2023 Alternative Proteins

LANDSCAPE

About this report

Two years ago, CRB published its first industry report examining how the pioneers of plant and cell-based proteins were addressing a rapidly growing market for meat and dairy alternatives.

We challenged our highly skilled corps of subject matter experts to deliver what was then the most exhaustive analysis of manufacturing trends shaping alternative proteins. A comprehensive industry survey and months of analysis revealed an incredibly promising but unpredictable marketplace. Trailblazers with visions of solving food scarcity were often met by the sobering regulatory, supply chain, and resource challenges that go along with changing the world.

Now in 2023, the products, ingredients, and tactics of commercial-scale production may be evolving, but a central question remains: How does your manufacturing strategy mesh with customers who demand a quality product at a price they're willing to pay?

In the following pages, our SMEs tackle that question head on and from multiple angles. Once again, they do so with the survey responses of 150 industry leaders who weigh in on their plans for cultivated meat, fermentation-derived proteins, and plant-based meat and dairy—as well as their strategies for addressing the complex safety, regulatory, and sustainability challenges that often vex large-scale food production.

The result is a compelling snapshot of the industry today, and where it's headed tomorrow.

We're proud to bring you this report, and we invite your own reflections about how our industry can move forward. Submit your feedback through our contact page at crbgroup.com, and we wish you a continued safe and prosperous 2023.

Sam Kitchell
Chief Operating Officer, CRB

The alternative road to mainstream

Today's alternative protein manufacturers are developing a savvy business approach. To continue succeeding, they'll need it.

By: Jason Robertson, Vice President, Food & Beverage

You don't see many songwriters turning to the food and beverage industry for inspiration, yet I can't help but wonder if Cat Stevens had us in mind when he declared that it's a wild world.

Ask any manufacturer—startup or established, commodity or premium, regional or global—and they'll likely agree. Even once they've mastered the complicated calculus of scaling from lab-made recipes to commercial production, the simplest detail can derail a whole project. Take, for example, the story I recently heard of a food product that sailed through consumer testing only to fail in the market because retail employees were stocking it upside down. To paraphrase Cat, nice things don't always survive out there.

That's why I find myself particularly impressed by today's manufacturers of alternative proteins. They're relatively new to the scene, they're competing in an unproven marketplace, and they face regulatory and commercial challenges that the traditional food and beverage industry can't necessarily solve for them. Despite all of this, they're persisting—thriving, even. This year's *Horizons: Alternative Proteins* report, based on detailed survey responses from more than 150 manufacturers in operation today, is proof.

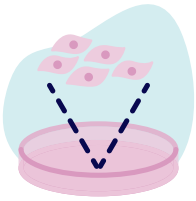
When we last surveyed on this industry in 2021, we found both optimism and uncertainty among manufacturers, often in equal measure. Test kitchens were generating innovative products and processes, but the challenges of commercial scale-up were frustrating even for the most well-established operators.

Two years later, our updated survey charts a promising evolution:

- **More than 70% of survey respondents are manufacturing at commercial scale, up from 65% in 2021**—a signal that manufacturers are solving at least some of their scalability challenges.
- **66% of respondents have seen an increase in sales volume since 2021**—a signal that consumer demand for alternative proteins is healthy and growing.
- **Today's manufacturers plan to spend nearly 50% less on capital projects than they did in 2021**—a signal that manufacturers are more strategic with their budgets, investing surgically where capital is needed and benefiting from their early investments in flexible, future-proof facilities designed to sustain long-term growth.

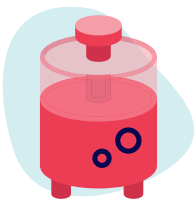
More interesting is what *hasn't* changed. Average company sizes remain largely consistent between 2021 and 2023; then as now, only about a third of respondents have more than 1,000 employees. This could indicate a healthy pipeline of new and pioneering entrants, but it's also a signal of persistent challenges—consider the large-scale layoffs, high-profile recalls, and bleak outlooks from market analysts that have recently plagued this industry. It does not appear the industry has seen large-scale consolidation, as some had predicted.

How can these manufacturers maintain the resilience and ingenuity that got them this far in the face of such formidable challenges? In this report, we will attempt to answer questions like this one by examining our survey data through a series of lenses, including:



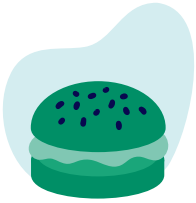
CULTIVATED MEAT: Our survey responses highlight the maturation of the cultivated meat industry. Price parity is coming soon, at least for premium or value-added products, and most manufacturers are hopeful that their products will be on the market within two years. But to achieve this—while making a profit—production levels must rise and costs must fall.

Join Derek Ung, Sebastian Bohn, and Krizia Diaz as they unpack this challenge and deliver good news: There has been an exponential decrease in the cost of culture media, by far the most expensive material two years ago, and production targets have risen dramatically since our last report. Momentum is certainly in the right direction, and if the challenges identified by our trio of experts are addressed, the outlook for a sustainable and profitable future is good.



FERMENTATION-DERIVED PROTEINS: A surprise awaited Sebastian Bohn, Brendan Kress, and Tony Moses when they examined the survey data from this segment. They had expected fermentation-derived proteins manufacturers to overtake cultivated meat manufacturers in terms of go-to-market readiness—what they *didn't* expect was to see these manufacturers move ahead of all other markets and emerge as the most commercially advanced segment in our survey.

However, the path ahead may not be smooth. Our survey data reveals a few challenges brewing that will soon boil over. For example, respondents in this segment are hoping that a sustainability-focused promise will justify a premium price, despite acknowledging, in a different survey question, that sustainability isn't driving consumers' buying behavior in a significant way. To continue their successful trajectory, manufacturers in this segment will need to address these problematic areas—and soon.

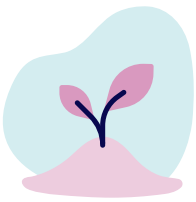


PLANT- AND MYCELIUM-BASED MEAT: Given the grim headlines hounding plant-based protein manufacturers, our experts Jason Tucker and Tony Moses wondered if the survey results would uncover a slump in growth. However, they discovered a surprisingly robust pipeline of new entrants, and an interesting pivot in terms of this segment's core identity: Instead of nobly setting forth to save the planet, today's plant- and mycelium-based manufacturers have developed a savvy business model that's hardly discernable from the mature commercial strategies guiding today's traditional food and beverage industry.

How can manufacturers in this segment continue this trend toward resilient business practices and reliable growth? In this section, Tucker and Moses dive into the survey data to propose an answer.

PLANT-BASED DAIRY: A subtle but remarkable shift is underway in the plant-based dairy segment. Two years ago, our survey respondents indicated a keen focus on upstream innovation as they searched for the right ingredients and formulations to offset their material costs while perfecting their core offering. As our experts Pablo Coronel and Jonathan Clark note, today's producers have the same appetite for innovation, but it's playing out further downstream.

Packaging upgrades hover near the top of manufacturers' capital investment wish list. As well, diverse formats like cheese, sour cream, and yogurt are catching up to—and in some cases surpassing—fluid milk alternatives in the overall product pipeline. To keep this momentum going, our experts advise an optimistic but measured approach to future development—more haste, less speed.



SUSTAINABILITY: Most alternative protein manufacturers indicate that they have sustainability budgets, while fewer have goals and concrete plans to put those budgets to work. In this section of our report, experts Maya DeHart, Aaron Kilstofte, and Jonathan Dressler go deep into the survey data to understand and contextualize this phenomenon, and to offer advice for companies trying to access the rewards of good environmental stewardship from both a brand positioning perspective and in terms of ROI and optimized manufacturing.

Their key advice? Get started now and develop a strategy that will steer you away from a troubling pattern noted in the survey data—that is, a growing disconnect between capital expense planning and the complexity of making meaningful changes at a facility level to achieve sustainability goals.

REGULATION: As companies mature from start-up to production scale, the importance of food safety and hygiene is clearly paramount. Our respondents indicate an improved understanding of the regulations that govern them and have dedicated significant resources to quality assurance, compliance, operational procedures, and facility upgrades.

How does this evolution in regulatory maturity play out across companies of different sizes? Join experts Dennis Collins and Pablo Coronel as they offer their perspectives on what companies at both ends of the CapEx spectrum are doing to implement a strong regulatory strategy—and, more importantly, to earn and maintain the trust of consumers.

A smile won't get you by—but a strong commercial strategy might

To operate successfully at a commercial scale, manufacturers of alternative proteins need a strategy that integrates both consumer expectations and the realities of operating a large-scale food and beverage plant.

This is, perhaps, our biggest takeaway from the 2023 survey: to shift from a fledgling idea to a cash-positive manufacturing company, today's manufacturers of alternative proteins are pushing themselves beyond the single-note mission that may have galvanized them initially ("Let's change the world!") and toward a savvier, more nuanced commercial strategy ("Let's generate a sustainable profit by selling cost-effective products!"). This shift may not inspire powerful feelings in the heart, but it does generate a powerful balance sheet. It's this industry's best hope for continued progress in an increasingly wild world.

Aged to perfection:
The maturation of the cultivated meat industry

By: Derek Ung, Sebastian Bohn, and Krizia Diaz



The cultivated meat industry is showing signs of maturity. These include the appearance of premium products in development, like bluefin tuna, oysters, and steaks. Then there's the launch of a federal government biomanufacturing initiative to improve US food security by applying innovative technologies to foods with cultured animal cells. Perhaps most telling is the fact that investments into the cultivated meat industry skyrocketed from roughly $60 million to $1 billion over the past three years.

The results of our survey suggest that optimism accompanies this maturation, especially with the approach of price parity—at least for products like burger patties and chicken nuggets. It seems that the cost of producing one pound will soon no longer exceed the price consumers are willing to pay. But, as we'll see, these exciting developments bring up additional questions about profitability, especially if producers are going to focus on burger patties as opposed to premium products.

The survey respondents came from a range of roles well-versed in the requirements of cultivated meat production, with 76% being either food scientists or engineers. These professionals are tasked with taking technological innovations from the biopharmaceutical industry—primarily the use of large, stainless-steel bioreactors to grow cell cultures—and applying them to the production of cultivated meat.

PRICE PARITY IS ON THE HORIZON

When we published our 2021 *Horizons: Alternative Proteins* report, the price of a single cultivated meat burger was about $100. Today, respondents said their target cost to produce one pound of cultivated meat has dropped to an average of $3.67/lb

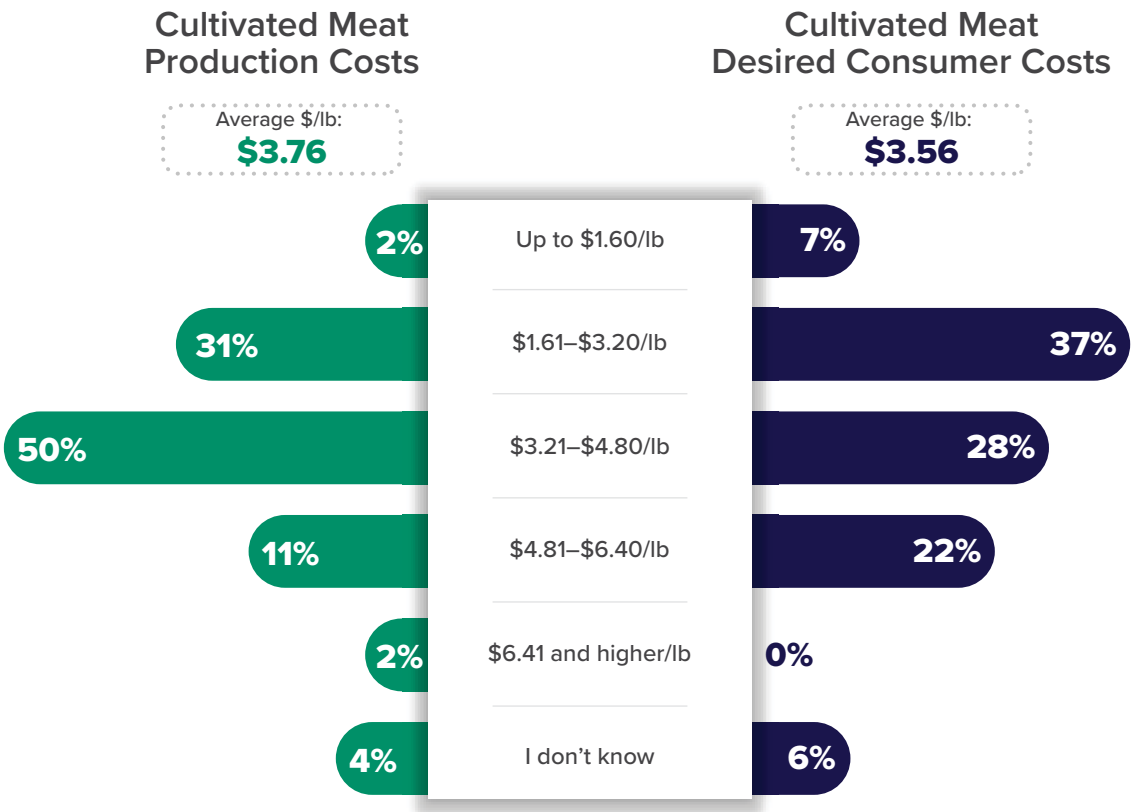
(Figure 1.1). This is close enough to their average desired consumer price of $3.56/lb to instill optimism.

According to survey results, one of the likely factors closing the gap on price parity is the use of cell suspension as the primary manufacturing process. In fact, 70% of respondents are using this method, suggesting producers are aiming to compete with value-based meats as opposed to more expensive premium products. While it is more efficient, allowing greater cell densities than adherent cell cultures, it can't be used to form the higher-end structured meats that require forming, scaffolds, or 3D printing—techniques that are not yet proven at scale.

Almost three-quarters of respondents anticipate their first sale of cultivated meat to occur within the next two years, which seems realistic. But to get to the goal of price parity, two things must happen: Production costs need to decrease, and cell culture yield and production throughput need to increase.

FIGURE 1.1

What is your company's current cost to produce per pound for cultivated meat? [Single select]
What is your company's desired consumer cost per pound for cultivated meat? [Single select]



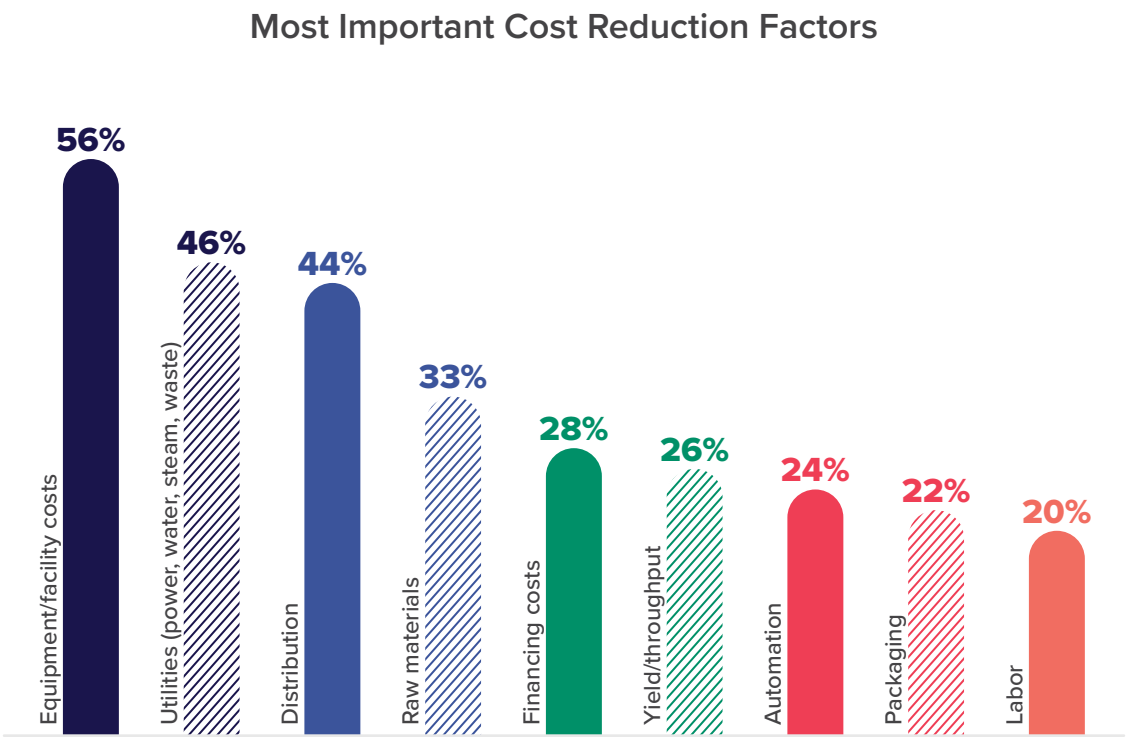
Source: CRB

OPPORTUNITIES TO REDUCE COST

When producers were asked which factors were most important to bring costs down, reduction in equipment and facility costs topped the list (Figure 1.2). While start-ups need to keep capital investment low or offset as long as possible, there is a minimum cost of entry they can't avoid in terms of equipment and facility costs to prove their product and process. Although these table stakes are not baked in, we peg them in the range of $30–100 million, based on the costs of pilot plant facilities. While equipment and facility costs seem like attractive targets—these are, after all, the largest capital expenses—our experience has shown that available technologies and strategies may provide only incremental decreases. Instead, we have seen the greatest opportunities for cost reduction in other areas surveyed (Figure 1.2), including yield and throughput (26%), raw materials (33%), utilities (46%), and automation (24%).

FIGURE 1.2

Please rank the top three attributes from most to least important for your company's goals of reducing costs.



Source: CRB

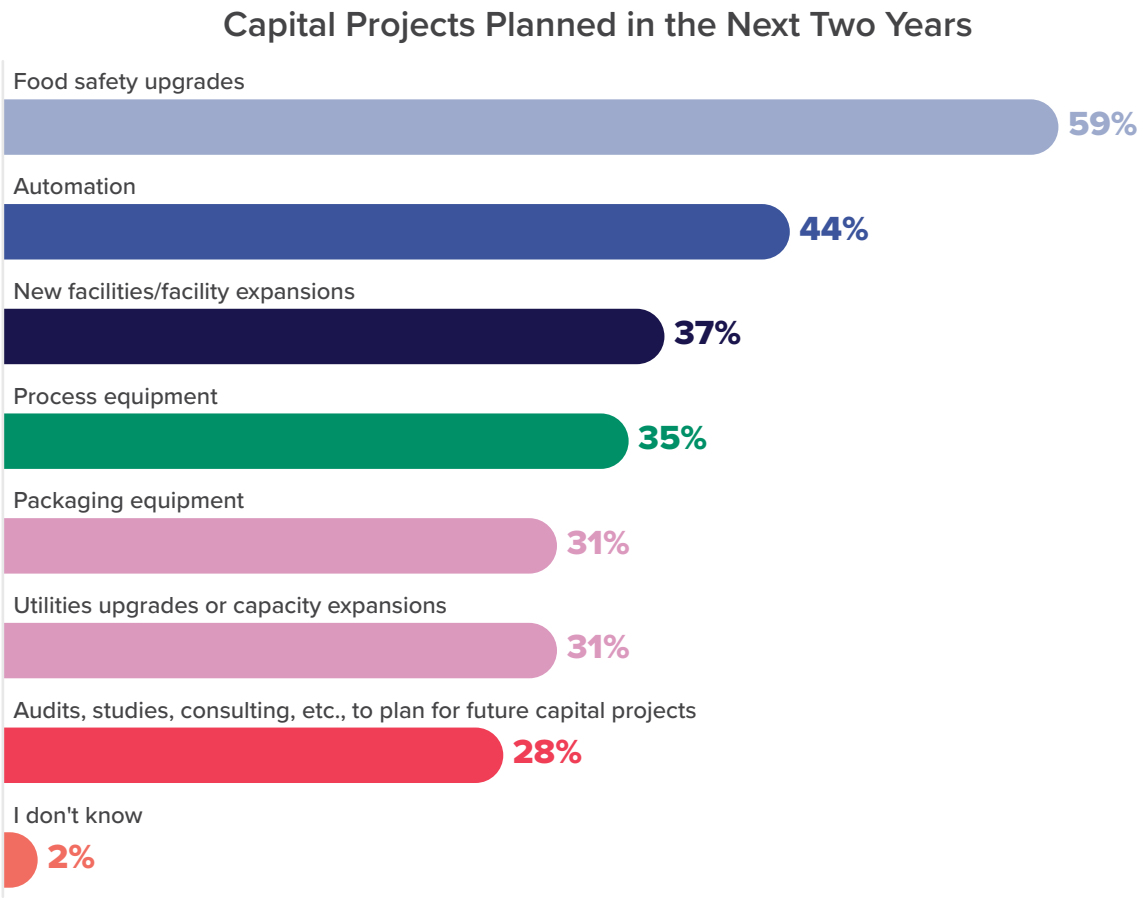
Automation

We're heartened to see that 44% of respondents intend to embark on automation upgrades in the next two years (Figure 1.3). In fact, companies have already put some

automation infrastructure in place (84%), while 7% have fully digitalized Industry 4.0 operations. Automated processes lower capital costs since they require less building space and smaller personnel areas due to lower headcount on the production floor. Automation also leads to better process control, reducing the number of lost batches and increasing throughput and yield.

FIGURE 1.3

Is your company planning capital projects in any of the following areas in the next 2 years? [Multi select]



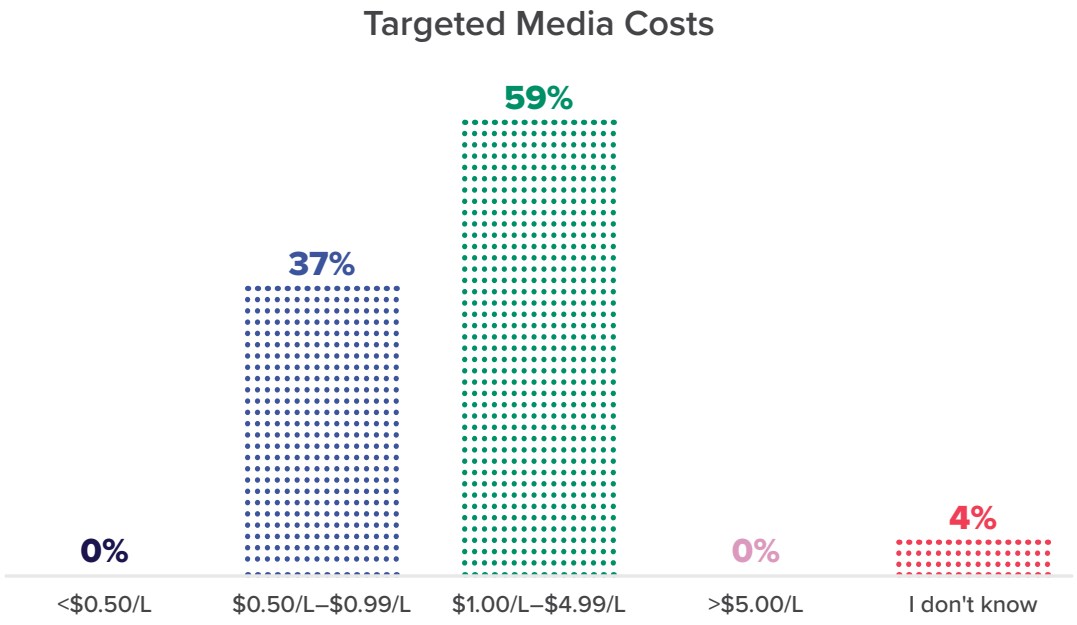
Source: CRB

Media

A 2020 analysis showed that culture media accounted for 55–95% of the cost of goods. The average target price among these experts is now only $2.13/L, an exponential decrease from three years ago. Additionally, 37% of respondents said they are aiming for less than $1.00/L. This is where we believe the industry needs to be profitable and is cause for optimism.

FIGURE 1.4

What is your company's targeted cost for media? [Single select]



Source: CRB

PRODUCTION NEEDS TO CONTINUE TO IMPROVE

Consumer demand continues to increase, with one consultancy projecting that by 2040, 60% of meat will be cultivated meat. So far, sales have been focused on attention-getting events, such as the first cell-cultured meat to be served to the public in a restaurant in Singapore.

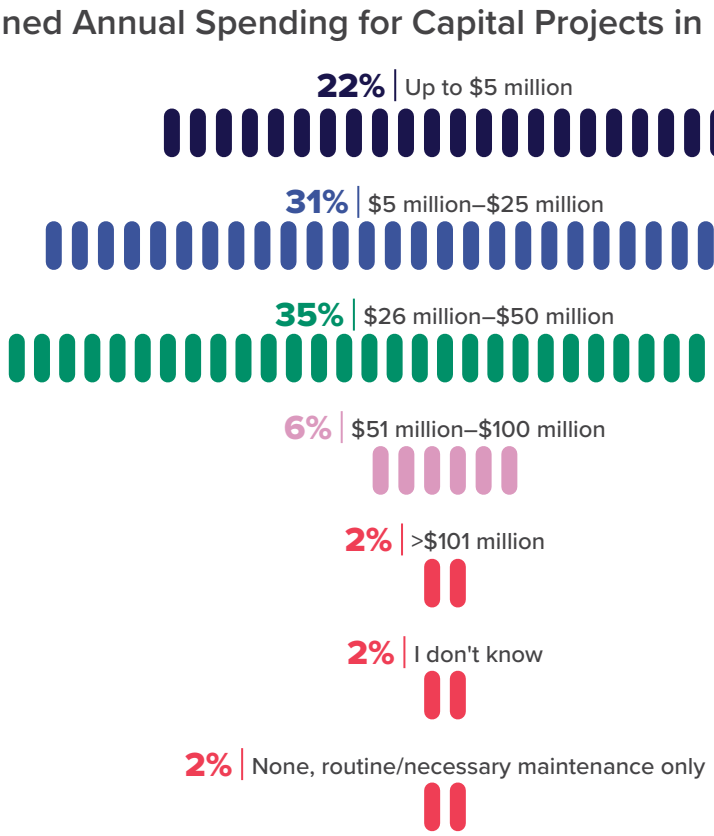
Of the 31% of respondents who had a production target, the average target was almost 300,000 pounds per year, substantially higher than recent estimates of actual production of only 10,000 pounds per year. Despite this, we believe such targets are achievable. The history of biopharma manufacturing has shown us that exponential growth is possible and, with advances in perfusion cell culture and harvest techniques, we're confident that levels of production of cultivated meats will increase dramatically. Our modeling has shown that production can be increased by how our clients do harvest splits, and computational fluid dynamics (CFD) modeling has been used to optimize cell density and yields.

The sobering news is that adequate production will require much more capital than many are planning to spend in the next two years (Figure 1.5). Achieving these ambitious goals of commercial scale throughput of at least 300,000 pounds is likely to require investments of upwards of $100 million to build a greenfield plant. A positive take on this data is that companies have become strategically cautious about their capital investments. The push to quickly build manufacturing facilities has

slowed down, while companies focus on optimizing their technology and business models, as opposed to near-term facility launches.

FIGURE 1.5

What is your company's planned average annual spending for capital projects for each of the next two years? [Single select]



Source: CRB

Production targets of 300,000 pounds per year are remarkable given how new this industry is. However, at the anticipated market price mentioned above, this amounts to little more than $1 million in revenue—too little for long-term profitability or to compete with traditional meat. While many producers are not aiming to make premium products with higher selling prices, the economics may steer them toward this eventuality.

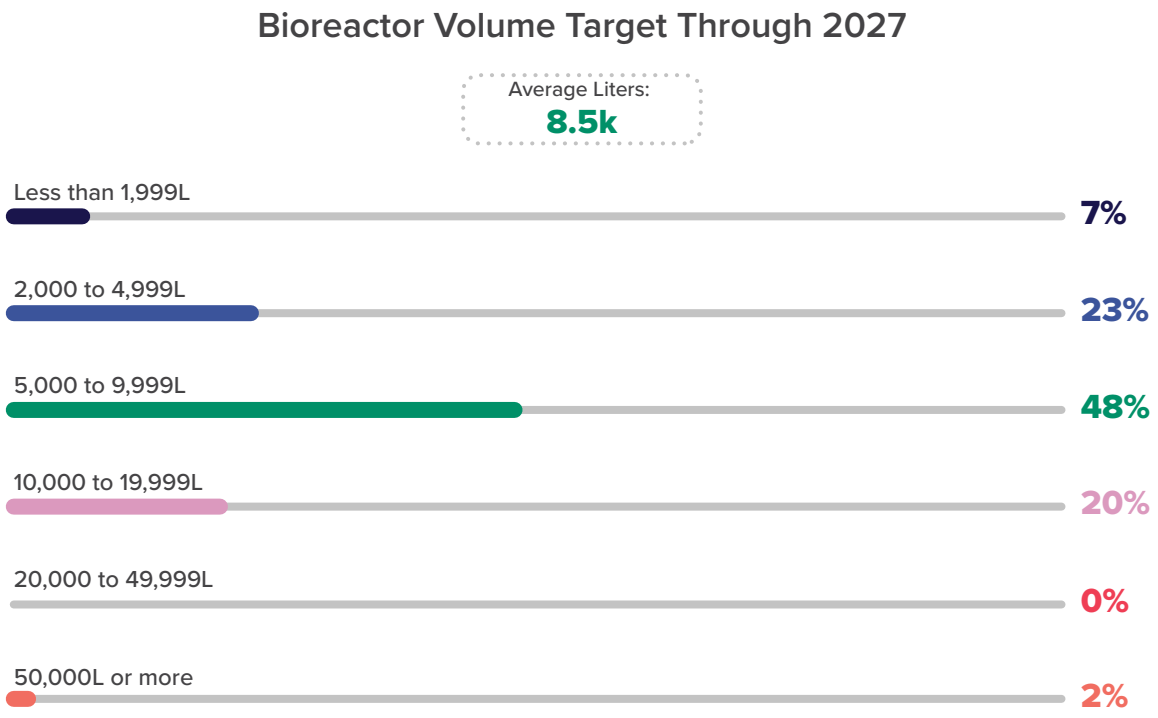
Bioreactor volumes and yields need to increase

Scaling up by increasing bioreactor volume is a good opportunity to reduce the price of the final product. Yet more than three-quarters of respondents are aiming to rely on a bioreactor volume of less than 10,000L through 2027, with few respondents

planning for greater than 20,000L (Figure 1.6). While a 20,000L bioreactor could be profitable as long as cell densities are optimized, we urge evaluating volumes in the 50,000–100,000L range since growing cells is the most capital-intensive part of the process. From a CapEx perspective it makes more sense to scale up than out, using fewer, larger bioreactors.

FIGURE 1.6

What is your company's production bioreactor volume target through 2027? [Single select]



Source: CRB

Outsourcing is an option to increase productivity

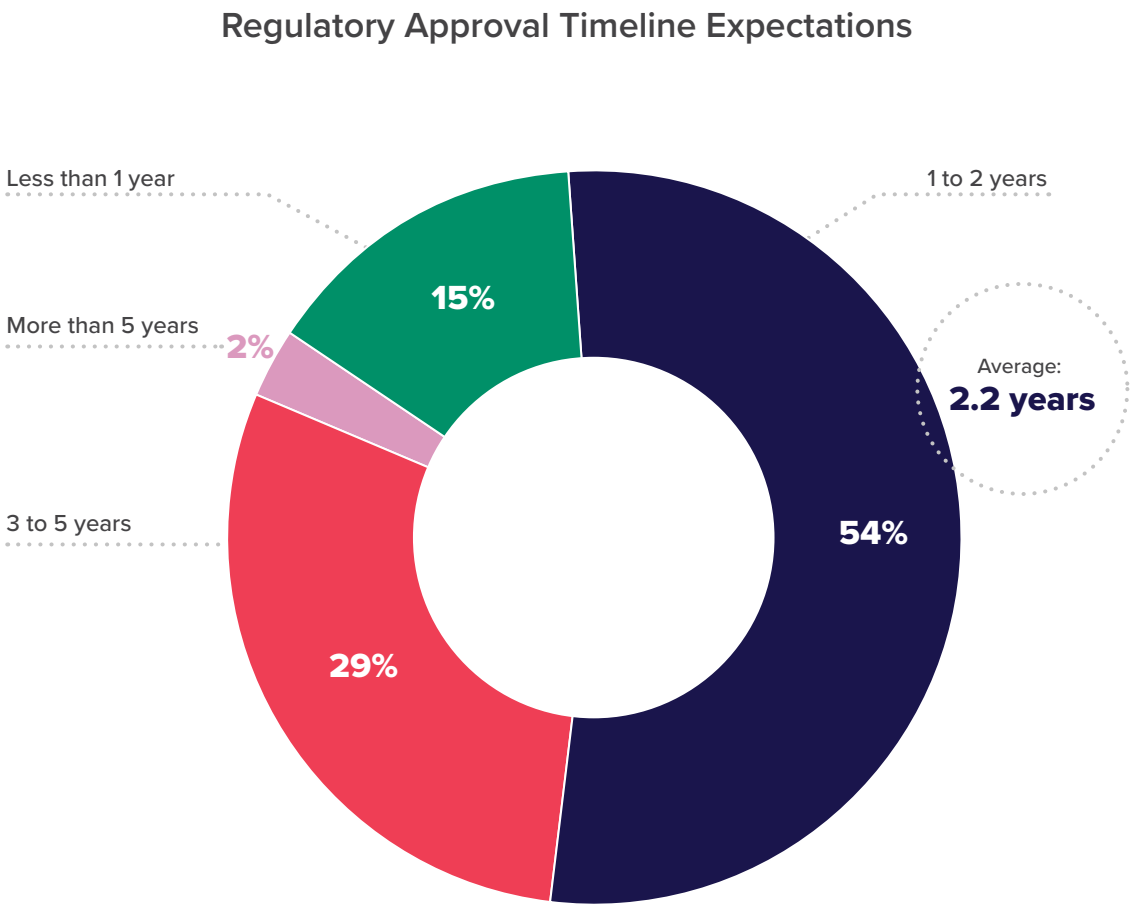
Partnering with an experienced manufacturer can minimize initial investment in buildings and equipment while speeding up the path to market. Alternatively, outsourcing of processing and packaging has the benefits of eliminating the capital outlay for a processing facility, as well as allowing a rapid switch to another product if consumer preferences change. This strategy, known as asset-light supply chains, has been adopted by companies to preserve capital or enhance margin.

REGULATORY APPROVAL EXPECTATIONS

Singapore remains the only country to allow the sale of cultivated meat, though 69% of survey respondents anticipate regulatory approval of their products within two years, reflecting a positive outlook on the future of the industry (Figure 1.7).

