
THE ALMOND CONFERENCE
2025
WELCOME!
1
CULTIVATING A HEALTHIER
FUTURE

2025 THE ALMOND CONFERENCE

ALMOND HULLS AND SHELLS FOR FOOD USES

MODERATOR: MICHAEL KELLEY, CCAGA

SPEAKERS: DANIEL KURZROCK, UPCYCLED FOODS, INC.
BARB STUCKEY, MATTSON CO.
WILLIAM GHIRARDELLI, BÜHLER INC.
MARK SOBERMAN, BÜHLER INC.

DECEMBER 10, 2025

CULTIVATING A HEALTHIER FUTURE

UPCYCLED FOODS INC™ + LAB™

Hulls and Shells for Food Uses

Transforming almond hulls into innovative ingredients and applications is at the intersection of profit, health, nutrition, and sustainability!

The Almond Conference 2025

UPCYCLED FOODS INC + LAB

WHO WE ARE

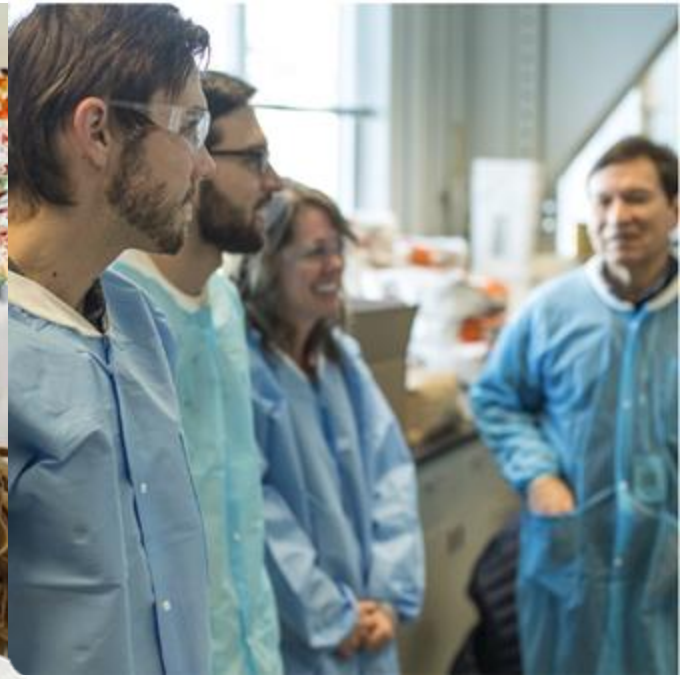
We supply high-quality upcycled ingredients and partner to help companies uncover and develop their own upcycling opportunities.

Turning waste into profitable and impactful innovation.

OUR INTEGRATED PLATFORM:

How it started and how it's going...

UPCYCLED FOODS INC™ + LAB™



2011

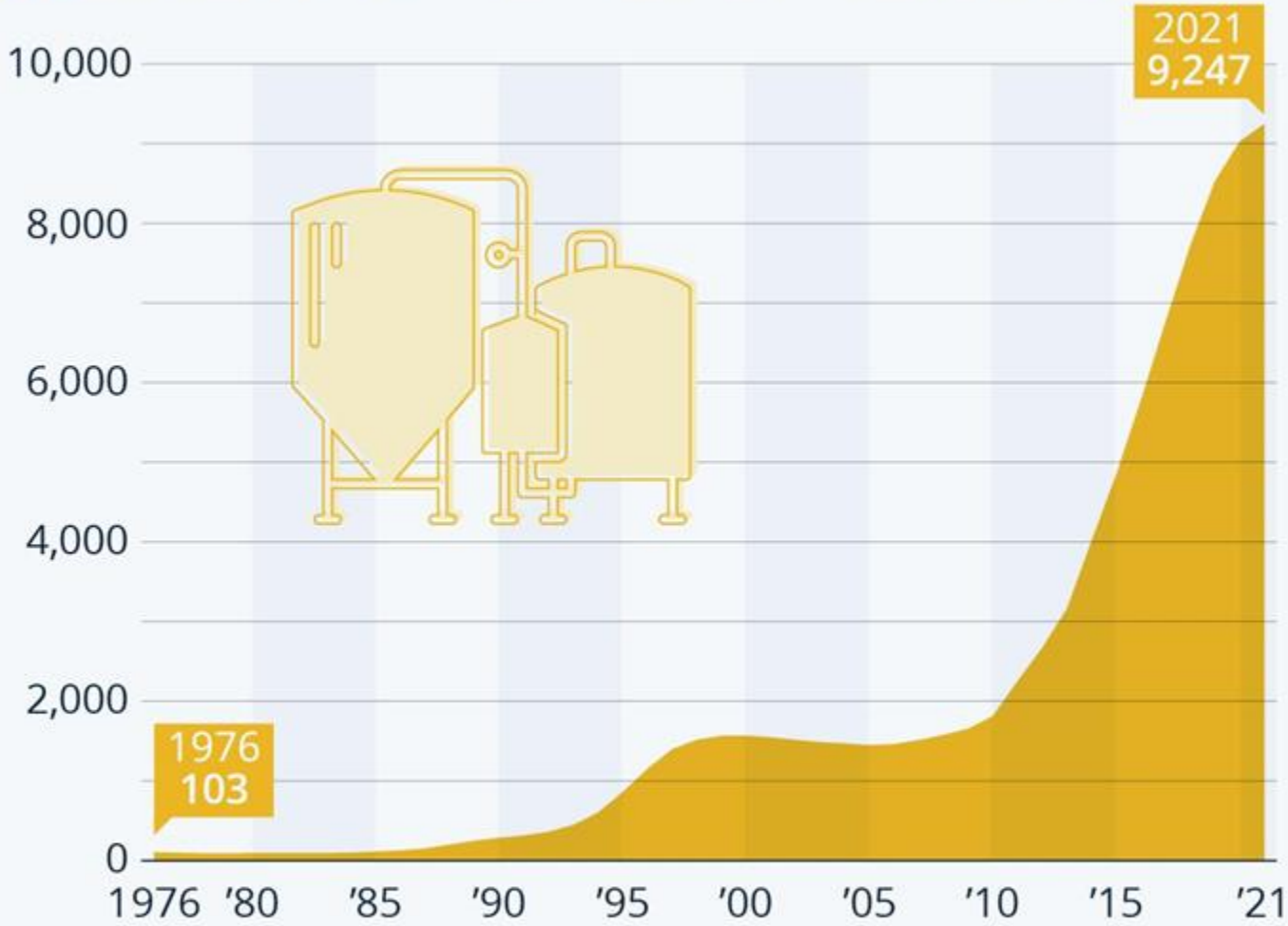
2015

2023

UPCYCLED FOODS LAB™

America's Brewery Boom

Number of breweries in the U.S. from 1976 to 2021



Source: Brewers Association

statista

Flagship Ingredient Product:

UPCYCLED FOODS INC + LAB

REGRAINED
SuperGrain+®

*Average vs whole wheat flour

CO2
40%
REDUCTION
111.5 G CO2
PER 100G FLOUR

LAND
0%
OF AVG
0 M2
PER 100G FLOUR

WATER
.002%
OF AVG
0.004 L H20
PER 100G FLOUR

PROTEIN
2-4X
OF AVG*
30-50G PROTEIN
PER 100G

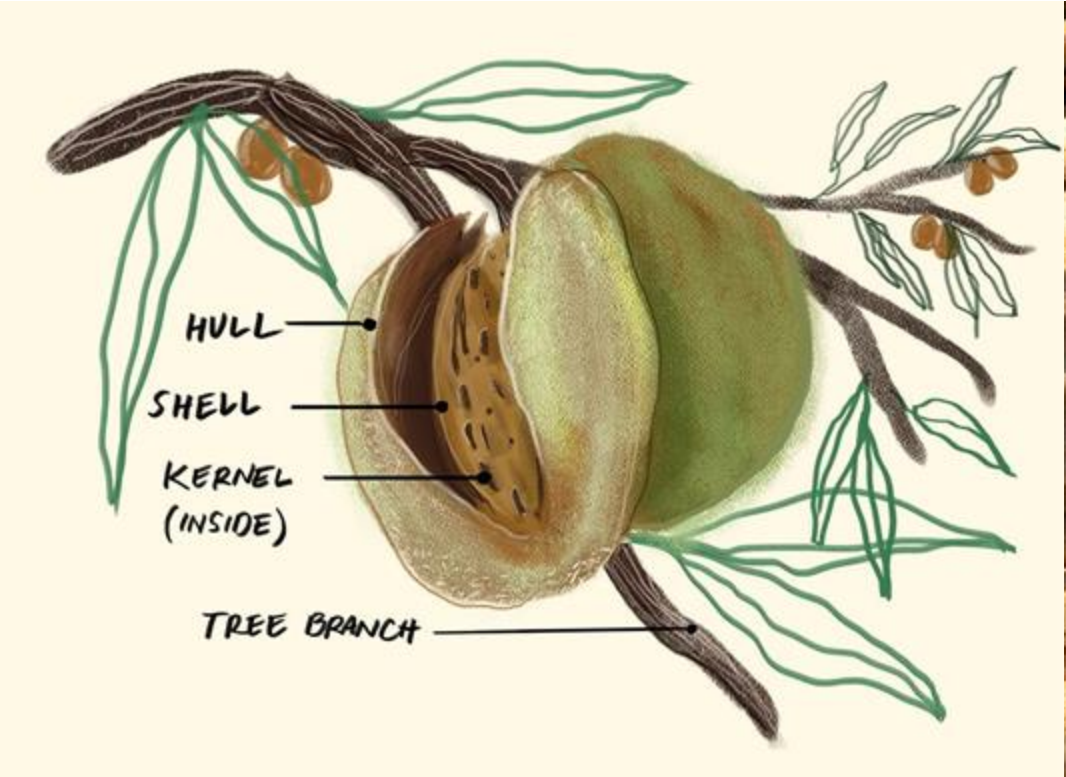
FIBER
4-7x
OF AVG
44-70G FIBER
PER 100G

Kroger®

> *Upcycled Foods, Inc. helped us connect the dots between our food waste reduction goals and our private brands product innovation priorities.*

– Mike Florea, Kroger Private Brands

Now we seek to do the same with almond hulls!



BEAM CIRCULAR
BIOECONOMY • AGRICULTURE • MANUFACTURING

california almonds

UPCYCLED FOODS LAB

ALMOND UPCYCLING POTENTIAL

- Enhance the overall sustainability and circularity of operations
- Unlock new revenue streams
- Reduce disposal costs
- Align with growing consumer and industry demands
- Strengthen industry reputation in sustainability
- Create partnerships and collaborations that drive technological advancements and market expansion

Upcycling 101:

Did You Know?

76%

of the world's top 250 food and beverage companies have publicly committed to food waste reduction targets.[1]

YET

40%

food globally is lost through the cracks of the system.[2]

Sources: 1. Champions 12.3, September 2023. 2. ReFed, 2022.

Food waste is top of mind; consumers want brands and retailers to do more

98%

of global consumers are trying to reduce food waste.[1]

61%

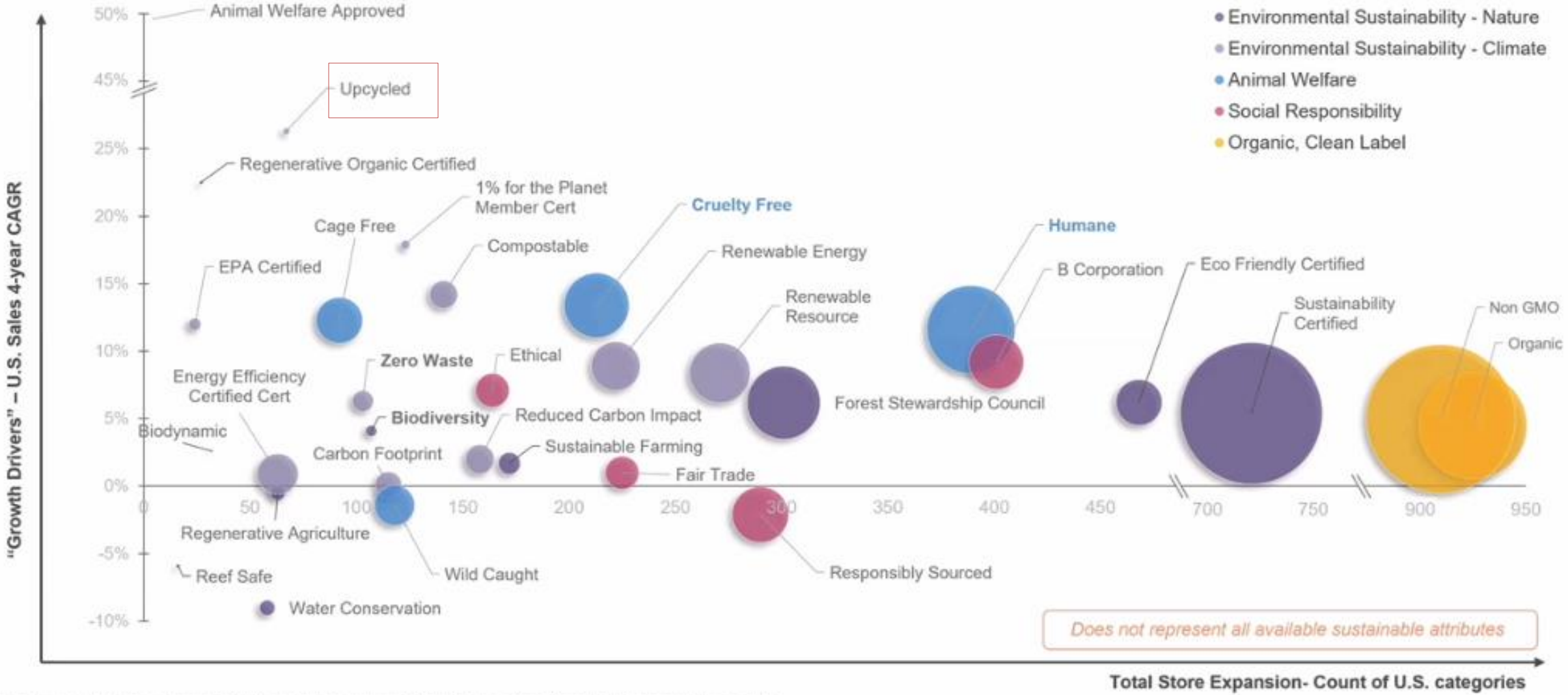
feel brands, stores, and supermarkets should do more to help reduce waste.[2]

57%

feel disappointed in these entities for not caring enough about the issue.[2]

Sources: 1. Kerry, 2023. 2. Capgemini Research Institute, 2022.

