drive this growth. Almond milk sits at the top of the plant-based milk category, but **oat milk recently pushed soy milk out of second place**, thanks to Oatly and big brands like Silk (owned by Danone) and Chobani **following Oatly's lead** with a range of oat-based dairy products.

In fact, Starbucks, which started using Oatly products last year in select US stores and rolled it out nationwide earlier this year, says its share of orders that use plant-based milk jumped from **17 to 25 percent after it introduced Oatly**.

These shifts from traditional to plant-based dairy are important in the fight against climate change, as traditional dairy is an especially resource-intensive sector. According to a 2018 University of Oxford study, any way you slice it, **cow's milk uses much more land and water and emits far more greenhouse gases than any plant-based milk**.

For example, almond milk gets a bad rap for being water-intensive, but cow's milk requires about 70 percent more water to produce, emits more than twice as much Co2, and requires more than 15 times as much land. Compared to almond milk, oat milk uses much less water but a little more land.

On top of the environmental impact of traditional dairy, most dairy cows, at least in the US, are **raised in factory farms**.

Yet despite the popularity of plant-based milks, they haven't quite made a dent in taking the cow out of dairy, their raison d'être. Some farmers do say **plant-based milk is affecting their bottom line**, and a **late 2020 report** that was funded by the United States Department of Agriculture found that "increased sales of plant-based alternatives are negatively affecting households' purchases of cow's milk" but that it's "not a primary driver."

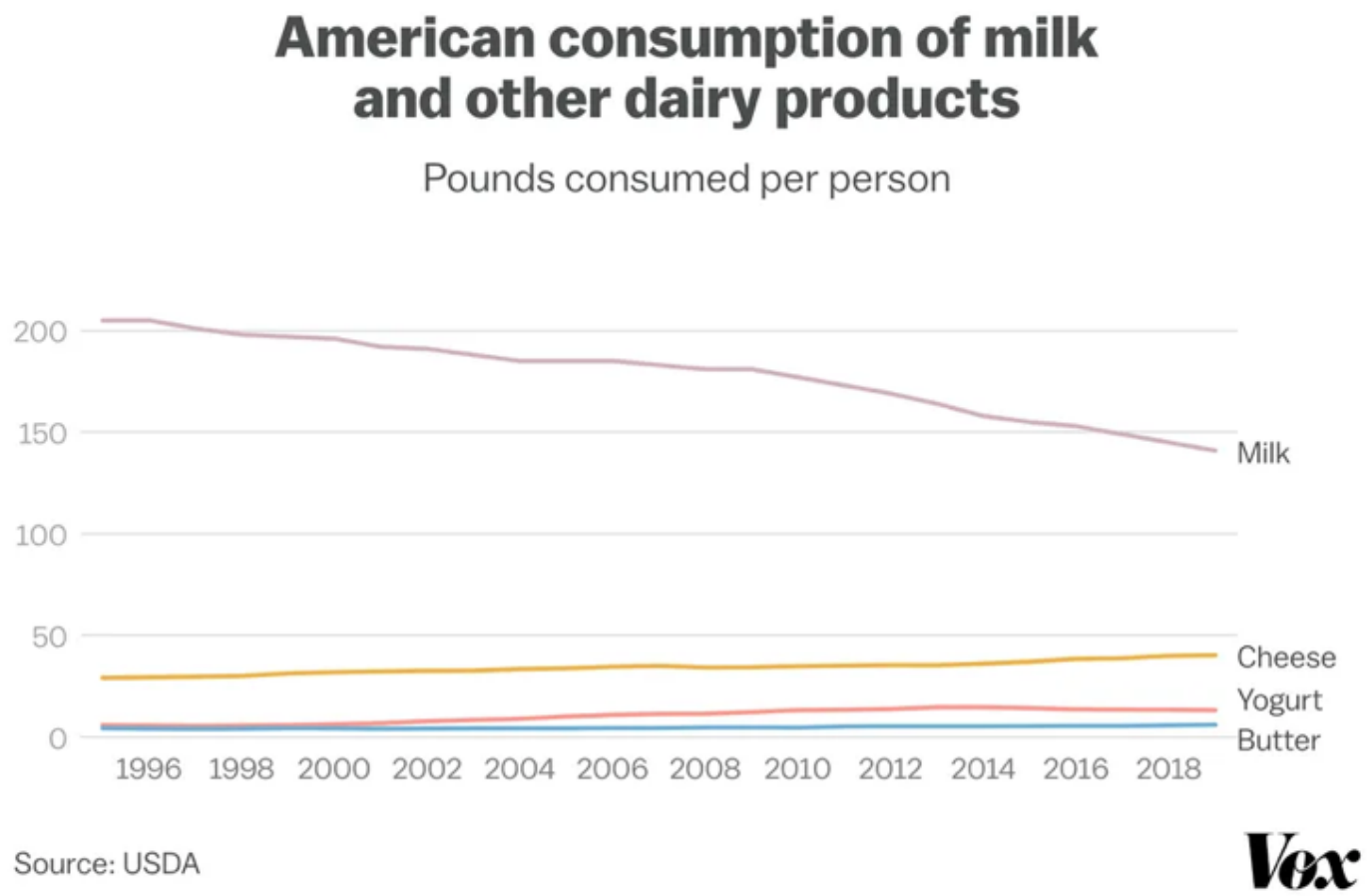
There are a lot of factors that affect dairy production and consumption, and adoption of alternatives is just one of them. But in order for plant-based startups to become a primary driver in displacing conventional dairy, stealing market share from the milk shelves of the supermarket isn't enough. Oatly and its competitors need to figure out how to make a great alternative for another dairy product: cheese.

