Good Food Institute

TECHNICAL SUMMARY

Plant-based meat techno-economic analysis



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The report summarizes the key results, interpretation, and recommendations of the plant-based meat techno-economic analysis conducted in partnership with Next Rung Technology. The full technical white paper with detailed model methodology, inputs, assumptions, and results, can be found here and referenced as:

Ashizawa, R., A. Haeger, J. Wimble, K. Trinidad, J. Ellersick. Plant-based meat manufacturing: A commercial scale TEA of extrusion and production formulation facilities. Washington D.C.: Good Food Institute. 2026. https://doi.org/10.62468/rphc5799

Regional Case Study Partners

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Data Partner: Bühler Group

Bühler Group is one of the largest providers of industrial processing solutions and serves billions of people every day through its food-production equipment and mobility-part-producing technology. Every day, two billion people enjoy foods produced on Bühler equipment, and one billion people travel in vehicles with parts manufactured with Bühler solutions.

Bühler Group provided essential industry data and technical expertise that strengthened the real-world basis of this analysis, including block flow diagrams, process parameters, mass balance, and price estimates for commercial-scale low-moisture and high-moisture extrusion systems using soy protein concentrate. These data were essential to ensuring that the techno-economic model in this analysis accurately reflected commercial-scale extrusion systems and real-world operating conditions.

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Executive summary

What we learned

Plant-based meat production costs remain above conventional meat targets, primarily because of formulation costs and manufacturing inefficiencies. In the near term, some products can reach cost parity without increased demand. In the long term, ingredient innovation must deliver better sensory performance at competitive cost to drive demand and enable the scale needed to close the remaining gap for a wide range of products.

This analysis explores the cost drivers of plant-based meat production and evaluates viable pathways to improve cost competitiveness today and in the future.

Why this matters

Plant-based meat can help meet the world's growing demand for meat while increasing food security, promoting biodiversity, and protecting public and planetary health. Realizing these benefits, however, requires products that can compete with conventional meat on the attributes consumers value most: taste and price.

Today, many plant-based meat products fall short on both fronts. Despite using less energy and fewer raw materials than conventional meat production, plant-based meat remains significantly more expensive. In 2025, in the United States, most plant-based meat categories averaged two to four times the price of their conventional counterparts on a per-pound basis. Further innovation is also needed to deliver the sensory experience consumers expect from meat.

Key findings

1 The current gap: Production costs are up to 2x higher than conventional meat.

Modeled production costs (represented by cost of goods sold, or COGS) for plant-based meat under current-state conditions are ~25–100% higher than conventional meat targets (Table 1). This cost gap is not uniform across products, for example, ground beef cost is relatively close to parity, while whole-cut chicken COGS is more than double the parity target (Table 1).

Table 1. Modeled cost of goods sold (COGS) for plant-based meat products under current production conditions compared to conventional meat cost targets. Conventional meat cost targets reflect the mainstream/standard segment of the benchmark products and are estimated from U.S. retail and wholesale prices minus post-production markups and costs.

$/kg	Ground beef	Chicken nuggets	Whole-cut chicken
Current plant-based COGS	$6.52	$6.20	$7.36
Conventional meat COGS parity target	$5.26	$3.77	$3.63
% difference	+24% above parity	+65% above parity	+103% above parity

2 Ingredients and manufacturing inefficiency drive the current cost gap.

A. Low market share and inconsistent demand lead to manufacturing inefficiencies.

- Interviews with 40+ companies and experts indicate that owned plant-based meat manufacturing facilities are relatively small-scale (5,000 metric tonnes per year (MTA) or less), and utilize only ~50% of available capacity on average, with product losses of up to 20%.
- Experts attribute these manufacturing inefficiencies to low and inconsistent demand, which contributes to shorter production runs, frequent changeovers, and underutilized capacity (Figure 1).
- Additionally, these conditions can lead to overreliance on contract manufacturing organizations (CMOs), which—particularly when CMOs charge fees over $2.00/kg of finished product—may increase costs.

B. Ingredients are the largest cost driver.

- Plant-based meat formulations often require specialty flavors, binders, and colors that are relatively expensive. This contributes to high ingredient costs, which account for over half (55–62%) of the modeled production cost.
- Flavor ingredients alone account for 33–39%, driven by specialty flavors, which are particularly cost-intensive, averaging ~$40–60/kg, because they are often customized for specific products.

