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# UNIT 5 PLANT LAYOUT

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## 5.0 OBJECTIVES

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After reading this unit, you will be able to:

- identify the essential components to be considered in establishing a poultry dressing plant; and
- discuss about the clean and unclean areas of the plant layout.

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## 5.1 INTRODUCTION

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You have read earlier in course BPVI-022 about layout of an abattoir. Similarly it is essential to know about the layout of poultry processing plant. Selection of site is an important aspect here also. Besides site selection, size of plant, mode of operation, ownership, government legislation and other associated infrastructures are important issues for discussion under plant lay-out.

The design, construction and layout of the poultry processing plant should comply with hygiene standards, which lead to the production of good quality wholesome meat.

Poultry processing is a systematic operation which has been mechanized extensively. The poultry slaughter house facilities and the surroundings, construction and maintenance should be in such a way that contamination from out-side source or as well as within the plant could be prevented.

You have to provide humane treatment to birds during catching, transport, and during slaughter to reduce stress they may suffer. The major factors to be considered for fresh poultry meat technology are:

- i) Planning of poultry slaughter house and their suitable operation.
- ii) Effective functioning of all machinery and equipment.
- iii) Adequate training and supervision of staff including bird's welfare.

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## 5.2 SELECTION OF SUITABLE SITE

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You have already learnt about selection of site for an abattoir in course BPVI-022. For poultry processing plant, it is also similar to an abattoir. Here just to refresh, some basic considerations have been summarized.

- Poultry processing plant should be situated nearby the poultry production area to minimize the transport cost and bird mortality. Sometime it is not possible because market demands fresh meat and poultry requires to be slaughtered nearer to the market.
- There should be adequate supply of water and electricity.
- The plant should be well connected by road and if possible by rail also.
- The locality of the plant should have sufficient labours to manage, operate and maintain the plant.
- There should be ample area for ancillary buildings, waste disposal systems, loading and unloading area and future expansion etc. According to general rule, buildings should occupy about 20% of the total ground area.
- The plant should be situated at a distance from any existing industry to avoid contamination of the poultry from the odours, fumes, smoke, sawdust etc.
- The ground of the site should have good load-bearing characteristics to support the building and should have a gentle slope to support adequate drainage.
- The proposal to build a poultry processing plant should be discussed with concerned local authorities to seek their approval.

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## 5.3 DESIGN AND CONSTRUCTION

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A poultry processor must look into proper design and construction to maintain high standard of hygiene and sanitation of plant and product. Good design helps different activities to keep apart, keeping area clean and prevent cross contamination. Following points should be looked into while designing and constructing poultry processing plant.

### 1) Building

Good design include separation of clean process from semi clean and dirty process, and proper storage of by-products. These facilities will permit easy cleaning; prevent entry of pests and environmental contaminants.

### 2) Ceiling

It should be made from materials that are smooth, durable, impervious, easy to clean, light coloured, not easily damaged by condensation, capable of holding ventilation grills, pipe works. High apex roof in hot areas and building with slopping roof in humid areas are considered best.

### 3) Walls

The walls should be smooth, durable, easy to clean, non flaking, light coloured. The walls would allow pipe work to pass through. Materials for construction of outside wall should be selected considering the climate and environment of the site. Outside wall should be made of low absorbent material like fired brick, marble or other local stone. Inside wall should be glazed for easy cleaning. Plastic sheeting, resin bonded fiber glass or stainless steel can be used for certain height of inside walls.

#### 4) Floor

Floor should be non-slip surface and made of solid type tiles, resistant to water, to acid, grease and salts. Adequate drainage facilities are to be provided.

#### 5) Ventilation

Good ventilation provides reasonable working condition, reduces humidity and temperature, condensation, dust, steam and removes odours and contaminated air.

#### 6) Electricity

Plants should have adequate number of power points. Wiring should be protected by water proof materials.

