PMMI Business Intelligence

DAIRY INDUSTRY REPORT

Innovation • Adaptation • Transformation

12930 Worldgate Dr., Suite 200 | Herndon, VA 20170

What We Do

PMMI is a global resource for the packaging and processing industry, uniting the industry across the manufacturing supply chain. Our members promote business growth in a variety of industries by developing innovative manufacturing solutions to meet evolving consumer demands, today and in the future. PMMI membership represents more than 1,000 manufacturers and suppliers of equipment, components, and materials as well as providers of related equipment and services to the packaging and processing industry.

PMMI connects consumer goods companies with our members' manufacturing solutions through the world-class PACK EXPO portfolio of trade shows, including: PACK EXPO International, PACK EXPO Las Vegas, PACK EXPO East, PACK EXPO Southeast, EXPO PACK México, and EXPO PACK Guadalajara.

About This Report

This report was produced by PMMI in conjunction with DDR//REACH, a specialized research and business development house delivering a broad range of packaging industry reports and white papers for over a decade. We are subject matter experts across many topics in B2B manufacturing and are adept at synthesizing in-depth VOC interviews, broad-reaching survey data, and voluminous secondary research into digestible and actionable intelligence.

Dairy Industry Report

Innovation • Adaptation • Transformation

PMMI The Association for Packaging and Processing Technologies
12930 Worldgate Drive, Suite 200 | Herndon, VA 20170
Phone: (571) 612-3200 | **pmmi.org/research**

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Jorge Izquierdo, Vice President, Market Development, PMMI
Rebecca Marquez, Director, Custom Research, PMMI

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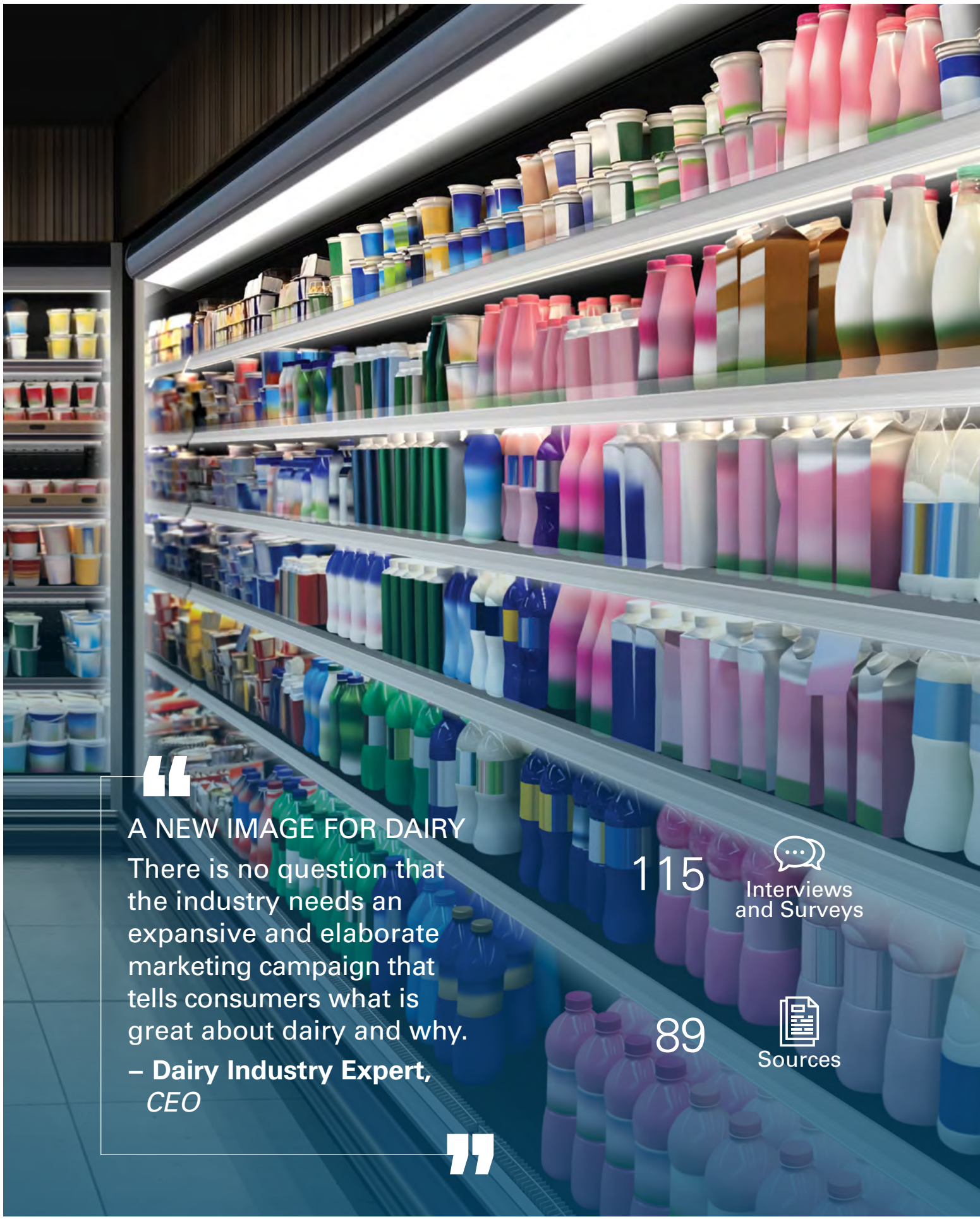


A NEW IMAGE FOR DAIRY

There is no question that the industry needs an expansive and elaborate marketing campaign that tells consumers what is great about dairy and why.

– **Dairy Industry Expert,** *CEO*

115 Interviews and Surveys

89 Sources

CONTENTS

SECTION ONE

EXECUTIVE SUMMARY

DAIRY INDUSTRY REPORT

Innovation • Adaptation • Transformation

> There is an opportunity across the entire industry to educate consumers on the health and wellness benefits of dairy products.
>
> Vice President Engineering, ***Large Milk Processor***

Dairy Industry Perspective

The findings in the PMMI Dairy Industry report are based on the opinions gathered from 115 dairy professionals. The commentary is the voice of the dairy industry sharing their experiences and recommendations toward a growing and prosperous future for the dairy industry.

The statistical charts, graphs, and tables throughout the report track the growth and contraction of five broad US dairy product segments from 2019-2022 – cheese, fluid milk, dry/condensed/evaporated products, ice cream/frozen, and creamery butter, as well as products within each segment. The data shows trends over time on the size of the industry, spend on machinery, materials and services, packaging types, consumer consumption, production by weight, unit sales at retail, dairy plants across the US, and imports and exports. Global trends are reported by region.

All uncited statistics in this report are derived directly from proprietary interview/survey information conducted for this report. All other statistics are cited with either an endnote or a direct mention of the source in the text.

INTRODUCTION

The dairy industry has faced numerous challenges in the last decade, which have fueled discussions amongst dairy producers. A prolonged downturn in fluid milk consumption, the rise of plant-based alternatives, persistent inflation, fluctuating supply chain costs, and ephemeral consumer preferences have all contributed to dairy companies' general concerns within the industry.

Despite these ongoing challenges, the future of the dairy industry is bright – especially for those players open to innovation and collaboration. New products, innovative formats, and increased avenues for consumer connection are helping dairy producers reach further into dairy markets and excite new demographics of dairy consumers. Advancements in processing and packaging technology are enabling dairy companies to keep up with changing consumer preferences by introducing new products and new formats without the need for constant, costly investment. Expanding partnerships and collaboration efforts are uniting stakeholders across the dairy industry in a shared goal of driving their products and markets to new heights.

By forging a new path with stakeholders across the dairy industry and remaining flexible to the needs of the market, dairy companies can position themselves for enduring success into the future.

TOP TAKEAWAYS DRIVING TRENDS IN THE DAIRY INDUSTRY

PACKAGING INNOVATION

- > Sustainability
- > New shapes/sizes
- > New products

TECHNOLOGY ADOPTION

- > Automating to minimize manual tasks
- > Increasing line integration
- > Deploying more robotics
- > Applying digital communications
- > Advancing the use of machine learning and AI-based applications

FASTEST GROWING DAIRY PRODUCTS

- > Extended shelf-life and shelf-stable
- > Plant-based products
- > Yogurt
- > Cheese
- > Ice cream

MACHINERY IMPROVEMENTS

- > Faster equipment cleaning times
- > Versatile machines to handle different shapes and sizes
- > Flexible machine tolerances for material variances
- > Increased throughput speeds

DESIRABLE PACKAGING FORMATS

- > Drinkables
- > Ready-to-consume
- > Single-serve
- > Shelf-ready

OEM SERVICES

- > Preventive maintenance capabilities
- > Knowledgeable service technicians
- > Timely delivery
- > Comprehensive operator training
- > Integration and installation services

INNOVATION

Promoting Health and Wellness in Dairy Products

Product and packaging innovation are key to help dairy producers distinguish their products as healthy and nutritious to appeal to a broader range of consumers.

PROMOTE HEALTH

Consumers are looking for healthy products – products that are 'better for me,' especially for younger customers. We have to continue to promote that dairy products have a wellness factor associated with them.

President, **Dairy Industry Expert**

Consumers are health conscious and looking for better choices.

Dairy companies are innovating new products to meet consumer preferences:

> Healthier products
> Flavorful ingredients
> Single-serve
> Reduced sugar
> Lactose-free
> Nutrient-enhanced

Dairy industry professionals report the following product categories are being targeted for new product innovations.

Innovation in Dairy Products

Cheese | Yogurt | Milk | Ice Cream | Plant-based

The following dairy products covered in this report are listed in alphabetical order:

> Butter
> Cheese (shredded/sliced/cubed/brick)
> Cottage cheese
> Fluid milk/cream
> Frozen (ice cream)
> Non-dairy milks
> Plant-based
> Powders (whey)
> Sour cream
> Yogurt (regular/Greek)

PRODUCTS

Dairy Industry: Five Trackable Dairy Product Segments

Five broad product segments are tracked throughout this report and showcase the growth and contraction of spending, production, and consumption over the last five years.

Green highlights indicate positive CAGR growth in that category during the years noted and the red highlights indicate a contraction in the product category.

Dairy Product Segments (2019-2021)	US Census – Value of Shipments at Point of Manufacture CAGR 2019-2021	US Census – Spend on Machinery CAGR 2019-2021	US Census – Spend on Materials and Services CAGR 2019-2021	US Census – Number of Dairy Manufacturing Plants CAGR 2019-2021	Federal Reserve – Production Index CAGR 2019-2022	USDA – Billions of Pounds Produced CAGR 2019-2022
Cheese	3.8%	-1.9%	3.1%	0.3%	2.3%	2.0%
Fluid Milk	3.8%	-13.4%	4.5%	-0.5%	0.9%	-4.5%
Dry/Condensed/ Evaporated	-3.6%	-16.4%	1.1%	1.5%	-4.6%	2.9%
Ice Cream/ Frozen Desserts	9.6%	-5.5%	0.1%	1.0%	3.8%	N/A
Creamery Butter	-7.5%	32.5%	-5.3%	5.1%	2.8%	1.0%

Details in Appendix B; Tables 1 - 7

Improving packaging sustainability is a top concern for the dairy industry – for instance, moving from polystyrene to PET.

NEW LOOK TO BOOST MILK IMAGE

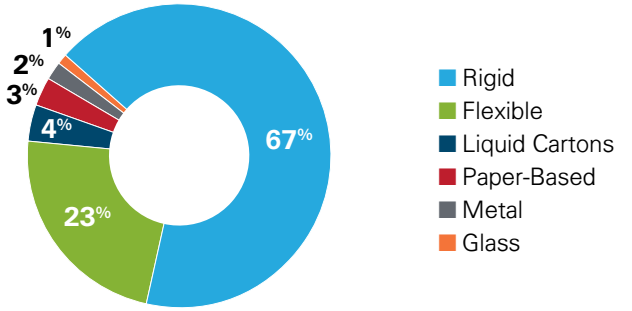
We produce fluid milk for convenience stores in the Midwest and we are working on a different look for the container, but not new bottles – we make our own bottles.

— *Production Project Manager,* **Retail Private Label**

PACKAGING

North American Dairy Industry: Packaging Materials

In North America, There Were 41.8B Units of Dairy Products Sold at Retail in 2022, Packaged in Six Types of Materials



Source: Euromonitor Retail Dairy Packaging Data 2019-2023 Global Statistics in Appendix B – Table 9

Rigid packaging remains dominant in the North American dairy industry, but Euromonitor's recent near-term forecast shows rigid packaging with a 0.8% CAGR (2022-2023) in dairy products sold at retail, while flexible packaging shows a 3.4% CAGR in the same time period.

$130.2B

US value of shipments of all dairy products 2021.

Source: US Census Bureau

67%

Over two-thirds of all dairy products at the retail unit level in NA are sold in rigid plastic packaging, which has showed slight contraction in the last few years.

3.4% CAGR

Flexible packaging contracted in 2022 after several years of steady growth; 2023 is forecast to exceed the number of units sold in 2019 with a CAGR of 3.4%.

MACHINERY AUTOMATION

Automation is a key strategy for dairy processors to improve efficiency and minimize costs. While initial investment may be high, even small dairy operations need to consider where automated solutions make sense.

Most Important Machine Improvements Requested by Dairy Professionals in Processing and Packaging

PMMI ©2022

Reduction in cleaning times with increased efficiency	**46%**
More automated operations: vision inspection, machine learning, minimizing manual tasks	**36%**
Versatility to handle different shapes and sizes	**35%**
Faster speeds to increase throughput	**30%**

41% Of dairy companies are spending more on equipment in the next 12-24 months.

27% Of dairy companies are spending more on software in the next 12-24 months.

Manufacturers Predict Where They Will Need New Machines in the Next 12-24 Months

PMMI ©2022

Processing	**57%**
Primary Packaging	**44%**
Secondary Packaging	**34%**
Transport Packaging	**15%**

TECHNOLOGY READINESS

We have a good plan already for predictive and preventive maintenance, but we are not yet working on AI.

— *Production Project Manager,* **Retail Private Label**

DIGITIZATION

Companies want to automate every task that will benefit them, but we haven't seen much materialize yet on digitalization and AI.

— *Vice President Business Development,* **OEM**

Our engineering team is working on how we can best use our digital data to improve maintenance scheduling, reporting, and performance tracking, and minimize manual tasks.

— *Sr Project Engineer,* **Dairy Processor Leader**

Since digital applications are the way of the future, everyone needs to get better at data analysis and management.

— *Senior Vice President, Product Science,* **Expert**

Everyone is talking about the use of AI and IIoT. Digital technology is a priority in the global dairy sector and engineers are trying to better understand how to efficiently apply it in dairy processing and packaging – which will ultimately increase investments in operations.

— *Senior Vice President,* **Product Science, Expert**

CONSUMERS AND RETAILERS

Drivers of Change Are Most Often Consumers and/or Retailers

Packaging and Processing Changes Dairy Companies are Making to Address Market Demands *(listed in order of importance:)*

> Sustainable packaging
> Variety of product sizes
> Clean labeling
> Ready-to-consume products
> Single-serve packaging
> E-commerce / DTC packaging
> Shelf-stable products
> Extended shelf life (ESL) products

MORE THAN **60%**

Of respondents said they'd pay more for a product with sustainable packaging.[1]

53% Of Millennials
+
44% Of Baby Boomers

Said that reducing the impact on the environment is an important consideration when choosing what type and brand of food to purchase.[2]

RETAILERS DRIVE CHANGE: ASKING FOR PACKAGING TO HAVE BETTER INTEGRITY, OFFER MULTIPLE SIZES, AND BE SHELF-READY

Retailers are driving a need to change packaging to improve integrity during transport.

— *Sales Manager,* **FMCG**

The retail giants get what they want from manufacturers – you either comply or don't supply and it often costs more to go greener.

— *Industry Expert,*
Food Engineering

Club stores and C-stores are for sure causing changes asking for bulk packaging; we are trying to figure out ways to create bulk packaging, maybe by sleeving a 3-pack.

— *Senior Packaging Engineer,*
Leader in Food Manufacturing

The two challenging requests from retailers right now are more shelf-ready packaging and smaller case sizes.

— *Packaging Engineer,*
Shelf-Stable Food Manufacturer

When a package is designed to retailer specifications to be easy to open on the floor, it creates problems along the supply chain where easy to open is not desirable. We are getting complaints from the warehouse that the top comes off, throwing product everywhere.

— *Principal Packaging System Design Engineer,*
Global Food Company

E-COMMERCE DRIVES CHANGE

Our packaging is not ready for e-commerce channels; we are learning this new supply network.

— *Associate Director Packaging,*
Large Food Manufacturer

INDUSTRY SIZE

Global Dairy Industry: Global Market Share 523B Units of Product Sold at Retail in 2022

45%

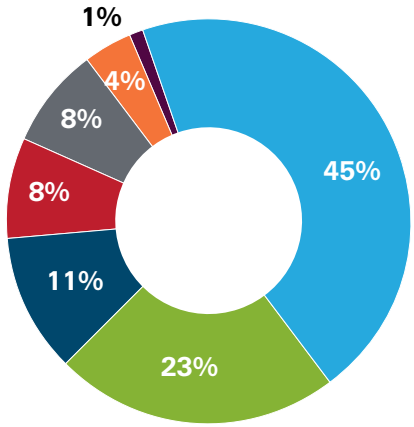
Nearly half of all global dairy products sold at the retail unit level in 2022 were in Asia Pacific, which is forecast to be the fastest growing region in 2023.

