

CHAPTER 3

MEAT AND POULTRY

INTRODUCTION

Fresh and frozen meat and poultry packaging in North America is required to comply with **Food and Drug Administration (FDA)** regulations. The meat industry is the largest sector of agriculture and agriculture is the largest sector of the United States (U.S.) economy. A wide variety of films and film constructions have been developed to meet the requirements of industry regulations due to increasing concerns for bacteria-free products. The specific film structures are dependent on the type of meat or poultry to be packaged, the distribution process, the end use (restaurant, institutional, or consumer), and time of storage before final sale and consumption.

The term "meat" refers to the skeletal muscle from the carcasses of animals such as beef and veal (cattle), lamb and mutton (sheep), and pork (hogs).

Meat is packaged in either primal or sub-primal cuts. The primal cuts are typically contained in primal cut shrouds, and sub-primal cuts are shipped in multi-layer coextruded barrier bags. Retail food stores repackage the meat before selling it to the consumer. Consumer-ready meat cuts, such as precut steaks and roasts, are prepared in vacuum sealed packages to be placed directly in refrigerated supermarket meat cases.

Most beef has been sold as "boxed beef", which is prepared at the packing plant by removing more of the bone and fat from the carcass as it is cut into smaller portions, vacuum-packed to reduce spoilage and shrinkage, and then placed into boxes that are easier to ship and handle. The U.S. is the world's largest producer of beef.

Other than the skeletal portion of the livestock, up to 15.0% of the value of the live animal may be consumed in the form of by-products such as hides, inedible and edible tallow, meat and bone meal, brains, kidneys, sweetbreads (calf thymus glands), the tail, and the tongue. By-products are an essential sector of the meat packing business.

Fresh and frozen poultry covers an assortment of domesticated birds, which are raised to provide food. Included among the list of poultry items are chicken, turkey, duck, goose, and other game birds such as guinea fowl, pigeon, quail, and pheasant. Chicken is by far the largest and most important due to consumption of both meat and eggs. Just over half of all chicken is packaged in parts, with a portion of the larger parts further processed into boneless products. Poultry is extremely susceptible to microbiological deterioration by salmonella microorganisms; therefore, oxygen transfer and reducing water vapor loss is extremely important in poultry packaging. Guinea fowl, pigeons, pheasants, and other game birds are produced in smaller numbers for specialty markets.

Turkey is shipped to packing plants where the slaughtering, scalding, and picking processes take place. Turkey meat is packaged whole and sold either fresh or frozen in vacuum shrink bags.

Like chickens, ducks are bred for their meat and eggs. Ducks are typically slaughtered, bled, scalded, and rough-picked in one machine operation and are packaged whole and frozen.

Polyethylene (PE) film currently dominates the meat and poultry packaging market. Polyvinylidene chloride (PVDC) films, laminations, and coextrusions are also used in the institutional and retail prepackaged meat and poultry market.

This chapter will focus on PE meat and poultry film. A market analysis, including discussions of market size, product specifications, factors affecting the market, materials competition, and participants will be provided. This chapter will also discuss PE film extrusion and resin technology, provide a value-in-use analysis, and a forecast of resin use and consumption for 2019 and 2022.

MARKET ANALYSIS

Market Size

Total PE resin consumption in 2019 for meat and poultry packaging reached approximately [REDACTED] lbs., and the market is expected to increase at an average annual growth rate (AAGR) of [REDACTED]% through the year 2022, reaching a PE resin consumption level of [REDACTED] MM lbs.

The meat and poultry industry feeds over 326.0 million Americans and is the largest segment of U.S. agriculture. According to the **United States Department of Agriculture (USDA)** and the **North American Meat Institute (NAMI)**, total meat and poultry production in 2019 reached approximately 104.6 billion lbs. Total meat and poultry production is expected to increase to 106.5 billion lbs. in 2020 (preliminary figures).

Meat:

According to the **USDA** in 2019, the U.S. produced approximately 54.8 billion lbs. of red meat and veal. The U.S. is predicted to increase production to 56.2 billion lbs. in 2020 (preliminary figures). Red meat includes beef, veal, lamb, mutton, and pork. Further breakdowns reveal that American meat packers produced 27.0 billion lbs. of beef in 2019. However, the beef production for 2020 was raised to 27.6 billion lbs., based on the expectation that the increase in cattle slaughter will rise faster in the first half of 2020. Approximately 150.0 million lbs. of lamb and mutton and 27.6 billion lbs. of pork were produced in 2019. According to preliminary figures, lamb and mutton are estimated to decrease to 148.0 million lbs., and pork is expected to increase to 28.4 billion lbs. in 2020.

According to the **USDA**, U.S. per capita consumption for total red meat (retail weight) reached approximately 110.6 lbs. in 2019. This is further broken down by beef and veal per capita consumption representing 57.4 lbs., pork per capita consumption representing 52.1 lbs., and lamb and mutton per capita consumption representing 1.1 lbs. In 2020 (preliminary figures), U.S. per capita consumption for total red meat (retail weight) is expected to reach 111.2 lbs. with beef and

veal per capita consumption representing 57.8 lbs., pork per capita consumption representing 52.3 lbs., and lamb and mutton per capita consumption representing 1.1 lbs.

The percent of commercial red meat production by state over the past 25 years has been relatively unchanged. Top cattle producing states were Nebraska, Kansas, Texas, Colorado, California, Wisconsin, Washington, and Pennsylvania. Top hog producing states were Iowa, Minnesota, Illinois, Indiana, Missouri, Oklahoma, and Pennsylvania.

Poultry:

According to the **USDA** in 2019, the total poultry market encompassed, raised and processed an estimated 49.2 billion lbs. This is expected to increase to 49.7 billion lbs. in 2020 (preliminary figures). According to the **USDA** in 2019, total poultry per capita consumption (retail weight) reached 109.5 lbs. This is expected to increase to 109.9 lbs. in 2020 (preliminary figures).

The largest sources of poultry production are commercial broiler farms. Broilers are seven- to eight-week-old chickens marketed at about 2.0 to 5.0 lbs. (1.0 to 2.5 kg) live-weight. In the U.S., Georgia, Arkansas, North Carolina, Alabama, Mississippi, Texas, Kentucky, Delaware, South Carolina, Maryland, and Virginia were the top chicken producing states. Ontario is the largest poultry producing province within Canada. According to the **USDA**, the total broiler market encompassed an estimated 43.3 billion lbs. in 2019 and is predicted to reach 43.8 billion lbs. in 2020 (preliminary figures). According to the **USDA** in 2019, per capita broiler consumption (by retail weight) reached 93.5 lbs. This is expected to increase to 93.9 lbs. in 2020 (preliminary figures).