#### 7) Water and steam

Adequate supply of potable water is essential for the plant and process. The water should be analysed periodically to test its fitness for food processing and meet the standard of potable water. Contamination of potable and non-potable water supply should be prevented. Water should be chlorinated so that residual concentration of 0.5 ppm free chlorine is available after 20 minutes contact time. Water should be supplied at a minimum pressure of 15 psi. A plant requires 25-35 liters water per bird slaughtered. Steam can be generated by electricity, gas or solar heaters at the place where it is used and can be used for scalding and cleaning in small plants. A mobile steam cleaner can also be effectively used for cleaning where cleaning agent is added to the water flow. These process are not economical in larger plants where steam should be generated in a boiler house.

#### 8) Lighting

Adequate lighting is desirable for staff to maintain clean and safe products. Fluorescent light fitted with diffusers would prevent glare. Daylight can be used as the cheapest source of lighting but as it is not possible in all the parts of the plant, a standard lighting facility for general work and meat inspection purposes should be provided. To use the daylight, windows with uncoloured glasses can be used. In meat inspection area light intensity should be 540 lux whereas in other working areas it should be 220 lux. In inspection area, light intensity is measured at least at 1.2 m height from the floor. Care should be taken to prevent contamination in case of breakage of glass tubes.

#### 9) Ventilation

In a tropical country like India, temperature and humidity of the air can be very high. So adequate ventilation is essential in meat plant. It is also needed to remove dust, gases and odour. Natural ventilation through openings in the wall or roof is economical but entry of birds, insects and rodents should be prevented properly. Artificial ventilation is expensive but necessary in some plants. In processing room 20 or more changes of air every hour is needed whereas for comfort in general rooms only 6 changes/ hour is sufficient. Counter-flow air system i.e air flow from finished product area to raw or non processed area should be used.

#### 10) Equipment Design and Installation

It should be ensured that all equipment and utensils used for the production is maintained in a manner to prevent contamination by microbiological, chemical or physical hazards. All equipment and utensils should be installed in such a way to

provide sufficient working space within and around the machinery. These should be designed to be cleaned properly after use. Preferably these should be made of stainless steel or galvanized steel and should have smooth surfaces and clean welds. No paint should be used in equipment or utensils as paint may flake and contaminate the carcass. If the stairway, overhead rails, platform, steps etc. are made of aluminium alloy, then these can be easily cleaned. Wash hand basin also should be made of stainless steel and foot or knee/arm operated. Above all the equipments should be bought depending upon the level of technology best suited to the system and the expected maximum throughputs in foreseeable future. Either the equipment should be raised 200 mm if not sealed to the floor or installed at a sufficient distance away from the walls for easy cleaning, operation and maintenance.

### **11) Work Surface**

Work surface should be smooth, impervious, free from cracks and easy to clean. It should be at correct height with firm base. Cracks and gaps to be sealed properly as it could harbour food scraps.

### **12) Environment**

Suitable environment inside the plant is essential for food safety. These include room temperature, product temperature, equipment settings to have optimum product quality. Correct storage is essential for hygiene and efficient food business.

### **13) Drainage**

Sufficient drainage should be provided and maintained in good order. Waste water should flows on the floor in such a speed that it rapidly flows to the drain but does not cause difficulty in walking or movement of the traffic. Thus the floor should have sufficient gradient (1:60). Drains should be covered with grill in the working room and flow from clean to dirty areas. The diameter of the drains should be at least 150 mm to facilitate free flow of large weights of feather, fat and faeces. During designing effluent disposal system, nature of the waste and its volume and the system of operation should be kept in mind. Traps should be for separating solid suspended materials and their removal. Inspection holes should be provided. There should be separate drains for rain water which may be open in places. Separate drains for human waste should pass through closed pipe and should have gullies and manholes.

### **14) Sanitary Facilities**

In the utility block necessary separation should be made for all washrooms, canteen and change rooms to prevent contamination. Washroom should be provided with sufficient number of easy cleaning sinks and with hot/cold water supply. Processing area is microbiologically sensitive area and needs special attention for hot and potable water to ensure safe product.

### **15) Pest Control**

The establishment should have an effective and safe pest control programme to prevent insects, rodents, birds and animals entering the plant. Electrical insect attractants with electrified grid should be used inside the production area to kill flying insects.