FIGURE 1.7

When does your company anticipate regulatory approval for your cultivated meat product? [Single select]

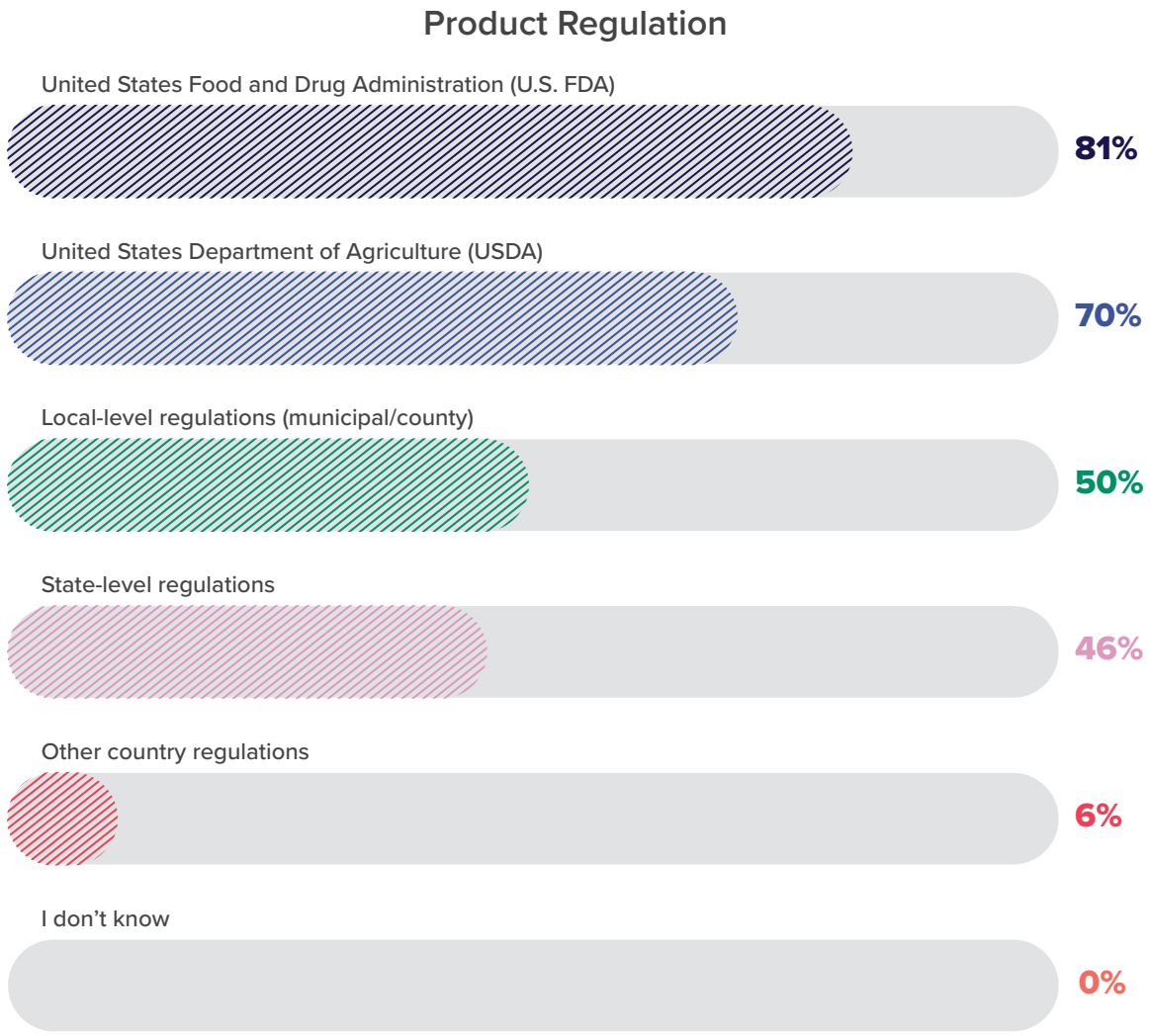


Source: CRB

Compared to our 2021 *Horizons: Alternative Proteins* report, which revealed confusion about which body is responsible for regulating cultivated meat, our recent respondents understand that it's both the FDA and the USDA (Figure 1.8). The FDA regulates the collection, growth, and differentiation of animal cells, as well as animal cells that don't fall under USDA jurisdiction (e.g., some seafood and game), and pet food. The USDA regulates the processing, packaging, and labeling of cultivated meat products, and requires an on-site inspector for cultivated meat processing. Virtually all companies have an in-house compliance officer or quality control manager responsible for FDA and USDA compliance, while more than half of those surveyed said their company's quality assurance and/or food safety team had experience complying with both FDA and USDA regulations.

FIGURE 1.8

What regulations are your products held to? [Multi select]



Source: CRB

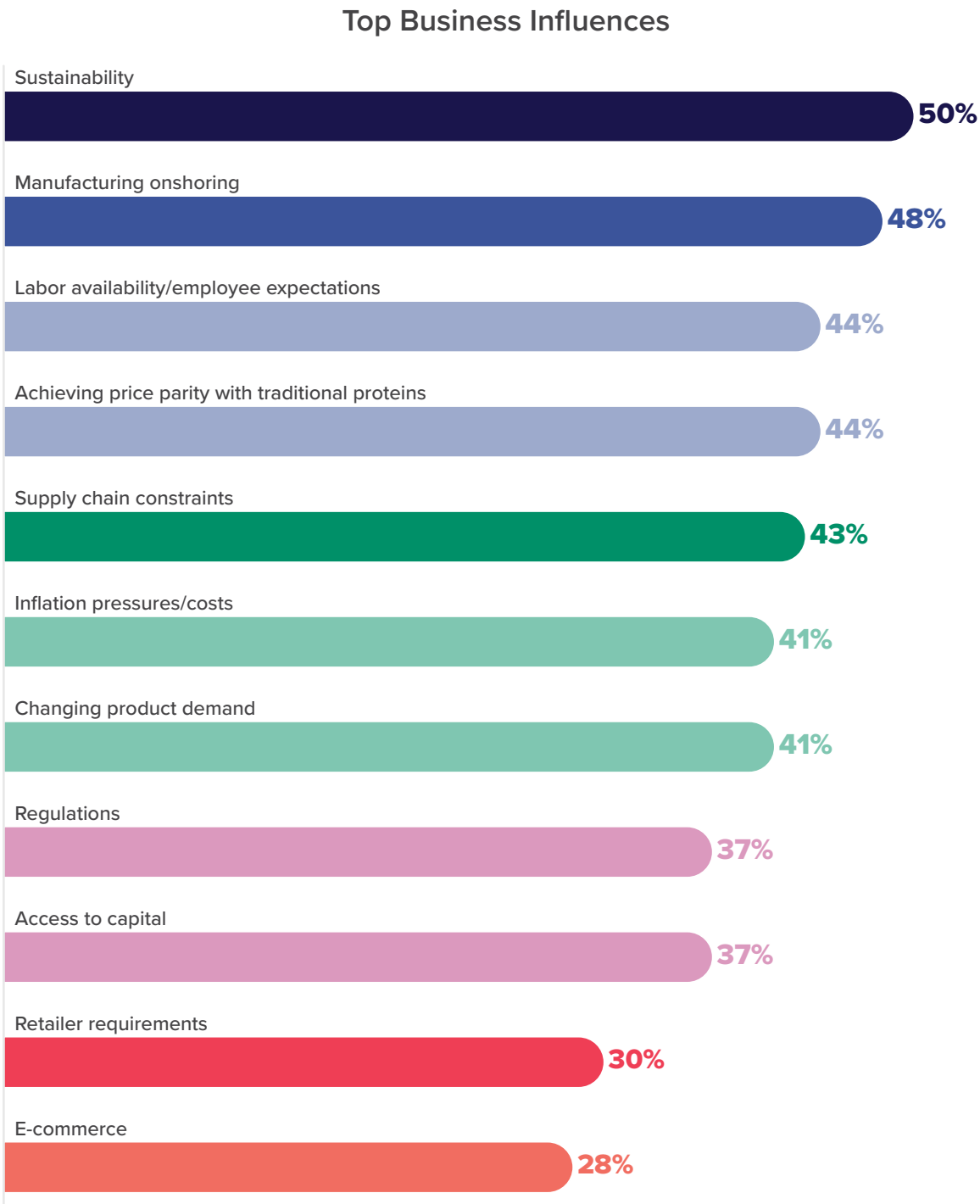
In addition, most respondents said their company is either certified or planning to be certified in the next two years for Safe Quality Food (83%), non-GMO (59%), and the Global Food Safety Initiative (78%). This reflects a healthy focus on food safety.

BUSINESS STRATEGIES REFLECT MATURATION

Among the most important influences to ensure business success chosen were sustainability, labor availability, and achieving price parity. The lack of skilled labor is a common refrain heard throughout high-tech industries and the cultivated meat industry is no exception. Automation should help with this, bringing on those with IT skills to replace some of the need for labor on the production floor.

FIGURE 1.9

Of the following, rank the top influences for your business (choose up to 5 total). % Selected as Important.



Source: CRB

The technology and applications are here—now companies should focus on their business models

Even with price parity, current production volumes and target price will not lead to profitability, based on the average cost of goods sold found in our survey. It's unusual to see this level of technological innovation being applied to a value-based product. Usually, producers would apply efficiencies and technology gains to lower the cost of production incrementally. Understandably, this space is developing an entirely new value proposition and requires this innovation, but it is coming at a high cost. Especially in the current tight investment climate, business decisions need to be considered alongside proving the technology.

It might make more sense for companies to pursue premium products, an evolution we've seen since our last survey. More companies are diversifying beyond ground beef and chicken nuggets to pursue a wider range of products, including lobster tails, Wagyu beef, and oysters. One example is bluefin tuna, a premium product mimicking a species on its way to potential extinction. Not only will it be easier to achieve price parity and profitability with this type of product, but consumer acceptance may be easier to achieve.

Be prepared for consumer sales within two years

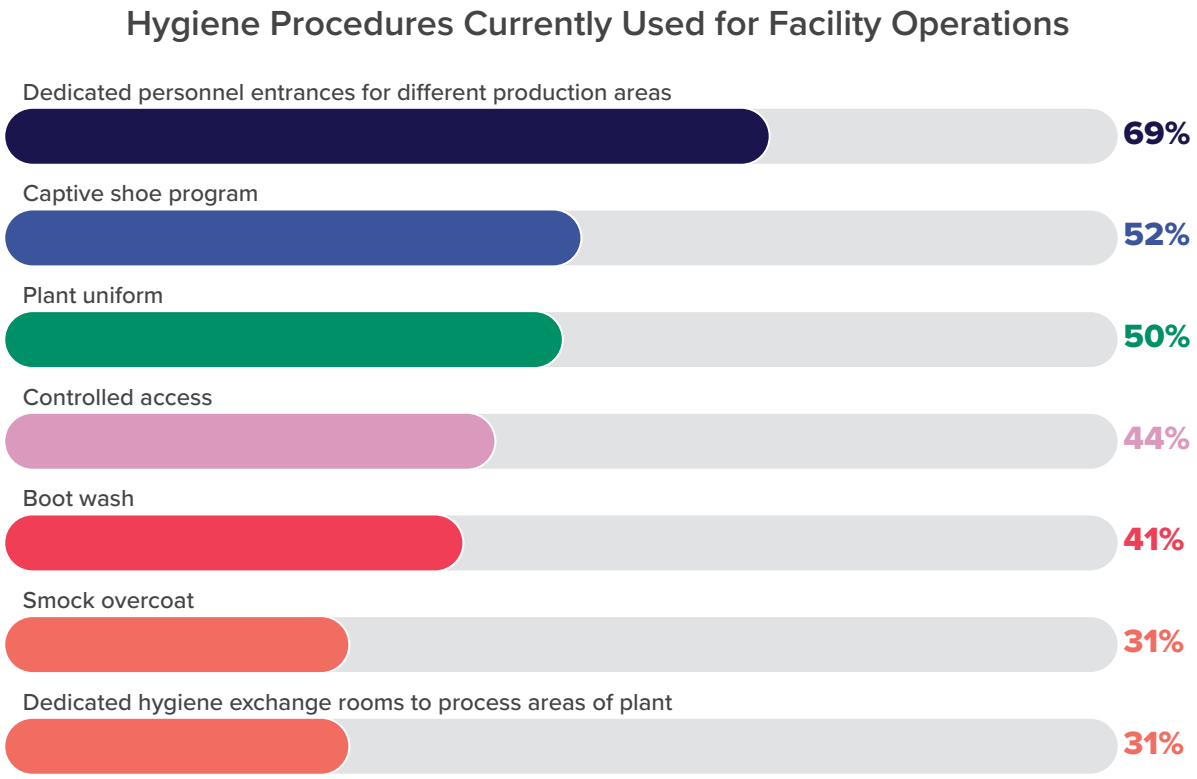
Given that capital is currently harder to come by, we expect to see companies invest wisely over the next two years. This means that fewer companies plan to build large facilities in the near future, focusing instead on improving platform technology and research. Once they've proven the technology, the process could be transferred to a contract manufacturing organization (CMO) or sold to another company for downstream processing steps and to manage the logistics of getting products to consumers. Almost one-third of respondents are planning to partner with a CMO as part of their near-term production strategy.

Hygiene practices provide a good PR opportunity

The indicated facility hygiene procedures reflect a more mature focus, with dedicated personnel and such things as boot wash stations, plant uniforms, and controlled access (Figure 1.10). Dedicated hygiene exchange is of particular interest to us as more mature companies, which tend to have biotech operational experience, are comfortable with and see the value in using room transitions. While not everything from a biotech approach needs to carry over into cultivated meat production, well-designed transitions help limit hazards and may be included in a facility's hazard analysis and critical control points (HACCP) plan. In terms of reducing production costs, while at the same time improving safety, it is worth relying on closed processing for upstream processes, as opposed to much more expensive clean rooms.

FIGURE 1.10

Which of the following hygiene procedures apply to your facility operations? [Multi select]



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The reliance on boot wash stations, gowns, and general cleanliness indicates a safer product. Along with cell cultures and bioreactors—production processes and equipment intimately familiar to biopharmaceutical manufacturers—these hygiene practices provide a unique PR opportunity to showcase the cleanliness of these facilities and could go a long way to calming consumers' concerns about these innovative products, as well as infusing investors with confidence.

We are cautiously optimistic about the next two years

Since our last survey, cultivated meat has evolved with respect to price parity and the exponential increases in production volumes; this indicates the industry is moving toward sustainability and profitability. Production costs continue to decrease and, while the industry is not yet where it needs to be in terms of production yields and throughput to reach profitability, it has made considerable progress.

The future of fermentation-derived proteins

They left the gate at high speed. What will it take for these manufacturers to avoid a slowdown?

By: Sebastian Bohn, Brendan Kress, and Tony Moses, PhD



Though they're in a relatively new market, manufacturers with fermentation-derived proteins in their pipeline reported, overall, a more commercially advanced position than any other segment we surveyed. In fact, they stand out from other survey respondents in several ways:

They have a larger workforce
Manufacturers in this market reported 6,554 employees on average, more than double the next-largest employer, plant- and mycelium-based meat manufacturers (3,242 employees on average).

They generate more revenue
These manufacturers report an annual revenue of $277 million on average. In second place, plant- and mycelium-based meat manufacturers generate almost $100 million less per year.

They're more likely to report an increase in sales volume
A slightly larger majority (71%) of manufacturers in this market reported an increase in volume over the last two years compared to cultivated meat manufacturers, the next-highest group at 70%.

These data points appear to tell a runaway success story, and in some ways that's true for fermentation-derived protein manufacturers. But the data also warns of challenges to come: Some of these manufacturers will continue their rapid climb

toward market dominance, while others face an uncertain future. The difference between them? It comes down to the countervailing forces at play in this market, and how well manufacturers adapt their strategies to address these clear points of tension. For example:

- 79% are shooting for a premium status, **even though** many are still working toward price parity with traditional proteins.
- 81% plan to rely on a sustainability claim to justify a premium price, **even though** sustainability doesn't rank highly in their assessment of consumers' buying behavior.
- Only 59% plan to invest in new organisms, **even though** 74% rank protein expression as a top production barrier.

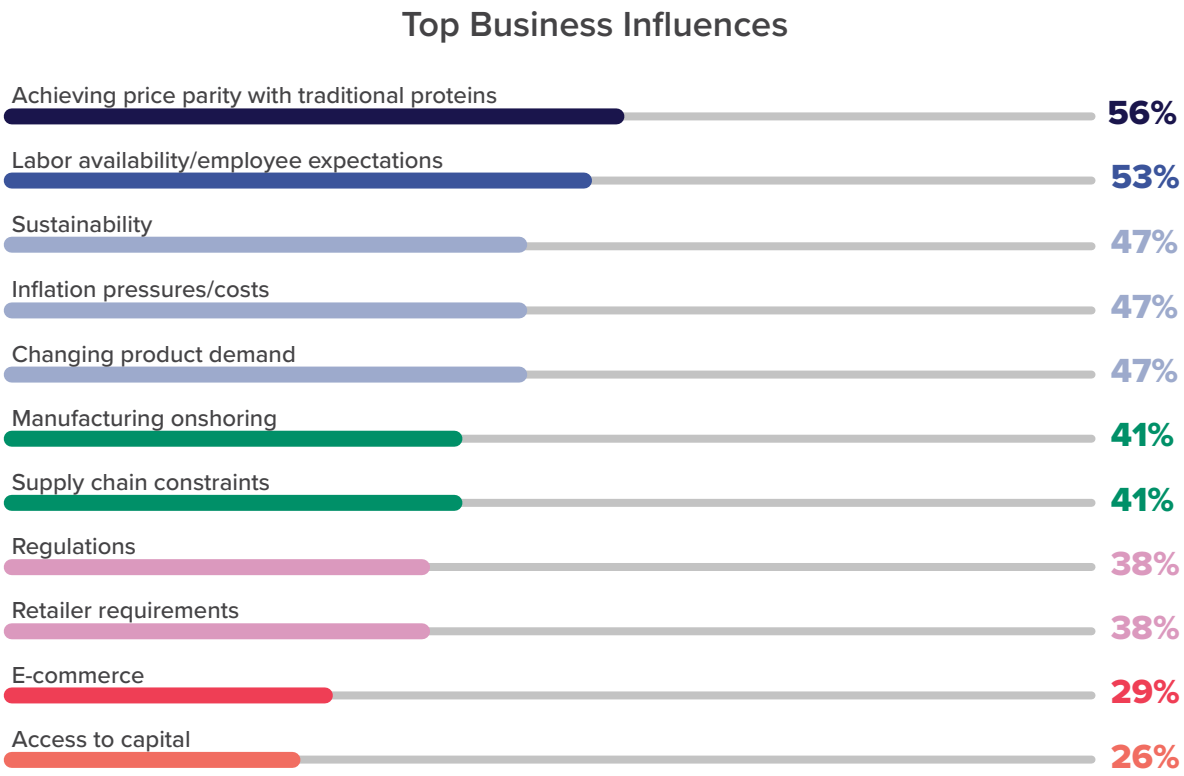
How can manufacturers navigate these apparent contradictions and emerge with a resilient and flexible business strategy—one that can fuel this market's meteoric climb? Let's dive in.

THE PRICE PARITY PROBLEM

These manufacturers remain focused on reaching price parity with traditional proteins, selecting this goal as their top business influence more often than any other segment we surveyed (Figure 2.1). They appear to know what's required to get there: improved purity and higher yield (Figure 2.2). Mastering these two critical factors would generate the one-two punch of higher throughput and lower production costs, helping them to bring their sticker price within range of the established standard. To do that, they need a plan.

FIGURE 2.1

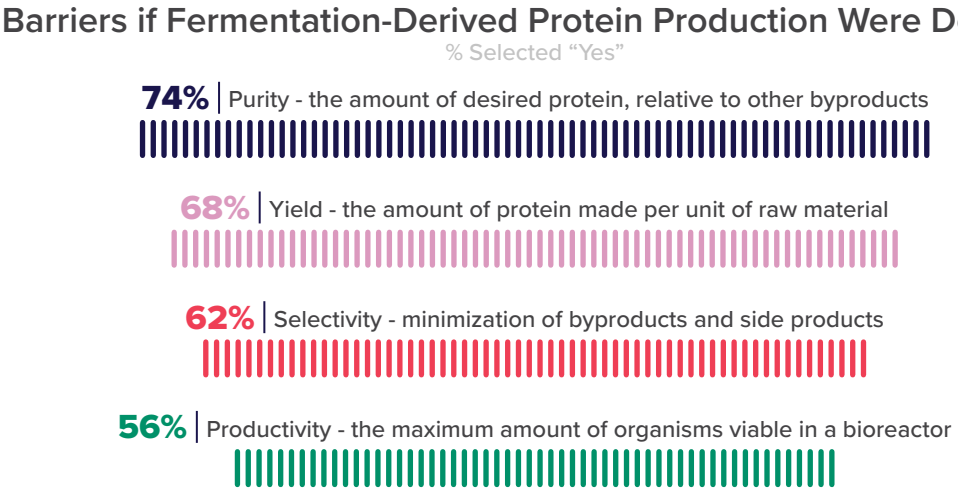
Of the following, rank the top influences for your business (choose up to 5 total)



Source: CRB

FIGURE 2.2

If your company were to double fermentation-derived protein production, would any of the following be major barriers? [Multi select]

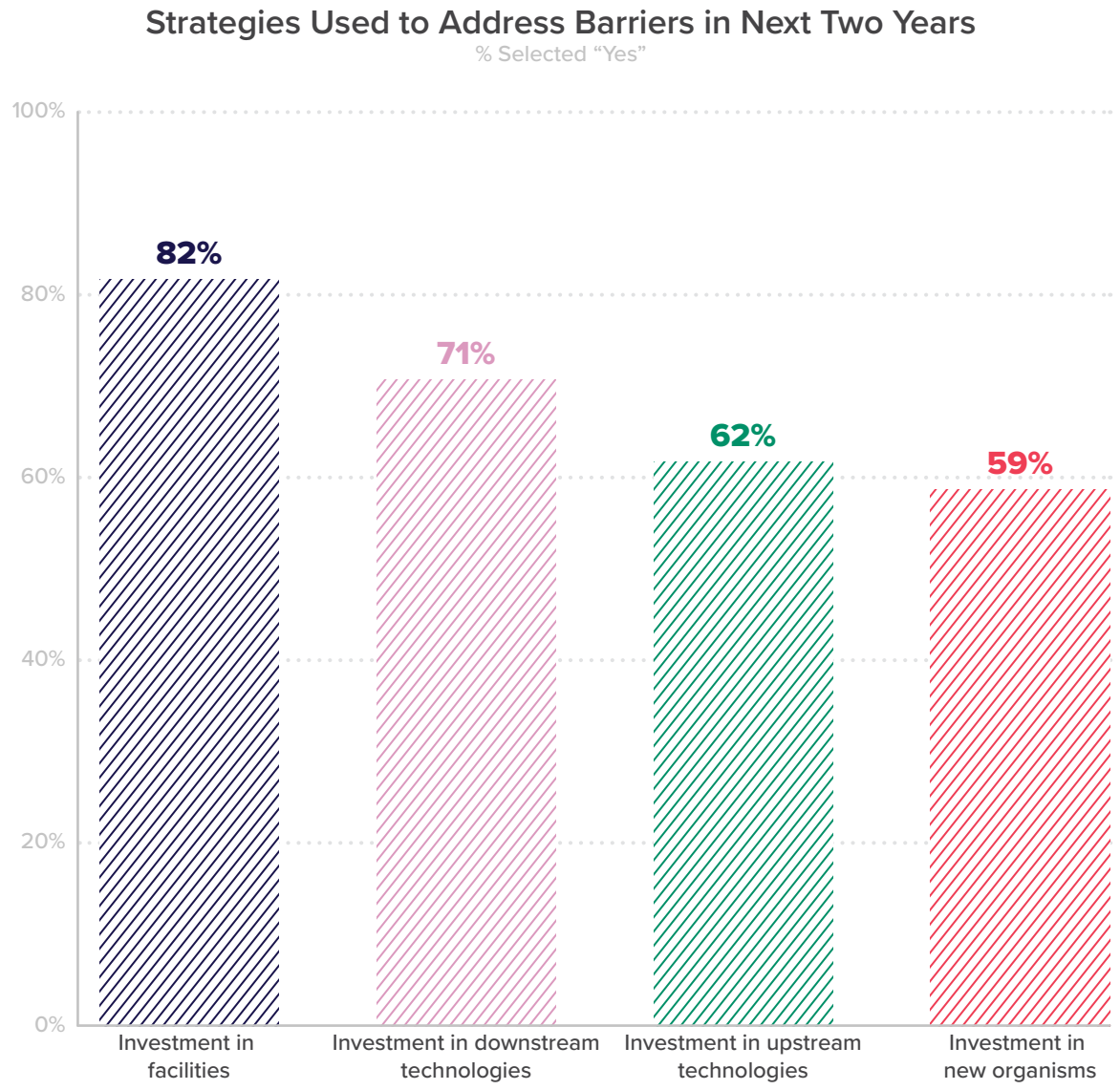


Source: CRB

For 82% of manufacturers in this segment, that plan hinges on facility investment (Figure 2.3). They've earmarked an average of $34 million over the next two years; after safety-related projects, they're prioritizing utility upgrades, capacity expansions, and new or larger facilities (Figure 2.4). This focus on brick-and-mortar growth appears to have helped this segment storm the marketplace; 58% of respondents in this category have products in national or global distribution, outpacing even the well-established plant-based dairy segment.

FIGURE 2.3

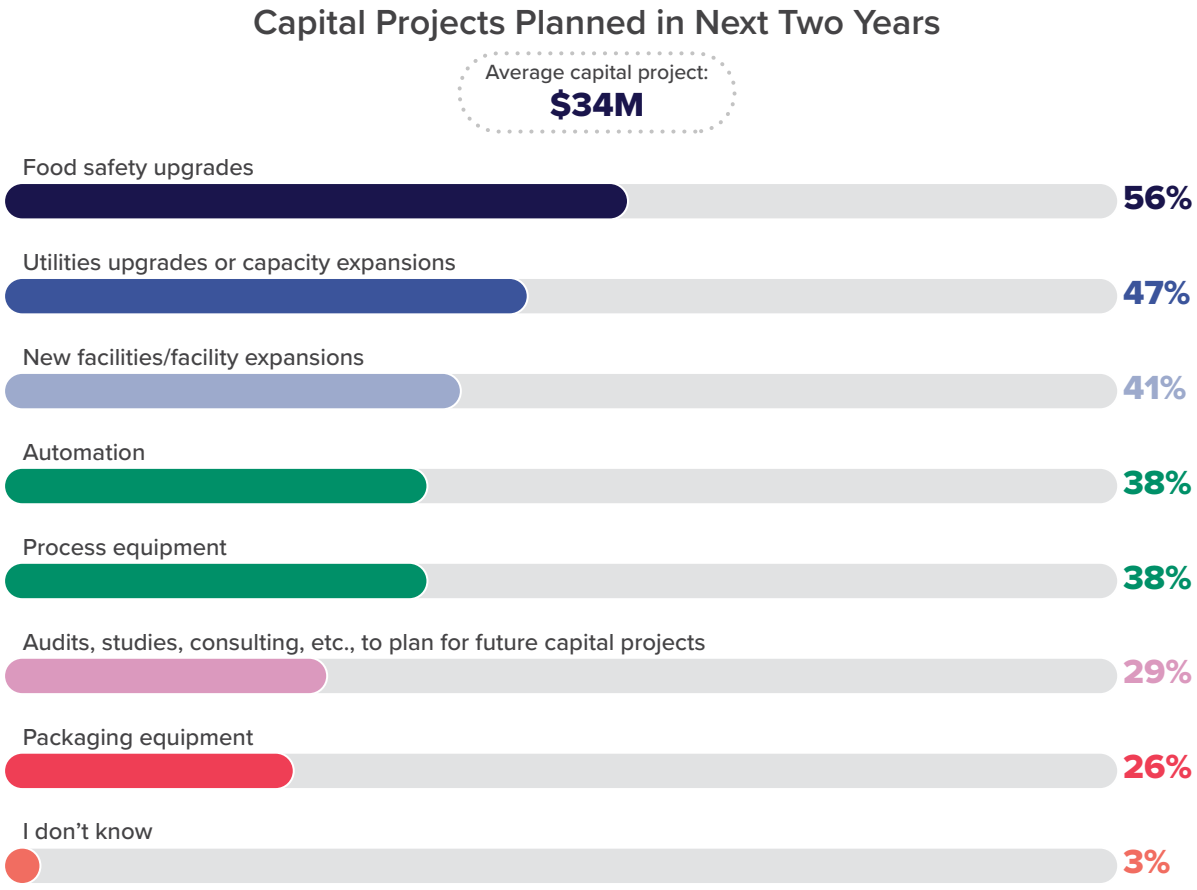
Are you using any of the following strategies to address barriers over the next two years? [Multi select]



Source: CRB

FIGURE 2.4

Is your company planning capital projects in any of the following areas in the next two years? [Multi select]



Source: CRB

But forcing growth through manufacturing expansion alone may not be sustainable from a cost perspective—especially if what you're expanding is suboptimal.

Before investing in additional infrastructure, consider these strategies:

Fine-tune your organism

Given that most respondents see yield as a significant barrier to scalability, we were surprised to note how relatively few plan to modify existing organisms or invest in new ones (Figure 2.3). Increasing throughput by adding a fermenter may seem like a simpler approach, but even that project requires a large effort—production schedules need to change, utility infrastructure needs to expand, and so on. Instead, consider the long-term payoff of modifying an organism to produce even a slightly higher yield relative to other byproducts. The benefits of this effort could cascade into far greater overall efficiency and throughput.

However, for many manufacturers, especially those in a race to meet investment milestones, the work required to engineer an organism for maximum protein expression may be too time-intensive and costly. There is an alternative, though: Many third-party specialists have the skills and computational power in place to screen thousands of variations in parallel. Instead of the months or even years required to apply a self-performing approach, these companies need just weeks to modify your organism's genetic code for a far more successful metabolic pathway. As an additional incentive, many of these outsourced partners offer a shared revenue model, making their services accessible for startups looking to delay larger capital spending.

Optimize your process

In addition to fine-tuning your organism, consider the impact that relatively minor adjustments in your process itself could have on that organism's productivity. Tweaking your pH scheme, your media feeding protocol, or even your carbon source could have a significant effect.

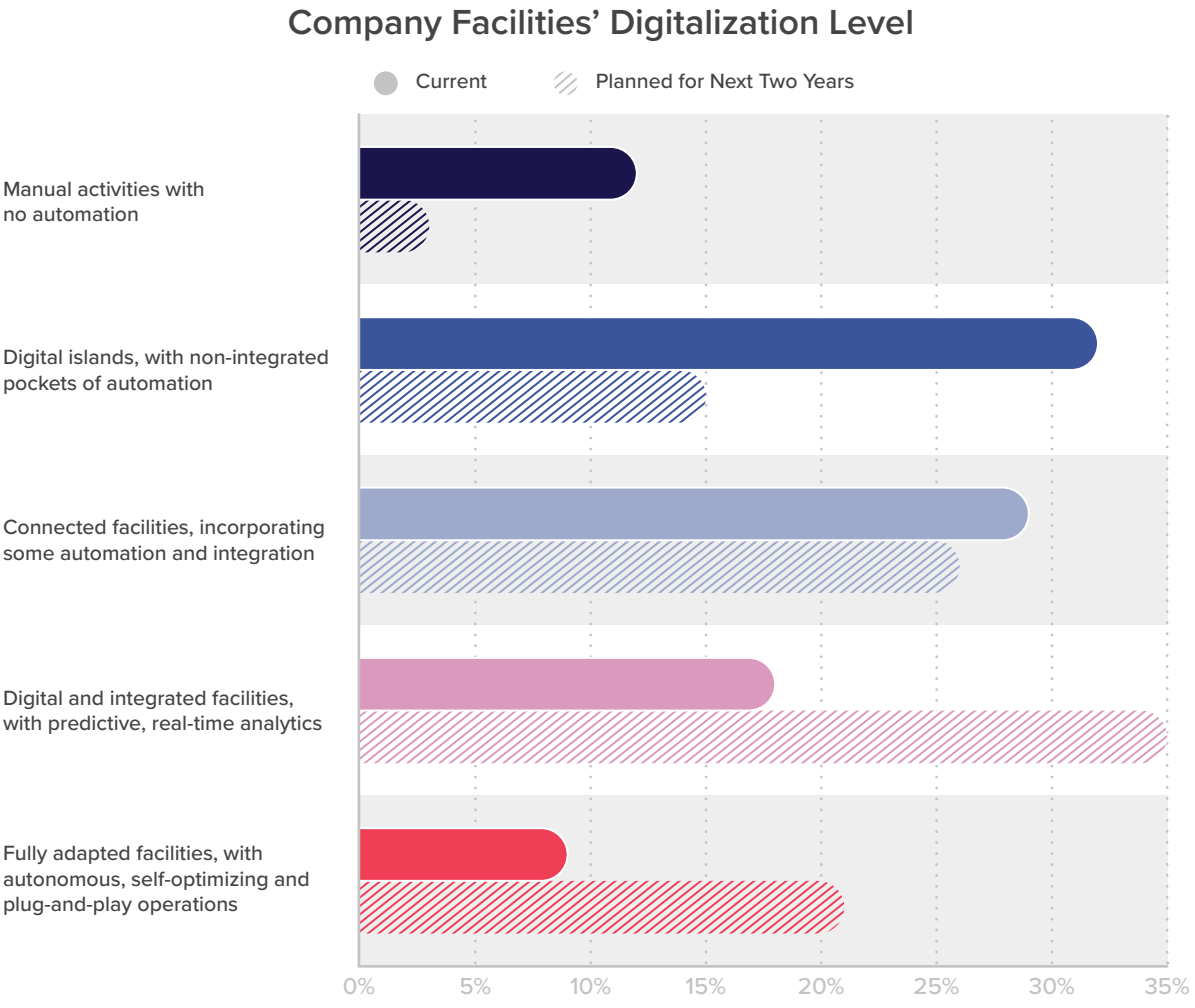
The sooner you can make these relatively minor tweaks, the better, because they could have major implications on your material handling infrastructure, facility layout, and operations. Imagine, for example, finding greater productivity with a solid media source than a liquid one, or discovering that even minor variations in temperature have dramatic impacts on yield. Such revelations could leave you wanting to replace a sizeable section of your utilities infrastructure—a pivot that's much easier and more cost-effective to make when it's initiated early.

If adjusting your infrastructure, layout, or sequence of operations does seem necessary to achieve your throughput goals, consider engaging a control systems integrator and a simulations team. They can help you plan, implement, and manage these adjustments as cost-effectively as possible, and they can even model potential process changes inside a digital environment, giving you valuable insights before you put real-world resources at stake. This may be especially valuable for manufacturers planning to reach a more advanced digitalization level over the coming years (Figure 2.5).

FIGURE 2.5

Regarding your current automation and control systems, what level of digitalization most accurately reflects the capabilities of your company's facilities? [Single select]

What level of digitalization does your company expect to achieve in 2 years? [Single select]



Source: CRB

Expand your facility in response to the needs of your organism and your process

By investing time in maximizing your organism's productivity and the efficiency of your upstream process, you've created the right conditions for a more future-proof capital investment. Instead of generating growth through the "brute force" of high-speed facility expansion, you have the insight you need to make strategic, meaningful investments where they'll generate the greatest return.