Turkey is consumed mainly in the U.S., Canada, and the United Kingdom. The U.S. raised and processed an estimated 5.9 billion lbs. in 2019 and is projected to remain the same in 2020 (preliminary figures). Top turkey producing states are primarily North Carolina, Minnesota, Indiana, Missouri, Arkansas, Iowa, and Virginia. According to the **USDA**, per capita consumption (by retail weight basis and boneless equivalent) of turkey in 2019 was 16.0 lbs. and is expected to remain the same through 2020 (preliminary figures).

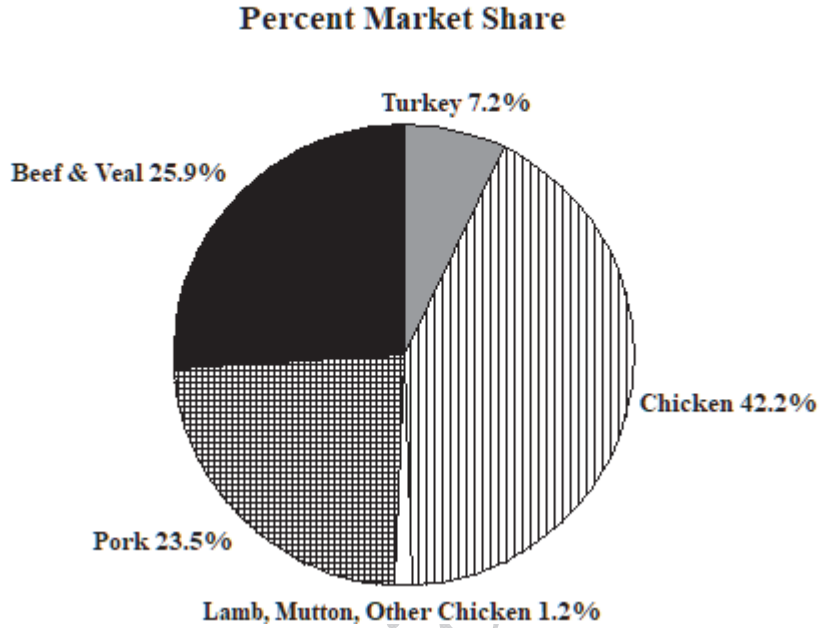
In the U.S., the “other poultry” (game birds) category represented an estimated 0.6 billion lbs. in 2019. According to the **USDA**, per capita consumption (retail weight basis and boneless equivalent) in 2019 for “other poultry” was approximately 1.6 lbs.

In conclusion and according to the **USDA**, meat and poultry consumption is measured on a retail weight basis, which refers to the weight of the meat purchased at retail stores. In 2019, per capita consumption of red meat and poultry was 221.7 lbs. This is further broken down as follows: beef and veal = 57.4 lbs., pork = 52.1 lbs., lamb and mutton = 1.1 lb., chicken = 93.5 lbs., turkey = 16.0 lbs. and other poultry = 1.6 lbs.

Please see Exhibit 3-1 for a graphic display of meat and poultry per capita consumption in the U.S. for 2019 by market share.

Exhibit 3-1

MEAT AND POULTRY PER CAPITA CONSUMPTION IN THE U.S. (2019)



Source: Mastio & Company Polyethylene Film Market Study and the USDA

Please see Exhibit 3-2 listing the top 25 meat and poultry companies along with their U.S. headquarters location and net sales (millions) for 2018.

Exhibit 3-2

TOP 25 MEAT AND POULTRY COMPANIES ALONG WITH THEIR U.S. HEADQUARTERS LOCATION AND NET SALES (MILLIONS) FOR 2018

Company Name and HQ Location	Net Sales (Millions)
JBS USA Holdings, Inc. (Greeley, Colorado)	\$38,642*
Tyson Foods, Inc. (Springdale, Arkansas)	\$38,260*
Cargill Meat Solutions Corp. (Wichita, Kansas)	\$20,000
SYSCO Corp. (est. sales of custom meat operations) (Houston, Texas)	\$16,479*
Smithfield Foods, Inc. (Smithfield, Virginia)	\$15,300
Hormel Foods Corp. (Austin, Minnesota)	\$9,200
National Beef Packing Co., L.L.C. (Kansas City, Missouri)	\$7,400
Perdue Farms, Inc. (Salisbury, Maryland)	\$6,500*
OSI Group, L.L.C. (Aurora, Illinois)	\$6,100
ConAgra Foods Inc. (Omaha, Nebraska)	\$5,862*

Company Name and HQ Location	Net Sales (Millions)
Sanderson Farms, Inc. (Laurel, Mississippi)	\$3,342
Koch Foods, L.L.C. (Pack Ridge, Illinois)	\$3,100*
American Foods Group, L.L.C. (Green Bay, Wisconsin)	\$3,100*
Keystone Foods, L.L.C. (West Chester, Pennsylvania)	\$2,700
Oscar Mayer/Part of Kraft Heinz Co. (Chicago, Illinois)	\$2,649*
Foster Farms (Livingston, California)	\$2,300*
Mountaire Farms, Inc. (Millsboro, Delaware)	\$2,214
Wayne Farms, L.L.C. (Oakwood, Georgia)	\$2,200*
Greater Omaha Packing (Omaha, Nebraska)	\$1,900
Seaboard Foods, L.L.C. (Shawnee Mission, Kansas)	\$1,609
Butterball, L.L.C. (Garner, North Carolina)	\$1,500*
Fresh Mark, Inc. (Massillon, Ohio)	\$1,400
Boar's Head Provisions Co., Inc. (Sarasota, Florida)	\$1,300*
House of Raeford Farms, Inc. (Rose Hill, North Carolina)	\$1,140
Georgia's, Inc. (Springdale, Arkansas)	\$1,125

*Estimated from other company reports or other published data.

Source: Mastio & Company Polyethylene Film Market Study and The National Provisioner

Market and Product Specifications

At the slaughterhouse, primal cuts are packaged in large carcass covers or shrouds to help protect the meat from dust and debris while they are shipped in refrigerated rail cars or trucks. This PE film is typically constructed with a low-density PE (LDPE) and linear low density PE (LLDPE) blended resin.

Sub-primal cuts of meat are packaged in barrier bags which are typically three-layer coextruded structures. LDPE-ethylene vinyl acetate copolymer (LDPE-EVA copolymer) and PVDC resins make up the layers typically in a LDPE-EVA copolymer/PVDC/LDPE-EVA copolymer structure. The PVDC resin provides the required oxygen barrier properties. The packaged meat is then placed under a vacuum and sealed until the film is shrunk around the meat. Other more sophisticated coextruded film structures can have as many as six or seven layers, which may consist of PE/tie-layer/nylon/ethylene vinyl alcohol copolymer (EVOH)/nylon/tie-layer/PE resins.

Sub-primal cuts of meat are transported from the slaughterhouse to retailers in barrier bags. It is very important to control the temperature and air exposure to prevent spoiling. After large meat cuts reach the retail level, it is cut into smaller pieces and packaged in tray overwrap. Small bags typically contain turkey, hams, steaks, and deli meats.

