

Chapter 6

Slaughtering and Slaughtering Procedures

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6.1. Animal welfare and Ante-mortem handling

What is animal welfare?

- ✓ Welfare is hard to define precisely. It obviously relates to an animal's mental and physical well-being.
- ✓ Physical well-being implies that an animal is fit and healthy, but mental well-being is harder to define because it is difficult to know whether an animal is content or not with its environment.

What is animal welfare? (Conti...)

Basic Animal Welfare involves:

- ✓ The **provision of potable water** ad lib as well as food and air to main health and productivity.
- ✓ **Protection from disease** and injury and access to veterinary care necessary.
- ✓ **Sufficient space to lie**, stand, stretch and enjoy natural behaviour patter
- ✓ **Adequate housing** (figure 1. shows an undesirable situation overcrowding).
- ✓ **Protection** from extreme climatic conditions e.g., excessive sun, rain.



Figure 1: Shows overcrowding

What is animal welfare? (Conti...)

- Animals that are stressed, experiencing pain and discomfort or are inadequately fed, watered or housed will not produce to their **full potential & the quality of their meat** produced is compromised.
- Poor welfare can lead to inferior meat quality (Gregory, 1993). In the fresh meat trade it results in **loss of yield and loss of sales through rejection or downgrading of poor quality product.**
- The links between poor welfare and downgrading apply to the following conditions in the fresh meat or carcass:

What is animal welfare? (Conti...)

- Abnormal meat colour;
- Pale soft exudative (PSE) meat in pork and turkey;
- Dark firm dry (DFD) meat in pork, beef and lamb;
- Poor shelf life;
- Dry meat;
- Heat shortening in poultry;
- Bruising;
- Torn skin;
- Broken bones.

What is animal welfare? (Conti...)

- Animal welfare is in **itself becoming a quality issue** because some retailers are imposing animal welfare standards in their specifications for suppliers.
- The retailers want to have a caring image for animals and for the company's customers.
- Some of the major supermarket companies are setting standards on animal welfare within the market.
- The specifications on welfare and product quality are taken seriously by the meat works which supply them because they need to secure the supermarkets' business.

What is animal welfare? (Conti...)

- ✓ Meat-exporting nations depend on agricultural produce for their livelihood.
- ✓ If sentiment goes against a country because it has unacceptable welfare, hygiene, environmental or sociopolitical standards, meat buyers may take their custom elsewhere.
- ✓ Consider the following example. Suppose that Country X exports beef to Country Y.
- ✓ There is a television programme broadcast in Country Y which shows hot-iron branding, and farmers in Country X are identified with this practice.

- The animal welfare pressure groups use the opportunity to lobby the public to stop buying beef from Country X.
 - ✓ A sector of the public responds, but more importantly the supermarkets in Country Y decide to stop sourcing beef from Country X because of its tarnished image.
 - ✓ The market forces that set this off originated with the animal welfare pressure group.
 - ✓ Animal welfare pressure groups try to influenced purchasing behavior through their publicity.
 - ✓ This may or may not have much effect on the way consumers spend their money, but it can influenced the purchasing patterns of the major retail companies which try to promote the image of a reputable and caring business.

- Some EU meat-importing countries have argued strongly that transport duration for livestock should be limited by EU regulations to eight hours, whereas some of the meat exporting countries have argued that there should be no limit on journey time.
- This is an example where an animal welfare issue could **become a barrier to trade**, assuming that a mutual agreement was reached.
- In practice, it is pressure from retailers, animal welfare pressure groups and consumers that is likely to have more influenced on market positioning in animal welfare issues.

Transport of Food Animals And Animal Welfare

- ✓ Transport affects adversely the condition of the animal and the consistency of the flesh.
- ✓ There are regulations in different countries, which govern the transport of animals by rail and road and these should be strictly enforced the careful handling of food animals before slaughtered has great importance.
- ✓ Unsuitable conditions of rail or road transport frequently lead to injury, lameness, and suffocation or transit fever.

Transport of Food Animals And Animal Welfare (cont...)



Figure 2 acceptable
Transportation



Figure 3 un acceptable
Transportation

Transport of Food Animals And Animal Welfare (cont...)

- The danger is great for fat animals than for lean and is accentuated,
- the more closely animals are loaded, the higher the temperature and the longer the journey.
- Large and small cattle and animals of different species must be separated by partitions.
- Animals undertaking a journey of 24 hours or more must be fed and watered before hand.
- And if the journey is of 36 hours duration they must be fed and watered in transit.

Transport of Food Animals And Animal Welfare (cont...)

- Water assists all animals to withstand heat.
- Fowls must only be transported in cages or other airy receptacles.
- Their transport in sacks and also tying and carrying by their feet should be prohibited .
- Transportation may take place by driving, trucking, rail and by boat or ship.

Driving on Foot



- ✓ Transportation by driving affects animals to a great degree corresponding to their being accustomed to outdoor exercise and the temperature of the season.
- ✓ Sheep and cattle raised under range conditions are least affected but difficulty is experienced with stabled cattle, calves and pigs.
- ✓ As driving of fattened animals affected them unfavourably in proportion to their fleshiness; they are driven only over short distances.
- ✓ Travel for long distances should be allowed, if they are accustomed to it.

Driving on Foot (cont....)

- Animals always get excited and tired during transport and if slaughtered immediately they bleed out incompletely and in most instances cause decrease in keeping quality of meat.
- Pigs when driven should never be struck with a stick.
- Skin discolourations and bruising become obvious especially after scalding of carcass with a resultant depreciation in value.
- Driving is best done with a flat canvass strap.
-)

Driving on Foot (cont....)

- Only cattle, sheep and goats can be successfully moved on hoof, and here certain risks are involved.
- The journey should be planned, paying attention to the distance to be travelled, opportunities for grazing, watering and overnight rest.
- Animals should be walked during the cooler times of the day and, if moving some distance to a rail head, they should arrive with sufficient time to be rested and watered before loading.
- The maximum distances that these animals should be trekked depend on various factors such as weather, body condition, age etc

Driving on Foot (cont....)

- It is illegal to make animals walk in heavy rain, thunderstorms or extremely dry or sultry conditions.
- Every animal shall be given a break of 20 minutes after being given water and a break of one hour after being given food

Table 1. Maximum Distances For Trekking

Species	One day Journey	More than one day	
		First day	Subsequent days
Cattle	30 Km	24 Km	22 Km
Sheep/Goat	24 Km	24 Km	16 Km

Transport by vehicles

- vehicles should be suitably constructed for carrying different species of animals and must permit a careful loading and unloading of animals.
- Animals should be secured only to reasonable extent, so as not to allow them to jump out of the truck.
- Forcible and painful tying of legs of calves and sheep especially with thin cutting strings is unwarranted
- Overcrowding of animals in small spaces should be condemned.
- In hot day they should be protected from sun

Transported by vehicles (cont...)

- ✓ Pigs should be kept cool by sprinkling water over them or by transporting them during night.
- ✓ Only four adult cattle or six calves may be carried per small truck. In any case, each cow should be given 2 square metres and an attendant should be able to move freely between the cattle.
- ✓ Only 40 sheep or goats may be carried per truck, and an attendant should be able to move freely between the animals.
- ✓ The minimum space for poultry within cages is 1'x1'x1' (feet) for chickens and 2'x2'x2' (feet) for hens and cocks

Transported by vehicles (cont...)

- ✓ All trucks carrying animals must be fitted with a ramp. Animals must be accompanied by an attendant.
- ✓ Food and water must be provided during long journeys. Animals must be accompanied by a veterinary certificate verifying that the animals are free from disease.
- ✓ The name and address of the owner, the number of animals being carried and the destination must be clearly marked on the truck.
- ✓ Vehicle floors should be matted or grooved to prevent slippage. The vehicle must travel at a measured, uniform speed to avoid discomfort to the animals (PETA).

Transported by vehicles (cont...)