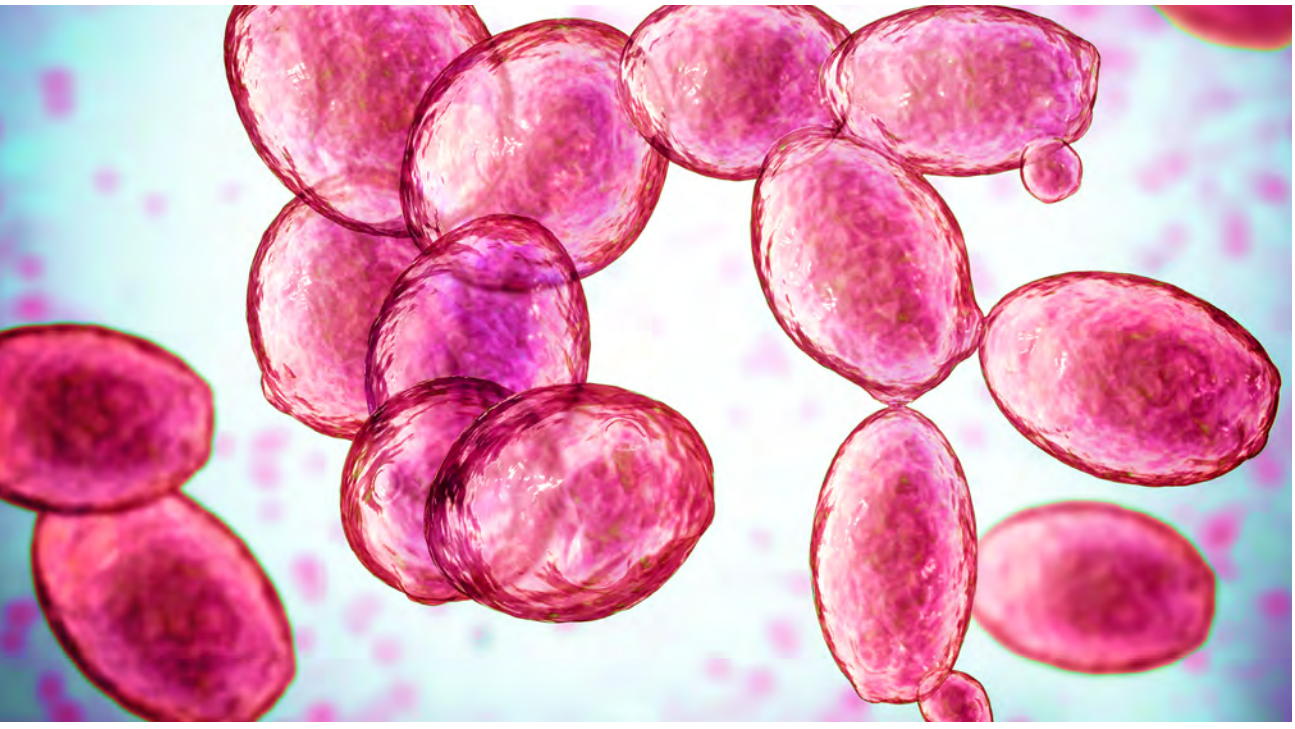
Take the example of a manufacturer with an aggressive two-year production target. In one scenario, they meet that target by adding a new fermenter in another building.

This approach works from a throughput perspective, but it means paying for the equipment itself *and* the infrastructure necessary to support it, which generates a downward drag on their overall production costs and broadens that "parity gap."

In another scenario, that same manufacturer works with a third party to model and optimize their upstream process, which reveals a simpler pathway: If they install a non-sterile holding tank, they can adjust their existing media feeding scheme and ultimately hit the same target as the first scenario, with comparatively minimal ancillary costs.

Of course, the scale, timing, and outcome of these capital investments hinges on your company's unique position and business goals. Consider the question of single-use versus stainless steel manufacturing systems, for example. Investors want a business case calibrated for long-term ROI, which often means stainless steel. This direction requires a more complex facility from a utilities perspective, but it generates less solid waste and relies on fewer specialized supply chain inputs—a good strategy for controlling lifetime operational costs. For the 11% of respondents who haven't yet reached pilot-scale manufacturing, however, a small, flexible single-use system may help establish proof-of-concept in the short term, providing speed to market while minimizing risk on capital spending.

These capital spending decisions must be tailored for individual scenarios, but one thing is true for all manufacturers: how you prioritize your capital spending has a lasting impact on your ability to achieve price parity. If you, like most respondents in this segment, are looking beyond parity at a future of premium pricing, every one of these choices carries even greater weight.

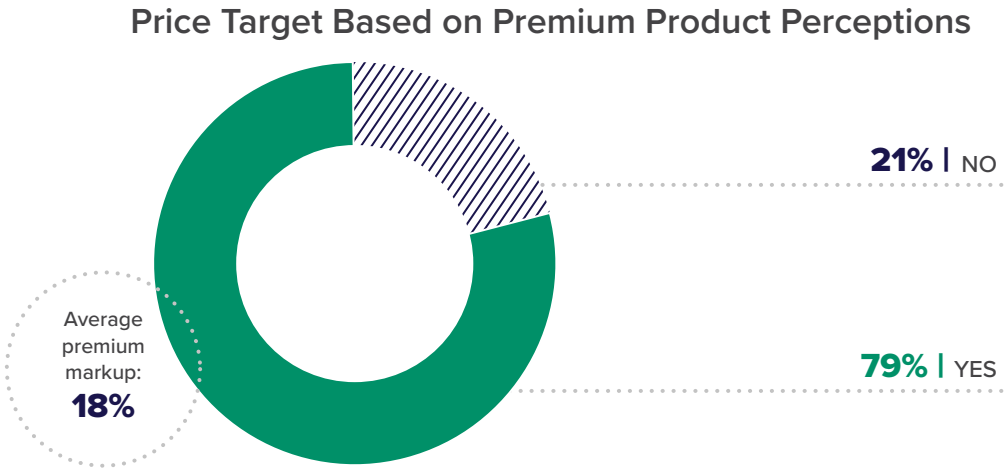


THE PATHWAY TO PREMIUM

For 79% of respondents in this segment, achieving parity with the traditional market is a step on the road to a loftier goal: status as a premium product (Figure 2.6). Compared to competitors in their shelf set, these manufacturers are planning an 18% premium markup on average. To get there, they're making a big bet: 81% believe that a sustainability claim will compel consumers to open their wallets (Figure 2.7).

FIGURE 2.6

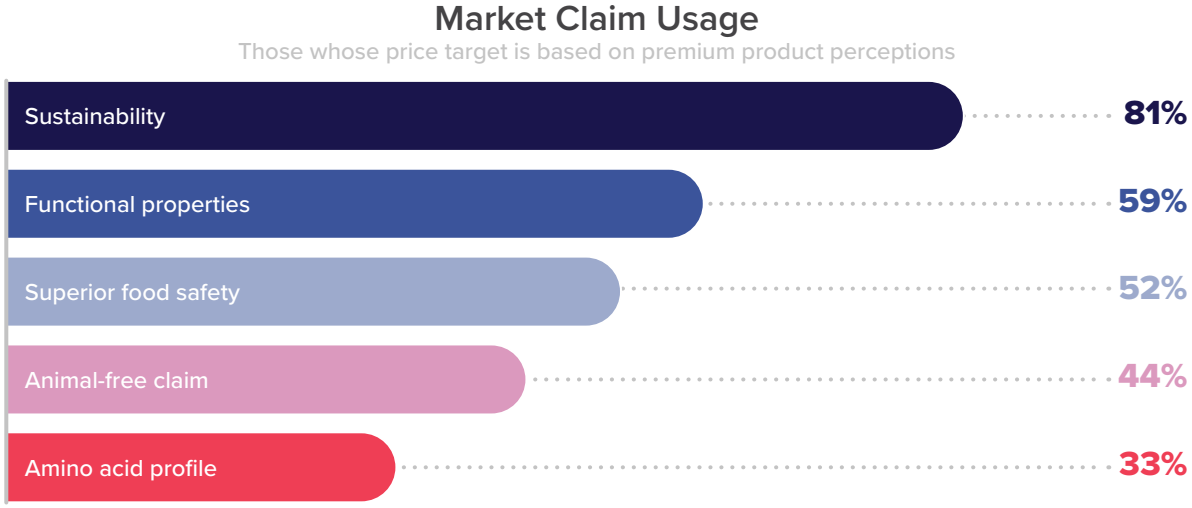
Is your price target for fermentation-derived proteins based on being a premium product?



Source: CRB

FIGURE 2.7

Do you use any of the following claims or characteristics to market your product as premium? [Multi select]

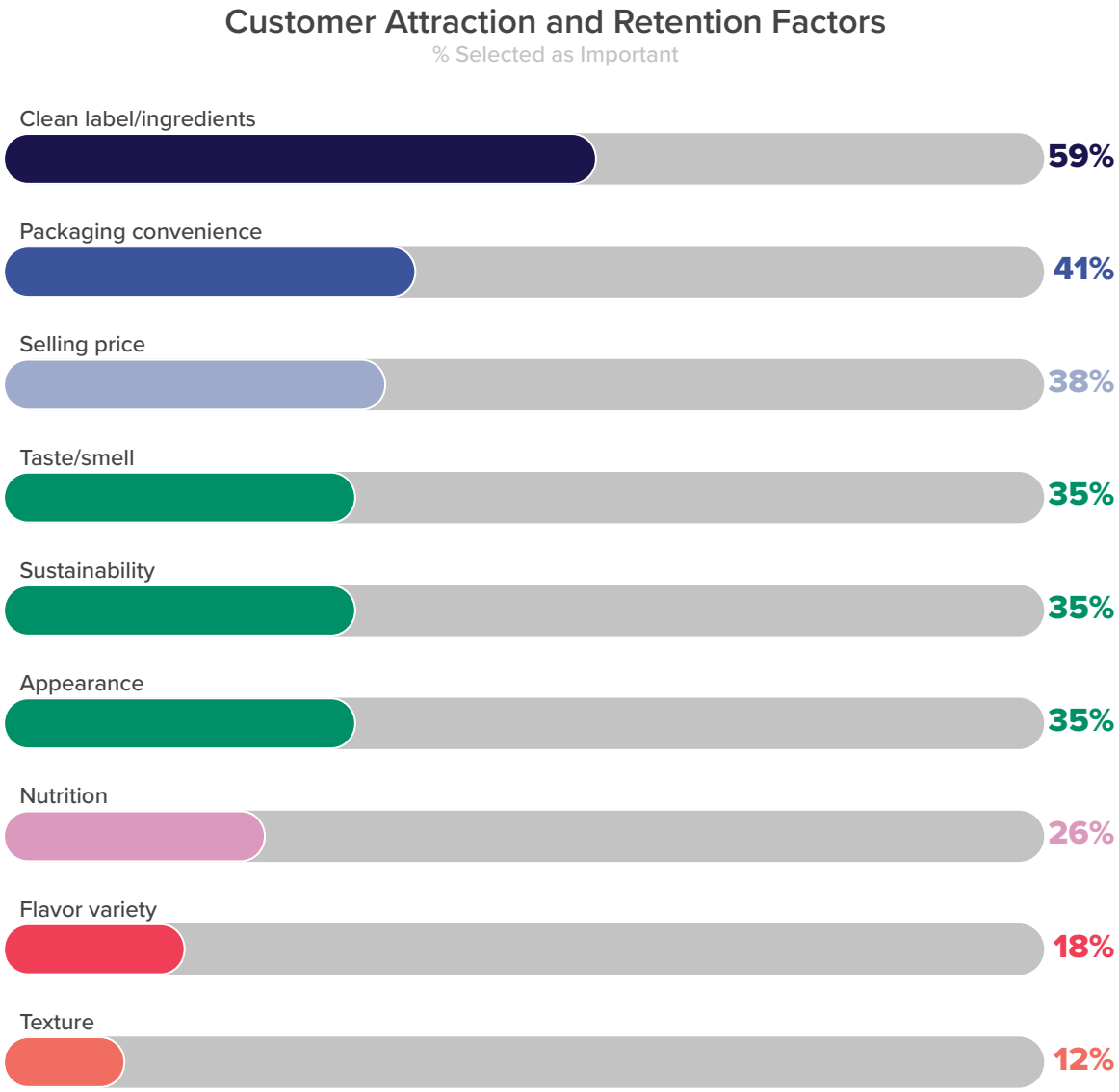


Source: CRB

This data reveals an interesting wrinkle in this sustainability-focused strategy. Though they heavily favor it as a marketing play, this segment also recognizes that buyers aren't motivated by sustainability alone. Labeling, packaging, and price outrank it as important attributes for customers, leaving sustainability in the middle of the pack (Figure 2.8).

FIGURE 2.8

Of the following, rank the top three most important product attributes to attract and keep customers. [Rank three]



Source: CRB

Other industry studies bear this out. In their 2022 Food & Health Survey, for example, the International Food Information Council (IFIC) reported that consumers rank sustainability below many other purchase drivers, with just 39% considering it a top priority. It's not *un*important—in fact, that same IFIC study indicates that Gen Z consumers give much more weight to environmental impacts than previous generations. But will a sustainability claim alone justify a premium price? Unlikely.

So what can manufacturers do to de-risk their quest for premium status?

Invest in your product's nutritional and functional properties

This market appears to perceive nutritional and functional properties as far less important than sustainability when it comes to premium-worthy marketing claims (Figure 2.7). This may be a missed opportunity. The traditional dairy market offers many examples of companies that leverage "lactose-free" and similar claims to earn their premium position. They've invested in an ultrafiltration process that opens the door to claims like "more protein" and "less sugar." On recent visits to our local grocery stores, we priced ultra-filtered milk at anywhere from 23% to 110% higher than non-premium milk, gram for gram.

In addition to nutritional claims, investing in your product's functional properties could also help you develop another important attribute: a clean label deck, ranked the top customer attraction factor by manufacturers in this segment (Figure 2.8).

Leverage food safety claims

Customers looking for alternatives to traditional protein sources may find fermentation-derived products more familiar and easier to accept than, say, animals raised in feedlots. Use that to your advantage by adding safety-related language ("no hormones," "GMO-free") to your marketing messages.

Third-party programs like the Global Food Safety Initiative's Safe Quality Food (SQF) certification scheme can also generate traction in the marketplace. That's particularly true if you're planning to sell your products to other food and beverage companies who recognize the rigorous food safety and ethical standards behind such a stamp of approval.

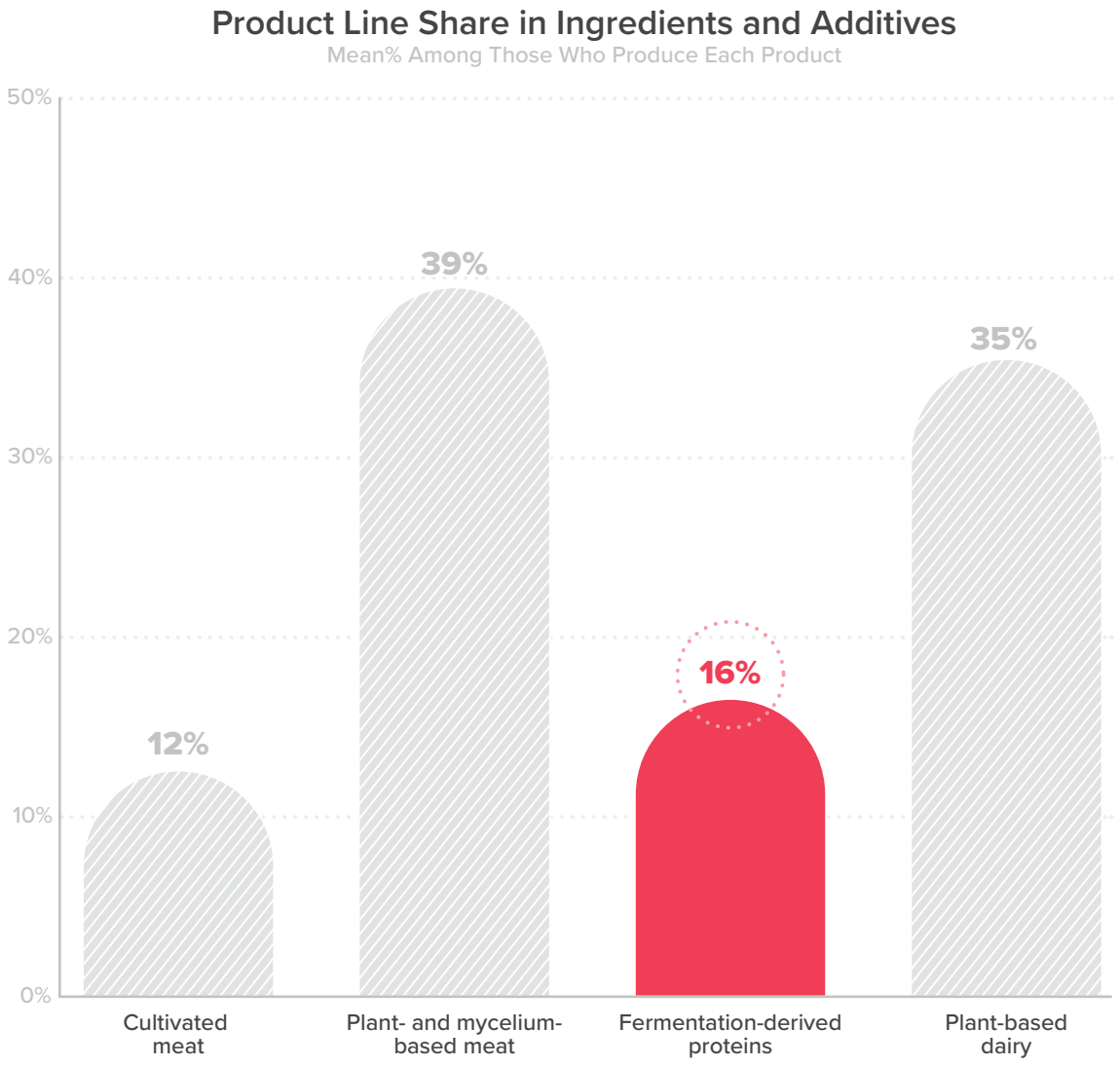
This brings us to our final recommendation—one that takes us out of the realm of the consumer marketplace and into a potentially more lucrative market.

Lean into ingredients and additives

Only 16% of respondents in this segment sell their products as ingredients and additives (Figure 2.9). This could be a lucrative pathway; by selling a bulk ingredient instead of a finished product, you're free to develop a simpler manufacturing model that's relatively insulated from the turbulent dynamics of the alternative proteins marketplace. If your product's functional properties are well-developed and competitively designed, you're in an even better position. A protein powder that mixes more efficiently than a competitor's ingredient, for example, could be a game-changing differentiator for co-packers seeking to optimize a high-throughput process.

FIGURE 2.9

What percentage of your company's product lines are considered the following?



Source: CRB

For many manufacturers, the only price-of-entry for the ingredients and additives market is a shift in packaging capabilities. Given that 71% of respondents already intend to invest in downstream technologies (Figure 2.3), the opportunity for this shift is there—and it's an investment that could expand your flexibility and commercial resilience. By simply adding the capability to handle two or three bulk formats in your packaging line, you could potentially sell to any business that needs your ingredient. In contrast, a packaging station designed to fill small, resealable pouches or single-serve cartons is only good as long as that's what consumers want.

Where speed meets strategy

“Go slow to go fast.”

If our industry overuses those words of wisdom, it’s only because they’re often true—never more so, perhaps, than in this case. Manufacturers producing fermentation-derived proteins have managed to outpace every other alternative proteins market on their way to commercialization, according to our survey data. But maintaining that speed will become more challenging as they face complex decisions on the way to price parity and a winding path to premium status.

To succeed, manufacturers in this market need a line of sight far into their future, helping them right-size today’s choices for tomorrow’s evolving demands.

Plant- and mycelium-based meat:

The industry's shift from passion to pragmatism

By: Jason Tucker and Tony Moses, PhD

Since its origin as a mission-driven movement to save the planet, the plant- and mycelium-based meat industry has tempered into a mature market segment focused on ambitious pipeline growth and commercial success.

If you've been monitoring recent news from this market, such a statement may seem surprising. Slumping sales, large-scale layoffs, and headlines featuring words like "underperforming" and "beleaguered" paint a grim picture. But our survey of the alternative proteins market, which includes the perspective of more than 100 plant- and mycelium-based meat manufacturers, reveals a much more nuanced—and far more encouraging—story. In particular:

- **More than one in three** alternative protein companies are planning to add plant- and mycelium-based products to their portfolio.
- **Two-thirds** of manufacturers with these products already in production are relatively small ventures, with less than $100 million in annual revenue.

These results suggest that the plant- and mycelium-based market is far from lagging; in fact, it's a powder keg of potential. To transform that potential into commercial longevity, these companies need the business-focused strategies that underpin the traditional food and beverage market. Companies are broadening their raison d'être beyond the passion that got them started and into a more capital-driven, commercially competitive position. In short, they're savvier—and that savviness is having a positive effect across the industry.

There's still room for improvement, though. To position your own plant- or mycelium-based company for success in this rapidly evolving market, our survey results indicate that you should focus on three key areas in particular:

1. The resilience and reliability of your sustainability strategy
2. Your readiness for long-term scalability
3. Your approach to capital project planning and digitalization

AREA OF FOCUS #1

The resilience and reliability of your sustainability strategy

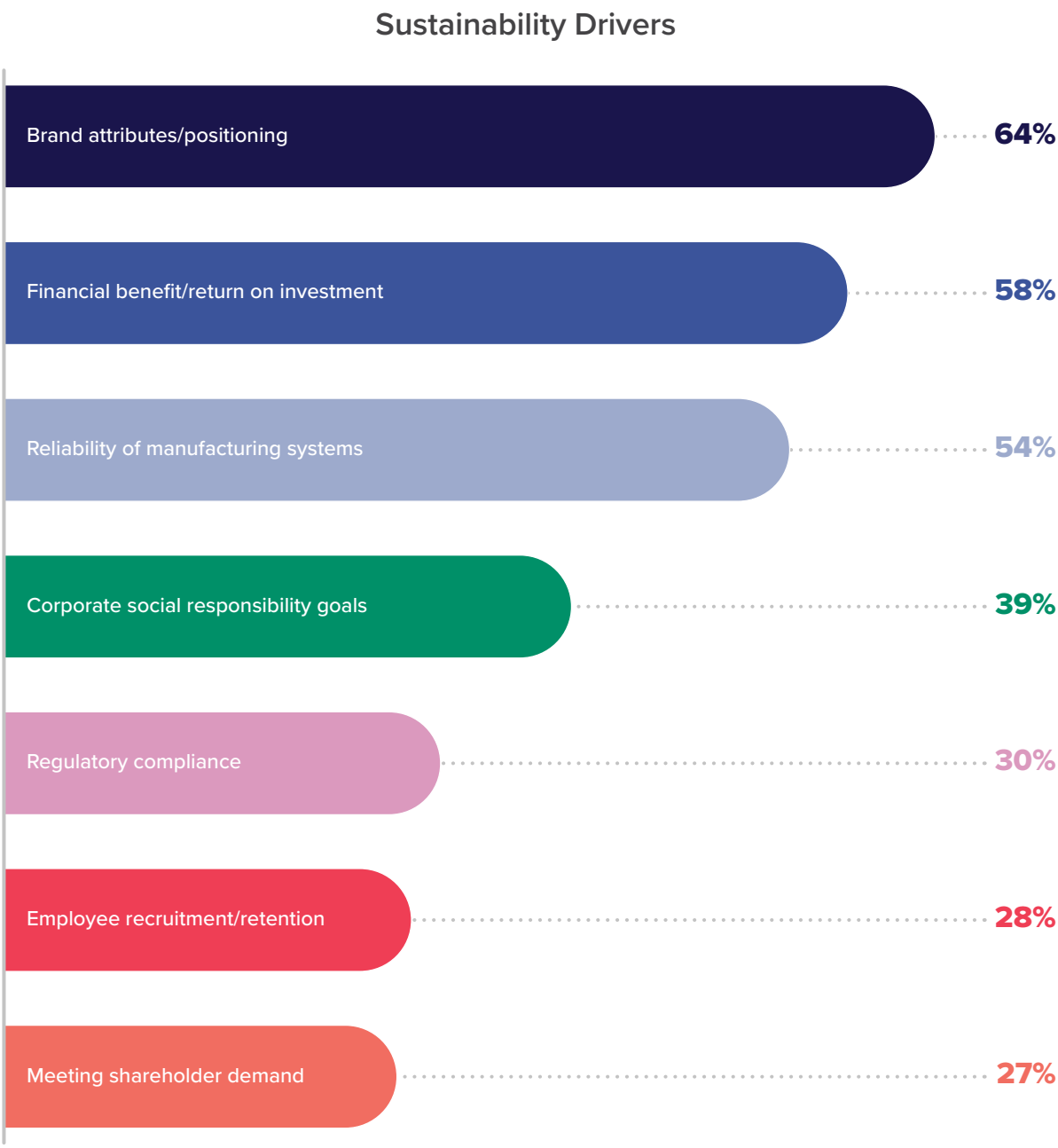
Key observation:
This market's vision of sustainability is generally grounded in pragmatic strategies, but there's still room for improvement.

Takeaway:
Before investing in hot new technologies, make sure you've mastered the fundamentals: reduce your energy load, reuse key resources, and recycle materials as much as possible.

Look to Figure 3.1 for one of the most notable indicators that plant- and mycelium-based manufacturers are developing their savvy. When asked what's behind their push for sustainability, this market's top three responses (brand, ROI, and system reliability) are focused on the health of their business at least as much, or more, as the health of the planet. The concept of social responsibility, once a bulwark of this passionate market, sits in the unremarkable middle of the pack—nice to have, but not a top driver.

FIGURE 3.1

What are your company's top three drivers for sustainability? [Select three]

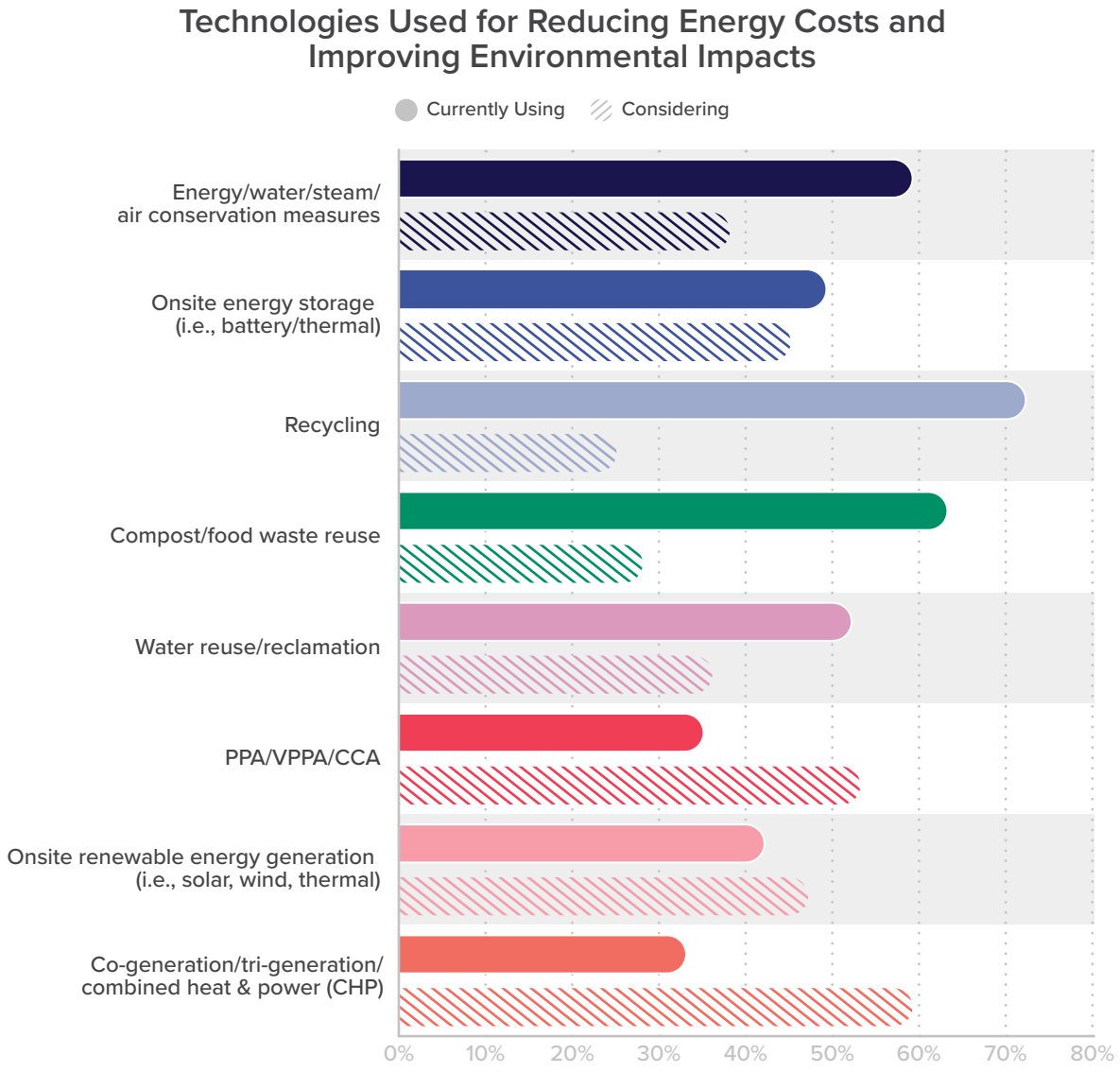


Source: CRB

It's not as though this market has given up on sustainability as a moral imperative, though. Instead, these manufacturers understand that for it to happen in a meaningful way, it must be profitable. That's likely why we see such practical technologies ranked highly on their list of energy reduction measures (Figure 3.2).

FIGURE 3.2

What technologies is your company using or considering using as a means of reducing energy costs and improving environmental impacts?

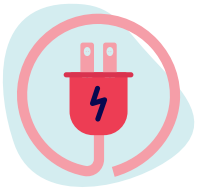


Source: CRB

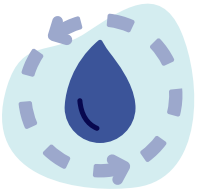
More can be done, however. Look at the trend coded into Figure 3.2: Reliable solutions are not quite as prevalent as they ought to be, while riskier endeavors may be creeping into the mainstream. To generate long-term impact from their investment in sustainability, manufacturers in this market ought to consider the long-term impacts of this trend, with close attention on where they're focusing their efforts, and what they might be overlooking. If you want to maximize the sustainability of your next capital project, take this advice into consideration:

Go back to the basics

Though they rank near the top of the list, we were surprised not to see more uptake of energy-reducing strategies that ought to be non-negotiable. Ideally, 100% of respondents should be invested in:



Energy/water/steam/air conservation (52% currently using): This is one of the lowest-hanging fruits on the list. Even a solution as simple as sensors to monitor for compressed-air leaks, supported by a low-cost repair strategy, could generate significant savings over the lifetime of a manufacturing plant.



Water reuse/reclamation (52% currently using): Plant- and mycelium-based food processing relies on large volumes of water relative to the volume of final product generated. Recovering that water for reuse in downstream food contact applications may be prohibitive, but there are many non-consumable solutions available. You could reclaim that water for use in your cooling towers or boilers, for example. Even redirecting it to flush your building's toilets could make a measurable difference in terms of how much water you send down the drain each year.

Recycling (72% currently using): With abundant solutions available for companies to redirect waste materials away from the landfill (including financially incentivized recycling programs for corrugate, as just one example), every manufacturer should have skin in this category.

When considering innovative solutions, keep your eyes on the long-term picture

We were surprised to see that nearly half of respondents in this market are actively investing in onsite renewable energy and a third are using co-generation, tri-generation, and combined heat and power (CHP) solutions. If you include those who are in the "consideration" phase, about 90% of respondents have a foot in each camp (Figure 3.2, above).

The perception that these technologies will attract big-ticket investors may explain some of this enthusiasm. That perception may be accurate—after all, talk of rooftop wind farms thrills the imagination more than a claim like, "We have a rational operating model that supports our commercial strategy."

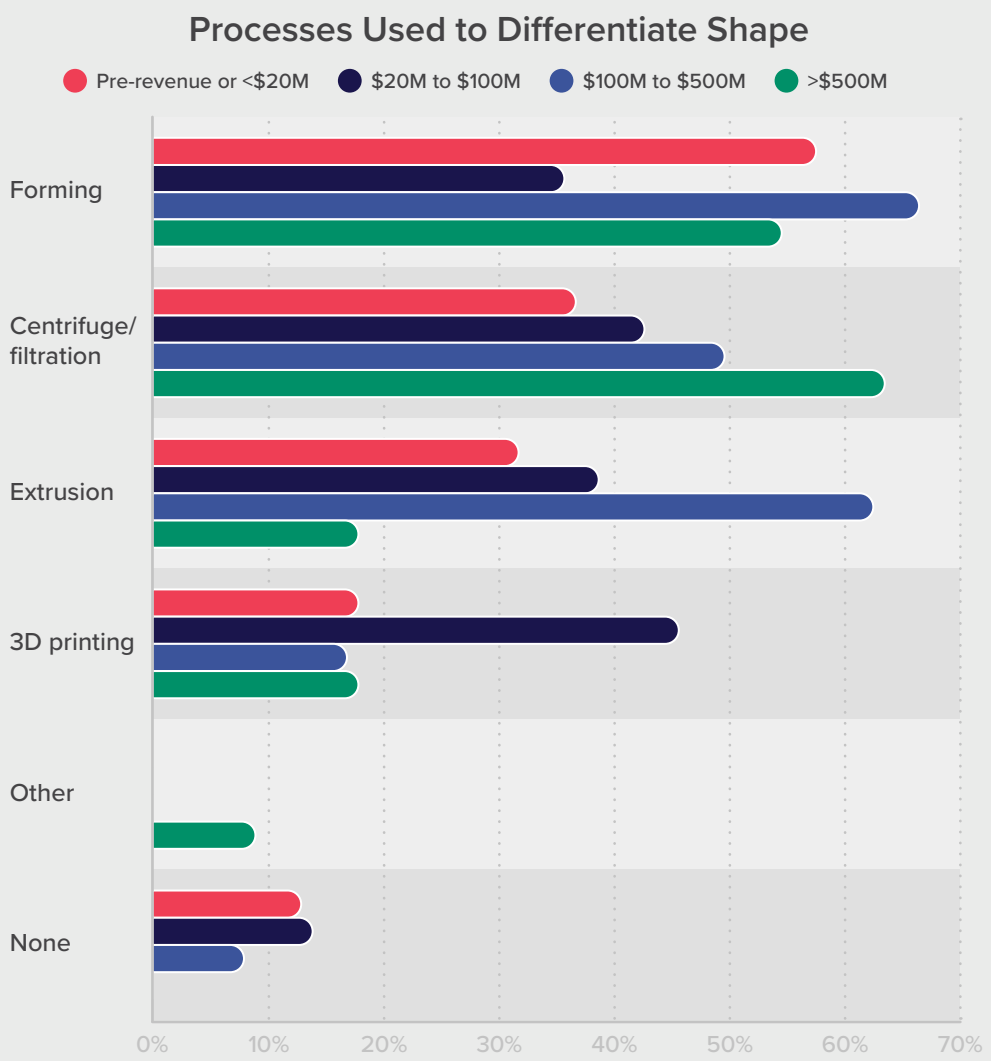
But these technologies aren't magic bullets, and we're concerned about the feasibility of managing what amounts to two different types of facilities in parallel: a commercial food manufacturing operation on one hand and a high-tech energy farm on the other. The first requires immense resources and expertise just to keep the processing equipment and critical systems running; the second requires a whole different set of skills. If you're a food manufacturer, adding renewable energy capabilities may not be in your line of business due to the complexity.

But it *is* important to the future of industrial energy conservation, and we aren't advocating against these solutions. Instead, we're suggesting that you go where 35% of this market has already gone: towards Power Purchase Agreements (PPAs), Virtual PPAs (VPPAs), and Community Choice Aggregation programs (CCAs).

THE CHALLENGE WITH NEW TECH? NEW PROBLEMS.
We observed a strong interest in 3D printing from smaller-sized companies in this segment (Figure 3.3).

FIGURE 3.3

Does your company use any of the following processes to differentiate the final product (i.e., shape it into the final product format)? [Yes, no]



Source: CRB

It's possible that this versatile technology could give up-and-coming companies a unique advantage as they grow—but it's equally possible that they'll find themselves constrained by a technology that hasn't yet been proven at commercial volumes, unable to scale it cost-effectively or efficiently. And like companies trying to solve energy conservation issues by venturing into the renewables industry, embracing in-house 3D technology requires a unique set of skills from beyond the food and beverage business.

Our advice: If you're set on experimenting, partner with specialists who can head up the technology side of your venture while your company brings the food manufacturing expertise. This one-two punch could be your gateway to reliable long-term success.