### **16) Product Flow**

The plant should be designed in such a way that the products can smoothly flow along the processing line. There should be minimum distance between all operations,

minimum interference between other operations and cross flows of operations. It is also needed that the operators should be kept to the minimum.

Above all, it should be kept in mind that clean and dirty operations in a plant should be carried separately to maintain the hygienic quality of the product. Thus there should be separate rooms for the following facilities:

- i) Reception area
- ii) Slaughter, scalding and defeathering
- iii) Evisceration, washing and giblet processing
- iv) Chilling
- v) Cutting and packaging
- vi) Freezing and storage
- vii) Despatch
- viii) By-product processing

(Source : [www.fao.org](http://www.fao.org))

### Check Your Progress 1

- 1) Adequate supply of potable water and electricity are essential while deciding on a location for a poultry dressing plant. Justify the statement.

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- 2) List four components which should be considered for good design and construction, to maintain high levels of hygiene inside the plant.

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- 3) What should be the intensity of the light in the meat inspection area and meat cutting area?

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## 5.4 EXAMPLARY PLANT LAYOUT

The plant layout below indicates clean and unclean poultry dressing layout. The unclean part includes reception and loading area, lairage, area for slaughter, scalding, defeathering, evisceration, and by-product processing. Plant also possesses a clean

section which includes chilling, packing, storage and despatch section. Different sections of the poultry processing plant are described here:

**i) Bird reception and loading area**

There should be a separate entrance for the birds as the bird itself, the person bringing the stock, vehicle and containers for birds may contain dirt, faeces, insects, microbial infection etc. This reception area should be provided with washing facilities for vehicles and bird carriers. The birds awaiting slaughter should be kept under cover. There should be sufficient space so that the vehicles can move and store both full and empty bird crates/containers properly. In modern poultry processing plant, processor makes arrangement for overhead spraying of live birds with sanitizer to minimize the microbial load. This area also should be provided with good ventilation. The provision of reception loading area should be made adjacent to the reception area. There should be sufficient space to sort stock and handle crates/ containers. There should be provision of hand wash basins for bird handlers and easy access to the equipment to hand the birds before slaughter.

**ii) Lairage**

Usually birds picked up from farm, are slaughtered immediately. However there may be a place intended to provide rest to birds before slaughter and that place is called as lairage. Poultry birds are more susceptible to high temperature and therefore fans, coolers along with facility of drinking water must be ensured in lairage. Droppings disposal is problematic in birds and therefore litter system may be adopted which should be turned up side down regularly. Birds are usually kept for a shorter duration (12 hours), not as long as cattle, buffaloes or other animals in lairage. Feed withdrawal before slaughter is also applicable here but time gap is not as long as other; usually 6-8 hours fasting is sufficient enough. Actually in practice, birds are being kept at farm-house itself. There should be good ventilation and lighting facilities at poultry lairage.

**iii) Slaughter hall**

It is the actual part of plant where birds are slaughtered. It is well lighted and ventilated but at the same time there should not be any ingress of flies, birds etc. You can say it most unclean area but adequate supply of water and good drainage system ensure cleanliness of area. There is an outlet for blood from the area. Blood should not be allowed to pass directly into the effluent disposal system because blood has a high Biological Oxidation Demand (BOD). In some large processing plant, vacuum pump is used to transfer the blood to a tank in the by-products room otherwise small quantity of blood can be scooped up and disposed-off directly.

In large plant, birds are hanged by leg from overhead rail and dipped into the scalding chamber. In small plant, birds are kept in the cage and the cage is placed in a scalding machine which automatically agitates the carcass in the hot water.

Feathers are then removed from the scalded birds in defeathering machine. In large plant, birds suspended from overhead rail are defeathered in a machine which has several services of pluckers i.e. finger like rubber projection. In small scale processing, birds are held against a rubber drum with fingers to pluck the feathers. Number of the defeathering machine and speed of the rail depend upon the number of the birds to be defeathered in a given time. Feathers are also disposed from this area. The feathers should be screened from the drain to avoid blockage. There should be sufficient space for the movement of a person who removes pin feathers and other remaining feathers by hand.