Milk sales are plummeting, but there are more cows than ever

Some vegan advocates say that "**dairy is dying**" (or **already dead**), in part because of the United States' **decades-long decline in milk consumption** coinciding with the rise of plant-based milk.

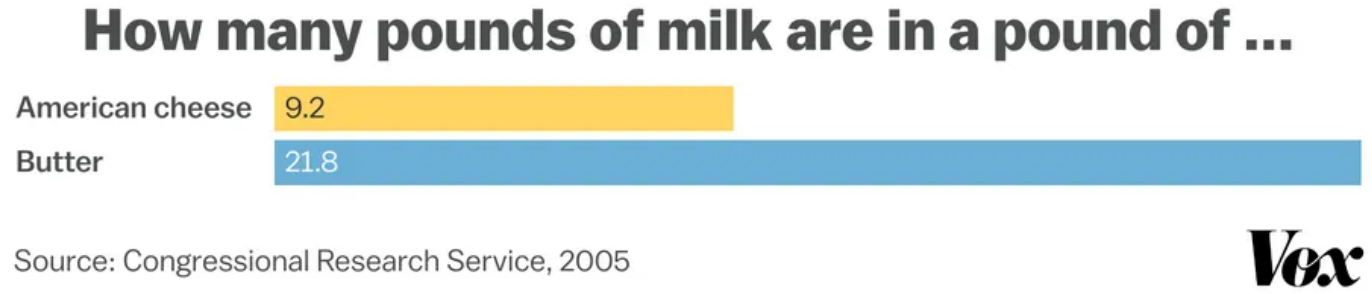
Many dairy farmers are indeed hurting, but plant-based milks aren't the biggest culprit — it's Big Dairy, which has been **consolidating and squeezing out small farmers**, one of several factors that caused **11,000 dairy farms** to shutter between 2014 and 2019. The pandemic only hastened this trend, as major dairy customers — schools and restaurants — closed down, resulting in farmers across the country dumping millions of gallons of milk. **Seven percent of US dairies closed in 2020.**

But dairy is far from dead: The number of dairy cows in production has **increased slightly in the past decade**, and they're producing **more milk** — **more efficiently** — than ever.



Tim Ryan Williams/Vox

This can be explained, in part, by Americans' love for cheese; per capita cheese consumption has risen **25 percent** since the early 2000s, which is one factor that has kept milk production high, since it takes nearly **10 pounds of milk to make one pound of cheese**. (Butter consumption is rising even faster, and it takes more than ***21 pounds of milk*** to make one pound of butter.)



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There are plant-based cheese alternatives on the market, and they generally fall into two categories. The first are the pricey, fermented wheels or tubs of spreadable cheese, often made of nuts, seasonings, and cultures (and sometimes oils, gums, and starches), which have managed to impress the **taste buds of omnivorous food critics**. Bigger brands like Miyoko's Creamery, Kite Hill, and Treeline Cheese dominate this first category, but there are **dozens of smaller, artisanal outfits** like the Herbivorous Butcher in Minneapolis and Rebel Cheese in Austin.