Table 2. Floor Space For Transporting Different Classes Of Animals

Classes of Stock		Floor Area/Animal (m ²)
Mature cattle		1.0 - 1.4
Small calves		0.3
	porker	0.3
	baconer	0.4
	sow/boar	0.8
Sheep/goats		0.4

6.2. Treating of animals in the holding-pen or lairage

- Rest after transport is desirable as an animal slaughtered without an adequate period of rest shows a reduction in keeping quality of flesh due to Incomplete development of acidity in muscle,
- Early invasion of the system, by putrefactive bacteria from the intestinal tract.
- Stress and fatigue lower the quality of meat in several ruminant species due to depletion of glycogen in muscle

6.2. Treating of animals in the holding-pen or lairage (Conti...)

- ✓ Due to low acid production, the ultimate pH of the muscle remains high causing a condition called dark cutting meat or dark, firm and dry (DFD) meat in cattle.
- ✓ Thus, the keeping quality of meat is reduced and it looks dark due to high water content.
- ✓ Such meat is unusually tender on cooking.

6.2. Treating of animals in the holding-pen or lairage (Conti...)

✓ A period of 6-24 hours with a maximum of 36 hours detention and rest in a lairage is essential for such animals before slaughter.

✓ The actual duration of the resting period depends on many factors such as; species of animals, age, sex, class and condition, time of year, length of journey, method of transportation, etc.

6.2. Treating of animals in the holding-pen or lairage (Conti...)

Watering

- Animal should receive ample drinking water during their detention in the lairage as this serves to lower the bacterial load in the intestine and facilitates removal of the hide or pelt during dressing of the carcass.
- If animals receive unlimited water during their rest period prior to slaughter stunning of animals by electrical and gaseous means becomes more efficacious.



6.2. Treating of animals in the holding-pen or lairage (Conti...)

❑ FASTING

- Animals with full stomachs will cause excessive contamination of carcass and offal if accidentally cut during the dressing procedure
- Wet hides and fleeces encouraging the transfer of faecal material particularly to areas such as the shanks brisket and hocks
- The withholding of feed begins at the time the animals leave the farm and causes loss of body weight

6.2. Treating of animals in the holding-pen or lairage (Conti...)

- It is important to know how long animals can be fasted before body weight losses commence and the extent of these losses.
- Adult cattle lose no weight three days after removal from pasture but loss severely after four days withdrawal of food.
- Adult sheep would not lose as much body weight as lambs in comparable periods.
- Therefore, resting periods should be geared accordingly and stock for slaughter should be drawn from production areas as close to slaughter points as possible



**Sticking
Knife**



**Skinning
Knife**

6.3. Slaughter Tools

- The amount of equipment will depend on the slaughtering procedures employed.
- If possible, all equipment should be made of stainless steel or plastic, be rust resistant and easily cleaned and sanitized.
- Basic equipment needed for the slaughtering operation:
 - a. **Sticking Knife:** A knife (with the different size based on the type meat animal slaughtered e.g. a six-inch blade for small ruminants and larger for cattle) sharpened on both sides and a pointed v-shaped end used for severing the blood vessels of the neck to allow animal to bleed.

6.3. Slaughter Tools (conti..)

b. Skinning Knife: As the name implies, this knife is used for the removal of the animal's skin.

✓It is characteristically curved backwards to allow for ease of operation,

✓it can be used to scrape off burned hair from carcasses being dressed with the skin-on

c. Meat Saw: A replaceable blade handsaw which is used in sawing through bones.



6.3. Slaughter Tools (conti..)

d. **Meat Chopper:** Also called the cleaver, the meat chopper is a heavy axe used for separating heavy structures, e.g. the head from the neck and the shanks from the leg.



e. **Spreader:** A metal device for suspending the animal's body and spreading out the legs for dressing and inspection purposes



f. **Steel:** A long tapering, rounded and smooth metal rod on which knives are smoothened from time to time to improve sharpness



6.3. Slaughter Tools (conti..)

G. Meat Hooks: These are metal devices with bent curved ends for holding or displaying parts of the carcass and offal for washing and inspection.



Butchers Gloves: Made of stainless steel to protect fingers from getting cuts during the dressing and fabrication processes



6.4. Procedures in slaughtering

- Unless not permitted by rituals and/or other established traditions, the humane method of slaughter is recommended for use as they allow for safer, more economic and hygienic operations and a desirable quality product.
- Humane slaughter is the slaughter of animals that are in a complete state of unconsciousness prior to bleeding.
- The following steps are crucial in the application of the method:

6.4.1. Stunning

- Stunning is rendering an animal completely insensible/unconscious similar to surgical anesthesia.
- The need for stunning:
 - to make the animal unconscious – no resistance;
 - to reduce the pain to the animal
- Stunning methods may be:
 - reversible e.g. head-only electrical stunning - so slaughter quickly before return to consciousness;
 - irreversible e.g. penetrating captive bolt or cardiac arrest electrical stunning (Hui et al., 2001)

Restraining Animals before Stunning

- This helps for operator safety since animal is conscious
 - Allows accurate shooting or application of the electrical current in the use of a mechanical or electrical stunning
 - Restraining is carried out in specially designed pens
 - Manual restraint - for small animal e.g. sheep, pigs, and goats, not for cattle
 - For cattle - more common to confine in a **stunning box**, and needs to **restrain the head part** (Warriss, 2000)
 - Aversive methods of restraint e.g. electrical immobilization that cause $\geq 3\%$ of animals to vocalize must not be used – causes **paralyses muscle**
-



Well designed stun-box with an adjustable side

Methods of Stunning

- Use of mechanical instrument
 - captive bolt pistol
 - free bullet
- Use of electrical current passed through the brain; and
 - Head-only
 - Deep stun/head-to-body/cardiac arrest
- Use of an anaesthetic gas such as carbon dioxide
 - E.g. CO₂

1 Stunning by Use of Mechanical Instrument

- Two kinds of mechanical methods:

A. Non-penetrating captive bolts - mushroom-headed blunt bolt usually on the forehead of animals

B. Penetrating captive bolts - sharp-rimmed bolt usually on the forehead of animals (European Food Safety Authority, 2004)

Use of a Free Bullet

- Only used for large bulls and boars
- Less safe method as bullet may pass through the animal's body
- Necessary if the animal has a very thick skull (Warriss, 2000)
- Occasionally used (e.g. for emergency slaughter or as a back-up method in case of failure of another method) (European Food Safety Authority, 2004)

Captive Bolt Stunning

- In the captive bolt pistol (Figure 1) the bolt is driven into the animal's brain by either the detonation of an explosive cartridge or by compressed air

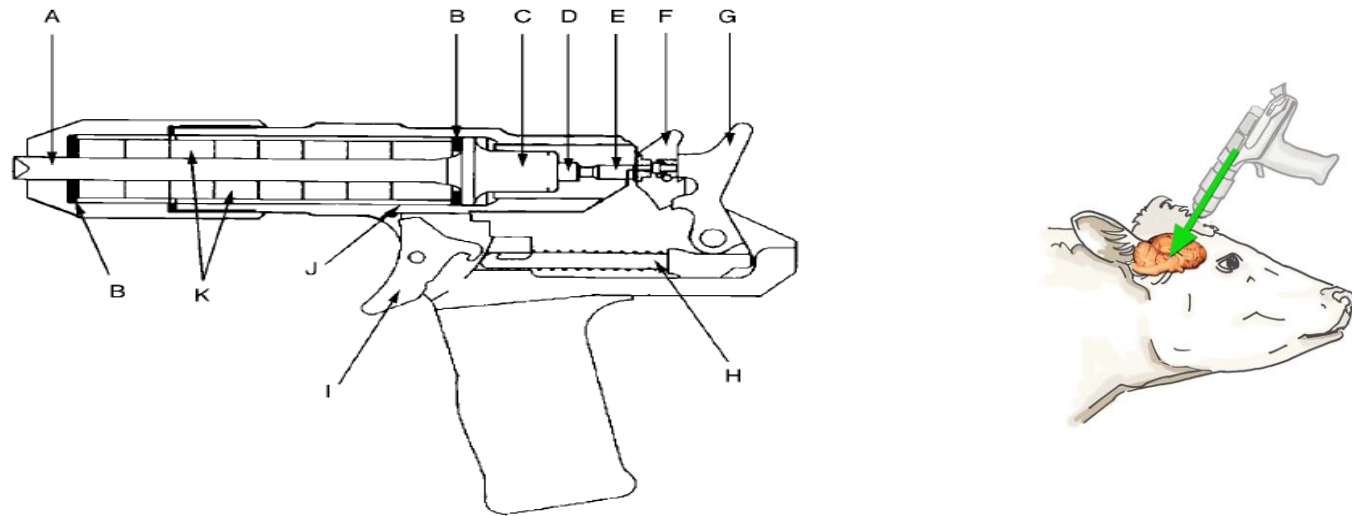


Figure 1. Schematic diagram of trigger operated bolt pistol:

- | | |
|------------------------|-------------------------------------|
| A. Bolt | B. Stop washers |
| C. Flange and piston | D. Expansion chamber |
| E. Breech | F. Ejector - housing the firing pin |
| G. Hammer | H. Trigger mechanism |
| I. Trigger | J. Undercut |
| H. Recuperator sleeves | |

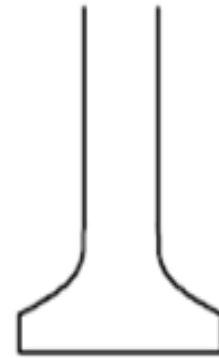
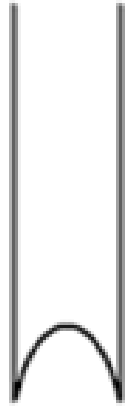


Figure 5. Typical bolt tip shapes: penetrating captive bolt (left) and non penetrating captive bolt (right)



Figure 6. Examples of penetrating bolt captive bolts: trigger operated for all species (left) and contact firing captive bolt for cattle (right)



A



B




C

Figure 5. Examples of non-penetrating captive bolts: trigger operated for cattle (A), contact firing for cattle (B); non-penetrating captive bolt for poultry (C)

Different cartridges size are used:

- **4–6 grain (1 grain = 0.065 g) cartridge for bull**
- **1–2 grains sufficient for sheep**

- 
- To stun animals-not necessary to penetrate brain
 - Non-penetrating blow to the head is achieved through a mushroom-shaped 'bolt'
 - If the bone is broken, some of the energy will be absorbed rather than transmitted to the brain
 - Because the brain is slightly differently positioned in relation to the head shape, different shooting positions are optimal for the different species (Figure 7)
 - Goats and horned sheep need to be shot in the poll position because of the bony mass found on top of the skull, or the tissue associated with the horns, in these animals

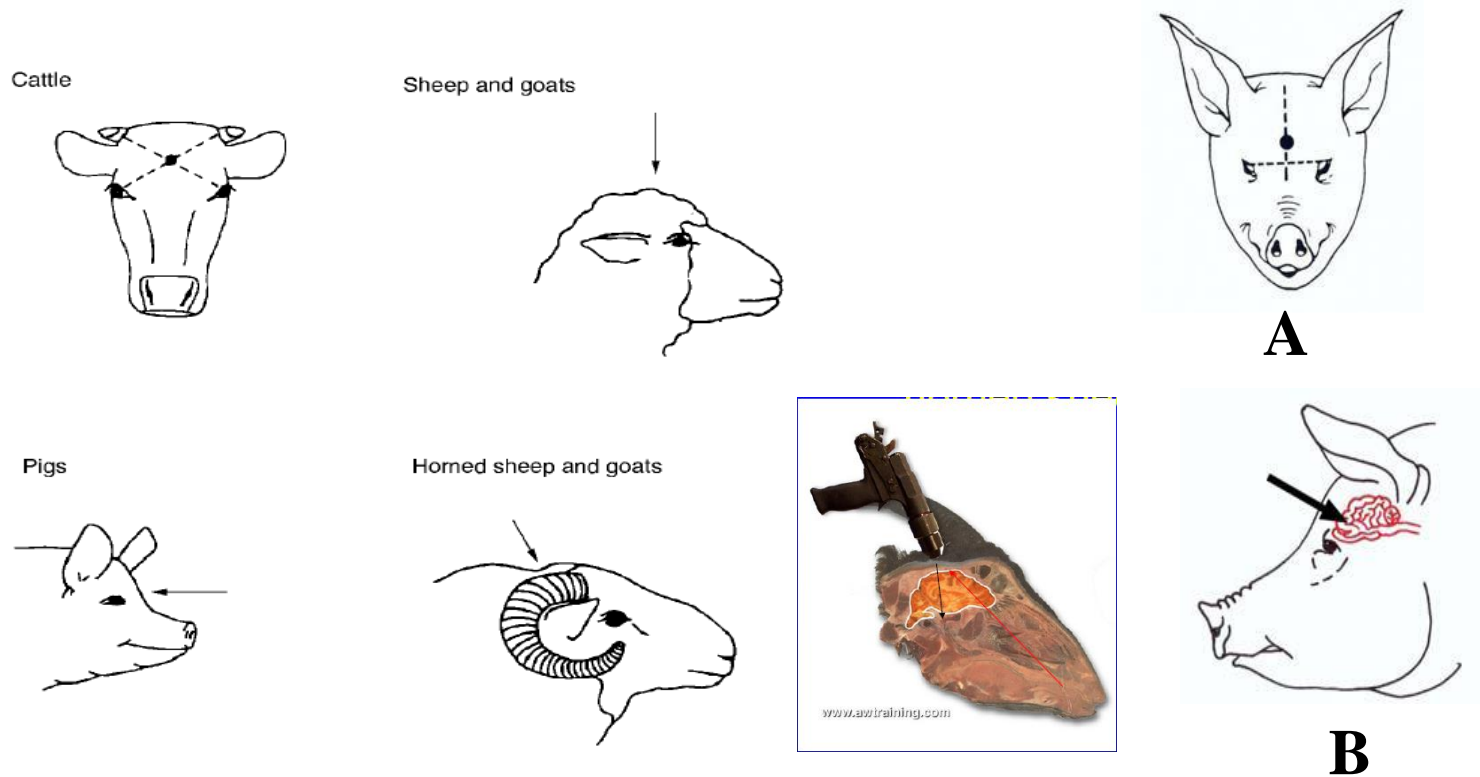


Figure 7. Positions for stunning the different species with a captive bolt pistol

In pigs - ideal position is in the mid line of the forehead 1-2 cm above the eye level (A) and the muzzle of the captive bolt be directed towards the tail (B)

2 Electrical Stunning

- **Objective:** to pass current through the brain to temporarily disrupt normal brain function
- Used mainly for poultry, pigs and sheep, but has been employed for mature cattle in some countries
- Voltage ranging from 150 to 700 V (AC, 50–60 Hz) is used depending on the system
- Effectiveness of stunning is determined by:
 - the positioning of the electrodes through which the current is applied,
 - the amount of current passed through the brain.
 - Ohm's Law: $\text{Current} = \text{voltage} / \text{resistance}$

Table 3. The amounts of current which have been recommended for stunning different species

Species	Current (amps)^a
Chicken	0.105
Rabbit	0.3
Lamb	0.6
Sheep	1.0
Goat	1.0
Calf	1.0
Pig	1.3

^a For head-only stunning

➤ The current should be passed for 3 seconds

3.2.1 *Head-Only Electrical Stun*

- Current is passed through the brain but no other vital organs (EFSA, 2004)
- Electrodes are applied only across the head using various designs of tongs with electrodes attached to the ends
- The ideal electrode position for pigs and sheep is:
 - *b/n eyes and bases of ears on each side of head;*
 - *one tong placed on the top and the other tong placed on the bottom of the head;*
 - *one electrode under the jaw & other electrode on the side of the neck right behind the ears (Hui et al., 2001)*