At the food service level, large bags or pouches are commonly packaged in a LDPE-EVA copolymer (2.0% to 4.0% EVA content) film for 10.0 and 25.0 lb. shipments. Meat patties for institutional use are also packaged in LDPE-EVA copolymer (2.0% to 4.0% EVA content) bags.

Preserving the freshness of red meat to delay spoilage is the purpose of oxygen barrier meat packaging. The color of red meat is an interpretation of freshness and depends on the presence of oxygen. At the consumer level, consumers don't like the looks of gray or blue beef on grocers' shelves. The red color is associated with the freshness of the meat, even though other technologies are newly developed to maintain freshness without the red color.

Modified atmosphere packaging (MAP) is a technology that has been developed to ensure that packaged food products stay fresh and attractive for as long as possible. Some technologies include MAP, such as a peel-away oxygen barrier film produced by **Sealed Air Corp. (Cryovac Div.)**. The peel-away barrier film is utilized by grocery store personnel by peeling off the top oxygen barrier, causing the beef to change color within minutes from brown to red, making it more appealing to consumers. Some benefits of case-ready and MAP packaging promote a longer shelf-life. MAP wrapped ground beef can last up to 14 days after the sell-by date versus three to four days for traditionally wrapped beef. This transfers into less food waste. Grocers can cut in-store labor and stock MAP meat for round-the-clock sales and three-day weekends. Gas flushed MAP allows grocers to sell uncooked fresh meat, marinated varieties and ready-made meals for quick preparation at home. Furthermore, a central meat-packer using MAP may cut steps in the distribution chain. The process prevents localized surface contamination such as salmonella or E. coli bacteria, which minimizes a grocer's food-safety liability.

Offal products, such as feet, hide, brains, kidneys, sweetbreads, and intestines are packaged in non-shrink, non-barrier PE bags.

Chicken is typically packaged in parts, and large pieces continue to be processed further into boneless products. Poultry products, such as whole birds, are individually packaged in well fitted vacuum-shrink bags. The bags can be square bottom or round bottom bags which help prevent the bag from splitting and chicken juices from leaking. They can also be side-seal or end-seal bags. Poultry bags vary in size depending on what type of bird is placed in the package and the size of the bird.

Participants

Mastio & Company profiled 29 producers of PE film for the meat and poultry market. In 2019, the top three PE film processors in the meat and poultry market were [REDACTED]

[REDACTED] Collectively, these three companies produced approximately [REDACTED] MM lbs. ([REDACTED]%) of the meat and poultry PE film, and the remaining participants processed approximately [REDACTED] MM lbs. ([REDACTED]%) of PE resin consumption for this market during 2019.

Two companies have exited the meat and poultry market since 2017. [REDACTED]

Please see Exhibit 3-3 displaying names and locations of major PE meat and poultry film manufacturers. The parent company names are listed first, with the division names (where applicable) listed in parentheses. The number of locations was provided by the respondent and may or may not represent their total facilities.

Exhibit 3-3

**NAMES AND LOCATIONS OF MAJOR NORTH AMERICAN
PE MEAT AND POULTRY FILM PRODUCERS**

Company	Location	# of Plants
[REDACTED]	Rhineland, Wisconsin	1
[REDACTED]	Toronto, Ontario, Canada	1
[REDACTED]	Neenah, Wisconsin	26
[REDACTED]	Orangeburg, New York	2
[REDACTED]	Van Buren, Arkansas	1
[REDACTED]	Evansville, Indiana	36-40
[REDACTED]	Troy, Michigan	2
[REDACTED]	Milton, Wisconsin	7
[REDACTED]	Carol Stream, Illinois	1
[REDACTED]	Alliance, Ohio	1
[REDACTED]	Council Bluffs, Iowa	1
[REDACTED]	Mount Pearl, Newfoundland, Canada	1
[REDACTED]	Montreal, Quebec, Canada	3
[REDACTED]	Hillside, New Jersey	1
[REDACTED]	Saint James, Missouri	1
[REDACTED]	Johnstown, Colorado	1
[REDACTED]	Lexington, Ohio	4
[REDACTED]	Hawthorn, New Jersey	1
[REDACTED]	Auburn, Washington	1
[REDACTED]	Hartsville, South Carolina	19
[REDACTED]	Carol Stream, Illinois	2
[REDACTED]	North York, Ontario, Canada	1
[REDACTED]	Atlanta, Georgia	4
[REDACTED]	Charlotte, North Carolina	4
[REDACTED]	Forest Park, Georgia	1
[REDACTED]	Louisville, Kentucky	1
[REDACTED]	Pompano Beach, Florida	28

Company	Location	# of Plants
[REDACTED]	Montreal, Quebec, Canada	6
[REDACTED]	Winnipeg, Manitoba, Canada	3

Source: Mastio & Company Polyethylene Film Market Study

Please see Exhibit 3-4 listing names and locations of other known North American PE meat and poultry film manufacturers.

Exhibit 3-4

NAMES AND LOCATIONS OF OTHER KNOWN NORTH AMERICAN PE MEAT AND POULTRY FILM MANUFACTURERS

Company	Location
[REDACTED]	Saint- Leonard, Quebec, Canada
[REDACTED]	Grandview, Missouri
[REDACTED]	Marievalle, Quebec, Canada
[REDACTED]	Covington, Ohio
[REDACTED]	Chattanooga, Tennessee
[REDACTED]	Oklahoma City, Oklahoma
[REDACTED]	Pleasant Prairie, Wisconsin

Source: Mastio & Company Polyethylene Film Market Study

Please see Exhibit 3-5 listing the producers of PE meat and poultry film with their market shares, volumes for 2019 and 2022, and the AAGR for each company.

Exhibit 3-5

ESTIMATED RESIN CONSUMPTION, MARKET SHARE, AND AAGR
FOR PE MEAT AND POULTRY FILM BY NORTH AMERICAN PRODUCER
2019 AND 2022

	2019		2022		2019-2022 AAGR (%)
	Consumption (MM lbs.)	Market Share (%)	Consumption (MM lbs.)	Market Share (%)	
	142.5	21.0	153.5	20.6	2.5
	136.9	20.2	136.9	18.4	0.0
	103.0	15.2	110.9	14.9	2.5
	58.4	8.6	77.7	10.4	10.0
	38.0	5.6	40.9	5.5	2.5
	29.0	4.3	38.6	5.2	10.0
	15.5	2.3	15.5	2.1	0.0
	14.0	2.1	18.6	2.5	10.0
	12.1	1.8	14.0	1.9	5.0
	10.1	1.5	10.9	1.5	2.5
	10.0	1.5	10.9	1.5	3.0
	8.5	1.3	9.3	1.2	3.0
	7.6	1.1	9.4	1.3	7.5
	5.1	0.8	5.9	0.8	5.0
	5.0	0.7	6.7	0.9	10.0
	4.8	0.7	4.8	0.6	0.0
	4.5	0.7	6.0	0.8	10.0
	3.0	0.4	3.8	0.5	8.0
	3.0	0.4	4.0	0.5	10.0
	2.6	0.4	2.6	0.3	0.0
	2.5	0.4	2.9	0.4	5.0
	2.5	0.4	2.5	0.3	0.0