AREA OF FOCUS #2

Your readiness for long-term scalability

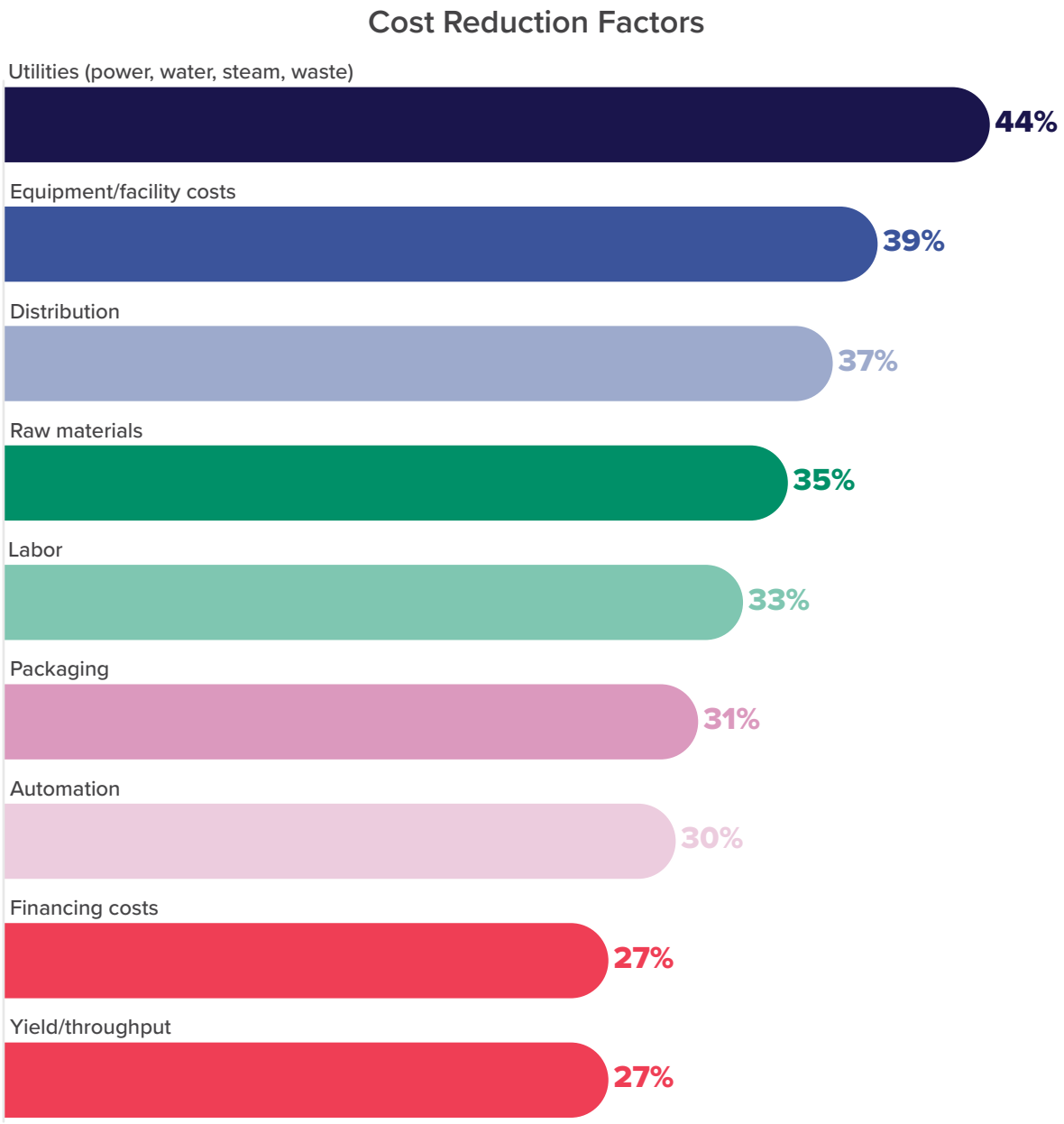
Key observation:
This market has a mature approach to cost control and appears to be scaling rapidly, though smaller companies would benefit from a clearer line of sight into their manufacturing future.

Takeaway:
If you're a small-scale manufacturer today, develop the habit of frequently questioning your assumptions about the best way forward. You could discover an opportunity you didn't know existed—and a new pathway to success in the broader food and beverage world.

Looking at this market from the perspective of commercial strategy, it's hardly distinguishable from any mature food and beverage vertical. For example, plant- and mycelium-based manufacturers have adopted the same cost-control approaches that we typically see across the larger industry (Figure 3.4).

FIGURE 3.4

Please rank the top three attributes from most to least important for your company's goals of reducing costs. % Selected as Important. [Rank three]

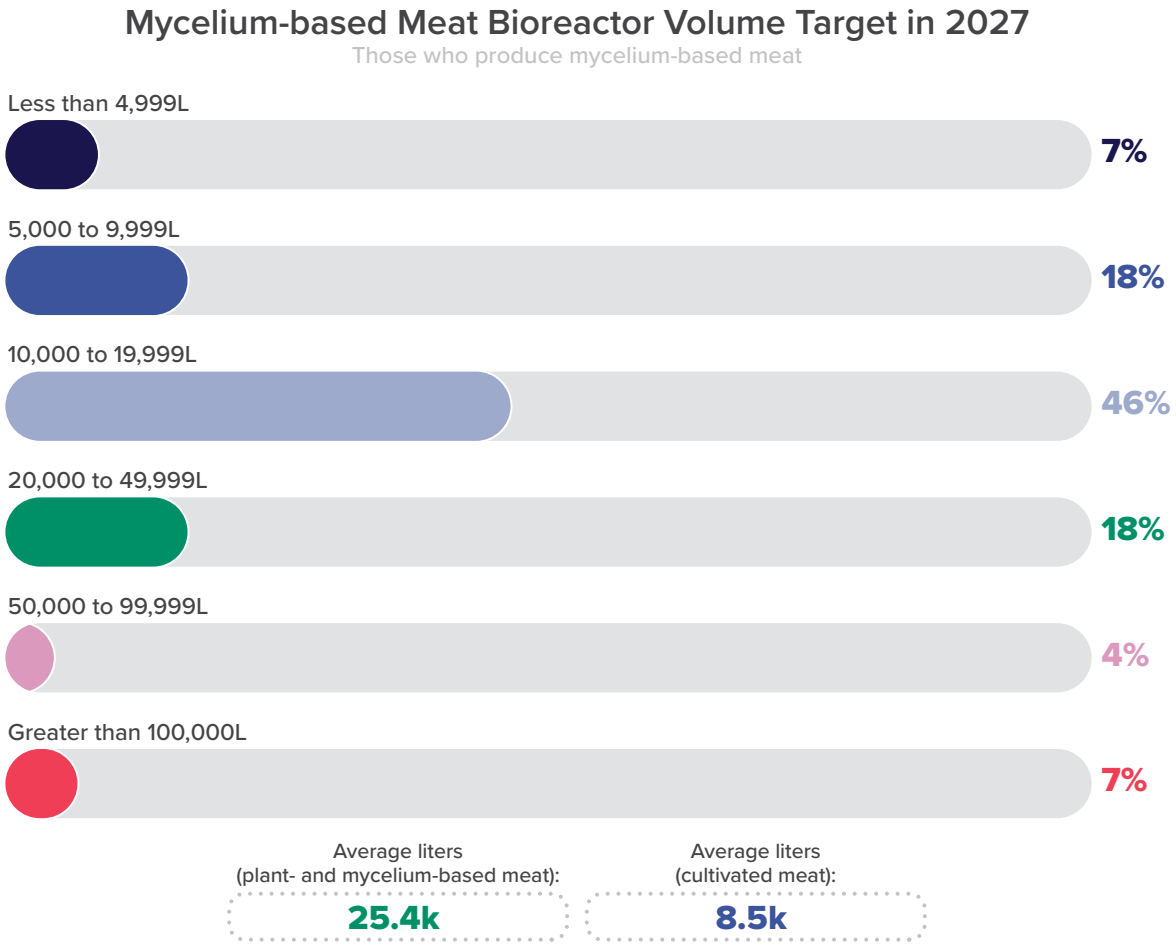


Source: CRB

This rational mindset has opened the door to rapid scale-up; despite the relative novelty of this submarket, mycelium-based meat companies are already averaging a bioreactor volume of 25,400L, with some even aiming for volumes north of 100,000L (Figure 3.5). Compared to cultivated meat manufacturers, this is an impressive feat—and a signal that respondents in this category are striving hard for commercial growth.

FIGURE 3.5

For mycelium-based meat production, what is your company's production bioreactor volume target in 2027? [Single select]

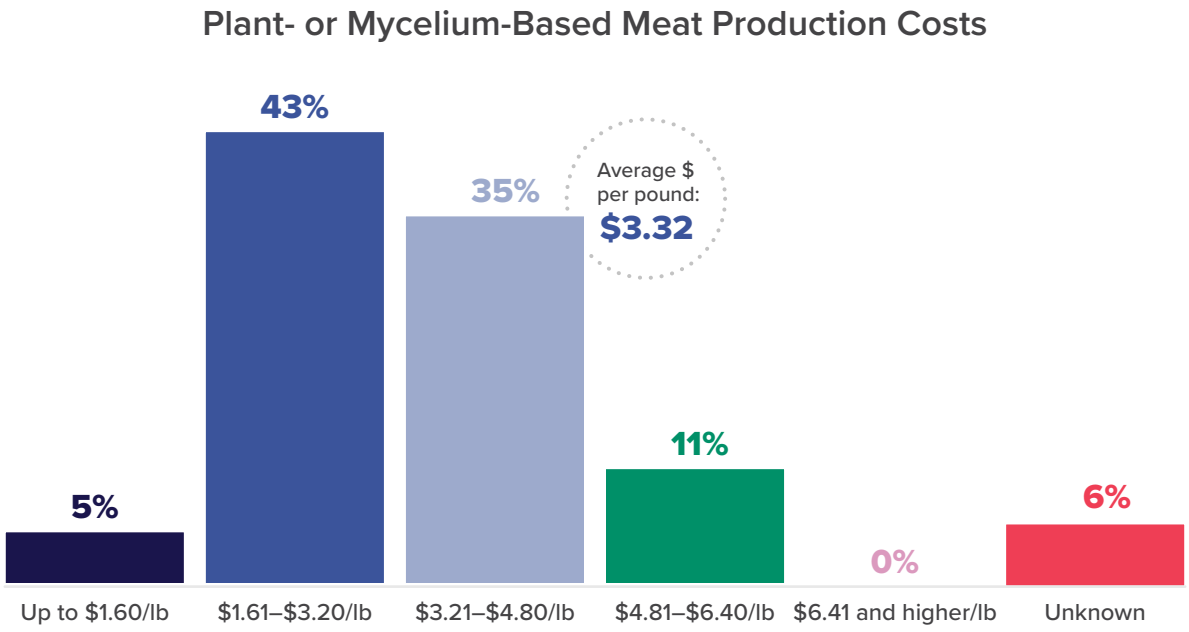


Source: CRB

Despite these indicators of achievement, though, the margin between production costs (Figure 3.6) and target consumer costs (Figure 3.7) remains unnervingly narrow. What can companies do to widen that margin and prepare themselves for resilience and growth in the broader food and beverage marketplace—particularly those who are still striving for a competitive position?

FIGURE 3.6

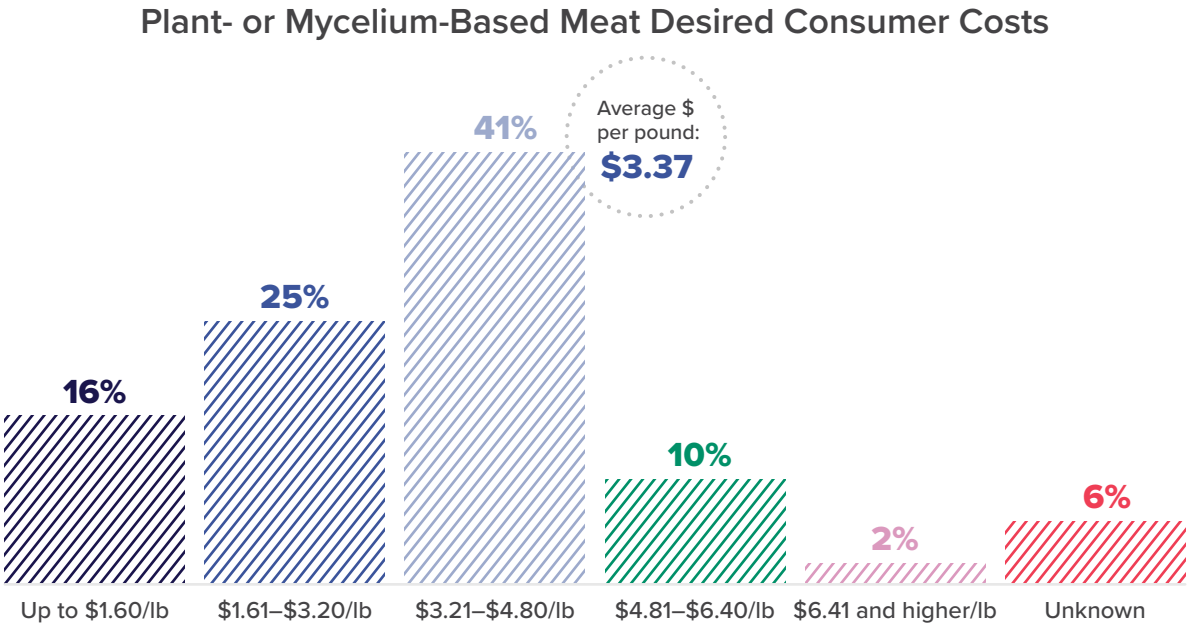
What is your company's current cost to produce per pound for plant- or mycelium-based meat? [Single select]



Source: CRB

FIGURE 3.7

What is your company's desired consumer cost per pound for plant- or mycelium-based meat? [Single select]



Source: CRB

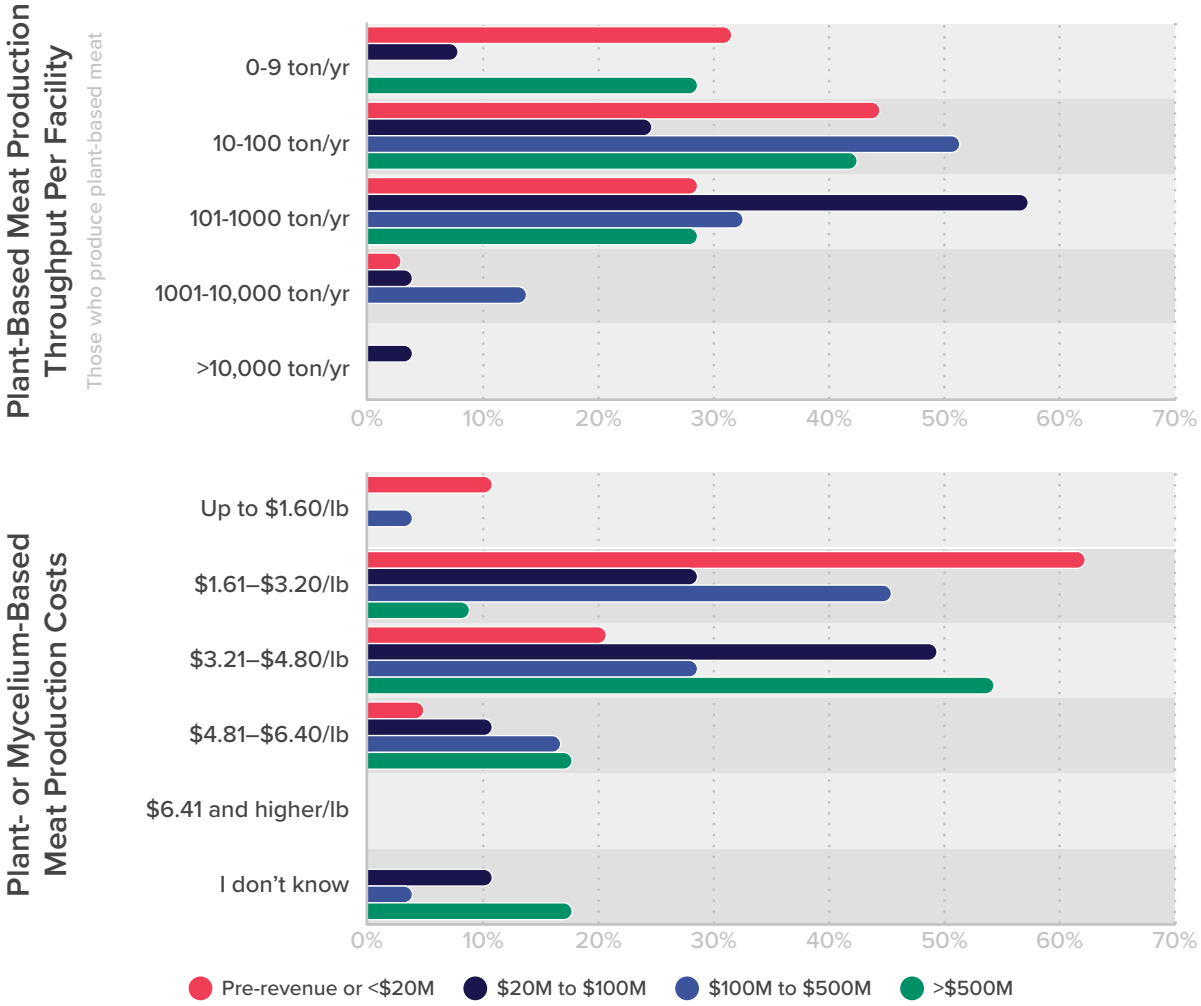
Build alignment between your target production volume and your target costs

When we cut the survey data along revenue lines, we noticed a surprising trend among companies who report less than $20 million in revenue or aren't yet earning revenue at all. Though they're targeting one of the lowest average throughput volumes, they're also reporting some of the lowest production costs (Figure 3.8). We'd typically expect to see production costs rise for lower-volume facilities. This suggests a misalignment between what these smaller-scale companies estimate as their average costs per unit of finished product, and what they may be paying in reality.

FIGURE 3.8

For plant-based meat production, what is the current average throughput for each facility in your network? [Single select]

What is your company's current cost to produce per pound for plant- or mycelium-based meat? [Single select]



Source: CRB

This uncertain relationship between throughput and costs comes up again when we examine throughput versus target costs for companies who are making at least 50% of their products internally. We'd expect those with a lower production volume to command a higher unit cost; as production swells toward commodity-level volume, that cost would typically come down. But the opposite is true here; at least up to a threshold of 1,000 tons per year (Figure 3.9).

FIGURE 3.9

Target Volume and Cost

Target production volume (ton/yr)	Average target consumer cost
0-9	$1.44
10-100	$2.72
101-1,000	$4.01
1001-10,000	$1.60

Source: CRB

What's going on here? The answer may fall somewhere in the gap between a company's mission and the reality of low-volume manufacturing.

If your mission involves going to market with a premium product, you need to prepare that product for close scrutiny in terms of its cosmetic and organoleptic attributes, and you'll need a commercial strategy resilient enough to withstand the changeable tastes of premium shoppers. From a facility perspective, be sure that your infrastructure and processes are set up to generate a profit at low volumes. You may also want to consider a future in which you pivot to the commodities market if a premium play just isn't profitable. By maintaining line-of-sight to a facility that's adequately sized for higher volumes, you can minimize the cost and complexity of such a pivot, if it becomes necessary.

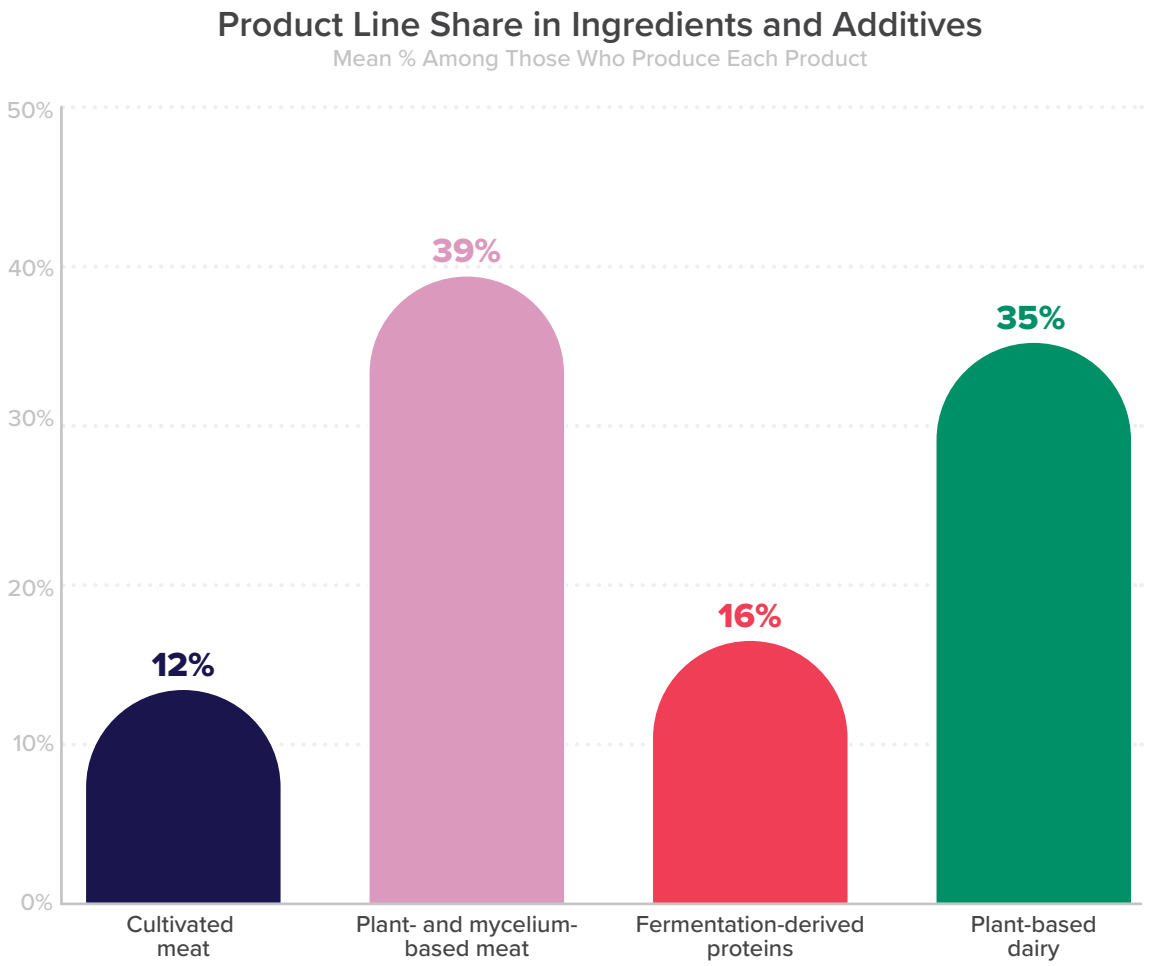
For most manufacturers, the commodities market may be less of a risky play. If you can establish yourself as a high-volume grocery staple, you're less vulnerable to the whims of the marketplace. But this pathway, too, requires a robust commercial strategy to help you navigate scale-up and distribution. Do you understand what

your target consumer is looking for? Do you understand the criteria that large retailers require of their suppliers, and are you positioned to meet it? Examining your strategy from these angles will help you to make decisions right now that will greatly improve your profitability and scalability in the future.

Consider a business-to-business (B2B) pathway, rather than business-to-consumer (B2C) Ingredients and additives make up a larger share of this market's product line than any other market we surveyed (Figure 3.10)—another indicator of this market's evolving maturity. If you're a smaller-scale B2C plant- or mycelium-based manufacturer, give this some consideration. Pivoting to the ingredients space could open a viable commercial opportunity for you. It would eliminate many of the challenges related to formulating, manufacturing, packaging, and marketing a finished product, and it may position you as an attractive asset to a larger entity, if consolidation is your ultimate exit strategy.

FIGURE 3.10

What percentage of your company's product lines are considered the following?



Source: CRB

Operating as a B2B manufacturer does introduce its own challenges, though. In the consumer marketplace, the product that emerges from your facility and sits on store shelves is your showpiece; in the B2B world, that scrutiny shifts to your facility itself. Under pressure to protect consumer health and stay on the right side of responsibility-of-ownership laws, co-packers and other potential manufacturing partners will only work with companies that operate world-class facilities in terms of efficiency, cleanliness, and regulatory compliance.

To help bolster your profile in the B2B world, you can follow the example already set by 85% of respondents in this market by acquiring a Safe Quality Food (SQF) certification. This type of third-party recognition holds weight among B2B food manufacturers and the agencies who regulate them, while self-generated marketing—such as a website—does not. For the quarter of respondents focused on an e-commerce play, this may be an important factor to keep in mind.

AREA OF FOCUS #3

Your approach to capital project planning and digitalization

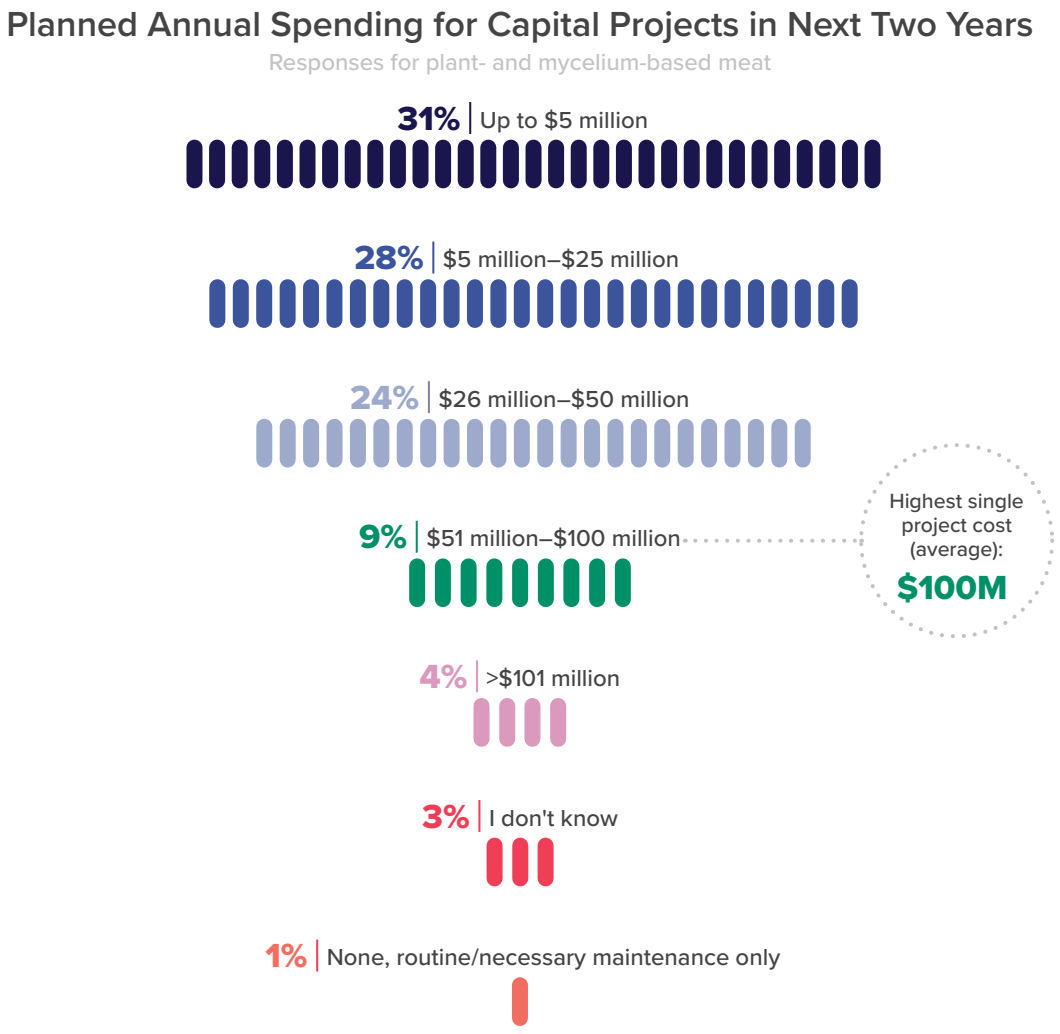
Key observation:
The correlation between average capital spending and the number of companies planning new and expanded facilities indicates a well-honed approach to project delivery.

Takeaway:
Companies still in their early stages, with years of rapid capital expansion ahead, should seek out the in-house or external expertise necessary to plan and manage a future-proof CapEx strategy.

More than a third of companies in this segment plan to spend more than $25 million on capital projects in the next two years; about the same proportion have $100 million earmarked for their highest single project cost (Figure 3.11).

FIGURE 3.11

What is your company's planned average annual spending for capital projects, for each of the next 2 years? [Single select]



Source: CRB

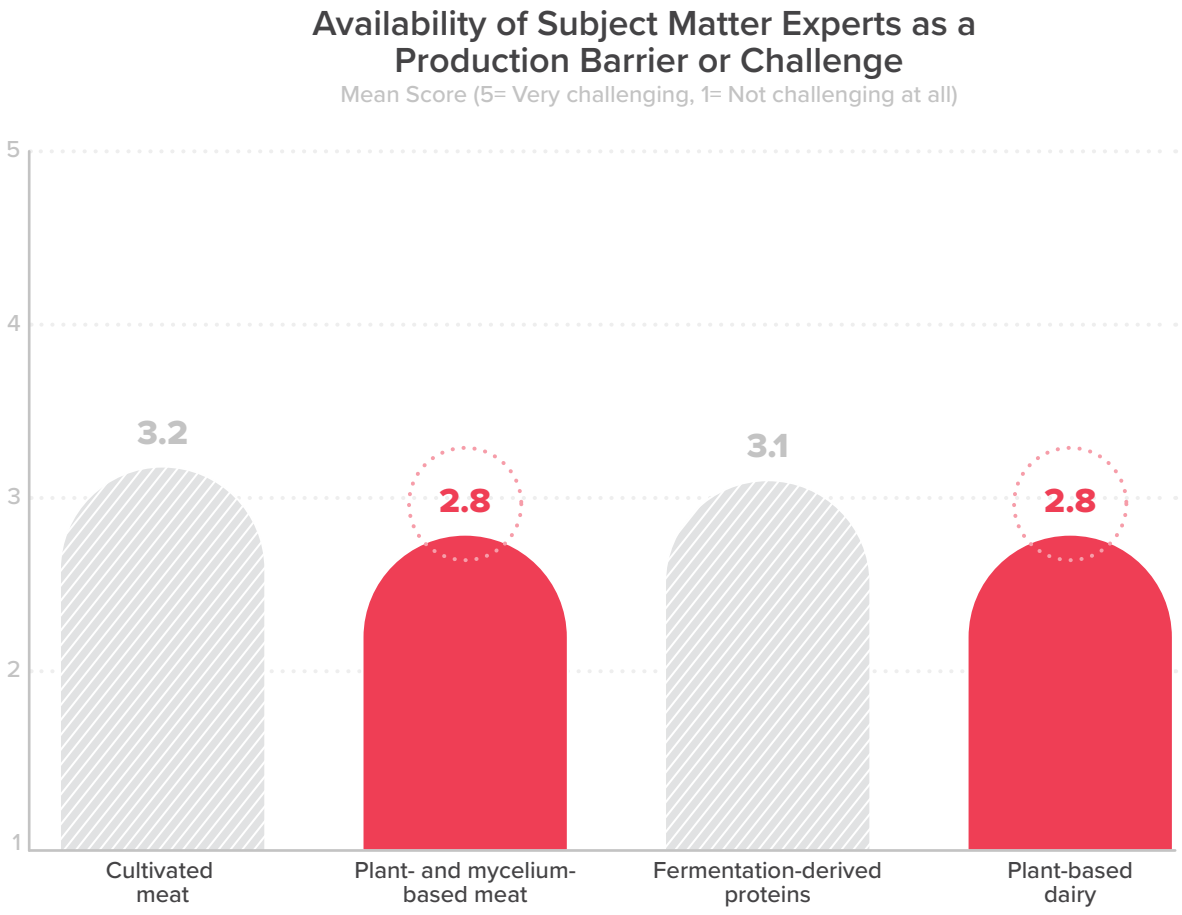
This is right in line with what we'd expect from a market in which 41% are planning to expand their facility or build a new one. These numbers suggest that companies in this space have experience managing large CapEx projects, and they know what's realistic. What will it take for smaller, less experienced companies to lift themselves to the same elevated perspective?

Be honest about internal knowledge or skills gaps, and bridge those gaps through external partnerships

When we asked each of our surveyed markets about their production barriers, plant- and mycelium-based manufacturers *and* plant-based dairy manufacturers ranked "availability of subject matter experts" as equally low (Figure 3.12).

FIGURE 3.12

How challenging are each of the barriers to production within your organization? [Rank each 1–5; 1 = not challenging at all, 5 = very challenging]



Source: CRB

There may be a good reason for this parallel experience: Unlike traditional meat and dairy manufacturers, who function in two very different worlds, there's significant crossover between these industries in the alternative proteins marketplace. Plant-based dairy and plant-based meat facilities share many of the same fit and finishes, cleanability standards, and operational steps, and it's not unusual for them to share the same parent company, either—in fact, over half of our survey respondents are active in both markets.

What does this mean for plant- and mycelium-based manufacturers who are planning their next capital project? It means you have two wells from which to draw specialized knowledge to help you scope, manage, and deliver a facility capable of generating long-term value. Take advantage of that opportunity by ensuring you have the right experts at the table from day one.

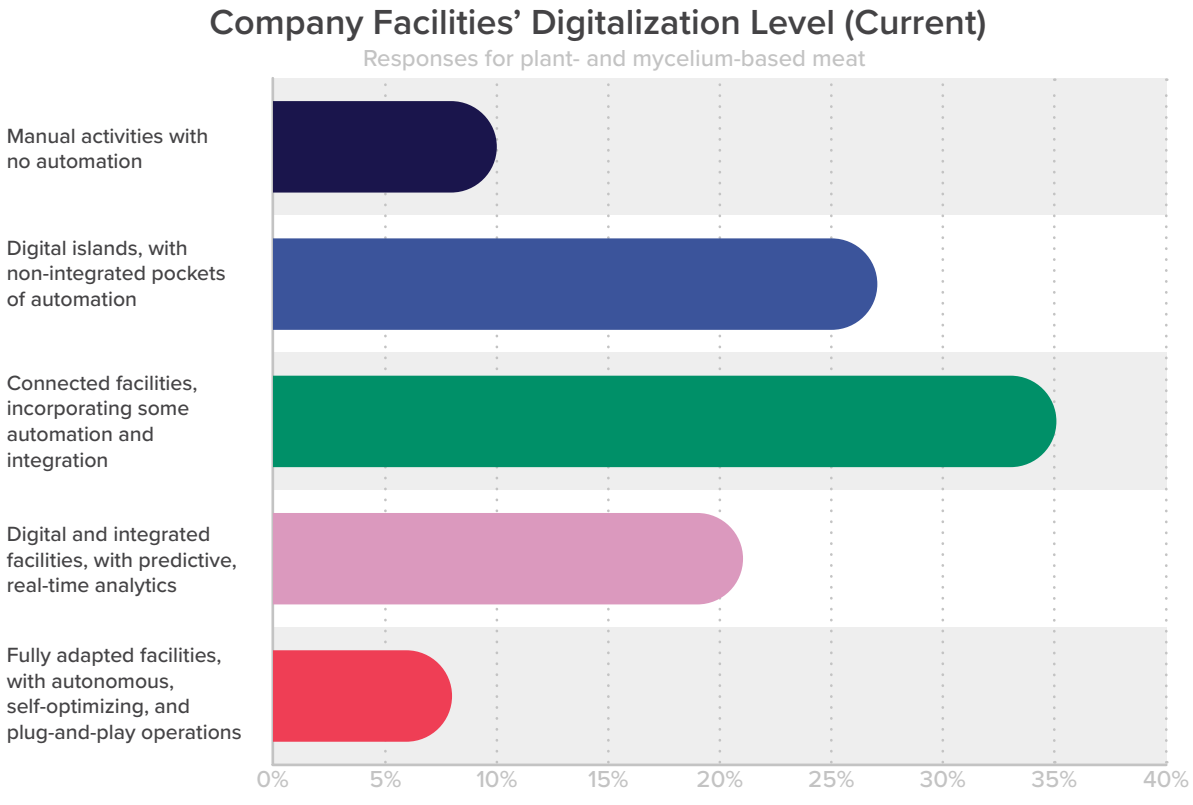
Establish a plan for integrating digital islands over time

That concept of generating long-term value from today's capital investment hinges on several factors, including—perhaps most significantly—your digitalization strategy.