Consumers continue to find sustainability attributes aligned with their values

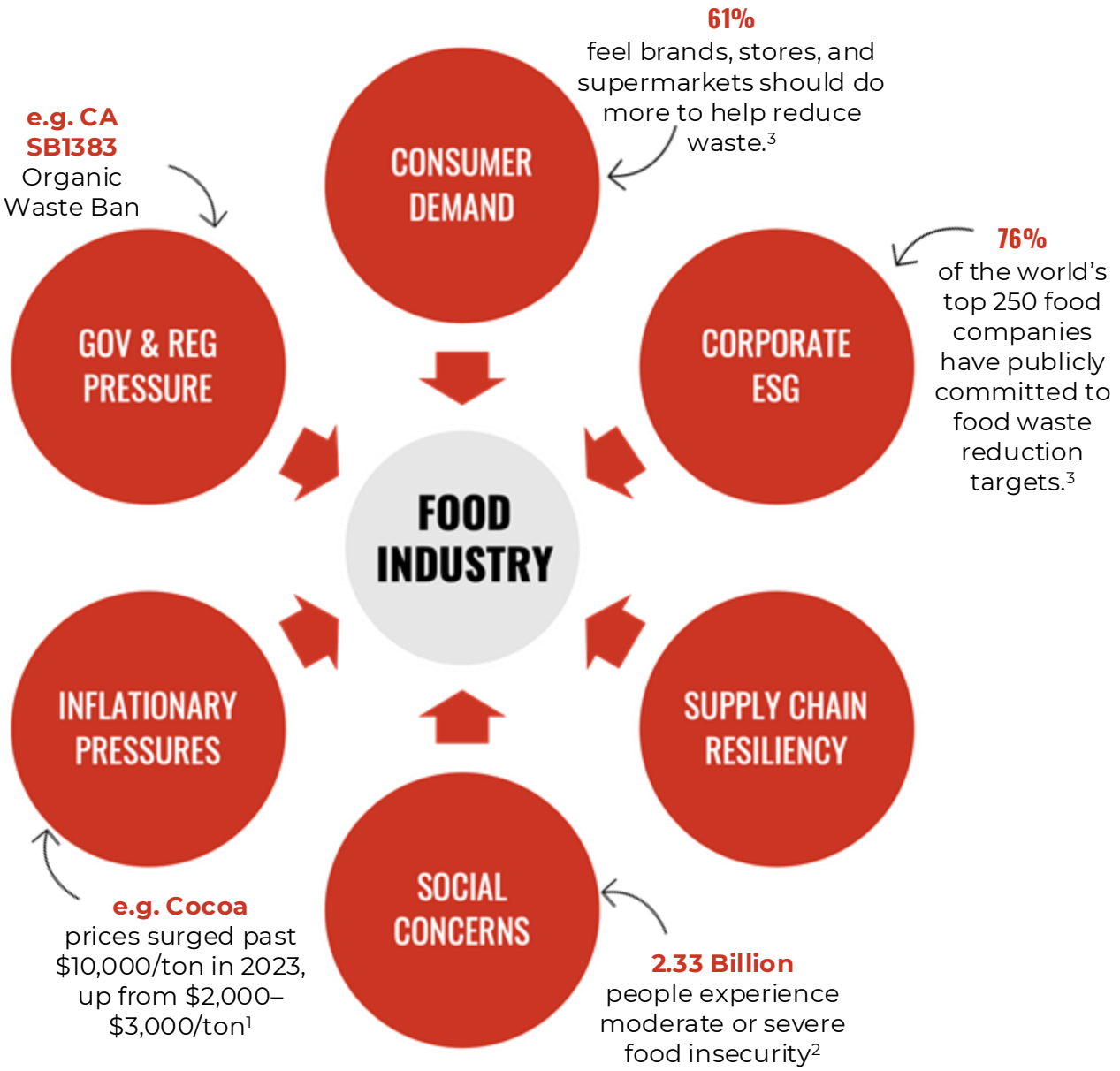


Bubble size denotes total sales in L52 week All attributes represent claims STATED on package unless indicated by an * symbol

Source: NIQ Retail Measurement Services, NIQ Product Insight—powered by Label Insight, Total US xAOC ; Total Store; Count of categories, 4-year $ CAGR; 52 weeks ending November 30, 2024; Regen Organic Certified v. 3YCAGR

NIQ

The current food system is driving up costs, creating supply chain issues, and increasing pressure from both consumers and regulators.



1. CNBC, NYT, 2024 2. UN FAO 3. Capgemini Research Institute, 2022

What Is Upcycling?

Root-to-Stem at Industrial Scale

It's industrial-scale "root-to-stem" cooking for the entire supply chain.

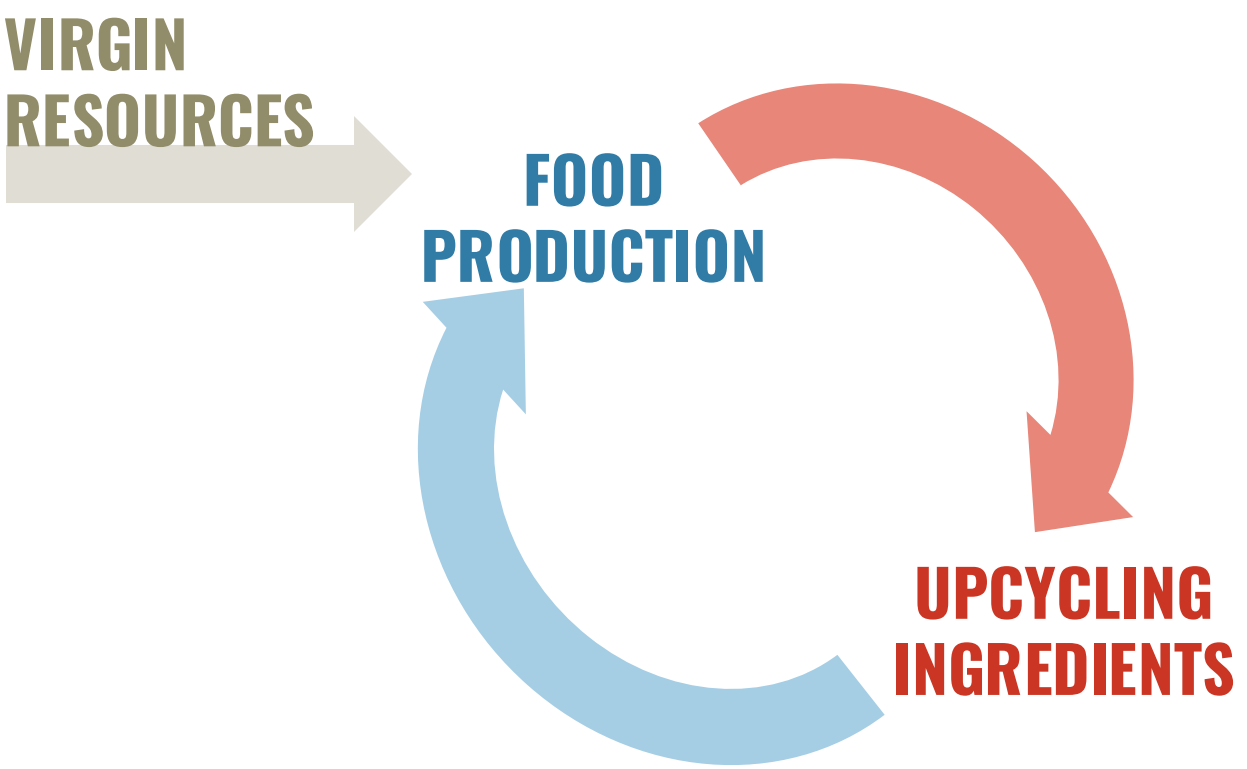
High-quality ingredients, once discarded for cosmetic or supply reasons, can be reimagined into nutrient-rich, flavor-forward, and profitable products.

UPCYCLED FOODS INC™ + LAB™

Upcycling reduces the use of virgin resources, maximizing existing ones

Water | Energy | Nutrition

Upcycling in the Circular Economy



Why Upcycle Food?

UPCYCLED FOODS INC™ + LAB™

Environmental Impact

Diverts food waste from landfills, reducing methane emissions and preserving natural resources

New Revenue Streams

Transforms by-products into profitable ingredients, maximizing value

Circular Economy

Closes the loop on food systems, supporting regenerative practices and resource efficiency

Consumer Appeal

Resonates with sustainability-minded buyers seeking transparent, eco-conscious food choices

“Maximized Product Utilization”

By the Numbers:

$5.6B

Net Financial Benefit

8.4B

Meal Equivalents

1.4T

Gallons Water Saved

5.1 M

Food Waste Tons Diverted

Source: Refed.org

Upcycled Foods Labs

UPCYCLED FOODS INC™ + LAB™

Opportunity Discovery

We uncover hidden opportunities in your byproducts and identify strategic pathways to transform them into valuable products.

Business Case Development

We build robust business cases by defining target customers, value propositions, channel strategy, and competitive benchmarking to ensure market fit and financial viability.

UPCYCLED FOODS LAB™

Product Development

We bring your product to life through formulation, prototyping, consumer research and validation, sensory testing, and claims substantiation to ensure it meets market needs and quality standards.

Scale-Up & Commercialization

We optimize production processes, supply chains, and go-to-market strategies that deliver profitability and impact.

the INCREDIBLE EGG

National Watermelon Promotion Board

Oasis Date™

Mondelēz International

WIZE COFFEE LEAF

puratos Food Innovation for Good

california almonds

How it works:

Upcycling as an Enabler

UPCYCLED FOODS INC™ + LAB™

RAW MATERIALS	INNOVATION	VALUABLE INGREDIENTS

Novel Ingredients
Better Substitutes

FOOD WASTE

- Fruit Peels
- Grain Husks
- Vegetable Trimmings

PROCESSING/INNOVATION

- Extraction
- Purification
- Refinment

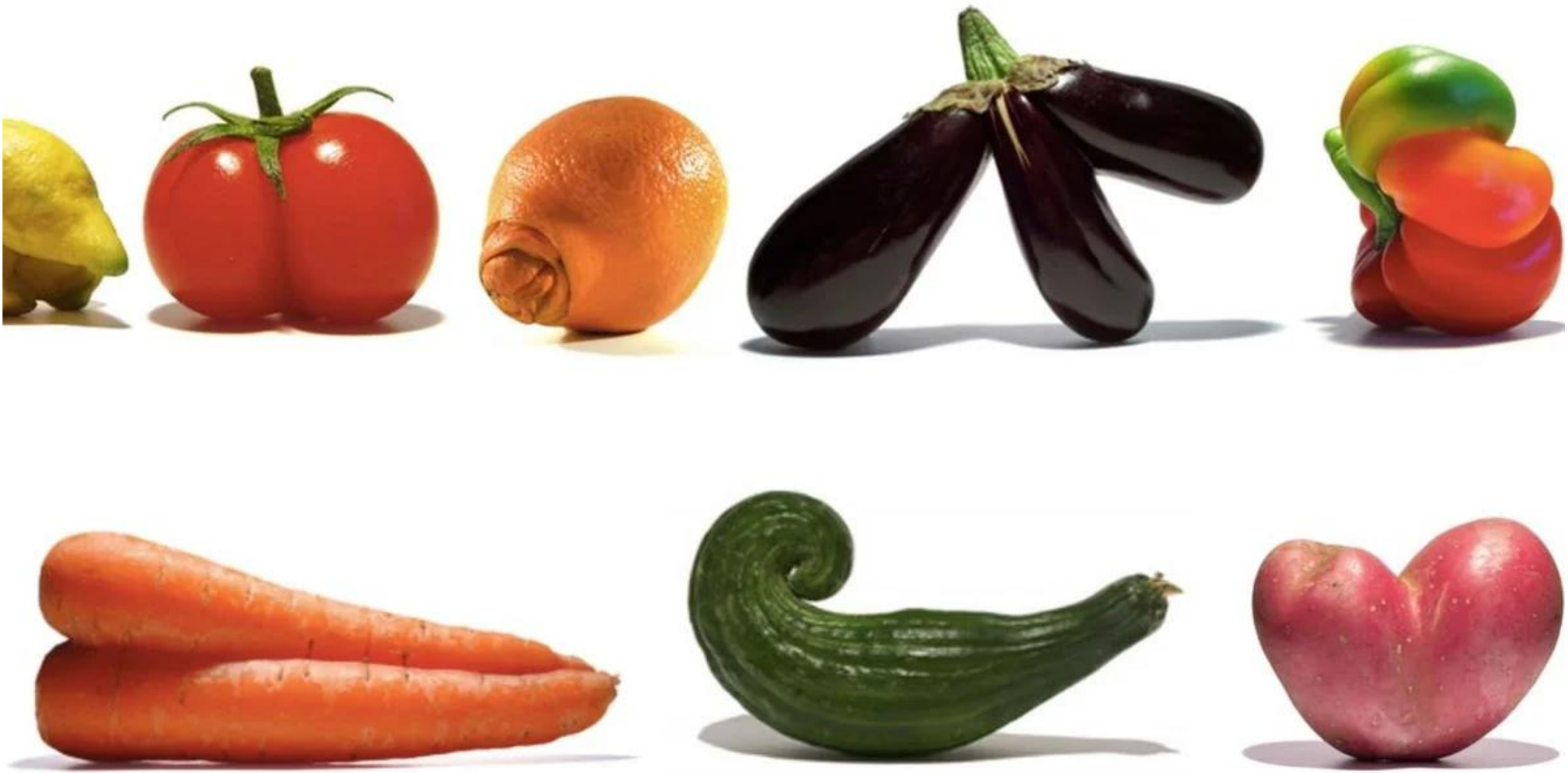
NEW INGREDIENTS

- Fiber Supplements
- Protein Powders
- Natural Antioxidants

Upcycled Ingredient Development

Food Waste → **Processing/Innovation New Ingredients** → **Product Integration**

Upcycling In Action



U.S. food manufacturers generate over **13M tons** of food waste annually—

90% of this waste is an **upcycling opportunity** waiting to be tapped.[1]

1. ReFed, 2023


CHOCOLATE NATURAL FLAVOR
20G PROTEIN
POWERFUL YOGURT
PROTEIN DRINK
MADE WITH GREEK YOGURT
ALL NATURAL INGREDIENTS 12FL OZ (355ML)


ONLY NATURAL INGREDIENTS
30G Protein
Zero Added Sugar*
Strawberries & Cream
LACTOSE FREE
Chob
14 FL OZ (414 mL)


Hruška skořice
Malina chilli
Borůvka čokoláda
Malina rebarbora
Maková švestka
Třešeň rum
Hruška mák
Meruňka skořice
Borůvka čokoláda
Hruška mák
Třešeň rum
Pomeranč
Třešeň


rudolf rubin ag


PULP PANTRY
PULP
REAL VEGGIES
GRAIN FREE
CHIPS
BARBECUE
5g FIBER
REAL CRUNCHY VEGETABLE CHIPS
— SIMPLE SUSTAINABLE INGREDIENTS —
PULP PANTRY
PULP
REAL VEGGIES
CHIPS
JALAPEÑO LIME


ECONOMY SIZE
Healthy Origins
Natural
Eggshell
Membrane
Natural Source of Collagen, Hyaluronic Acid and Chondroitin Sulfate
NEM
500 mg
120 Veggie Capsules
Dietary Supplement
WOLDO HEALTH
COLLAGEN
EGGSHELL MEMBRANE
HIGH QUALITY POWDER BY WOLDO HEALTH
ODORLESS
TASTELESS
BIOACTIVE
SMOOTHIES
SHAKES
SOUPS
25x20 g
500 g
COLLAGEN PEPTIDES OF TYPE I & III


Minus
VANILLA OAT MILK LATTE
BEANLESS COFFEE
Minus
BEANLESS COLD BREW COFFEE
NOTES OF BERRIES & BROWNIE
ATOMO!
MOLECULAR COFFEE
02


NON GMO • VEGAN • ALL NATURAL • GLUTEN FREE
MERLAYZYN
CRUNCHY SUPERFOOD SNACK
More ANTIOXIDANTS THAN A BOTTLE OF Wine
DRIED MERLOT WINE GRAPES
Net Wt. 8oz (227g)
NON GMO • VEGAN • ALL NATURAL • GLUTEN FREE
CHARDONAYZYN
CRUNCHY SUPERFOOD SNACK
More ANTIOXIDANTS THAN A BOTTLE OF Wine
DRIED CHARDONNAY WINE GRAPES
Net Wt. 8oz (227g)
NON GMO • VEGAN • ALL NATURAL • GLUTEN FREE
CABERNAYZYN
CRUNCHY SUPERFOOD SNACK
More ANTIOXIDANTS THAN A BOTTLE OF Wine
RIED CABERNET WINE GRAPES
Net Wt. 8oz (227g)


KULA
BBQ Sauce
SCOTCH BONNET
NO SUGAR ADDED
KULA
Hot Sauce
PILI PILI
NO SUGAR ADDED
KULA
BBQ Sauce
RED PEPPER
NO SUGAR ADDED


Cajú Love
Cashew fruit meat.
Unseasoned.
✓ Vegan
✓ Gluten Free
✓ Organic
✓ Soy Free
✓ Non GMO
FIBER
Net Weight
200g 7oz
Cajú Love
Cashew fruit


BESKID
CHOCOLATE
CACAO
TEA
KAKAŁSZALE
HERBATKA Z ŁUSKI KAKAO


FAIR & SQUARE
SEA SALT CRACKERS
GLUTEN FREE • PLANT BASED • GUT FRIENDLY
NET WT. 4 OZ (113G)
USDA ORGANIC

Upcycled Certified Today

3.4+ million tons

of food waste diverted since the program's launch in 2021

805

Products certified in total

105

Participants

18

Countries

Top 3 Upcycled Food Categories:

- *Pet Products, Snack Food, Fruits & Vegetables*

Top 5 Upcycled Inputs:

- *Spent Brewers Grains, Cacao, Peas, Soy, Bananas*

Upcycling Mythbusters

Mythbusters

Myth 1:

Upcycled Ingredients Can't Scale Reliably

- Many suppliers now operate with year-round availability, lot traceability, and third-party audits.
- Aggregator models and ingredient partnerships (e.g. brewers' grain) have proven multi-ton capacity.
- As with any commodity, supply risk can be mitigated with demand planning and/or offtake agreements.