The second category consists of the bags of shredded or sliced mozzarella or cheddar, often made with oil and potato starch or cornstarch, which don't melt and stretch (or taste) the way cheese from cow's milk does. The problem is best summed up by the joke about how a vegan's house burned down and the only thing that didn't melt was their cheese.

But Americans eat a lot of shredded and sliced cheese, and the vegan versions haven't improved much since I last heard that joke some years ago (though if you're curious, I suggest giving Violife, Field Roast, and Follow Your Heart products a try). And even though the plant-based food industry has grown rapidly in the past few years, its startups loaded with billions in investment, no company has come close to making a "breakthrough" shredded or sliced cheese product akin to the Beyond or Impossible burger — or a carton of Oatly — that can bring in curious omnivores.

Not yet, anyway.

The future of animal-free cheese

The absence of great shredded and sliced plant-based cheese could be a problem of demand or innovation, or both.

Meat gets much more attention for its ecological and animal welfare harms than cheese, to the point where nearly a **quarter of Americans** say they are trying to cut back. But you don't hear much about people trying to reduce their cheese intake, even though globally, the dairy sector **emits more greenhouse gases than all meat sectors** (except beef), and most dairy cows, at least in the US, are factory-farmed.

On the innovation side, it's simply much harder to replicate stretchy, melty cheese made from cow's milk than the soft, spreadable varieties.

"Achieving the stretchy quality and texture consumers expect from harder cheeses upon melting has proven challenging to date, which is why soft plant-based cheese may be more prominent," Dr. Priera Panescu, a senior scientist at the Good Food Institute, told me over email.

Ryan Pandya, the CEO and co-founder of Perfect Day — a food technology startup based in Berkeley, California — shared a similar sentiment with **Wired**, explaining, "The melty, stretchy thing is absolutely the most challenging holy grail thing to do. Because there's only one protein known to man that does this, and it's casein."

Through precision fermentation, which is used to make specific proteins, enzymes, or vitamins, Perfect Day has developed a microflora (fungi) that converts sugar into whey, another protein in milk, for its ice cream products. The company says it's also **working on cheese** but doesn't have plans for the shredded or sliced varieties in the near future.

Real Vegan Cheese, a nonprofit, open-science research project — quite rare in a field of venture capital-backed startups — *is* going for the "holy grail" of cheese by adding the genes for casein to yeast and other microflora, and then adding plant-based fats and sugars. New Culture, based in San Francisco, is also working to replicate casein, using microbial fermentation, similar to Perfect Day's approach, to make shredded cheese. The company plans to launch its first product in late 2023.

When asked about the lack of stretchy plant-based cheese, Panescu said that "academic researchers are working to address these challenges by using biological interventions, optimizing more flexible, well-assembled plant-based proteins, and applying mechanical texturization processes."