C. Capital efficiency is not a major constraint.

- Extrudate and finished-product facilities quickly achieve economies of scale even with moderate scale up because they use optimized, well-established, commercial-scale equipment and production systems.
- Plant-based meat requires similar capital investment per unit of capacity as conventional meat, suggesting limited need for further capital-cost reductions.

Low demand creates a negative feedback loop that increases costs and constrains consumer adoption.

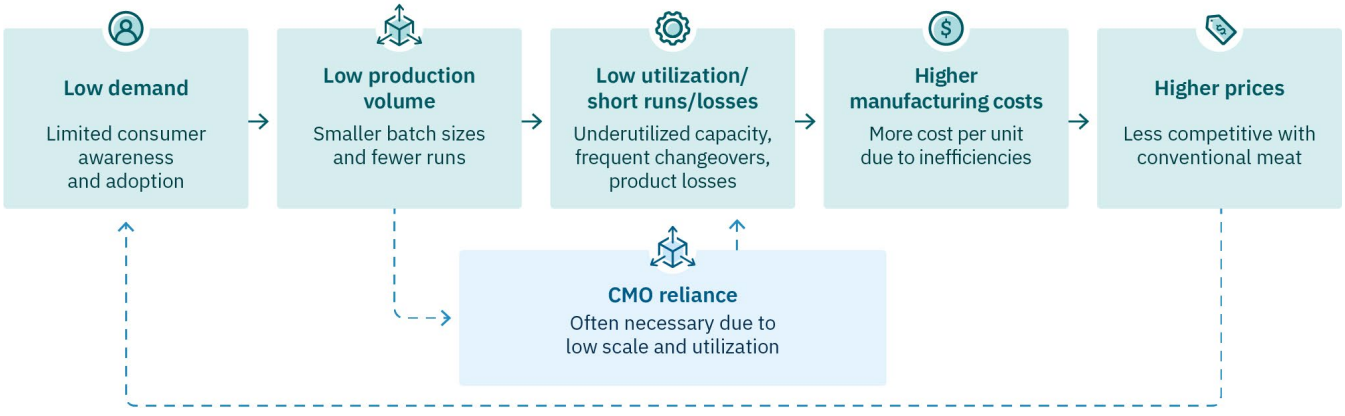


Figure 1. The negative feedback loop of plant-based meat production and cost.

3 Pathways to parity exist today without added demand.

Under weak demand conditions, several strategies exist to achieve parity for ground beef and chicken nuggets that do not depend on increased consumer demand (Figure 2). For ground beef, any one of the strategies below is sufficient to achieve or approach parity, but multiple strategies are needed for chicken nuggets.

A. Improve operational efficiency of owned manufacturing without added capital investment.

- Increasing utilization (from 50% to 100%) of the current-state small-scale facility and reducing product loss (from 20% to 10%) resulted in a ~$1.00/kg reduction in modeled COGS for ground beef and chicken nuggets, bringing ground beef within range of its parity target.
- Increased utilization and reduced product loss can be achieved by:
  - Centralizing production in fewer facilities,
  - Contracting excess capacity to other producers with similar production requirements, and
  - Optimizing production schedules.

B. Reduce formulation costs through lower-priced flavors and extrudates.

- Using specialty flavor and extrudate ingredients currently available at the low end of today's prices reduced COGS by ~$2.00/kg, achieving parity for ground beef.
- Low ingredient costs require deliberate formulation and supplier choices, with sensory trade-offs that may dictate product formats and sales channels.

C. Use CMOs with favorable fees.

- Modeled COGS for ground beef and chicken nuggets decreased by ~$1.80/kg when manufacturing was shifted from an underutilized, high-product-loss owned facility to a CMO with favorable fees.
- Use of a low-cost CMO (conversion fees below ~$2.00/kg of finished product) can help achieve cost parity for ground beef and chicken nuggets.