Myth 2:

Upcycled Ingredients Are Less Nutritious

- In most cases, they're refined fractions that are more nutrient-dense:
  - Protein (e.g. peptides)
  - Fiber (e.g. resistant starch)
  - Lipids (e.g. high oleic oils)
  - Bioactives (e.g. polyphenols)

2-4X
OF AVG*

30-50G PROTEIN
PER 100G

4-7x
OF AVG

44-70G FIBER
PER 100G

Mythbusters

Myth 3:

Upcycled Ingredients Are Less Safe

- Ingredients slot into existing QA and co-packing systems.
- Every credible supplier meets the same FSQA and regulatory benchmarks as conventional inputs.
- Standard artifacts exist: COA, HACCP plan, micro & heavy-metal panels, allergen and traceability records.
- Many have GFSI-aligned facilities and USDA / FDA oversight.

Myth 4:

Formulating can be challenging

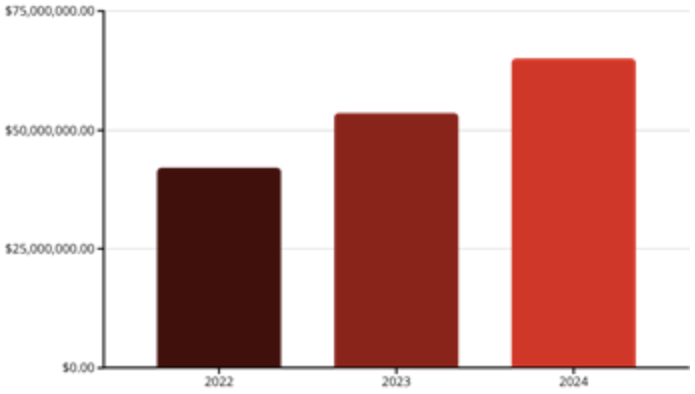
- Upcycled ingredients can enhance flavor, texture, and visual appeal.
- Value-added formats (powders, pre-blends, extracts) behave predictably.
- Application guides can advise on binding, moisture control, flavor carry, natural color, etc
- Semi-finished (e.g. speed scratch products, frozen doughs) make integration simple
- Viable ingredients are standardized and spec'd for inclusion ease.

Myth 5:

Upcycled Claims Don't Sell

Market Performance

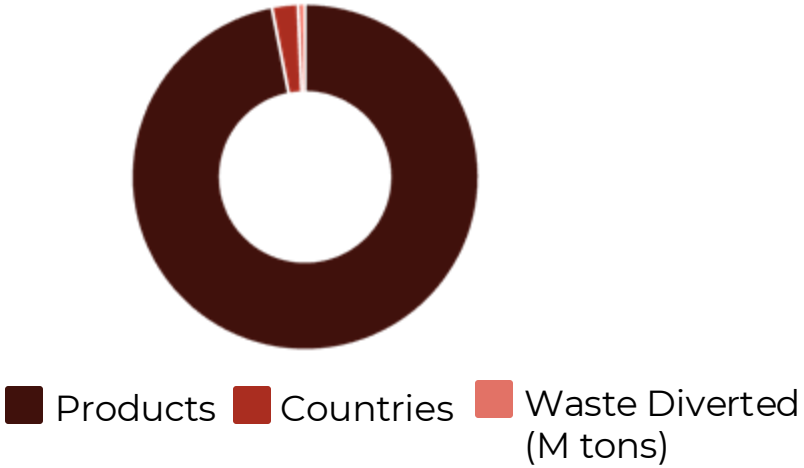
Upcycled products are outperforming the market **+55%**



Dollar sales of Certified Upcycled F&B products grew 55% in two years (from $42 M to $65 M in 2022–2024).

Consumer Impact

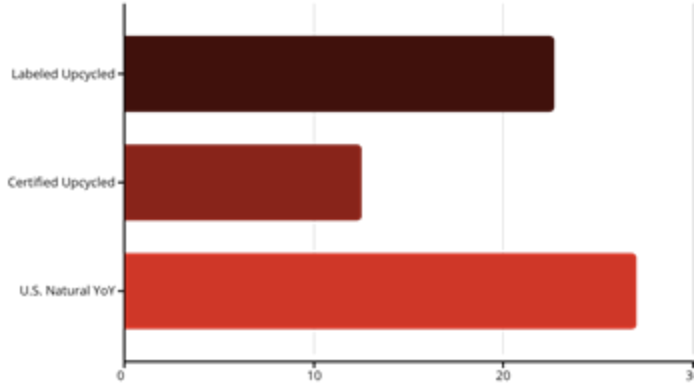
Waste reduction ranked **#1** sustainability priority



805 products now certified across 18 countries; 3.4 million tons of food waste diverted since 2021.

Certification Growth

Leading sustainability category with **+23%** YoY Q3 2025



+22.7% growth for "Labeled Upcycled," +12.5% for Certified Upcycled

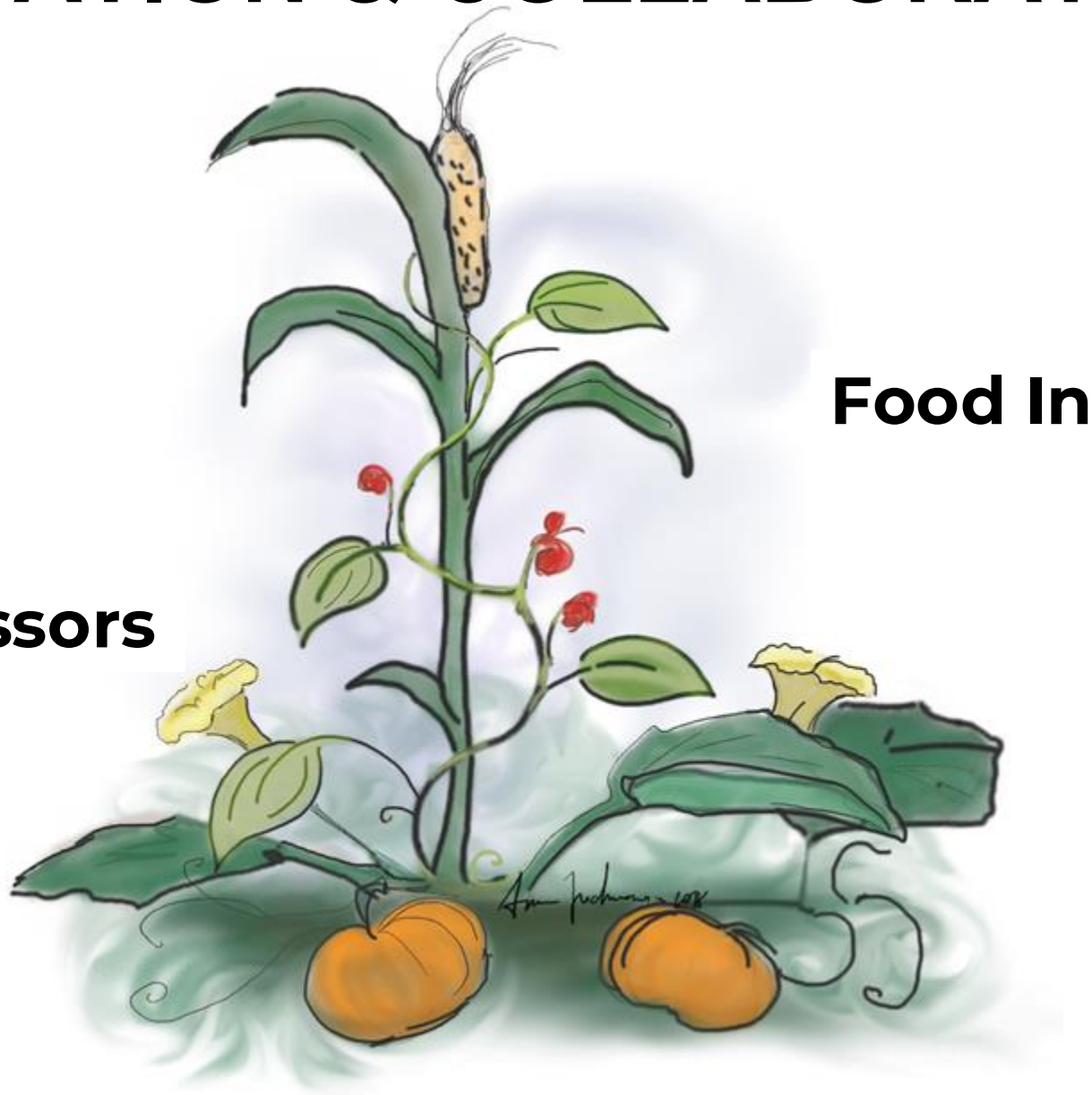
Q3 2025 SPINS data: +27% YoY in U.S. Natural Channels.

Almond Hull Upcycling Outlook

THE BIG QUESTION:

How might we design business models that reduce risk, share reward, and catalyze investment in circular innovation?

OPEN INNOVATION & COLLABORATION



Food Innovators

Processors

Researchers

Growers

BUSINESS MODEL INNOVATION: *INGREDIENT ECOSYSTEMS*

- **Asset-Light Pilots:** Leveraging co-man capacity to pilot ingredient production without upfront CapEx
- **Hub-and-Spoke Processing Models:** Centralizing stabilization + standardization, enabling satellite sourcing or final format production
- **On-Site Valorization:** Embedding processing systems (e.g., drying, pressing, fermentation) at source
- **Commercial Collaborations:** Partnering across supply chains (growers, CPGs, processors) to share risk, access byproducts, and align incentives
- **Joint Ventures & Shared IP Models:** Co-developing new formats with built-in commercialization rights across partners

THANK YOU!

DAN KURZROCK
Co-Founder & CEO

Dan@UpcycledFood.com

(650) 888-1179

The Business Case for Almond Hulls as a Human Food & Beverage Ingredient

12/10/2025

Barb Stuckey | Barb@MattsonCo.com

california almonds

CULTIVATING A HEALTHIER FUTURE

The Almond Hull Opportunity

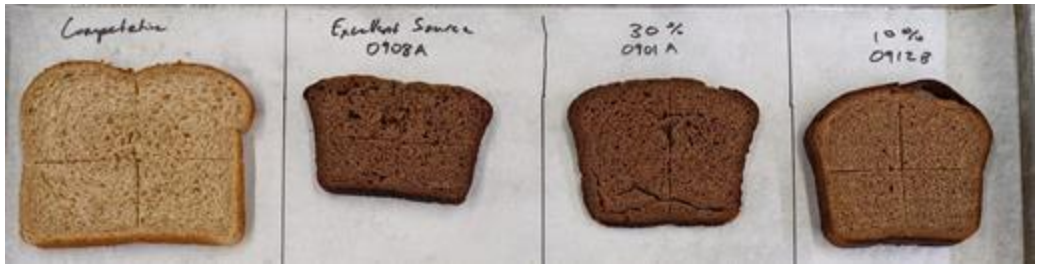
The almond industry generates over 4 billion pounds of almond hulls annually, the vast majority of which are used as animal feed. However, almond hulls contain valuable compounds such as polyphenols, fiber, and sugar, and the Almond Board of California (ABC) sees potential for almond hulls to become a source of value to the almond industry.

Previous research at Mattson and beyond has focused on the technical attributes of whole ground almond hulls, including application testing.

This project moved beyond feasibility to quantify the **strategic and economic potential** of almond hulls in human food and beverage through multimodal business modeling.

PREVIOUS MATTSON WORK

APPLICATION TESTING WITH WHOLE HULL POWDER



What Makes Almond Hulls Valuable?

Identifying opportunities as a human food and beverage ingredient

KEY COMPONENTS

- DIETARY FIBERS
- SUGARS
- POLYPHENOLS

We identified **polyphenols** as almond hulls' most differentiated benefit. We proposed two promising hull-derived ingredients for use in human food and beverage:

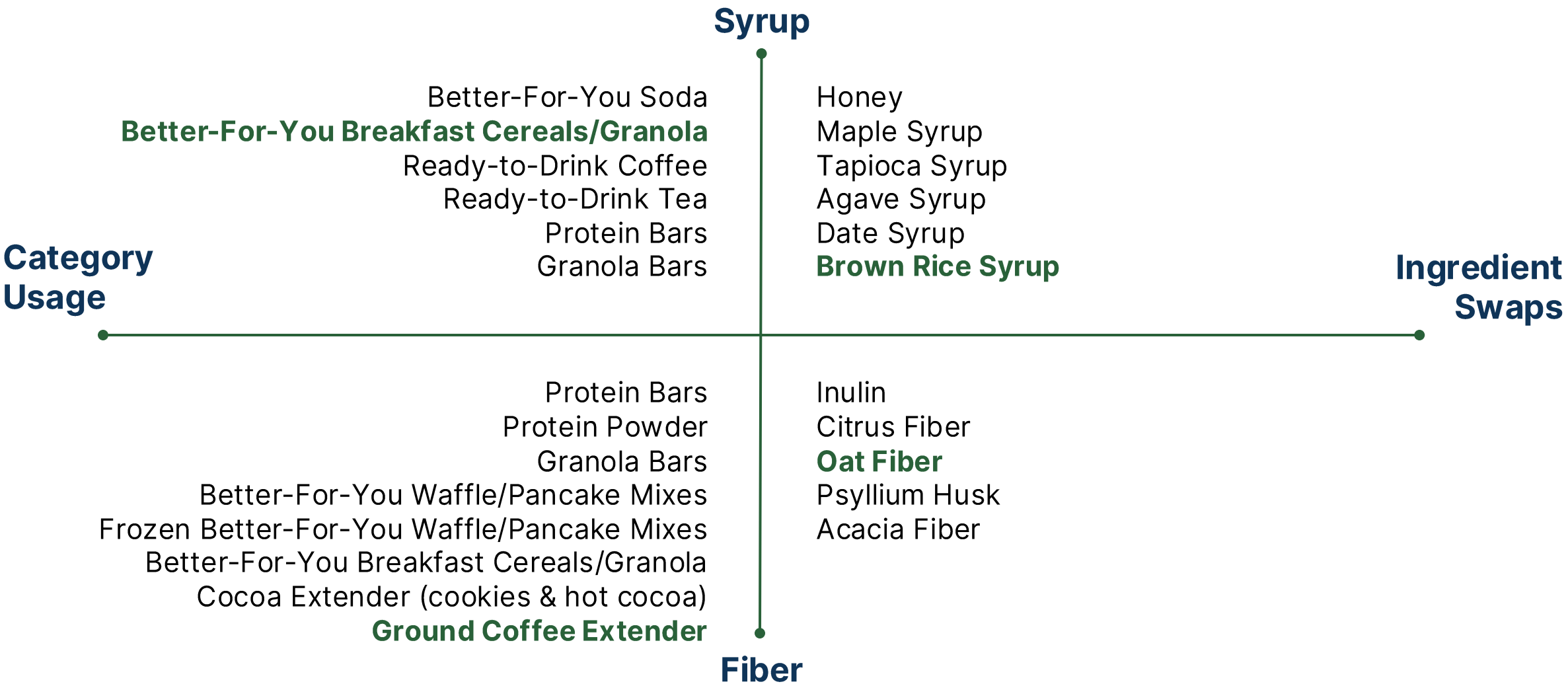
1. Polyphenol-rich **fiber**
2. Polyphenol-rich **syrup**

Where can these ingredients play?