A



B

Figure 8. Scissor stunning tongs (A) and fork stunning tongs (B)

The head electrode may be placed:

- on the forehead
- side of the head
- top of the head, or
- in the hollow behind the ear
- But never be placed on the neck b/c this would cause the current to bypass the brain; or
- Do not apply to sensitive areas such as inside the ear, in the eye, or in the rectum (Hui et al., 2001)

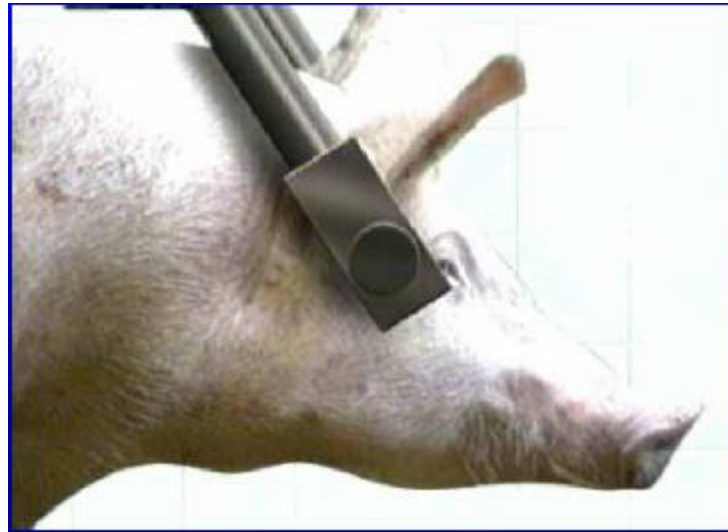
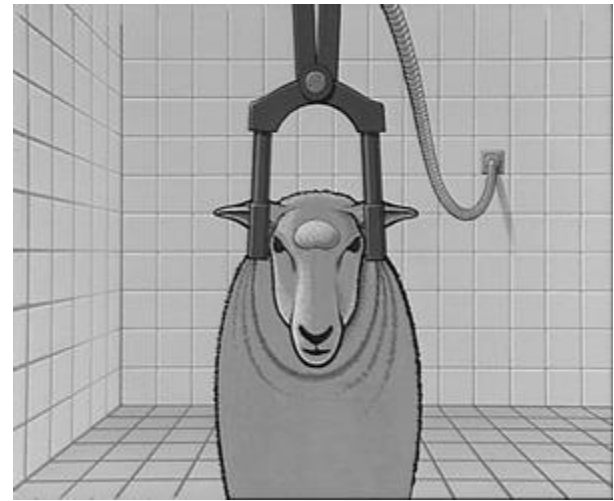
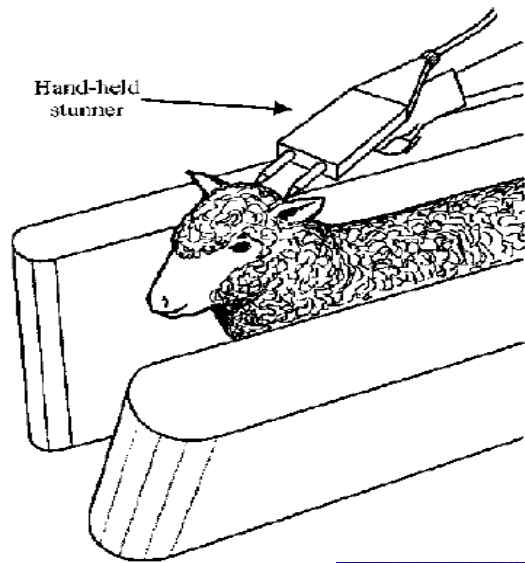


Figure 9. Head-only stunning of sheep and pig

Head-Only Electrical Stun (Cont'd...)

- Since no current passes through the heart:
 - ➡ the heart continues to beat;
 - ➡ if slaughter does not proceed, the animal will eventually recover with no ill effect;
 - ➡ the head-only stun is considered acceptable for Muslim (Halal) slaughter (Gilbert et al., 1986)
- *debating issue*
- ➡ Stunning is not recommended for the Jewish method

- Sequence of external responses displayed by the animal in a successful head-only stun:

Animal first becomes rigid (the tonic phase) with the head raised and the hind legs pushed up into the body

Breathing stops (10 to 25 sec)

Clonic phase (if no slaughter) - kicking movements for 15 to 45 seconds

Quiet phase - breathing restarts, gaining awareness

If animal responds to corneal contact, it is probably conscious

Table 4. Summary of time and current parameters of head-only electrical stunning

Parameter	Type of animal				
	Sheep	Lambs	Calves	Cattle	Deer
Minimum current (A)	1	0.7	0.9	1.1	1
Range (A)	1-1.5	0.7-0.9	0.9-1.5	1.1.-2.5	1-2
Minimum time (seconds)	1	0.8	1	1	1
Range (seconds)	1-4	0.8-1.5	1-4	1-4	1-3

Deep Stun or Cardiac Arrest or head-to-body Stun

- Involves passing current via brain and the heart
- Causes *blood circulation to stop* and the *animal will not recover*
- So is not suitable for Halal slaughter
- Two main current pathways are used: *head to back* and *head to lower chest or leg* (Hui et al., 2001)

Deep Stun or Cardiac Arrest or head-to-body Stun

- Head-to-body stunning of cattle with electricity requires 2.5 amps for 3 seconds via brain followed by 2.5 to 3 amps for 14 seconds via neck & brisket electrodes to stop the heart
- Advantage of head-to-body stunning - irreversible
- Current may pass from head to lower chest (thoracic stun) or to back (head to back stun) (Figures 9 and 10)
- For cattle, head-only stun is applied before thoracic or head-to-back stun to achieve a deep stun b/c cattle have a significant *blood supply to brain via vertebral arteries* that are not affected by a throat cut