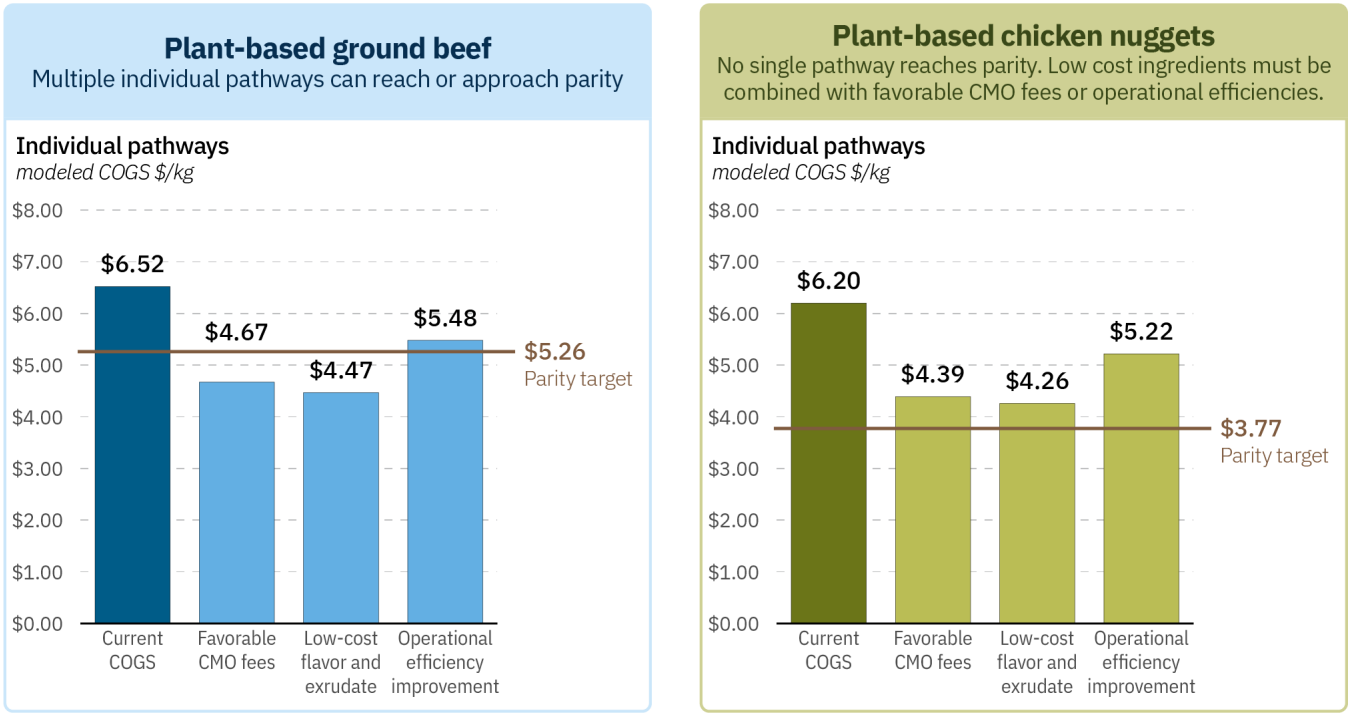


Figure 2. Pathways to achieve or approach parity today for ground beef and chicken nuggets. Favorable CMO fees = $1.32/kg final product; Operational efficiency improvement = 100% utilization (82% uptime) and 10% product loss; Low-cost flavor system (specialty flavors + spices and yeast) = $8.91/kg; Low-cost extrudate = $1.50/kg.

4 Breaking the cost-demand cycle in the long term will require ingredient innovation and scale.

To drive broader consumer adoption, plant-based meat needs to deliver improved sensory performance without increasing formulation costs. Increased and more consistent demand can then enable larger-scale, higher-utilization manufacturing, further reducing production costs. Together, lower-cost, higher-performing ingredients and scaled manufacturing can bring all three modeled products below conventional meat cost targets (Table 2).

A. Ingredient innovation: Deliver better sensory performance with flavor and extrudate improvements at lower cost.

- Ingredient innovation is essential for both cost and taste parity and creates conditions for greater consumer demand.
- Concentrating research on the highest-impact protein, flavor, and fat challenges while aligning with the cost targets defined in this analysis can focus development on solutions with the greatest potential to accelerate parity.

▸ See Key recommendations section for specific innovation recommendations.