Advantages	Limitations
• Roasted/fruity flavors • Naturally brown • Upcycled • US-grown	• Flavor and color aren't neutral • Potential grit • Not specialized

Where Almond Hulls-Derived Ingredients Fit Best

As assessed by Mattson developers



Calibrating the Market Size of These Ingredients

Modeling Approaches

We created calibrated estimates of almond hull-derived ingredients' market potential by building models with three different lenses:

Top Down *Industrial Ingredient Swaps* *E.g., what % of global oat fiber use could our ingredients replace?*	versus	**Bottom Up** *Category Usage* *E.g., what % ground coffee could incorporate our ingredients?*
High Case *Aggressive Assumptions*	versus	**Low Case** *Conservative Assumptions*
Maximized for Tonnage *Higher Usage, Lower Price* *Set price point for ingredients to compete with high volume ingredients such as oat fiber and brown rice syrup*	versus	**Maximized for Profit** *Less Usage, Higher Price* *Set a higher price point for ingredients that competes with higher-cost, lower volume ingredients*

Which Information Underpins the Market Size Model?

Category sales data

	Total US xAOC					
	52 Week Ending 05/17/25					
	$ Sales	$ Sales YA	$ % Chg YA	Unit Sales	Unit Sales YA	Units % Chg YA
Total Protein Bars	**$1,727,101,393**	**$1,565,827,648**	**10.3%**	**294,061,914**	**271,848,159**	**8.2%**
Quest Nutrition	$289,784,950	$290,309,435	(0.2)%	40,536,693	42,080,875	(3.7)%
1440 Foods Company	$195,088,504	$209,756,213	(7.0)%	20,320,667	21,723,110	(6.5)%

Ingredient sales data

Global Agave Syrup Market: Revenue in USD Million, 2023-2024		
	2023	2024
Market Size	125.49	132.17

Food scientist input

Competitive Ingredient	Key Functions	Strengths	Weaknesses
Tapioca Syrup	Sweetener, binder	Mild flavor, clean label	Higher glycemic index, not widely recognizable
Agave Syrup (ingredient)	Low-glycemic sweetener, binder	Clean label, good solubility	Expensive, imported
Brown Rice Syrup	Sweetener, binder	Clean label, mild flavor, sticky texture	High glycemic index, less sweet than sugar

Assumptions

Food/Beverage Category	Competing Almond Hull Product	% of US Products Incorporating AH Ingredient (low)	% of Non-US Products Incorporating AH Ingredient (low)	% of US Products Incorporating AH Ingredient (high)	% of Non-US Products Incorporating AH Ingredient (high)	AH Ingredient Usage Rate
Protein Bars	Fiber	15%	11%	25%	18%	15%
Protein Powder*	Fiber	8%	6%	15%	11%	5%
Granola Bars	Fiber	15%	11%	25%	18%	15%

Prioritizing Tonnage Used versus Profit

Based on background research and conversations with Mattson food scientists, the most effective ingredient swaps for AH-derived ingredients would be **brown rice syrup** (for syrup ingredient) and **oat fiber** (for fiber ingredient).

However, based on ingredient costs pulled from Mattson's sourcing databases, these are also the cheapest comparable ingredients.

Capitalizing on the overlapping functionality of brown rice syrup and oat fiber would drag down the price AH-derived ingredients could command.

For this reason, we created two separate models intended to maximize for different priorities - almond hull tonnage or profit - by adjusting the price charged per lb.

AH Syrup	$0.65/lb
AH Fiber	$1.15/lb

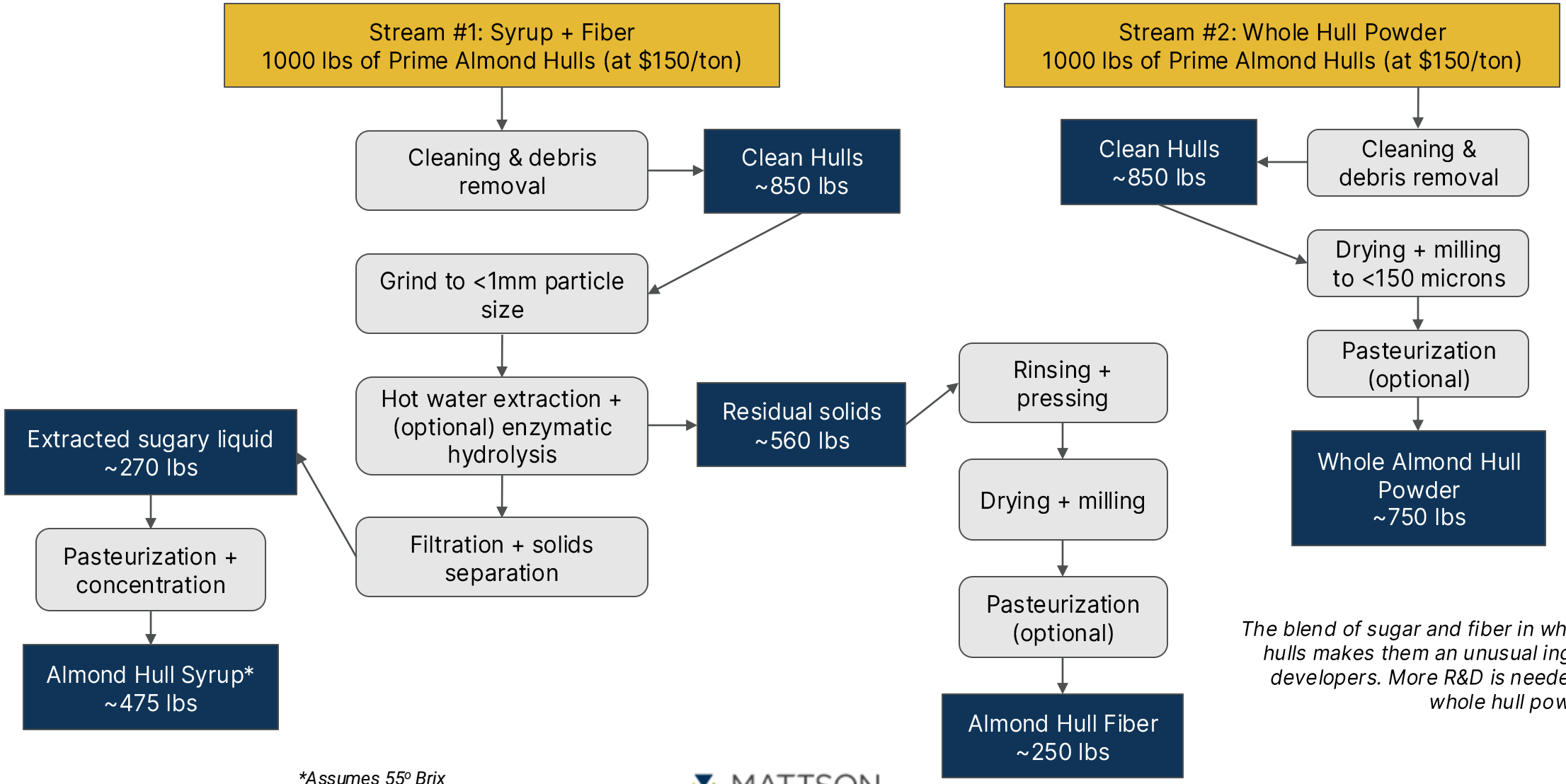
AH Syrup	$0.95/lb
AH Fiber	$3.25/lb

Brown rice syrup

Oat fiber

How to Manufacture Dual Almond Hull-Derived Ingredients

A preliminary/theoretical operations flow



The blend of sugar and fiber in whole almond hulls makes them an unusual ingredient for developers. More R&D is needed to model whole hull powder usage.

**Assumes 55° Brix*

Final Calibrated Market Size

Incorporates almond hull-derived syrup and fiber only (no whole hulls)

	Maximized for Tonnage		Maximized for Profit	
	5 Year Almond Hull Usage	**5 Year Almond Hull Profit**	**5 Year Almond Hull Usage**	**5 Year Almond Hull Profit**
Top Down *Via industrial ingredient swaps*	High: 1.7M tons Low: 1.3M tons	High: $3.1B Low: $2.1B	High: 940K tons Low: 555K tons	High: $3.0B Low: $1.3B
Bottom Up *Via category usage*	High: 1.7M tons Low: 925K tons	High: $3.2B Low: $1.8B	High: 945K tons Low: 526K tons	High: $6.0B Low: $3.3B
Estimate *Average of 4 scenarios + 25% overage*	**1.75M tons**	**$3.2B**	**926K tons**	**$4.3B**

Summary & Next Steps

Summary

- Polyphenols are the most differentiated component of almond hulls
- Polyphenols can pair with fiber and sugar to create two high-value derivatives that are co-produced
- A syrup ingredient could replace ingredients such as brown rice syrup
- A fiber ingredient could replace ingredients such as oat fiber
- Almond hull-derived ingredients could generate $4.3B in profit over 5 years OR use approximately 700M pounds a year

Next Steps

- Validate theorized manufacturing operations flow at pilot and full scale
- Conduct food safety & quality testing for pesticide residue risk and allergenicity
- Test ingredients' polyphenol levels
- GRAS Approval for almond hull-derived ingredients (in addition to whole hulls)
- Pursue application testing to validate usage rate and level assumptions

MATTSON

WE MAKE FOOD HAPPEN

Thank you to the Almond Board of California for funding this project.

mattsonco.com / 650.574.8824 / contact@mattsonco.com

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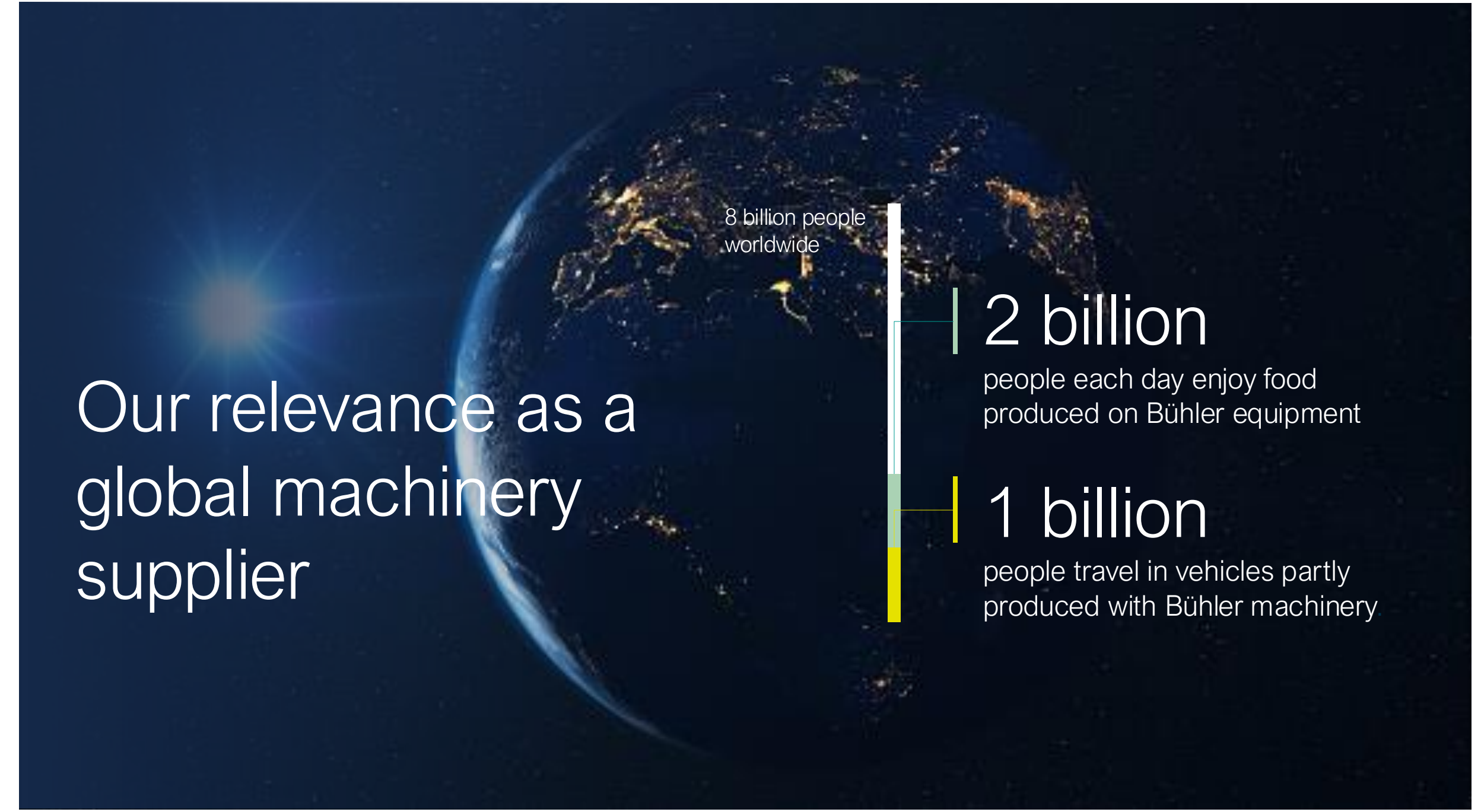
MATTSON CHICAGO / 1649 W Grand Ave. Chicago, IL 60622

Almond Hulls

The transformation of an agricultural waste stream into a new revenue stream

Our relevance as a global machinery supplier



2 billion

people each day enjoy food produced on Bühler equipment

1 billion

people travel in vehicles partly produced with Bühler machinery

6:30 a.m.

7:15 a.m.

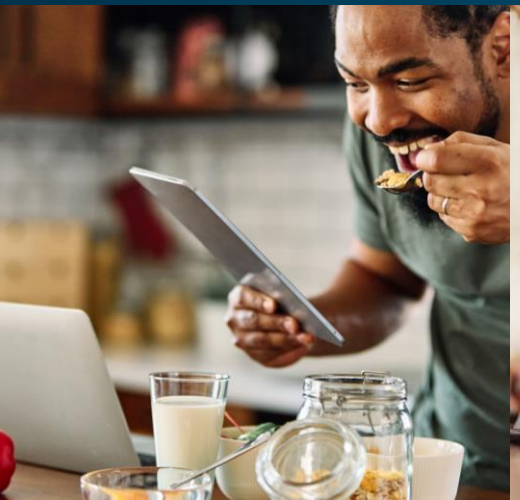
10:00 a.m.

3:00 p.m.

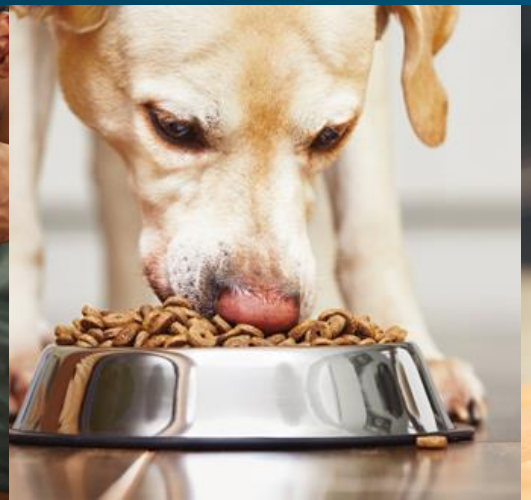
7:00 p.m.

Bühler is part of the everyday life of billions of people

7:00 a.m.



7:30 a.m.



12:00 p.m.

6:00 p.m.

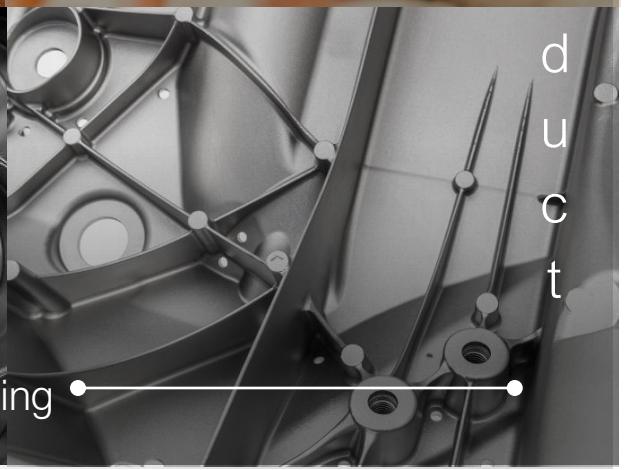
8:00 p.m.