Trends in Retail Unit Sales (Globally 2019-2022):

There have been wide fluctuations across the globe in unit dairy sales year-over-year as shown in Appendix B, Table 10.

The global dairy industry experienced a slight contraction of -0.3% in 2022. Analysts have forecast a strong rebound for 2023 in all regions. Euromonitor forecasts relatively flat growth of 1.2% CAGR through 2027.

Global Dairy Market Share by Region: 523B Units Sold at Retail 2022



Dairy packaging units include rigid plastic, flexible, glass, liquid cartons, paper-based containers, and metal.
Details in Appendix B, Table 10

Source: Euromonitor Retail Dairy Packaging Data 2019-2023

FULL REPORT

Products and Packaging
Innovative • Sustainable • Shelf Stable

Machinery Forecast
Cleanability • Automation • Versatility

Advancing Automation
Integration • Robotics • Compliance

Actionable Directive
Innovate • Collaborate • Support

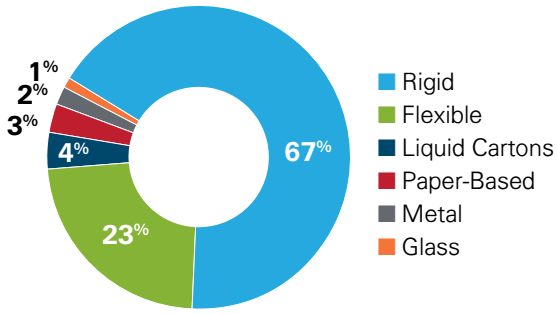
SECTION TWO

PRODUCTS AND PACKAGING

Innovative • Sustainable • Shelf Stable

North America Dairy Industry: Packaging Materials

NA Dairy Packaging Material Types: Units Sold at Retail 2022



In North America,* there were 41.8B units of dairy products sold at retail in 2022 packaged in six types of materials. 42.4B units are forecast to be sold in 2023.

**Global Statistics in Appendix B, Table 9*

Supply Chain Issues Have Influenced Packaging

Dairy companies reported significant supply chain issues during the pandemic. In some cases, companies struggled with obtaining adequate packaging material for their standard packaging, forcing them to switch formats or limit production of select products. Dairy producers specifically noted difficulty in reliably sourcing rigid packaging formats, forcing some to migrate to flexible materials. While the supply chain has improved post-pandemic, challenges still remain.

North America Dairy Industry Material Usage: Growth and Contraction CAGR 2019-2002 and Forecast 2023 CAGR

Packaging Material Type	CAGR 2019-2022	CAGR 2022 Actual to 2023 Forecast
Rigid Plastic	-0.5%	0.8%
Flexible Packaging	-0.3%	3.4%
Liquid Cartons	-1.5%	-1.5%
Paper-based Containers	1.0%	2.8%
Metal	0.1%	-0.6%
Glass	10.1%	8.7%
NA CAGR	-0.4%	1.4%

Source: Euromonitor Retail Dairy Packaging Data 2019-2023

Glass packaging shows double-digit growth in recent years but only holds a 1% market share.

Fluid Milk and Glass Packaging

While glass remains a very small portion of overall fluid milk packaging at 1%, some participants have noted a recent increase in demand. One supplier in particular has seen an increase in their business for liquid milk in glass, reporting 10% year-over-year growth for the past few years which has necessitated bringing in new equipment to keep up with demand.

Dairy companies can differentiate themselves through product and packaging innovations that speak to their consumers' preferences and lifestyles.

> Product innovation takes time with consumer testing and long lead times to build a dairy plant, but the industry is trying to spur new product development. Some companies are doing it successfully.
>
> — *Senior Vice President,* **Product Science, Expert**

YOGURT in the Spotlight

CONSUMPTION SHOWS GROWTH

While yearly yogurt consumption peaked in 2013 at 14.9 pounds/person and fluctuated for several years after, the USDA consumption data shows a slight rise in 2022 with a five-year peak at 14.3 pounds/person.

Appendix B, Table 8

VALUE OF SHIPMENTS SHOWS DECLINE

Yogurt products showed a decline of -7% in the value of shipments over a single year from 2020 to 2021, according to the US Census.

Appendix B, Table 6

RETAIL UNIT SALES PREDICT SLIGHT CONTRACTION

Euromonitor forecasts to 2027 show a slowing but continued contraction of yogurt at retail unit volumes of -0.4% CAGR.

Details in table on page 23

> **DOWNTURN IN YOGURT**
>
> We are experiencing a downturn in our yogurt business; we don't know exactly why, it's supposed to be healthy.
>
> — *Packaging Engineer,* **Retail Private Label**

Multiple Dairy Products are Targeted for Innovation and Growth

Innovation in Dairy Products

Dairy companies are working on new product innovation for the following product categories:

- Cheese
- Yogurt
- Milk
- Ice Cream
- Plant-based

INNOVATIVE PRODUCT DEVELOPMENT

Work is happening on different flip-top products.

— *Senior Vice President,* **Product Science, Expert**

We are looking at doing new cheese blends driven by consumer preferences.

— *Controls Engineer,* **Boutique Cheese Processor**

Sometimes innovating a new product requires finding a solution for a different dispensing method.

— *Vice President,* **Food Engineering Expert**

Dairy Products Showing Growth

Participants share their fastest growing product segments in the US dairy industry.

- Shelf-stable
- Plant-based
- Yogurt
- Cheese
- Ice cream
- Whey protein
- Butter
- Organic

The following product formats were mentioned most often:

- Drinkables
- Ready-to-consume
- Single-serve
- Shelf-ready
- Extended shelf-life

DAIRY ALTERNATIVE PRODUCTS GROWING

Dairy alternatives and plant-based products seem to be the areas of significant growth.

— *Director Of Package Engineering,* **Leading Dairy Processor**

I don't know by how much, but I think dairy alternative products are growing the fastest.

— *Food Engineering Expert*

There are three products showing growth: drinkable yogurt with longer shelf life, single serve protein milks, and family size non-dairy milks.

— *International Sales Manager,* **OEM**

INNOVATIVE DAIRY PRODUCTS

Product, Brand, and Packaging Innovation

Dairy companies are innovating dairy products in response to consumer preferences: more protein, less sugar, more convenience, and lactose-free.

TRENDY PRODUCT ATTRIBUTES

A recently released line of cottage cheese fortified with probiotics aligns with consumer desires. The product also promotes itself as having twice the protein content of yogurt, contains real fruit, and is high-fructose corn syrup free, covering a wide array of consumer concerns.

E-COMMERCE DAIRY

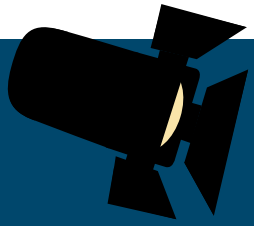
With the advent of more advanced shelf-stable technology and (crucially) growing consumer interest, dairy companies have expanded DTC shipping beyond liquid milk. Dairy producers can stand out by catering to DTC channels, but they must ensure their packaging can withstand the rigors of rougher handling.

HEALTHIER PRODUCTS THROUGH SUGAR REDUCTION

Reducing or eliminating sugar is an excellent way for dairy producers to cater directly to consumer requests. However, sugar is also an important texture-improving ingredient, meaning dairy producers must rely on other bulking agents, fiber, or other texturizers to replicate the mouthfeel of sugar. It is important for dairy producers to explain what these additives are and why they are used – label-savvy consumers often don't recognize these ingredients and don't realize they are texture additives.

CONVENIENT PACKAGING AND PORTIONS

One producer recently launched a new butter product that is portioned into individual, uniform balls to facilitate easy home cooking and measurement. The product addresses the needs of consumers by making it more convenient and usable since cooking at home increased during the pandemic and has endured into recovery.



INNOVATION IN MILK PRODUCTS in the Spotlight

ANIMAL-FREE DAIRY MILK

One novel product in development that is expected to hit the market is animal-free dairy milk. Produced from strains of whey protein through cellular agriculture, this "lab-grown" milk boasts a significantly smaller carbon footprint and can be easily manipulated into formulations like lactose-free.

A2/A1 MILKS

While lactose sensitivity is well known, recent research suggests that some individuals are actually sensitive to one of the casein (protein) compounds in milk, specifically the A1 beta casein. To address this, dairy producers are introducing products that contain only the A2 beta casein, giving consumers with A1 sensitivity a healthier and more approachable option.

PROBIOTIC MILK

Liquid milk can be made more attractive through trendy additives, such as probiotics. Dairy producers can tout the extra benefits of probiotic-infused milk over simple probiotic supplements by emphasizing the naturally healthy characteristics of liquid milk like vitamins A and D.

EXTENDING THE SHELF LIFE OF FLUID MILK

Advanced processing technology has enabled dairy producers to significantly extend the shelf life of their fluid milk products. ESL, or extended shelf-life processing, utilizes high temperature to produce milk that has lower microbial counts than pasteurized milk, extending the refrigerated shelf life by up to four months. UHT, or ultra-high temperature processing, takes this concept a step further but utilizing additional heat and aseptic filling techniques to produce a fluid milk product that is fully shelf-stable at ambient temperatures for up to a year. These two technologies are helping fluid milk producers drive their products into new channels and improve the convenience of fluid milk, especially in developing countries with less refrigerated distribution infrastructure.

INDUSTRY-WIDE STRATEGIES TO MEET DEMAND: PRODUCTS AND PACKAGING

Keeping Up With Consumers Through Flexibility

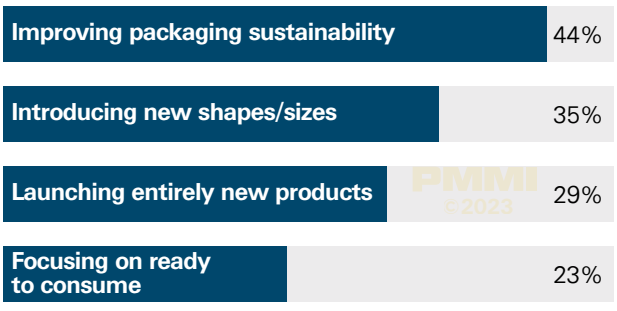
To remain competitive, dairy processors must adjust to consumer preferences for how and when they consume dairy products. With increasingly busy lifestyles and more out of home consumption resuming after the pandemic, consumers are now pivoting toward smaller sizes and convenient packaging, preferably with a sustainable option. Packaging such as single-serve formats with resealable peel-off lids can satisfy consumer preferences for convenience, size, and sustainability, but they often present additional challenges for processors.

Because these formats are often new and novel to the dairy industry, many processors lack the flexibility to produce them and may struggle to stay ahead of the consumer desire curve. These obstacles can be overcome through strategic investment in equipment that is highly flexible and designed to cope with changing packaging formats. While this type of equipment is more capital-heavy upfront, dairy processors can set themselves up for success by selecting equipment that can grow with their operation and adjust to shifting consumer demands.

It is vitally important that dairy processors carefully analyze where investment makes sense and what type/price of packaging their consumers will support –these considerations may be different from product to product. Dairy processors can get a leg up on this analysis by working closely with OEM partners that can present options and help scale operations to meet processors' needs.

> Participants are most often improving packaging sustainability and introducing new shapes/sizes to satisfy consumer demand.

Top Dairy Product and Packaging Improvements



Exceeds 100%; multiple answers

Other product or package improvements mentioned: adding shelf-stable products and changes in package durability for e-commerce and DTC.

SUSTAINABILITY

As we look to innovate products, improving packaging sustainability has a high influence.

— *Principal Packaging System Design Engineer,* **Global Food Company**

SINGLE-SERVE DRIVING INNOVATION

Our biggest focus is always on innovative, single-serve products.

— *Senior Packaging Engineer,* **Industry Leader**

MULTI-SERVE ON THE RISE

There is a trend toward more multi-serve formats as prices increase – families are looking for bargains.

— *Director of Packaging Sustainability,* **Leader in Cultured Products**

DIRECT-TO-CONSUMER

Our product innovation is focused on changes to comply with e-commerce and DTC delivery.

— *Director Of Package Engineering,* **Leading Dairy Processor**

COSTS AND CONSUMER DEMANDS

There is a conundrum around sustainability; consumers say they want recyclable packaging, but sustainable packaging adds cost to the product and consumers are not 'buying into' the added cost.

— *Industry Expert,* **Food Engineering**

DAIRY PACKAGING LAGS

There are some brands looking for opportunities to innovate and be more sustainable, but overall, the industry lags in innovative packaging.

— *Senior Vice President,* **Product Science, Expert**

There is not as much packaging innovation in the dairy industry as there is in juices and alcoholic beverages – maybe some new sleeved products, but dairy containers and caps do not change much.

— *International Sales Manager,* **Expert**

SUSTAINABILITY DRIVES CHANGE

Sustainability will be a big driver in the industry – retailers and customers are both asking for more sustainable packaging solutions.

— *Packaging Engineer,* **Shelf-Stable Food Manufacturer**

We have been focusing on all possible solutions for packaging sustainability for the past eight years – this is an ongoing initiative.

— *Senior Packaging Engineer,* **Industry Leader**

We are using less plastic and lightweighting our packaging, which certainly has a sustainability aspect, but also brings cost savings too.

— *Senior Packaging Engineer,* **Leader in Food Manufacturing**

We are always looking for cost savings like lightweighting, but recently we are more focused on raising our awareness of other sustainable projects, like the elimination of colorants and exploring bio-based resins.

— *Director Of Package Engineering,* **Leading Dairy Processor**

Our focused initiative right now is using more PCR materials.

— *Senior Packaging Engineer,* **Leader in Food Manufacturing**

There are mixed opinions on the real benefits and costs of adding PCR material to packaging; it's mandated in California, but the jury is still out elsewhere on the feasibility.

— *Senior Vice President,* **Product Science, Expert**

Improving sustainability is driving changes to our packaging right now. One strategy is graphical communications about sustainability through consumer outreach projects.

— *Director Of Package Engineering,* **Leading Dairy Processor**

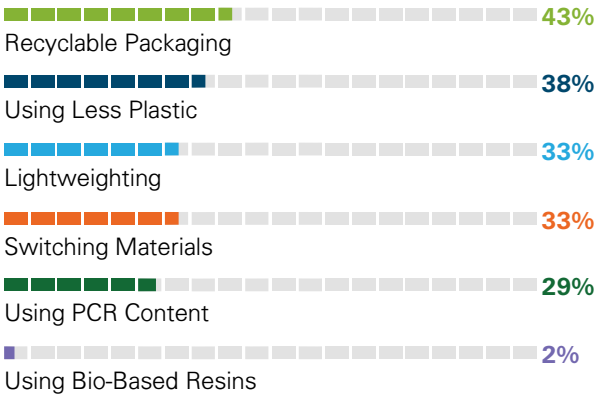
PACKAGING SUSTAINABILITY GOALS FOR DAIRY PRODUCTS

FLUCTUATING CONSUMER DEMANDS

While consumers are consistently concerned about sustainability, those concerns are spread across the sustainability spectrum, from sourcing to packaging. Because of this, companies pursuing sustainability initiatives must address a wide array of sustainability strategies across their entire operation to satisfy a diverse collection of consumer concerns.

Participants are most often looking for recyclable materials or using less packaging for their sustainable dairy packaging initiatives.

Dairy Companies are Making Sustainability Changes to Packaging



Exceeds 100%; multiple answers

89% Of participants stated they are currently pursuing sustainability initiatives.

Consumers Demand Sustainability

In a survey from 2021

76% Of US consumers stated they would switch their preferred packaged goods brands if they were offsetting carbon emissions.[3]

Is reducing your impact on the environment an important consideration in what food you choose to eat?

53% Of millennials said important or very important.[4]

44% Of baby boomers said important or very important.[5]

Of global consumers

NEARLY **73%** Feel more positive toward companies that are transparent about where their products come from and how they are made.[6]

58% Are more attentive to "locality claims" post-covid than before.[7]

Dairy Companies are Responding to Consumer Demands for Sustainability

A 2023 survey of dairy executives found

75% Have an ESG strategy, sustainability strategy, or both.[8]

67% Have allocated funds for their ESG/sustainability strategy, an increase from 57% in 2022.[9]

Of the 75% with an ESG/sustainability strategy

70% Cited customer requirements as the top motivator for implementation. This drastically outpaced the next two motivators: investor pressure (28%) and regulatory requirements (23%).[10]

Plant-based Dairy Consumers Most Willing to Spend for Sustainability

Consumers were asked if they would be willing to spend an additional 10% on products that do not harm animals and have a smaller carbon footprint to produce:

- **13%** of traditional dairy consumers stated they would;
- **24%** of mixed traditional and plant-based dairy consumers stated they would;
- **25%** of plant-based only dairy consumers stated they would.[11]

Euromonitor predicts retail unit volume of all plant-based dairy products combined to grow by 4.3% CAGR through 2027.