B. Scaling: Increase facility production volume and operational efficiency

- More consistent and greater consumer demand breaks the negative feedback loop (Figure 1) and allows for larger-scale facilities with high operational efficiency (high facility utilization + low product loss).
- When modeled together, scale and operational efficiency reduce the cost gap by 29–38% compared to the modeled current production scenario (holding other input costs constant).

Combined with flavor, fat, and protein prices at the low end of modeled ranges, scale and operational improvements bring all modeled products below parity targets (Table 2).

Table 2. Future COGS + low protein, flavor, and fat ingredient pricing. Future COGS represents a 15,000 MTA facility at 100% utilization (82% uptime) and 10% product loss. Low protein, flavor, and fat ingredient pricing represents the low end of 2026 ingredient prices.

$/kg	Ground beef	Chicken nuggets	Whole-cut chicken
Future COGS + low ingredient pricing	$2.97	$2.84	$3.01
COGS parity target	$5.26	$3.77	$3.63
% difference	**44% below parity**	**25% below parity**	**17% below parity**

Main takeaway

Plant-based meat production costs remain above conventional meat targets, primarily because of formulation costs and manufacturing inefficiencies. Ground beef and chicken nuggets can reach cost parity today without increased demand through improved operational efficiency, lower-cost formulations, and/or favorable CMO economics (Table 3). In the long term, ingredient innovation must deliver better sensory performance at competitive cost, helping drive demand and enable the scale needed to close the remaining gap for whole-cut chicken and create a more mature and stable manufacturing supply chain.

Table 3. Summary of scenarios where products achieved conventional meat cost target.

	Ground beef	Chicken nuggets	Whole-cut chicken
Current "low-demand" manufacturing	✗	✗	✗
Current + near-term cost reduction strategies	✓	–	✗
Future ingredient innovation + scale-up with higher demand	✓	✓	✓

✗ = did not achieve target; ✓ = achieved target with a single strategy applied; – = achieved target with multiple strategies applied. Current conditions = low-demand environment resulting in manufacturing inefficiencies and small-scale facilities. Future conditions = high-demand environment with larger-scale facilities, high manufacturing efficiency, and cost-competitive ingredients.



Photo credit: Impossible Foods

Key recommendations

Plant-based meat manufacturers and supply chain partners

Actionable pathways exist to reduce costs and accelerate the path to price parity, even without increased demand. Targeted formulation and manufacturing efficiency improvements can deliver meaningful near-term savings, with greater reductions possible as the market scales.

Use low-cost CMOs where quality can be maintained.	Expert interviews and modeling indicate CMO tolling fees range from ~$1.32–5.00/kg. For plant-based ground beef, fees at the lower end of this range can significantly reduce COGS relative to production in current-day owned facilities, bringing costs below parity targets. Manufacturers should weigh these savings against potential trade-offs in production quality control and reliability.
Generate value from idle capacity by contracting production for similar products.	Manufacturers with excess capacity could contract production for plant-based products with similar processing requirements, increasing utilization and enabling longer production runs while minimizing changeovers and product losses.
Reduce formulation costs by testing lower-cost extrudates and flavor systems.	Lowering flavor and extrudate costs was the single most effective way to significantly reduce COGS across products. Selecting ingredients at the low end of their price ranges ($10/kg for specialty flavor and $1.50/kg for extrudate) significantly reduced COGS. Managing trade-offs in sensory performance can be achieved by choosing appropriate formats, sales channels, or complementary ingredients such as spices and sauces.
Co-manufacture with legacy producers using existing facility production lines.	Leveraging existing producer infrastructure avoids capital-intensive builds, though allergen isolation and dedicated runs remain crucial for product integrity.



Photo credit: Carlos Gonzales/Stocksy/Adobe Stock

Researchers and ingredient developers

Ingredient innovation is essential for both cost and taste parity. Concentrating research on the highest-impact protein, flavor, and fat challenges paired with specific cost-in-use targets can focus development on solutions with the greatest potential to accelerate parity.

