

Beef Processing and Value Addition

There are several ranches, groups and cooperative enterprises involved in beef production. There are many value added beef products and the methods differ from one product to the other. The main beef products include fresh meat and processed products such as sausages, meat balls. This involves high investment in slaughter houses, specialized equipment and development of skills in processing. Some of the byproducts of beef value are manure, milk, bones, blood, hooves and horns, skins.

Steps in slaughtering process

i} Livestock pens (lairages)

Lairage is the area where the animals are rested and conciliated prior to slaughter to overcome the fatigue and are rested for 24 hours without feed but with copious water.



Lairages Requirements

Livestock pens, chutes and/or squeezes must be provided at all slaughtering establishments. The holding of animals prior to slaughter should be for a minimum time. Chutes, ramps and inclines should be "stepped" and have a reasonable incline to prevent slipping, falling or injury. All floors, alleyways and chutes must be impervious, paved, properly drained and scored to prevent slipping. The floor area should have rough cement mortar finishing with 1% slope to the drainage canal. There must be an open space between the wall and the roof of the lairage for ample natural light and ventilation. The lighting in all parts of the lairage should be bright enough so that animals can be inspected at any time by designated and competent personnel. Each pen should be supplied with concrete water troughs at about 50 cm from the floor, with 60 cm width and 25-40cm depth across the length of one side of each pen. Animals should have ready access to grazing/feed/food in the event they are not slaughtered within 24-

48 hours of arrival to the abattoir. Metallic hayracks should be installed in those pens wherein the animals stay until before 24-72 hours of slaughter at about 60-100 cm from the floor across the length on the opposite side of the water supply line. Area of about 3.25 m² and 0.55 m² per head of cattle and shoats is required, respectively. The livestock holding pen capacity at the establishment shall be sufficient to hold the number of animals slaughtered during one half slaughter shift. The capacity of each livestock pen shall indicate on the establishment drawings. Cattle will be cleaned and watered to get rid of dust, minuscule materials from skin, and holding yards will be maintained in a clean condition. Every effort need to be taken and arrangements to be made to mollify the animals while in pens and during run-up to slaughter. Stress has direct impact on quality of meat produced. Stress makes the pH in the tissue of cattle increase, which can cause the meat to become dark, firm and dry. Relevant guidelines and best practices to be followed for handling of Animals as discussed in subsequent chapters. If possible, animals from different groups should be kept separate until they move to the knocking box. The lairage shall be connected to the slaughter hall with an animal race. The lairage should be designed to allow a one-way flow of animals from unloading to the point of slaughter. Outdoor lairage should be given shelter from adverse weather conditions.

ii. Slaughter Hall/ Kill Floor

A kill floor is where animals are slaughtered for processing. The kill floor is divided spatially into a clean side and a dirty side. The kill floor is usually hot and humid, temperature of this area is relatively higher than other areas of processing plant. In Slaughter hall or kill floor area all cattle should be well spaced to prevent any contamination. Kill lines of kill floor merge into one line after evisceration for splitting, trimming, washing, grading and labeling.

Slaughter Hall/ Kill Floor Requirements

Each area on the kill floor must be physically identifiable and there must be separation of operational zones as far as possible such as killing, dressing, inspection and cleaning areas. Each zone or area should have its own set of equipment. The floor of the slaughter hall shall be finished with washable, non-absorbent and easy to clean material. Where appropriate, the wall of the slaughter hall shall be white ceramic tile up to the level of rail(s). Slaughter hall shall be fitted with sufficient exhaust fans to avoid hot and humid air

in the slaughter area. Slaughter hall will incorporate improved practices of animal handling. The slaughter halls in a slaughter house shall provide separate sections of adequate dimensions sufficient for slaughter of individual animals to ensure that the animal to be slaughtered is not within the sight of other animals. Abattoir shall be provided with distributed artificial light of an overall intensity of not less than 200 lux at the distances as may be specified by guidelines throughout the slaughter hall. A constant supply of clean hot water shall be available in the slaughter hall. The roof of the slaughter hall and all buildings with direct relation to the service of the slaughter hall shall be such that they do not transmit any undesirable substances to the slaughter product/meat/.All corners and edges of the slaughter hall and accessories shall have curved finishing. To avoid insects, rodents and vermin, windows and openings made for sufficient ventilation shall be covered with screens.