	2019		2022		2019-2022 AAGR (%)
	Consumption (MM lbs.)	Market Share (%)	Consumption (MM lbs.)	Market Share (%)	
	2.2	0.3	2.1	0.3	(-1.0)
	2.1	0.3	2.4	0.3	5.0
	1.8	0.3	2.1	0.3	5.5
	0.9	0.1	1.0	0.1	5.0
	0.8	0.1	0.8	0.1	2.0
	0.5	0.1	0.5	0.1	0.0
	0.2	0.0*	0.2	0.0*	0.0
	50.0	7.4	50.0	6.7	0.0
GRAND TOTAL		100.0	745.6	100.0	

* Market share not shown due to rounding.

Source: Mastio & Company Polyethylene Film Market Study

Growth Projection By Processor

The exhibit compares the processor's company growth estimate with their overall market growth estimate. This table and the explanation for differences can be found in the electronic edition (file name: Growth Comparisons).

2019		2022		Explanation -Company & Market Growth/Decline
Consumption (MM lbs.)	Market Share %	Consumption (MM lbs.)	Market Share %	

Capacity Utilization By Processor

Please see the electronic edition (file name: New Equipment, Capacity Utilization, Favorite Resin Supplier, & Additional Capacity Coming Online). An example of the table included in the electronic edition is provided below.

Processor Name/HQ Location	Operating Capacity 2019	Projected Operating Capacity 2022	Reason(s) for the Capacity Difference	How Will Additional PE Capacity Coming Online in Next Few Years Grow Your Business

FACTORS AFFECTING THE MARKET

Please see the electronic edition (file name: Factors Affecting the Market), for all *Factors Affecting the Meat and Poultry Film Market by processor name and HQ location*. Topics discussed in the electronic edition include: key factors affecting growth or decline for the market and their company; challenges or threats the market faces (economy, imports, mergers and acquisitions, etc.); growth opportunities; environmental issues (recycling, biodegradable polymers, and government/customer shareholder pressures); changes over the last two years (big historical events or market trends); and solutions for sustainability. An example of the table included in the electronic edition is provided below.

Processor Name/HQ Location	Key Factors Affecting Market Growth/Decline	Key Factors Affecting Company Growth/Decline	Challenges or Threats Faced in the Markets Served?	Growth Opportunities in the Markets Served?	Environmental Issues Encountered?	Changes Over the Last 2 yrs. for markets served?	Solutions for Sustainability

In the U.S. meat and meat-packing industry, livestock marketing and prices are affected by weather patterns, livestock feed prices, federal import and export policies, population growth, and consumer demand. Since the mid-1970's, total U.S. per capita beef consumption has declined a little over 60.0%. Per capita consumption of beef reached an all-time high of 94.3 lbs. in 1976 when beef supplies were at record levels, due to the liquidation of the nation's beef herd. As mentioned earlier, per capita consumption of beef in 2020 is predicted to be 57.8 lbs. The decline is largely due to the relatively higher prices for beef versus other meats and the concerns about the health effects of diets heavy in fat-rich red meats. Saturated animal fats are suspected in the etiology of heart disease and certain types of cancer.

Although there are some film companies expecting or experiencing high rates of growth, many film extrusion companies today are less focused on expecting growth than trying to remain profitable and not lose any production. A few companies stated they will remain stable and flat and are not focusing on this market. They plan to spend resources on more profitable food markets.

Some participants feel that most syndicated market research for the food industry has growth rates that are too high. Growth rates can be dependent on their placement within a store. For example, in the perimeter of the grocery store some industry sources see the food and packaging markets growing at a 2.0% to 3.0% compounded annual growth rate. However, consumer packaged goods in the center of the store is growing less. The majority of meat and poultry film extrusion companies believe they will grow at a rate between 2.0% and 5.0% over the next three years. The challenge for many participants is to come up with innovative packaging to keep customers going back to them. Additionally, smaller film manufacturers are unable to compete with the larger more profitable companies.

The few companies experiencing a double-digit AAGR are increasing capacity, upgrading extrusion equipment, focusing on the coextrusion film process, and producing more sophisticated food packaging.

The Economy

The current state of the North American economy has a direct effect on consumer consumption of meat, fish, and poultry. According to the **NAMI**, the meat and poultry industry feeds our economy. Additionally, the beef sector has done well recently, most likely due to product quality, the economy, promotions at stores and restaurants, consumer interest, and upscaled meat purchases.

Government Regulations

Meat and poultry film producers must follow guidelines set by several organizations including the **Occupational Safety & Health Administration (OSHA)**, the **FDA**, and the **International Standards Organization (ISO 9000)**.

It is essential for food packaging manufacturers to demonstrate to the **FDA** that all materials coming in contact with food are safe before being authorized for use. If a substance is added to a food for a specific purpose, it is referred to as a direct additive. Indirect food additives are those that become a part of the food in trace amounts due to its packaging, storage or other handling requirements. Any substance implemented in the production, processing, treatment, packaging, transportation or storage of food, which affects the characteristics of any food, must be pre-approved by the **FDA**.

Environmental Issues

Many companies are utilizing more LLDPE resin to enable further downgauging. LLDPE resin manufactured with the metallocene, single-site catalyst process (mLLDPE) is utilized by many meat and poultry film producers because it allows film downgauging, which significantly reduces solid waste and disposal problems associated with meat packaging.

Air and water quality concerns have led to the establishment of emission regulations for the printing of plastic film. The regulations require companies to capture or eliminate airborne solvents while using solvent-based inks in their printing processes. Greater use of water-based inks provides a more feasible solution to this issue.

Customers want more sustainable products at lower prices; therefore, some companies are continually trying to make their products recyclable or biodegradable while meeting consumer demands for sustainability. A few companies continue to educate and re-educate their customers on the facts surrounding these issues. Furthermore, even though the **FDA** prohibits the use of post-consumer resin (PCR) in all food packaging markets, many film processors are recycling and utilizing scrap film materials in the production of non-food film products. Most meat and poultry film manufacturers are recyclers of internal PE film scrap.

Sustainability Issues

Sustainability is a term companies are utilizing more frequently. Although not mentioned as often in the meat and poultry film market, some extrusion companies have already been implementing sustainable

practices, such as recycling, for years and even decades. They have been reducing the amount of material used in production and using internally generated waste.