Our respondents in this market appear to be progressing steadily along the digital transformation pathway; nearly two-thirds have at least some level of integrated automation in place (Figure 3.13), and this is one of the most ambitious markets we surveyed in terms of planning for future integrations (Figure 3.14). This is good news from both a throughput perspective (more automation = fewer bottlenecks) and from the perspective of risk; mycelium-based manufacturers in particular are motivated to protect their sensitive fermentation process as much as possible through automation.

FIGURE 3.13

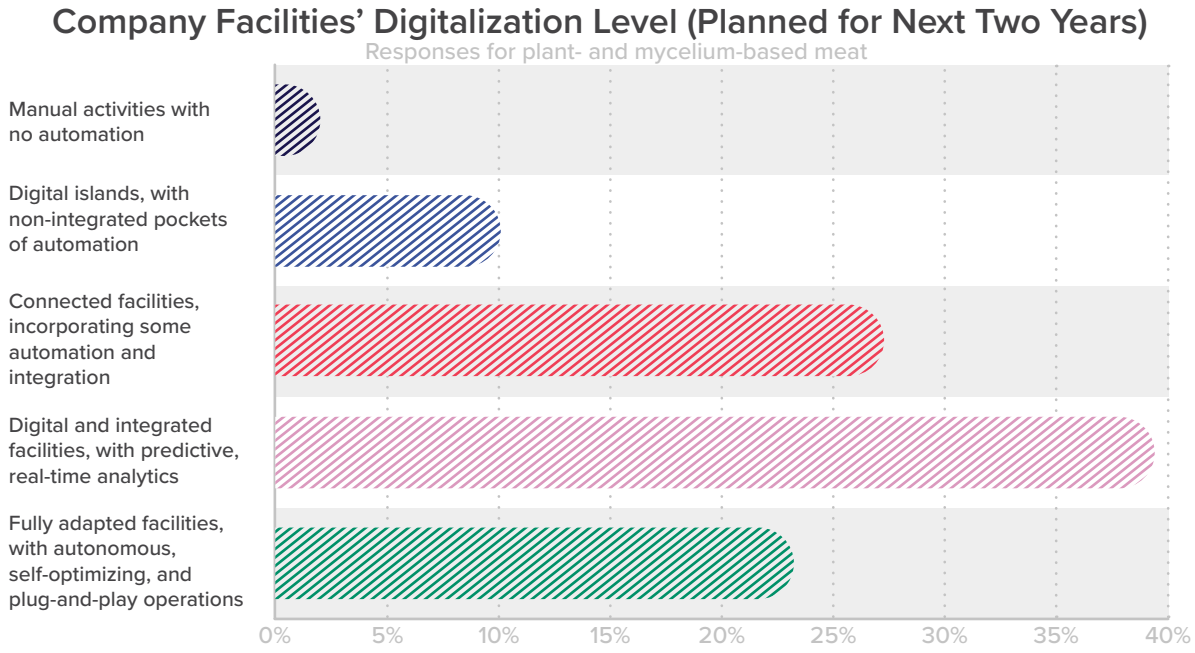
Regarding your current automation and control systems, what level of digitalization most accurately reflects the capabilities of your company's facilities? [Single select]



Source: CRB

FIGURE 3.14

What level of digitalization does your company expect to achieve in 2 years? [Single select]



Source: CRB

But digitalization is about much more than simply adding automated equipment to an established process. It's about developing a long-term digital strategy and atomizing it into discrete steps, then building those steps into your capital expansion strategy from the start. That could be as simple as running ethernet through your whole facility when you build it—the point is to right-size every decision to align with a future vision of end-to-end digital integration. The more you're able to do that from the start, the more cost-effective and attainable that future becomes.

How to win profits and influence the planet

The survey results are clear: if your mission is sustainability and you're a profit-driven company, you have to make sustainability itself profitable.

That reality is driving more plant- and mycelium-based companies to shift from "superhero mode" to a more achievable, commercial-ready position, akin to the most successful companies of the traditional food and beverage sector. And that's a good thing for these companies, for the people who seek out their products, and—potentially—for the planet itself.

Got milk. Now what?

From a position of hard-earned success, plant-based dairy producers are looking for their next big opportunity

By: Pablo Coronel, PhD and Jonathan Clark

Ask a manufacturer in any segment of the alternative proteins industry for the secret to commercial success, and you'll get diverse answers: innovation, automation, access to capital, consumer research—it's a long list.

There's one factor that you don't often hear about, at least not directly: *time*.

Unlike other segments we surveyed for this report, plant-based dairy producers have had time to master their fundamental product: fluid milk alternatives. Time to resolve the scalability challenges of early growth. Time for subject matter expertise to cross-pollinate between companies. Time to establish a strong reputation among consumers.

This head start gives these producers a unique position in the broader landscape of alternative proteins. Of all the submarkets we studied for this report, plant-based dairy producers have:

- **The highest** growth target for the next two years
- **The largest** proportion of fully adapted digital facilities
- **The lowest** annual CapEx budget on average

These results indicate an ambitious and well-established industry backed by a portfolio of existing facilities. There's also a recent FDA victory to celebrate: In February of this year, the regulatory agency issued draft guidance approving use of the word "milk" on plant-based dairy products, alongside a qualifier (such as

“oat milk” or “almond milk”). Although this draft guidance acknowledges a gap in consumer education (manufacturers are encouraged to identify their product’s nutritional deficiencies relative to traditional milk on their label), it’s also an indicator that the plant-based dairy industry is mature, ubiquitous, and not going anywhere.

However, despite this strong position, continuous success isn’t guaranteed—and these manufacturers are savvy enough to know it. Their survey answers point to three areas of particular concern and consideration: pipeline expansion, food safety, and automation. Developing a robust strategy that integrates all three factors is the key to their commercial future.

PIPELINE EXPANSION

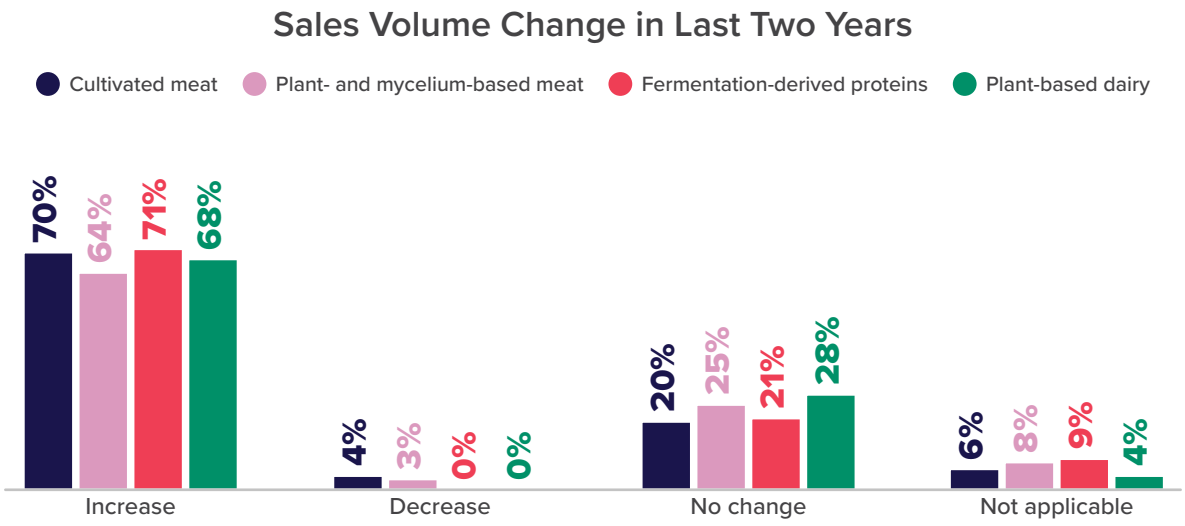
Plant-based dairy producers are shifting their focus from “How can we make more?” to “How can we get it to more people?”

Of all the segments we surveyed, plant-based dairy producers are more likely than any other group to report no change in sales in the recent past—and yet they’re targeting the highest annual growth over the next two years (Figure 4.1). Nearly 90% plan to meet that growth by increasing their manufacturing capacity. This tension between past and projected performance is fertile ground for innovation; it’s as though these producers are saying, “Now that we’ve successfully stabilized our position in the market, let’s have some fun.”

Plant-based dairy producers have a
28%
annual growth target
over the next two years

FIGURE 4.1

How has your sales volume changed over the last two years? [Single select]

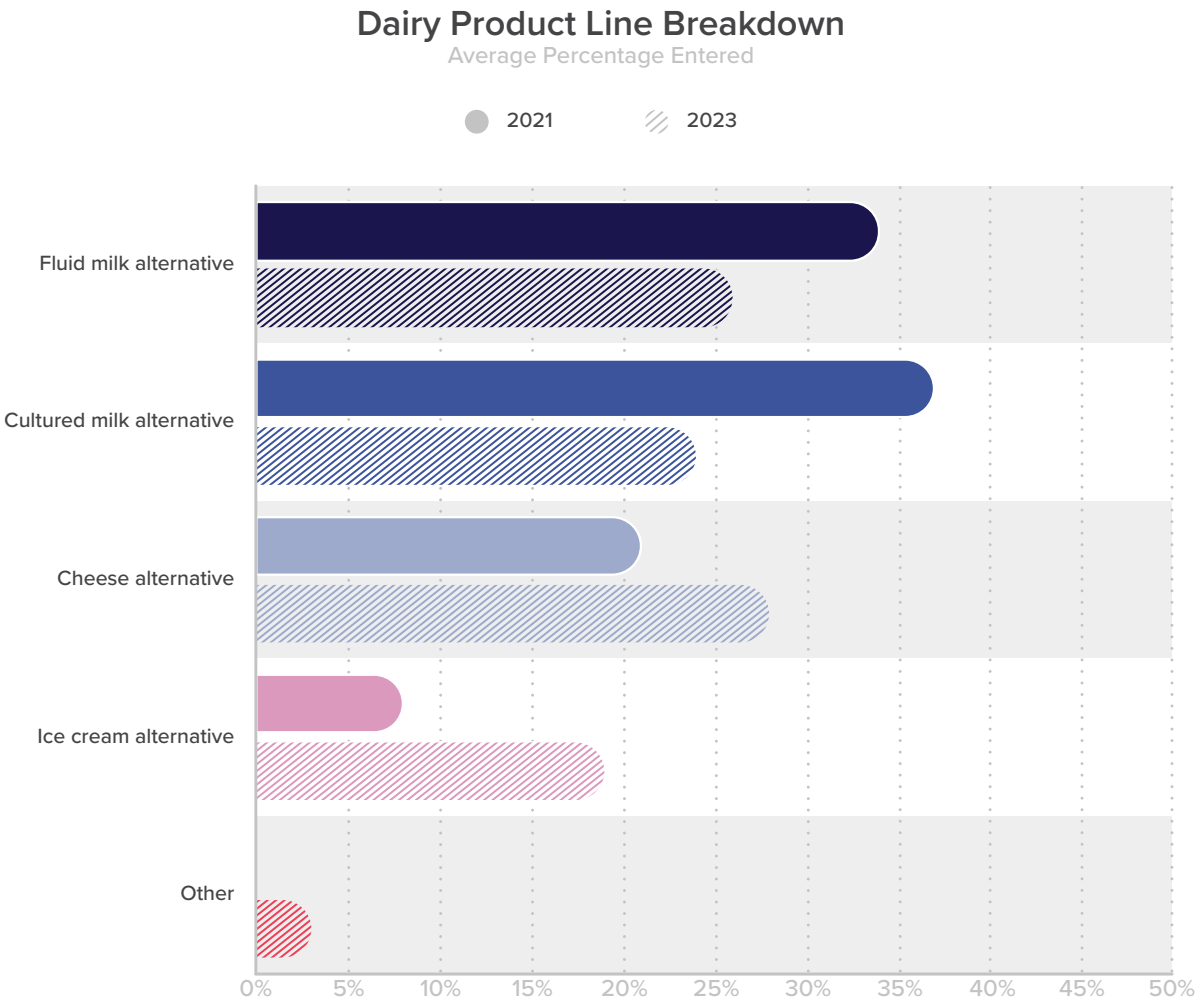


Source: CRB

This spirit of innovation could involve tweaking existing formulations in response to consumer trends ("Lower fat!", "Excellent source of Omega-3s!"), but we're also seeing evidence of a more substantial appetite for change. Since our last market survey in 2021, ice cream production has more than doubled, a sour cream alternative has hit the market, and cheese alternatives have overtaken all other products to claim the top production spot (Figure 4.2).

FIGURE 4.2

Compared to your entire product line, what percentage of the following dairy products does your company manufacture?



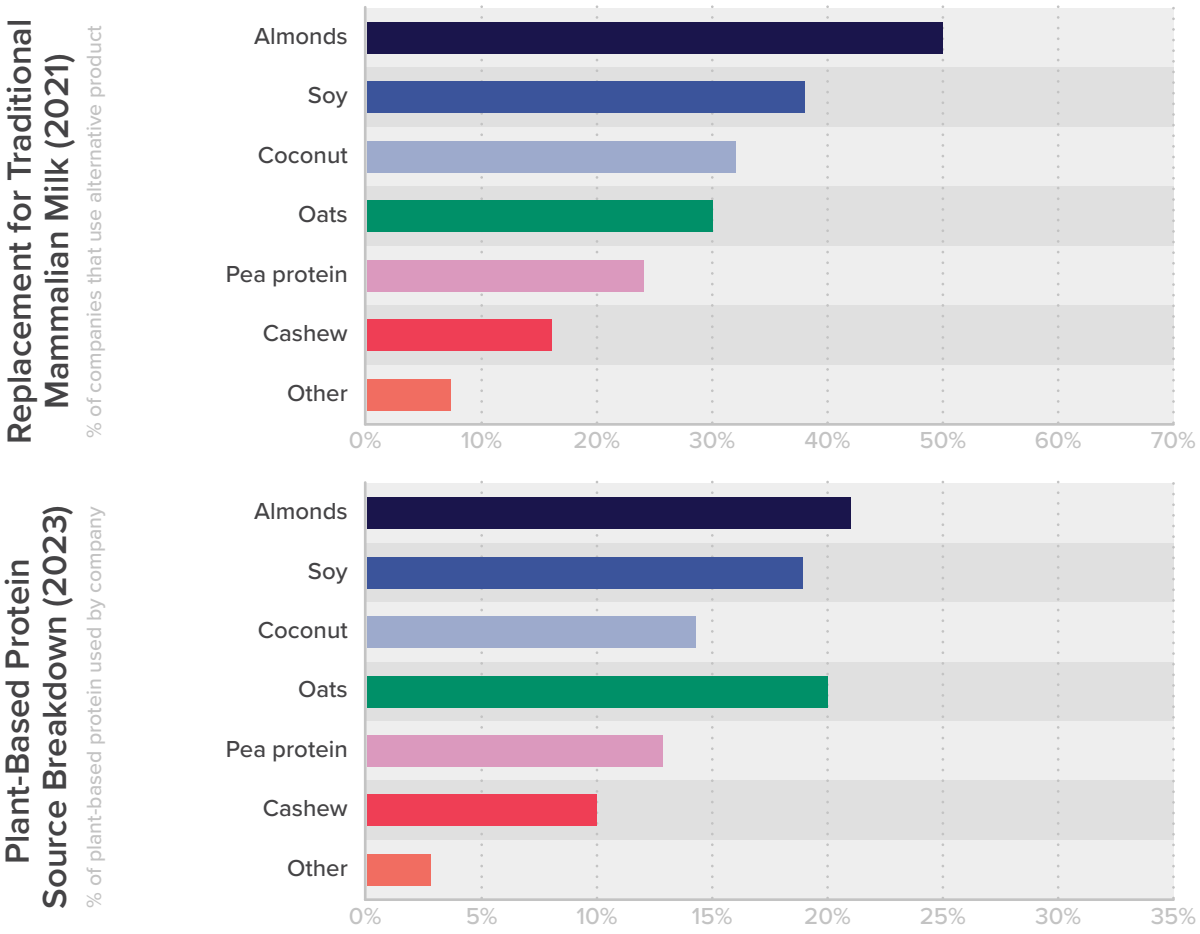
Source: CRB

We're also noting important shifts in producers' choice of source protein. The reign of soy and almonds has gradually tempered while other base ingredients such as oats, cashews, coconut, and pea protein are attracting more attention (Figure 4.3).

FIGURE 4.3

What does your primary product use to replace traditional mammalian milk? [Multi select]

What percentage of plant-based protein sources does your company use for the production of plant-based dairy? [Single select]



Source: CRB

This data indicates a growing sense of confidence in the industry. Plant-based dairy producers have had time to monitor the marketplace and understand their customers—what they're buying, what they aren't, and which new flavors or formulations are most likely to receive their approval. This confidence—and the experimentation that follows—reminds us of historic shifts in the established food and beverage industry, such as when the traditional dairy pipeline expanded to accommodate the Greek yogurt boom.

As they lean into this future of pipeline diversity, what lessons can plant-based dairy producers draw from that wider industry—and how can they position themselves for market growth?

Takeaway #1:

The key to reaching more consumers may be less about what you're offering, and more about how you offer it.

Although experiments in formulation and ingredient selection continue, our survey data points to another, more significant trend underway: the pursuit of improved and expanded packaging capabilities.

Manufacturers in this segment are more likely to invest in new packaging equipment than any other group we surveyed, and although they plan to spend less on overall capital projects than other manufacturers, their highest single project is $69 million on average—the second-highest in our survey (Figure 4.4). This tells us that the opportunity for a significant step change in downstream capabilities is high.

FIGURE 4.4

Is your company planning capital projects in any of the following areas in the next two years? [Multi select]

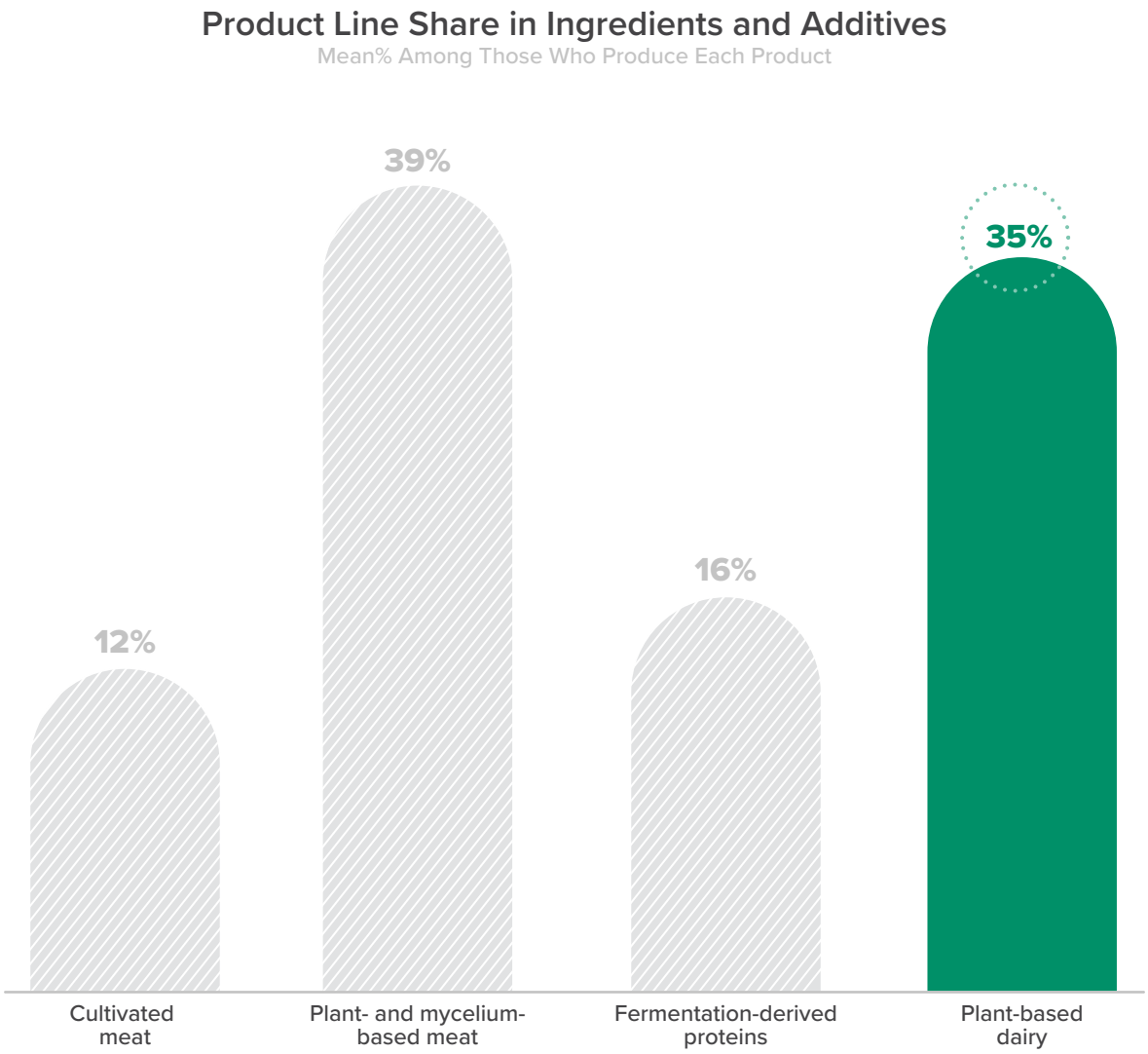
Source: CRB

To generate long-term value from that investment, it needs to be grounded in a robust commercial strategy. In our experience, that could mean:

Larger packaging formats to support business-to-business (B2B) distribution
More than a third of this segment operates in the ingredients and additives market (Figure 4.5). Interestingly, about the same proportion distribute their product in a shelf-stable format (Figure 4.6). Where these two strategies meet—selling shelf-stable ingredients to other manufacturers—lies a potentially lucrative opportunity for plant-based dairy producers with bulk packaging capabilities.

FIGURE 4.5

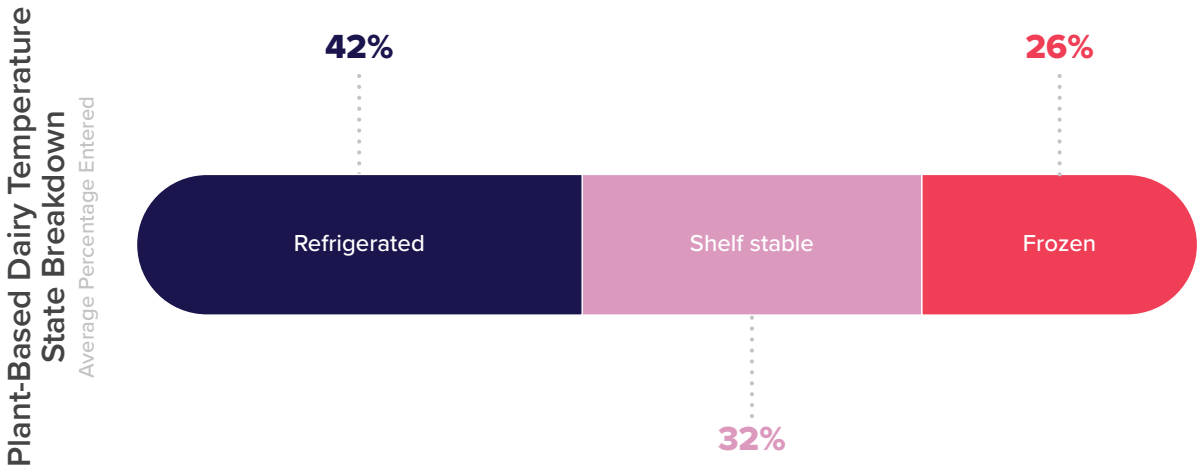
What percentage of your company's product lines are considered the following?



Source: CRB

FIGURE 4.6

What percent of your company's plant-based dairy product is sold in the following temperature states?



Source: CRB

Instead of selling a single product to consumers whose tastes and preferences may change rapidly, you're selling a base ingredient that your manufacturing partners can use across a diverse product pipeline. And if that ingredient is shelf-stable, your distribution area won't be constrained by cold-chain logistics, giving you an even more resilient and flexible position in the B2B landscape. This strategy may also help you to lower your marketing budget, increase your downstream efficiency, and keep your business resilient in case of unforeseen changes in the marketplace.

Smaller package formats to reach new markets

At the other end of the packaging spectrum lies a different opportunity: investing in smaller, single-serve packaging capabilities optimized for institutional customers, such as hospitals and schools. If your product is cost competitive and meets the USDA's nutritional requirements, this could be a fruitful avenue both in terms of generating immediate revenue and, in the case of school distribution, establishing brand recognition and taste preferences among a future generation of consumers.

FOOD SAFETY

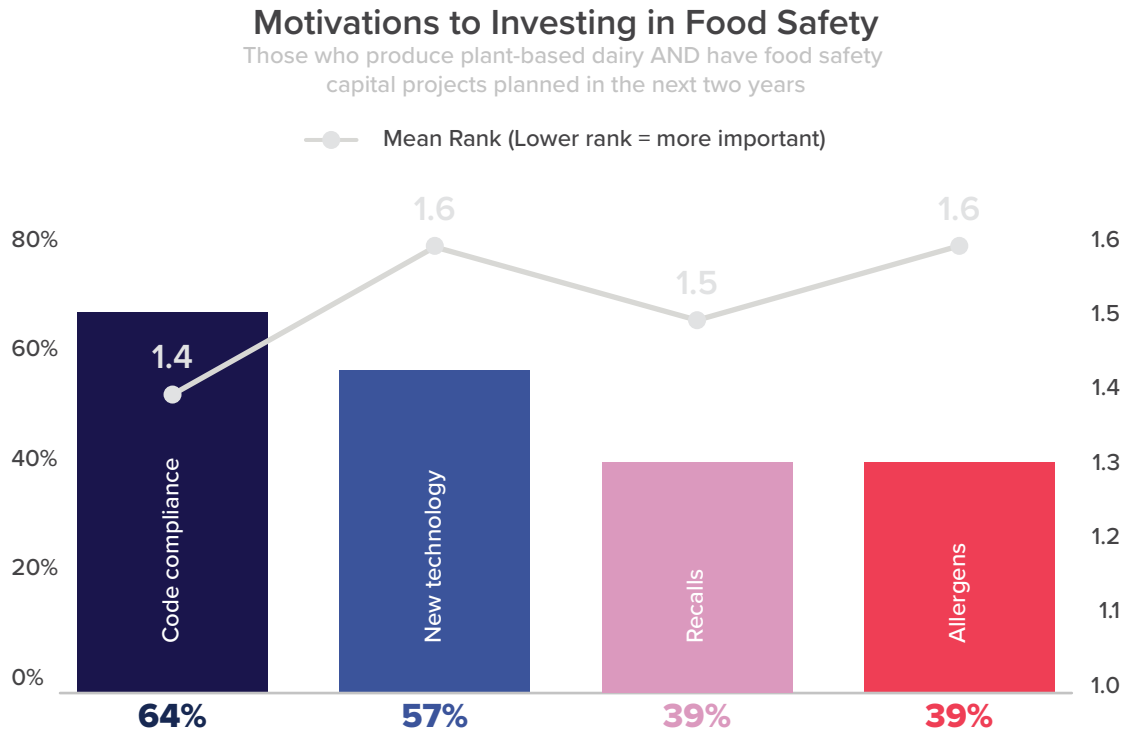
Producers should approach food safety as a continuous process—and adapt that process to meet the challenges of new product formats.

Along with new products come new food safety challenges. For all the plant-based dairy producers who are expanding their portfolio beyond fluid milk into cheese, yogurt, sour cream, ice cream, and other alternatives to dairy, this is an important consideration—and it may be the reason why this segment includes food safety upgrades among their top three capital project goals for the next two years (Figure 4.4, above).

When we looked more deeply at how this segment thinks about the safety-related considerations behind their capital spending, some interesting nuances emerge (Figure 4.7). Code compliance is a top driver; it could be that manufacturers are feeling pressure, given that the Food Safety Modernization Act's grace period has now expired and on-site inspections are ramping up following pandemic lockdowns. We also noted significant concern around managing allergens and preventing recalls, two other factors which could be driving this push toward code compliance.

FIGURE 4.7

What are the primary motivations behind your capital spending on food safety? [Rank up to two; 1=most important]

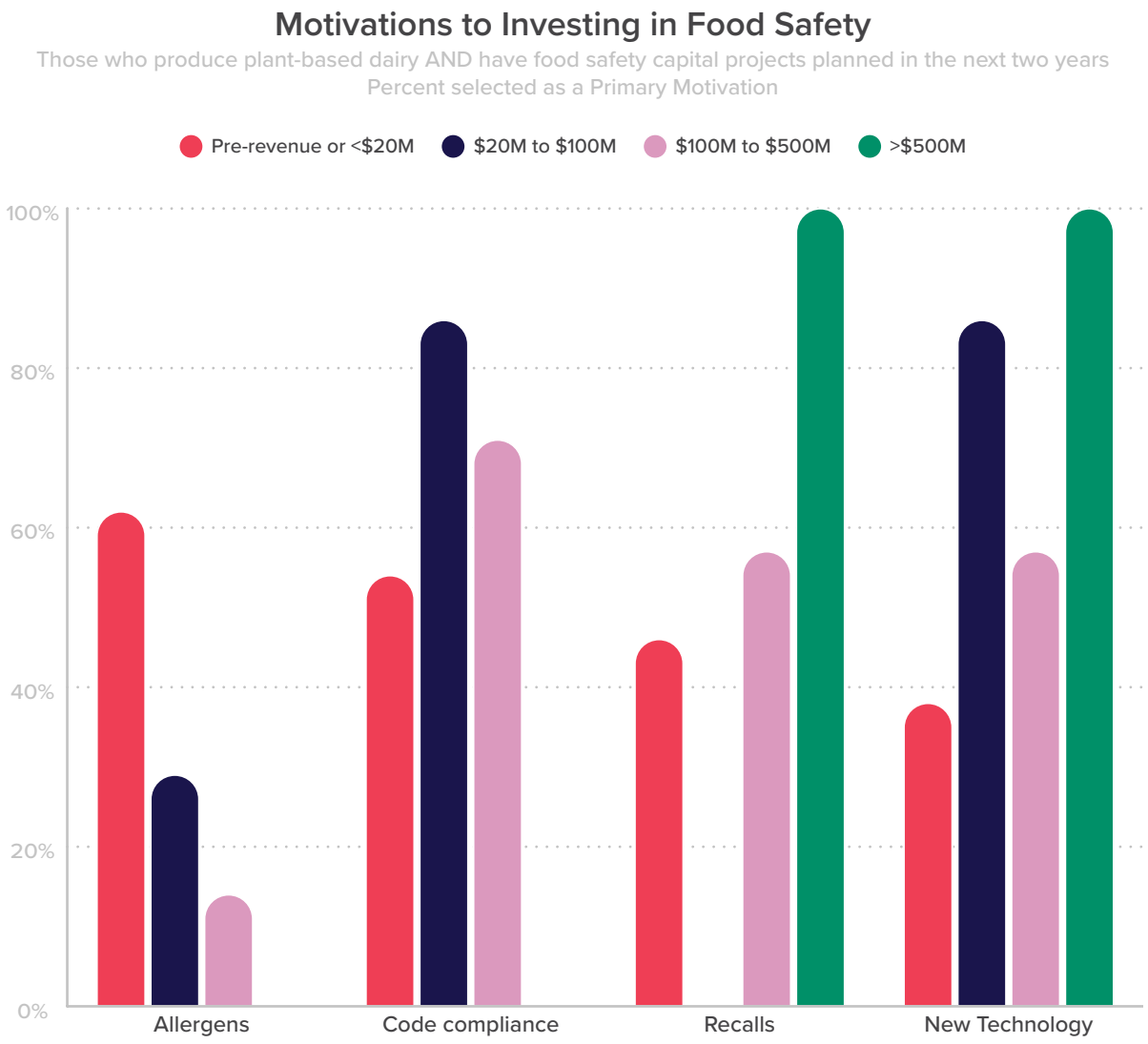


Source: CRB

A more detailed data cut sheds light on how these food safety factors motivate different companies in different ways (Figure 4.8). Small companies are aware that controlling allergens is mission-critical, and they're investing in solutions; as they mature and those solutions prove reliable, anxiety over allergens falls. Meanwhile, fear of a recall follows the opposite trajectory: As companies grow from under $100 million to over $500 million, they become incrementally more invested in mitigating against potential recalls. This makes sense: the larger the company, the greater their incentive to prevent a potentially devastating blow to their reputation.

FIGURE 4.8

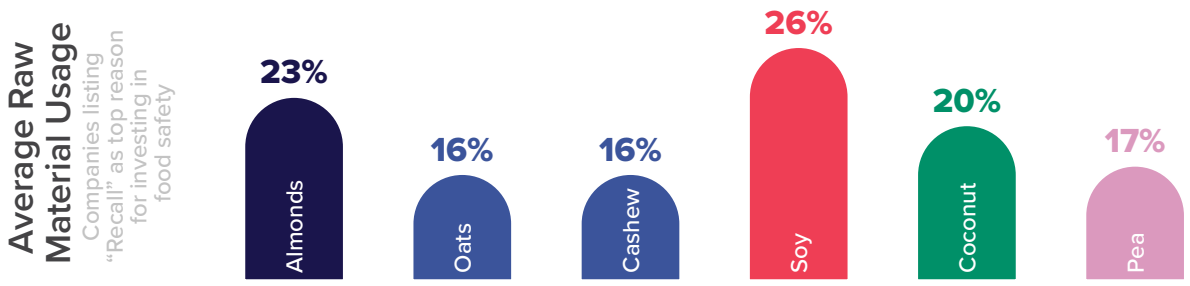
What are the primary motivations behind your capital spending on food safety? [Rank up to two]



Source: CRB

Given the negative press surrounding recent high-profile recalls, we hypothesized that all manufacturers would be investing actively in recall prevention. A closer look at the data reveals more nuance: Soy- and almond-based dairy manufacturers lead the pack in recall-related investment—this suggests that allergen control is likely a bigger concern than the effectiveness of their kill step (Figure 4.9). These also happen to be the top two protein sources of choice for companies earning north of $500 million per year (Figure 4.10)—further evidence that the larger the company, the longer the shadow cast by the threat of recall.