Operations should consider the air-flow throughout the plant – coolers, cut floors, kill floors - including air from personnel fans, on the kill floors and ensure that air is not carrying contamination into exposed product. Air Quality - make-up air pulled in to plant should be assessed for directional source, environmental contamination potential, filtrations may be needed.

iii} Restraining Box & Cradle for Slaughtering the Animal

After reaching the kill floor, cattle are herded in to a moveable cradle or box chute. This is a Box which is used to restrain the animal to facilitate stunning and slaughter. For this purpose the animal is brought from the lairage through the ramp in the restraining box. From the restraining box the animal falls/ ejected on a raised sturdy metallic frame (Cradle) where it is restrained and slaughtered quickly and humanely. Cradle is specially designed to block the animal's view from what's going on outside of the cradle, restrain it, enable the person above to stun it, drop the side to release the stunned or killed animal to shackle one or both of the hind legs for rest of the slaughtering and dressing process.

In the medium to high rainfall areas, most farm inputs are readily available in the markets, except a few vaccines which are sometimes sourced out of the country. However, in the arid and semi-arid areas, beef input suppliers are rare and poorly distributed. The prevailing relatively poor infrastructure in such areas increases transportation and storage costs for beef inputs, placing the prices of beef inputs beyond the reach of most farmers.

Stunning, hoisting and bleeding areas

The animals are led from the holding area to the immobilization, or stunning, area where they are rendered unconscious. Workers called stunners use mechanical or chemical devices to make the animals unconscious before they slaughter them. Animal stickers then cut the jugular vein and let all the blood drain from the carcass, or dead body. Under the cradle there should be a bleeding trough, having a good gradient with two drains, one for the blood only going to blood collection room and the other for water used for cleansing the blood.

i. Overhead Rails for Carcasses

An overhead system of rails for handling of carcasses after slaughter point shall be provided up to the process hall via chillers with hooks of stainless steel. After slaughtering the animal is shackled to the hooks on the rail. The overhead rail brings the carcass to steamers, de-hairing machine tenders, singers, and shavers, who remove the hide, hair, and dirt, and clean the carcass with water and brushes

ii. Electrical Stimulation

The use of electrical pulses to use up energy reserves in meat is called electrical stimulation. In some plants, electrical stimulation (ES) is applied to the carcasses to improve lean color, firmness, texture, and marbling score; to improve bleeding of carcasses; and to make removal of the hides easier. Applying electrical stimulation to beef carcasses, cold-induced toughening can be reduced. When the cattle come out of the kill floor they receive an electric shock stimulation which breaks down the sugar particles in the meat and ensures a more tender beef carcass for eating. Electrical stimulation also permits rapid chilling by hastening the onset of rigor before temperatures drop to the cold shortening range. Processing plants use a variety of post-stunning immobilizers and hid-pulling equipment which used electric current to stiffen the carcass. All this equipment has the effect of stimulating the carcass and impacting on pH decline. Electrical Stimulation can reduce the risk of cold shortening of lighter carcasses, and carcasses which have been trimmed of fat when in chillers.

Horn & Hooves Removal

Because of the high risk of contamination of carcasses from feet and udders which have

been removed from carcasses, special facilities, such as a chute or slide, should be used for transferring these parts to containers.

The horns are removed from the head and transferred to room meant for Horn and Hooves. Suitable facilities and floor space must be provided for dehorning, removal and thorough washing of heads and their preparation for inspection. If the retain compartment is located in the cooler, the compartment should be separated from the remainder of the cooler to prevent cross-contamination of inspected and passed carcasses.

