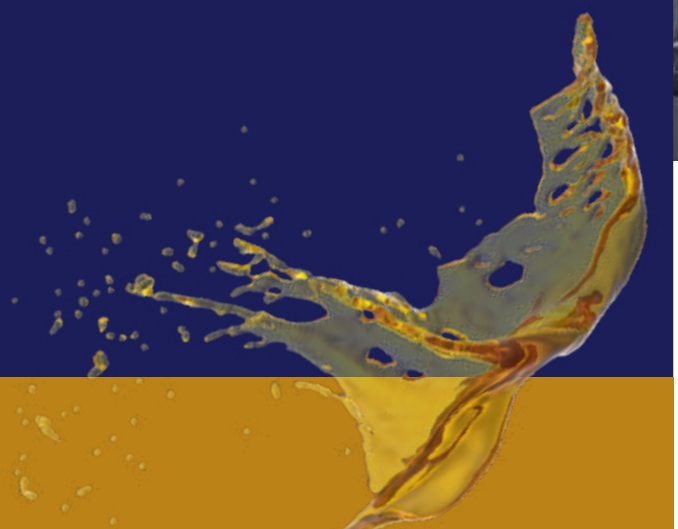
Chap 1.
About Rendering

Introducing
Chapter 1

Whether it's for breakfast, lunch, dinner, or a simple afternoon snack, today we have access to all the food necessary for our sustenance. Over the past 40 years, we have faced a significant population growth rate, nearly doubling to reach over eight billion people worldwide. In North America alone, the average individual consumes approximately 78.5 kilograms of meat per year (a projected figure between 2023 and 2030). This means we produce about 63.4 million metric tons of poultry, red meat, and fish to meet both domestic demand and export needs across the three countries.

In many regions of the world, people incorporate most parts of the animal into their diets. However, in countries like the United States, Canada, Brazil, and members of the European Union, cultural preferences limit consumption to approximately 50-60% of a bovine, about 70% of a chicken, and less than 75% of a pig. This practice results in the generation of approximately 60 to 70 million metric tons of animal by-products that require processing each year. But who takes on this task? And how do they do it?

Known under the title of the "Animal Recycling Industry" or more commonly referred to in English as "Rendering1," this type of business collects animal by-products from slaughterhouses and butcher shops to responsibly process them and transform them into a wide range of products, such as industrial lubricants, biofuels, and protein-rich ingredients used in animal nutrition and pet food (Meeker & Hamilton, 2006).



[1] The word "Rendering" in English refers to the recycling of raw tissues from animals not intended for human consumption, as well as fats and used cooking oils from all types of restaurants, to produce a variety of value-added products.

1 RENDERING EVOLUTION

Although it may seem like a new way of doing things, this practice dates back more than 2,000 years, when our ancestors processed these by-products to produce candle wax. It was finally in the 19th century that science discovered animal by-products could be useful in the production of lubricants, dyes, soaps, leather, esters, etc., officially giving rise to the animal recycling industry (Bisplinghoff, 2006).

Despite technological advancements, animal recycling processes have essentially remained under the same operational principle over the years: using heat to eliminate bacteria in perishable animal by-products. However, rigorous quality control procedures and innovative manufacturing methods have been implemented over time to meet the requirements of international legislation and the local standards of each country.

These innovations have primarily led to the production of two highly sophisticated raw materials with significant added value, which are now essential to multiple industries:

ANIMAL FATS, mainly used in the production of biofuels, soap, cosmetics and animal feed.

ANIMAL MEALS, rich in protein, intended for feeding livestock and pets, as well as for producing fertilizers.

DID YOU KNOW?

- Did the crises related to BSE (bovine spongiform encephalopathy) in the 1990s lead to significant reforms regarding the use of animal meals in animal feed?
- Did the European Union and other regions adopt regulations aimed at reducing the environmental impact of the industry while promoting energy recovery?

Regarding regulatory evolution, in recent decades, governments and international organizations have implemented strict regulations to ensure the safety, traceability, and sustainability of products derived from animal recycling.

Under these conditions, companies within this industry have effectively met sanitary criteria and corporate social and environmental responsibility (CSR) standards in the context of sustainability, while also complying with the demands of the "Triple Bottom Line" model. But specifically, how have they achieved this recognition?

Although alternative methods to rendering can be used for the disposal of animal by-products, such as incineration or burial in sanitary landfills, these alternatives, besides being very expensive and harmful to the environment, do not allow for value addition to these by-products. Consequently, they do not generate any benefit for the planet or society at large.

In summary, the evolution of the animal recycling industry demonstrates its ability to adapt to economic, technological, and environmental challenges. By transforming by-products into valuable resources, it not only contributes to environmental and social sustainability but also strengthens global supply chains.

2 PURPOSE AND PROCESS

You may have heard that the odors emitted during the transformation and recovery of by-products in the rendering industry are among the most intense and least tolerated, or that the decomposition and fermentation of animal waste collected and processed in a rendering plant negatively affect nearby communities. Over the years, this industry has been heavily criticized, especially by those not involved in the agri-food sector, without understanding the role or critical importance of this industry's work.

However, at this point, we will not contradict these arguments. Instead, we will highlight all the elements related to the true way this industry operates and why it has become one of the most relevant in the history of our society, even without being fully recognized or understood by many.

As mentioned earlier, the animal recycling industry plays an essential role in global environmental and economic sustainability. From its modest beginnings, this industry has evolved into a key player in food, agricultural, energy, and industrial supply chains. It is an industrial process designed to valorize animal by-products, transforming them into useful raw materials while becoming an essential activity for environmental sustainability, food security, and the reduction of organic waste.

But wait a moment... Since it is also a recycled product, could there be infectious material in the finished products?

From a superficial perspective, it is entirely possible that bacteria or other contaminants could be present during the transformation process of raw materials. However, it has been proven that the "magic formula" based on temperature, pressure, and time during the cooking process (analyzed in detail later), along with proper handling of raw materials from slaughterhouses and other sources, plays a fundamental role in the successful management of by-products.

Thus, we can affirm that, although contamination risks are present, there are already sufficiently sophisticated technical and technological methods and mechanisms to ensure that the quality of recycled products from the rendering industry fully complies with international sanitary standards and the legislation of the countries where they are marketed. To better understand all this, let us explore rendering from its primary purpose:

1. REDUCTION OF ORGANIC WASTE

Each year, over 60 million metric tons of animal by-products are generated by slaughterhouses, butcher shops, and supermarkets. Animal recycling prevents these materials from ending up in landfills or being incinerated, helping to limit negative environmental impacts.

2. PRODUCTION OF ESSENTIAL RAW MATERIALS

- **Animal fats:** Used in the production of biofuels, soaps, candles, lubricants, and as an ingredient in various industrial applications.
- **Animal meals:** Rich in protein, used in animal feed (for livestock and pets) as well as in agricultural applications through fertilizers.
- **Other derivatives:** Collagen, gelatin, and ingredients used in cosmetics, pharmaceuticals, and even bioplastics.

3. CONTRIBUTION TO SUSTAINABILITY AND THE CIRCULAR BIO-ECONOMY

- Reuses biological resources that would otherwise go to waste.
- Reduces greenhouse gas emissions associated with the decomposition of organic waste.
- Minimizes dependency on natural resources such as soy, palm oil, and fossil fuels.