Furthermore, sustainability has resulted in discussions around biodegradability. The term “biodegradable” refers to the degradation process of plastic waste. However, consumers like the idea of biodegradable products until learning about the higher price of the material used to produce biodegradable film. Many companies that produce meat and poultry film may also produce other PE films that utilize biodegradable materials.

Many major film extrusion companies have a hand in sustainability mostly in other PE film markets. [REDACTED] participates in the “Green for 3 Sustainability” (Reuse, Reduce, Recycle) Program. [REDACTED] uses recycled materials where applicable, and they are now a member of the GreenBlue Sustainable Packaging Coalition (SPC). The SPC is an industry working group inspired by cradle to grave sustainability principles and dedicated to creating a robust environmental vision for packaging.

[REDACTED] is in an alliance to end plastic waste. They are leading a program called SMART Solutions to reduce the scrap rate, save energy, improve the quality of plastics (so they stay in the service cycle longer), utilize more recycled materials when possible, and generate or leave no waste to the environment. [REDACTED] is working on a five and ten year plan to make their plant more green. They are experimenting with constructing a bag made from plant-based EVOH copolymer resin.

Over the next five years a few companies have big plans to become more sustainable. For example, [REDACTED] has pledged that by 2025, they will have everything recyclable or recycle-ready. Although in its infancy stage, [REDACTED] plans to push all polyolefins towards being recycle-ready, at the expense of polyethylene terephthalate (PET) film. [REDACTED] is also driving towards getting meat and poultry and cheese packaging recyclable by steering away from nylon and leaning more towards easy-to-recycle barrier films. They are currently working on providing recycle-ready films. [REDACTED] is an active member of the Sustainable Packaging Coalition (SPC) and participates in SPC’s Multi-Material Flexible Recovery Committee. They are working to advance recycling of multi-layer flexible packaging materials by supporting the effort of the collection and recycling of post-consumer waste. [REDACTED] is continuing to evaluate biobased thermoplastics as well.

During 2019, the sustainable conversation seems to have shifted dramatically towards recyclability. That is a positive ambition to strive to be good stewards. However, the intense desire for recyclability is driving the entire industry towards greenwashing. Greenwashing is a marketing tactic in which businesses trick consumers into believing they are more environmentally conscious than they actually are. Virtually every company is claiming recyclability for flexible PE films. The films are recyclable in a theoretical sense, but there is essentially no infrastructure to render these films recyclable in the real world. Many say that time will be the deciding factor for film recyclability.

Imports and Production Shifts from U.S. and Canada

In 2003, China banned U.S. beef imports following concerns about bovine spongiform encephalopathy. The shipment was brought in by **Cofco Meat Holdings Ltd.** from **Tyson Foods, Inc.** According to the **NAMI**, it wasn't until July of 2017 that China processed the first shipment of beef from the U.S. in 14 years. This was possible after the Chinese government agreed to resume accepting U.S. beef imports in May of 2017.

According to the **USDA**, red meat and poultry products from slaughter also contribute to the positive trade balance in agriculture. In 2019, the U.S. exported 2.8 billion lbs. of beef, with Japan being the top destination. The U.S. exported nearly 6.6 billion lbs. of pork in 2019. There was a major decline in pork production in China due to the African Swine Fever. In 2020, this is predicted to cause higher prices for all animal proteins as well as increase imports of beef, pork, and chicken to China in record highs. This is expected to result in U.S. exports increasing nearly 11.0% in 2020 due to a robust demand from China, a healthy demand from Japan and Korea, and increased sales to Mexico. According to the **National Chicken Council**, a little over 7.0 billion lbs. of broilers were exported in 2019.

In terms of packaging, it is difficult for U.S. plants to compete with the cheap labor and land costs that Asian countries have to offer. Many meat and poultry film manufacturers claim that foreign countries continue to take business away from North American manufacturers. However, some film markets are said to continue to grow and remain "China-proof" if they are able to shorten lead times and make high-end quality products. As film complexity increases, it can result in fewer competitors and higher profit margins.

Mergers and Acquisitions

Numerous acquisitions have occurred in the meat and poultry film market over the past few years. **Bemis Co., Inc. (Bemis North America Div.)** was acquired in June of 2019 by **Amcor Ltd.** that is based in Melbourne, Australia. **Bemis Co., Inc.**, based in Neenah, Wisconsin, is now a wholly owned subsidiary of **Amcor Ltd.**, and the combined company will operate as **Amcor Plc (Amcor Flexibles North America Div.)**.

Gelpac Bags, Inc. made several acquisitions during 2019 including **Film-Tech Extrusions (Film-Tech Plastics Div.)** and **WBC Extrusion Products, Inc.**, who both use the **Gelpac Bags, Inc.** name.

Charter NEX Films, Inc. has merged with **Next Generation Films, Inc.** In 2019, both companies expressed their desire to maintain their existing management teams and brand identities. They will continue to operate as two distinct, but synchronized, divisions of the combined company.

In May of 2019, **Kohlberg & Company, L.L.C.** announced that they have sealed the deal on the **Pexco Packaging** acquisition and successfully merged the business with **PPC Industries, Inc.** (a **Kohlberg** portfolio business which also includes **Kelpac Medical Div.**). The new entity will be named **Spectrum Plastics Group**, and for the meat and poultry chapter they will be referred to as **Spectrum Plastics Group (PPC Industries, Inc./Kelpac Medical Div.)**

In 2019, **Sealed Air Corp.** acquired **Automated Packaging Systems, Inc.**, further increasing their presence in the PE film industry. **Shields Bag & Printing Co.** of Yakima, Washington was acquired by **NOVOLEX** in December of 2017 and have exited the meat and poultry market. Lastly, **TC Transcontinental Packaging** acquired **Mutilfilm Packaging Corp.** in March of 2018, and later **TC Transcontinental Packaging** announced that they acquired the business of **Coveris Americas** (formerly **Coveris High Performance Packaging**) a business held by **Coveris Holdings S.A.**

New Designs and Technological Trends

A majority of meat and poultry film extrusion companies are continuing to promote growth through improved technology, high quality materials, good customer service, and attaining the image of being sustainable. Innovation with stronger materials and lighter gauges are still as important today as they were three years ago.

Meat and poultry film still incorporates the following market drivers: promoting product freshness, increasing shelf life extension, preventing food spoilage, and optimizing packaging (both gauge and performance). Currently, there are some active packaging opportunities that a few companies are looking into, such as driving towards making meat, poultry and cheese packaging more recyclable. One participant is moving away from nylon and leaning more towards using barrier films more often, which are easier to recycle.

FILM EXTRUSION TECHNOLOGY

During 2019, PE film for meat and poultry packaging was produced by the blown film and cast film extrusion processes and consisted of monolayer and multi-layered coextruded structures.