De-hiding

The fore and hind feet are removed to prevent contamination of the carcass with manure and dirt dropped from the hooves (shanking or legging). Each of the legs is then skinned. The hide is then opened down the middle of the ventral side over the entire length of the carcass. The hide is removed or from the middle down over the sides (siding). Air or electrically powered rotary skinning knives are often used to make skinning easier. The hind quarters are separated with a saw or knife. The tail is skinned and then removed two joints from the body. After removing the tail, the hide is completely flayed from the carcasses. Hides are collected, intermediate preserving operations performed, and the preserved hides sent to tanners for processing into leather.

Head Removal

The head is removed (the skin is removed from the head, and the head is removed from the carcass). Heads must be removed in a sanitary manner to prevent contamination. This process step may also involve the activities for dehorning, ear removal, etc. Employees must clean and sanitize hands and equipment throughout the head removal process to ensure sanitary dressing. Head must be inspected (part of post-mortem) on the line especially meant for this purpose. Each room should have adequate space which allows effective segregation of inedible and condemned parts.

Evisceration

The carcasses are hung by hocks to the shackles for evisceration. By a slit opening from the tip of breast bone, abdominal cavity is opened by means of a transverse cut. A circular cut is made around the vent. The viscera is drawn outside but allowed to remain attached to the carcass for post mortem inspection. Meanwhile, a slit is made in the skin of the neck for easy removal of crop and neck. Evisceration procedures must be developed and implemented for proper sanitary

dressing.

Brisket splitting

Brisket opening is usually a two-part process (knife and saw). The initial knife cut should be made with a clean and sanitized knife. The saw should be cleaned and sanitized between carcasses to prevent cross-contamination. After head removal, the breast is cut opened by sawing the sternum bone with the help of Brisket saw. After brisket opening, the internal organs green and red offal are taken out.

Brisket splitting Requirements

A chute or slide should be used to avoid splashing of milk or other contaminants onto the carcasses, floor, equipment, and personnel.

Carcass Splitting

After the hide is removed, the carcass is eviscerated. With a knife, the abdomen of the carcass is opened from top to bottom. Carcass is split into two halves with help of a vertically operated splitting saw. Then carcass splitters cleave the carcass open and remove the innards. The diaphragm membrane is cut and the thoracic organs are removed.



Carcass Splitting

Dressing

Dressing is the process of progressive separation of the body of an animal into a carcass and other edible and inedible parts. Carcass dressing should begin after bleeding without further delay. After exsanguination, the actual "dressing", or cleaning, of the carcasses begins. Dressing of the carcasses is done on overhead rails. Inedible materials (offal) including a lamb pelt and cow hoof have been placed in a large container which will then be picked up by the renderers. A

dressing cradle is equally suitable for bovines and small-stock. Percentage of individual animal dressing was defined as the hot carcass weight divided by the live weight 14hr. before slaughter. The mean dressing percentage is around 55%. Carcass dressing can be influenced by inherent oscillation factors such as genotype, rumen fill, fasting period and transportation; it can also be influenced by the slaughter location and cleaning process. Post-dressing antimicrobial treatments are also important, but their effectiveness depends in large part on how well your sanitary dressing procedures have minimized contaminants to that point.

Post Mortem Inspection

Inspection is normally carried out by trained Public Health Inspectors. Their duty is to examine the slaughter products for evidence of disease and abnormality and eliminate them from the public meat supply. The head of every animal slaughtered is checked to ensure that the animal was healthy. Like the head, organs are also inspected. The carcass is held in the suspended position, while the visceral organs including the head and tongue are placed on hooks in a separate area and the stomach and intestines remain in the basin or bucket. Besides, the carcass parts of the animal body which are assembled for inspection are the tongue, head, pluck, liver and stomach and intestines

Carcass Retention (Room) & inspection requirements

All carcasses and parts of carcasses shall be inspected by competent establishment employees who shall remove any foreign matter from the said carcasses or parts thereof prior to deboning. Post mortem veterinary inspection is required by law of all carcasses and fifth quarter components. During this inspection diseases and aberration are rejected, and carcass quality classification recorded. The carcass is allowed for further processing or sale only after approbation of inspecting agency. Where appropriate, the wall of the detained room shall be non-absorbent, easy to clean, washable and free from crevices. The floor of the room shall be non-absorbent, easy to clean and with 2% slope to the drainage canal. The retain room or compartment must be equipped for locking or sealing.