Process solutions for material transformation

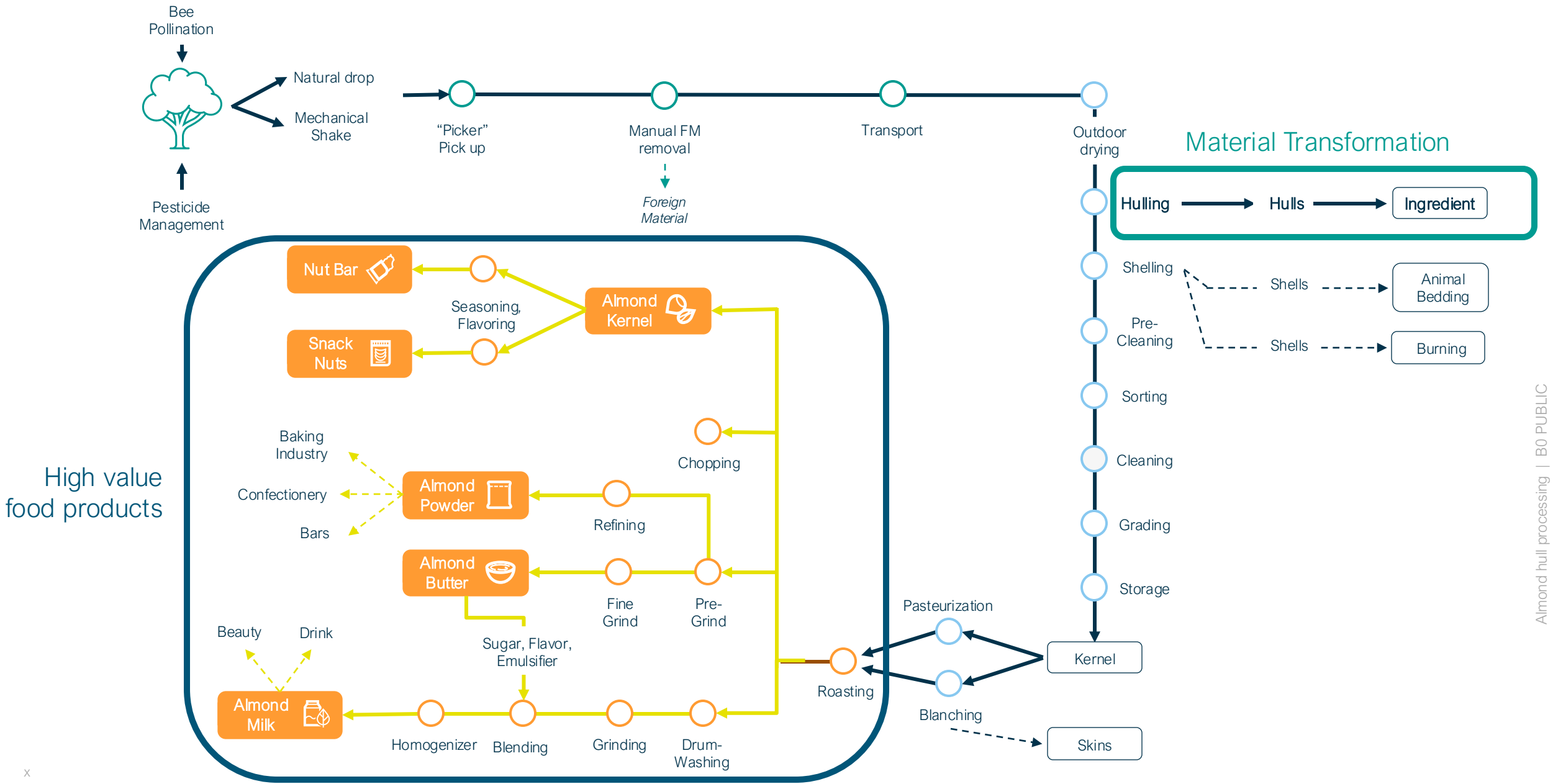
Cleaning → Milling → Mixing → Extrusion

Cleaning → Milling → Mixing → Baking

Dosing → Casting → Trimming → Marking



The almond value chain



How to transform 2.4 million tons of almond hull into a value-added powder ingredient

Initial Roadmap

Applications

- Interest in beverage application
- Interest in ingredient application
- Interest as partial replacement for high value raw materials

Trial Targets

- Coarse Powder = > 170 micron
- Fine Powder = < 170 micron

Considerations

- Color development
- Flavor development
- Grindability

Hull Preconditions

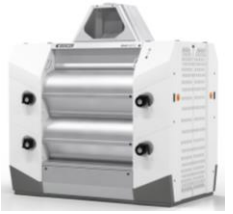
- Dry Matter = 88% - 94%
- Sugar = 20% - 36%
- Fat = 1% - 1.5%
- Starch= 0.5% - 1.5%
- Silica = 0.14%

Natural

Toasted

Roasted

Solutions



1 Intake

2 Cleaning

3 Optical Sorting

4 Sterilization

5 Humid Treatment

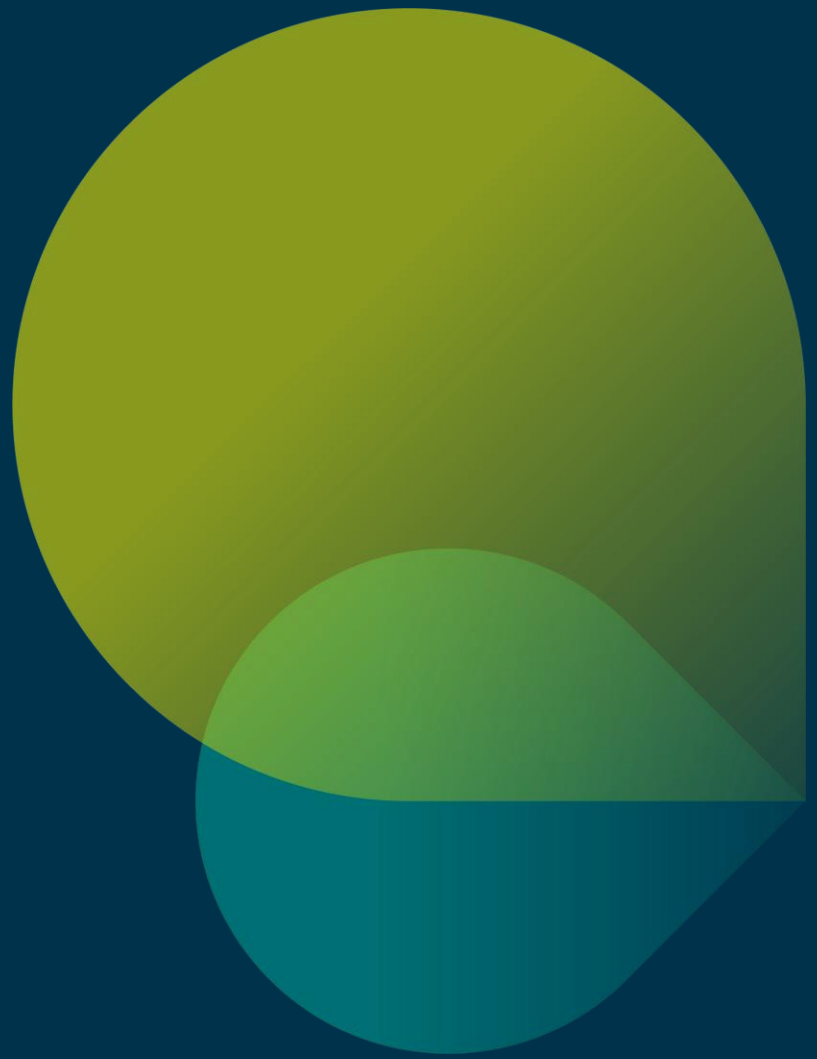
6 Thermal Treatment

7 Milling

8 Milling

9 Milling

10 Sieving



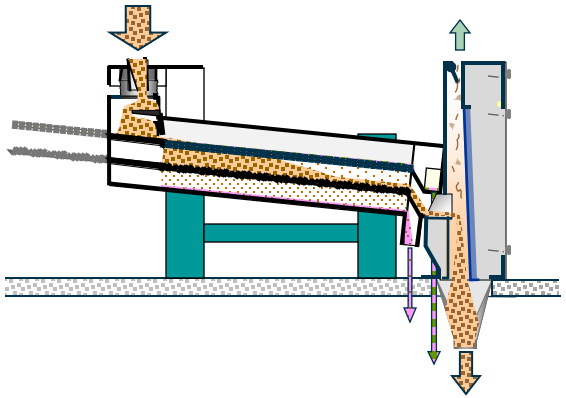
01

Raw Material Cleaning

Raw Material Cleaning – removal of foreign materials

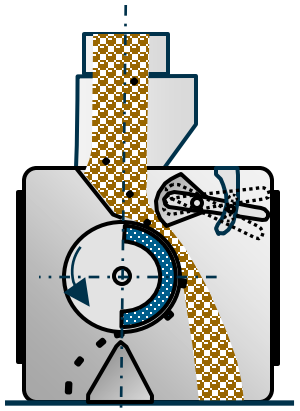
Separator Classifier

Removing coarse and fine impurities



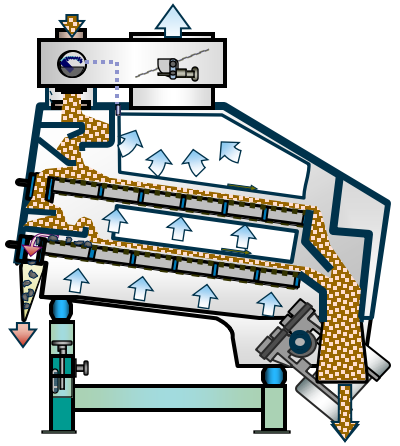
Drum Magnet

Removing ferrous impurities



Destoner

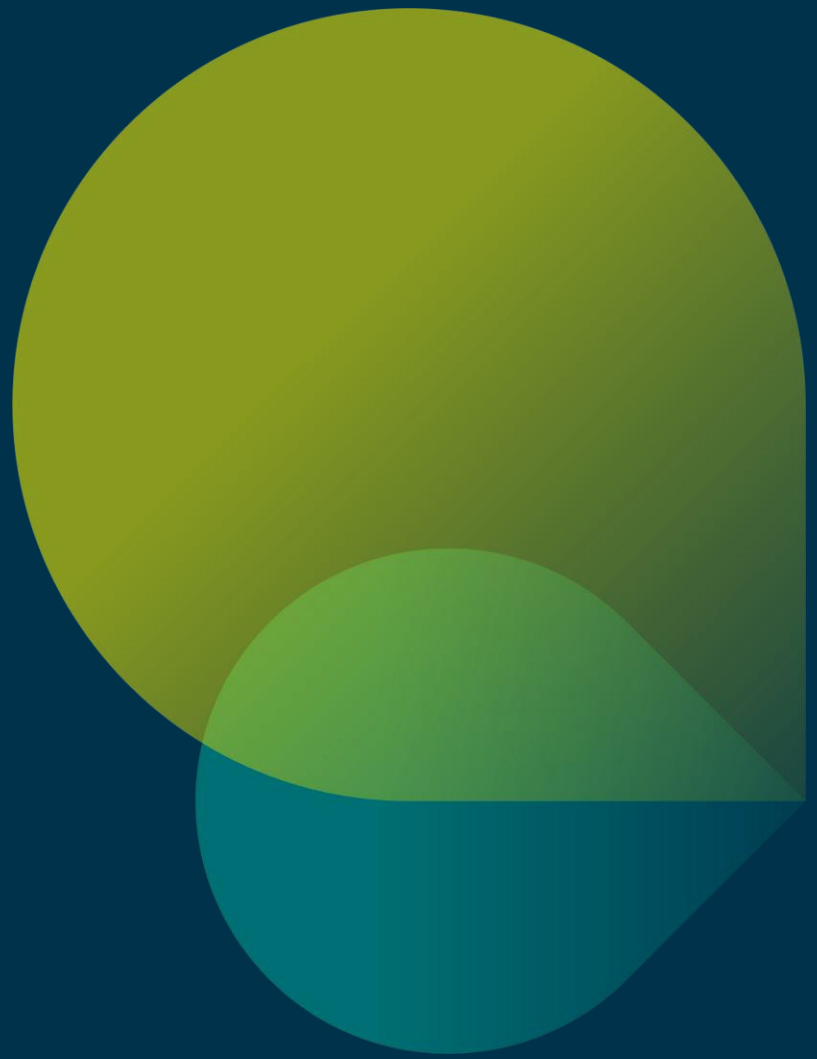
Removing high density impurities such as stone or glass



Optical Sorting – removal of foreign materials

Sorts the product according to **size, shape, color and removes hazardous materials**

- Size: Removes under and oversized objects for easier downstream processing
- Shape: Removes foreign material for a cleaner and safer product
- Color: Removes products with color defects for more product uniformity
- Hazardous material: Detects the smallest pieces of hazardous materials that can't be seen in the visible spectrum



02

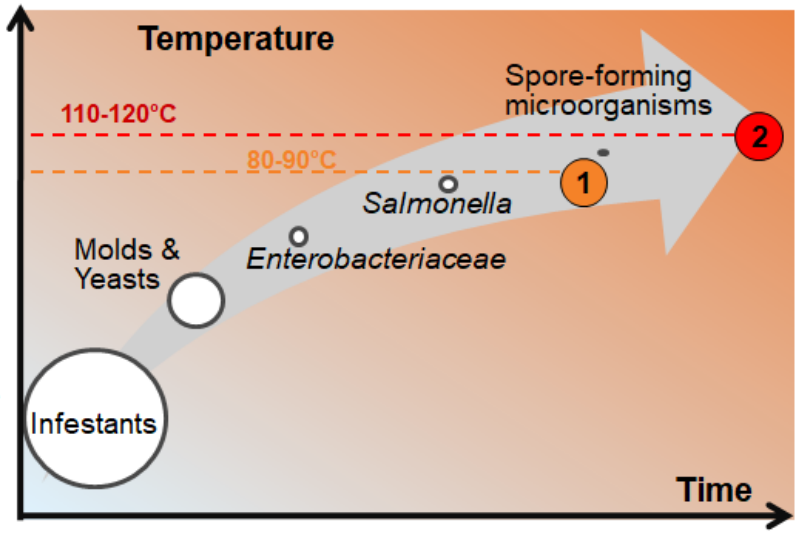
Sterilization

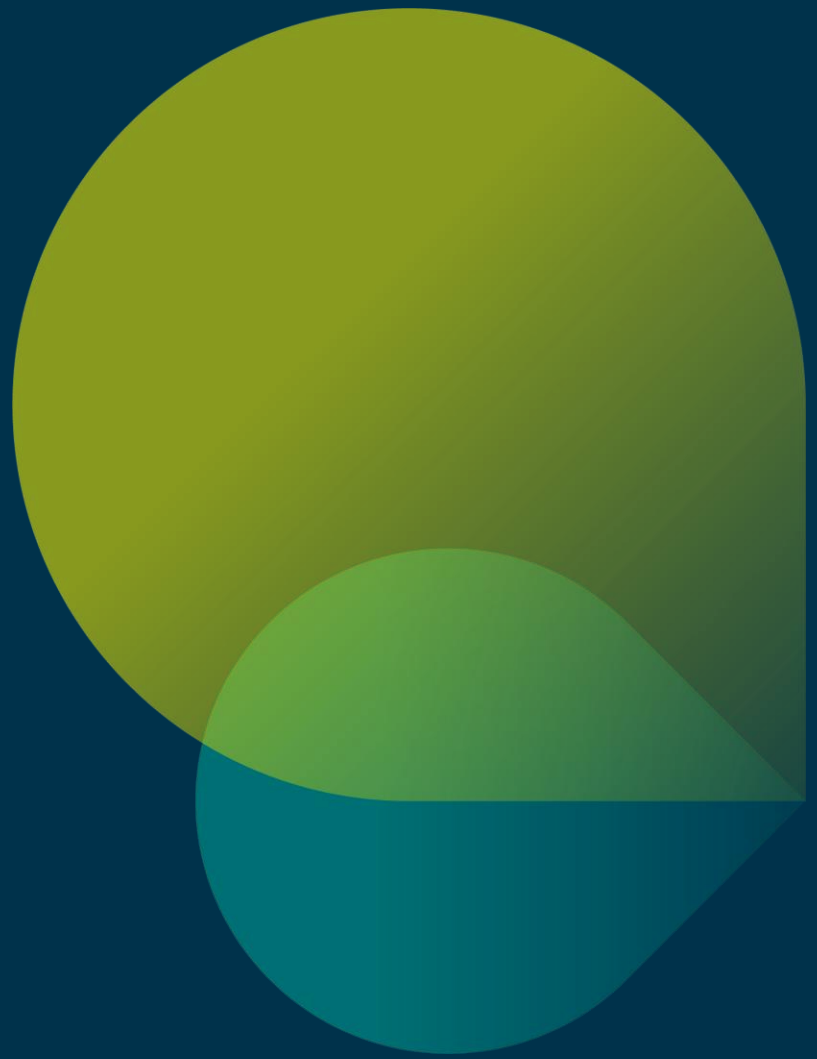
Sterilization – elimination of microorganisms