4. HEALTH AND ENVIRONMENTAL SAFETY

This process helps prevent the spread of diseases by effectively disposing of materials considered to be at risk. The industry's strict sanitary standards also ensure that the final products are safe and suitable for their specific uses.

Now it is time to understand how animal recycling follows a well-defined industrial process, which includes several stages to transform animal by-products into high-quality final products that comply with the sanitary requirements of international legislation.

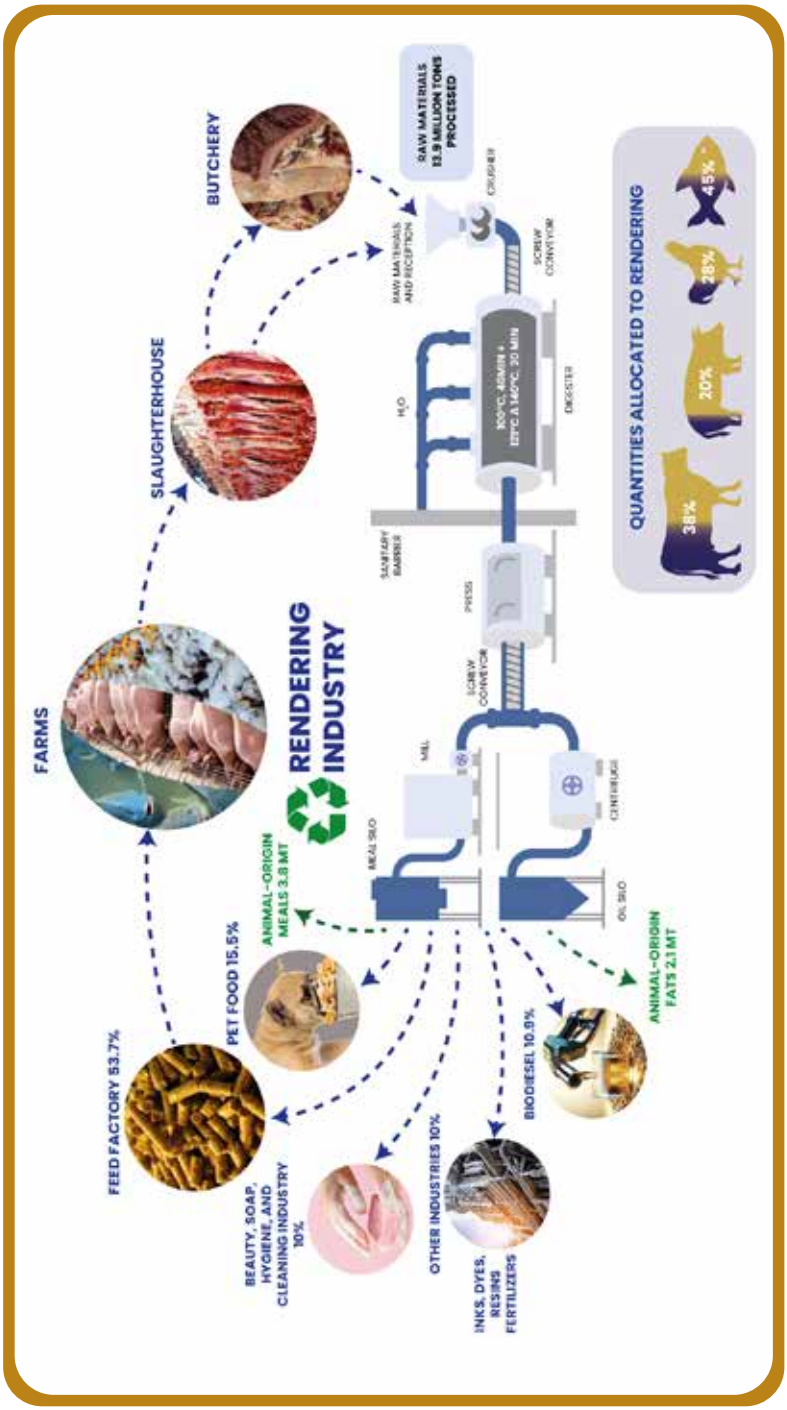


Figure 1: Map of the Circular Bio-Economy in Animal Recycling.
Source: Inspired by ABRA

RENDERING PROCESS FLOW

1 RAW MATERIAL COLLECTION

The raw materials used by the rendering industry come from various sources:

- By-products from slaughterhouses (bones, fats, meat scraps).
- Expired products from supermarkets (meat and other animal-based foods).
- Butcher shop leftovers.

These materials are transported to specialized facilities under controlled conditions to avoid any contamination and reduce their degradation by using antioxidants. In some cases, refrigerated trucks are used when distances are very large.

2 PREPARATION AND CLASSIFICATION

At the source, the raw materials are classified by animal species or by-product type (ruminant raw material—mainly from cattle—and non-ruminant raw material—poultry, pork, and fish). Generally, the collection trucks are specialized for each type of raw material and/or have special compartments for each, such as viscera, feathers, and blood tanks. Once they arrive at the plant, the raw materials undergo a visual inspection to ensure correct separation of usable elements from contaminants or non-transformable waste, such as plastics and metals

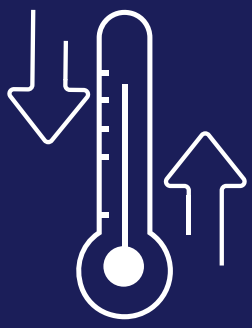
3 COOKING AND STERILIZATION

After being ground into small fragments—ideally no larger than one inch by one inch (2.54 cm x 2.54 cm)—to optimize processing, the raw materials pass through metal detectors before being subjected to high temperatures and controlled steam pressure for a specific time in industrial digesters or evaporators. At this stage, the internationally recognized standard formula for cooking raw materials in the rendering process is applied, requiring strict control of temperature, pressure, and time. Although exact values may be adjusted according to the raw material type and relevant regulations, the most commonly used parameters are:

TEMPERATURE:
- Generally, between 115°C and 145°C (239°F and 293°F).
- At this temperature, pathogen sterilization and protein denaturation are achieved.

TIME:
- 40 to 90 minutes, depending on the composition and volume of the raw materials.
- The duration must be sufficient to achieve uniform cooking and sterilization of the materials.

PRESSURE:
- Ranges between 3 and 5 bar (43 to 72 psi).
- This level of pressure effectively eliminates pathogens and facilitates the separation of components such as fats and solids.



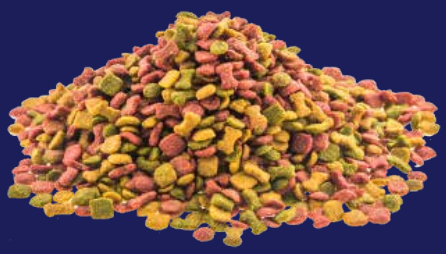
MAIN OBJECTIVES OF THE PROCESS:
- Eliminate pathogens: Ensure the processed materials are safe for subsequent use.
- Separate components: Water is evaporated, fats are melted, and solids (proteins and minerals) are isolated.
- Optimize the quality of the final product: Make sure that the by-products (meals, fats and other derivates of animal origin) comply with international standards.

This process is crucial for meeting food safety and environmental regulations, such as those established by the European Union, the FDA in the United States, and the WOAH.