Defeathered birds are spray washed in cold water, thus the area should be properly drained. The slaughter hall should be well ventilated to prevent condensation of aerosol on the carcass, equipments and the workers. A contaminating aerosol is formed in this area from the dirt of the flapping bird and whirling rubber fingers of defeathering machine, steam from scalding tank and faeces from dead birds. Devices for stunning, bleeding, scalding and supply of hot and cold water to this area should also be ensured. The area has direct connection with by-product processing section so that the discarded blood and feather reach to this area for their utilization.

#### iv) Evisceration room

After slaughter section, evisceration area is located where birds are eviscerated and examined. Special facilities should be provided in this area to prevent contamination of the carcass from the spoilage and pathogenic bacteria of viscera. Operators remove the visceral organ by hand from the birds hanging from overhead rails or hooks in case of small processing plant whereas in large plant, machines automatically remove the viscera. For this purpose 1 meter space per operator should be provided. Offals should be dropped into a trough. The fate of bird is decided here. After postmortem examination, rejected birds are either directed to by-product section or condemned room. The edible and inedible viscera are separated from the carcass. Carcass and edible viscera after washing and inspection, are sent to chilling section while the inedible viscera are directed to by-product section. Ample amount of water is required by this section for washing of carcass and others.

#### v) Chilling Room

Just after evisceration the carcass is hot and it is suitable for sharp cut. Moreover retention at this temperature is not advisable from microbial quality point of view. The main aim of chilling is to bring down the carcass temperature around 3-4°C but it should not be brought down immediately because of chances of cold shortening. Chilling of poultry is divided into two parts i.e. once immediately after evisceration and washing; and secondly after packing. Generally the eviscerated poultry carcasses are immersed in a tank of cold water which is chlorinated. Water may be cooled by addition of ice which is generally required at the rate of 2 kg per bird (*Source: www.fao.org*). According to USDA regulations, it requires at least 2.25 liter of overflow (water) for each bird. Chlorine is added regularly to maintain a residual level of 50 ppm. For cooling the carcasses in the chilling tank, arrangements are made in such a way that the cooling medium flows towards the carcass entry i.e. it is counterflow to the product. Carcasses may be passed through a series of tank to get better result. In chilling section carcass is retained which gives added advantage of ageing. Once the carcass is set it is sent to packing section. After packing, the carcass may be stored in chilling rooms or freezing room. Chilling room or the cold store should have facilities for easy storage of products on shelves or pallets; adequate circulation space for staff; sufficient light to read the labels; and floor drainage to wash the room regularly. At 2-4°C, chilled poultry can be stored for one or two days before despatch to retail outlet.

#### v) Packing

It is packing cum cutting section. In case of poultry, whole carcass may be packed or cutting to different pieces before packing may also be practiced. One of the important events associated to this section is separation of extra-fat and undesired tissues from carcass. These are trimmed-off before packaging. Carcasses are deboned partially or completely, if required. After chilling carcass get set and therefore trimming becomes easier. The trimmed portions are directed to by-product section.

The temperature of area is kept low (10-12°C). Here poultry are graded according to class, weight and appearance. Cutting may be done by hand or by sophisticated machinery. This room should be well lighted, well drained and provided with the facilities for grading, cutting, weighing, wrapping, marking and packing into secondary containers. Sufficient space should be there for packing tables, equipments and for movement of the trolleys. Adequate hand wash basins and towels should be there to provide hygienic facilities to the staffs.

**vi) Offal room**

The area is connected with slaughter section, evisceration section and packing section as well. The area and sub division depends on processing facilities in the by-product section. It collects feathers, blood, heads, feet, intestine and trimming from different sections. The staffs working in this room should not enter in any other processing room. The floor and the wall upto 3 meter or more from the floor of this room should be impervious to water.