Advance protein solutions to improve flavor neutrality and enable greater use of less-refined ingredients.	Crop breeding and improved ingredient processing can produce protein inputs with fewer off-notes and reduce the need for masking agents and complex flavor systems, freeing up formulation budget while also making it easier to achieve the desired sensory profile. Improving the texturization and sensory performance of less-refined inputs, such as dry-fractionated protein concentrates and protein flours, can further reduce protein ingredient costs.
Design multifunctional hybrid and blended ingredients that replace existing cost drivers.	Fermentation-derived, cultivated, and animal-derived fats, proteins, and flavor ingredients can improve sensory performance while replacing multiple existing formulation components, potentially offsetting their higher cost. Researchers should design these systems around the maximum cost-in-use the finished product can support, considering both inclusion rate and the costs of the ingredients they displace. The report's ingredient price ceilings provide concrete R&D targets for balancing performance, inclusion rate, ingredient displacement, and price.
Enable larger-scale production and distribution of high-moisture extrudate (HME) ingredients.	Develop more standardized HME formats and stronger demand signals across the industry to aggregate purchasing volumes and make ingredient-supplier-led HME production more commercially viable.
Develop cost-effective flavor systems and solid fat alternatives to tropical oils.	Design flavor and structured fat technologies around finished-product cost-in-use targets and assess economic feasibility early in development. Prioritize solutions that can meet ingredient price ceilings at scale or replace other costly ingredients.



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Investors and capital providers

Plant-based meat offers low technical execution risk and high capital efficiency. Targeted investments in near-term production improvements can deliver significant cost reductions, improve unit economics, and increase product competitiveness.

Invest in cost-effective ingredient innovation, with a focus on flavor.	Prioritize technologies that can meet the ingredient price ceilings required for finished-product cost parity or that replace other costly ingredients in the formulation. Flavor is particularly constrained: at baseline prices for other ingredients, flavor must remain below approximately $51/kg for ground beef, $25/kg for chicken nuggets, and $20/kg for whole-cut chicken to maintain parity.
Invest in companies scaling sensory-enhanced HME.	Few U.S. ingredient suppliers currently produce HME, forcing plant-based meat manufacturers to rely on CMOs or build their own capacity. Co-producing low moisture extrudate (LME) and HME at commercial scale can substantially reduce HME costs while maintaining similar LME production costs. Importantly, sensory-enhancing HME technologies (e.g., gas injection) can be integrated into commercial extrusion with relatively modest additional capital investment.
Prioritize operational enablers like shared infrastructure models and yield-optimizing technologies.	Fund low-cost (≤$2.00/kg final product) CMO or shared manufacturing models and processing automation technologies. Aggregating volume to achieve full facility utilization is the most powerful operational lever for cost reduction. Pairing higher utilization with loss-reducing technologies drives compounding savings across fixed overhead and raw material costs.



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Policymakers

Plant-based food manufacturing facilities can create high-quality jobs and access new markets for regional crop inputs such as soy, corn, wheat, and specialty crops. Plant-based foods have important production efficiency, shelf-stability, and sustainability benefits, making them more resilient against food supply shocks. Investment in plant-based food manufacturing is investment in food security, resource efficiency, public health, and economic development.

Establish or expand loan, loan guarantee, tax incentive, and grant programs to support efficient commercial-scale manufacturing.	Loan and loan guarantee programs can de-risk and crowd in private capital to finance plant-based manufacturing facilities at low cost to the government. Tax incentives and grants can reduce the capital burden on companies, allowing them to build and scale sooner and manage the ramp toward higher facility utilization. GFI interviews with industry stakeholders indicate that where companies choose to build facilities greatly depends on the public incentives available. Policymakers who establish and expand programs that support manufacturing scale up will successfully attract business to their jurisdictions.
Fund open-access research to optimize ingredients for flavor.	Funding R&D for crop development, ingredient optimization, flavor enhancement, and product formulation will improve the taste and lower the cost of plant-based meat and de-duplicate research currently occurring within private companies. Establishing an AI-enabled national data repository for food biotechnology would improve ingredient discovery and optimization.
Support shared infrastructure.	Shared pilot-, demonstration-, and commercial-scale infrastructure can allow food companies to test, develop, and produce products without outlaying large amounts of capital to build facilities. By aggregating fragmented production across multiple facilities, shared infrastructure can improve facility utilization and reduce capital burden. Governments should fund and incentivize shared facilities, which can also function as workforce development hubs.