4 COMPONENT SEPARATION

Once cooking is finished and the material exits the digester, it is transported to a screening machine, which functions as a screw feeder with a screen at the bottom and a collection tank underneath. The remaining fraction then goes into presses, where the fat is separated from the solids (known as “crax,” “press cake,” “cracklings,” or “greaves”). At this point, the flow splits into two distinct streams: **fat and crax.**

• **The melted fat** generated in the presses and/or the screening machine is pumped into a rotary screen that retains meal particles. It is then transferred to a centrifuge to remove any impurities through the centrifugation process.
Subsequently, the fat passes through a filter and is stored in a finished product tank, making it available for dispatch in tanker trucks to local customers or in ISO tanks or flexitanks for export (these logistical methods will be discussed further on).



• **The crax** from the presses is introduced into a curing container or taken to cooling machines to bring it to ambient temperature and facilitate the grinding process.

It is then moved via a conveyor belt to the metal detector and subsequently passes through a vibrating screen. After this stage, the product goes to the milling system, where it is reduced to the particle size specified in the product data sheet—generally around 0.035 inch (89 mm) or as requested by the customer—and passes again through the metal detector before going to a classifier for low-ash meals only, prior to storage.
The product can be dispatched in bulk trucks, big bags of 1–1.5 metric tons, or even in 40 kg bags in certain countries.

5 REFINING FATS

Depending on the type of industry the fat is intended for, product refinement processes may be required. This is the case for animal fats for human consumption in Argentina, primarily used in the production of croissants and alfajores in the bakery sector. Some of the processes applied at this stage include:

DEODORIZATION (FOR SPECIFIC APPLICATIONS):
• Certain industries, especially pharmaceutical, cosmetic, or food-related, require the removal of residual odors and flavors. This is achieved through a deodorization process, which involves injecting high-temperature steam under vacuum to volatilize and remove the compounds causing odors.

PARAMETER STANDARDIZATION:
• Depending on the target market and the final use of the product, fat may require adjustments to its fatty acid profile when destined for biofuels, animal nutrition, or personal care soaps. A similar situation occurs with the well-known M.I.U. (Moisture, Impurities, and Unsaponifiables), which measures the content of moisture, physical impurities, and unsaponifiable compounds that affect the quality and value of the product, primarily required for biofuel production.

BLEACHING OR CLARIFICATION (IF NECESSARY):
• When the fat is intended for highly demanding cosmetic, pharmaceutical, or food applications, a bleaching process with filtering agents (e.g., diatomaceous earth or activated clays) may be applied to clarify and reduce color.

6 CLASSIFICATION FOR LOW-ASH MEALS

As previously mentioned, the classification process for low-ash meals in rendering focuses on minimizing the amount of inorganic material, such as bones and bone residues, in the raw material before and during production stages. This process is crucial to ensure that the ash content in the final meals is low and meets the quality standards demanded by premium markets. This requires mechanical bone separation, advanced extraction in wet processes, and/or raw material selection at the source:

TYPES OF MECHANICAL BONE SEPARATION
Vibratory classifiers:
• Crushed by-products are placed in vibratory screens that separate larger particles, such as bone fragments, from soft tissues.
• This equipment works through controlled movements that allow only smaller materials meeting specifications to pass through.

AIR OR GRAVITY SEPARATORS:
• The crushed material passes through systems that use airflows or weight differences to separate denser bones from softer tissues

CENTRIFUGAL DECANTERS
•At this stage, centrifugal separators spinning at high speed are used to differentiate heavier bone fragments from lighter fat and protein tissues.

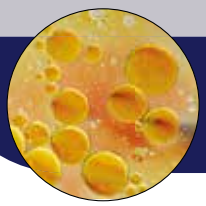
ADVANCED EXTRACTION IN WET PROCESSES
Differentiated cooking:
• During cooking, some systems allow the automatic separation of calcified bones that sink to the bottom of the tank, leaving fats and proteins at the surface for further processing.

Partial decalcification:
• Some plants use enzymatic or chemical hydrolysis systems to reduce the amount of minerals adhered to bone fragments.

Thus, the classification process for low-ash meals combines advanced technologies in mechanical separation, filtration, and quality control to ensure a high-quality product. This specialized approach reduces ash content, optimizing nutritional value to meet the quality standards required for what is now referred to as **“Pet Food Grade.”**

One of the most popular foods in North America is fried products. In this scenario, their preparation generates large volumes of used cooking oil. So, what happens to this oil once it loses its quality and needs to be replaced?

Here arises a win-win solution: restaurants can safely dispose of this potentially polluting waste, while rendering industry companies collect it for recycling. This oil is transformed into a wide variety of products, including additives, soaps, biofuels, and even ingredients for animal nutrition in countries where legislation allows its use after specific recovery processes.



What other aspects does this industry have?

So far, it is evident that the rendering industry brings numerous benefits that meet the three pillars of sustainable development.

• **Economically**, this industry generates an estimated income of $5.5 billion annually in the United States and Canada alone.
• **Socially,** it has a positive economic impact on local communities, as rendering plants contribute to the tax base and support local services and infrastructure, as well as offering employment opportunities to people in nearby communities (Woodgate, 2006).
• **Environmentally**, it has been highlighted that this industry reduces sewer and pipeline blockages by 47%, thus preventing the spread of bacteria in communities (North American Renderers Association, 2024).

As mentioned earlier, one of the most significant benefits of this industry lies in the production of biofuels, such as biomass for energy generation in boilers, and the conversion of animal fats and used cooking oils into biodiesel, renewable biodiesel, or, more recently, SAF (Sustainable Aviation Fuel). Since biodiesel has become a very promising fuel alternative for compression ignition engines due to its renewable origin and lower toxicity compared to conventional diesel, the rendering industry has become an essential element within business ecosystems and the value chain of the fuel industry (Toscano, Montero, Stoytcheva, Campbell, & Lambert, 2011).

A study conducted in Baja California, Mexico, highlighted that a combination of biodiesel derived from animal by-products and petroleum-based biodiesel could cover 25% of the total fuel consumption for private vehicles and trucks registered in that state.

3 SUPPLY CHAIN

You might not know it, but the supply chain of the agricultural and livestock industry is much larger than you could imagine. Everything that must happen for food to reach our table goes far beyond simply planting grains or vegetables and extends well beyond animal production.