**vii) Freezing room**

There are several methods of freezing poultry carcass. Usually the wrapped carcasses or portions are placed in metal or plastic trays and kept in the blast freezer at -40°C for 2-3 hours. Then these are stored at -20°C or below for a longer period (may be upto six months). The temperature of the area depends on how long the carcass has to be stored there. Usual temperature for frozen storage is -18°C. The storage area is least approachable. On the other side it opens to despatch section. Plate freezing and cryofreezing can also be used for this purpose and you have studied about these methods earlier. This room should have adequate facilities for storage of the products on shelves or pallets, easy removal of ice, light and easy access to the despatch section.

**viii) Despatch**

This section is designed as per mode of outlet. It has been designed in a way that materials could be loaded easily and despatched. The temperature in the area is kept low very similar to chilling section.

**ix) Dry store**

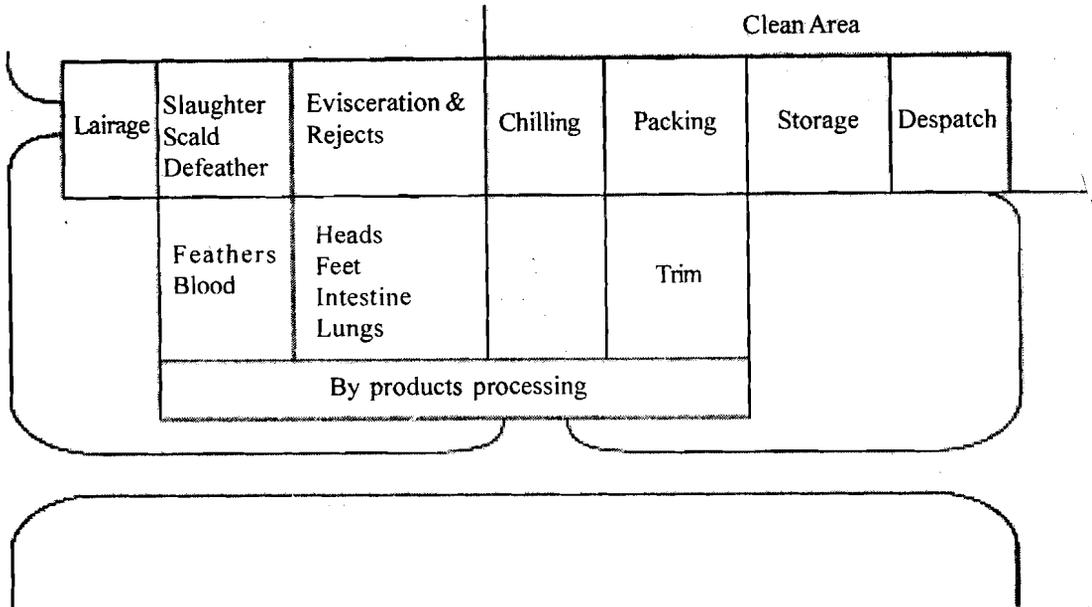
There should be a provision for storage of bulk packaging materials in the poultry processing plant. Care must be taken to prevent the insects and dust in the dry store.

**x) Staff facilities**

Staff facilities indicate changing room, toilets, showers, washing facilities, lockers, bins for dirty laundry, dinning room for the personnel working in the poultry processing plant. There should be separate facilities for men and women. You have already studied about these facilities in course BPVI-022 under the heading of utility services. The changing room should be planned in such a way that staff arriving for work and leaving at the end of the shift can enter the room directly without passing through any production area.

Beside these there should be boot and hand wash facilities, laundry, office, inedible by-products and waste disposal facilities. Waste disposal will be discussed in detail in course BPVI-027.

Rest things such as unidirectional movement of carcass, limited access to clean area, separate workers and timing schedule for clean and unclean area etc. are applicable for poultry plant also.



Source : US Grains Council

Fig. 5.1: Example of clean and unclean area layout for Poultry

**Check Your Progress 2**

1) “Blood should not be allowed to pass directly into the effluent disposal system”- Justify the statement.

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2) What is the use of overhead sprayer at the bird reception area?

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3) List different activities which take place in the packing section.

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4) Enlist the clean and unclean area of the poultry processing plant.

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- 5) Evisceration is included in unclean area, where as, chilling, in clean area. Give reasons.