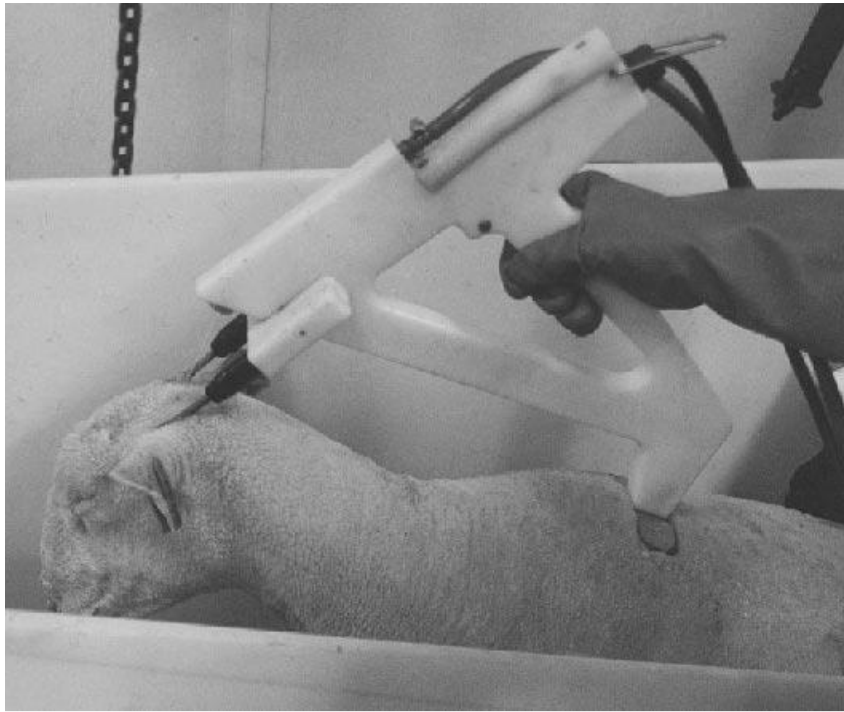


Figure 10

Figure 10. Head-to-back cardiac arrest electric stunning of sheep

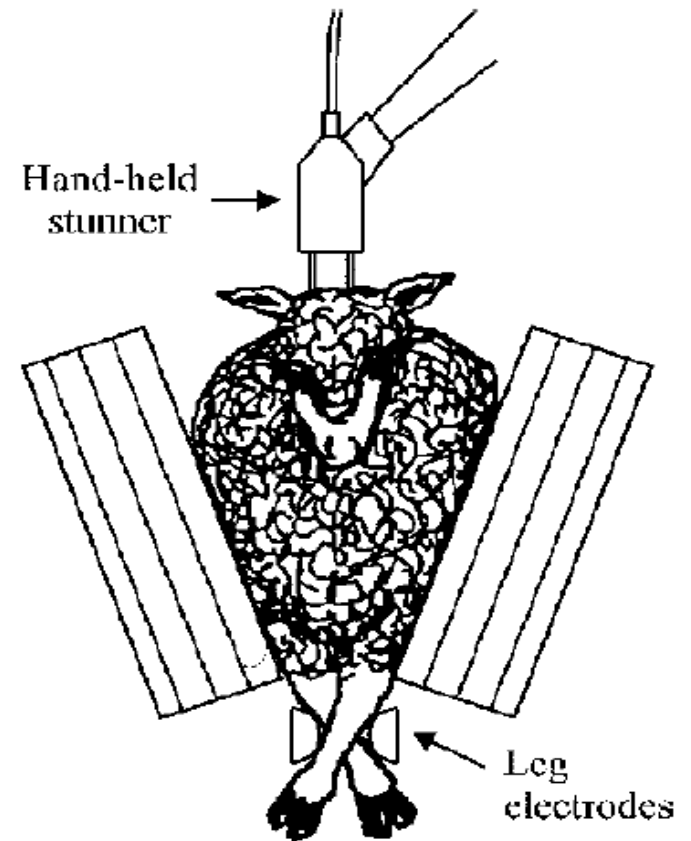


Figure 11

Figure 11. Head-to-chest (or foreleg) stunning of sheep

Figure 12. Automatic beef cattle stunning

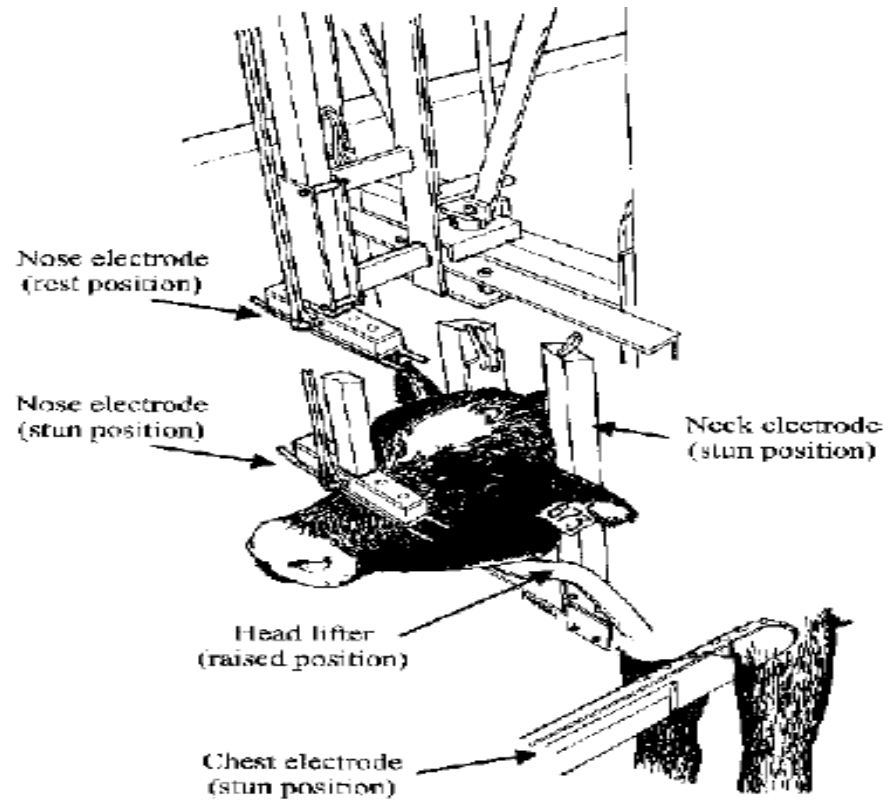
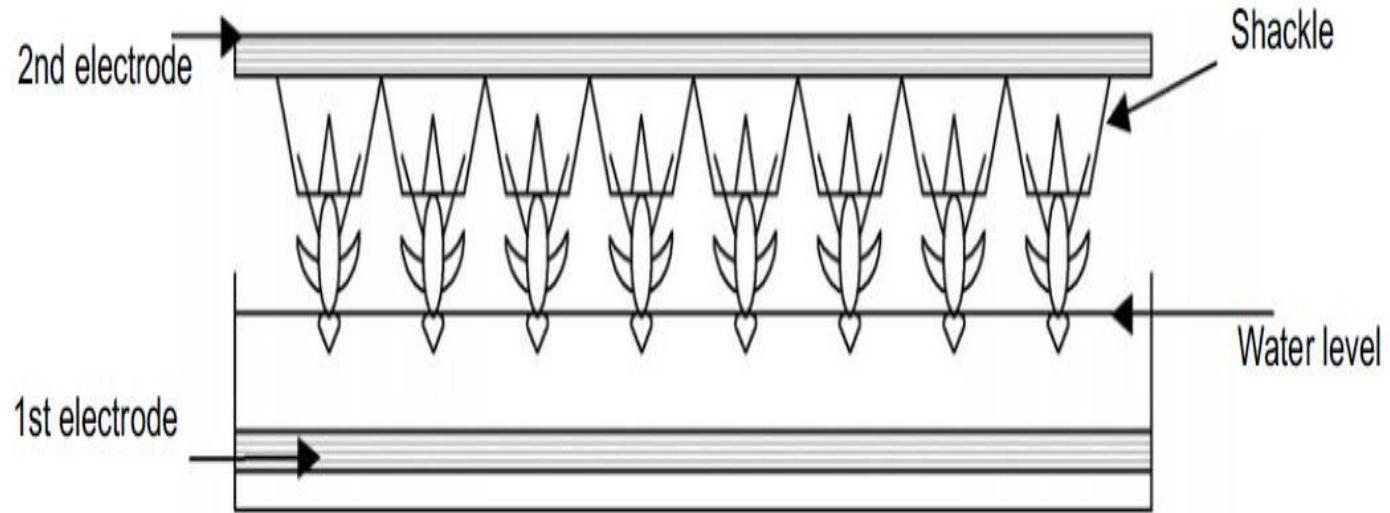


Figure 13. Diagram of birds passing through an electrical water bath



- In poultry stunning, the birds are suspended by their legs from metal shackles. The shackles are connected to ground and their heads dip into a water bath maintained at an electrical potential
- Current, therefore, flows from the water through the head and body to the shackles

Table 5. Summary of time and current parameters of head-to-body electrical stunning

Parameter	Type of animal				
	Sheep	Lambs	Calves	Cattle	Deer
Minimum current (A)	1	0.7	0.9	1.1	1
Range (A)	1-3.5	0.7-1.3	0.9-1.5	1.1.-6	1-2
Minimum time (seconds)	1	0.8	0.9	1	1
Range (seconds)	1-4	0.8-4	0.9-4	1-18	1-3

3 Stunning with Gases

- Commonly used in pigs
- Performed by exposing animals contained in cages, cradles, crates or conveyor, to a predetermined gas mixture contained within a well or tunnel
- The composition of gas mixture and duration of exposure varies according to the *species*, *manufacturer of the equipment* and *the requirement (stunning vs. killing)*

3 Stunning with Gases (cont'd...)

- Various physiological states and associated effects on the brain occur with gas stunning
- **Hypercapnia** refers to the presence of an excessive amount of carbon dioxide in the blood
- **Hypoxia** and **anoxia** refer to varying degrees of oxygen deficiency in the blood
- **Asphyxia** refers to the physical separation of upper respiratory tract and the atmospheric air