- Fast and energy-efficient steam sterilization
- Treatment temperatures of 125 – 150 C

- Safe elimination of vegetative, pathogenic microorganisms and spores
- Consistent and efficient germ-count reduction

- State-of-the-art control technology ensures fully automatic and reliable operation
- Process can be validated
- Complete traceability – every batch is documented





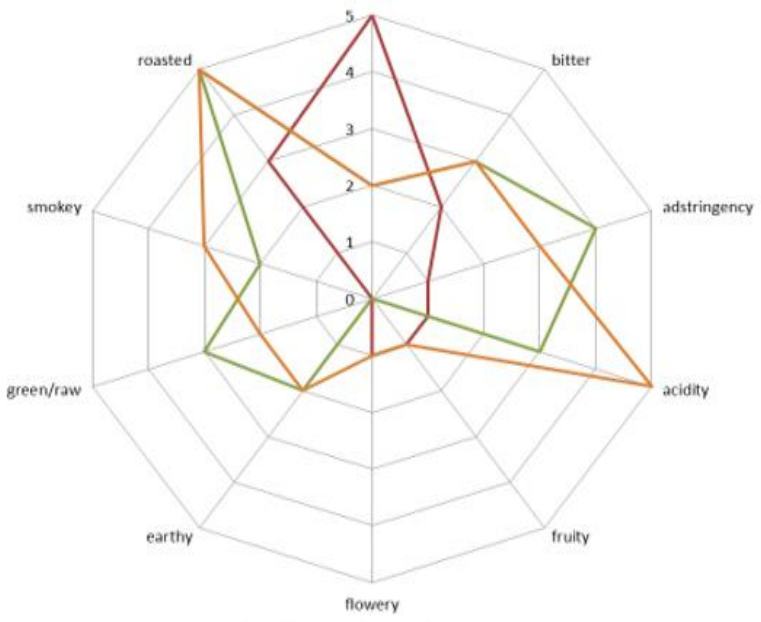
03

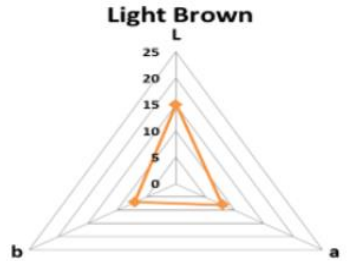
Humid Treatment

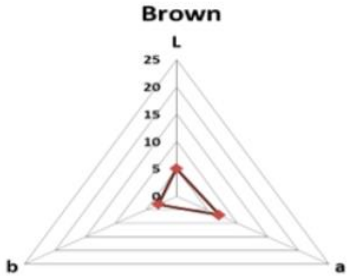
Humid Treatment - influence on aroma, flavor, color

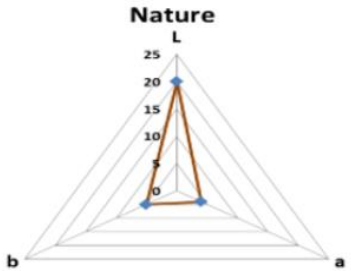
Considerations:

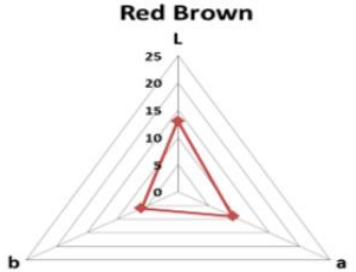
- Vacuum / Atmospheric / Overpressure Conditions
- Saturated Steam Injection’
- Solution Injection
- Hot Air Injection