Details in table on page 23.

US DAIRY INDUSTRY: PRODUCT GROWTH AND CONTRACTION MEASURED BY VALUE OF SHIPMENTS AND WEIGHT

VALUE OF SHIPMENTS*

Dairy Product Activity 2019-2021

In the data below, the North American Product Classification System (NAPCS) reports several product lines generated double-digit rates of growth in the period 2019-2021.

Growth 2019-2021

> **Fluid milk** (lactose-free and flavored milk, 22.2% CAGR)
> **Concentrated milk products** (bulk, 15.1% CAGR)
> **Frozen desserts** (yogurt, sherbet, water ices, etc., 15.1% CAGR)
> **Raw liquid whey** (10.7% CAGR)
> **Fluid milk** (2%, 1%, 0.5% at 7.8% CAGR)
> **Processed cheese** (7.5% CAGR)

Contraction 2019-2021

> **Yogurt** (-4.3% CAGR)
> **All other processed cheese and related products** (-3.8% CAGR)
> **Fluid milk** (fat-free, skim at -2.8% CAGR)
> **Fluid milk and cream** (bulk at -2.8% CAGR)

Note: The product categories shown are only those reported by NAPCS, and do not represent every product category manufactured.

** US Census Bureau, Annual Survey of Manufacturers, NAPCS Collection, 2019-2021. NAPCS only has data available through 2021. Details in Appendix B, Table 6*

PRODUCTION BY WEIGHT*

Dairy Product Activity 2019-2021

The USDA data below shows dairy product manufacturing by weight (not sales revenue) and it includes 2022.

The largest product lines produced by weight are whole milk, cheese, and 2% milk. The next tier is ice cream, yogurt, and flavored milk.

Growth 2019-2022

> **Evaporated/condensed** (3.4% CAGR)
> **Whey protein** (2.1% CAGR)
> **Cheese** (2.0% CAGR)
> **Yogurt** (1.8% CAGR)
> **Dry skim** (1.0% CAGR)
> **Butter** (1.0% CAGR)
> **Ice cream** (0.9% CAGR 2019-2021^)

^USDA withheld figures for 2022

Contraction 2019-2022

> **Total Fluid Milk** (-4.5% CAGR)
> **Skim milk** (-13.7% CAGR)
> **Low-fat milk** (-8.6% CAGR)
> **2% milk** (-5.9% CAGR)
> **Flavored milk** (-3.0% CAGR)
> **Whole milk** (-2.8% CAGR)
> **Lactose** (-1.6% CAGR)
> **Dry whey** (-1.0% CAGR)

*Source: *US Department of Agriculture (USDA) Economic Research Services, Dairy products produced by millions of pounds, United States (Annual) published 9/30/2022*
Details in Appendix B, Table 7

USDA DAIRY CONSUMPTION

Dairy Consumption on the Rise

Overall, US per capita consumption of dairy products has been steadily growing for nearly 50 years. In 1975, the US consumed 539 pounds of dairy per capita; by 2021, this number had ballooned to 661 pounds per capita – an increase of nearly 23%.

On a snapshot basis, 2021 per capita dairy consumption is up 4% over the last five years, 9% over the last 15 years, and 19% over the last 30 years. In a sign of recent healthy growth, per capita dairy consumption increased by nearly 2% from 2020 to 2021.

Details in Appendix B, Table 8

Fluid Milk Consumption on the Decline

Annual per capita consumption of fluid milk in the US has been steadily declining for decades. In 1975, the US consumed 247 pounds of fluid milk per capita; by 2021, this number had fallen to 134 pounds per capita – a decrease of approximately 46%.

Factors such as an overall decrease in cereal consumption and consumer concerns over fluid milk's healthiness and digestibility are driving this steady decline in fluid milk consumption. However, research suggests that fluid milk producers can make their products more attractive to consumers by focusing on value-add and health-related claims on their fluid milk products. Consumers were most receptive to fluid milk that touted attributes including organic, all-natural, reduced fat, high protein, vitamin-fortified, and grade A. By promoting these attributes prominently on their packaging, fluid milk producers can help their product stand out to consumers.

US DAIRY INDUSTRY: FORECAST RATE OF PRODUCT GROWTH AND CONTRACTION, RETAIL SALES 2023-2027

US Dairy Products, Unit Sales Growth Forecast (2023-2027), Largest to Smallest

Dairy Product Category	Forecast CAGR 2023 - 2027
Flavored Milk Drinks	4.5%
Plant-Based Dairy	4.4%
Plant-Based Milk	4.3%
Plant-Based Ice Cream	4.1%
Processed Cheese	2.6%
Shelf-Stable Milk	2.3%
Drinkable Milk Products	2.2%
Cream	2.1%
Soft Cheese	2.0%
Other Cheese	1.8%
Coffee Whiteners	1.8%
Take-Home Ice Cream	1.6%
Impulse Ice Cream	1.5%
Chilled and Shelf-Stable Desserts	1.2%
Cow's Milk	1.2%
Fresh Milk	1.1%
Packaged Hard Cheese	0.9%
Butter and Spreads	0.8%

Source: Euromonitor: Packaged Food Trade Sources/ National Statistics
Forecast 2023-2027

US Dairy Products, Unit Sales Contraction Forecast (2023-2027), Smallest to Largest

Dairy Product Category	Forecast CAGR 2023 - 2027
Condensed and Evaporated Milk	0.0%
Yogurt	-0.4%
Sour Milk Products	-1.0%
Frozen Yogurt	-1.5%
Cottage Cheese	-1.7%
Powdered Milk	-3.1%

1.2%
CAGR growth predicted for all dairy product unit sales at retail. (2023-2027)

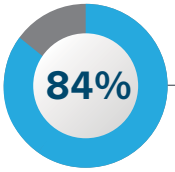
Whey Protein: Tapping into Consumer Lifestyles

Protein supplementation is an extremely popular consumer trend in the food industry, with products from cereal to sports drinks boasting fortified protein content. While some of this protein fortification is derived from plant-based sources like pea protein, whey protein is an increasingly attractive and natural protein source for manufacturers, especially in the protein-fortified RTD sports drink market. The growing popularity of this segment is reflected in the healthy (10.7%) CAGR of raw liquid whey, which tracks closely with growth expectations for the protein supplement market in general. Dairy producers struggling to innovate should consider looking to these growing niche markets where consumer interest and engagement is high.

In a recent survey of dairy executives, 80% expected to see at least 3% revenue growth over the next three years and 75% predicted to see even larger volume growth.[12]

PLANT-BASED DAIRY ALTERNATIVES CONTINUE TO GAIN POPULARITY

CONSUMERS OF DAIRY



Of US consumers eat and drink dairy or dairy alternatives[13]

71% Exclusively consume dairy products[14]

24% Consume both dairy and plant-based alternatives[15]

5% Exclusively consume plant-based[16]

About 45% of plant-based dairy consumers plan to increase their consumption in the next three years.[17]

Consumers of plant-based dairy alternatives are strongly motivated by health and wellness:

> More than 40% of plant-based consumers choose plant-based dairy alternatives because they perceive it's a healthier option.[18]

> Plant-based dairy consumers are more motivated by health reasons (42%) than product taste (36%) in their decision to consume dairy alternatives.[19]

> 75% of plant-based dairy consumers believe it is very important to eat healthy and 63% claim to lead healthy lifestyles. Traditional dairy-only consumers report only 46% and 35% for each claim, respectively.[20]

> 31% of US cheese consumers believe that dairy-free cheese is healthier than regular cheese.[21]

Speaking the Plant-Based Dairy Consumer Language

Consumers of plant-based dairy have made it abundantly clear that they are choosing dairy alternatives primarily as a lifestyle choice that supports their healthy living goals. Concerns about health and wellness even outstrip taste in the plant-based category – although with 57% of traditional dairy-only consumers noting taste is the reason for their dislike of plant-based products, alternative producers cannot ignore this quality entirely.[22]

To meet these consumers where they are, dairy processors should consider focusing their packaging messages on the health benefits and bonafides of their products. Products fortified with extra nutrients – like protein and probiotics – can be particularly attractive to this segment of consumers. By combining health claims with detailed product information like a sustainable farm-to-table story, plant-based dairy producers can present a holistic product anchored by a message of healthiness and sustainability. These product qualities can be turned into a further value-add by using packaging features like a scannable QR code to provide consumers with a complete product story.

Dairy Allergies: A Driver of Dairy Alternatives

A key driver of alternative dairy products are allergies and sensitivities to dairy-based products. Approximately 6 million people – or roughly 2% of the US population – have an allergy to dairy, most commonly lactose (milk sugar) or casein (milk protein).[23] On top of this, a 2022 survey found 37% of global dairy consumers self-reported sensitivity or intolerance to dairy products.[24] Research has shown that one of the entry points for dairy alternatives is consumers trying plant-based options because someone in their household has a dairy allergy.

Dairy producers have an important role to play in this market, especially through labelling. Producers should pay particular attention to labeling plant-based alternatives as entirely dairy-free and allergen safe, while producers of modified dairy products (like lactose-removed and A1/A2-selected milk) can emphasize the removal of one or more allergens. A clear, unambiguous label can help these products stand out to consumers with sensitivity to dairy products.

PRIVATE LABEL DAIRY PRODUCTS SHOW SUSTAINED GROWTH

Private Label Dairy Grows in 2022

Overall private label dairy products reached nearly $30B in sales during a 52-week period ending December 9, 2022, an 18% year-over-year increase.[25]

> Private label refrigerated white milk lead this category, with $8.6B in sales.[26]

> Private label natural cheese accounted for $8.1B in sales.[27]

> Private label butter/butter mixes and cream/creamers both accounted for $1B in sales.[28]

Packaged ice cream novelties and fluid milk products both placed in the top 15 fastest-growing private label products of any category in 2022.[29]

Outsourcing Services

OF DAIRY COMPANIES INTERVIEWED,

50% outsource processing operations

31% outsource packaging operations

Private Label Dairy Continues Growth in 2023

Private label has continued to gain share in 2023, with inflation as a primary driver. Of the top 15 US dairy categories, 13 have experienced more dollar sales growth in private label products than branded products.[30]

Top three dairy categories by dollar sales

Total Milk: **$18.5B; +8.5%** (volume down 3.3%)

Natural Cheese: **$17.3B; +8.2%** (volume down 0.7%)

Yogurt: **$9.1B; +12.7%** (volume down 1.6%)

Private label vs branded dollar growth for the top three dairy categories:

Total Milk: **Private Label: 10.5%** **Branded: 6.4%**

Natural Cheese: **Private Label: 11.6%** **Branded: 5.1%**

Yogurt: **Private Label: 21.5%** **Branded: 12%**

Private Label Dairy Producers

Consumers are embracing private label products as a strategy to combat inflation and balance their spending. With prices staying stubbornly high and many consumers noting worry about a future recession, it is unlikely demand for private label will slip in the immediate future.

With demand increasing, it will be even more necessary for private label producers to carefully manage their operations to keep up with demand and consumer trends. To accomplish this, private label producers will need machines that are flexible and adaptable to new packaging materials, sizes, and shapes. Modular equipment, capable of being redeployed, is another feature growing in popularity for private label producers looking to keep their operations nimble. Automated features are especially important for these producers to maximize efficiency and reduce downtime between different private label runs.

OEMs and suppliers have an important role to play in supporting private label producers by tailoring machines and solutions to their specific needs and challenges.

Consumers Adjusting to Inflation

To compensate for inflation, 42% of consumers report buying more private label products in 2023.[31]

SECTION THREE

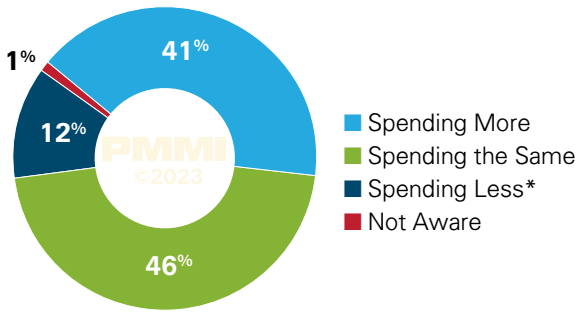
MACHINERY FORECAST

Cleanability • Automation • Versatility

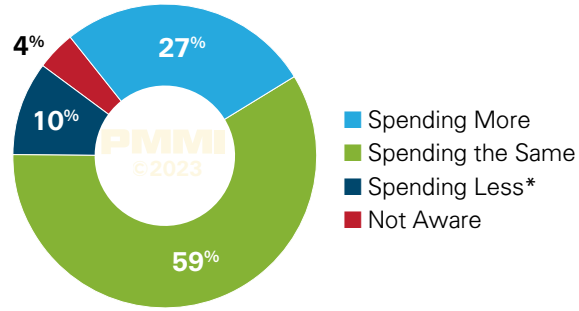
TWO OF FIVE RESPONDENTS FORECAST SPENDING MORE ON CAPITAL EQUIPMENT IN THE NEXT 12-24 MONTHS

Capital Spending in the Next 12-24 Months

MACHINERY



SOFTWARE



**Respondents reporting less capital spending are experiencing a decline in dairy sales.*

> We have a steady budget increase to invest in the improvements that come with more advanced automation.
>
> — *Sr. Project Engineer,* **Dairy Processor Leader**

> We plan to increase our capital budget this year; with costs going up, everything we thought a year ago is going out the window.
>
> — *Production Project Manager,* **Retail Private Label**

41% Of dairy companies are spending more on capital equipment in the next 12-24 months

27% Of dairy companies are spending more on software in the next 12-24 months

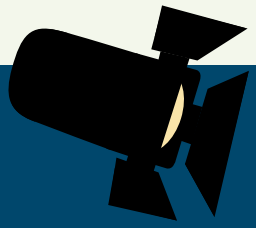
> There is additional capacity being built in the US – for instance, new cheese plants and processing plants for aseptic milk-based products. If a customer has a new innovative product, they are spending significant capital from processing to packaging.
>
> — *Senior Vice President,* **Product Science, Expert**

BUTTER

39% CAGR

US Census data shows capital expenditures contracted in nearly every dairy product category over the past three years except butter, where spending rose as high as 39% CAGR (2020-2021) after a continued increase starting in 2019.

Details in Appendix B, Table 2



ICE CREAM in the Spotlight

FROZEN DAIRY SHOWED THE HIGHEST RATE OF PRODUCT GROWTH DURING COVID YEARS

Ice cream/frozen desserts category claims the leader position in year-over-year revenue growth since 2019, reaching a double digit CAGR of 10.9% (2020-2021).

Appendix B, Table 1

EQUIPMENT INVESTMENT RESUMES

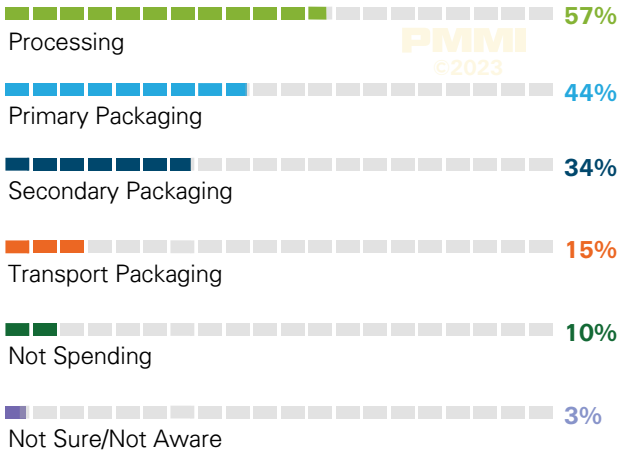
Frozen dairy products saw a sharp spike in capital expenditures in 2021 at 21.9% CAGR, up in a single year from a low of -26.7% CAGR in 2020.

Appendix B, Table 2

The International Dairy Foods Association (IDFA) data recently revealed the average American eats 20 pounds of ice cream per year.

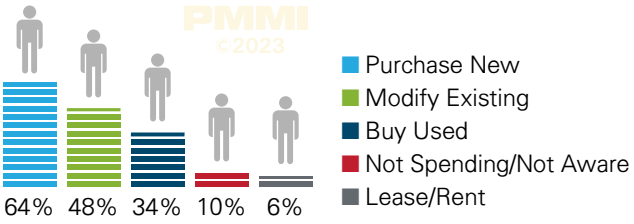
OVER HALF OF RESPONDENTS FORECAST A NEED FOR PROCESSING EQUIPMENT

Manufacturers Predict Where They Will Need New Machines in the Next 12-24 Months



Exceeds 100%; multiple answers

Participants are Most Often Buying New Equipment



Exceeds 100%; multiple answers

Skilled and Knowledgeable Technicians

48% of participants noted they look to modify existing equipment in their operations. It is crucial for OEMs/suppliers to have knowledgeable and experienced staff able to identify where machine improvements can be made and efficiently execute machine retrofits/additions.

NEW EQUIPMENT

We are adding equipment along the entire line to support our plant expansion and new product introduction by the end of this year.