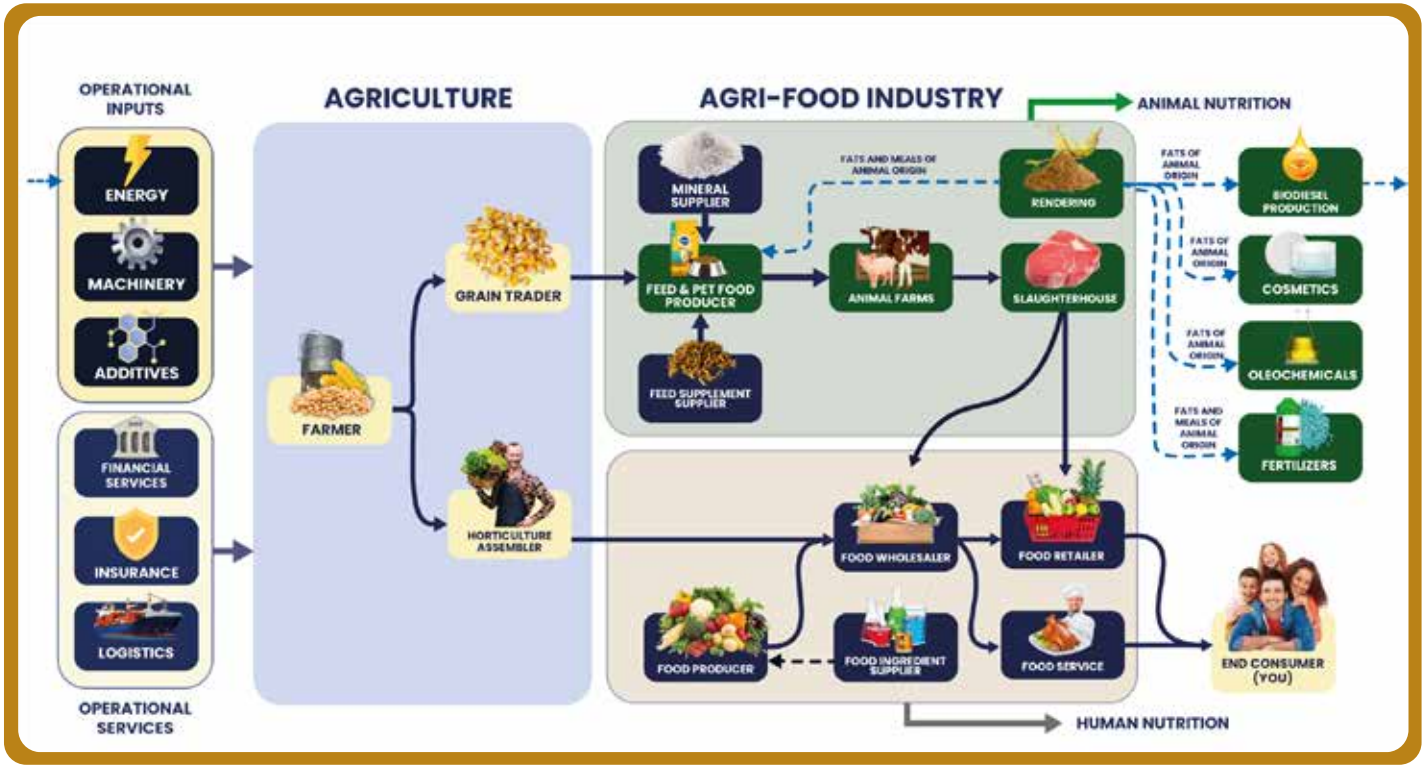


Figure 2: Agri-Food Supply Chain
Source: USDA Agri-Food Supply Chain Assessment: Program and Policy Options for Strengthening Resilience

LET'S START WITH ENERGY!

To better understand, let's first define what we mean by operational inputs. Have you considered that energy is indispensable for carrying out any production process? Whether in the form of electricity or through steam generation, we now have a wide variety of fuels that make industrial operations possible.

From fossil fuels like oil and natural gas, to biodegradable options like wood, and even renewables such as biofuels, a significant portion of these today are produced from animal by-products. Without a doubt, the energy component is one of the most crucial links in the value and supply chain.

Today, the rendering industry has successfully positioned itself as one of the leading sustainable suppliers to those operating within this sector.

The Role of Machinery and Technology

Both in production and administrative management, the use of machinery plays a fundamental role. Through technology, the creation of high-quality products that meet international standards is facilitated. These tools not only ensure quality standardization but also promote sustainable practices that respect the environment.

From processing and packaging equipment to logistics fleets and advanced software systems, the variety of tools employed is vast.

Basic technologies like email, along with more advanced tools such as business intelligence platforms and artificial intelligence, continuously expand possibilities and improve operational efficiency throughout the supply chain.

ADDITIVES AND CHEMICALS: ENSURING QUALITY AND PRESERVATION

Beyond energy and machinery, we must highlight an essential group that enables products to be mass-produced and delivered in optimal condition to consumers: additives and chemical products. This sector plays a vital role in preserving packaged goods, grains, raw materials, and finished products—including those derived from rendering. Antisalmonella agents, antifungals, antioxidants, and a wide range of chemical compounds help combat degradation caused by time and environmental factors. Their use not only ensures the quality and safety of products but also represents a significant share of the total value generated by the agri-food and rendering industries.

OPERATIONAL SERVICES: EFFICIENCY AND SUSTAINABILITY

When we talk about agricultural and livestock production, there are less visible players who make the flow of the "farm to fork" model possible.

These actors not only support primary production but also carry out essential processes such as animal rendering. By transforming by-products into valuable resources, rendering integrates the concept of sustainability into the agri-food supply chain.

LOGISTICS: PACKAGING AND DISTRIBUTION

The logistics for dispatching rendering products, such as animal-origin meals and fats, is designed to meet the needs of diverse markets while ensuring transportation efficiency, product quality, and regulatory compliance. Below are the main shipping modalities for both products:

TYPES OF LAND AND MARITIME CARGO

IMO Cargo (International Maritime Organization):

- Involves hazardous materials or those posing specific risks, such as flammable products or substances that generate dangerous gases.
- Classified into 9 risk classes, including flammable substances (Class 3), toxic substances (Class 6), and corrosive materials (Class 8).
- Requires specific packaging and warning labels.

REGULAR CARGO

- Non-hazardous products such as meat and bone meal, blood meal, and refined oils that do not present chemical risks.

BULK CARGO

- Includes raw materials such as animal meals or fats that do not require individual packaging and are transported in large volumes.

TEMPERATE-CONTROLLED CARGO

It is used to transport products that need to maintain a controlled temperature, such as rendering derivatives intended for the pharmaceutical industry or human nutrition, which require a cold chain. This category also includes tallows, which require constant heating to prevent variations in acidity and ensure a minimum temperature of 63°C at the time of unloading, facilitating pumping during the process.

CONTAINERIZED CARGO (FCL AND LCL)

- FCL (Full Container Load): A container fully loaded with products from a single exporter, such as a complete batch of bone meal.
- LCL (Less than Container Load): Shared between multiple exporters, ideal for small volumes of animal recycling products.

LOGISTICS FOR ANIMAL MEALS

Animal meals are dispatched in different formats depending on customer needs and the infrastructure available in each country. These modalities include:

BULK RAILCARS:

- **Average capacity:** 85-110 metric tons per railcar.

- **Ideal use:** Transportation of large volumes over long distances, especially for markets with access to railway infrastructure. Commonly used in the United States, Canada, and the European Union.

BULK TRUCKS:

- **Average capacity:** 25-40 metric tons per truck, depending on the transportation regulations of each country.

- **Ideal use:** National or regional transport to feed mills, farms, and other industrial customers.

BULK CONTAINERS:

- **Average capacity:** 25 metric tons per container. Applies to both standard 20-foot and 40-foot containers.

- **Ideal use:** Low-cost exports for plants with bulk reception systems. Widely used in countries with high labor costs, such as Canada and the United States.

BIG BAGS:
• **Average capacity:** 1,000 kg to 1,500 kg per big bag.

• **Transport capacity:** Up to 25 metric tons per container for export or 25-40 metric tons by truck, depending on the size of the big bag, arrangement, and local transport regulations.

• **Ideal use:** Customers requiring moderate volumes with easy handling. Widely used in countries like Argentina, Brazil, and Chile. Ideal for transporting blood meal even in countries with railway infrastructure.

SMALL BAGS (25-40 KG):
• **Transport capacity:** Up to 25 metric tons per container for export or 25-40 metric tons by truck, depending on local transport regulations.

• **Ideal use:** Local markets or small distributors handling bags manually. Widely used in countries like Colombia and Peru.