If the retain compartment is located in the cooler, the compartment should be separated from the remainder of the cooler to prevent cross-contamination of inspected and passed carcasses. Carcass inspection point shall be located immediately after the carcass splitting operation and prior to any trimming being performed on the carcass. The minimum unobstructed space (length) for this inspection station is 2.5 m. The online carcass inspection point shall be

adjustable to accommodate inspectors of different heights. The point shall be capable of being positioned so the eyes of the inspector are level with the lumbosacral area (rump) of the carcass. Records have to be kept of all rejected materials. HACCP methodology is needed these include complex methods of risk analysis and require staff to be trained in the international standards. The establishment shall be responsible for grouping the product into coded lots which shall be acceptable to the Authorized Officer, and for adequately identifying and re-conditioning rejected lots.

Chillers

Cooling of carcasses is necessary before it is taken to the market. Considerations must be given to the fact that freshly slaughtered carcasses are warm with temperatures close to ordinary body temperatures (37°C or 98.6°F) of the live animals and are subject to the growth and multiplication of bacteria. After eviscerators and offal separators separate the edible and inedible parts from the carcass, split sides are sent to a chilling room for twenty-four to forty-eight hours. The emphasis of carcass chilling should focus on the carcass surface temperature because this is where the pathogen contamination is most likely. Cold Chain Management includes all factors that contribute to temperature reduction of the carcass — spray chill, carcass spraying, air-flow, BTUs.

Chillers/ cooling room requirements

All carcasses spend at around 2 hours in the pre-cooling hall to remove water and excess blood before chilling. All carcasses need to begin chilling within 1 hour from bleed-out. All variety meats need to begin chilling within 1 hour after removal from carcass.

All coolers have a certain maximum capacity which is contingent, not only on the refrigerating capability of the unit, but also on the provision of an adequate circulation of air. Therefore, the holding capacity of all carcass chilling and holding rooms shall be indicated on the establishment drawings. A thorough chilling during the first 24 hours is essential, otherwise the carcasses may sour. Air chillers are most common for beef sides. A desirable temperature for chilling warm beef carcasses is 0°C (32°F). Because a group of warm carcasses will raise the temperature of a chill room considerably, it is good practice to lower the temperature of the room to 5°C below freezing (-30°C [27°F]) before the carcasses are moved in. Temperatures more severe than this can cause cold shortening, an intense shortening of muscle fibers, which brings about toughening. Beef undergoes maturation and should be held for at least a week (preferably longer)

at 00C (320F) before butchery into retail joints. Sheep and goat carcasses should be cooled to a temperature of between -2oC and +2oC (or approximately 28oF to 35oF) for a period of 18 to 24 hours prior to being taken to market. During the cooling process cold air should flow rapidly and in so doing prevents surface spoilage and deterioration in deep tissues. After cooling the carcasses must be refrigerated. Specialized protective clothing is needed for the colder conditions in boning rooms and chillers. The hangers in the cold room should be stainless steel. The floor of the cold rooms must be resistant to blood, fat, acid, and non-slippery. The doors of the cold room shall be resistant to temperature variation and air tight with rubber gaskets and be made of non-rusting material. A suitable area must be designated in a cooler for chilling and storing "held carcasses" and parts. This section should be segregated from the remainder of the cooler and sealed or locked.