— *VP Manufacturing Operations,* **Specialty Frozen Products**

We are getting new case packers, case erectors, and palletizers – we try to install some new equipment every year.

— *Sr Project Engineer,* **Dairy Processor Leader**

For new product innovations we buy new equipment – if we are looking to increase capacity, the equipment could be modified or we might look for used, it all depends.

— *Associate Director Packaging,* **Large Food Manufacturer**

MODIFIED EQUIPMENT

Given our capital constraints, we'll only be looking at modifying existing equipment.

— *Principal Packaging System Design Engineer,* **Global Food Company**

We first try to modify existing equipment before we evaluate new purchases.

— *Engineering Manager,* **Global Leader**

The choice of equipment purchases depends on the product situation and the customer we are working with.

— *Packaging Engineer,* **Shelf-Stable Food Manufacturer**

Processors Investing to Meet Demand

As overall demand for dairy grows, processors are actively making investments in capital equipment to keep up with the market. Recently, more than 20 major industry stakeholders have announced investments explicitly into expanding capacity and increasing production, including equipment purchases. Suppliers can distinguish themselves by proactively identifying bottlenecks and assisting dairy processors in crafting expansion plans and goals.

Cloud-based Simulation

Integrated software systems such as centralized ERP (Enterprise Resource Planning) management platforms have spread across the manufacturing industry as an essential part of efficient and high-capacity operations. Another software-based solution is also gaining traction within the dairy industry specifically: cloud-based plant and process simulation. By using software-based inputs and uploading data to the cloud, dairy processors can create a "digital twin" of their operations, accessible from anywhere, that can accurately simulate production conditions.

Cloud-based simulations allow processors to adjust all relevant input data from setting hardware-based conditions to simulating new software functionality, creating a highly accurate and malleable picture of their operations. These simulations enable processors to test expensive and time-consuming projects, such as adding equipment, adjusting lines, or changing packaging formats, in a no-stakes digital environment before any real-world implementation takes place. Entire plants can even be simulated, allowing processors to refine their operations before construction even begins. By leveraging cloud-based software solutions, dairy processors can ensure they are executing an efficient plan before any capital investment is required.

UNIQUE HANDLING

We struggle to attain an acceptable IRR [internal rate of return] when adding advanced automation, unless it's allocated as a strategic initiative.

— *Principal Packaging System Design Engineer,*
Global Food Company

Companies are still very fuzzy on the business case for investing in new technologies.

— *Director Of Packaging Operations,*
Cheese Processor

US DAIRY INDUSTRY: CAPITAL EQUIPMENT AND MATERIALS/SERVICES

Spending on Capital Equipment and Materials/ Services as Tracked by US Census Shows Spending Trends Depend on the Product Type

> Our capital budget will increase to support our growth in entirely new products, new shapes, and new multi-packs.
>
> — *Vice President Engineering,* **Large Milk Processor**

Capital Expenditures $2.0B (2021)

Trends in Capital Equipment Investments (2019-2021)

Dairy manufacturers did not invest in machinery and equipment with much vigor in the years 2019-2021. The butter industry did invest in assets (32.5% CAGR 2019-2021). Butter is the smallest dairy segment with declining revenues and diminishing spend on materials and services, but is the only industry that did not lose manufacturing facilities during the same time period.

CATEGORY	MACHINERY INVESTMENT TRENDS
Cheese	Contraction occurred in 2019, growth since 2020
Fluid Milk	Contraction since 2019, some recovery in 2020
Dry/Condensed	Double digit contraction in 2019, remains flat in 2021
Ice Cream/Frozen Desserts	Contraction in 2019, double digit growth in 2020
Creamery Butter	Growth began in 2019 and continued through 2021

Details in Appendix B, Table 2

Materials and Services $84.4B (2021)

Trends in Spending on Materials and Services (2019-2021)

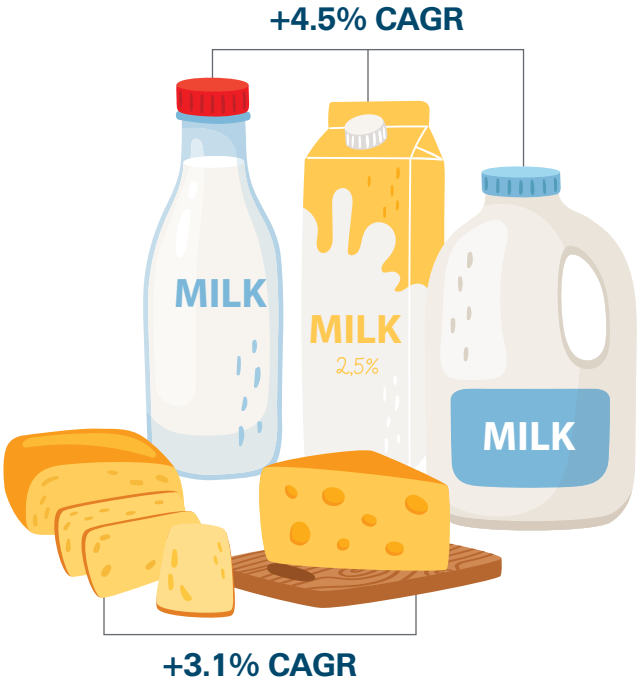
The two industries that have the highest costs for production materials also saw the greatest rate of year-over-year increases in those costs 2019-2021: fluid milk manufacturing (+4.5% CAGR) and cheese manufacturing (+3.1% CAGR).

The dry/condensed/evaporated industry saw a jump in the costs of production materials despite a contraction in revenue, the number of production facilities and employees, and industrial production index score.

Details in Appendix B, Table 3

Source: US Census Bureau, Annual Survey of Manufacturers for years, 2019, 2020, 2021.

NOTE: 2022 data is not yet available.



SECTION FOUR

ADVANCING AUTOMATION

Integration • Robotics • Compliance

MOST IMPORTANT MACHINE IMPROVEMENTS: CLEANABILITY, AUTOMATION, VERSATILITY

Automated solutions must withstand the rigorous cleaning required in the dairy industry.

The three most important machine improvements respondents want for improved processing and packaging:

1. More efficient and faster cleaning times.
2. A broader range of automated capabilities to minimize manual tasks.
3. Versatility to handle different shapes and sizes on the same machine.

Most Important Machine Improvements Requested by Dairy Professionals in Processing and Packaging

Reduction in cleaning times with increased efficiency	**46%**
More automated operations: vision inspection, machine learning, minimizing manual tasks	**36%**
Versatility to handle different shapes and sizes	**35%**
Faster speeds to increase throughput	**30%**

Exceeds 100%; multiple answers

Other improvements mentioned

19% Energy Efficiency

11% Customization

12% Data Collection

9% Traceability

11% Integration-Ready

VERSATILITY

There is still a need for machine flexibility to handle different packaging shapes and sizes as well as box variations on the same machine.

— *Principal Packaging Design Engineer,* **Industry Leader**

CLEAN AND SANITARY

We want to see a reduction in sanitation cycle times to enable longer run cycles.

— *Vice President Engineering,* **Large Milk Processor**

Today's sterilization methods use a lot of water and chemicals – I ask our OEMs, what could be done differently to improve efficiencies?

— *Engineering Manager,* **Global Leader**

The next generation of dairy equipment definitely needs to be more energy efficient and maintain a high level of cleanliness in the design.

— *VP Manufacturing Operations,* **Specialty Frozen Products**

AUTOMATION / TECHNOLOGY

For automated vision inspection, we'd like to get information from our data tabulation that tells us: 'You seem to have a lot of issues with bad seals on your lids, it seems to correlate to this failure mode, you might want to investigate changing that.'

— *Senior Packaging Engineer,* **Leader in Food Manufacturing**

The big improvements for us are machine learning and integration.

— *Director Of Package Engineering,* **Leading Dairy Processor**

We are always looking to get product out the door faster with fewer people – we look to minimize manual tasks.

— *Packaging Engineer,* **Retail Private Label**

It's not necessarily the specific machine improvements we are focusing on because technology will simplify the operator's role.

— *Director Of Packaging Operations,* **Cheese Processor**

TRACEABILITY

Traceability is necessary – if there is a consumer incident, being able to trace the origin of a product back to the farm, the process, or the packaging is certain to be required from FDA.

— *Industry Expert,* **Food Engineering**

DAIRY PROCESSORS WANT PREVENTIVE MAINTENANCE AND KNOWLEDGEABLE SERVICE TECHNICIANS

UPTIME NEEDS TO BE ALL THE TIME

Implementing preventive maintenance is a key driver – downtime costs money.

— *Vice President,* **OEM**

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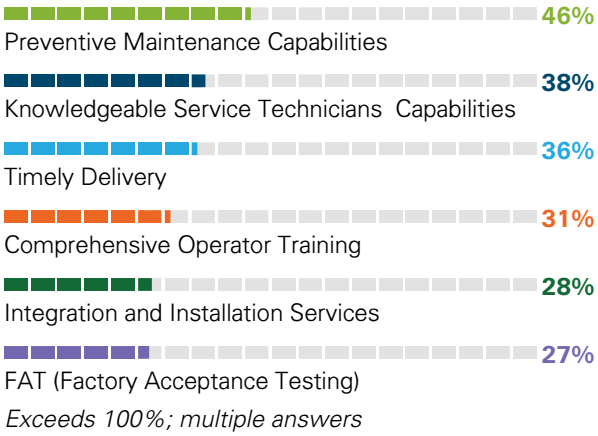
Leading Services That Dairy Companies are Looking for From OEMs to Improve Their Operations



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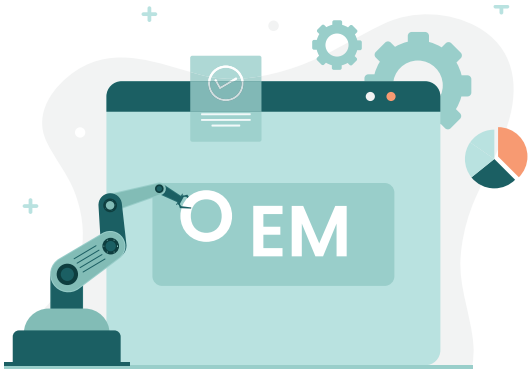


OEMs should focus on:

1. Including preventive maintenance capabilities on their equipment.
2. Ensuring they have knowledgeable technicians.
3. Making turnaround and delivery as timely as possible.

BETTER KNOWLEDGE OF FAILURE MODES

We are asking OEMs to initially design the interface of predictive and preventive failure modes so we can understand them better during operation.

— *Senior Packaging Engineer,* **Leader in Food Manufacturing**

HIGHLY SKILLED TECHNICIANS

Highly skilled OEM equipment technicians are critical to provide training and line optimization.

— *Senior Packaging Engineer,* **Industry Leader**

COLLABORATION AND TRAINING

The most important services OEMs can provide are collaboration and training – coming in and offering the right talent, at the right place, at the right time would have the greatest impact.

— *Vice President Engineering,* **Large Milk Processor**

We need to make an operator that has been here for two weeks be as good as if they have been here for 10 years – OEMs need to design equipment to be more straightforward.

— *Director Of Packaging Operations,* **Cheese Processor**

We have a lot of turnover and we rely on our OEMs for operator training as well as onsite troubleshooting.

— *Associate Director Packaging,* **Large Food Manufacturer**

More operator training and education is necessary on advanced machines – we need simpler controls on equipment or better education.

— *Engineering Manager,* **Global Leader**

COLLABORATION AND INTEGRATION

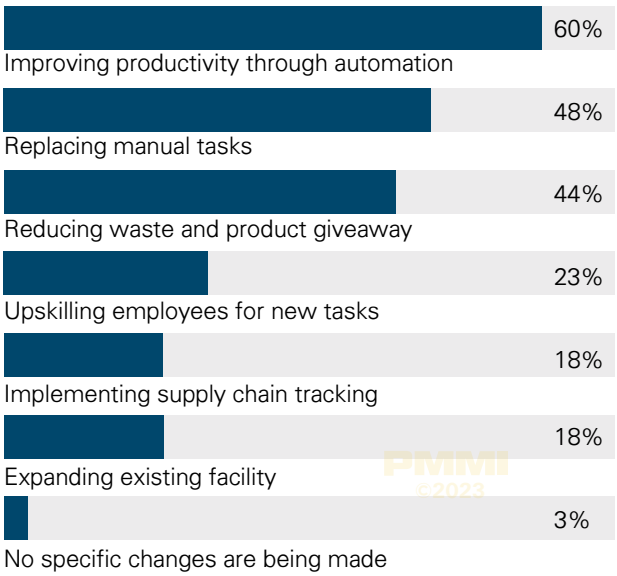
We are looking for collaboration with OEMs on integration services as well as ongoing efficiency improvements.

— *Director Of Package Engineering,* **Leading Dairy Processor**

MANUFACTURING IMPROVEMENTS TO ADDRESS PRODUCTIVITY AND LABOR SHORTAGES ARE MOST OFTEN FOUND IN AUTOMATION

In some cases, the operational goals of dairy processors can directly enable and support one another. 60% of dairy processors cited improving productivity through automation as a key operational goal and 23% noted they are seeking to upskill their employees. A dairy processor that expands their integration and automation capabilities within their operation can enable solutions such as augmented-reality devices capable of training employees on new equipment and new procedures without the need to allocate additional labor for instruction.

Participants Seek Changes to Address Productivity Demands and Labor Shortages



Exceeds 100%; multiple answers

> We are always evaluating capacity constraints depending on the product category and we need more technology to compensate for labor shortages – equipment that is safe, efficient, and intuitive.
>
> — *Packaging Engineer,* **Shelf-Stable Food Manufacturer**

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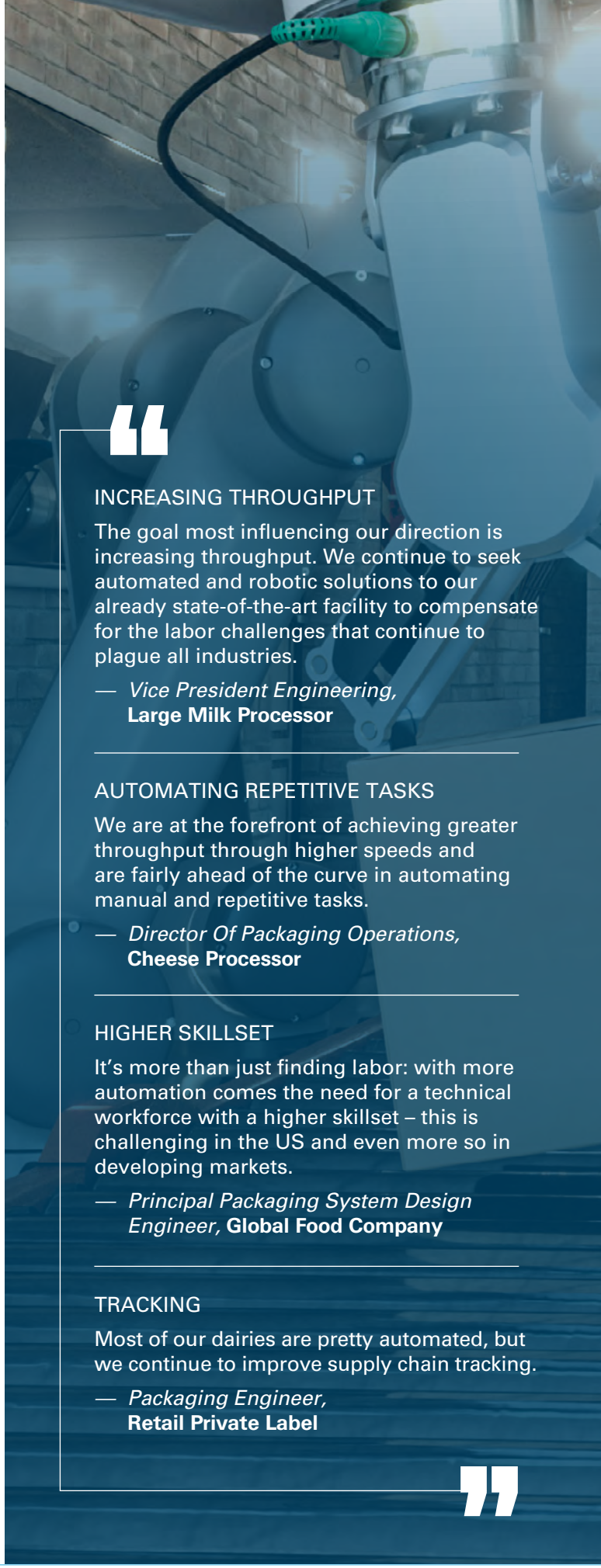


INCREASING THROUGHPUT

The goal most influencing our direction is increasing throughput. We continue to seek automated and robotic solutions to our already state-of-the-art facility to compensate for the labor challenges that continue to plague all industries.

— *Vice President Engineering,* **Large Milk Processor**

AUTOMATING REPETITIVE TASKS

We are at the forefront of achieving greater throughput through higher speeds and are fairly ahead of the curve in automating manual and repetitive tasks.