LOGISTICS FOR ANIMAL FATS

TANKER TRUCKS:
• **Average capacity:** 25-40 metric tons of liquid fat per truck, depending on the regulations of each country.

• **Ideal use:** National or regional transport, with thermal insulation or heating optional systems to maintain the liquid state.

TANK RAILCARS:
• **Average capacity:** 80-120 metric tons per railcar.
• **Ideal use:** Transport of large volumes over long distances by rail.

FLEXITANKS:
- **Average capacity per flexitank:** 22-24 metric tons.

- **Ideal use:** Maritime exports using standard 20-foot containers.

ISOTANKS:
- **Average capacity:** 20-25 metric tons per isotank.

- **Ideal use:** International transport, especially on maritime and land routes, with quality and temperature control.

FACTORS AFFECTING CAPACITY

PRODUCT DENSITY
- Meals and fats have different densities, which can influence maximum transport capacity.

Example: Given that the density of feather meal is considerably lower than that of poultry viscera meal (feather meal: approximately 0.103 g/mL vs. poultry viscera meal: 0.6 g/mL), for a weight of 25 metric tons, feather meal would definitely occupy a significantly larger volume compared to the latter product.

LOCAL REGULATIONS
- The total gross weight restrictions for trucks and railways vary by country or region. There are also often variations in the total allowable load capacity during thaw periods in Nordic countries.

- Some countries limit the import of animal meals in bulk transportation.

CUSTOMER INFRASTRUCTURE
- Some customers prefer certain transportation formats based on their storage and unloading capacities. Additionally, cultural models and the economic capacity of each country can influence the infrastructure available for receiving finished products from the rendering industry.

Product	Type of Transport	Average Capacity	Main Use	Countries Where It Is Used
Meals	Bulk railcars	85-110 MT	Long distances by rail.	U.S., Canada, European Union
	Bulk trucks	25-40 MT	Regional or national transport.	U.S., Canada, European Union
	Bulk containers	Max 25 MT	Low-cost export.	U.S., Canada, European Union
	Big Bags	1,000 kg - 1,500 kg per bag	Moderate volumes; easy handling.	Argentina, Brazil, Chile, etc.
	40 kg bags	Export: 20-25 MT Domestic market: 25-40 MT	Local markets or clients without logistics infrastructure.	Colombia, Peru, among others
Fats	Tanker trucks	20-40 MT	Regional transport of liquid fats.	All countries
	Tank railcars	80-120 MT	Long distances by rail.	U.S., Canada, European Union
	Flexitanks	22-24 MT	Maritime exports.	All countries
	Isotanks	20-25 MT	Maritime exports.	All countries

Summary of Rendering Products Logistics
Source: Ministry for Primary Industries | New Zealand Government

SEALS ON CONTAINERS:

TYPES OF SEALS:

- Standard security seals: Plastic or metal seals with unique numbers that prevent unauthorized opening.
- High-security seals (ISO 17712): Internationally required for the transport of sensitive goods, used for IMO cargo or high-value shipments.
- Electronic seals: Equipped with chips for tracking and recording openings.

IMPORTANCE OF SEALS:

- Ensure product integrity from the point of origin to the destination.
- Facilitate customs procedures and prevent contamination or unauthorized handling, which is critical in the animal recycling sector.

TRACKING SYSTEMS IMPLEMENTED:

CURRENT TECHNOLOGIES:

- GPS Tracking: Enables real-time location of containers and trucks, ensuring efficient route management.
- RFID (Radio Frequency Identification): Used to monitor inventories and track product movements in warehouses and during transportation.
- Blockchain: Applied to the documentation and tracking of goods, ensuring transparency and traceability, which is critical for animal recycling products.
- E-Seals (Electronic Seals): Equipped with tracking technology that issues alerts in case of unauthorized openings.

DIGITAL PLATFORMS:

• **Port Community Systems (PCS):** Integrate actors from maritime, land, and rail transport to facilitate data exchange.

• **Fleet Management Systems (FMS):** Technological platforms designed to help transport operators monitor, manage, and optimize the use of their vehicles and logistical resources. These tools provide real-time information and detailed analytics to improve operational efficiency.

STORAGE LOGISTICS IN THE RENDERING SECTOR

Storage is a critical stage in the logistics chain of the animal recycling sector, as it ensures the preservation, integrity, and quality of products before their transportation or distribution. The following are key aspects of storage:

Bulk Storage:

• **Usage:** Applied to unpackaged products such as meat and bone meal or liquid animal fats.

• **Facilities:** Meals are stored in specialized silos.

• **Fats are stored** in stainless steel tanks with temperature control for sensitive products.

• **Applications:** Commonly used in port facilities to accumulate fats for subsequent export.

Palletized Storage:

• All solid products packed in small bags or big bags must be stored on pallets. For this, aisles must be at least 2.5 to 3.5 meters wide to allow forklift movement.

• The relative humidity should not exceed 65% to prevent the meals from absorbing moisture.

• The warehouse temperature should ideally range between 15°C and 25°C, depending on the type of meal.

• Odor accumulation should be avoided, and proper air circulation must be maintained.

• Pallets must be elevated at least 15 cm off the ground to prevent contact with moisture or pests.

• The minimum distance between the pallet and the wall must be at least 30 cm (12 inches) to allow air circulation, visual inspection, and maintenance access, as well as to prevent moisture buildup or pest infestations.

TYPE OF CARGO AND STORAGE FOR MEALS AND FATS OF ANIMAL ORIGIN

Product	Type of Cargo	Type of Storage
Meat and bone meal (bovine, poultry and pork)	Regular	Bulk / Bags or big bags on pallets
Blood meal	Regular	Bags or big bags on pallets
Feather meal	Regular	Bulk / Bags or big bags on pallets
Fish meal	IMO (flammable)	Bulk / Bags or big bags on pallets
Animal fats (beef and pork)	IMO (flammable)	Bulk tanks (heating required)
Poultry fat	IMO (flammable)	Bulk tanks (optional heating)
Used cooking oil	IMO (flammable)	Bulk tanks (optional heating)
Fish oil	IMO (flammable)	Bulk tanks
Refined oils	IMO (flammable)	Bulk tanks
Fertilizers with animal meals	Regular	Bulk / Bags or big bags on pallets
Derived biofuels	IMO (flammable)	Bulk tanks

Type of cargo and storage for animal-based meals and fats
Fuente: Ministry for Primary Industries | New Zealand Government

INVENTORY MANAGEMENT:

- **Warehouse Management Systems (WMS):** Control the flow of products, record entries and exits, and ensure traceability.
- **RFID (Radio Frequency Identification):** Facilitates real-time tracking of products, reducing errors in inventory management.
- **Barcoding:** Identifies specific product batches, ensuring quality control.
- **Inventory Rotation:** Application of methods such as FIFO (First In, First Out) to ensure the freshness and shelf life of meals and the quality of fats.
- Ensures that products with shorter shelf lives are distributed first.
- **Security and Control:** Constant surveillance and access control systems in warehouses, along with sensors to monitor humidity, temperature, and storage conditions.

In summary, the choice of dispatch method, tailored to the client's specific needs and the product's characteristics, ensures safe, efficient, and cost-effective handling while complying with international regulations and optimizing resources. Additionally, the use of security seals and modern tracking systems reinforces traceability, protecting both the products and the reputation of companies in global markets.