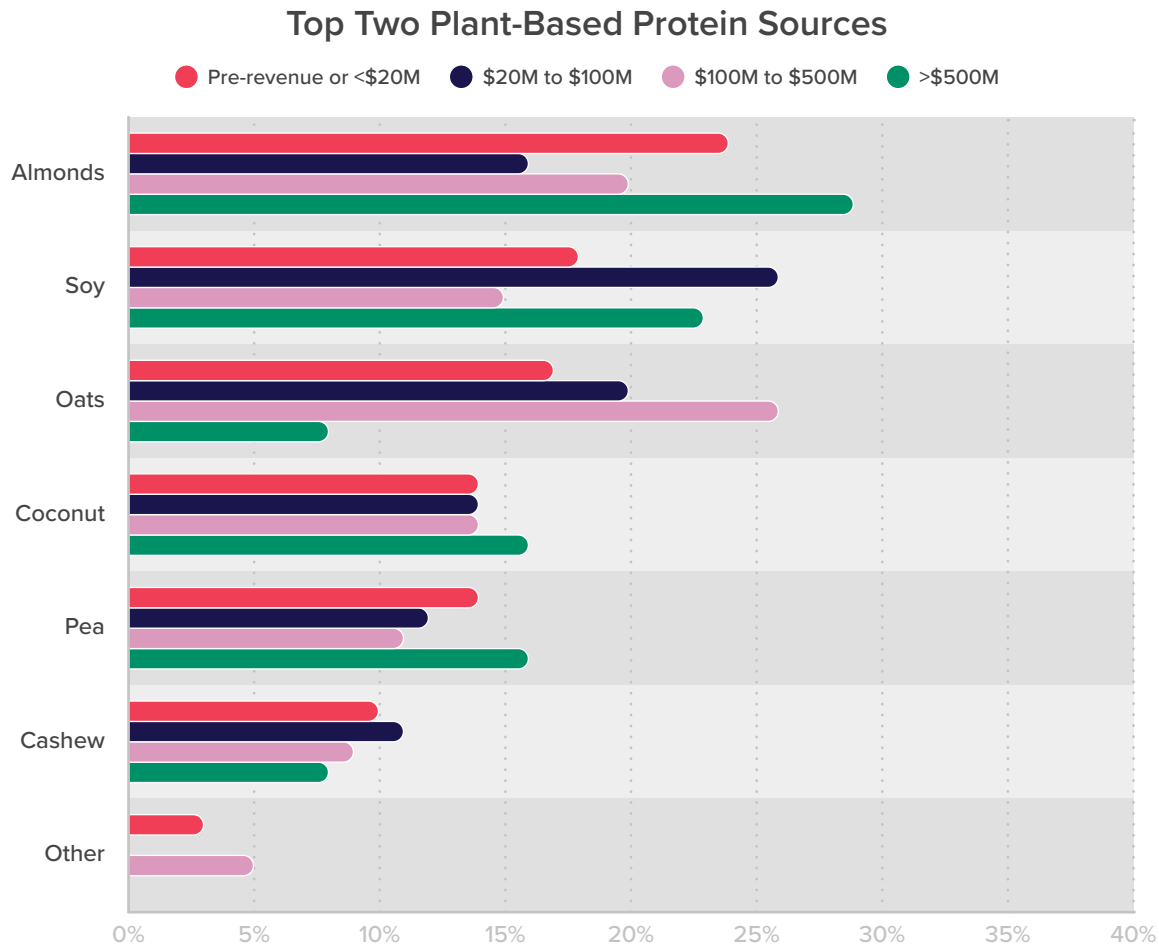
FIGURE 4.9



Source: CRB

FIGURE 4.10

What percentage of plant-based protein sources does your company use for the production of plant-based dairy



Source: CRB

What insight does this data offer to companies still finding their way through the complexities of food safety in the plant-based dairy industry?

Takeaway #2:

As your pipeline changes, your food safety plan should change, too.

All manufacturers should approach their pipeline expansion projects knowing that their safety risks are likely to change. Adding a production line for plant-based cheese to a facility designed for plant-based milk requires much more than additional equipment, for example; it's a different process with all-new food safety considerations, and that means rethinking everything from material handling to sanitation protocol and personnel training. Underestimating these challenges as your pipeline grows could prove disastrous.

If your expansion strategy involves new source proteins, food safety is even more critical from an allergen control perspective. This is especially true for manufacturers with both traditional and plant-based dairy products emerging from the same legacy facility, and those who plan to expand into schools or hospitals where consumers may be particularly vulnerable. You needn't look far to understand why—earlier this year, for example, a young woman died from suspected anaphylaxis after eating a "vegan" dessert which contained traces of milk protein.

To prevent further tragedies and ensure that your products are safe for consumers, review your food safety plan regularly and right-size it to accommodate any changes in your product line-up.

Takeaway #3:

Before partnering with a co-manufacturer or co-packer, investigate their approach to food safety thoroughly.

If a co-manufacturer inadequately handles your products, prompting the FDA to initiate a recall and distribute warning letters, your brand's reputation will likely take a hit—even if you didn't directly produce the product.

That's why it's crucial to understand a co-manufacturer's food safety plan before proceeding. This is especially relevant for the 59% of respondents who plan to increase the volume of products they produce with third-party manufacturers, as well as for the 53% of respondents who are co-manufacturers. Transparency and trust based on a thorough due diligence exercise are the keys to commercial longevity and consumer safety. Don't move forward without them.

AUTOMATION

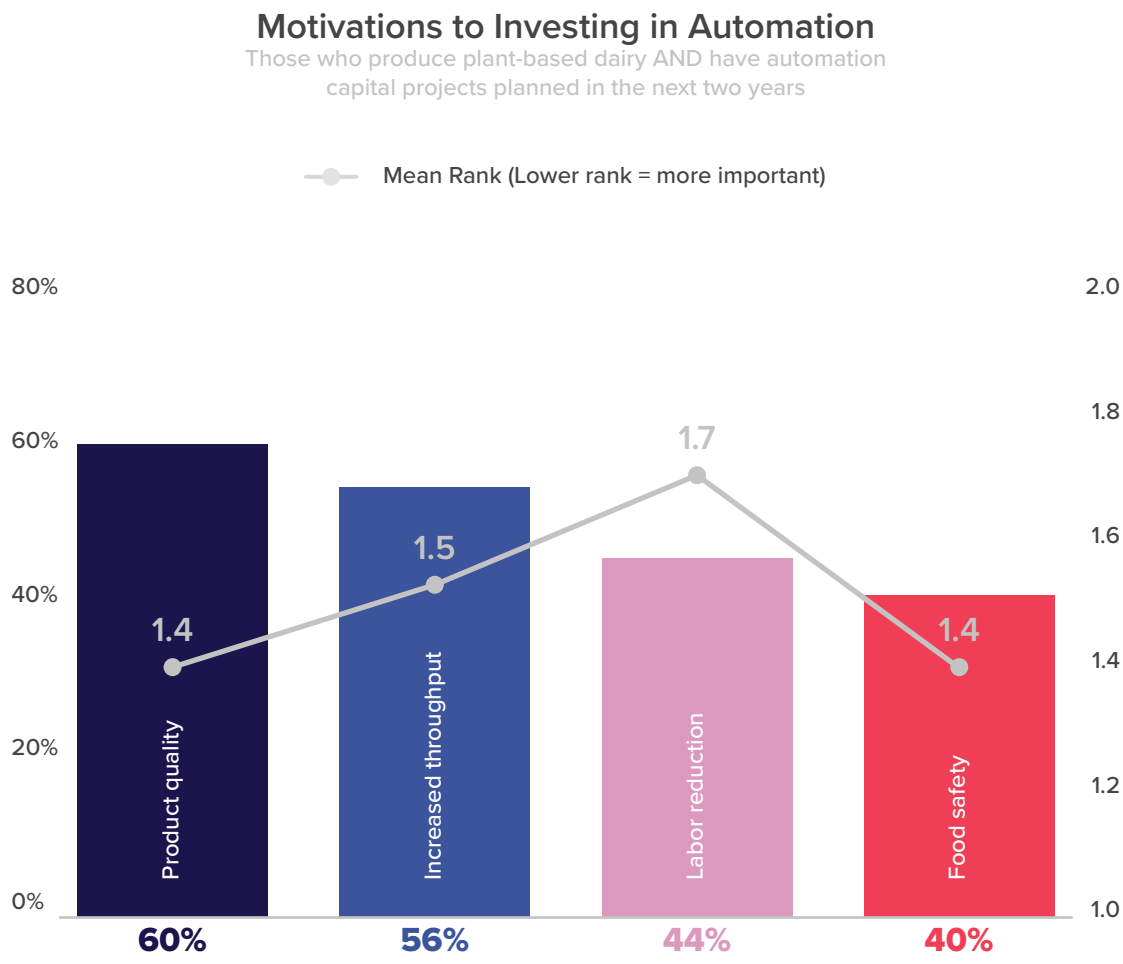
It doesn't necessarily take a big budget to get the most from automation, but it does take strategy and good planning.

Food safety and automation go hand-in-hand. By replacing manual tasks with automated processes, producers can greatly improve the repeatability and reliability of their process, generating safer outcomes for consumers. That's why we were

surprised to see food safety at the bottom of the list in terms of automation incentives (Figure 4.11). Quality reigns the top spot, which makes sense; in such a competitive market in which second chances are rarely granted, manufacturers can't afford to give consumers a single bad experience.

FIGURE 4.11

What are the two primary motivations behind your capital spending on automation? [Rank up to two; 1=most important]



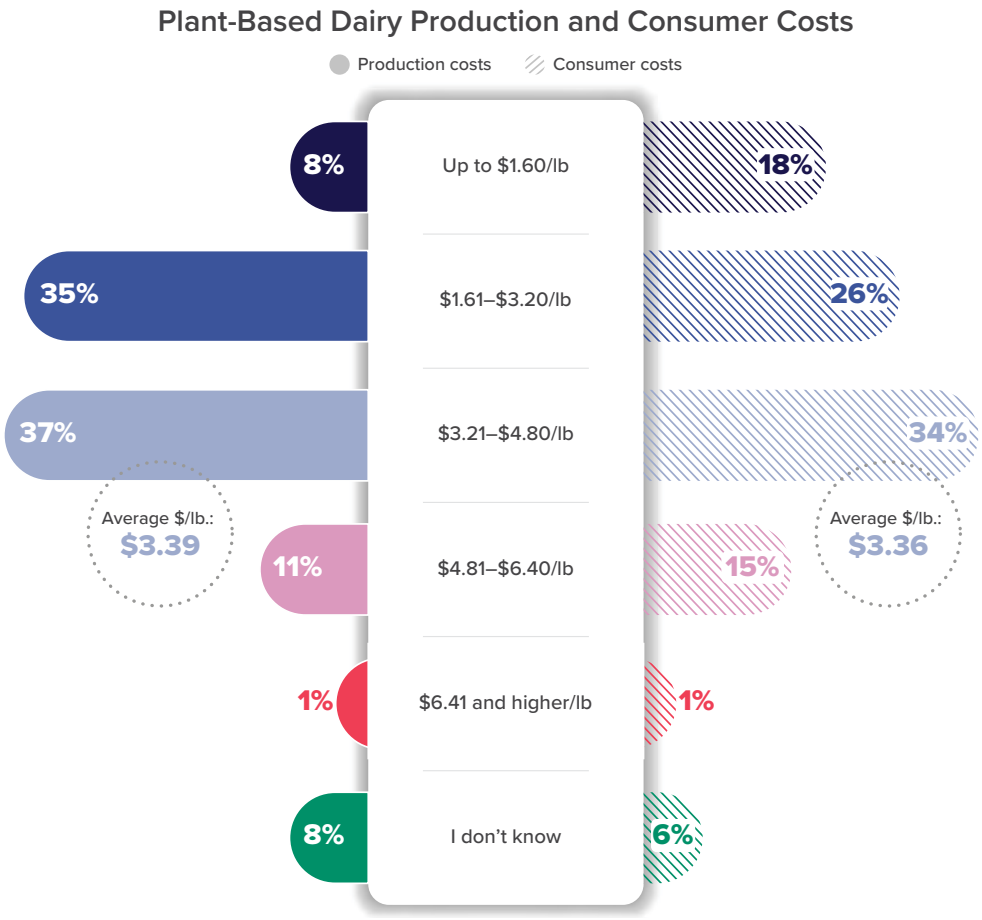
Source: CRB

Between these top and bottom extremes sit two factors which greatly impact production costs: throughput and labor. If producers can leverage automation to increase the former and reduce the latter, they may be able to influence the margin between what they pay to produce their products and what they plan to charge consumers—a margin which, for the time being, is not calibrated in the producers' favor (Figure 4.12).

FIGURE 4.12

What is your company's current cost to produce per pound for alternative dairy products? [Single select]

What is your company's desired consumer cost per pound for alternative dairy products? [Single select]

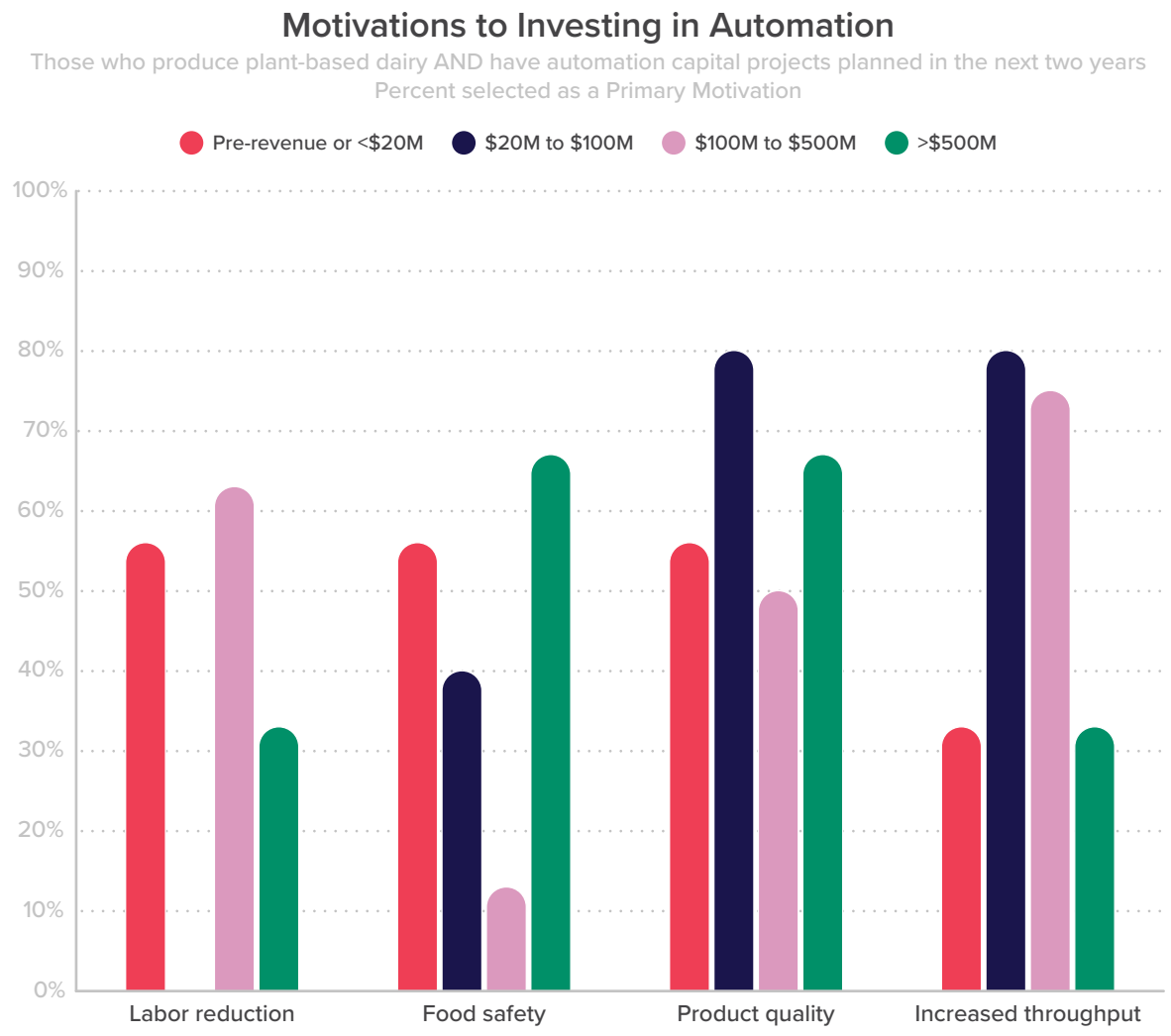


Source: CRB

It's interesting to track the effect of these cost-related factors on companies of different sizes in terms of their incentive to automate (Figure 4.13). Small companies likely don't yet have the scalability to increase throughput, so their best option for controlling costs is to reduce labor through automation. As they make their first significant leap in revenue, labor considerations drop while their attention swings to steeply climbing throughput targets and quality considerations; these dynamics shift again in more mature stages, as companies invest in automated solutions capable of maintaining high throughput while keeping labor costs under control. The largest companies of all have solved for labor and throughput, and are focused on using automation to prevent a safety-related disaster.

FIGURE 4.13

What are the two primary motivations behind your capital spending on automation? [Rank up to two]



Source: CRB

What can other plant-based dairy producers glean from this data to help them prioritize and optimize their own automation projects?

Takeaway #4:

As your pipeline changes, your food safety plan should change, too.

Which automation project is right for your plant-based manufacturing facility? The answer is: it depends.

Your company's unique business and manufacturing goals should determine the way you automate your facility. Take production costs, for example. Given that ingredients are especially expensive for plant-based dairy manufacturers, many companies are focused on reducing waste as a strategy for lowering their spending. If this is an important business driver for you, then an automation project focused on labor reduction could be impactful; fewer manual tasks mean less human error and more robust record-keeping, which in turn translates to a lower volume of wasted materials.

Other automation projects may be optimized for quality, throughput, operator safety—or a combination of goals. We recently worked with a soy-based manufacturing client whose automation project was designed around two primary drivers: sustainability and food safety. With this clarity guiding our decisions, we developed an automated solution to govern the use of steam throughout their facility, which reduced their energy load while improving product consistency. This single project delivered on two objectives, extending the value of that client's investment.

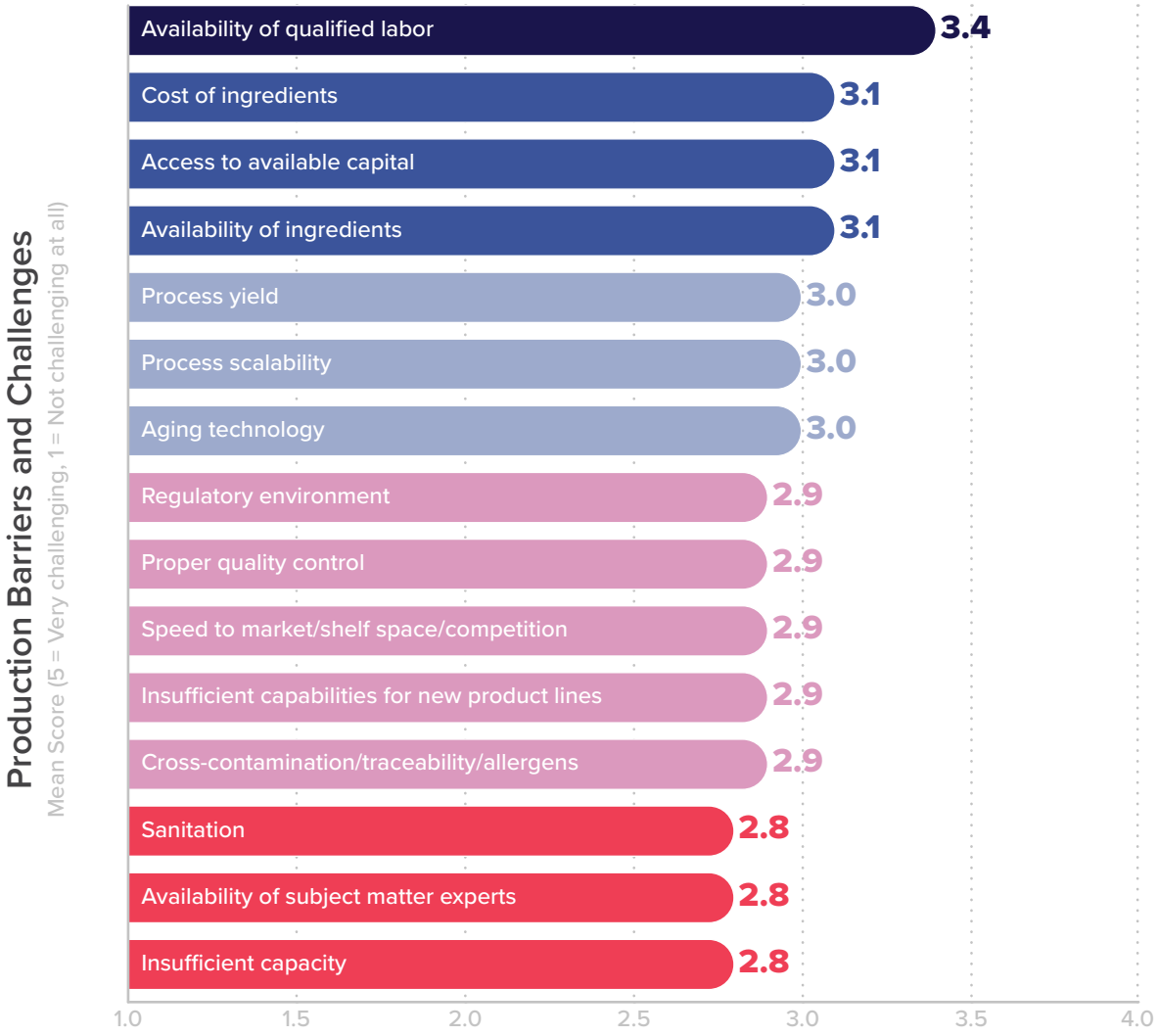
Takeaway #5:

Leverage automation to support your workforce—not replace it.

Alternative dairy producers see the availability of qualified labor as their greatest barrier to production (Figure 4.14). Automation may ease part of that burden by compensating for gaps in the workforce, but there's another approach which could have a more durable effect on your labor strategy: Instead of replacing people, use automation to improve working conditions for the people you already have (and those you may work hard to recruit in the future). From the perspective of a skilled worker, this could position you as a sought-after employer.

FIGURE 4.14

How challenging are each of the barriers to production within your organization? [Rank each 1-5; 1 = not challenging at all, 5 = very challenging]



Source: CRB

Leveraging automation as a support for your workforce doesn't necessarily require a big-budget project. Simply adding a single well-thought-out piece of automated equipment can have a significant benefit; consider a scissor pallet lift to improve the ergonomics of unloading ingredients for batching or manually palletizing boxes.

By thoughtfully integrating these solutions, you're giving employees what they need to succeed long-term: a work life without physical stress, repetitive motion, and fatigue. You're also freeing them for higher-value tasks while improving the consistency of your process—a win for everyone, including the end consumer.

Optimism flavored with a drop of caution

Alternative dairy producers are excited about the future of their industry and eager to make headway towards new and promising opportunities.

To continue this trajectory, they need to double down on the principle which got them this far: more haste, less speed. Invest the time required to get the next product or package right before pushing it to market. Focus on incremental pipeline changes that are grounded in consumer requirements, and with a robust food safety strategy and enabled by thoughtful, well-integrated automation. With this clear-headed and systematic approach to growth, the plant-based dairy industry will continue to reap the rewards of commercial success—one breakthrough at a time.

Sustainability: From here to net-zero

Many companies have sustainability budgets, goals, and plans to reach carbon neutrality. But is it enough and are the milestones within reach?

By: Maya DeHart, Aaron Kilstofte, and Jonathan Dressler



We call them alternative proteins for a reason. They provide an option for consumers wishing to avoid animal products and for those wanting to reduce the environmental impact of the food they eat. Sustainability is important to them and, provided the taste, nutrition, and selling price of alternative proteins are competitive with animal products, people are increasingly willing to give them a chance.

A focus on sustainability may start with consumers but, with climate change in the news daily, it continues to gain urgency for governments, regulators, investors, and shareholders. In the food and beverage industry, we anticipate the accelerating effects of the Inflation Reduction Act of 2022 (IRA), which aims to reduce energy costs by promoting green energy, and in the prevalence of climate-related financial disclosures (CRDs), which help mitigate corporate risk by providing information to investors and consumers about how companies are addressing climate change and sustainability.

But how does this intense focus on sustainability affect the alternative protein sector? Here are six key messages we've derived from our survey of industry experts.

Takeaway #1:

Most have budgets but lack goals and concrete plans.

It is a healthy sign for this sector that a notable number of those surveyed said their companies have sustainability budgets (55%), while only a small fraction are not currently developing sustainability practices (Figure 5.1). On the other hand, there

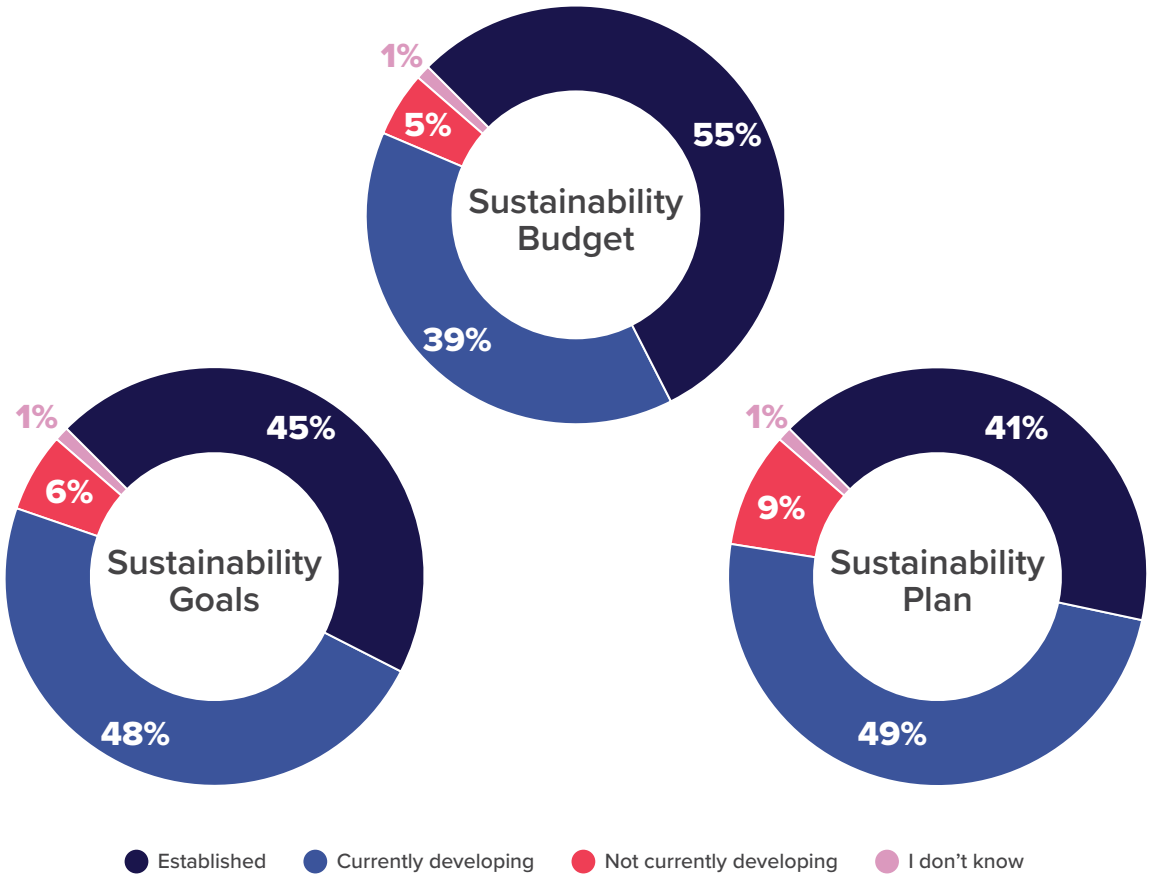
are significantly fewer with sustainability goals (45%) and a plan to reach those goals (41%). Taken together, this data suggests that while there is desire to move forward with sustainability, many are not applying available resources to achieve management's goals. In other words, onsite implementation of corporate budgets may be a challenge.

Develop a roadmap for your sustainability plan

Creating a master plan to achieve your sustainability goals and milestones is key. With resource and knowledge constraints across many facilities, this is an opportunity to engage an experienced partner to lay out a path forward. A cohesive roadmap has the strategic advantages of ensuring that maintenance, equipment upgrades, and utility replacements are managed over the next five to ten years with big-picture goals in mind. For example, large-scale changes can be scheduled to coincide with planned shutdowns.

FIGURE 5.1

Which of the following does your company currently have established or under development? [Multi select]



Source: CRB

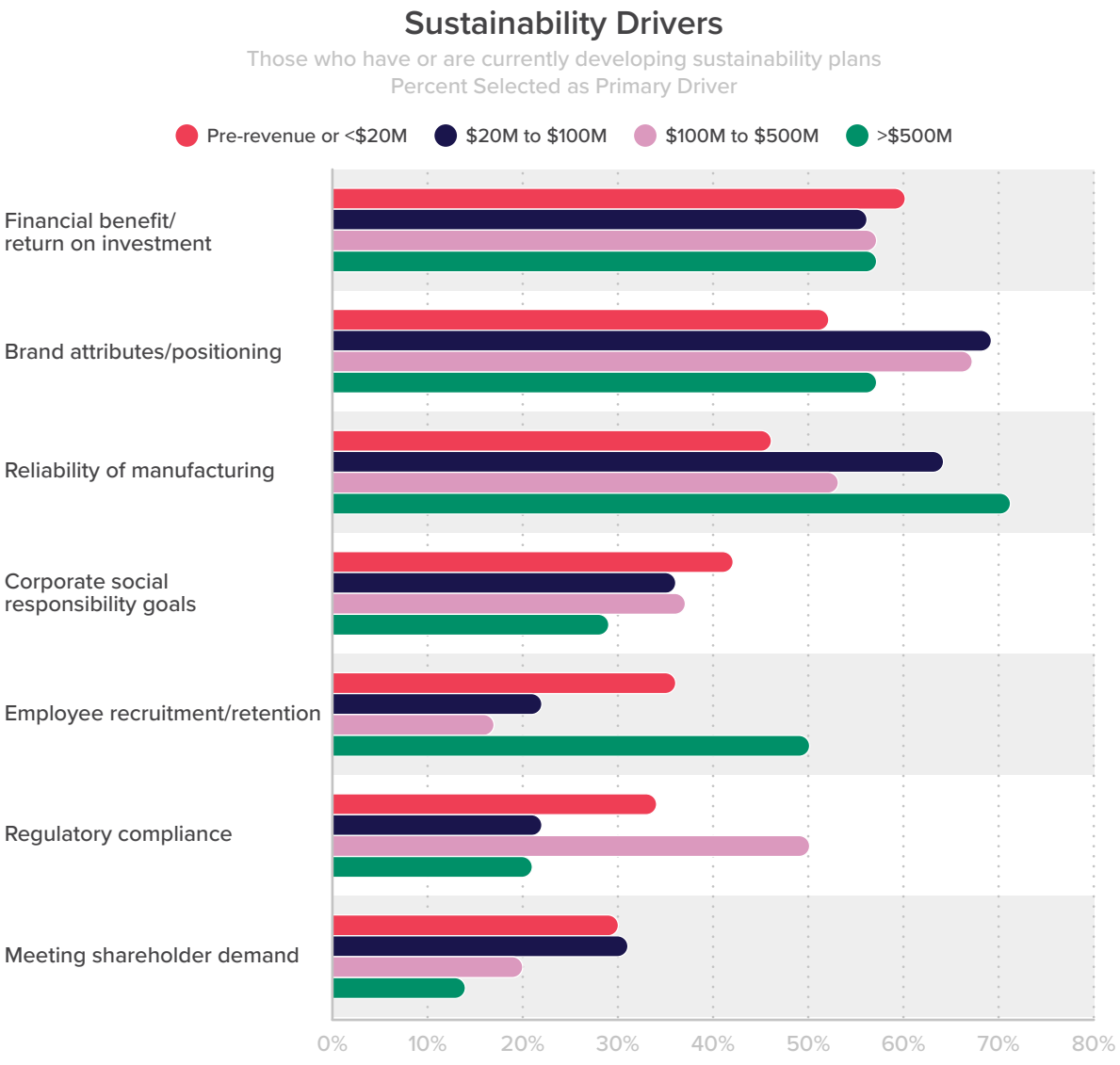
Takeaway #2:

Brand positioning and return on investment drive the desire for change.

We understand why brand attributes and financial benefit rank highest among the impetus to make changes (Figure 5.2). Alternative proteins are aimed at a demographic that cares greatly about environmental concerns, and return on investment (ROI) is vital to the entire food and beverage market whether they implement sustainability or not.

FIGURE 5.2

What are your company's top three drivers for sustainability? [Rank three]



Source: CRB

While reliability of manufacturing systems was also a highly ranked driver, it was chosen by substantially more respondents from companies with greater than $500 million in revenue (71%) than those with less than $20 million (46%). This reflects the shift in focus to manufacturing optimization that occurs once a company has met its financial goals and has well-established brand attributes.

But lack of shareholder demand could reduce the pressure to change

Given that only a small fraction indicated the importance of meeting shareholder demand (Figure 5.2)—a number that dropped to only 14% for companies with >$500 million in revenue—it appears another big challenge might be that the lack of shareholder pressure could lessen the urgency of adopting goals and plans. Therefore, it's critical that companies in this space carefully align their sustainability goals to what matters in the boardroom, to boost financial viability, and to support brand growth. Spending on sustainability initiatives should either have a clear payback or position the brand to stand out on the shelf.

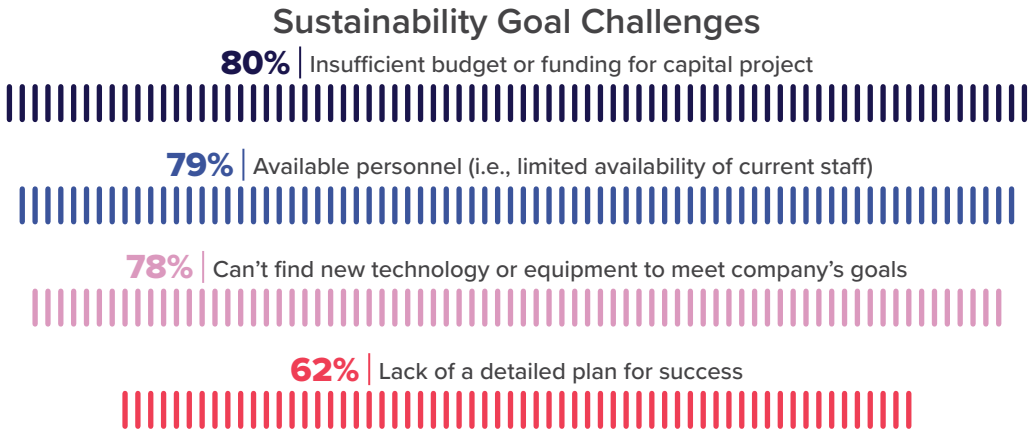
Takeaway #3:

Insufficient budgets and limited labor hamper success.

Despite most having established budgets, 80% believe these may be insufficient to address their company's sustainability goals (Figure 5.3). Another major challenge is the lack of available workers (79%), which is a common theme throughout manufacturing. The lack of available personnel need not hamper planning since hiring external experts to help develop a roadmap can take the pressure off your internal team. It can, however, be a real hindrance to the implementation of changes.

FIGURE 5.3

What do you see as the most significant challenges in addressing your company's sustainability goals? [Rank up to three]



Source: CRB

Implementation challenges

When respondents were asked to rate how challenging various aspects of production were to implement sustainability measures, processing yield/efficiency topped the list; this is what producers sweat about every day (Figure 5.4). Fortunately, we foresee these challenges easing with the continued evolution of the technology.

While lack of a detailed plan is not the primary challenge, putting that plan into motion can be. Do not underplay the difficulty of execution.