— *Director Of Packaging Operations,* **Cheese Processor**

HIGHER SKILLSET

It's more than just finding labor: with more automation comes the need for a technical workforce with a higher skillset – this is challenging in the US and even more so in developing markets.

— *Principal Packaging System Design Engineer,* **Global Food Company**

TRACKING

Most of our dairies are pretty automated, but we continue to improve supply chain tracking.

— *Packaging Engineer,* **Retail Private Label**

WASTE REDUCTION

We are looking to eliminate waste and materials that go down the drain.

— *Director Of Package Engineering,* **Leading Dairy Processor**

We are focused on waste reduction, energy efficiency, and green energy potentials.

— *Vice President Engineering,* **Large Milk Processor**

ENERGY EFFICIENT

There are efforts internally to reduce non-required running times and use idle modes - waste costs money.

— *Senior Packaging Engineer,* **Leader in Food Manufacturing**

We try to make every piece of equipment energy efficient, but it's not always feasible.

— *Production Project Manager,* **Retail Private Label**

INTEGRATED AND DATA-DRIVEN

We are moving toward making a lot more operational decisions on data-driven intelligence.

— *Principal Packaging System Design Engineer,* **Global Food Company**

A GREEN OPERATING PLANT

We have recycling strategies to harness some of the leftover cooling water to use for the next batch.

— *VP Manufacturing Operations,* **Specialty Frozen Products**

THE GOAL OF CARBON NEUTRAL

Sustainability is a big issue for dairy trying to find ways to reduce waste, methane, green house gasses, and, at some point, become carbon neutral.

— *VP,* **Dairy Industry Expert**

SUSTAINABILITY GOALS FOCUS ON EFFICIENT PLANT OPERATIONS

Dairy companies are making sustainable changes to plant operations and looking for equipment that can:

Reduce Waste

Improve Energy Efficiency

Collect Production Data

We are focusing on a more integrated and data-driven operation to achieve a more efficient plant overall.

— *Senior Packaging Engineer,* **Industry Leader**

Automation and Integration can Support Plant Sustainability

Dairy processors that have expanded the level of integration and automation in their operations also have the opportunity to increase the overall sustainability of their production processes, with the added bonus of cost savings on the back end. For instance, data from an automated and integrated line can be analyzed to understand energy usage and identify inefficiencies and waste. Furthermore, a fully integrated line can be set up to automatically cycle down into a "sleep mode" during lulls in production, eliminating the energy waste accumulated by idle lines.

58%

Of US consumers expect companies to invest in sustainability and 64% believe companies should be more efficient in their use of natural resources.[32]

> Automation is key for the dairy industry to compensate for labor shortages and increase operator efficiencies to grow the bottom line.
>
> — *Vice President,* **Industry Expert**

> The industry as a whole needs to be faster to market with new product and packaging ideas - the dairy industry is about ten to fifteen years behind in automation technologies.
>
> — *Systems Specialist,* **Dairy Processor**

CHEESE in the Spotlight

AMERICA BOUGHT CHEESE DURING THE PANDEMIC

Cheese products claimed the largest share in the US value of shipments at $57B (44%) in 2021 and showed double digit growth of 11.8% CAGR 2019-2020. However, the category contracted -3.7% 2020-2021.

Appendix B, Table 1

Cheese manufacturing has the greatest number of facilities (573). The number of cheese manufacturing plants declined 2019 - 2021, but facilities gained employees (+3.9% CAGR) during the same period.

Appendix B, Table 4

CHEESE AND YOGURT TARGETED FOR INNOVATION

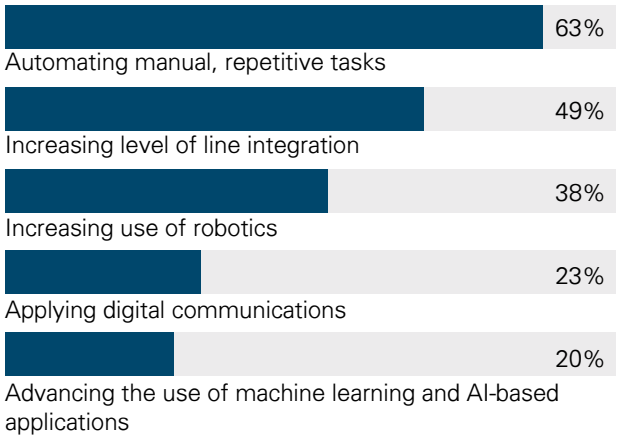
> Research is being done right now to find more innovative products and packaging in cheese and yogurt.
>
> — *Senior Vice President,* **Product Science, Expert**

OPERATIONAL IMPROVEMENTS TO ADVANCE AUTOMATION AND LINE INTEGRATION

Companies are prioritizing automation and integration in the next 12-24 months.

- Automating repetitive tasks
- Increasing line integration
- Deploying robotics
- Applying digital data collection
- Advancing machine learning and AI

Changes to Increase Automation and Integration



Exceeds 100%; multiple answers

DTC Shipping and Automation

DTC shipping is emerging in dairy as a viable sales channel thanks to improvements in shelf-stable processing and packaging technologies.

Automation is essential to establishing DTC shipping in a dairy operation: not only are the machines necessary for shelf-stable packaging enhanced by automated processes (especially for product quality, safety, and consistency), but the entire DTC process also requires a high level of integrated operations.

Dairy producers looking to ship DTC will need to have a firm grasp on their product demand, throughput speeds, and shipping logistics, all of which requires a high level of automated and integrated processes capable of generating vital data. Dairy producers looking to establish DTC shipping can benefit from working together with OEMs/suppliers to better understand how automated and integrated equipment and components can support expansion into new sales channels.

PRODUCTIVITY

Improving throughput is a priority but challenging with the labor shortage; companies are looking at automation to help a reduced number of employees achieve the same tasks that more people used to do.

— *Industry Expert,*
Food Engineering

INTEGRATION

Our facility is about as integrated as we can get, but we're not yet ready for things like AI.

— *Controls Engineer,*
Boutique Cheese Processor

FULL LINE AUTOMATION

We are looking to automate the entire line from processing, to wrapping, to case packing – all the way to palletizing.

— *Packaging Engineer,*
Shelf-Stable Food Manufacturer

ROBOT DEPLOYMENT

Our goal is increasing our level of automation: installing robots for repetitive tasks, looking at the future of line integration, and using AI and machine learning.

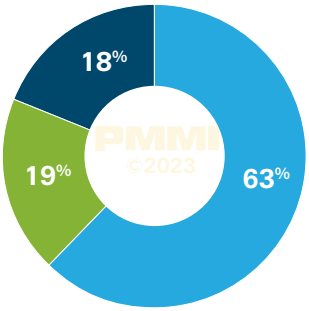
— *Sr Project Engineer,*
Dairy Processor Leader

Increasing the level of plant integration and automating repetitive tasks with robots is driving change – robots show up everyday.

— *Packaging Engineer,*
Retail Private Label

THE MAJORITY OF DAIRY PROCESSORS OUTSOURCE SOME SERVICES

Dairy Processors' Level of Outsourcing



Outsourced Services

Listed in order of priority

1. Machine Installation
2. Processing
3. Machine Integration
4. Packaging
5. Project and Line Design
6. Software Installation/Management
7. Engineering
8. Data Management

Outsourced Experts

A significant number of dairy producers noted they outsource several technical aspects of their business, especially tasks related to designing, installing, and commissioning new additions to their facility and portfolio. Dairy producers also identified wanting more knowledgeable technicians as the second most important need from OEMs/suppliers.

OEMs/suppliers have an essential role to play in helping dairy operations expand and improve by ensuring their technicians and consultants are true experts in the field. OEMs/suppliers can take this a step further by proactively identifying where dairy producers could improve their operations and suggesting executable projects to realize those improvements. Those OEMs/suppliers that are able to provide consistent, proactive expert assistance will be well positioned to forge new client relationships and grow existing ones.

Drivers of Outsourced Services:

LACK OF CAPACITY

There is simply not enough aseptic production capacity right now to support ESL product innovation – even the contract packagers are all booked.

— *Senior Vice President,* **Product Science, Expert**

OFFSITE DATA STORAGE

Some dairy plants are storing recipe data offsite to share with all plants around the world – so data safety and security is key, since food manufacturing continues to experience cyberattacks.

—*Industry Expert,* **Food Engineering**

TURNKEY ENGINEERING

We have looked at ways to use more external engineering as the labor market continues to tighten. We need a company that does it all – not necessarily just our dairy portfolio manufacturing, but all of our products.

— *Principal Packaging System Design Engineer,* **Global Food Company**

MEETING INDUSTRY REGULATIONS WITH COMPLIANT EQUIPMENT

Do you require equipment in your facility to be tested and certified by third-party validators to meet industry certifications?

YES **68%** Of participants require validation for USDA certification, Grade-A pasteurization, or 3-A sanitation for their facilities.

Of those responding yes, specific requirements include:

- **28%** Require USDA Certification
- **22%** Require Grade A Pasteurized Milk Ordinance
- **18%** Require 3-A Sanitary Standards Certification

NO **18%** Of participants selected no. However, they still require machines to be designed to third-party certification specifications and standards.

NO **14%** Of participants do not require the machines in their facility to carry any third-party certification marks.

If you make physical changes to existing equipment on the line, do you require the machine to undergo a recertification process for 3-A standards for the modified equipment?

YES **31%** Of participants do require a recertification process to meet 3-A standards if there are changes to existing equipment.

NO **38%** Of participants stated they do not require recertification if there are machine changes.

NO **31%** Of participants do not require 3-A certification on their machines.

NAVIGATING DAIRY INDUSTRY MACHINE CERTIFICATIONS

> We feel we are constantly adapting to changing regulations.
>
> — *Associate Director Packaging,* **Large Food Manufacturer**

The dairy industry is governed by an array of government-mandated regulatory standards for equipment and machines that are supported by industry-specific best practices from third-party organizations. Untangling how these different organizations and standards function, how they interact, and what is legally required is vitally important for dairy producers to remain regulation compliant.

There are two major players that are involved in setting dairy industry machine regulations:

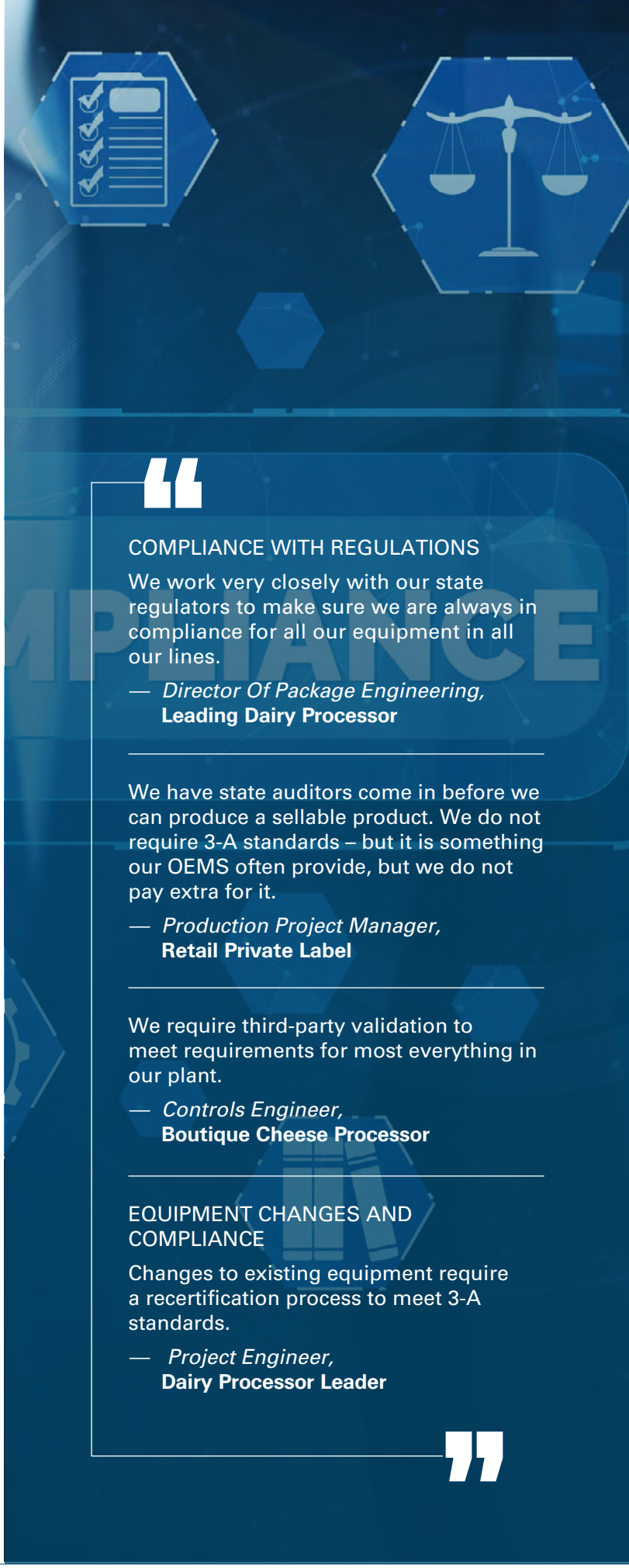
> The Dairy Grading Branch (DGB), a department of the USDA, is responsible for regulating certified dairy equipment and issuing Certificates of Acceptance to organizations that undergo their equipment certification process. The certification process and its requirements fall mostly under USDA rule 7 CFR Part 58.

> 3-A Sanitary Standards (3-A) is an independent third-party company dedicated to setting design standards for dairy equipment and machinery. 3-A creates their own detailed standards and sells them to producers, administers third-party certification of their standards, and licenses the 3-A logo for use on compliant equipment.

Under the US regulatory framework, dairy producers are legally required to adhere to food safety practices and requirements outlined under FSMA and enforced by the FDA. However, OEMs may also opt to pursue a more rigorous validation of their equipment by obtaining a DGB Certificate of Acceptance. These OEMs can more easily satisfy the stringent DGB requirements by getting their machinery 3-A certified before the DGB review process.

Understanding the relationship between DGB and 3-A

The DGB's Certificate of Acceptance is considered the gold standard for dairy industry equipment and machinery that receives the certificate is added to a list of compliant suppliers maintained by the USDA. Equipment that is already 3-A certified will inherently meet the DGB requirements – an official inspection and validation is still required by the DGB, but 3-A certified machinery is designed specifically to satisfy the DGB requirements. 3-A certification is not absolutely required to received DGB certification, however – it is possible for machinery that is not 3-A certified to still receive DGB certification.



> COMPLIANCE WITH REGULATIONS
>
> We work very closely with our state regulators to make sure we are always in compliance for all our equipment in all our lines.
>
> — *Director Of Package Engineering,* **Leading Dairy Processor**

> We have state auditors come in before we can produce a sellable product. We do not require 3-A standards – but it is something our OEMS often provide, but we do not pay extra for it.
>
> — *Production Project Manager,* **Retail Private Label**

> We require third-party validation to meet requirements for most everything in our plant.
>
> — *Controls Engineer,* **Boutique Cheese Processor**

> EQUIPMENT CHANGES AND COMPLIANCE
>
> Changes to existing equipment require a recertification process to meet 3-A standards.
>
> — *Project Engineer,* **Dairy Processor Leader**

NAVIGATING DAIRY INDUSTRY MACHINE CERTIFICATIONS

Dairy Facility and Product Certification

Both DGB and 3-A certification can help dairy operations more easily achieve additional certificates, especially through the USDA-DGB-run Dairy Plant Survey Program. The Dairy Plant Survey Program is another voluntary service that issues certifications of quality for dairy facilities. Facilities that are certified are added to a list of approved plants maintained by the USDA. Receiving plant certification is also a required step for all USDA dairy product grading and certification.

In this way, 3-A certification of machinery can be seen as a first step in the process of achieving additional certificates for dairy producers. OEMs can ensure their equipment will be DGB-compliant by getting their machines 3-A certified before undergoing the DGB certification process. Dairy producers can get a leg up on achieving plant certification by selecting machinery bearing the 3-A certification logo that has been additionally certified by the DGB. More easily achieving plant certification can also help cut down the time to receiving official product certification and grading.

> 3-A compliance needs to be 'a given' in dairy equipment manufacturing now, not 'a nice to have'.
>
> — *Engineer,* **East Coast Dairy Processor**

DGB Certification Shelf Life

DGB certification for dairy machinery expires after five years, at which point OEMs must undergo the certification process again. OEMs are also responsible for notifying the DGB that they would like to renew an expired/expiring certification. If there are any changes to the design, materials used, construction, or fabrication of the DGB-certified piece of machinery during the five-year period, they must be submitted to the DGB for review and comment.

Specifications Required for DGB Machine Certification

Engineering drawings of the entire piece of equipment are generally required for evaluation of details for DGB acceptance. Engineering drawings must be of sufficient detail to clearly show:

- ✓ The dimensions of each part;
- ✓ The minimum radii dimensions of internal angles of less than 135 degrees;
- ✓ The product contact surface finish specifications;
- ✓ The specifications for welds and other permanent joints;
- ✓ The design details for flanges, or gasketed joints which are to include enlarged drawing(s) (at least 2X) of the details of O-ring retaining grooves as appropriate;
- ✓ The dimensions of O-rings, gaskets, and any other type of seals; and
- ✓ Explanations about company welding symbols and metal finishes.