FINANCIAL SERVICES: DRIVERS OF PROGRESS

In the agri-food and rendering industries, financial services play a crucial role as enablers of operations across the entire supply chain, from primary production to the marketing and distribution of products. These financial tools not only support the continuity of operations but also drive innovation, expansion, and sustainability in the sector. Let's explore the key financial services fundamental to these industries:

AGRICULTURAL CREDITS AND FINANCING
These credits provide producers with the capital needed to invest in inputs, machinery, infrastructure, and technology.

MERGERS & ACQUISITIONS (M&A)

The rendering industry also relies on strategic investments to maintain competitiveness and adapt to market demands. Mergers and acquisitions, along with various elements of the financial system and investment banking, enable companies to consolidate, optimize operations, and explore new markets. Over the years, these tools have become one of the most common methods for fostering growth and expansion in the animal recycling industry, both nationally and internationally.

While most mergers and acquisitions occur between companies within the same sector, larger companies have increasingly chosen to diversify their operations through both vertical and horizontal expansions. In this context, it is now common to see transactions where rendering companies acquire equipment manufacturers, biofuel producers, or even fertilizer companies. Additionally, there is a notable interest from integrated producers in acquiring independent rendering companies to secure operating permits and ensure a consistent supply of raw materials for their integrated operations.

RISK COVERAGE (HEDGING) AND FUTURES MARKETS
The agri-food sector is highly exposed to risks associated with price volatility, currency fluctuations, and weather conditions. To mitigate these risks, tools such as the following are used:

- Hedging: Allows sector participants to protect themselves against price fluctuations through futures contracts, options, and financial swaps.
- Futures Markets: Ensure price stability, enabling producers and buyers to plan their operations with greater foresight and minimize financial risks.

FACTORING AND LEASING

- Factoring: Provides immediate liquidity by selling accounts receivable.
- Leasing: Allows access to machinery, equipment, and vehicles essential for production and distribution without significant upfront investments.

CIRCULAR ECONOMY FINANCING

Within the framework of sustainability, financial services support circular economy projects, such as animal recycling and the reuse of agri-food by-products. This includes:

- **The construction of rendering plants.**
- **Research and development of new technologies for the creation of sustainable products.**

TRANSACTIONAL FINANCIAL GUARANTEE

n a globalized world, international trade is an integral part of the agri-food supply chain. To protect all parties involved in a transaction, different payment models and financial guarantees are used in the rendering industry:

- Pre-Payment: This method involves the buyer transferring the total or partial amount of the transaction to the seller before the shipment of goods or the provision of services. It is commonly used in trade relationships based on trust or in markets where the seller seeks to ensure the buyer's solvency before dispatching the products. Although it provides financial security for the seller, the buyer assumes the risk of not receiving the goods or receiving non-compliant products. It is frequently used in exports to countries with weak legislation or high risks of fraud or non-payment.

- Letter of Credit (LC): A financial instrument issued by a bank at the request of the buyer, guaranteeing payment to the seller once the specified terms are met, such as the submission of documents proving shipment of goods. This method reduces risks for both the buyer and seller, as the bank acts as an intermediary, ensuring compliance from both sides. Despite its high costs, it is widely used in international transactions due to its security and reliability.

- Cash Against Documents (CAD): In this method, the seller sends shipping documents through a bank, which only releases them to the buyer upon payment. It is a secure option for the seller, as control over the documents necessary to claim the goods is retained until payment is made. However, it does not guarantee that the buyer will accept the goods, which could result in logistical and financial risks if the payment is not completed.

- Combination of Methods: A mix of methods, such as partial advance payment combined with a letter of credit or payment against documents, is used to balance risks between both parties. For example, the buyer may pay a percentage of the amount before shipment to demonstrate commitment, while the remainder is secured through a letter of credit or payment against documents. This strategy helps mitigate financial and commercial risks, adapting to the specific needs of each transaction.

TECH-DRIVEN FINANCIAL SOLUTIONS
Finally, the integration of technology into financial services, such as digital platforms and predictive analytics tools, enhances operational efficiency and decision-making within the supply chain.

Financial services not only provide stability and operational support to the agri-food industry but also serve as key drivers of innovation, growth, and sustainability in this dynamic sector.

INSURANCE: RISK PROTECTION

Although the value of insurance may not appear on invoices for rendered products like animal meals and fats, insurance is always present as an essential tool to mitigate risks throughout the supply chain. Agricultural, livestock, and transport insurance play a critical role in protecting assets and operations from unexpected events such as:

- **Extreme weather phenomena.**
- **Crop or livestock diseases.**
- **Transport accidents.**
- **Environmental liability for waste and by-product management.**

Key Types of Insurance in the Agri-Food Sector:

- **Agricultural Insurance:** Protects crops from natural disasters, pests, or droughts.
- **Livestock Insurance:** Covers losses related to diseases, accidents, or disasters affecting animal production.
- **Liability Insurance:** Protects companies against claims for environmental damage, contamination, or defective products.
- **Transport and Logistics Insurance:** Ensures the safe storage and transit of goods.
- **Infrastructure and Equipment Insurance:** Covers damages to facilities, machinery, and critical technology.
- **Cybersecurity Insurance:** Protects companies from digital risks like cyberattacks, data breaches, and operational interruptions.

These insurance policies are essential for mitigating risks and ensuring financial and operational stability in a sector that is critical to the global economy.

LABORATORIES AND QUALITY CONTROL

Laboratories and quality control are fundamental pillars within the operational services of the supply chain, particularly in industries such as agri-food and rendering, pharmaceuticals, and cosmetics. Their primary goal is to ensure that products meet quality, safety, and international regulatory standards, from raw materials to the finished product.

KEY FUNCTIONS OF LABORATORIES AND QUALITY CONTROL

Raw Material Analysis:

- Verification of physicochemical and microbiological properties of raw materials before processing.
- Identification of contaminants such as pesticides, heavy metals, and pathogenic microorganisms.
- Example: Grain analysis to detect aflatoxins or evaluate moisture levels.

Monitoring in Production Processes:

- Real-time control to ensure each production stage complies with established parameters.
- Example: In rendering plants, monitoring protein levels in meals or peroxide values in fats.

Final Product Testing:

- Certification that the finished product meets technical, safety, and legal specifications.
- Analysis of characteristics such as nutritional composition, stability, texture, and taste.
- Example: Determination of crude protein, fiber, and metabolizable energy in animal feed.

Food Safety Evaluation:

- Implementation of systems like HACCP (Hazard Analysis and Critical Control Points) to identify and mitigate potential risks in the supply chain.
- Validation to ensure that products pose no risk to consumers.

Regulatory Compliance and Certifications:

- Verification of conformity with national and international regulations, such as FDA, EFSA, ISO, and other market-specific standards.
- Management of documentation and certifications required for export and import.

Development and Innovation:

- Research and development of new products or improvements to existing ones.
- Stability tests and pilot trials to evaluate the feasibility of potential innovations.

TYPES OF ANALYSES CONDUCTED IN LABORATORIES

PHYSICOCHEMICAL ANALYSES:
• Determination of moisture, protein, fats, ash, fiber, and carbohydrates.
• Analysis of pH, acidity, and fatty acid profiles.

MICROBIOLOGICAL ANALYSES:
• Identification of pathogens such as Salmonella, E. coli, or Listeria.
• Evaluation of total microbial load to ensure safety.

TOXICITY AND CONTAMINANT DETECTION:
• Detection of mycotoxins, heavy metals, pesticides, and chemical residues.