Besides the carcass, other edible meats include red offals (liver, kidney and heart), grey offals (stomach, intestine, lungs and spleen) and dark offals (head and feet). The red offals can be given the same cooling treatment as the carcass, but the others should be sold quickly. If storage is desired the grey and dark offals should be held in a separate chamber and spread out to allow for more effective cold action.

Loading Station Requirement

The rails of the production room, refrigeration and freezing rooms should be conjoined with loading ramps for meat transportation vehicles. The entrance of the cold storage should be along the dispatch hall. Finished product storage areas should not exceed 40 °F. Aged beef should be held no longer than 7 days at a temperature not exceeding 40 °F.

Meat Packing

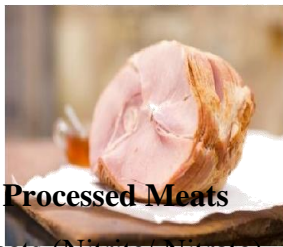
A. Typical Process Flow for Meat Packing

i. Cutting and deboning

- Meat Cutting/ Deboning Area
- Fresh Packing Area
- Freezers
- Frozen Packing Area
- Metal Detection
- Cold Storage

ii. Meat processing

- Meat Processing Unit read more
- Smoking & Cooking Section read more
- Wrapping Storage & Dispatch Section read more



Types of Processed Meats

Cured Meats (Nitrite/ Nitrate) – [Polony, Ham & Bacon, Frankfurters, Bologna, Corned Beef, Pastrami]

Uncured Meats (No added Nitrite/ Nitrate)- [Lamb Roast, Bratwurst, Sausages]



Value added products include meatballs, beef burger, marinated products, stir fries, sausages and pet food, as well as canned products that include corned beef, ox-tongue. A growing category of exports is the pet food by products production which includes meat and bone meal, tallow, skin and hide, blood meal, horns and hooves, ox-gall, ox-skull, mask, ox-pizzle, ears and the offal category of the liver and tripe.

Meat by-products

There is gamut of byproducts which can be derived harnessing offal and inedible products/ rejects from meat processing plants.

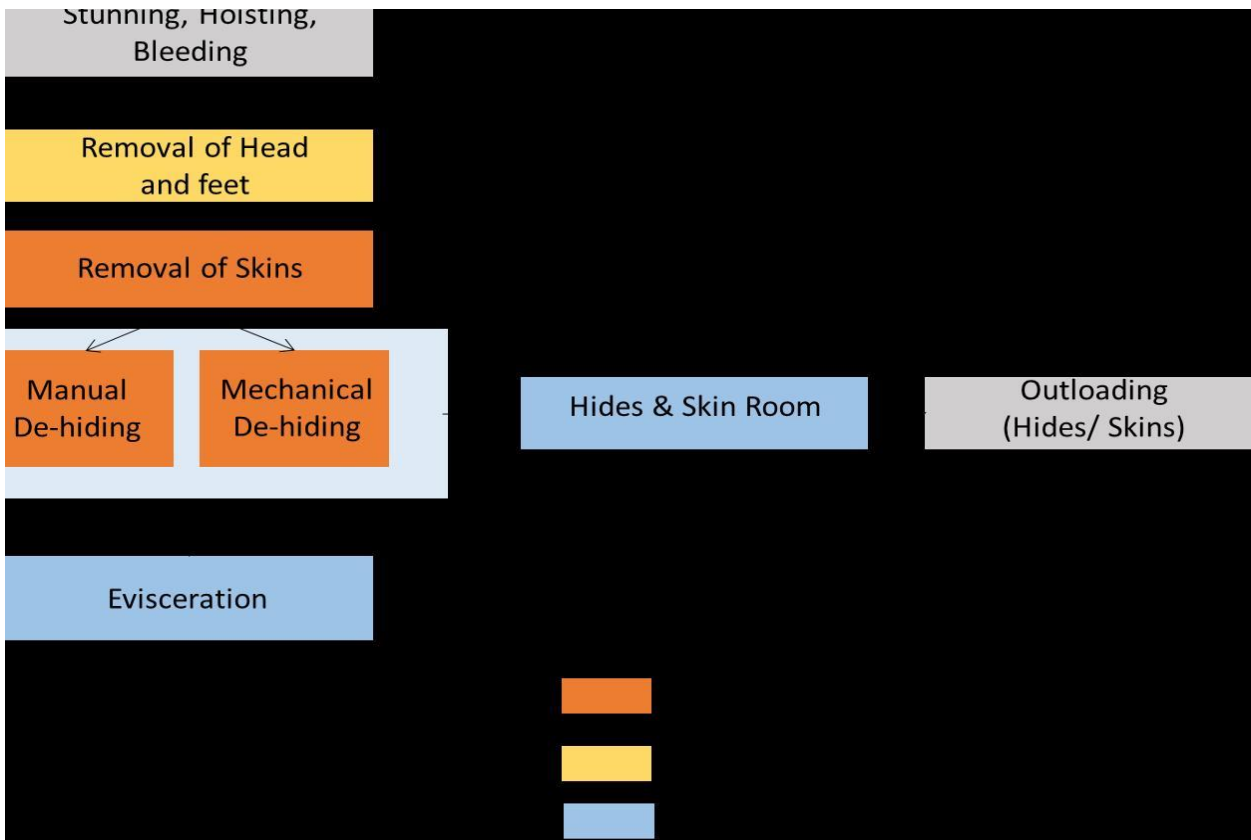
Multifarious byproducts from meat processing industry provides further diverse downstream networking opportunities with industries ranging from health and pharmaceuticals to leather and Textile to cosmetics to lifestyle and household products to chemical and other industries.