To initiate a machine design review, the perspective applicant may contact the DGB by telephone, fax, e-mail, or mail. A request for inspection must also be accompanied by an Equipment Review Request form.

SECTION FIVE

ACTIONABLE DIRECTIVE

Innovate • Collaborate • Support

PLANT-BASED MILK in the Spotlight

Consumers of plant-based dairy alternatives are strongly motivated by health and wellness.

About 45% of plant-based dairy consumers plan to increase their consumption in the next three years.[33]

Over the next five years, Euromonitor predicts a 4.3% CAGR in the units sold at retail of plant-based milk (2023-2027).

In 2022, Euromonitor data showed US plant-based milk products held 12% of the overall milk market, while plant-based cheese and yogurt made up barely 2% of their respective dairy categories.

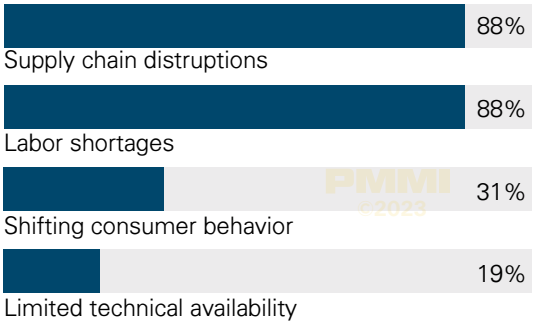
Details in Table on page 23

> All are growing – shelf-stable dairy products that last longer on the shelf, plant-based, muscle milk, soy milk, oak milk, and almond milk.
>
> — *Vice President,* **OEM**

THE COVID IMPACT

The Lasting Effects of Covid Still Remain

Challenges Still Facing Dairy Companies



Exceeds 100%; multiple answers

Other lasting challenges from the covid impact are: machine delays, inflation, and capital budget cutbacks.

DELIVERY AND INSTALLS

Machine installs and startups remain too long – we question if the lead times will improve or stay the same?

— *Sr Project Engineer,*
Dairy Processor Leader

45% of dairy executives are prioritizing new growth opportunities in 2023 and most executives expressed optimism about the future of the dairy industry as a whole.[34]

COLLABORATE AND COMMUNICATE

Communication is key to bring up issues before they become problems – the dairy industry is using more real-time data and we all need to use it to communicate better.

— *Controls Engineer,*
Boutique Cheese Processor

COVID IMPACT IS REAL

The impact from the last three years is still with us: delivery delays, supply disruptions, labor shortages, budget constraints, and more are still all issues we are managing day-to-day.

— *Senior Packaging Engineer,*
Industry Leader

SUPPLY CHAIN DISRUPTIONS EASING BUT NOT COMPLETELY

We are seeing that our company is less concerned about inventory levels than about availability. We would rather pay to have it sitting on our shelves than not have it. I think in the next three years, supply chains are going to be very different than pre-covid.

— *Package Engineering,*
Leading Dairy Processor

Ingredients can be hard to obtain in good environments – right now, dairies are certainly having issues finding the raw materials and ingredients needed to produce products.

— *VP,* **Dairy Industry Expert**

There are still too many of us scrambling for components – OEMs need to stock up and help us stay ahead of this continued issue.

— *Director Of Packaging Operations,*
Cheese Processor

LABOR SHORTAGES

Finding skilled labor is a big challenge!

— *Senior Packaging Engineer,*
Frozen Dairy Products

We are all suffering with labor shortages – it is still a lot harder to get an OEM technician onsite to get something fixed.

— *Production Project Manager,*
Retail Private Label

A NEW IMAGE FOR DAIRY: FLAVORFUL AND NUTRITIOUS

Dairy participants shared their opinions about the direction of the the dairy industry and aligned on several key topics for future growth and success.

Revitalize the image of dairy by communicating and educating consumers with messages about:

Sustainability

Innovative Products

Healthy Benefits

A RENEWED SPOTLIGHT ON DAIRY

The industry image needs an overhaul: the industry is reducing greenhouse gas emissions, upcycling dairy waste, and looking at new ways of dispensing. We need to tell these stories about sustainable initiatives because nobody knows them.

— *Senior Vice President,* **Product Science, Expert**

THE SUSTAINABILITY STORY

The industry needs to align on the best practices for recyclable materials that meet the unique barrier requirements of dairy products – a lot of dairy packaging is not recyclable and optimizing packaging to reduce the carbon footprint is the top priority.

— *Director of Packaging Sustainability,* **Leader in Cultured Products**

DAIRY PRODUCT INNOVATION

IN A RECENT SURVEY

90%

Of dairy executives expect to see growth in the next three to five years in both product innovation and investments in manufacturing innovation.[35]

70%

Of dairy executives planned to expand their portfolios last year, including lactose-free products, products with claims of origin, and fortified products (especially protein).[36]

ALIGN WITH THE DAIRY INDUSTRY:
A RENEWED STORY FOR DAIRY

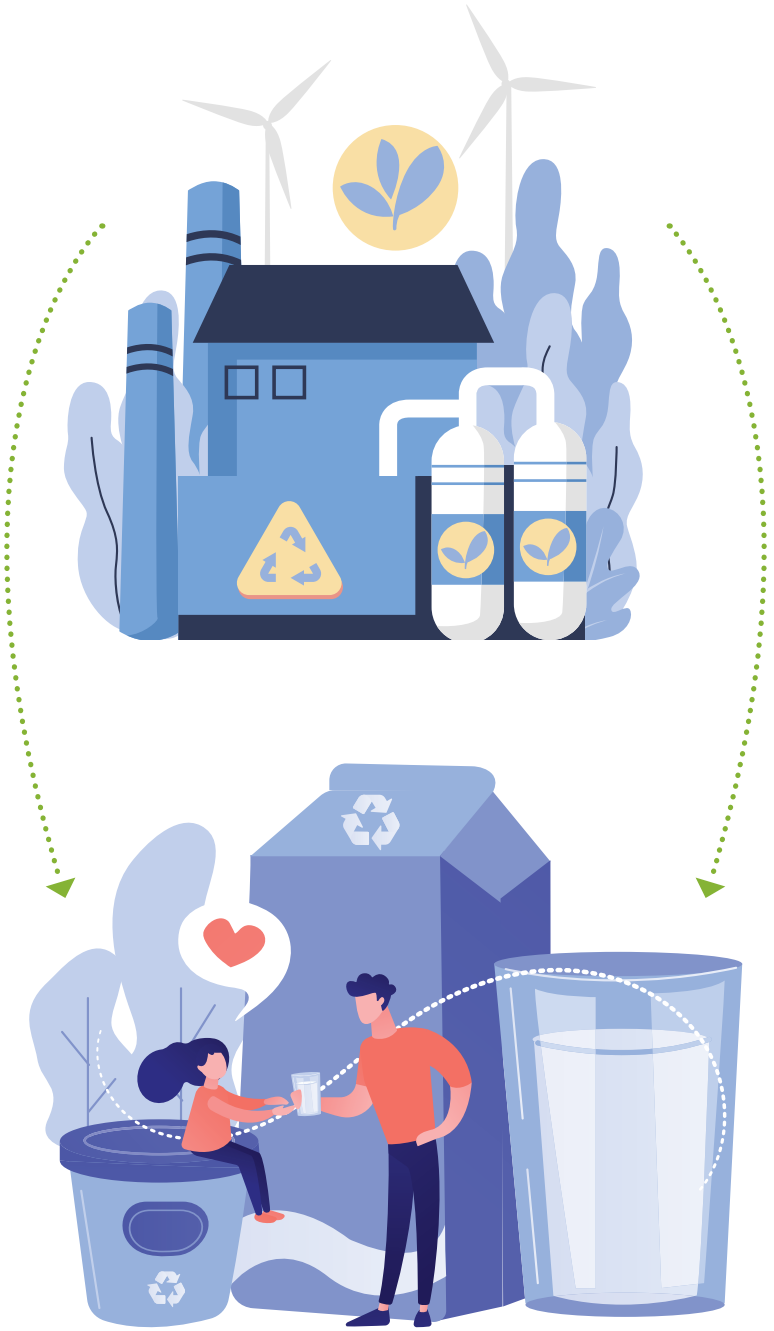
Looking Forward

The dairy industry has experienced some significant difficulties in recent years, especially in the fluid milk segment. Looking ahead, the industry has identified supply chain disruption, labor shortages, and shifting consumer behavior as top concerns that will challenge their operations. While these are real obstacles for dairy producers, they are also opportunities to better position the dairy industry as a whole. It is a cliché to say challenges are simply opportunities in disguise, but for the dairy industry this aphorism is frequently a truism. By addressing challenges on both an individual operations basis and a wider industry basis, dairy producers can improve their own bottom lines and strengthen the image of the entire dairy industry.

Craft a Sustainable Story

Sustainability has become an essential issue for consumers – it is always a top concern for every manufacturing industry and dairy is no exception. While previously the dairy industry focused primarily on sustainable production practices (especially animal welfare and production carbon footprint), consumers are now approaching sustainability from a more holistic perspective.

Not only do dairy producers have to ensure their sourcing and production practices are sustainable, they must also strive to achieve sustainable packaging and transport practices. Sustainability efforts must also be clearly communicated to consumers as a comprehensive sustainability story – thankfully, interactive smart packaging offers an easy solution to telling that story. With 22% of consumers under 40 stating they care about and make decisions based on a company's ESG strategy, the importance of a clear sustainability story will only continue to grow as consumer demographics shift.[37]



> REALIGN THE PUBLIC PERCEPTION
>
> The dairy industry has to change public perception of its sustainability – from the methane at the farm level to the packaging.
>
> — *Director Of Packaging Operations,* **Cheese Processor**

ALIGN WITH THE DAIRY INDUSTRY: PRODUCT AND PACKAGING INNOVATION

Innovate Packaging to Thrive

The pandemic drastically upended consumers' routines, and the reemergence from the pandemic has similarly disrupted habits established over the last three years. Consumers are now focusing on convenient and functional packaging like single-serve sizes and resealable features, a notable shift from the bulk buying of large sizes seen just a few years ago. Dairy producers need to be responsive to these changing consumer preferences, emphasizing nimble equipment and operations that can be pivoted to new packaging materials, shapes, sizes, and features. Those dairy producers that are able to offer interesting, innovative, and value-enhanced packaging will be best positioned to capture consumer attention.

Explore New Products and Formulations to Stand Out

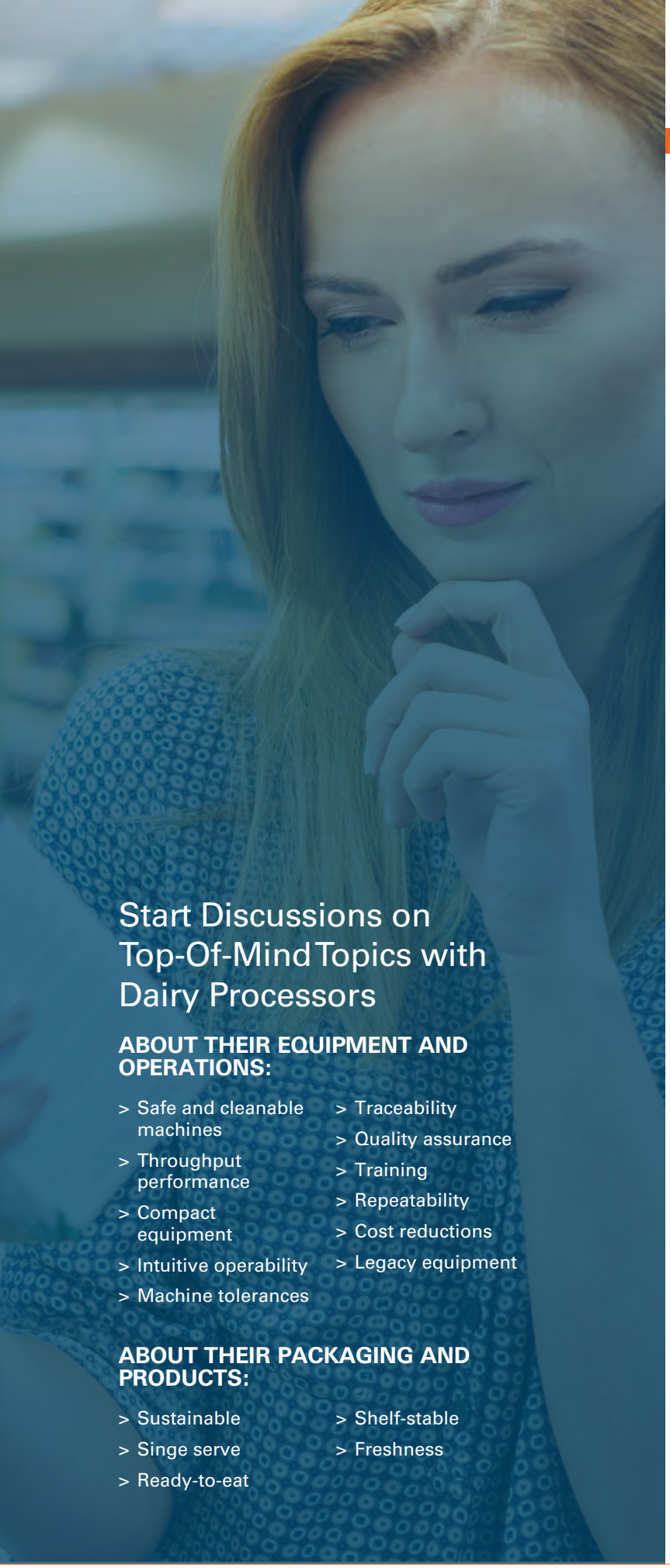
Consumers are constantly looking for new and novel products and dairy producers have ample opportunity to deliver on that desire. Dairy producers can entice customers with innovations like new flavor offerings, less sugar, enhanced and fortified products, or by introducing dairy products that are lesser-known to western audiences, like kefir. Packaging OEMs/suppliers have a vital role to play in supporting dairy producers looking to introduce new products by helping design and implement packaging that will assist in conveying the messages of new and novel.

Speak to Consumer Needs

Consumer preferences have shifted over the last few decades to emphasize healthy lifestyles and conscious consumption – trends that were only accelerated by the recent pandemic. Consumers are looking to make healthy choices and are savvier than ever, frequently scrutinizing labels to make determinations of what to eat and drink. Dairy producers can help steer consumers toward dairy products by clearly communicating the natural benefits of their products like healthy fats, calcium, vitamin D, and high protein content. These messages can be further enhanced by fortification ingredients like extra protein or probiotics and by healthier formulations like low sugar and no preservatives. It is essential that dairy producers utilize packaging and labeling to clearly communicate their healthy stories to consumers. Dairy has a lot of positive health stories to tell, and consumers want to hear them.

> I know most dairy suppliers use the same type of packaging and have for years – innovation is needed.
>
> — *Sr. Project Engineer,* **Dairy Processor**

> While the growth of large corporate dairies is important, small artisan dairies need help from the industry so we don't lose part of our culinary heritage.
>
> — *Engineer,* **Small Dairy Processor**



Start Discussions on Top-Of-Mind Topics with Dairy Processors

ABOUT THEIR EQUIPMENT AND OPERATIONS:

- Safe and cleanable machines
- Throughput performance
- Compact equipment
- Intuitive operability
- Machine tolerances
- Traceability
- Quality assurance
- Training
- Repeatability
- Cost reductions
- Legacy equipment

ABOUT THEIR PACKAGING AND PRODUCTS:

- Sustainable
- Singe serve
- Ready-to-eat
- Shelf-stable
- Freshness

ALIGN WITH THE DAIRY INDUSTRY: COLLABORATION AND AUTOMATION

Automate into the Future

With dairy producers pinched by difficulties finding labor and by inconsistent supply chains, automation has become vital to long-term success. While operation size and available capital can be obstacles to implementing more automated solutions, an initial investment in automation and the infrastructure needed to support it can set a company up for sustained success in the future.

Dairy suppliers will need the expertise of OEMs/suppliers in identifying where automated solutions could bring substantial production efficiency improvements and evaluating potential options to find a solution that works for each dairy producer's specific situation. One size does not fit all, but it is becoming increasingly important for even small dairy producers to explore automation as a long-term solution.

Collaborate to Succeed

Collaboration amongst all stakeholders in the dairy industry is becoming essential for dairy producers to build shared success. In a recent survey of dairy executives, 70% noted they are collaborating with other stakeholders to improve business.[38] For instance, consider a dairy producer that wishes to communicate a farm-to-table story about their product. The producer has to work with milk suppliers to ensure both operations are integrated to some extent and transferring the needed data, which may require outside assistance from an integrator or software specialist.

The dairy producer must also ensure their own operations are integrated and their production lots are trackable, which will often require third-party assistance for implementation and possible ongoing management. The dairy producer's shipping and logistics also need to be trackable and may require the use of a third-party logistics supplier for all or some of the distribution process.