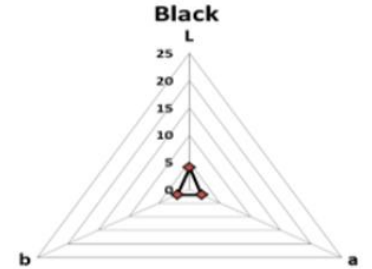


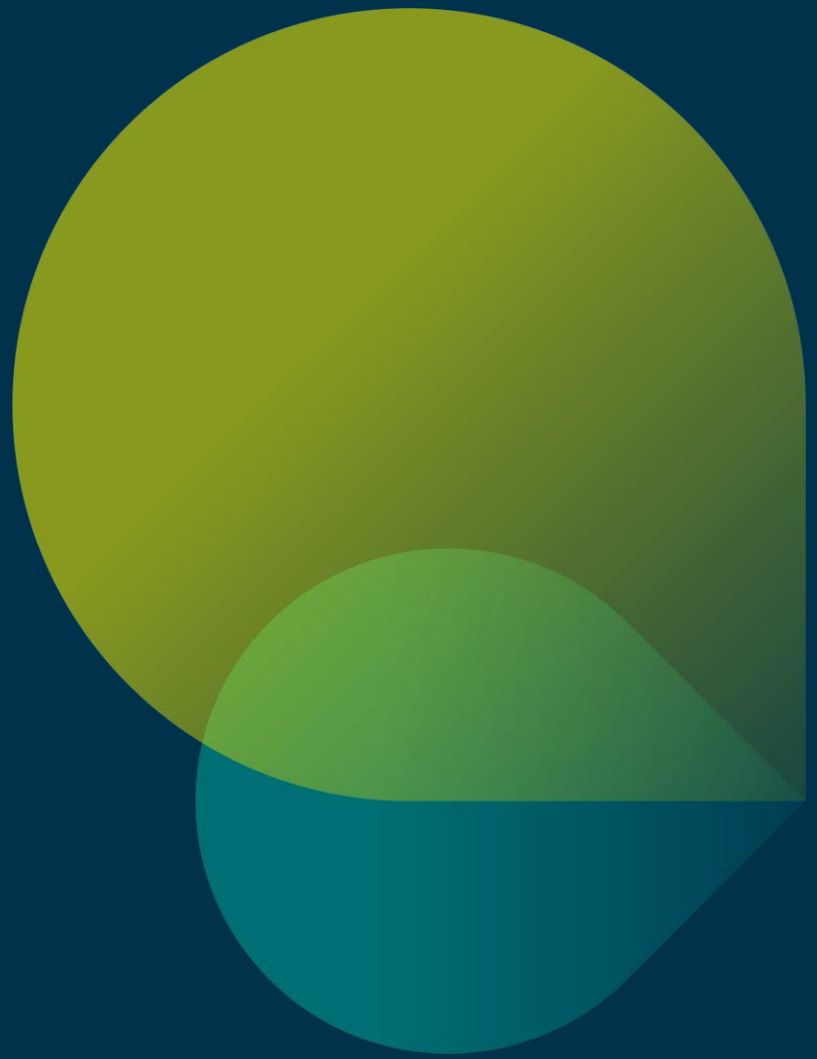












04

Thermal Treatment

Thermal Processing - influence on flavor, color and grindability

RoaStar™ Modular Dryer

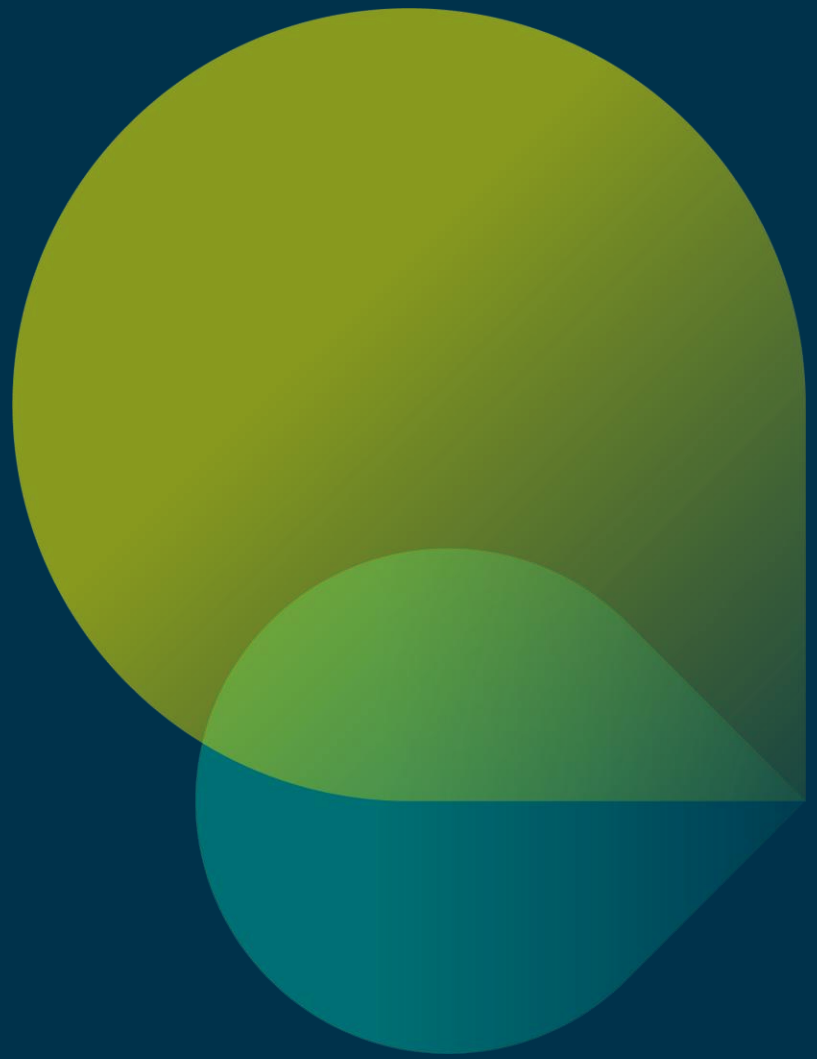
- Vertical dryer
- Two or three-zone

AeroToast™ Fluidized Toaster

- Impingement toaster
- Product Fluidization

AeroRoast™ Hygienic Roaster

- Conveyor roaster
- Multiple heating zones, alternating heat flow



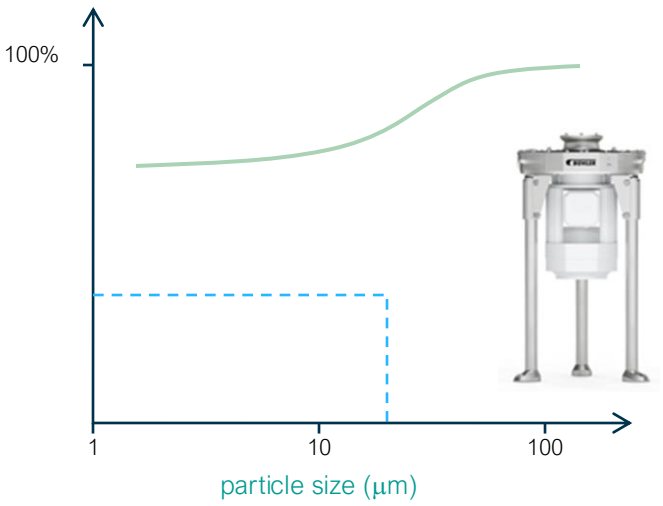
05

Milling – Particle Size Reduction

Milling - influence particle size and particle distribution

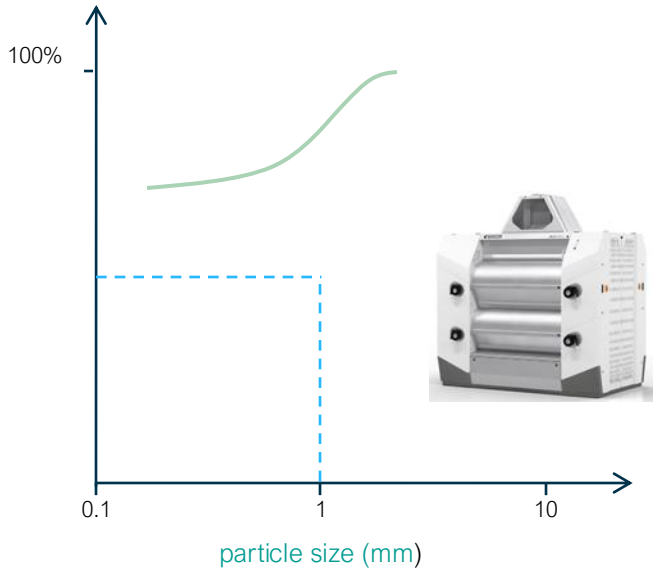
- particle size +

Pin Mill



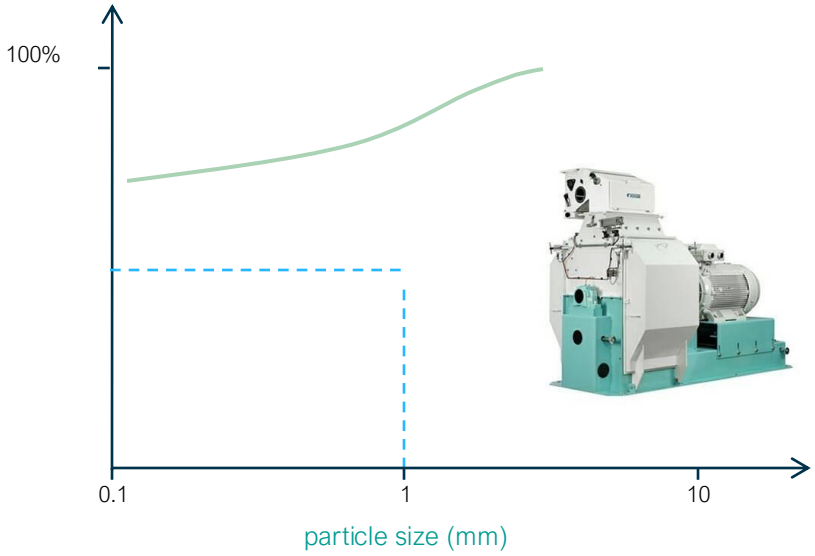
particles < 100 µm

Roller Mill



relatively narrow PSD

Hammer Mill

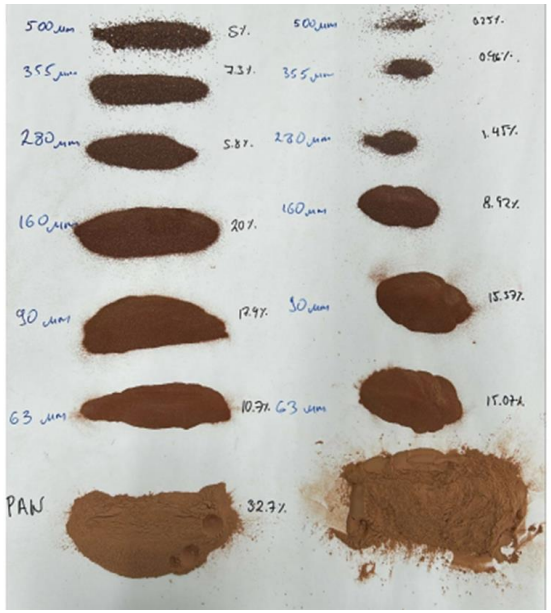


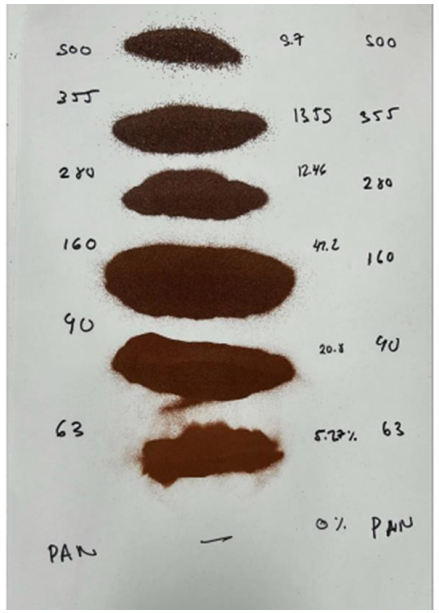
relatively wide PSD

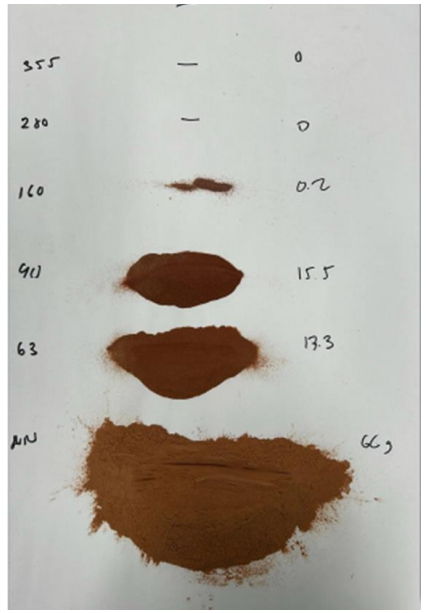
06

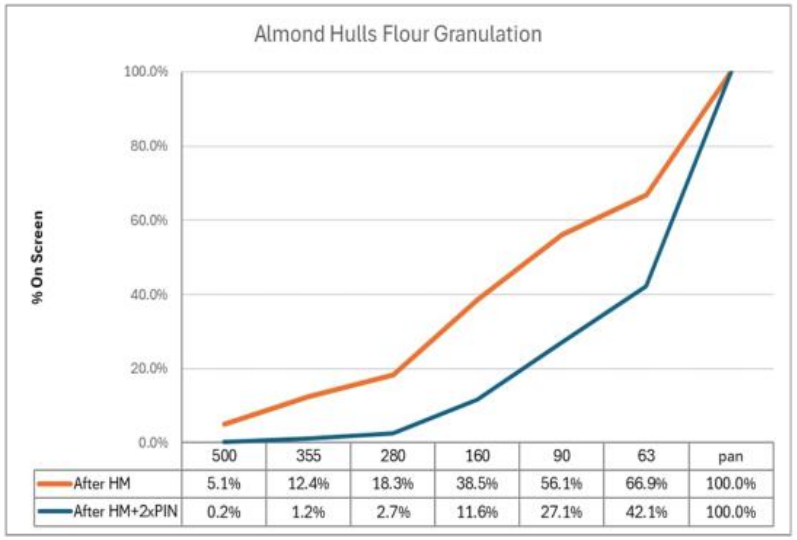
Sieving – Particle Size Distribution

Sieving - particle size and particle distribution

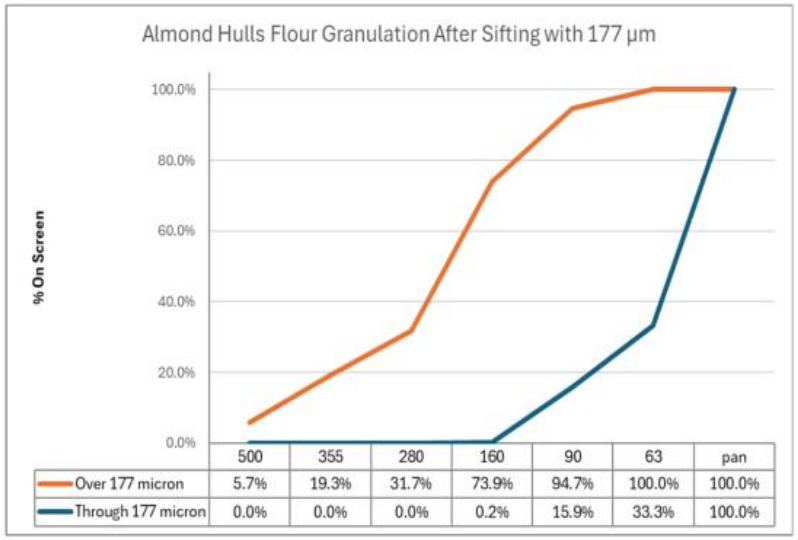








	500	355	280	160	90	63	pan
After HM	5.1%	12.4%	18.3%	38.5%	56.1%	66.9%	100.0%
After HM+2xPIN	0.2%	1.2%	2.7%	11.6%	27.1%	42.1%	100.0%



	500	355	280	160	90	63	pan
Over 177 micron	5.7%	19.3%	31.7%	73.9%	94.7%	100.0%	100.0%
Through 177 micron	0.0%	0.0%	0.0%	0.2%	15.9%	33.3%	100.0%

07

Initial Trial Findings

Initial trial findings

Raw Material

- Varies considerably in quality and level of contamination
- Caries a microbial load
- Contains high level of silica (wear on equipment)

Sensory

- Broad color range can be influenced by humid and thermal treatments.
- Some aroma and flavor development can be influenced by humid and thermal treatments.

Grindability

- Silica, sugar and moisture content have an influence
- Coarse fractions appear as different composition
- Broad range of particle size and distribution are achievable

INNOVATIONS FOR A BETTER WORLD

Compostable packaging

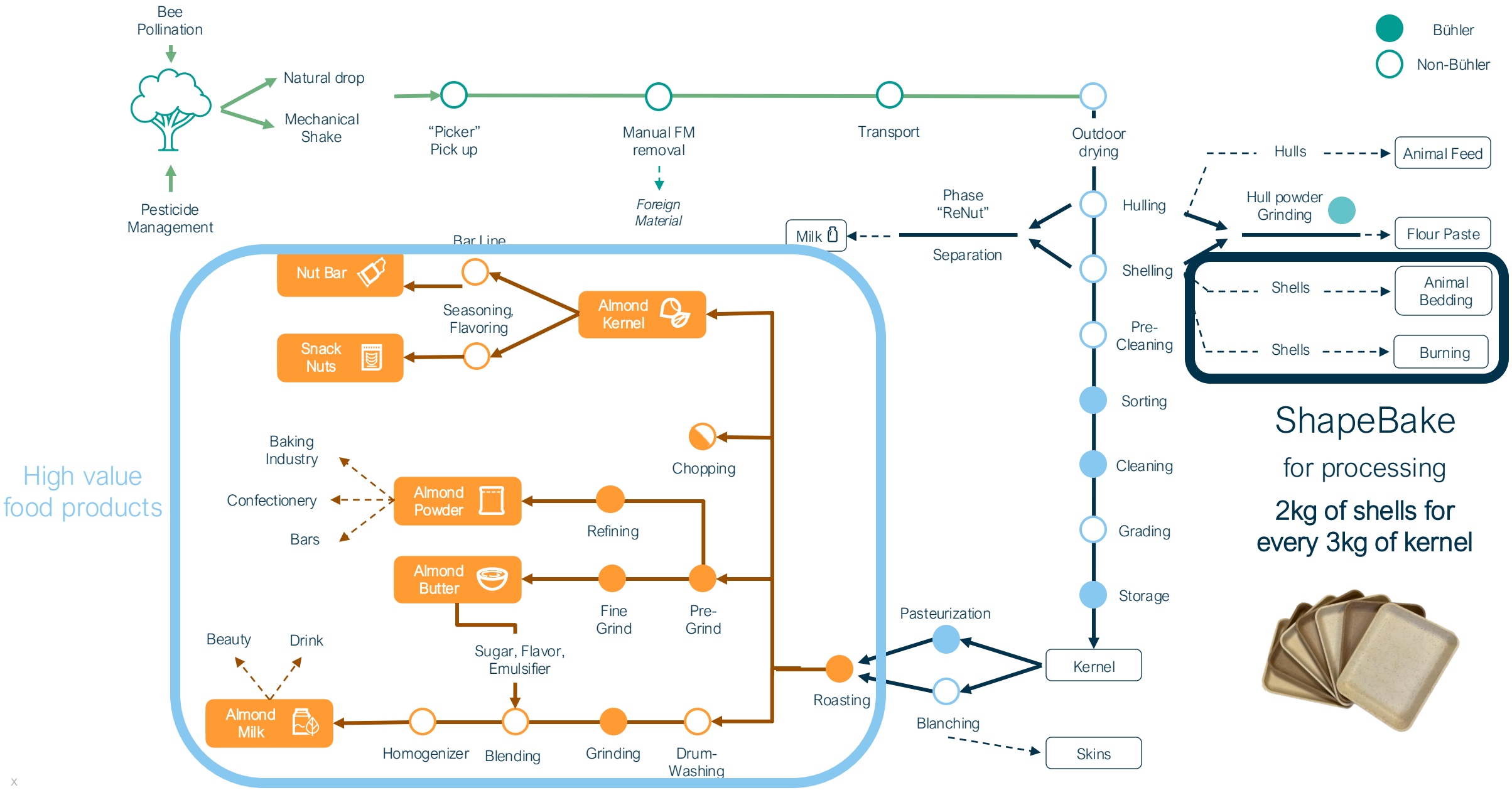
Made from upcycled almond shells

The transformation of an agricultural waste stream into a new revenue stream

BÜHLER

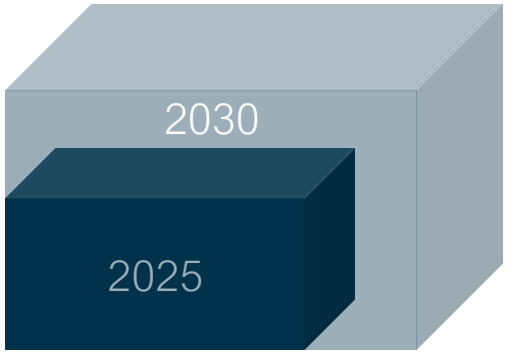
How can we create value from California's almost 1 million tons of almond shell waste?

Bühler's equipment solutions across the entire nut value chain



Consumer behavior

Compostable food service packaging market size



USA

20% annual growth rate 2.0bn USD → 5.0bn USD

*"In all surveyed countries and across end-use areas, the majority of respondents claim to be **willing to pay more for sustainable packaging**"*

McKinsey Packaging Survey
March 2023
McKinsey & Company

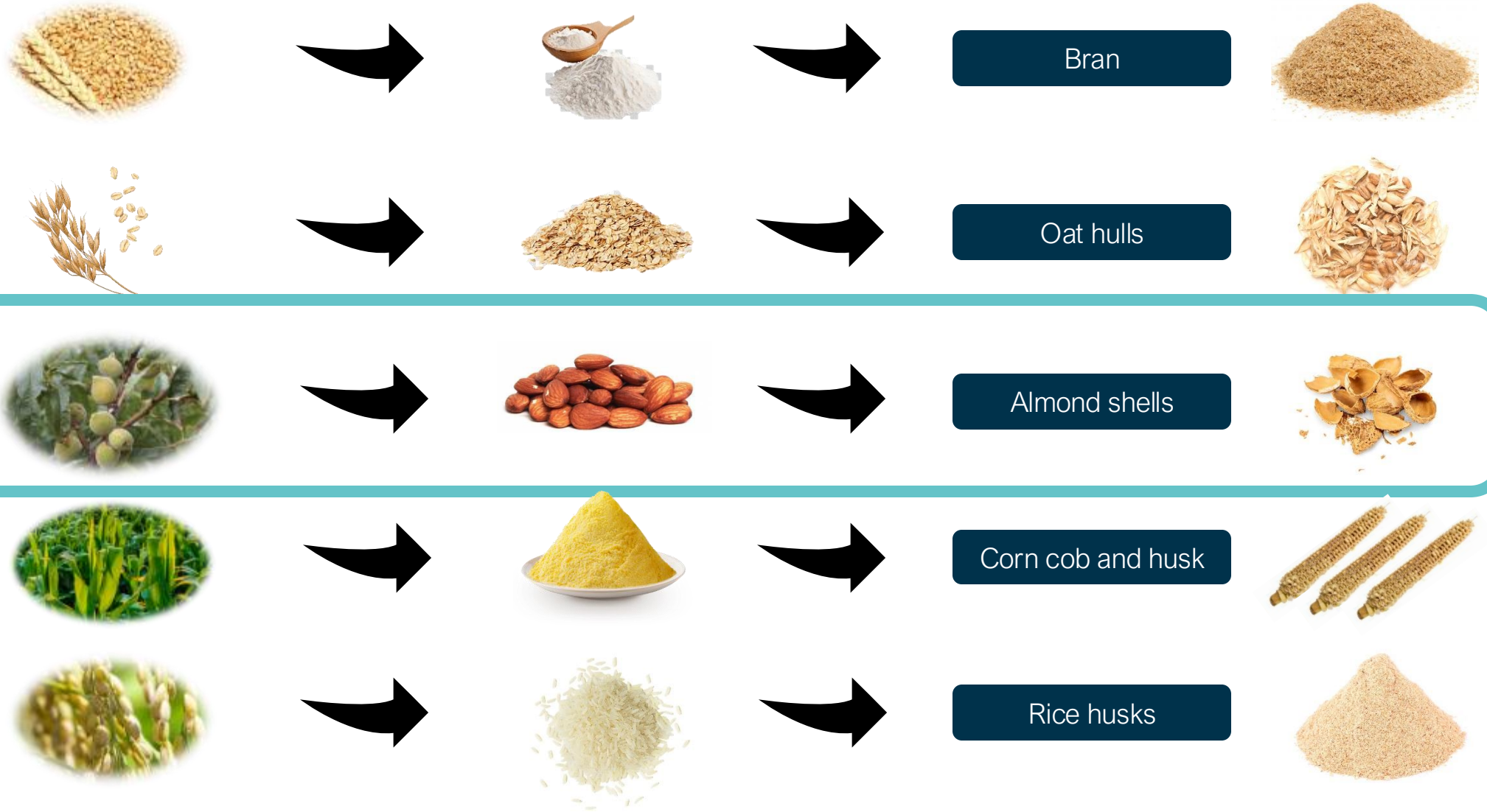
Q: "How sustainable do you think each of these packaging types are?," ranked by number of respondents who indicated "extremely" or "very strong," %

Ranked in top 3 | Ranked in bottom 3

	North America		Europe					Latin America	Asia			Global average, %	2020 Rank
	US	Mexico	UK	Germany	France	Italy	Sweden	Brazil	India	China	Japan		
Compostable packaging	72	82	74	68	51	62	58	82	78	68	61	69	
Plant-based packaging	70	81	66	70	50	61	57	87	77	70	57	68	
Plastic films made out of renewable raw materials that can be compostable	61	69	54	57	37	54	44	77	70	72	61	60	1
Paper-based cartons	59	63	60	49	34	54	43	60	76	59	42	55	4
Fully recyclable plastic bottles and containers	56	67	55	41	36	35	41	74	62	66	61	54	3
Flexible paper	52	57	63	50	33	54	42	59	74	62	39	53	6
Glass bottles and jars	51	54	55	65	56	53	38	41	60	50	44	52	2
Plastic bottles and containers made out of recycled plastic materials	53	62	47	36	30	37	36	67	62	61	46	49	7
Fully recyclable plastic films	57	60	54	36	35	43	29	68	64	26	59	49	5
Metal containers	37	33	40	22	25	27	23	35	54	50	36	35	8
Packaging combining plastic, paper, and aluminum foil	28	36	22	12	15	14	14	29	48	42	16	25	10
Aluminum foil wraps	25	24	23	8	16	27	13	24	46	37	15	23	9

ShapeBake

A versatile technology to valorize the raw materials in your region



End-product possibilities

Trays, plates, dishes

Cutlery: forks, spoons

Other molded shapes

100% plant-based, 100% biodegradable

Compostable trays made from agricultural waste

- Upcycling of nutshell waste stream into biodegradable tableware
- Sustainable replacement for single-use plastics
- 100% compatible with food waste / compost