Offal Processing Unit

On average proteins associated with the meat industry byproducts constitute more than one-eighth of the total protein in the lean meat. Besides feeds and fertilizers, there is growing market for protein hydrolysates which may be used as flavor enhancers, functional ingredients or simply as nutritional additives to food of low protein quality. The Offal processing unit would require a good refrigeration facility along with the various processing equipment and machinery.



Process



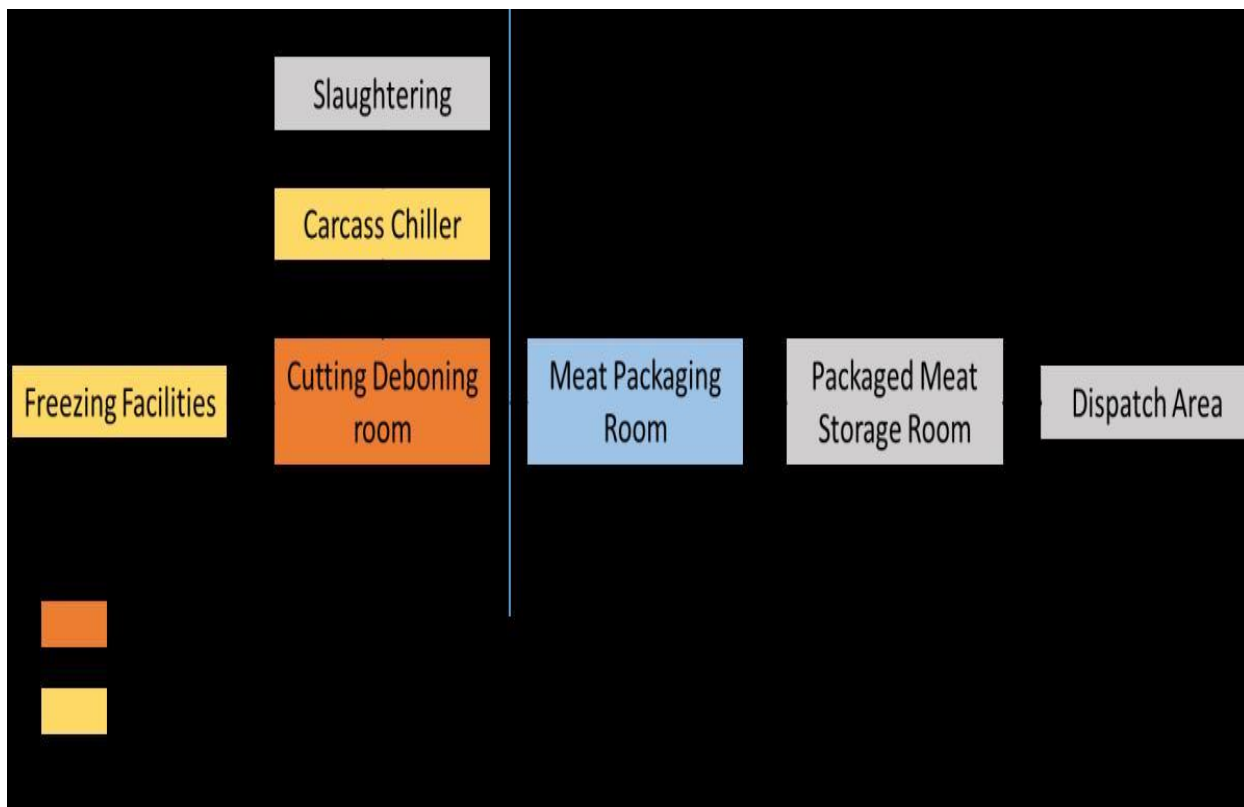
Flow for Meat Packing

Many large scale plants ship whole graded carcasses to retail markets, others perform some on-site processing to produce retail cuts. The processes are the following:

- Cutting and deboning
- Meat processing

Meat Cutting & Deboning

Meat cutting a deboning area is a hall of sufficient size where the cutting and deboning of chilled Carcasses is done. The meat shall be deboned in a manner so as to ensure a clean and Deboning of wholesome product.



Cutting & Deboning Area Typical Process Flow

Meat Cutting/ Deboning Area requirements

The Deboning room should be large enough to handle maximum possible throughputs Deboning area should be equipped with deboning tables of galvanized steel, finished with a top of stainless steel or high density plastic.

The premises should have the facility to maintain the room temperature at 12oc. There has to be red offal and green offal areas where offal is chilled on a continuous conveyor. The deboning area shall have facilities for washing hands and sterilizing. The room temperature in the deboning area should be below 100C as prescribed by norms.