Coextruded film remains the dominant structure used to manufacture meat and poultry film. Most companies typically coextrude three or five layers; however, some companies have the capabilities to coextrude two to fourteen layers of PE film. Coextruded film structures offer additional barrier properties that monolayer films can't provide. Highly layered films are tailored to create specific levels of barrier properties for meat and poultry packaging. This helps keep oxygen or ultraviolet (UV) light out and flavors in. A common seven-layer coextruded film structure produced for meat and poultry consists of outer PE layers followed by tie-layers, adhering the nylon layers and incorporating a middle layer of EVOH copolymer resin. The following tables show a three-layer and a seven-layer meat and poultry film structure:

Three-Layer Structure
PE Blend
PVDC or PVC
PE Blend

Seven-Layer Structure
PE
Tie-layer
Nylon
EVOH Copolymer
Nylon
Tie-layer
PE

_____ have gone beyond nine layers by creating an eleven to fourteen layer structure, but only by self-laminating or “collapsed surface welding” a tube of six or seven layers into a single flat web.

Please see Exhibit 3-6 displaying estimated resin consumption and market share for the types of film extrusion processes and constructions utilized in the meat and poultry film market for 2019 and comparison film extrusion process market shares from 2017.

Exhibit 3-6

BREAKDOWN OF RESIN CONSUMPTION FOR PE MEAT AND POULTRY FILM BY PROCESS TYPE AND FILM CONSTRUCTIONS

	2019		2017
	Consumption (MM lbs.)	Market Share (%)	Market Share (%)
Film Extrusion Process			
Blown Film Extrusion		86.4	86.9
Cast Film Extrusion		13.6	13.1
Totals		100.0	100.0
Coextruded Film Constructions		90.7	89.2
Monolayer Film Constructions		9.3	10.8
Totals		100.0	100.0

Source: Mastio & Company Polyethylene Film Market Study

Equipment Utilization and New Equipment Purchases

Please see the electronic edition (file name: New Equipment, Capacity Utilization, Favorite Resin Supplier, & Additional Capacity Coming Online). An example of the table included in the electronic edition is provided below.

Processor Name/HQ Location	Description of Process Type	Plans to Purchase New Film Extrusion Equipment	Brand and Equipment Type of Planned Purchases

RESIN TECHNOLOGY

LLDPE resin continues to be the most prevalent in this market because it offers better downgauging capabilities than does LDPE resin. Film producers in the meat and poultry film market utilized all grades of LLDPE resins including LLDPE-butene, LLDPE-hexene, LLDPE-super hexene, LLDPE-octene, and mLLDPE.

The consumption of mLLDPE resin has increased because it is more tear resistant, has good puncture resistance, good impact properties, and sealability. mLLDPE resin is the highest grade of LLDPE resin, due to its superior strength allowing further film downgauging, thus reducing costs and source reduction to landfills.

Specific types of PE resins and film configurations are used in meat and poultry film for specific packaging requirements. Meat barrier bags for beef are typically comprised of a three-layer coextruded structure of LDPE-EVA copolymer/PVDC/LDPE-EVA copolymer resins.

Offal products, such as liver or sweetbreads, are typically packaged in a LDPE non-shrink PE bag. The primary purpose of the bag is to protect the organs from freezer burn. The majority of pork is also packaged in PE non-barrier bags made of LDPE and LLDPE film. Processed pork is often packaged in barrier bags with a high LDPE-EVA copolymer resin content.

Poultry bags for turkey are typically constructed with a three-layer coextruded structure of LDPE-EVA copolymer/LLDPE/LDPE-EVA copolymer resins. The LDPE-EVA copolymer layers give the bag clarity, sparkle, an improved printing surface, and the inner layer of LLDPE provides additional strength.

In the past, a few processors utilized LDPE-ethylene acrylic acid copolymer (LDPE-EAA copolymer) resin, also referred to as ionomer resin (Surlyn™ supplied by **DuPont**). LDPE-EAA copolymer resin has high seal strength, low temperature heat seals, transparency, high shrink force at low temperatures, reduced leakage rate, and outstanding puncture, abrasion, and tear resistance. LDPE-EAA copolymer resin was typically coextruded with LDPE-EVA copolymer, LLDPE, nylon, and PVDC resins. Currently, some companies have replaced LDPE-EAA copolymer resin with mLLDPE resin because it is less expensive. mLLDPE resins offer clarity, downgauging, seal strength and toughness while maintaining nearly the same processability of LDPE, and the grease resistance equivalent to ultra low density PE (ULDPE).

High molecular weight-high density PE (HMW-HDPE) and medium molecular weight-HDPE (MMW-HDPE) resins are occasionally utilized for meat and poultry applications due to their strength and excellent barrier properties.

Nylon and EVOH copolymer resins are used along with PE resin for meat and poultry packaging. Nylon resin is used as a barrier resin for hermetic seal (no leaks), temperature resistance, and oxygen migration. EVOH copolymer resin is used as the inner layer of coextruded meat and poultry bags, providing superior oxygen and gas barrier properties while keeping out odors.

Other resins reported included PE-based adhesive resin (tie-resin), PVDC resin, ULDPE, and very LDPE (VLDPE) resin. PVDC film properties include ease of use, clarity, and low cost. A few participants sometimes utilize **ExxonMobil's** Vistamaxx's™ propylene-based elastomer instead of ULDPE resin. Vistamaxx™ performance polymers are semi-crystalline copolymers with adjustable amorphous content that is compatible with other polyolefins. This versatility allows companies to tailor end-product attributes, such as: toughness, cling, sealability, softness, clarity, dispersion, adhesion, elasticity, and flexibility.

The melt flow index (MFI) is a measure of the ease of flow of the melt of a thermoplastic polymer. Synonyms of melt flow index are melt flow rate and melt index. More commonly used are their abbreviations: MFI, MFR and MI.

MFR is a measure of the ability of the material's melt to flow under pressure. It should be kept in mind that the viscosity for material depends on the applied force. Ratios between two MFR values for one material at different gravimetric weights are often used as a measure for the broadness of the molecular weight distribution.

MFR is commonly used for polyolefins with PE being measured at 190 °C. The plastics engineer should choose a material with a melt index high enough so that the molten polymer can be easily formed into the article intended, but low enough so that the mechanical strength of the final article will be sufficient for its specific use.

Please see Exhibit 3-7 listing the typical melt flow indexes used by several meat and poultry film manufacturers by resin type.