Table 6. Gas mixtures evaluated or used for stunning or stun/killing

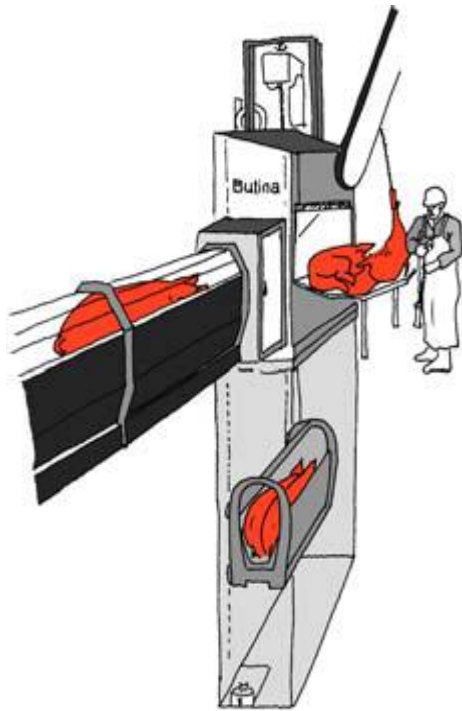
Species	CO₂	CO₂ plus O₂	Argon and /or nitrogen	Argon and /or nitrogen plus CO₂
Pigs	Used	Evaluated	Evaluated	Evaluated
Chickens	Used	Used	Used	Used
Turkey	Used	Used	Used	Used

Key:

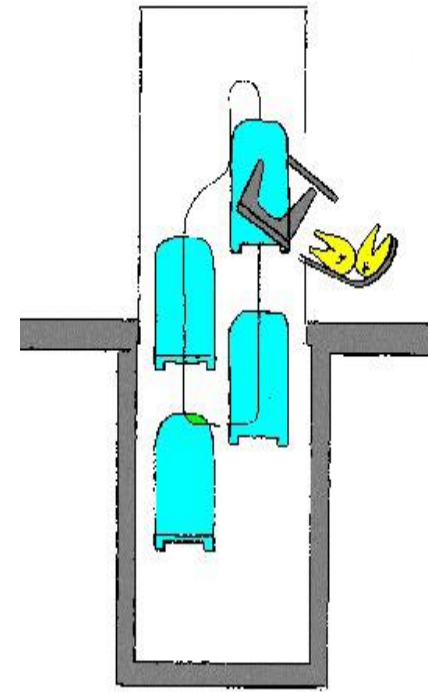
- **Used = commercially practiced;**
- **Evaluated=laboratory and pilot studies have been carried out but not implemented commercially**

1 Carbon dioxide Mixtures (in air or oxygen)

- Inhalation of CO₂ induces respiratory & metabolic acidosis, reduces pH of cerebrospinal fluid (CSF) and neurons thereby exerting its neuronal inhibitory and anaesthetic effects
- A concentration of 80–90% by volume (in air) is used in pigs
- Stun pigs for 90 seconds (if > 90 s, pigs will feel pain or die) → CO₂ & water will form formic acid) → acid dissolves in the blood → reduces pH of cerebrospinal fluid surrounding the brain → animal loses consciousness (if pH falls below about 7.1)



A



B

Figure 14. Diagram of the Butina Compact CO₂ stunning system for pigs

- (A) Dip-lift stunning systems where pigs are lowered directly;
- (B) Paternoster systems where pigs are lowered successively into the bottom of the pit as live pigs during a stop enter an empty gondola and stunned pigs are tipped out of gondola

2 Hypoxia Induced with Argon or Nitrogen

- *Xenon, krypton and argon* are chemically inert and all have anaesthetic properties
- Argon or nitrogen are commonly used in pigs
- Hypoxia induced with inert gases causes *intracellular metabolic crisis* leading to death in neurons
- Brain oxygen deprivation leads to accumulation of extracellular K and a metabolic crisis as indicated by the depletion of energy substrates and *accumulation of lactic acid in the neurons* (pH < 7.1)

3 Carbon dioxide and Nitrogen or Argon Mixtures

- Involves stunning by anoxia through lack of O₂ (\leq 2%)
- Anoxic conditions are produced by using argon
- B/c it is tasteless and odourless, argon is not detectable by animals and the gas's high density makes it relatively easy to confine in a chamber
- Duration of unconsciousness after removal from the gas is very short unlike in CO₂; thus kill animals by prolonged exposure, rather than simply using the gas to stun

3 Carbon dioxide and Nitrogen or Argon Mixtures (Cont'd...)

- A 70% argon:30% CO₂ mixture is important
- This makes the stunning faster
- Because *argon is relatively expensive*, this reduces the cost of the process
- Commercial use of anoxia stunning focused for slaughtering of pigs (Mohan Raj, 1993)

Signs of Recognition of a Successful Stunning, Ineffective Stunning, and Recovery of Consciousness

1 Signs of Recognition of a Successful Mechanical Stunning

- Immediate collapse (in restrained poultry severe wing flapping occurs due to the destruction brain)
- Apnoea (absence of breathing)
- Onset of tonic seizure lasting several seconds
- Loss of corneal reflex
- Gradual pupillary dilation
- Absence of response to a painful stimulus (to nose prick with a hypodermic needle and to comb pinch for poultry) (EFSA, 2004)

2 Signs of Recognition of a Successful Electrical Stunning or Killing

Successful Electrical Stunning

- ❖ Immediate collapse (not be applicable to poultry restrained)
- ❖ Onset of tonic seizure, followed by clonic seizure (reverse sequence in head-only electrical stunning of poultry, i.e., clonic-tonic)
- ❖ Apnoea (absence of breathing) in tonic-clonic periods
- ❖ Upward rotation of eyes
- ❖ Dilated pupils due to prolonged apnoea
- ❖ No response to hypodermic needle at nose

2 Signs of Recognition of a Successful Electrical Stunning or Killing (cont'd...)

Successful Electrical Killing

- ✿ Immediate collapse (not be applicable to poultry)
- ✿ Onset of tonic seizure lasting several seconds
- ✿ Immediate onset of apnoea (absence of breathing)
- ✿ Dilated pupils
- ✿ Clonic seizure (un-coordinated kicking or paddling leg movements) follows the tonic seizure but is less pronounced than with an electrical stun
- ✿ No response to nose prick by needle
- ✿ Complete relaxation of carcass without a pulse

3 Signs of Recognition of a Successful Stunning or Killing with Gas Mixtures

- ◉ All the signs are normally evaluated at the exit from the gas mixture and include:
 - Dilated pupils apply to pigs
 - Absence of corneal reflex applies to pigs
 - Brief gasping may be present in pigs
 - No response to nose prick by hypodermic needle in pigs
 - Complete relaxation of carcass in stun without a pulse under stun or kill

4 Signs of Ineffective Stunning or Killing

● Ineffective stunning or killing (to all species) can be recognized by:

- Rhythmic (periodic) breathing
- Attempts to raise the head
- Vocalization during stunning and/or seizures
- Corneal reflex
- Response to a painful stimulus
- Ears held stiff especially after captive bolt stunning

5 Signs of Recovery of Consciousness

- Rhythmic breathing
- Corneal reflex
- Attempts to raise the head
- Return of stiffness (muscle tone) in ears

Effects of Stunning Methods on Carcass and Meat Quality

- *Captive bolt stunning* in pigs leads to a lot of convulsions (shakings) that cause faster muscle acidification, thereby PSE (pale, soft, exudative) meat
- *Prolonged & high voltage electrical stunning* can lead to faster acidification, blood splash, haemorrhaging or broken bones, particularly in pigs if not suitably restrained

Effects of Stunning Methods (cont'd...)