Now more than ever dairy producers must look to industry partners for assistance in collectively addressing the challenges facing the industry. OEMs/suppliers that focus on building these collaborative relationships will be best positioned to assist their dairy industry customers.

SECTION SIX

APPENDIX

A:
Profile of Participants

B:
Global, NA, US Dairy Markets
Explanation of Four Statistical Sources

- Table 1 – US Dairy Value of Shipments
- Table 2 – US Dairy Capital Expenditures
- Table 3 – US Dairy Spend on Materials and Services
- Table 4 – US Dairy Number of Establishments/Employees
- Table 5 – US Dairy Industrial Production Index
- Table 6 – US Dairy Product Level Value of Shipments
- Table 7 – US Dairy Industry Billions of Pounds Produced
- Table 8 – Dairy Products Per Capita Consumption
- Table 9 – Global Dairy Unit of Sales at Retail by Packaging Type
- Table 10 – Global Dairy Unit of Sales at Retail by Region
- Table 11 – US Dairy Product Imports and Exports

C:
Endnotes and Sources

APPENDIX A

Profile of Participants

115 Interviews and Surveys

89 Sources

Broad Perspective

The findings in the PMMI Dairy Industry report are based on the opinions gathered from 115 interviews/surveys and 89 industry-wide sources.

Companies Interviewed Directly:

57% Large > $500 million and up

13% SMEs $100-$499 million and < $100 million

30% Industry Experts

Participating companies manufacture the following dairy products in the following product categories:

- Butter
- Cheese (shredded/sliced/cubed/brick)
- Cottage cheese
- Fluid milk/cream
- Frozen (ice cream)
- Non-dairy milks
- Powders (whey)
- Sour cream
- Yogurt (regular/Greek)

> Fresh
> Frozen
> Drinkable
> Plant-based
> Processed
> Shelf-stable
> Dry/dehydrated

DAIRY PROFESSIONALS/AREAS OF RESPONSIBILITY

Sr. Management/Operations
President
Sr. Vice President
Vice President
VP, Engineering
VP, Manufacturing Operations

Directors
Director of Package Engineering
Director of Packaging
Director of Packaging Sustainability
Director of Packaging Operations

Engineering/Managers
International Manager
Sr. Packaging Engineer
Packaging Systems Design Engineer
Packaging Engineer
Sr. Project Engineer
Engineering Manager
Production Project Manager
Controls Manager

APPENDIX B

Global, NA, and US Dairy Market Data Analysis from Four Industry Sources

Fluctuating Consumer Demand for Dairy Products

The global and US statistical data presented throughout this report spans the year before the pandemic (2019-2020), the year during pandemic (2020-2021), the year of recovery (2021-2022), and looks at future forecasts.

Dairy Manufacturing Industry-Wide Statistics
Federal Reserve
US Census Bureau

Dairy Product Statistics
US Census Bureau
USDA
Euromonitor (global)

Geographic Packaging by Units
Euromonitor (global)

Four sources, each showing a different view of the dairy industry (2019-2022)

1. US Census Bureau reports data at the point of manufacture measuring industry performance (2019-2021).

   A North American Industry Classification System (NAICS)
   - > Value of Shipments
   - > Investment in capital machinery
   - > Spend on materials and services
   - > Distribution of establishments across the US

   B North American Product Classification System (NAPCS)

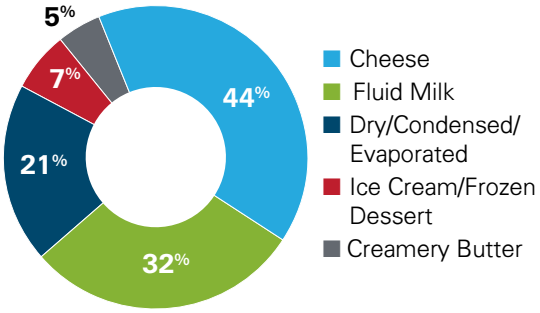
2. USDA provides information on specific dairy products by millions of pounds of product produced and consumed over the past five years (2019-2021).

3. Federal Reserve produces the G17 index reporting on industrial production and capacity utilization that measures the real output of manufacturing. (2019-2022).

4. Euromonitor calculates the millions of units of retail dairy products sold globally, reported by region and type of packaging material, providing actual data for the years 2019-2022 and forecasted data for 2023-2027.

US DAIRY INDUSTRY:
$130.2B VALUE OF SHIPMENTS 2021

US Dairy Industry: Revenue Market Share by Product Segment, 2021



The US Census Bureau reports on dairy products highlighted in this report in five industries.

Trends in Revenue (2019-2021):

Aligning with the Fed's G17 IPI metric reported in Table 5, ice cream and frozen dessert manufacturing led all industries year-over-year.

Cheese	Double digit growth, 11.8% CAGR 2019-2020; the category contracted -3.7% 2020-2021
Fluid Milk	Flat growth year-over-year
Dry/Condensed	Contraction year-over-year with growth 6.0% CAGR 2020-2021
Ice Cream/Frozen Desserts	Leader in growth of revenue year-over-year reaching a double digit CAGR of 10.9% (2020-2021)
Creamery Butter	Contraction year-over-year with slight recovery in 2020-2021

Table: 1
US Dairy Industry: Value of Shipments* 2021
2019-2021 CAGR Fluctuations in Revenue

Dairy Product Industry			The Year Before COVID	The Year of COVID	The Recovery Year of COVID
	2021 Value of Shipments* $ US B	CAGR 2019 – 2021	CAGR 2019 – 2020	CAGR 2020 – 2021	CAGR 2021 – 2022
Cheese	$57.2	3.8%	11.8%	-3.7%	N/A
Fluid Milk	$41.3	3.8%	3.8%	3.9%	N/A
Dry/Condensed	$15.9	-3.6%	-12.4%	6.0%	N/A
Ice Cream/ Frozen Desserts	$9.7	9.6%	8.3%	10.9%	N/A
Creamery Butter	$6.1	-7.5%	-12.6%	-2.1%	N/A
Total Dairy	**$130.2B**	**2.6% CAGR**	**4.3% CAGR**	**0.9% CAGR**	**N/A**

*The value of shipments includes the cost of materials, supplies, containers, fuel, purchased electricity, and contract work.

Source: US Census Bureau, Annual Survey of Manufacturers for years 2019, 2020, 2021. NOTE: 2022 data is not yet available.

US DAIRY INDUSTRY: CAPITAL EXPENDITURES INVESTMENTS AND RATE OF GROWTH 2019 - 2021

$2.0B Capital Expenditures for Machinery and Equipment
Percent spending in 2021 by product segments

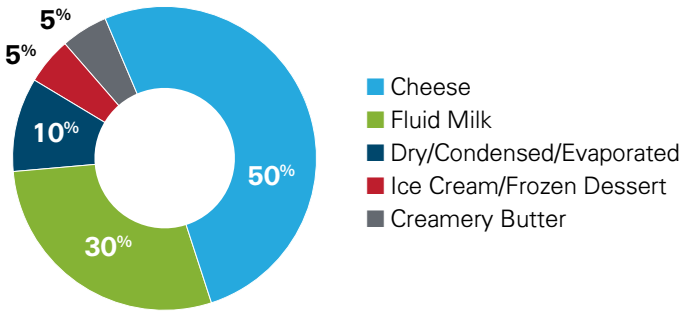


Table: 2
US Dairy Industry: Capital Expenditures* 2021;
2019-2021 CAGR Fluctuations in Spending

Dairy Product Industry			The Year Before COVID	The Year of COVID	The Recovery Year of COVID
	2021 Value of Shipments* $ US B	CAGR 2019 – 2021	CAGR 2019 – 2020	CAGR 2020 – 2021	CAGR 2021 – 2022
Cheese	$1.0	-1.9%	-3.2%	-0.6%	N/A
Fluid Milk	$0.6	-13.4%	-14.1%	-12.6%	N/A
Dry/Condensed	$0.2	-16.4%	-16.7%	-16.1%	N/A
Ice Cream/ Frozen Desserts	$0.1	-5.5%	-26.7%	21.9%	N/A
Creamery Butter	$0.1	32.5%	26.2%	39.1%	N/A
Total Dairy	**$2.0B**	**-6.5% CAGR**	**-9.2% CAGR**	**-3.8% CAGR**	**N/A**

*Includes new and used production machinery and equipment. Excludes capital expenditures for automobiles, trucks, etc. for highway use, computers, and peripheral data processing equipment.

Source: US Census Bureau, Annual Survey of Manufacturers for years 2019, 2020, 2021.
NOTE: 2022 data is not yet available.

US DAIRY INDUSTRY: MATERIALS AND SERVICES COSTS AND RATE OF GROWTH 2019 - 2021

$84.4B Materials and Services Spending
Percent spending in 2021 by product segment

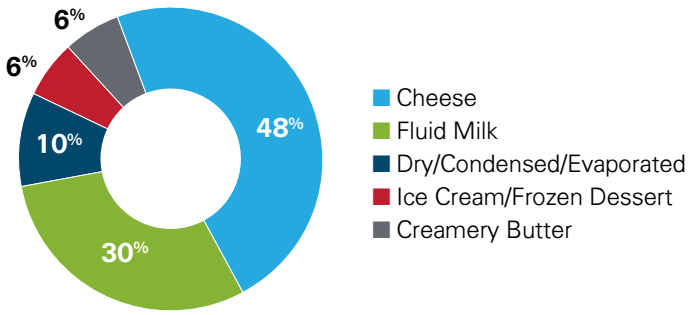


Table: 3
US Dairy Industry: Spend on Materials and Services* 2021;
2019-2021 CAGR Fluctuations in Spending

Dairy Product Industry			The Year Before COVID	The Year of COVID	The Recovery Year of COVID
	2021 Value of Shipments* $ US B	CAGR 2019 – 2021	CAGR 2019 – 2020	CAGR 2020 – 2021	CAGR 2021 – 2022
Cheese	$40.4	3.1%	12.1%	-5.2%	N/A
Fluid Milk	$25.4	4.5%	1.4%	7.8%	N/A
Dry/Condensed	$8.7	1.1%	-10.1%	13.7%	N/A
Ice Cream/ Frozen Desserts	$4.8	0.1%	1.6%	-1.3%	N/A
Creamery Butter	$5.1	-5.3%	-17.6%	8.7%	N/A
Total Dairy	**$84.4B**	**2.6% CAGR**	**3.9% CAGR**	**1.2% CAGR**	**N/A**

*Includes the cost of materials, operating supplies and consumables, containers/packaging, maintenance, and equipment not capitalized. Excluded are costs of resales; cost of fuels consumed; cost of electricity; and the cost of contract work.

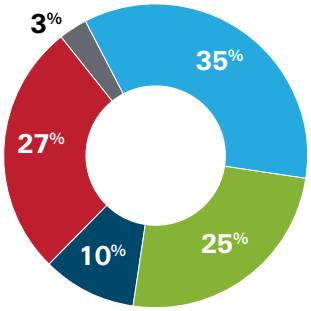
Source: US Census Bureau, Annual Survey of Manufacturers for years 2019, 2020, 2021.
NOTE: 2022 data is not yet available.

US DAIRY INDUSTRY: 1,664 US ESTABLISHMENTS IN 2021

1.2% CAGR

2019-2021 Contraction in the number of dairy establishments across the US.

Percent Share of Establishments by Industry Segment, 2021



- (573 establishments) Cheese
- (420 establishments) Fluid Milk*
- (172 establishments) Dry/Condensed/ Evaporated*
- (442 establishments) Ice Cream/Frozen Dessert
- (57 establishments) Creamery Butter*

*The dairy industry has experienced flat growth over the past several years; three industries reported a decrease in the total number of manufacturing establishments from 2020-2021.

> The combined group of five dairy industries lost a few manufacturing establishments 2019 – 2021 (–1.2% CAGR).

> The creamery butter industry, with by far the fewest number of manufacturing plants, is the only industry of the group that did not lose plants 2019 – 2021.

> Although the number of cheese manufacturing plants contracted from 2019 – 2021, it gained employees (+3.9% CAGR) during the same period.

80%

Of the dairy industry operates in 16 states

The TOP states with more than 100 establishments are:

1. Wisconsin
2. California
3. New York
4. Pennsylvania
5. Illinois
6. Texas
7. Florida

1 in 4

US Dairy plants have more than 100 employees

Table: 4 – US Dairy Industry:
Size Classification by Number of Employees

Employee Categories	Number of plants	% share of total
Less than 20	666	45.0%
20 to 49	216	14.6%
50 to 99	171	11.5%
100 or more	428	28.9%

US DAIRY INDUSTRY: G17 FEDERAL RESERVE THE ECONOMIC ACTIVITY BY DAIRY SEGMENT

G17 Industrial Production and Capacity Utilization

The Federal Reserve publishes the G17* index reporting on industrial production and capacity utilization that measures the real output of manufacturing. The reference period for the index is 2017, which means each industry is given a base score of 100 for that year. Progress annually is gauged against that index base-year score.

The industrial production index (IPI) measures the pulse of economic activity within its component sectors, which make up a sizeable share of total US GDP. Therefore, the index is closely followed as a measure of total business activity and overall economic health.

Trends in the G17 Index Report (2019-2022):

The dairy group saw its greatest IP index rate of growth in the Covid year 2019-2020 (+3.3% CAGR) and has contracted each year since.

Cheese	Growth of 7.2% CAGR, 2019-2020; contraction in 2020-2021 of -2.3%; recovery of 2.1% CAGR 2021-2022
Fluid Milk	Spike of 2.8% CAGR 2019-2020 with steady contraction years following
Dry/Condensed	Most contraction at -4.6% CAGR, 2019-2022
Ice Cream/Frozen Desserts	Most growth at 3.8% CAGR, 2019-2022
Creamery Butter	Greatest year-over-year growth (21.4%) and year-over-year contraction (-10.2% CAGR)

Table: 5
US Dairy Industry: Industrial Production (IP) Index* 2022
2019-2022 CAGR Fluctuations in Dairy Production

Dairy Product Industry			The Year Before COVID	The Year of COVID	The Recovery Year of COVID
	2022 IP Index	CAGR 2019 – 2022	CAGR 2019 – 2020	CAGR 2020 – 2021	CAGR 2021 – 2022
Cheese	117.1	2.3%	7.2%	-2.3%	2.1%
Fluid Milk	103.1	0.9%	2.8%	1.1%	-1.1%
Dry/Condensed	86.4	-4.6%	-7.1%	-5.0%	-1.5%
Ice Cream/ Frozen Desserts	113.8	3.8%	5.6%	9.9%	-3.5%
Creamery Butter	124.5	2.8%	21.4%	-10.2%	-0.3%
Total Dairy	**106.2**	**0.8% CAGR**	**3.3% CAGR**	**-0.7% CAGR**	**-0.2% CAGR**

Source: Federal Reserve G-17 reports, for NAICS groups and industries.
**Measured by 1) output in physical units and 2) data on inputs to the production process.*

US DAIRY INDUSTRY: VALUE OF SHIPMENTS PRODUCT CATEGORIES

Tracking dairy product activity 2019-2021

The following three tables provide product-level statistics from three different sources. The product categories show data that has been published, not statistics representing every product category manufactured.

In Table 6, NAPCS reports several product lines generated double-digit rates of growth 2019-2021.

Growth 2019-2021

Fluid milk (lactose-free, and flavored milk at 22.2% CAGR)
Concentrated milk products (bulk at 15.1% CAGR)
Frozen desserts (yogurt, sherbet, water ices, etc. at 15.1% CAGR)
Raw liquid whey (10.7% CAGR)
Fluid milk (2%, 1%, 0.5% at 7.8% CAGR)
Process cheese (7.5% CAGR)

Contraction 2019-2021

Yogurt (-4.3% CAGR)
All other process cheese and related products (-3.8% CAGR)
Fluid milk (fat-free, skim at -2.8% CAGR)
Fluid milk and cream (bulk at -2.8% CAGR)

Table: 6 – US Dairy Industry: Product Level Value of Shipments* North American Product Classification System (NAPCS)
2019-2021 CAGR Fluctuations in Revenue

Dairy Product Category		Value of Shipments	The Year Before COVID	The Year of COVID	The Recovery Year of COVID
	2021 Value of Shipments* $ US B	CAGR 2019 – 2021	CAGR 2019 – 2020	CAGR 2020 – 2021	CAGR 2021 – 2022
Fluid milk (2%, 1%, 0.5% reduced fat milk)	$6.1	7.8%	8.5%	7.0%	N/A
Fluid milk (Fat-free or skim milk)	$1.2	-2.8%	6.1%	-11.0%	N/A
Fluid milk and cream (bulk sales-whole milk, 2%, 1%, skim, fat-free, flavored, buttermilk, eggnog, etc.)	$6.5	-1.9%	-1.4%	-2.4%	N/A
Fluid milk (lactose-free, flavored milk, and ultra-high temperature processing (UHT)	$3.5	22.2%	16.3%	28.3%	N/A
Raw liquid whey	$0.70	10.7%	32.7%	-7.7%	N/A
Concentrated milk products (bulk barrels, drums, and tanks)	$1.4	15.1%	-2.6%	36.1%	N/A
Process cheese	$5.3	7.5%	5.1%	10.0%	N/A
All other process cheese and related products	$2.3	-3.8%	8.4%	-14.6%	N/A
Yogurt, excluding frozen	$6.4	-4.3%	-1.5%	-7.0%	N/A
Frozen desserts (yogurt, sherbet, etc.)	$1.3	15.1%	6.9%	23.9%	N/A
Ice cream, including custards (excluding lowfat and nonfat)	D	N/A	-1.0%	N/A	N/A
Frozen whipped topping, dairy or nondairy base, and other frozen dairy product substitutes	$0.45	N/A	N/A	10.6%	N/A

**Sales, value of shipments, or revenue of NAPCS collection code ($B): US | Census Bureau, Annual Survey of Manufacturers, NAPCS collection, 2019-2021. | NAPCS only has data available through 2021.*

US DAIRY INDUSTRY: PRODUCTION BY WEIGHT PRODUCT CATEGORIES

Tracking dairy product activity 2019-2022

In Table 7, USDA data shows dairy product manufacturing by weight (not sales revenue) and it includes 2022.