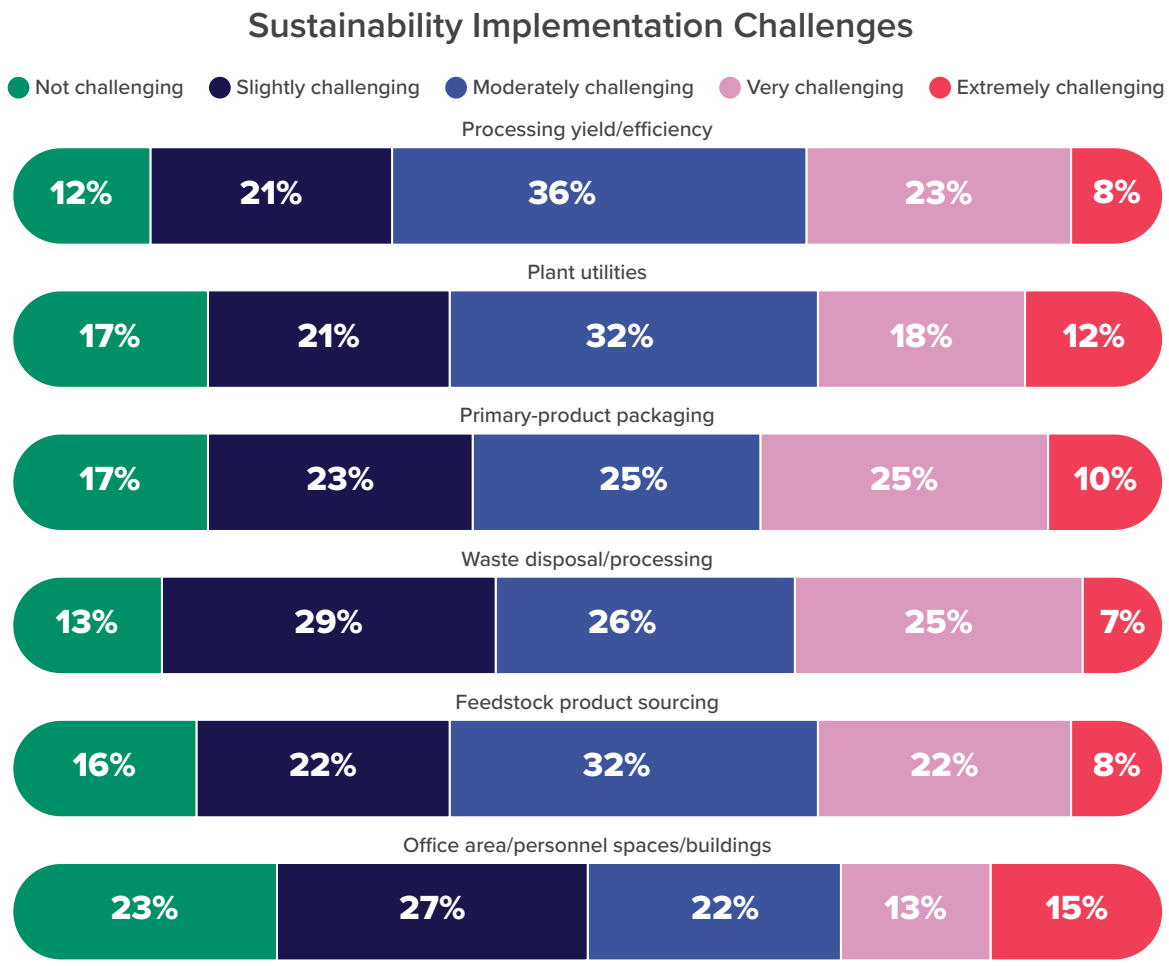
Feedstock product sourcing is a problem we've also seen in plant-based dairy and mycelium-based facilities when the quality of feedstock is found to be inadequate for their process. This can be especially frustrating—and expensive—if they co-located their facility to be near a feedstock supplier. As more companies consider the impacts of their value chain on Scope 3 emissions, supplier proximity and reducing transportation and material carbon footprint will continue to impact sustainability, as well as production.

The significant number of respondents indicating the challenge to upgrade office areas and buildings likely reflects that simple changes have already been made (e.g., a switch to LED lighting) and it becomes increasingly difficult to further optimize those spaces. The production spaces presenting greater challenges are top of mind.

Given the challenges of budget constraints, and the need to show solid ROI on sustainability projects, it may be wise to combine sustainability goals with other goals. For example, investing in technologies to reduce utility use, such as compressed air and water use monitoring, can address both utility consumption and the sustainability of the product.

FIGURE 5.4

Rate the following parts of the production to implement sustainability measures.



Source: CRB

Takeaway #4:

A lack of near-term milestones suggests procrastination.

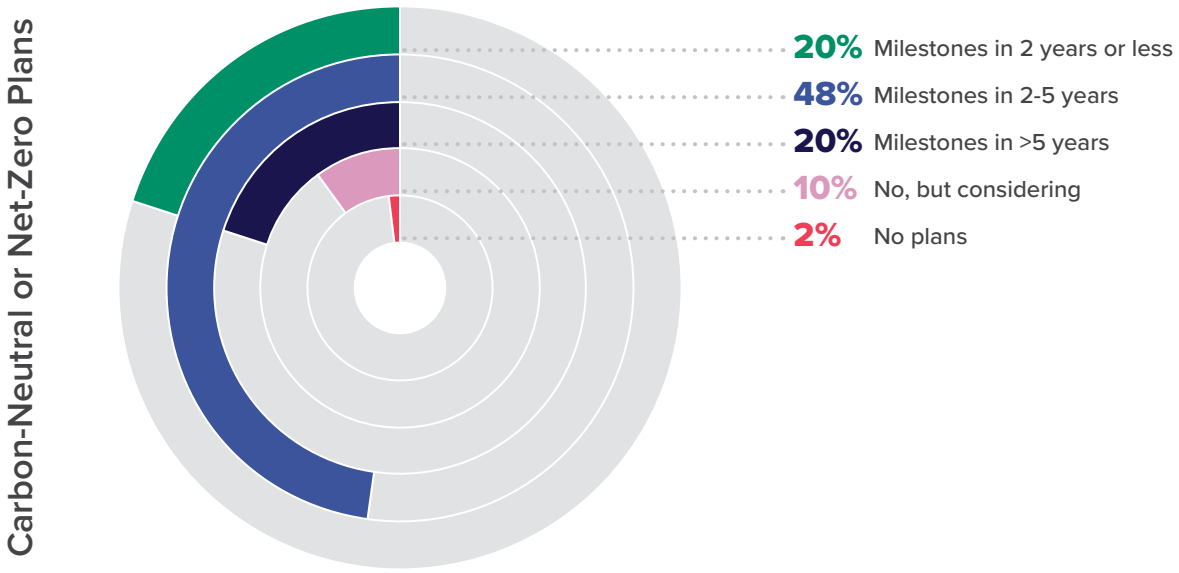
When asked about their company's timeframe for developing a carbon neutral or net-zero plan, almost half (48%) said it would happen in two to five years (Figure 5.5). This appears to be a trend across multiple food and beverage sectors and closely matches what we found in our *Horizons: Pet Food* survey.

With limited capital budgets, achieving net-zero takes planning several years in advance and intermediate action over time. To achieve these goals, intermediate milestones are key to tracking initiative progress and ensuring that you are on a realistic path to meeting your metrics. Don't camp out with five-year milestones.

Unfortunately, having long-term milestones might reflect a desire to put off difficult decisions until the future. And many lack a timeframe for intermediate milestones within those five years. At least some of the initiatives should be planned for the next two years, as long as they are actionable.

FIGURE 5.5

Does your company's sustainability plan include carbon-neutral or net-zero goals within the following timeframes? [Single select]



Source: CRB

Yet capital-intensive projects can take longer than two years

Those with a sustainability milestone of two years or less—only one-fifth of respondents—are much more likely to be companies with less revenue (<$20 million). This may be due to alternative protein startups valuing sustainability as central to their mission, as well as a need to attract investment by including sustainability as a brand attribute.

For larger companies, and those closer to commercial production, some changes needed to achieve sustainability goals will require more than two years. The shortest realistic timeframe to change current operations in existing plants is between two and five years. Adding capabilities to improve sustainability often takes extensive planning and preparation, including engineering studies to properly design and install capital upgrades, as well as building inventory to mitigate the impacts of disrupting production. The roadmap we create for a client's existing plant takes into account that, for capital projects, it typically takes at least two years to transform the infrastructure (e.g., replacing equipment) and sometimes more than five to change current operations in an existing plant.

We conclude that companies need to find the right balance between taking sustainability goals seriously and getting started where they can, but allocating enough time to make larger, more meaningful changes.

Zero-carbon milestones require PPAs and CCA

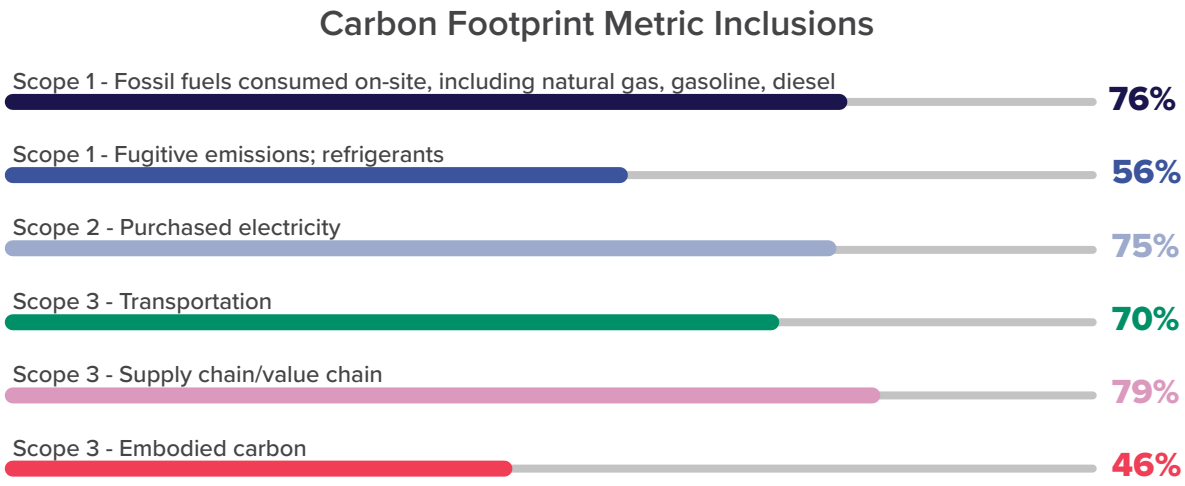
Purchased electricity was included as a carbon footprint metric by three-quarters of those surveyed (Figure 5.6). Included within this will be Power Purchase Agreements (PPAs) and Community Choice Aggregation (CCA), currently being used by 35% (Figure 5.7). The decarbonization of electricity is in progress around the world. Most US states have Renewable Portfolio Standards (RPS) that require utilities to generate a specified minimum percentage of electricity through a particular renewable technology. Though many utility suppliers are greening their energy supply to comply with these standards, most will not be offering 100% renewable energy within the next five years. This is why PPAs and CCAs, which can immediately provide 100% renewable electricity, will be important to hit net-zero milestones.

For those without significant space and capital for onsite renewable energy, PPAs and CCA allow achieving zero-carbon electricity and, as such, are key to enabling zero-carbon operations. Considerable negotiation is typically needed to get a PPA or CCA at a reasonable price. As the market evolves with improving technology and growing demand, companies with approaching net-zero targets will be at the mercy of a fluctuating market, making it critical to negotiate plans as quickly as possible.

For the 53% considering a PPA, any plan under review now will need to be implemented within that time span. Tapping into a CCA also requires coordination several years in advance of any solar project under development.

FIGURE 5.6

Does your company include any of the following in its carbon footprint metrics? [Multi select]



Source: CRB

Don't forget about embodied carbon!
Greenhouse gas emissions from the extraction, manufacture, transport, and disposal of materials can be significant. While the value of including this embodied carbon in carbon footprint metrics may be less understood (46%), it should be measured. Companies with revenue over $500 million are more likely to be measuring embodied carbon (64%), perhaps because they are further along the path to sustainability improvements with purchased electricity, transportation, and their supply chain. Embodied carbon has often been overlooked for operational carbon impacts, but life cycle assessments increase awareness of the significant carbon footprint of the supply chain and disposal stages; scrutiny here will continue to increase. For most companies, Scope 3 emissions far outweigh Scope 1 and 2 put together.

less than

50%

of respondents include embodied carbon in carbon footprint metrics.

Fugitive emission and refrigerants
More than half (56%) include fugitive emissions and refrigerants in carbon footprint metrics (Figure 5.6). Our experience shows that this tends to be a manageable issue if facilities have a good maintenance plan for their fugitive emissions and refrigerants. However, there is variation between companies that require refrigerants to be replaced or need to select new low-GWP equipment to meet the codes driving these changes. Some new equipment (e.g., ammonia-based refrigeration) poses other challenges in terms of the construction and safety of hazardous areas. A full inventory of refrigerants and replacement plans integrated into the site sustainability roadmap is key to low-capital cost management.

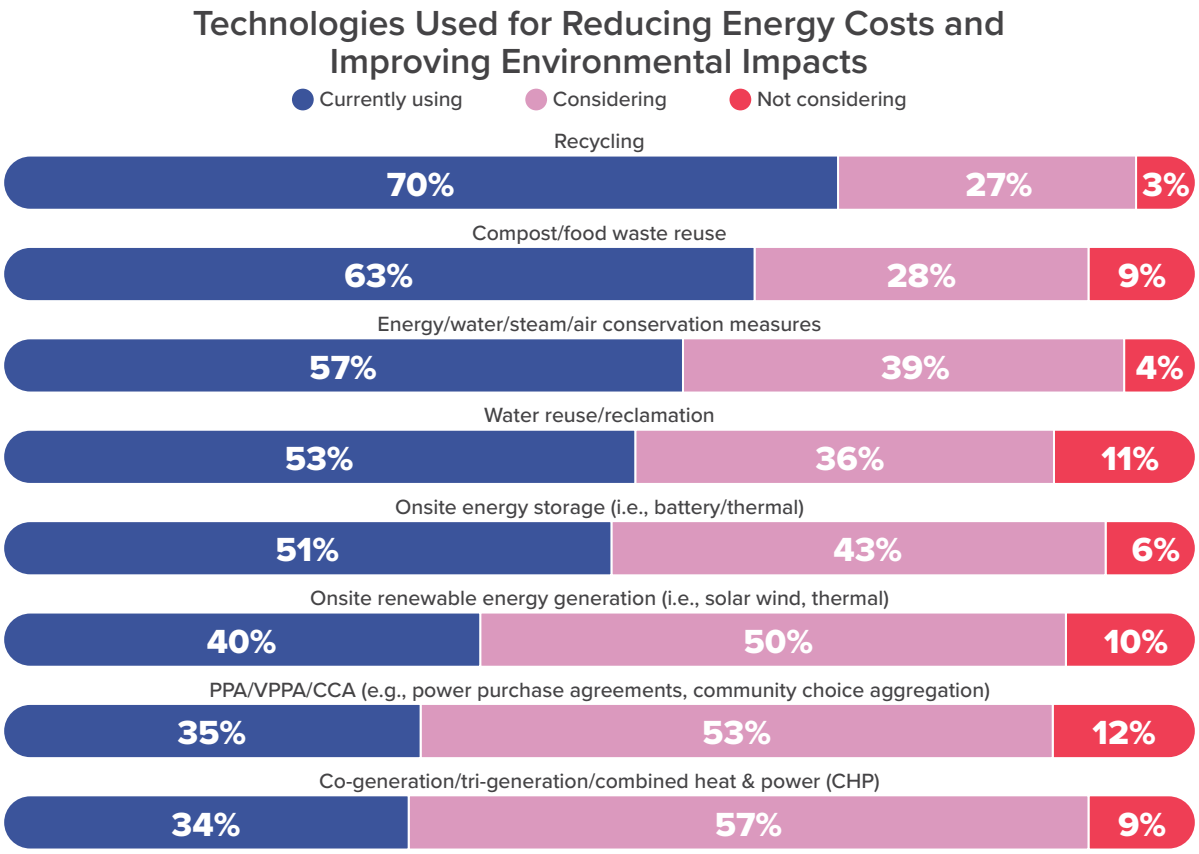
Takeaway #5:
Successful companies follow an adoption curve.

The data confirms our experience of an adoption curve for technologies to reduce energy costs and improve sustainability (Figure 5.7). Those 'Not Considering' are at the beginning of the journey, looking to aim for lofty options, including PPAs and onsite renewable generation. Those 'Considering' improvements have moved along the curve to more tangible tech, such as co-generation and some utility conservation measures.

Current users start with factors having the lowest barrier to entry
Those furthest along the adoption curve are looking at the items easiest to implement and the quickest to see a return, such as recycling, composting, water reuse, and utility conservation measures. It may be wise for companies new to this game to follow their lead, aiming for quick gains with recycling and utility efficiencies while simultaneously planning for larger long-term capital-intensive changes.

FIGURE 5.7

What technologies is your company using or considering using as a means of reducing energy costs and improving environmental impacts?



Source: CRB

Don't mess with our core process!

The process for manufacturing alternative proteins—as with any biomanufacturing—is highly tuned and delicate. This is no doubt why the number one ranked implementation challenge is processing yield/efficiency (Figure 5.4). We believe this shows respondents are reluctant to alter the core process to enhance sustainability. As with biologics, which also have high production costs, there is hesitancy to affect anything that could impact yields. Instead, they're wanting to focus on the building envelope and office areas.

Our suggestion? Make modifications adjacent to the process without jeopardizing the process itself. Altering the supporting mechanical and clean utilities and cleaning cycles that serve the process can have big impacts on reducing resource use. For example, without changing the bioreactor you can explore efficiencies in the way it's cleaned after use, reviewing the energy and water use via cycle time and temperature studies.

Takeaway #6:

There are good support systems to achieve sustainability goals.

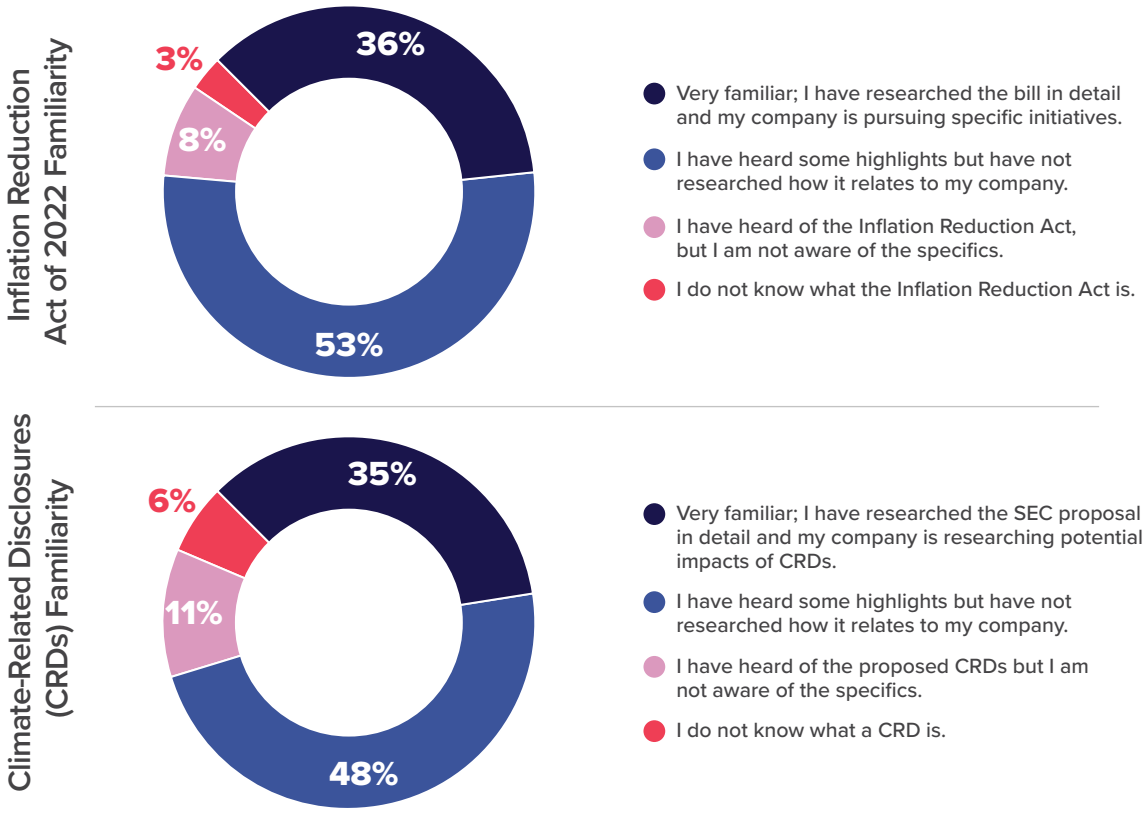
We were heartened by the level of familiarity with enabling policies, with more than one-third having deep familiarity with the IRA and Climate-related Disclosures (CRDs) (Figure 5.8). People are aware of executing projects based on the incentives offered (IRA) or mitigating risk (CRD)—opportunities that should be taken considered by all alternative protein producers.

All companies should be familiar with these two pieces of legislation even if meeting shareholder demand is not a major driver. Will CRDs drive shareholder demand long-term? We don't know. What they are likely to reinforce is consumer demand for sustainability.

FIGURE 5.8

Rate your familiarity with the Inflation Reduction Act of 2022 and its impact on your company. [Single select]

Rate your familiarity with proposed SEC rules for Climate-Related Disclosures (CRDs) and the impact on your company. [Single select]



Source: CRB

There’s cause for optimism but the time to start is now

Congratulations if you’re in that top half with the pieces in place to move toward sustainability. You have a budget, goals, and direction. Just don’t underestimate the expense or complexity of making it happen, whether it’s negotiating a PPA or prioritizing a central plant upgrade within the next five years. You can start with the simplest modifications, those that provide a relatively good ROI without affecting your core process, but the key message here is, you need to start.

Rising to the regulatory challenge:

Companies embrace food safety and quality to drive the industry forward

By: Pablo Coronel, PhD and Dennis Collins

It may sound like a contradiction, but industry regulations and the organizations that oversee them are having a moment. A steady drumbeat of headlines—new laws, new leadership, and increased scrutiny by consumers and shareholders—has put this traditionally conservative, yet essential, part of the alternative protein manufacturing industry in the spotlight.

What's more, with an infusion of cash that began in 2018, regulators are better resourced than ever before. The result is greater efficiency, more inspectors, and shrinking process review timelines. We're seeing this play out in our results: regulations have traditionally been viewed as a production barrier; they now rank a lowly eighth on the list of business influences.

It's great news for the maturing alternative protein industry. With a significant interest in getting to market quickly and banking on the popularity of its products, these companies' futures can hang on what and how they are able to communicate to potential customers.

As companies move from pilot to production scale, they are behaving more like food and beverage manufacturers and less like start-ups. Our survey results reflect an increase in maturity, awareness, and understanding of the regulatory environment and its impacts. And, while cell-based protein manufacturers lag slightly behind their more advanced plant-based and fermentation peers, we expect that the regulatory environment will continue to become more clear once industrial scale production begins.

With the anticipation of regulatory changes in the next few years, our respondents are showing attention to both hygiene procedures and methods for ensuring food safety and product quality.

Not surprisingly, the upgrades planned tend to align with the scale of the company. Smaller businesses are focused on hygiene procedures and operations, while larger businesses with capital are more capable of tackling environmental controls, utilities, and processing equipment.

And finally, safety and quality certifications are becoming increasingly important to manufacturers, driven by dual market demands by consumers and retailers. We're seeing signs that more alternative protein products are using this as an essential part of their go-to-market strategy, evidenced by a significant number intending to obtain external certification status in the next two years.

With 84% of respondents anticipating an increase in manufacturing capacity in the next two years, there's no question that the alternative protein industry is maturing, and, in terms of regulations, they are more ready than ever before (see Firmographics).

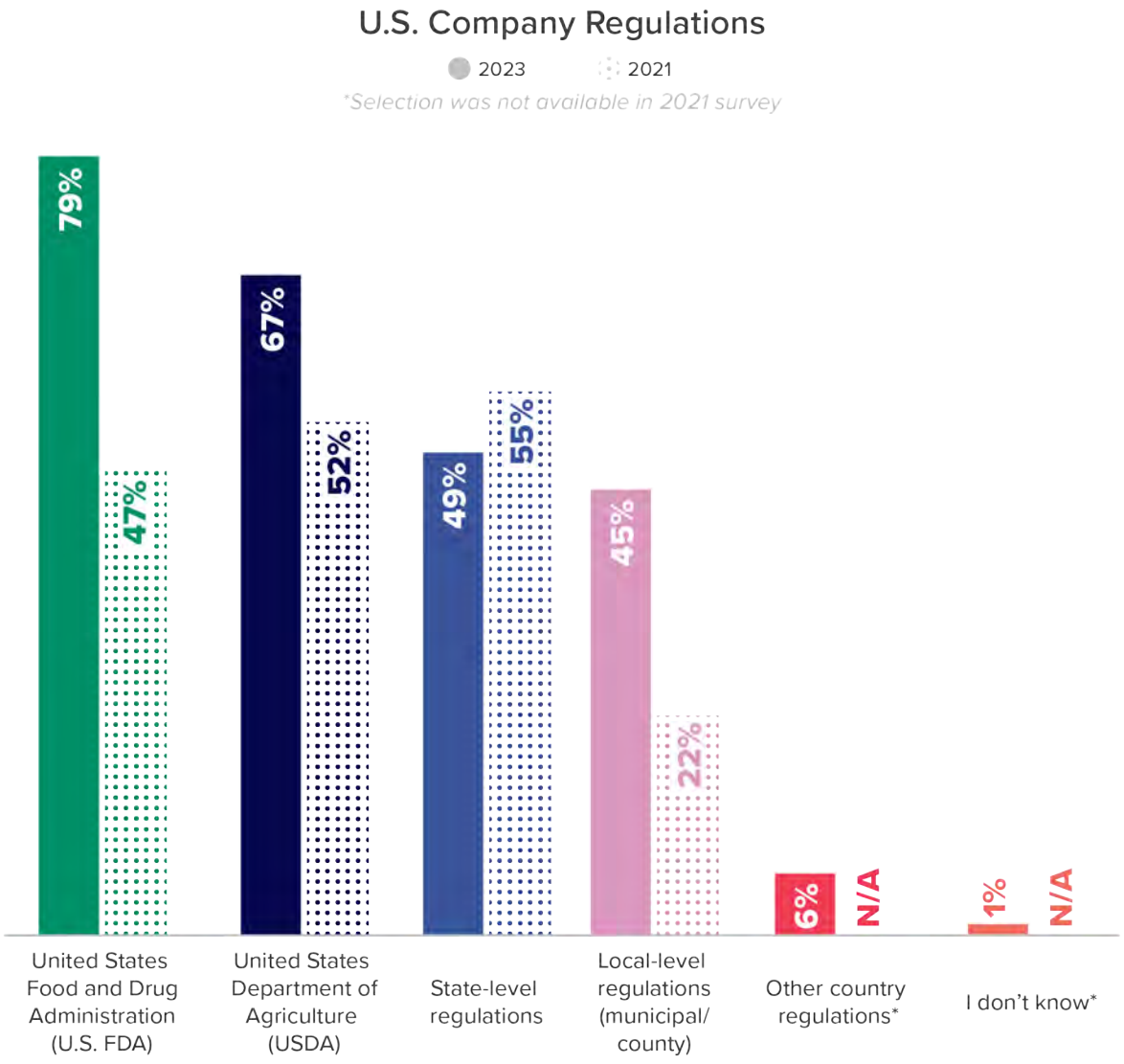
A GREATER AWARENESS AND UNDERSTANDING OF THE REGULATORY ENVIRONMENT

Every alternative protein manufacturer's products are regulated by the FDA. And cell-based protein products will also need to meet requirements outlined by the USDA.

So, while 100% of our respondents should have answered 'the FDA' in response to the question 'What regulations are your company held to?', the actual result was 79%. However, it's a substantial increase on the answers provided two years ago (Figure 6.1).

FIGURE 6.1

What regulations are your product(s) held to? [Multi select]



Source: CRB

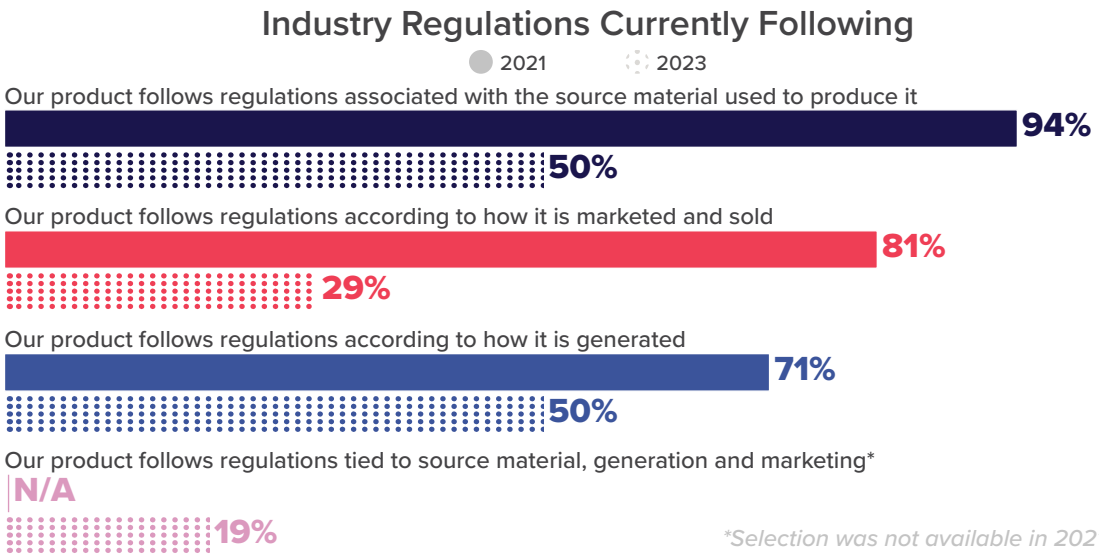
This demonstrates an increased awareness and maturity in alternative protein companies. In general, the industry is progressing beyond small-scale, start-up mode into more mature companies that are well-versed on where they want to be and how they need to get there.

These results are repeated when we dive into the specifics.

Between 2021 and 2023, there is an increase in following industry regulations across all categories (Figure 6.2).

FIGURE 6.2

What industry regulations are you following? [Yes/no for each]

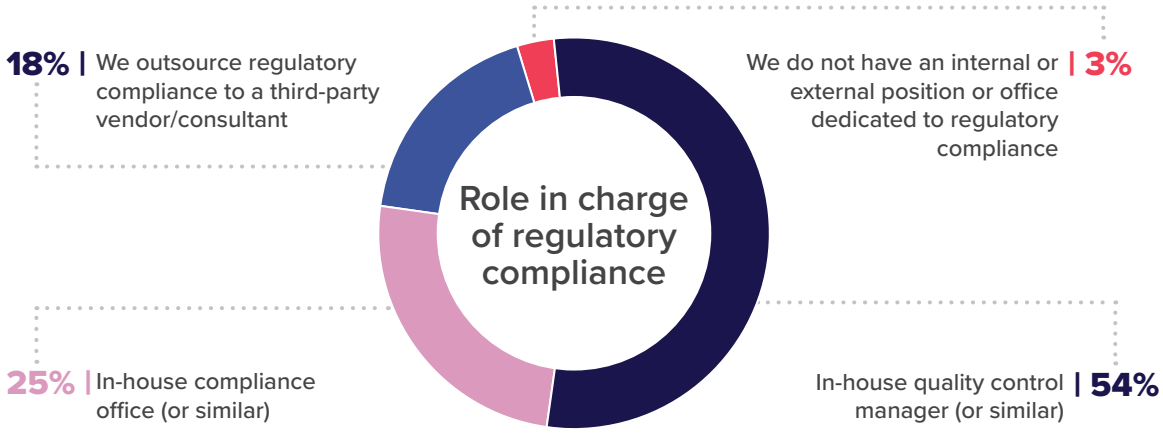


Source: CRB

Smaller operations continue to follow the trend of outsourcing compliance oversight, but larger firms find it more practical and economical to maintain compliance and quality control in-house (Figure 6.3).

FIGURE 6.3

Who is primarily in charge of regulatory compliance at your company? [Single select]



Source: CRB

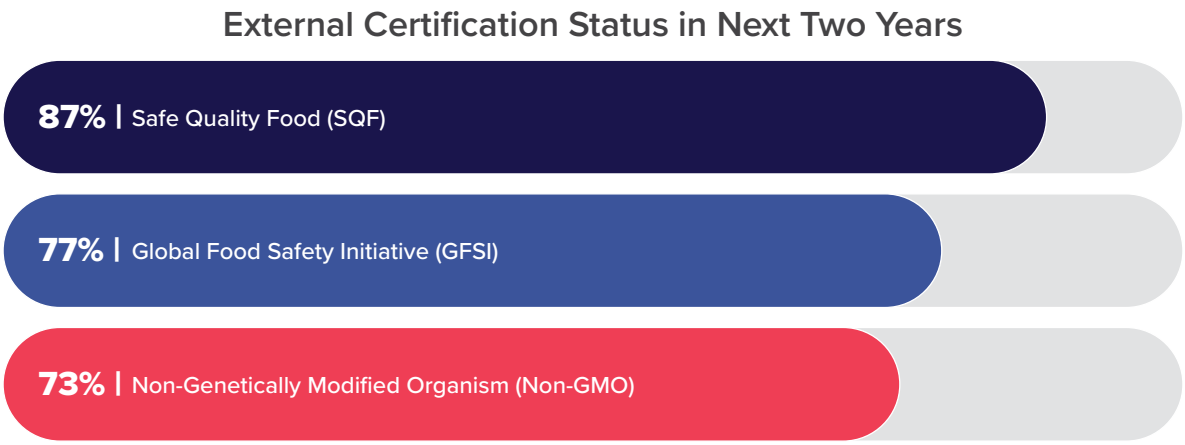
TIMELINE OF REGULATORY CHANGE AND CERTIFICATION

Alternative protein companies are showing their sophistication as they burst onto shelves and dinner tables. A full 92% report that they expect impactful new regulations in the next five years, with the average sitting at 3.4 years. Why does it matter? Because these companies know that as they scale production and get products to market in a real way, oversight may increase, and they will need to build flexibility into their operations to comply with potential new regulations.

Further, results around external quality and safety certification indicate strong moves to market (Figure 6.4), where consumers and large retailers insist on having these certifications as a sign of quality.

FIGURE 6.4

Is your company certified, or planning to be certified in the next two years, by an external program? % selected yes. [Multi select]



Source: CRB

INCREASING FOCUS ON HYGIENE AND FOOD SAFETY PROCEDURES

Companies are paying close attention to hygiene procedures as an integral part of their mission to provide safe products. Their approach to hygiene, due to the presence in retail, is showing signs of sophistication.

As companies move to production scale, they are increasingly focused on hygiene, food safety, and product quality.

A significant number are implementing hygiene procedures like dedicated personnel entrances for different production areas, 63%, controlled access at 57%, 60% reporting the use of plant uniforms, and captive shoe programs at 49% (Figure 6.5). Again, as these companies mature toward market, they are introducing the procedures needed to succeed at production scale.