If there is a gap in the cold chain, the meat may possibly become foul, diminished in quality or impaired in its life. Hygiene & cleanliness in the meat deboning are the most important and should be assured. The deboning area shall have facilities for washing hands and sterilizing knives and tools prior to and during the deboning operations and shall be provided with adequate light. The conveyor belt should be easily cleanable and offer a longer lasting cleanliness in the hygiene sensitive handling of meat. Boneless meat re-inspection shall apply to all deboned skeletal meat from carcasses and heads of cattle, calves, sheep, goat, and swine intended for cooking, canning, packaging, boxing, freezing and other processing at establishments preparing meat products.

Packing Area

The deboning and packing area is separated from each other by partitions.



Meat packing



Packaged Meat

Freezers

After packing, the processed meat is delivered to either Plate freezers or Blast freezers. Freezer construction requires a clear comprehension of all aspects of building construction design and practice including heat transfer, mass transfer, air infiltration detailing, and structural design considerations. Meat is aged by holding either carcasses or primal cuts at refrigeration temperatures for extended periods of time after slaughter and initial chill and some after packing. This aging process improves the tenderness and flavor of meat. There are two methods of aging namely – wet aging & dry aging.

Enterprise development

In Kenya the following forms of business enterprises exist -

- Sole Proprietorships
- Co-operatives
- Partnerships
- Private Registered Companies
- Public Registered Companies
- Branch offices of companies registered overseas

- The registered companies are regulated by the Companies Act

There are a number of beef enterprises that can be carried out and these includes breed improvement, pasture improvement, quality feeds, meat cold chain and beef health.

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