The largest product lines produced by weight are whole milk, cheese, and 2% milk. The next tier is ice cream, yogurt, and flavored milk.

Growth 2019-2022	Contraction 2019-2022
Evaporated/condensed (3.4% CAGR)	Total Fluid Milk (-4.5% CAGR)
Whey protein (2.1% CAGR)	Skim milk (-13.7% CAGR)
Cheese (2.0% CAGR	Low-fat milk (-8.6% CAGR)
Yogurt (1.8% CAGR)	2% milk (-5.9% CAGR)
Dry skim (1.0% CAGR)	Flavored milk (-3.0% CAGR)
Butter (1.0% CAGR)	Whole milk (-2.8% CAGR)
Ice cream (0.9% CAGR 2019-2021^)	Lactose (-1.6% CAGR)
^USDA withheld figures for 2022	Dry whey (-1.0% CAGR)

Table: 7 – US Dairy Industry: Billions of Pounds Produced United States Department of Agriculture (USDA)
2019-2022 CAGR Fluctuations in Production

Dairy Product Category	Pounds Produced	The Year Before COVID	The Year of COVID	The Recovery Year of COVID
	2022B of lbs	CAGR 2019 – 2022	CAGR 2019 – 2020	CAGR 2020 – 2021	CAGR 2021 – 2022
Milk production total	226.5	1.2%	2.2%	1.3%	0.1%
Fluid milk - Whole milk	14.8	-2.8%	3.3%	-5.0%	-6.3%
Fluid milk - Reduced-fat (2% milk fat)	12.7	-5.9%	3.6%	-7.8%	-12.9%
Fluid milk - Low-fat (1% milk fat)	4.6	-8.6%	-4.3%	-6.1%	-15.0%
Fluid milk - Skim	2.3	-13.7%	-13.4%	-12.3%	-15.5%
Fluid milk - Flavored	4.1	-3.0%	-19.5%	14.5%	-1.1%
Fluid milk - Buttermilk	.5	0.4%	-5.5%	8.0%	-0.7%
Fluid milk - Eggnog	N/A	N/A	8.8%	6.6%	N/A
Fluid milk - Total	40.4	-4.5%	-0.1%	-4.0%	-9.2%
Dry skim (nonfat dry milk, skim milk powder)	2.5	1.0%	9.2%	2.4%	-7.9%
Dry whey	0.9	-1.0%	-1.9%	-2.6%	1.4%
Whey protein concentrate	0.5	2.1%	-2.6%	6.5%	2.7%
Lactose	1.2	-1.6%	-8.7%	2.8%	1.6%
Evaporated and condensed whole milk	0.7	3.4%	12.4%	-1.6%	0.0%
Butter	2.1	1.0%	7.6%	-3.5%	-0.7%
Cheese	14.0	2.0%	0.8%	3.5%	1.7%
Ice cream	N/A	N/A	1.8%	-3.5%	N/A
Yogurt (not frozen)	4.6	1.8%	N/A	N/A	-2.5%

Source: US Department of Agriculture (USDA) Economic Research Services, Dairy products produced by millions of pounds, United States (Annual) published 9/30/2022

US DAIRY PRODUCT CONSUMPTION IN POUNDS CONSUMED PER CAPITA

The table below presents detailed historic breakdowns of per capita dairy consumption (measured in pounds consumed per person) as recorded by the USDA dairy segment categories. A few quick notes about reading the table:

- Numbers presented in **BLUE** represent category highs for the time period examined;
- Numbers presented in **RED** note year-over-year contraction;
- Numbers presented in **GREEN** note year-over-year growth;
- Numbers presented in **BLACK** denote years of no change.

Key Data from Per Capita Dairy Consumption

Fluid milk consumption has been steadily declining (192 pounds/person in 2001 to 134 pounds/person in 2021).

Yogurt has experienced significant growth in the last 20 years. While yearly consumption peaked in 2013 at 14.9 pounds/person and fluctuated for several years after, consumption has risen overall from 7 pounds/person in 2001 to 14.3 pounds/person in 2021. In alignment with Euromonitor and US Census statistics, USDA consumption data shows relatively flat growth in yogurt in the last five years.

Butter consumption has been expanding over the last 20 years with growth accelerating in the last ten years: consumption rose over 20% from 2011 to reach a peak of 6.5 pounds/person in 2021.

OVER THE NEXT THREE YEARS

ABOUT

90%

Of consumers have no plans to reduce their dairy product consumption.[39]

Table: 8A – Dairy products per capita consumption (2017-2021), United States *(pounds per person)*

Product	2017 per capita consumption*	2021 per capita consumption*	CAGR 2017 - 2021
Fluid beverage milk	149.0	134.0	-2.6%
Cheese american	15.1	16.1	1.6%
Cheese other than american	21.9	22.3	0.5%
Cheese cottage	2.1	1.9	-2.5%
Butter	5.7	6.5	3.3%
Dry whole milk	0.3	0.2	-9.6%
NDM and SMP	2.8	2.3	-4.8%
Dry buttermilk	0.2	0.2	0.0%
Dry whey and WPC	2.0	1.7	-4.0%
Yogurt (other than frozen)	13.7	14.3	1.1%
Evap / condensed canned and bulk	6.9	6.6	-1.0%
Milk equivalent- milk fat basis	643.0	661.0	0.7%
Milk equivalent- skim solids basis	529.0	519.0	-0.5%
Sub non frozen dairy products	1,391.7	1,386.1	-0.1%
Ice cream and sherbet	19.8	19.2	-0.8%
Frozen yogurt	1.2	0.9	-6.6%
Other frozen dairy	0.4	0.2	-14.7%
Sub tot frozen dairy	21.4	20.3	-1.3%
Total Dairy	**1,413.1**	**1,406.4**	**-0.1%**

Source: U.S. Department of Agriculture, Dairy products: Per capita consumption, United States (Annual) published 9/30/2022
** pounds per person – NDM = nonfat dry milk. SMP = skim milk powder. WPC = whey protein concentrate.*

Table 8B – Dairy Products: Per capita consumption (2001-2021), United States *(pounds per person)*

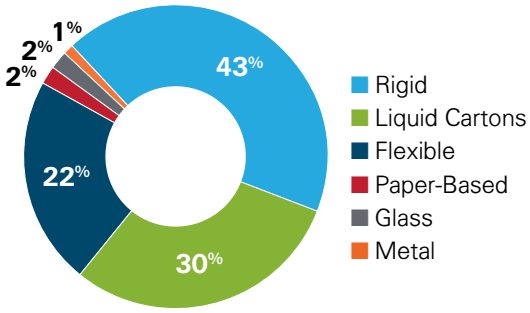
		Cheese				Dry Products			
Year	Fluid Beverage Milk	American Type	Other than American	Cottage	Butter	Dry Whole Milk	NDM and SMP	Dry Buttermilk	Dry Whey and WPC
2001	192	12.8	17.0	2.6	4.3	0.1	3.3	0.1	3.3
2002	191	12.8	17.4	2.6	4.4	0.2	3.1	0.2	3.4
2003	188	12.6	17.7	2.6	4.5	0.2	3.4	0.2	3.4
2004	185	12.9	18.1	2.7	4.5	0.1	4.3	0.1	3.0
2005	185	12.6	18.7	2.7	4.5	0.2	4.2	0.2	2.9
2006	185	13.1	19.1	2.6	4.7	0.1	3.2	0.2	2.8
2007	183	12.8	19.9	2.6	4.7	0.2	2.9	0.2	2.3
2008	181	13.1	19.0	2.3	5.0	0.1	3.1	0.2	2.9
2009	181	13.4	18.9	2.4	5.0	0.3	4.0	0.2	2.5
2010	177	13.3	19.4	2.3	4.9	0.2	3.2	0.2	1.9
2011	173	13.0	20.0	2.3	5.4	0.2	3.0	0.2	1.5
2012	169	13.3	20.0	2.3	5.5	0.2	3.6	0.2	1.8
2013	164	13.4	20.1	2.1	5.5	0.2	2.9	0.3	1.9
2014	158	13.7	20.5	2.1	5.5	0.2	3.1	0.2	2.0
2015	155	14.0	21.1	2.1	5.6	0.3	3.2	0.2	2.4
2016	153	14.4	22.1	2.2	5.7	0.3	2.9	0.2	2.0
2017	149	15.1	21.9	2.1	5.7	0.3	2.8	0.2	2.0
2018	145	15.4	22.6	2.1	6.0	0.4	2.3	0.2	2.2
2019	141	15.5	22.8	2.1	6.2	0.3	2.7	0.2	2.2
2020	141	15.5	22.6	2.0	6.3	0.3	2.4	0.2	1.6
2021	134	16.1	22.3	1.9	6.5	0.2	2.3	0.2	1.7

		Frozen Products				Evaporated and Condensed Milk			All Products, Milk-Equivalent	
	Ice Cream					Whole		Skim		
Year	Regular	Low-fat and Nonfat	Frozen Yogurt	Other Frozen Dairy	Yogurt, Other Than Frozen	Canned	Bulk	Bulk and Canned	Milk-Fat Basis	Skim Solids Basis
2001	15.8	6.5	1.5	0.2	7.0	1.6	0.5	3.4	585	NA
2002	16.2	5.8	1.5	0.2	8.0	1.9	0.4	3.7	588	NA
2003	15.9	6.7	1.5	0.1	8.6	2.0	0.7	3.3	596	NA
2004	14.6	6.5	1.3	0.2	9.2	1.7	0.6	3.2	594	NA
2005	15.1	6.0	1.3	0.2	10.3	1.7	0.6	3.7	603	NA
2006	15.3	6.1	1.3	0.2	11.1	1.7	0.6	4.2	612	NA
2007	14.8	6.1	1.5	0.2	11.6	1.6	0.5	5.6	612	NA
2008	14.2	6.1	1.5	0.3	11.7	1.7	0.6	5.1	606	NA
2009	13.9	6.3	0.9	0.3	12.5	1.7	0.6	5.0	607	NA
2010	14.0	6.5	1.0	0.2	13.4	1.5	0.5	5.2	603	NA
2011	13.2	6.4	1.2	0.2	13.6	1.5	0.4	5.2	603	516
2012	13.2	7.0	1.1	0.2	14.0	1.5	0.5	5.3	613	524
2013	13.0	6.0	1.4	0.2	14.9	1.5	0.4	5.3	606	513
2014	12.5	6.2	1.3	0.2	14.9	1.0	0.4	5.4	614	512
2015	12.9	6.5	1.4	0.3	14.4	1.4	0.7	5.5	628	526
2016	12.9	6.4	1.2	0.3	13.7	1.5	0.6	5.4	644	531
2017	12.3	6.7	1.2	0.4	13.7	1.2	0.5	5.1	643	529
2018	12.0	6.6	1.0	0.4	13.6	1.3	0.6	4.9	644	525
2019	12.3	6.8	1.0	0.4	13.4	1.3	0.6	4.6	651	522
2020	12.7	6.5	0.6	0.3	13.6	1.6	0.5	4.8	651	510
2021	12.0	6.4	0.9	0.2	14.3	1.6	0.5	4.5	661	519

Source: U.S. Department of Agriculture, Dairy products: Per capita consumption, United States (2001-2021)

GLOBAL DAIRY INDUSTRY: PACKAGING MATERIALS

Global Dairy Packaging Material Types; 523B Units Sold at Retail 2022



Globally there were 523B units of dairy products sold at retail in 2022 packaged in six types of materials.

Source: Euromonitor Retail Dairy Packaging Data 2019-2023

Table: 9 – Global Dairy Industry Material Usage:
Growth and Contraction 2019-2022 and Forecast 2023

Packaging Material Type	CAGR 2019 – 2022	CAGR 2022 Actual to 2023 Forecast
Rigid Plastic	0.1%	1.5%
Liquid Cartons	1.0%	1.9%
Flexible Packaging	1.7%	2.8%
Paper-based Containers	1.0%	1.0%
Glass	2.4%	5.3%
Metal	0.3%	1.0%
Global CAGR	1.0%	1.7%

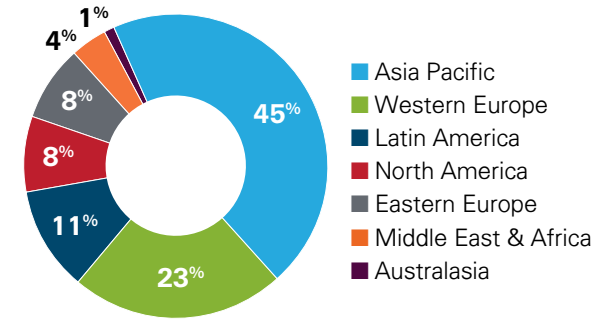
MACHINE TOLERANCES

When switching packaging to more sustainable materials containing PCR, OEMs need to verify and guarantee their machinery will perform the same.

— *Engineer,*
East Coast Milk Producer

GLOBAL DAIRY INDUSTRY: GLOBAL MARKET SHARE

Global Dairy Packaging by Region: 523B Units Sold at Retail 2022



*Dairy packaging units include rigid plastic, flexible, glass, liquid cartons, paper-based containers, and metal.

Table: 10 – Global Dairy Industry Material Usage: Units Sold at Retail 2022; Growth and Contration 2019-2022: Forecast 2023

Regional Share of the Global Dairy Market	2022 Dairy Products Billions of Units Sold at Retail	Units Sold at Retail	The Year Before COVID	The Year of COVID	The Recovery Year of COVID	The Year Beyond COVID
		CAGR 2019 – 2022	CAGR 2019 – 2020	CAGR 2020 – 2021	CAGR 2021 – 2022	CAGR 2022 Actual to 2023 Forecast
North America	41.8	-0.5%	8.1%	-3.5%	-5.6%	1.4%
Latin America	52.3	-0.1%	0.3%	-1.1%	0.7%	1.6%
Western Europe	122.2	0.6%	4.0%	-0.7%	-1.6%	0.5%
Eastern Europe	42.4	1.6%	4.7%	1.9%	-1.7%	0.1%
Middle East & Africa	21.4	1.6%	3.9%	-0.2%	1.2%	2.1%
Asia Pacific	237.6	1.2%	0.6%	1.8%	1.3%	3.2%
Australasia	5.6	2.7%	3.7%	2.7%	1.8%	3.1%
Global CAGR Growth and Contraction	**523B**	**0.9% CAGR**	**2.5% CAGR**	**0.4% CAGR**	**0.3% CAGR**	**1.7% CAGR**

Source: Euromonitor Retail Dairy Packaging Data 2019-2023

Global Trends in Retail Sales Units (2019-2022)

The data shows wide fluctuations across the globe in unit dairy sales year-over-year. The global dairy industry experienced a slight contraction of -0.3% in 2022. Analysts have forecast a rebound for 2023 in all regions. Euromonitor forecasts relatively flat growth of 1.2% CAGR through 2027.

532B Units are forecast to be sold in 2023

DAIRY PRODUCTS: US IMPORTS AND EXPORTS MEASURED BY MILLIONS OF POUNDS, 2019 - 2021

Table: 11 – Dairy Products Showing Rate of Activity as Measured by Millions of Pounds Produced

	IMPORTS	EXPORTS
	CAGR 2019 – 2022	CAGR 2019 – 2022
Butter	7.9%	52.2%
Dry Skim Milk	35.3%	5.7%
American Cheese	-2.9%	14.2%
Other Cheese	1.2%	6.4%

	IMPORTS	EXPORTS
	CAGR 2019 – 2022	CAGR 2019 – 2022
Dry Whey	114.1%	13.4%
Whey Protein Concentrate (WPC)	-12.1%	10.6%
Lactose	2.6%	6.2%
Evaporated and Condensed Milk	-7.7%	0.9%

Source: USDA, Economic Research Service (ERS) 2019-2022

APPENDIX C

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12930 Worldgate Dr., Suite 200
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F: (703) 243-8556
E: pmmi@pmmi.org
www.pmmi.org

PMMI LATIN AMERICA
Homero 418 Piso 7
Col. Miguel Chapultepec
Miguel Hidalgo, D.F. 11570 Mexico
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F: + (52 55) 5545 4302
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