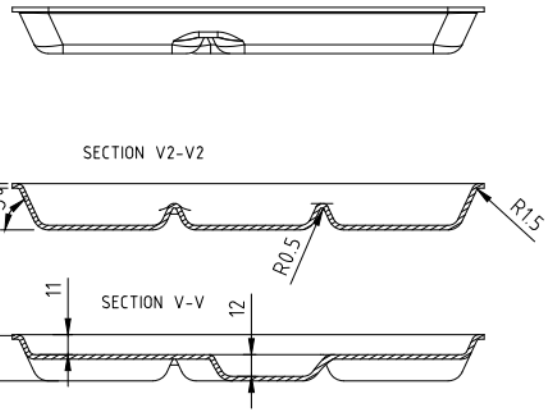
Biodegradable (or even edible) cutlery

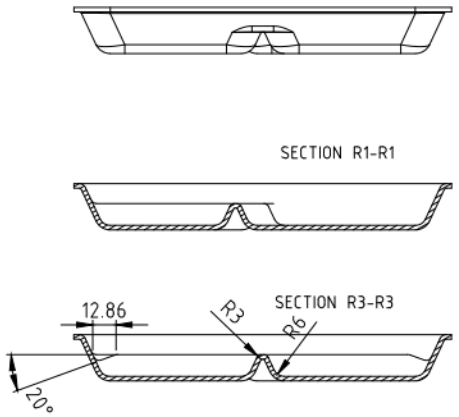
- Optimized recipes for the intended application
  - Edible and optimized for flavor, or
  - Compostable with high side-stream content
- 100% compatible with food waste / compost

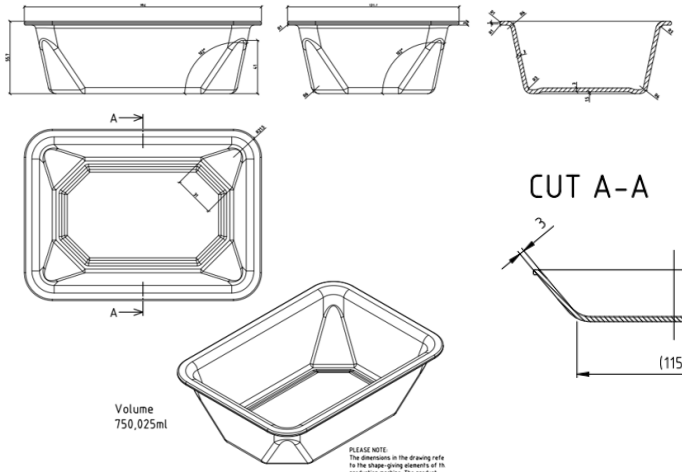
Other possibilities for creating your desired end-product

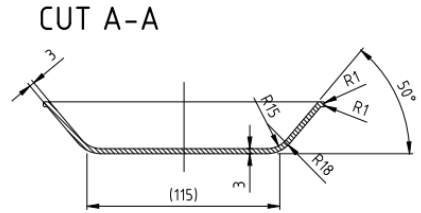
- Example: edible coffee cup lids
  - Fun and flavorful alternative to single-use plastic cup lids

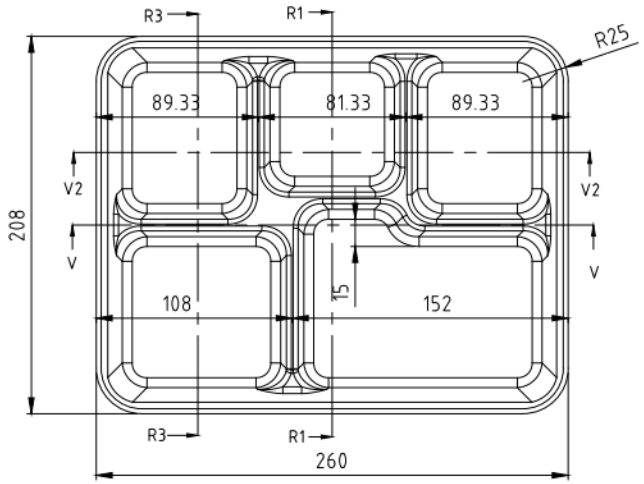
Tray and plate possibilities using almond shells





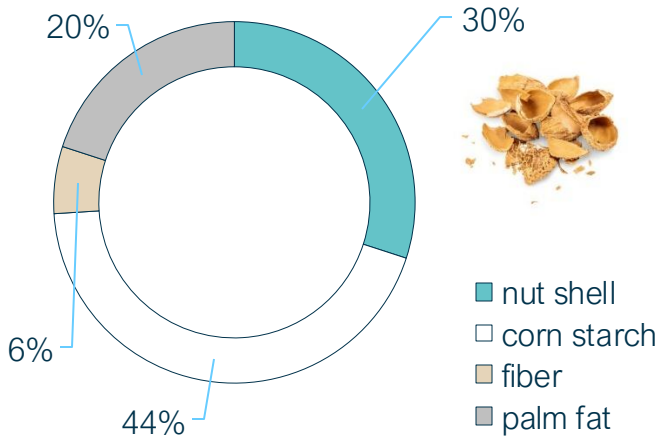


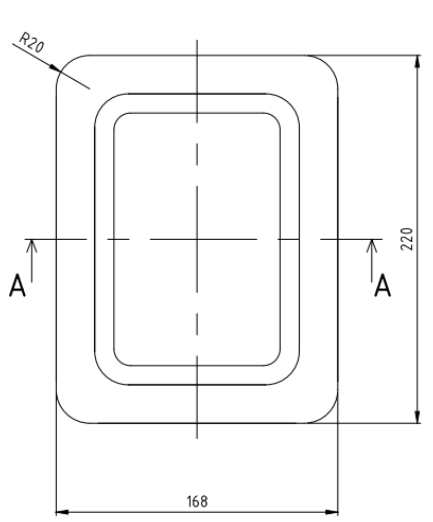


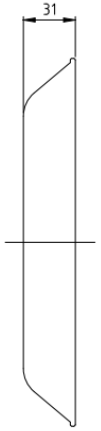


Example formula

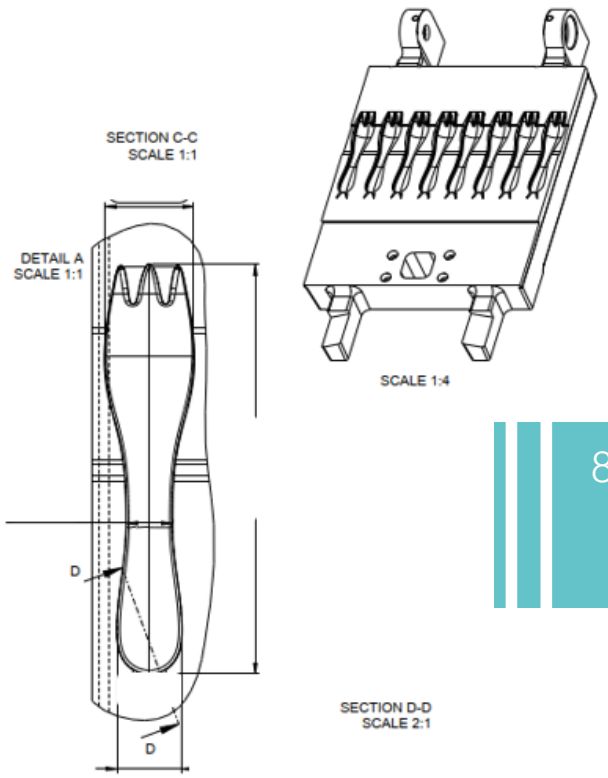
100% plant-based



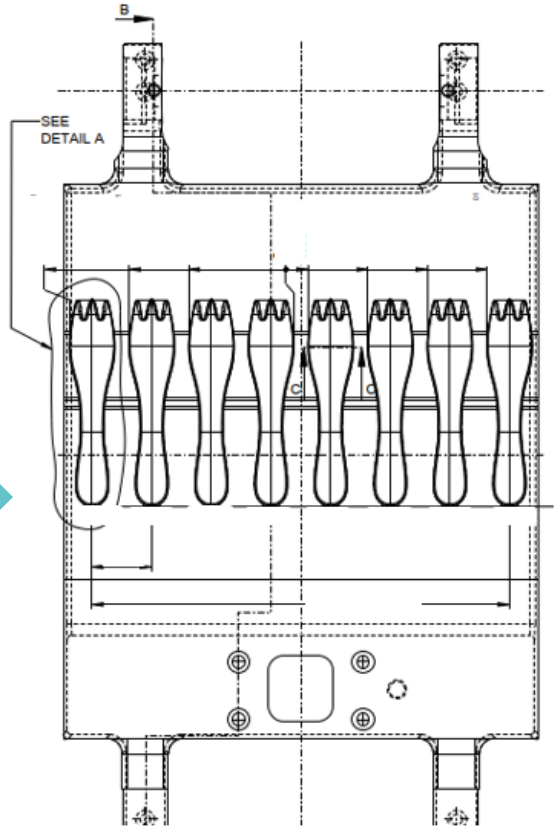




Compostable cutlery produced on ShapeBake

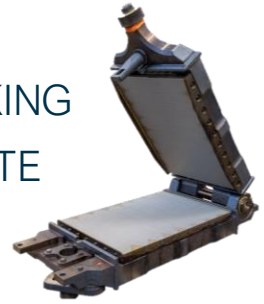


8 products per baking plate = 8x output!



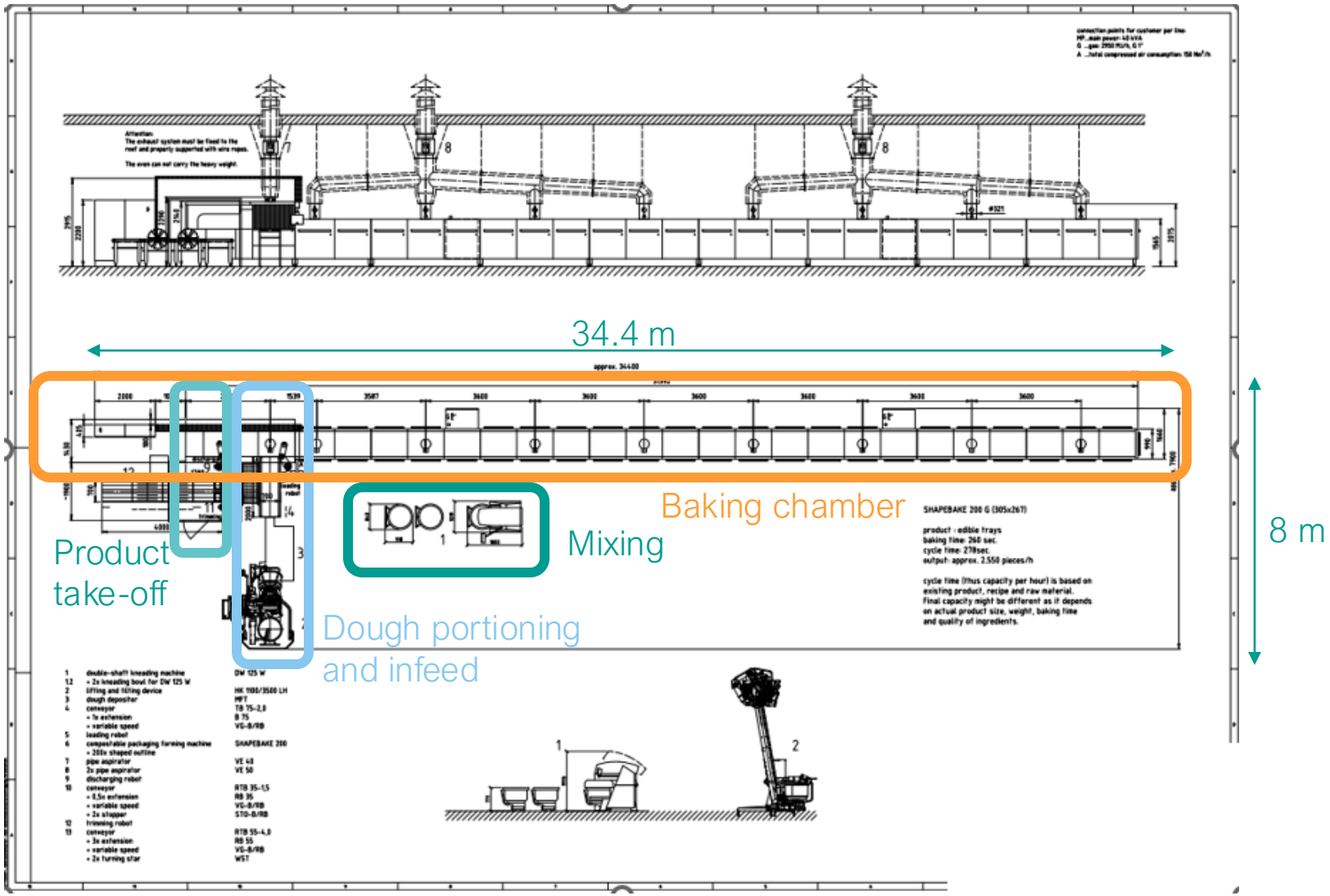
Our processing technology: ShapeBake

Turn-key solution for molded starch-fiber packaging



Mixing	Dough portioning	Pick-and-place depositing	Thermo-molding	Pick-and-place product removal	Stacking or packaging
Solid dough	Precise dough portioning	High accuracy dough portion depositing robot	High speed ShapeBake oven	High accuracy product removal robot	

Standard layout for ShapeBake 200 for trays



Key Features

- Automated production
- 200 baking plates (max)
- **Capacity: 1000-2000 tons/yr**

Compostable trays version

- High nutshell content (55%)
- Baking time: ~ 3.5 - 4 minutes
- **~ 3000-3500 pieces per hour**

Cutlery version

- 8 products per baking plate
- **~ 25,000 pieces per hour**


32g tray
145 x 210 x 16 mm
50g tray
168 x 220 x 31 mm
8 g spoon

Use cases

Professional sports stadiums

Professional League	Annual attendance	Games per season	Stadium size up to (# people)
MLB	70 million	~ 2400	57,000
NFL	19 million	~ 270	82,000
NBA	22 million	~ 1200	21,000
NHL	23 million	~ 1300	21,000
NCAA football	37 million	~ 1600	107,000

Total attendance: 171 million

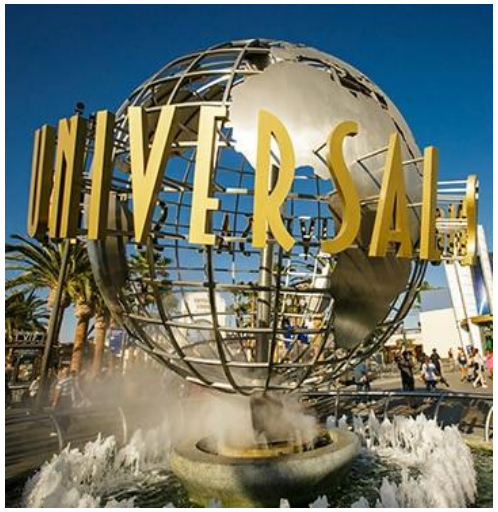
Use cases

Los Angeles 2028: hundreds of sporting events in a single location

PARIS 2024

Use cases

Theme parks with existing waste infrastructure



Music festivals and other outdoor events

Turn your waste stream into useful products that make a difference

For the end user

For your industry's reputation

For your bottom line

For the environment

Industrially & home compostable & naturally biodegradable

Biodegradable plant-based packaging

ShapeBake

Transform your waste stream into value

BÜHLER

The value proposition

Let’s work together to create your ideal compostable packaging item from almond shells!

Circular economy

The 100% plant-based formula with locally-sourced raw materials otherwise discarded as waste

Getting more out of every drop

Reducing harmful plastic pollution mitigates some concerns around resource-intensive irrigation

Quality product

Customers will love the premium feel and quality of the compostable packaging

Natural biodegradability

Packaging produced on our equipment vanishes without a trace, regardless of where it ends up

ShapeBake

x


THANK
YOU!
2025
THE ALMOND
CONFERENCE
CULTIVATING A HEALTHIER
FUTURE