- Broken backs with haemorrhaging can occur in pigs stunned using *head-to-back electrode placement* (Wotton et al., 1992)
- Due to the fast falling of the muscle pH after powerful activation of glycolysis in the muscles of electrically stunned pigs, the *CO₂ method* is sometimes preferred by reducing blood splashing and PSE meat incidence
- Many authors agree with positive effect of CO₂ stunning on pig meat quality in terms of higher 24 h muscle pH and more desirable muscle color (Hui Y. H., 2012)
- Video 1

6.4.1.2 Bleeding

- Stunned animals must be positioned for bleeding.
- Sticking must only be carried out on animals that are stunned and should immediately follow the stunning process.
- The knife that is used must be clean and sharp and as specified previously be of sufficient length for the specie and size of the animal.
- If only one carotid artery is cut, time to death will be prolonged.
- Brain death occurs in 15-20 seconds after correct sticking at which time around 50% of the total blood is lost.



Fig 15 bleeding

6.4.1.2 Bleeding (Conti..

- The pattern of blood loss is similar for the different species. About 40-60% of the animals' total blood is lost at exsanguination, a weight of blood equivalent to 4-5% of an animal's body weight.
- The remaining blood is largely retained in the viscera rather than in the carcass

Fig 16 After sticking, the animal should be left to bleed until the blood flow becomes negligible



6.4.1.2 Bleeding (Conti..)

- Hoist bleeding is more hygienic and is recommended. It also facilitates collection of blood for further use.
- The actual bleeding operation is done by sticking or inserting the sticking knife through the neck behind the jaw bone and below the first neck bone. The objective is to sever the blood vessels of the neck and let out the blood
- Insufficient bleeding and slow death could be caused by incomplete severing of the blood vessels of the neck, particularly if the arteries are missed and only the veins are cut during sticking. Both carotid arteries and the vessels from which they arise (close to the heart) should be severed. Practice and experience can however perfect the technique.⁷⁷

6.4.4.2 Skinning of cattle and small ruminants

4.4.2 .1 Skinning of cattle

- The outer side of the hide must never touch the skinned surface of the carcass. Operators must not touch the skinned surface with the hand that was in contact with the skin.

a/ Combined horizontal/vertical methods

- **Head.** After bleeding, while the animal is still hanging from the shackling chain, the horns are removed and the head is skinned.



Hang the head on a hook
(Fig. 17)

- The head is detached by cutting through the neck muscles and the occipital joint.
- Hang the head on a hook (Fig. 17). Lower the carcass on its back into the dressing cradle.

6.4.4.2 .1 Skinning of cattle (Conti...)

- **Legs.** Skin and remove the legs at the carpal (foreleg) and tarsal (hind leg) joints.
- The forelegs should not be skinned or removed before the carcass is lowered on to the dressing cradle or the cut surfaces will be contaminated. The hooves may be left attached to the hide.
- **Flaying.** Cut the skin along the middle line from the sticking wound to the tail.
- Using long firm strokes and keeping the knife up to prevent knife cuts on the carcass, skin the brisket and flanks, working backwards toward the round

6.4.4.2 .1 Skinning of cattle (Conti...)

- Skin udders without puncturing the glandular tissue and remove, leaving the super mammary glands intact and attached to the carcass.
- At this point raise the carcass to the half-hoist position, the shoulders resting on the cradle and the rump at a good working height.
- Clear the skin carefully from around the vent (anus) avoiding puncturing it and cut the abdominal wall carefully around the rectum. Tie off with twine to seal it.
- Skin the tail avoiding contamination of the skinned surface with the hide. Raise the carcass free of the floor and finish flaying.

6.4.4.2 .1 Skinning of cattle (Conti...)

b/ Vertical methods

- High-throughput plants have overhead rails which convey the carcass from the sticking point to the chills. Hide removal is carried out on the hanging carcass
- The operations are as in the combined horizontal/vertical method, but as it is not possible to reach the hide from ground level more than one operator is needed.
- A single operator may work with a hydraulic platform which is raised and lowered as required

6.4.4.2 .1 Skinning of cattle (Conti...)

- Automatic hide pullers are used in high-throughput slaughterhouses. Some types pull the hide down from the hind, others from the shoulders upwards toward the rump.
- Automation of hide removal reduces contamination since there is less handling of the carcass and less use of knives.
- Moving overhead rails also improve hygiene by reducing carcass contact with operators, equipment such as dressing cradles and with each other since carcasses are evenly spaced

6.4.4.2 .2 Skinning of Small ruminants

- ✓ Sheep fleeces can carry large volumes of dirt and faeces into the slaughterhouse.
- ✓ It is impossible to avoid contamination of sheep and lamb carcasses when the fleece is heavily soiled.
- ✓ The fleece or hair must never touch the skinned surface, neither must the operator touch the skinned surface with the hand that was in contact with the fleece.

6.4.4.2 .2 Skinning of Small ruminants (Conti..)

a/ Combined horizontal/vertical method

- The animal is turned on its back and cuts are made from the knuckles down the forelegs.
- The neck, cheeks and shoulders are skinned. The throat is opened up and the gullet (food-pipe) is tied off (see Fig 18.).
- The skin on the hind legs is cut from the knuckles down to the tail root.
- ✓ The legs are skinned and the sheep is hoisted by a gambrel inserted into the Achilles tendons.



Fig 18

a/ Combined horizontal/vertical method (cont...)

- A rip is made down the midline and skinning proceeds over the flanks using special knives or the fists (see Fig. 18).
- The pelt is then pulled down over the backbone to the head. If the head is for human consumption it must be skinned or it will be contaminated with blood, dirt and hairs.

Moving cratch and rail system. The hanging carcass is lowered on to a horizontal conveyor made up of a series of horizontal steel plates, bowed slightly and divided into sets large enough to cradle a single animal

- Two operators usually work together on each lamb performing the legging operations and opening the skin to the stage where it can be pulled off the back. When the gambrel is inserted into the hind legs it is hoisted on to a dressing rail.

a/ Combined horizontal/vertical method



Animal after bleeding



Incision of skin around the rectum



Incision of skin starting at tarsal joint



Incision toward the Linea Alba on both legs



Skinning commence at the tarsal joint



Skinning of the abdomen



Fisting

6.4.4.2 .2 Skinning of Small ruminants (Conti..)

Horizontal Skinning

- ✓The animal is placed on its back on a skinning cradle as indicated in the picture of skinning cattle.
- ✓Cutting and fisting then begin at the forelegs, working toward the belly and sides of the animal, ending at the hind legs.
- ✓The body skin is removed in a similar manner as in hoisted skinning, the exception is that the carcass is hoisted and the skin along the back bone pulled off.

6.4.3. Evisceration

- **Evisceration** is the removal of the internal organs from the abdominal and thoracic cavities of a carcass.
- With all species care must be taken in all operations not to puncture the viscera.
- All viscera must be identified with the carcass until the veterinary inspection has been passed.
- After inspection the viscera should be chilled on racks etc. for better air circulation.

6.4.3.1. Evisceration of Cattle carcasses

The brisket is sawn down the middle (Figure 19). In the combined horizontal/ vertical system this is done with the animal resting on the cradle.

The carcass is then raised to the half-hoist position and when hide removal is complete the abdominal cavity is cut carefully along the middle line.