STABILITY AND SHELF LIFE:
• Accelerated storage tests to predict product longevity under normal market conditions.

SENSORY ANALYSES:
• Tests for taste, odor, texture, and appearance in final products, particularly in food and cosmetics.

RELATIONSHIP WITH OTHER OPERATIONAL SERVICE

Logistics: Quality control results determine whether products meet the necessary requirements for storage, transportation, or distribution.

Production: Laboratories work closely with processing plants to monitor parameters in real time.

Commercialization: They ensure that products meet the technical specifications required for sale in specific markets.

In summary, laboratories and quality control are not just operational tools but strategic components within supply chains. Their role is to ensure that each product meets the highest quality standards, from its origin to the final consumer, strengthening company reputations, reducing risks, and supporting the sustainability of operations in a globalized and competitive environment.

AGRICULTURE: PRODUCTS FROM THE LAND FOR THE SUPPLY CHAIN

Products derived from the land form the foundation of the agri-food industry and the supply chains that support it. These products include a wide range of agricultural raw materials that are cultivated, harvested, processed, and transformed into food and consumer goods. Each of these products plays a vital role in global supply and the sustainability of the industry.

Here are some of the main categories of products from the land:

GRAINS AND CEREALS
Examples: Wheat, corn, rice, barley, oats, sorghum.

Uses:
- Production of flour and baked goods.
- Manufacture of animal feed.
- Production of biofuels such as ethanol.

FRUITS AND VEGETABLES
Examples: Apples, citrus fruits, bananas, tomatoes, lettuce, carrots.

Uses:
- Fresh and Processed Product (juices, purees, canned goods, dehydrated foods).
- Ingredients in prepared food products.
- High-value products in global markets.

LEGUMES AND OILSEEDS
Examples: Soybeans, sunflower, peanuts, rapeseed, lentils, chickpeas.

Uses:
- Production of vegetable oils, protein meals, and biofuels.
- Base for animal feed and alternative protein sources.

TUBERS AND ROOTS
Examples: Potatoes, cassava, sweet potatoes, carrots, beets.
Uses:
• Direct consumption as staple foods.
• Production of starches for industrial and food applications.

HORTICULTURAL PRODUCTS AND SPICES
Examples: Basil, pepper, turmeric, onion, garlic.

Uses:
• Flavoring for foods.
• Ingredients for value-added products such as extracts and essential oils.

In conclusion, products from the land are the cornerstone of the agri-food industry and its supporting supply chains. From their production to their transformation and consumption, these products not only meet global food needs but also drive the economy, sustainability, and innovation within the sector.

AGRI-FOOD INDUSTRY AND ANIMAL PROTEIN PRODUCTION FOR THE SUPPLY CHAIN

We have finally reached the central point of our study: the agri-food industry. Focused on animal nutrition and meat production, it stands as a complex and essential chain to meet the global demand for animal protein. This sector integrates various interconnected links, ranging from the production of animal feed to the distribution of the final product. Below, let's explore each of these links and their role in the value chain:

ANIMAL FEED PRODUCTION

The production of balanced animal feed is the starting point of the meat production process. These products are formulated to meet the nutritional requirements of various species, promoting efficient performance in aspects such as weight gain, milk production, egg laying, and more, thereby ensuring the economic sustainability of farming activities for producers.

DID YOU KNOW?

- Animal feed represents approximately 75% of the total cost of the meat we consume on our tables.

MAIN COMPONENTS:
Raw Materials: Cereals (corn, wheat, barley), oilseeds (soybean, sunflower), and animal by-products such as fish meal, bovine and porcine meat and bone meal, etc.

Additives: Vitamins, minerals, amino acids, and probiotics to optimize growth and animal health.

Key Processes:
- **Selection and blending of ingredients.**
- **Pelleting or extrusion to improve digestibility.**
- **Quality analysis to ensure food safety.**

ANIMAL PRODUCTION FARMS

Farms are the core where animals are raised and fattened for meat, milk, or egg production. These operations can be intensive, semi-intensive, or extensive, depending on management practices and infrastructure. Let's delve a bit deeper into each of these systems:

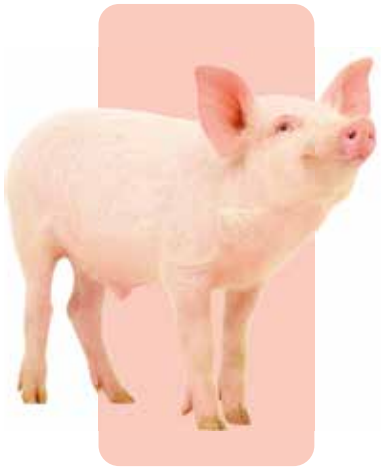
Animal	Fattening Time	Final Weight (Approx.)	Common Breeds
Broiler Chickens	35-45 days	2.5-3.5 kg	Cobb, Ross
Pigs	4-6 months	90-120 kg	Landrace, Yorkshire, Duroc
Cattle	18-24 months (extensive) / 90-120 days (intensive)	450-600 kg	Angus, Hereford, Brahman
Tilapia	6-8 months	800-1,000 g	Nile, Red
Salmon	18-24 months	4-5 kg	Atlantic, Chinook
Trout	9-12 months	250-350 g	Rainbow, Brown

Fattening times on farms.
Source: Ministry for Primary Industries | New Zealand Government.

POULTRY FARMS
Purpose: Production of meat and eggs from birds such as chickens, turkeys, and hens.

Classification:
- **Broiler Farms:** Specialized in raising chickens for meat in a short period (approximately 35-45 days). These farms focus on maximizing weight gain in the shortest possible time.
- **Layer Farms:** Dedicated to egg production, utilizing laying hens with specific diets to ensure high productivity.

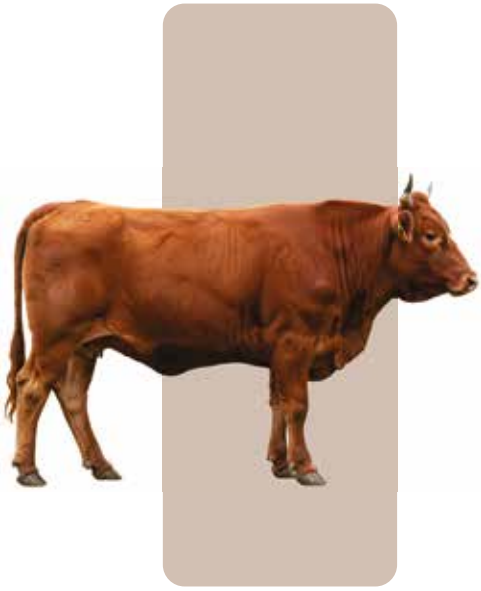
Infrastructure:
- Housing with temperature, ventilation, and humidity control.
- Automated feeding and egg collection systems.



SWINE FARMS
Purpose: Breeding, reproduction, and fattening of pigs for meat production.

Classification:
- **Breeding Farms:** Focused on the reproduction of sows and piglet production.
- Fattening Farms: Dedicated to raising pigs from weaning to slaughter weight (approximately 90-120 kg).

Infrastructure:
- Pens or housing with environmental controls.
- Manure management systems to minimize environmental impact.



CATTLE FARMS
Purpose: Production of meat and milk from cattle.

Classification:
- **Beef Cattle:** Includes breeding farms (for calf production), rearing, and fattening operations. Focuses on breeds like Angus, Hereford, and Brahman.
- **Dairy Cattle:** Dedicated to milk production with breeds such as Holstein and Jersey. These farms require facilities like milking parlors and refrigeration systems.