Exhibit 3-7

TYPICAL MELT FLOW INDEXES FOR MEAT AND POULTRY FILM BY RESIN TYPE

Resin Type	Melt Flow Index
LLDPE	0.8-1.8
LLDPE-butene	0.9, 2.0
LLDPE-hexene	0.8, 0.92, 0.9-1.0
LLDPE-octene	0.8, 1.0, 4.0
mLLDPE	0.8, 1.0, 4.0
LDPE-homopolymer	0.2, 0.4, 0.8, 1.0, 1.5, 2.0, 5.0
PE-Adhesive (Tie Resin) made from LLDPE-butene	2.0-4.0

Source: Mastio & Company Polyethylene Film Market Study

Favorite Resin Supplier

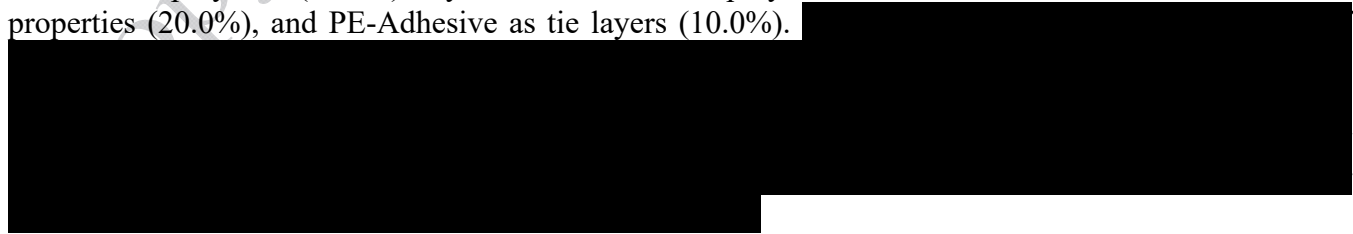
Please see the electronic edition (file name: New Equipment, Capacity Utilization, Favorite Resin Supplier, & Additional Capacity Coming Online), which contains the respondents' favorite resin supplier and their reasons why. An example of the table included in the electronic edition is provided below.

Processor Name/HQ Location	Favorite Resin Supplier	Resin Types	Explanation For Being Favorite Resin Supplier

VALUE-IN-USE

Meat and poultry packaging is a specialty application and requires lengthy approval times for product development. The average selling price of meat and poultry packaging will increase as other resins and layers, such as LDPE-EVA copolymers, EVOH copolymers, and nylon resins are incorporated into the films.

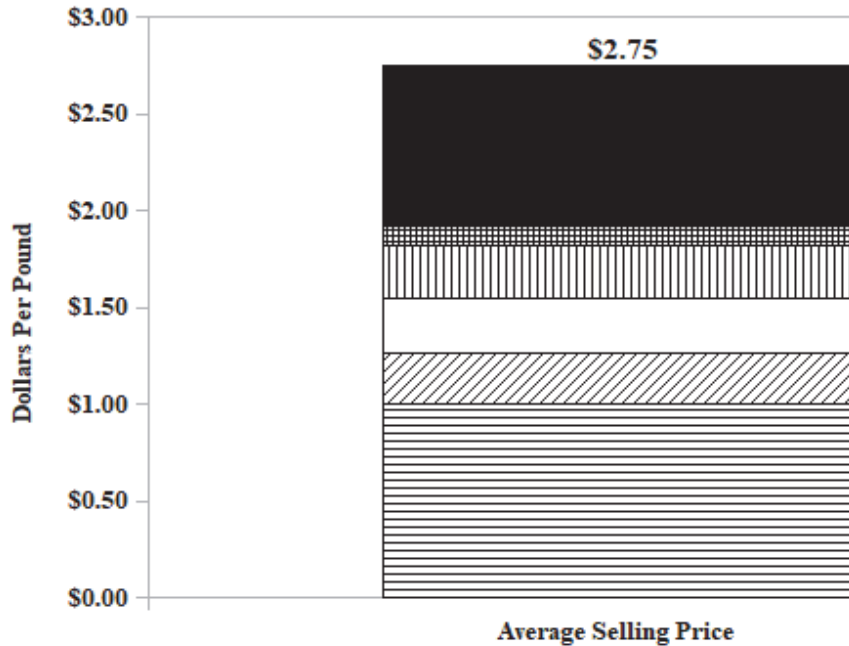
For the first value-in-use analysis, **Mastio & Company** will present a cast coextruded (seven, nine or eleven layers) egg protein package utilizing a combination of LLDPE-octene and mLLDPE (50.0%), LDPE-homopolymer (20.0%), nylon and EVOH copolymer materials used for core and barrier properties (20.0%), and PE-Adhesive as tie layers (10.0%).



Please see Exhibit 3-8 illustrating the value-in-use analyses for a coextruded egg protein packag.

Exhibit 3-8

VALUE-IN-USE ANALYSIS FOR A COEXTRUDED EGG PROTEIN PACKAGE



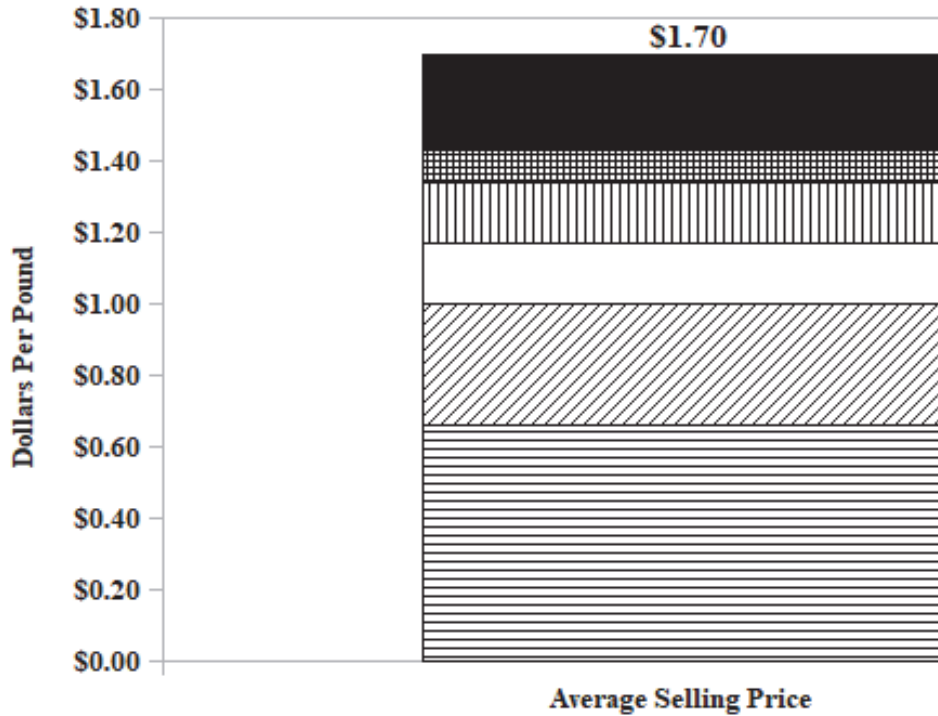
Source: Mastio & Company Polyethylene Film Market Study

For the second value-in-use analysis, Mastio & Company will present a blown monolayer chicken or beef bag utilizing a LLDPE-hexene (60.0%) and LDPE-homopolymer (40.0%) resin blend.