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## 5.5 LET US SUM UP

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The location, design and construction of plant are governed by number of factors. Proper facilities should be provided inside the plant for the production of wholesome good quality meat. To maintain high levels of hygiene inside the poultry processing plant and produce good quality poultry products it is to be ensured that there are proper segregation of clean and unclean area; adequate supply of potable water; adequate drainage facility and proper maintenances of equipment and utensils used in the plant. Usually the plant has unclean areas like reception and loading area, lairage, slaughter area, scalding, defeathering, evisceration, and by-product processing area. The clean part of the plant includes chilling, packing, storage and despatch section.

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## 5.6 KEY WORDS

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- Aerosol** : It refers to airborne solid particles or liquid droplets.
- BOD** : Biological Oxidation Demand (BOD) is the amount of oxygen required by micro-organisms to biologically degrade the organic material present in the waste water in 5 days at 20°C.
- By-product** : Everything from slaughter of an animal that is not directly sold as consumable meat is known as by-product. e.g. Head, feet, liver, heart, gizzard etc.
- Defeathering** : It is a process of removal of feather.
- Evisceration** : Removal of visceral organs from a carcass.
- Humane Treatment** : Gentle, soft handling of live birds.
- Lairage** : Holding place of birds before slaughter.
- ppm** : Parts per million
- psi** : Pound per square inch – it is an unit of pressure.
- Scalding** : Dipping of carcass into or spraying with hot water to facilitate defeathering.

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## 5.7 SOME USEFUL BOOKS/REFERENCES

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Alan R Sams (2001). *Poultry Meat Processing*, CRC press, New York.

Carmen R. Parkhurst and Georage J. Mountney (2002). *Poultry Products Technology*. Haworth Food Products Press.

Shai Barbut (2005). *Poultry Products Processing*, CRC press, New York.

www.fao.org

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## 5.8 ANSWERS TO CHECK YOUR PROGRESS

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### Check Your Progress 1

- 1) The slaughter and dressing of poultry includes different steps to be performed in systematic manner. The steps such as scalding, washing, evisceration, and chilling requires supply of potable water. Similarly, adequate supply of electricity is required to operate different machines and for lighting.
- 2) Following components should be considered for good design and construction, to maintain high levels of hygiene inside the plant:
  1. Proper segregation of clean and unclean area.
  2. Adequate supply of potable water.
  3. Adequate drainage facility.
  4. Proper maintenances of equipment and utensils used inside the plant.
- 3) The light intensity in meat inspection area should be at least 540 lux and that is in the meat cutting area should be at least 220 lux.

### Check Your Progress 2

- 1) Blood should not be allowed to **pass** directly into the effluent disposal system because blood has very high biological oxidation demand. If it is directly passed into effluent disposal system, it will create a high level of pollution. High concentrations of organic matter in blood could result in almost complete depletion of oxygen in the soil-water matrix and damage the local ecology.
- 2) In bird reception area overhead sprayer is used to spray the solution containing sanitizer over the birds kept in the crates or containers. Spraying can be done when the birds are waiting in the vehicle or on the platform before slaughter. This is done to maintain hygienic quality of the product by minimizing the microbial load of the birds.
- 3) In the packing section following activities take place:
  - Weighing of the carcass,
  - Grading of the carcass according to class, weight and appearance
  - Trimming off extra-fat and undesired tissues from carcass
  - Cutting of the carcass into different parts
  - Deboning of the carcass
  - Wrapping of the carcass or the parts in packaging material
  - Marking/labelling of the packages
  - Packing into secondary containers

4) Clean area of the poultry processing plant includes:

- Chilling section
- Packing section
- Storage area
- Despatch section.

Unclean part of poultry processing plant includes:

- Reception and loading area
- Lairage
- Area for slaughter
- Scalding area
- Defeathering area
- Evisceration room
- By-product processing area

- 5) Evisceration is the removal of visceral organs. It includes separation of intestines, gizzard and lungs etc., from the carcass, which carries microbial load that's why it is included in unclean area. Chilling is performed after evisceration and post-mortem inspection in the carcass. The carcass is thoroughly washed before post-mortem inspection. Thus chilling is done in clean area.