Infrastructure:
- Pastures, pens, and mechanized milking systems.
- Storage facilities for silage and balanced feed. systems.

AQUACULTURE FARMS
Purpose: Farming of fish, shellfish, and other aquatic organisms for human consumption.

Classification:
- Fish Farming: Cultivation of fish such as tilapia, salmon, trout, and carp.
- Mariculture: Production of marine species such as shrimp, oysters, and mussels.

Infrastructure:
- Ponds, floating cages, or recirculating water systems.
- Automated feeding systems and water quality monitoring.

In conclusion, each type of farm plays a critical role in producing food for the global population. Their specialization allows for the optimization of available resources, ensures sustainability, and meets the growing demand for animal proteins worldwide.

MEAT PROCESSING PLANTS (SLAUGHTERHOUSES)

Slaughterhouses, also known as meat processing plants, play an essential role as key suppliers of raw materials for the rendering industry. Their primary function is the transformation of animals into meat products for human consumption. During this process, they generate a wide range of by-products that, while not suitable for our tables, hold significant potential value in the animal recycling sector.

KEY PROCESSES

- **Slaughter:** Ensuring compliance with animal welfare standards.
- **Cutting and Processing:** Dividing into primary and secondary cuts, as well as derivatives (sausages, burgers).
- **Packaging and Preservation:** Utilizing technologies such as modified atmospheres and cold chains.

RAW MATERIALS GENERATED BY SLAUGHTERHOUSES:

Solid Waste:

- Meat scraps, bones, fat, blood, feathers, and viscera, though unsuitable for human consumption, are now considered the “gold” of the animal recycling industry. Unlike many other industries, the primary challenge in this sector lies not in selling the finished product but in securing its raw materials.

- Specific Risk Materials (SRMs), such as skulls and spinal cords in cattle, require special handling under strict sanitary regulations due to their potential health risks to humans and animals.

Liquid Waste:
Fats and oils derived from the deboning or extraction process are key by-products generated by slaughterhouses. These raw materials are highly valued due to the growing demand for animal-based fats in the biofuels industry, animal nutrition, and even human nutrition through refined fats and other high-value products.

Other Waste:
Sludge: Generated during wastewater treatment used in the slaughtering and cutting processes. This sludge contains a mix of organic matter, fats, proteins, and suspended solids. Though considered a by-product, it holds high potential for rendering, being used to produce biogas, fertilizers, or components in animal recycling processes.

STRATEGIC ROLE IN RENDERING:

- **Constant Supply of By-Products:** Slaughterhouses are the primary source of raw materials for rendering plants, ensuring a steady and predictable flow of inputs.
- **Material Quality:** The quality of the by-products provided by slaughterhouses directly impacts the quality of the rendering industry's final products, such as animal meals and fats.
- **Waste Reduction:** By transferring inedible by-products to the rendering sector, slaughterhouses minimize waste generated in meat processing, contributing to a circular economy.
- **Regulatory Compliance:** Slaughterhouses must handle by-products according to strict sanitary and environmental regulations to ensure they are transported and processed safely.

In summary, slaughterhouses are a critical link in the rendering value chain. Their ability to efficiently manage by-products ensures not only the supply of essential raw materials for the industry but also progress toward more sustainable and responsible practices in animal resource management.

ANIMAL RECYCLING IN THE SUPPLY CHAIN

Up to this point, we have explored numerous concepts related to the rendering industry, but it is here that animal recycling finds its essential place within the supply chain. It stands as the key link that ensures efficient sanitary and environmental management throughout the value chain.

While we are already familiar with the finished products of this industry and the origin of its raw materials, it is vital to reflect on its true role within the bio-circular economy and why it is an indispensable component that transforms the entire supply chain.

Rendering, in its current role as the central axis of the supply chain, takes what others consider waste or garbage and transforms it, through a bio-circular economy model, into valuable resources. Whether as an energy source, soil fertilizer, protein or energy source for animal nutrition, or as raw material for consumer goods such as soaps and cosmetic products, rendering is now a catalyst for value-added opportunities in the agri-food industry.

This industry not only contributes significantly to the global GDP but also plays a crucial role in reducing the carbon footprint and building a more sustainable future. Its contributions leave a positive mark on the planet for future generations, advancing toward a more conscious and sustainable production model.

4 WHY USE RENDERING PRODUCTS?

Now that we have a clearer understanding of the rendering industry's position and its importance to the agricultural and agrifood supply chain, it becomes evident that the benefits of its finished products not only contribute to environmental sustainability but also offer commercial and technical advantages, making them strategic options for various industries.

FROM A COMMERCIAL PERSPECTIVE!

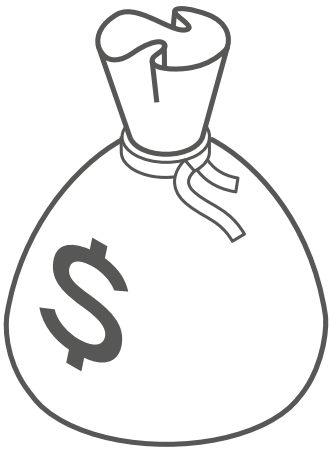
COMPETITIVE COSTS
Animal recycling products offer a cost-effective alternative to traditional inputs, such as plant-based proteins in animal nutrition or fossil-based raw materials in the biofuels sector. Their utilization allows companies to reduce raw material costs without compromising the quality of the final product.

ACCESS TO SUSTAINABLE MARKETS
Utilizing recycled inputs strengthens a company's commitment to sustainability, a quality increasingly demanded by consumers and regulators. This enhances corporate reputation and creates opportunities in markets that prioritize responsible practices.

WASTE REDUCTION
By integrating these products into the value chain, companies contribute to the circular economy, preventing tons of byproducts from ending up in landfills and maximizing the use of available resources.

COMPLIANCE WITH ENVIRONMENTAL REGULATIONS
In an increasingly strict regulatory environment, the use of rendering products enables companies to align with environmental and sustainability standards, avoiding penalties and gaining access to government incentives.

FROM A TECHNICAL PERSPECTIVE!



HIGH NUTRITIONAL VALUE
Meals and fats derived from rendering boast superior protein and energy content, making them ideal for use in animal feed, fertilizers, and biofuels, among other applications.

VERSATILITY OF APPLICATIONS
Products derived from animal recycling are used across multiple industries, including animal nutrition, agriculture, cosmetics, pharmaceuticals, and energy production, making them highly adaptable and in demand.

STABILITY AND LONG SHELF LIFE
Thanks to advanced production processes, recycled products maintain chemical and microbiological stability, ensuring their quality during storage and transportation.

INNOVATION AND TECHNOLOGY
The rendering industry has developed sophisticated technological processes, such as the extraction of hydrolyzed proteins and refined fats, improving efficiency and the quality of the final product.

CONTRIBUTION TO THE BIOCIRCULAR ECONOMY
Recycled products close the production cycle by reintegrating as inputs into new value chains, reducing dependence on nonrenewable resources.

In Conclusion, the use of products derived from the animal recycling industry is not only a commercially intelligent decision but also a technically efficient and environmentally responsible solution. By incorporating these products, companies can optimize costs, innovate in their processes, and contribute to a more sustainable future, addressing the growing demands of consumers and regulators in an interconnected global market.