Please see Exhibit 3-9 illustrating the value-in-use analyses for a monolayer chicken or beef bag.

Exhibit 3-9

VALUE-IN-USE ANALYSIS FOR A MONOLAYER CHICKEN OR BEEF BAG



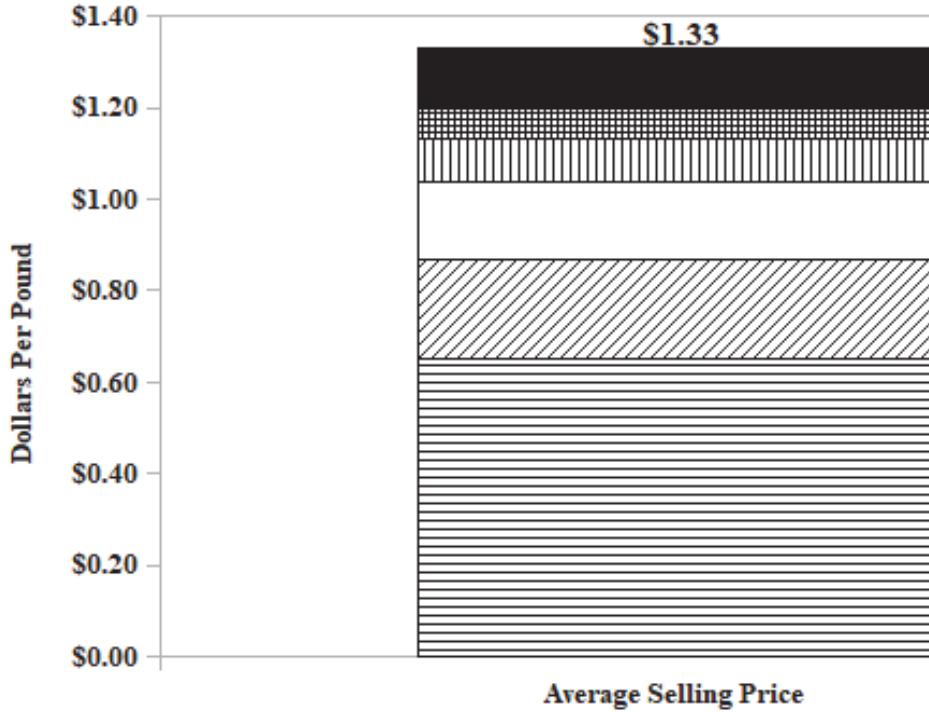
Source: Mastio & Company Polyethylene Film Market Study

For the third value-in-use analysis, Mastio & Company will present a blown monolayer meat

Please see Exhibit 3-10 illustrating the value-in-use analyses for a monolayer roll of meat and poultry film.

Exhibit 3-10

VALUE-IN-USE ANALYSIS FOR A MONOLAYER ROLL OF MEAT AND POULTRY FILM



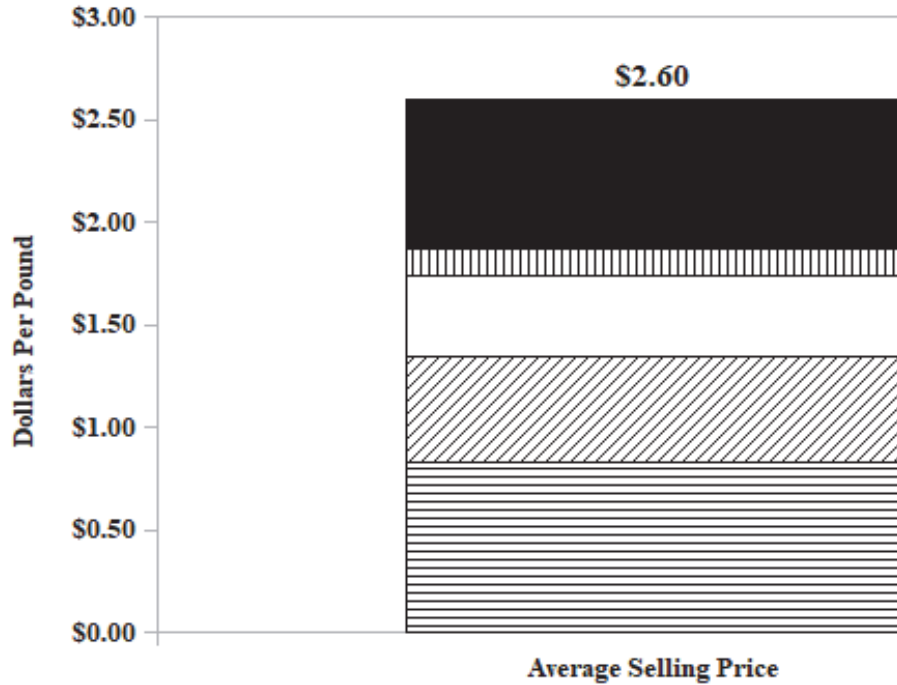
Source: Mastio & Company Polyethylene Film Market Study

Lastly, Mastio & Company will present a blown coextruded (three to nine layers), processed meat barrier package utilizing a combination of LLDPE-octene and mLLDPE (35.0%), LDPE-homopolymer and LDPE-EVA copolymer (55.0%), and nylon and EVOH materials used for barrier properties (10.0%).

Please see Exhibit 3-11 illustrating the value-in-use analyses for a coextruded processed meat barrier package.

Exhibit 3-11

VALUE-IN-USE ANALYSIS FOR A COEXTRUDED
PROCESSED MEAT BARRIER PACKAGE



Source: Mastio & Company Polyethylene Film Market Study

FORECAST OF RESIN USE AND CONSUMPTION

Total PE resin consumption in 2019 for meat and poultry film was [REDACTED], and is projected to increase to [REDACTED] lbs. by the year 2022, with an AAGR of [REDACTED] %.

Please see Exhibit 3-12 displaying the forecast of resin use and consumption for meat and poultry film, by resin type, for 2019 and 2022.

Exhibit 3-12

FORECAST OF RESIN USE AND CONSUMPTION, MARKET SHARE, AND AAGR
FOR MEAT AND POULTRY FILM BY RESIN TYPE
2019 AND 2022

	2019		2022		2019-2022 AAGR (%)
	Consumption (MM lbs.)	Market Share (%)	Consumption (MM lbs.)	Market Share (%)	
Resin					
mLLDPE					
LLDPE-octene					
LLDPE-butene					
LLDPE-hexene					
LLDPE-super hexene					
Total LLDPE					
LDPE-homopolymer					
LDPE-EVA copolymer					
Total LDPE					
MMW-HDPE					
HMW-HDPE					
Total HDPE					
EVOH Copolymer					
Nylon					
PVDC					
VLDPE					
PE-Adhesive					
ULDPE					
GRAND TOTAL					

* Market share not shown due to rounding.

Source: Mastio & Company Polyethylene Film Market Study