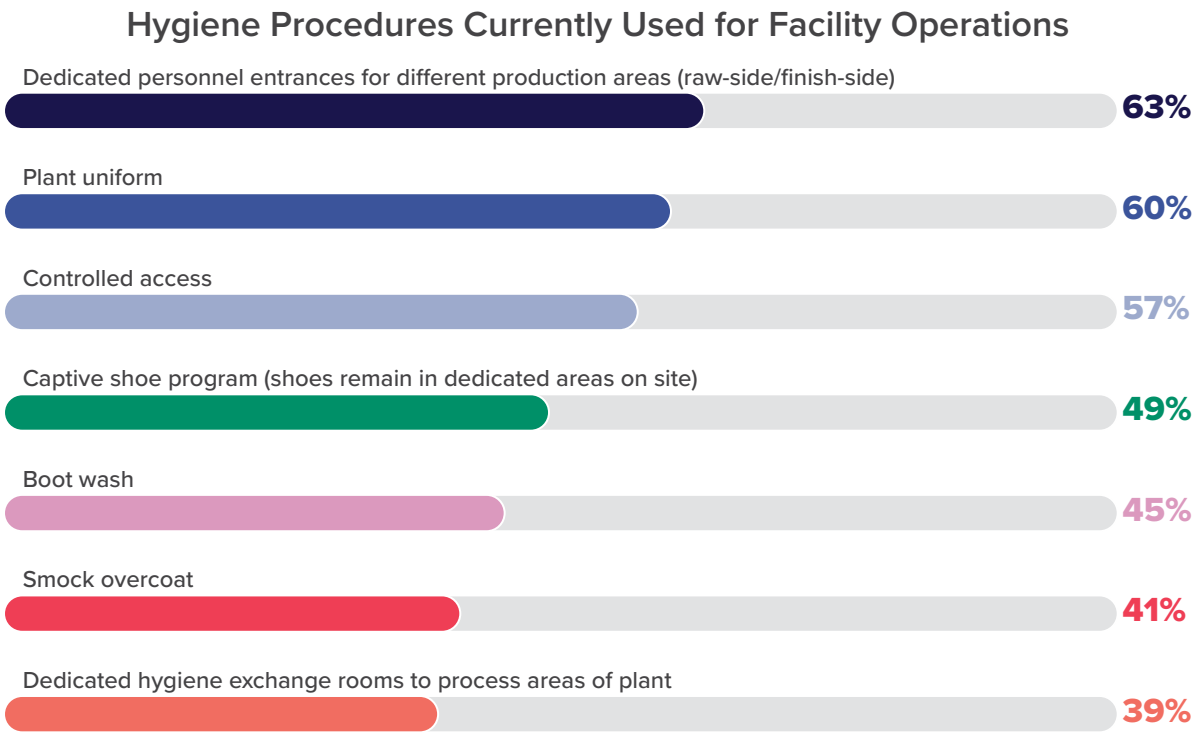
Implementation of dedicated hygiene exchange rooms is not widespread—with only 39% of respondents using them. This is likely due to the variety of products that are produced with alternative proteins, which require different types of care and processes. For example, closed processes used by alternative dairy production are treated differently than plant-based meat, where the entire facility should be considered as a ready-to-eat space. The risk analysis in each case determines whether dedicated exchange rooms inside the plant are required.

39%

of respondents are using dedicated hygiene exchange rooms.

FIGURE 6.5

Which of the following hygiene procedures apply to your facility operations? [Multi select]

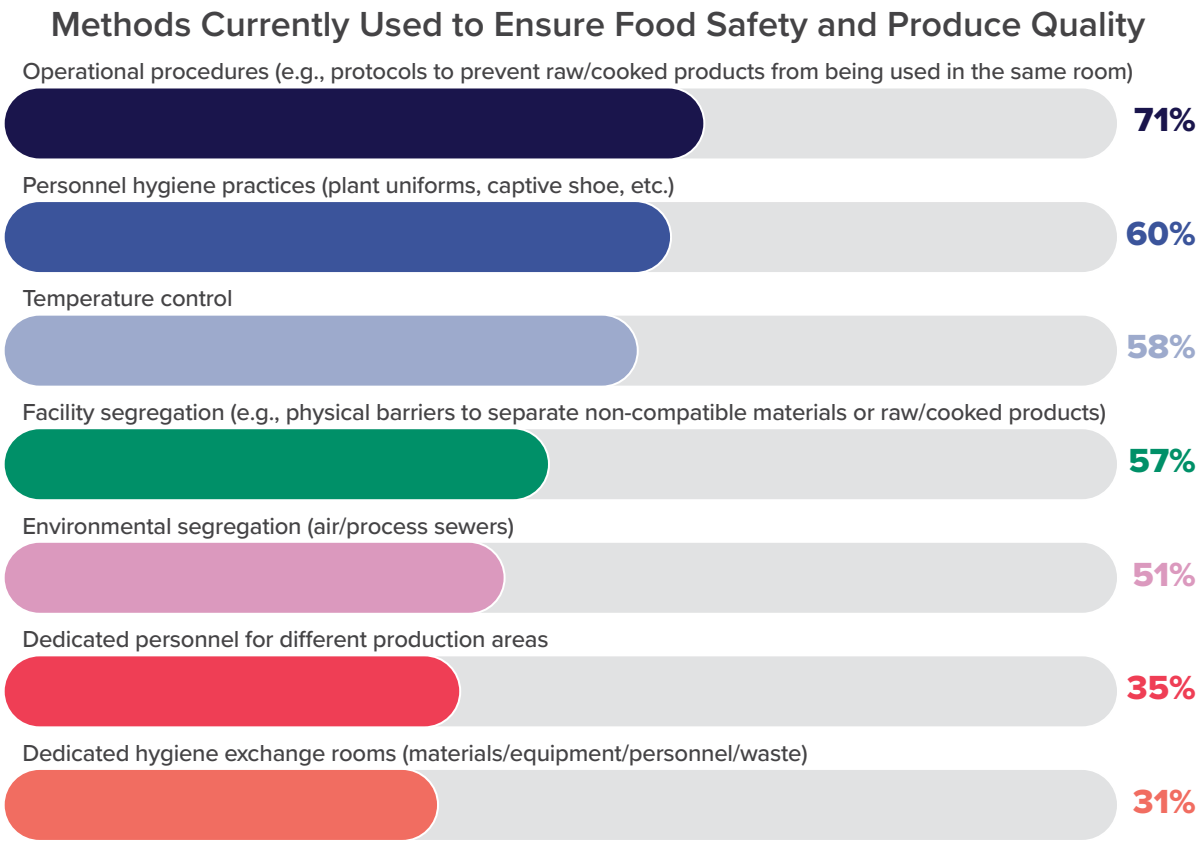


Source: CRB

In terms of food safety and product quality, results suggest that lower capital cost items are more likely to be implemented as food safety measures, suggesting that many respondents are likely still operating in older plants and at pilot scale (Figure 6.6). While they are not yet able to tackle difficult-to-change items like environmental segregation and temperature controls, they are very focused on operational procedures, hygiene, and segregation. We explore this more fully in the next section: planned upgrades.

FIGURE 6.6

What methods do you currently use to ensure food safety and product quality? [Multi select]



Source: CRB

PLANNED UPGRADES TO IMPROVE FOOD QUALITY AND SAFETY

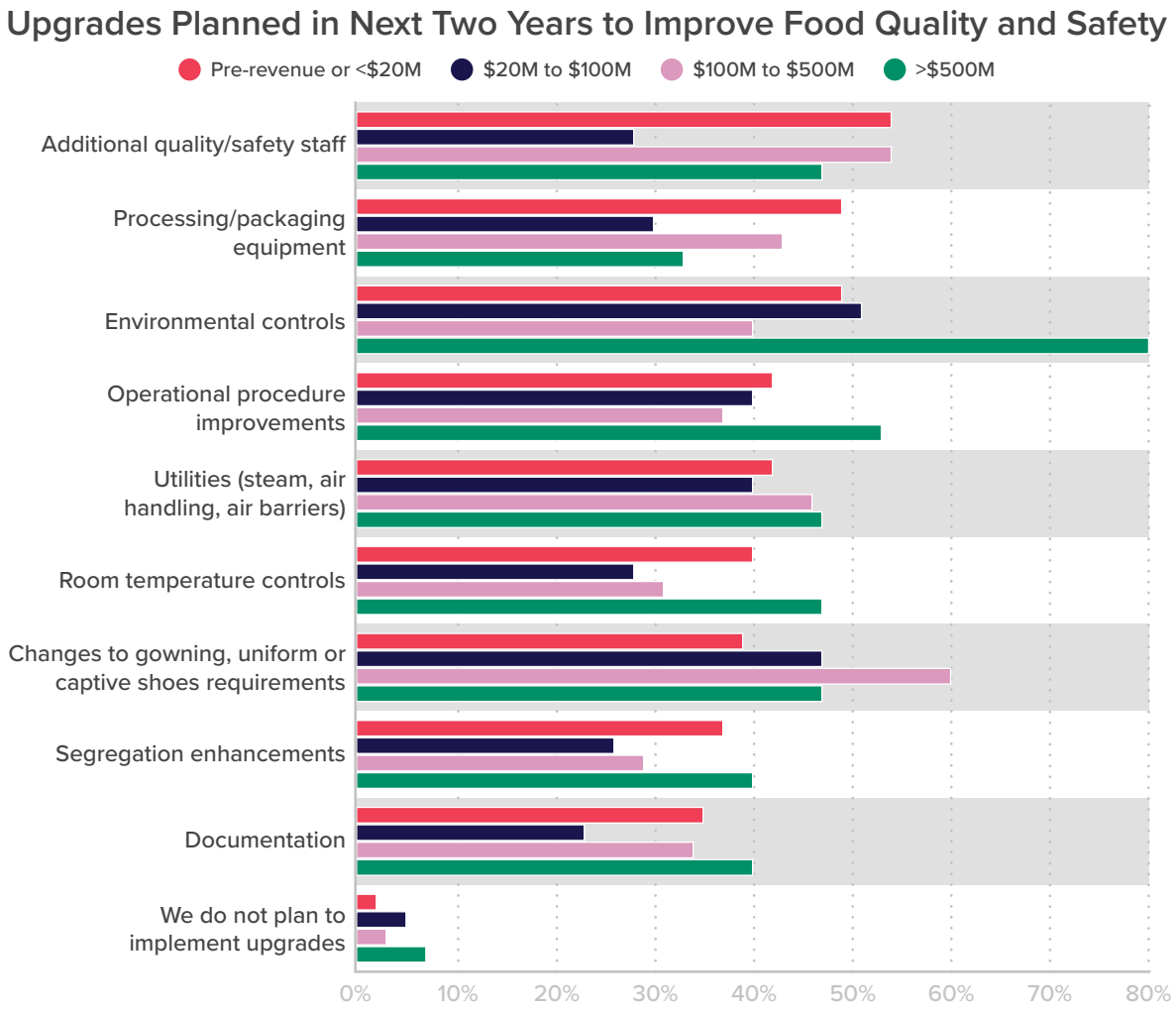
We know what these companies are doing now, but are there plans for the years ahead? The short story is that every company is growing and is facing new challenges as consumers and regulations exert pressure to maintain safety. As a rule of thumb, the larger the company, the more capital is available to make large upgrades, or even start greenfield construction. Likewise, these companies are more likely to be formalizing distribution arrangements with large retailers with high expectations on manufacturing controls. Here, we take a look at the responses broken down by company size.

As a company grows, it invests more in automation and incorporating engineering controls into the facility to ensure safety from the ground up.

Most interesting are the upgrades planned for mid-sized companies (Figure 6.7). The numbers here show clearly the tension at play for a company that is too large to depend only on people and hygiene procedures, but aren't quite ready to make major retrofits or plant additions.

FIGURE 6.7

Over the next two years, what upgrades do you plan to implement to improve quality/safety? [Multi select]



Source: CRB

SAFETY AS A RESPONSE TO MARKET PRESSURES

The ability to recall products, identify suppliers and purchasers, and alert them to issues has been given more exposure over the last several years. In addition to federal and state inspection, HACCP-based quality and safety certifications have grown as brands in and of themselves, with consumers viewing them as a badge of trust, particularly for new products.

Programs such as SQF, GFSI and British Retail Consortium (BRC) are becoming an imperative for US consumers, and we expect that it will become a global imperative in the next few years. More companies are obtaining certification to meet retailer demands and adding the logo to packaging to build brand trust (Figure 6.4).

Rising to the challenge

From a regulatory perspective, the results tell a story of a maturing alternative protein manufacturing industry. Whether it’s an understanding of the regulations themselves, a focus on procedures, personnel and facilities to improve food quality and safety, or plans for external certifications, the industry is growing up. It’s primed and ready for the challenges placed on it by consumers and large retailers alike, and it's supported by better resourced, more nimble regulatory oversight. So yes, exciting times for our rule-making and compliance friends, indeed.

AUTHORS

Sebastian Bohn, EIT, Sub Market Leader of Alternative Proteins, has a passion for guiding alternative proteins producers through scale-up and process technology selection for their evolving industry. His expertise includes fermentation, cell culture, data analytics, facility integration, project execution, and process scale-up. Bohn has executed a wide range of projects in the food and beverage, industrial biotech, and life sciences industries and appreciates the challenge of designing processes and facilities that can expand and grow to meet future needs.

Jonathan Clark, PE, is a licensed professional mechanical engineer with over 15 years of experience. He has designed and worked with sanitary and industrial heat exchangers, conducted steam system surveys, gummy and confectionery processing systems, biopharmaceutical batch blend systems, and clean-in-place system designs and surveys. Clark's knowledge extends into batching and blending kitchens for liquid foods and has experience with mycelium fermentation in a variety of food products.

Dennis Collins, AIA, CRB Sr. Associate, brings 39 years of experience in architectural design to his role as Architectural Group Leader. Dennis works closely with food and beverage clients to understand their business drivers and leverage creative solutions to deliver safe, lean, and well-organized facilities.

Pablo Coronel, PhD, is a Senior Fellow of Food Processing and Food Safety and an FDA-recognized Process Authority. He leverages 20 years of experience as a process engineer and food scientist, especially in the development of novel technologies processing and hygienic manufacturing field, to lead clients in product and process design, food safety, and regulatory compliance development. He is a co-editor of the third edition of the Handbook of Aseptic Processing and Packaging.

Maya DeHart, EIT, LEED GA, is an Energy and Sustainability Specialist with over 7 years in the AEC industry. Experienced in managing process design, she brings a holistic approach to sustainability to our client's projects. Maya believes that sustainability should be a thread that runs through every aspect of every project and has helped integrate clients' goals of LEED building certification into the design and construction processes.

Krizia Diaz, AIA, NCARB, is a Market Team Lead with over 10 years of experience in architectural design. Krizia serves as an architectural subject matter expert for food & beverage projects, particularly in the alternative protein space. She has performed as lead architect in a variety of project types through all design phases and construction, including meat processing plants, and RTE and food ingredients manufacturing facilities.

Jonathan Dressler, PE, is a Project Manager and Electrical Engineer, leveraging his experience in design and execution to deliver innovative and efficient solutions to clients' complex challenges. Jonathan is dedicated to understanding clients' business drivers and their impact on project success.

AUTHORS

Aaron Kilstofte, PE, is a Mechanical Engineer with 10 years of experience in engineering design, systems analysis, performance testing, business development, and engineering services management. His experience includes front-end conceptual design, detailed engineering, equipment procurement, and construction oversight of mechanical systems throughout industrial-scale food production facilities and utility-scale power plants.

Brendan Kress, AIA, NCARB, is a Senior Architect with over 20 years of experience. Brendan has experience in all phases of the design and construction process including master planning, space needs study, programming, design and detailing, production of construction documents, and construction observation. He has project experience in food and beverage production, ingredient food additives production, alternative proteins, and pet food facilities.

Tony Moses, PhD, a Fellow of Product Innovation, is passionate about developing successful manufacturing strategies for Food and Beverage companies in high-growth markets. He brings more than 15 years of industrial experience, ranging from new product commercialization to capital project design and planning, in both CPG brands and food ingredients.

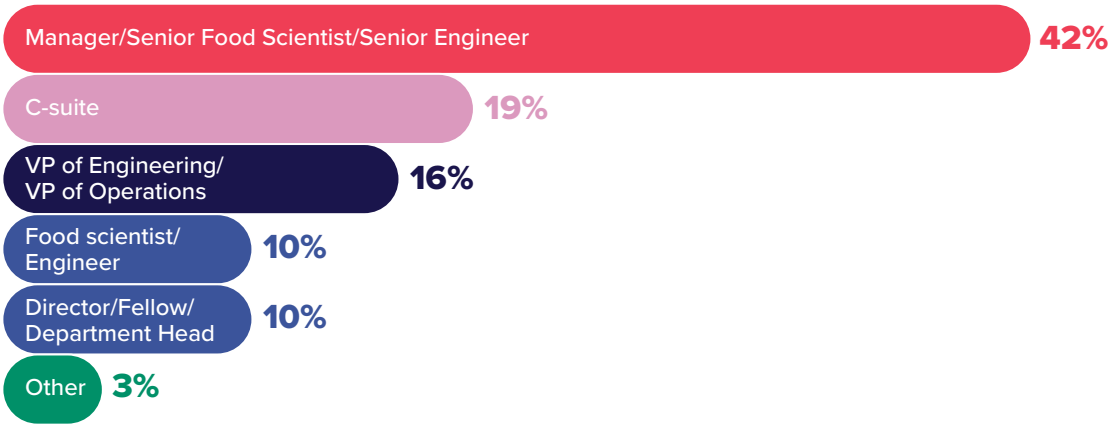
Jason Robertson is Vice President of Food + Beverage at CRB with more than 25 years of experience in design and construction. He has dedicated his career to bringing innovative solutions to food and beverage clients by leveraging industry expertise and collaborative relationships.

Jason Tucker is a Fellow of Food Equipment & Systems and a 3-A Certified Conformance Evaluator. Jason brings more than 20 years of experience in process and equipment design, with a focus on the design of food and beverage equipment and hygienic regulatory standards.

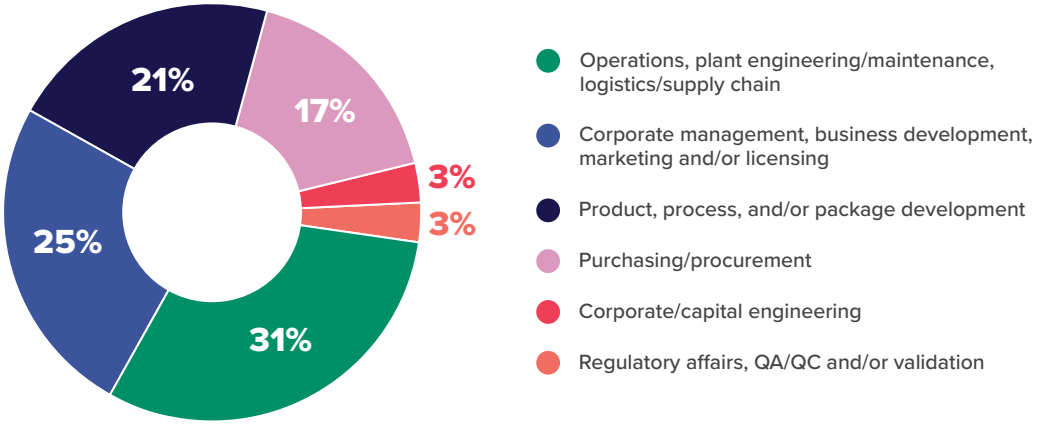
Derek Ung, PE, is a Western Region Process Group Leader with more than 25 years of knowledge in facility, process and equipment design for fermentation, cell culture in alternate proteins, therapeutic proteins, and gene therapy industries. His blended expertise in alternative proteins and life sciences allows him to develop innovative cell-based and plant-based protein facility designs. Ung is well versed in the evolving regulatory requirements for alternative proteins manufacturers and appreciates the challenge of designing a process and facility to meet both FDA and USDA requirements.

FIRMOGRAPHICS

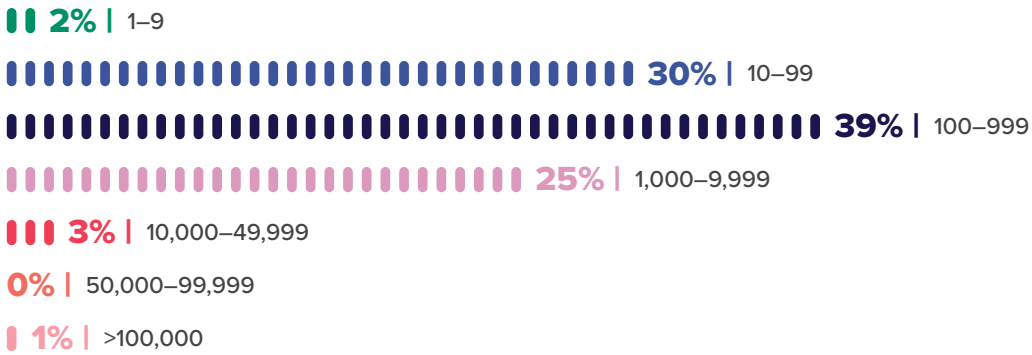
Primary Respondent Role



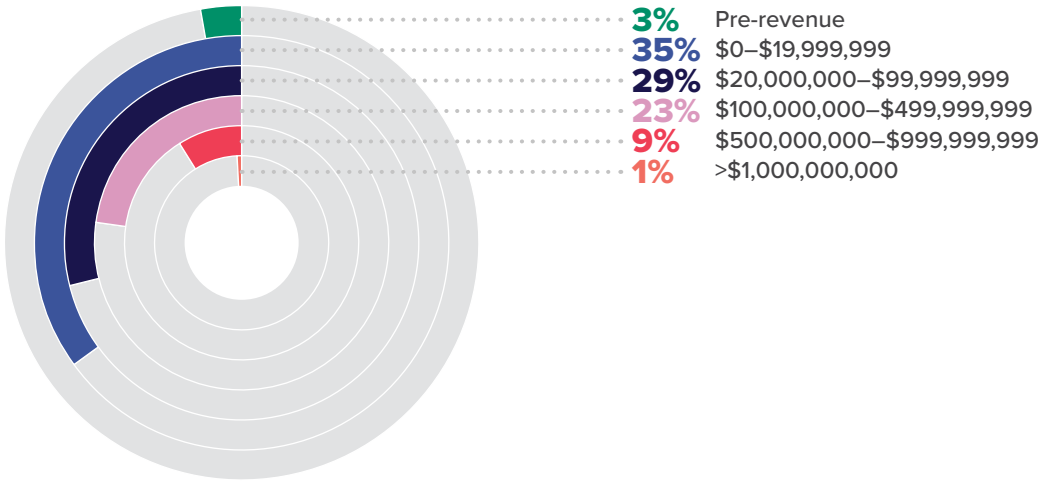
Primary Respondent Job Function



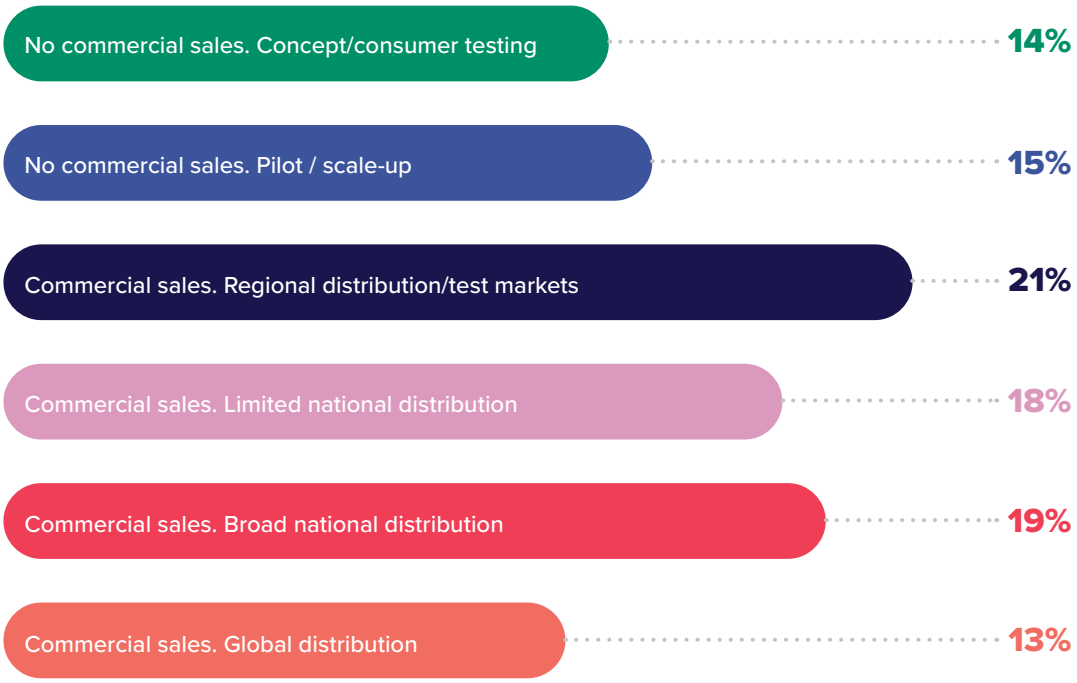
Company Size by Employees



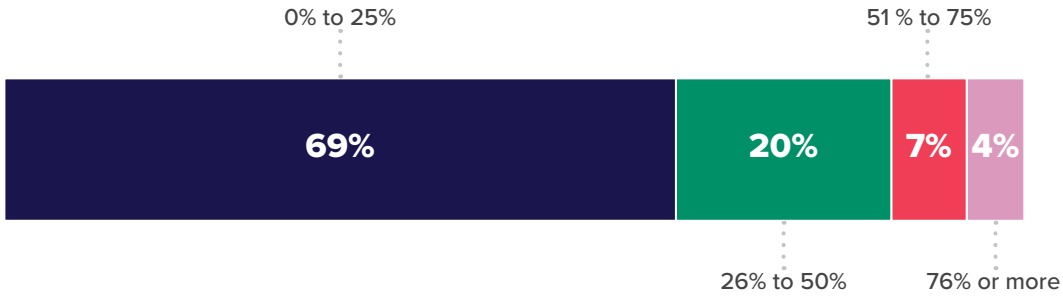
Estimated Annual Revenue



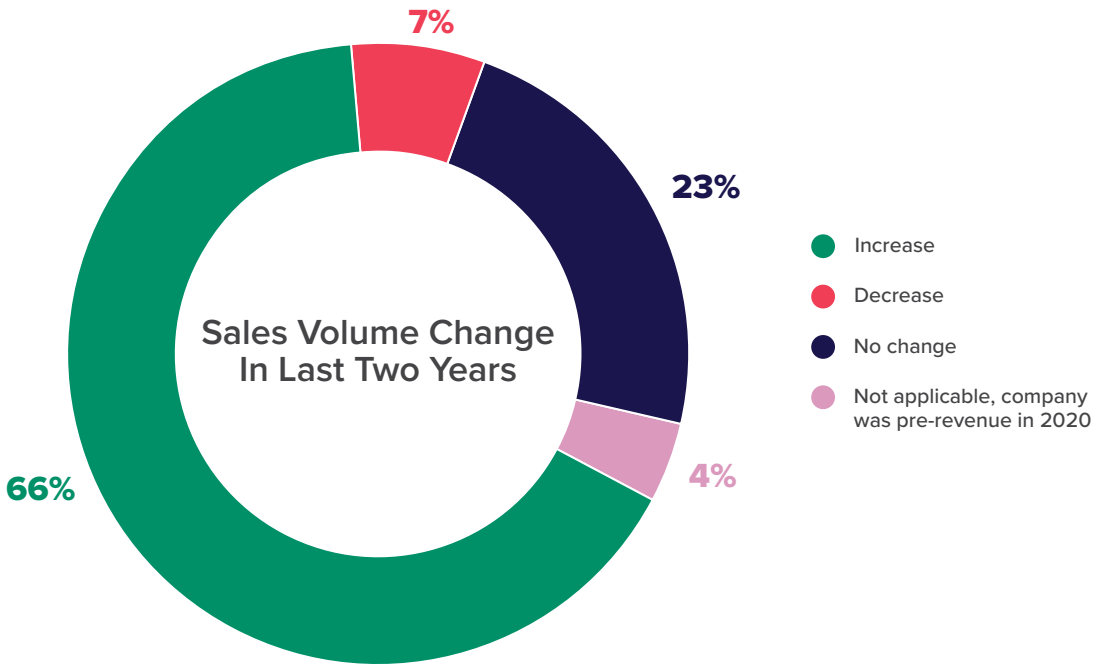
Development Phase Breakdown



Annual Growth Target Over Next Two Years

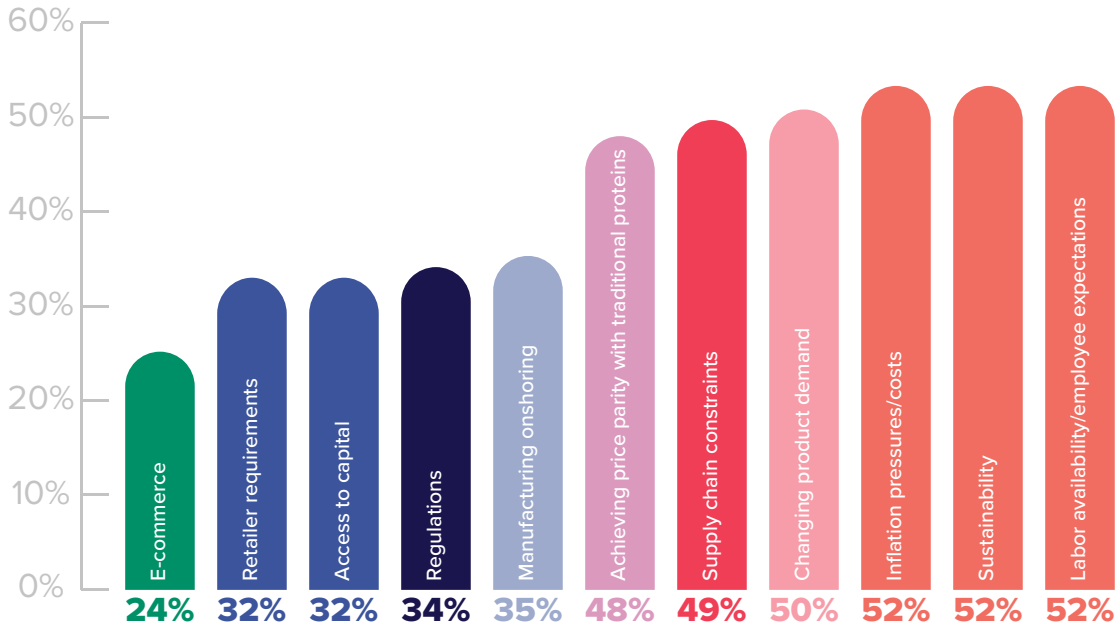


Sales Volume Change In Last Two Years



Top Business Influences

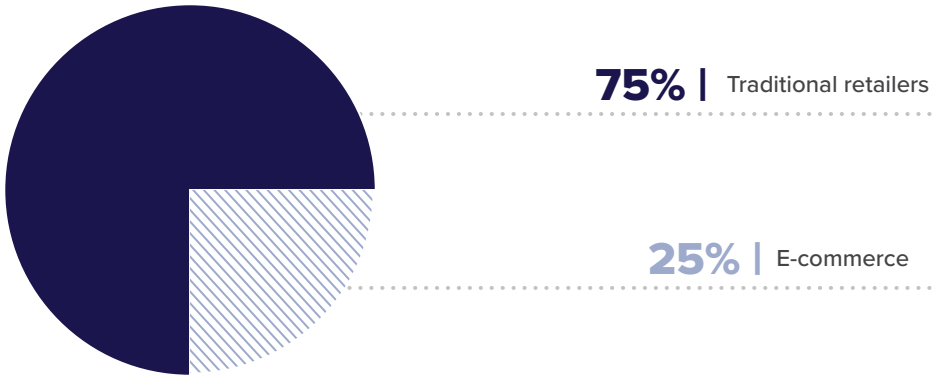
% Selected as Important



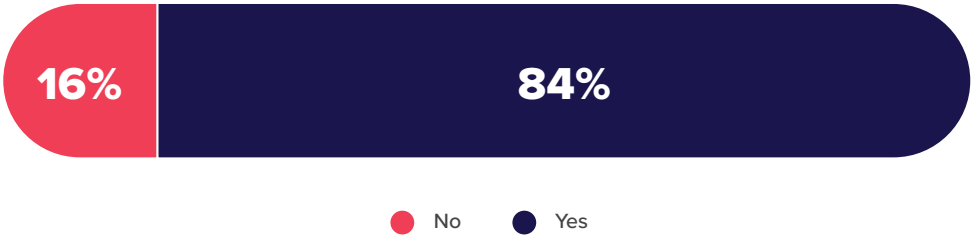
What percentage of your company's products go to the following destination(s)?

What best describes your company's area of focus in the retail store?

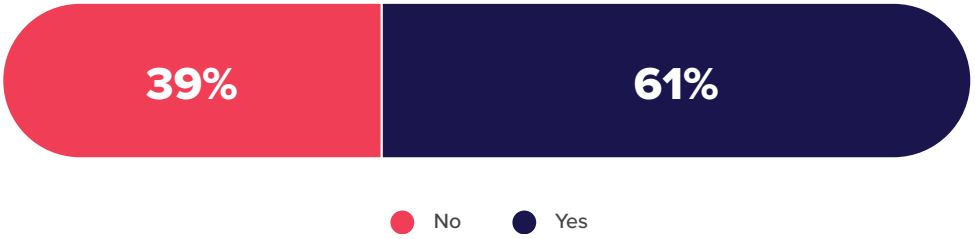
(Those who send at least some share to retail)



Do you anticipate needing to increase your manufacturing capacity in the next two years?

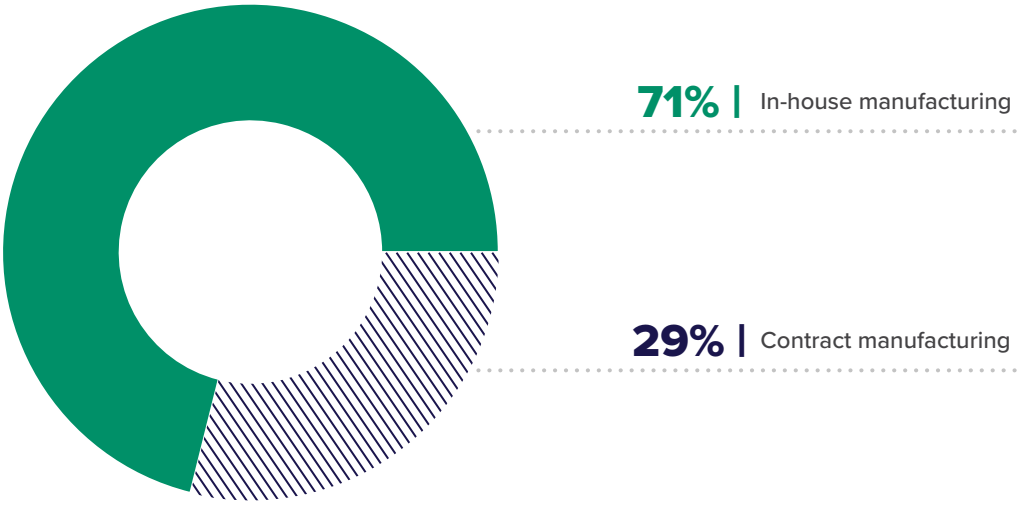


Are you a contract manufacturer?

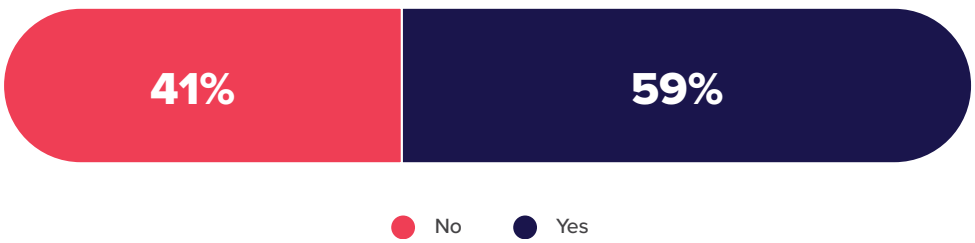


For your company's production strategy over the next two years, how much are you planning to pursue in-house or contract manufacturing?

(Non-contract manufacturers only)



In the future, do you plan to increase the percentage of product made at contract manufacturers/contract packers?



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