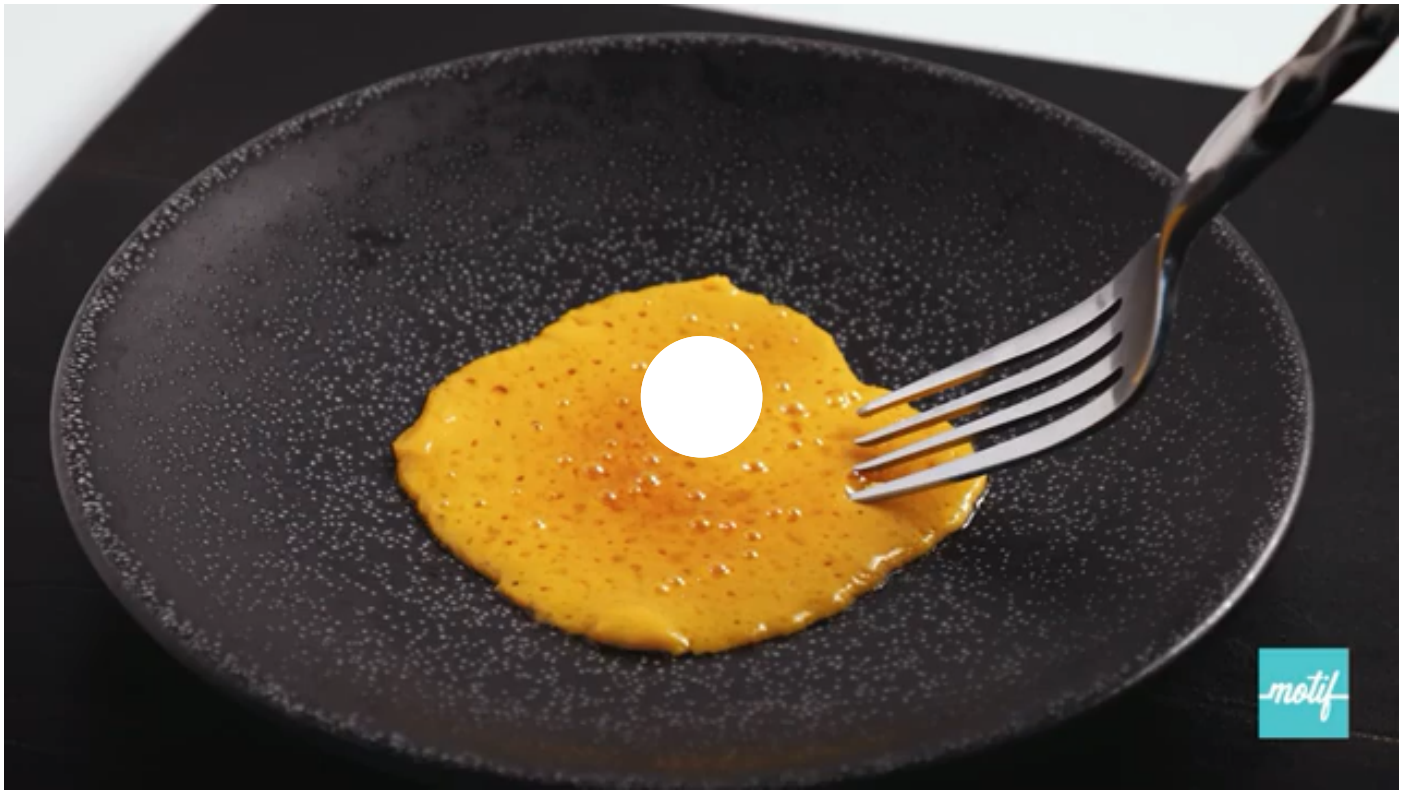
One of those researchers is Alejandro Marangoni at the University of Guelph in Ontario, Canada. According to **Marangoni's research**, zein — a protein found in corn — is an overlooked tool in the search to make plant-based alternatives to animal products. Most companies making shredded and sliced plant-based cheese use starches and gums for

the melt and stretch effects, but zein could be a better route. When hydrated and heated above a certain temperature, it forms a "flexible, bendable mass which may be pulled, stretched, and sculpted," sharing "melting characteristics with cheddar cheese."

Motif FoodWorks, a food tech startup based in Boston that has received investment from the major dairy company Fonterra, recently **signed an exclusive licensing deal** to use a unique food processing technology Marangoni developed using zein.

Motif's CEO, Jonathan McIntyre, told me their newly acquired tech will enable them to make a stretchy, gooey vegan cheese that's better than what's currently on the market. "This technology doesn't solve all problems in plant-based cheese," he said, and that "there are other aspects, like mouthfeel and creaminess" that they're using other tools to address.

McIntyre isn't yet sure whether Motif will develop its own products, work with a dairy company to make a plant-based product, or partner with an existing plant-based cheese company to upgrade its own, but he does envision it being used on nachos and, of course, pizza. You can see it in action below or **here**.



Given all the hype around plant-based food, it may come as no surprise that there are **dozens more startups** racing to make convincing cheese alternatives — but Impossible Foods isn't one of them. While it is developing Impossible Milk, a spokesperson told me the company won't be selling Impossible Cheese anytime soon.

Then there's Oatly, which recently **told Bloomberg** it's making "good progress" on developing oat-based cheese products, though its CEO didn't specify what kinds. Given the **$1.4 billion** the company raised from last month's IPO, it seems like it should have the resources to raise the bar on plant-based cheese, and a devoted customer base who will likely be curious enough to give it a try.