The carcass is then fully hoisted to hang clear of the floor so that the viscera fall out under their own weight (Figure 20)

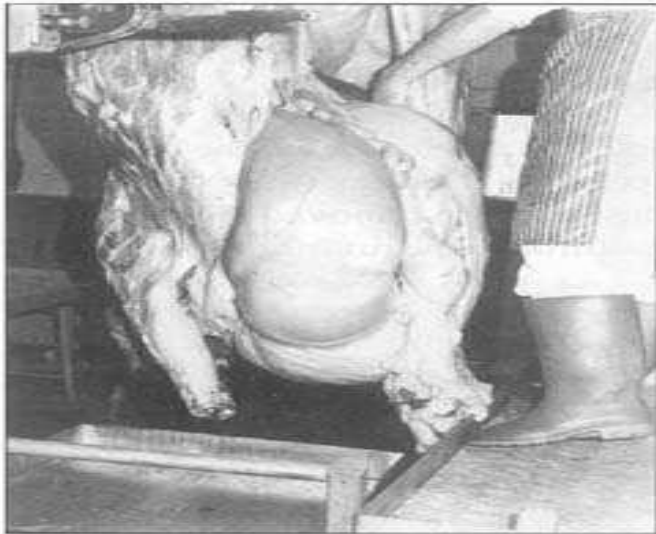


Figure 20

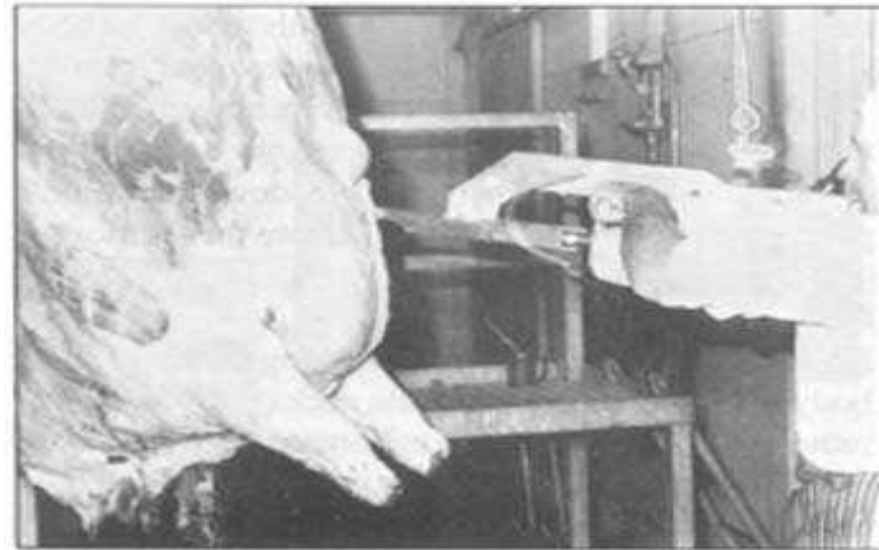


Figure 19

6.4.3.1. Evisceration of Cattle carcasses

✓ They are separated into thoracic viscera, paunch and intestines for inspection and cleaning.

✓ If any of the stomachs or intestines are to be saved for human consumption, ties are made at the oesophagus/stomach, stomach/duodenum boundaries, the oesophagus and rectum having been tied off during hide removal.

✓ This prevents cross-contamination between the paunch and the intestines



6.4.3.2. Evisceration of Small ruminant's carcasses

- With the external structures, skin, feet and head removed, the next step is to cut open the animal's body to dislodge the contents and produce the carcass.
- Try to avoid contamination of the carcass through accidental cuts or punctures of the stomach and intestines. For this, it is important that the carcass is placed in the hanging position.
- A small cut is made in the abdominal cavity wall just above the brisket, and the fingers of the other hand are inserted to lift the body wall away from the viscera as the cut is continued to within about 5 cm of the cod fat or udder.

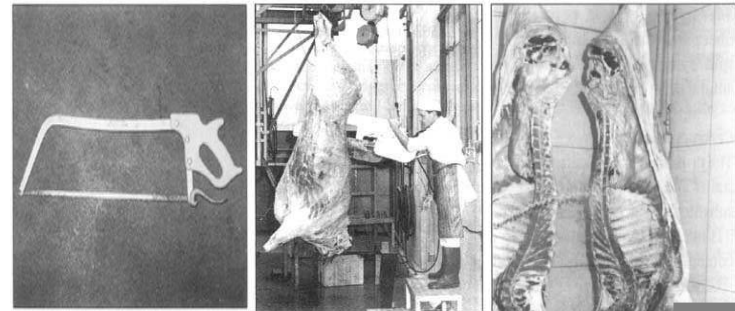
6.4.3.2. Evisceration of Small ruminant's carcasses (Cont...)

- The omentum is withdrawn and then tie off the rectum and esophagus, loosened, and the viscera freed and taken out.
- The food-pipe (tied off) is pulled up through the diaphragm. The breastbone is split down the middle taking care not to puncture the thoracic organs which are then removed.

6.4.4. Splitting, washing and dressing of carcasses

6.4.4.1 Splitting

- Dressing is defined as the progressive separation of the body of an animal into a carcass and other edible and inedible parts.
- In splitting the carcasses of Cattle (figure 17), work facing the back of the carcass. Split the carcass down the backbone (chine) with a saw or cleaver (butchers heavy chopping tool) from the pelvis to the neck



6.4.4. Splitting, washing and dressing of carcasses

- Sawing gives a better result but bone dust must be removed. If a cleaver is used, it may be necessary to saw through the rump and loin in older animals. The saw and cleaver should be sterilized in hot (82°C) water between carcasses. Power saws increase productivity.


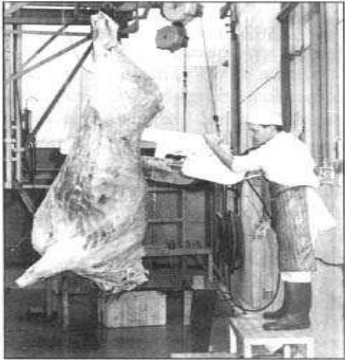
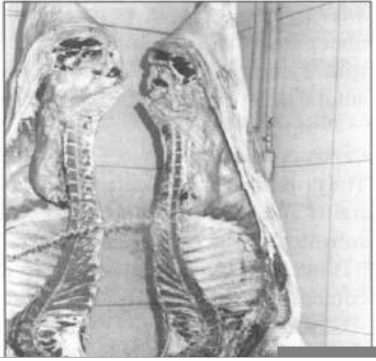
		
Handsaws are much slower than mechanical saws though they are preferable to cleavers which splinter bones	Mechanical saw for splitting The backbone (chine) of Beef carcasses	Splitted carcass in to two halves

Figure 21. splitting the carcasses of Cattle

6.4.4.2 *Carcass washing*

- The primary object of carcass washing is to remove visible soiling and blood stains and to improve appearance after chilling (Fig. 22).
- Washing is no substitute for good hygienic practices during slaughter and dressing since it is likely to spread bacteria rather than reduce total numbers.
- Stains of gut contents must be cut off. Wiping cloths must not be used.



6.4.4.2 Carcass washing (cont..)

- ◆ A wet surface favors bacterial growth so only the minimum amount of water should be used, and the water should be allowed to drain from the carcass, and then chilling should start immediately.
- ◆ If the cooler is well designed and operating efficiently the carcass surface will quickly dry out, inhibiting bacterial growth.

6.4.5. Refrigeration and handling carcasses

- Carcasses should go into the cooler as soon as possible and should be as dry as possible.
- The object of refrigeration is to retard bacterial growth and extend the shelf-life.
- Chilling meat post-mortem from 40°C down to 0°C and keeping it cold will give a shelf-life of up to three weeks, provided high standards of hygiene were observed during slaughter and dressing

6.4.5. Refrigeration and handling carcasses (cont..

- Carcasses must be placed in the cooler immediately after weighing. They must hang on rails and never touch the floor (Figure 23).
- After several hours the outside of a carcass will feel cool to the touch, but the important temperature is that deep inside the carcass. This must be measured with a probe thermometer (not glass), and used as a guide to the efficiency of the cooling.



Figure 23 Sheep carcasses in the chill-room, hung on rails clear of the floor and spaced to allow air circulation to speed drying

6.4.5. Refrigeration and handling carcasses (cont..

- After several hours the outside of a carcass will feel cool to the touch, but the important temperature is that deep inside the carcass.
- This must be measured with a probe thermometer (not glass), and used as a guide to the efficiency of the cooling.
- The rate of cooling at the deepest point will vary according to many factors including the efficiency of the cooler, the load, carcass size and fatness.

6.4.5. Refrigeration and handling carcasses (cont..)

- ❖ As a general guide a deep muscle temperature of 6–7° C should be achieved in
 - ✓ 28 to 36 hours for beef,
 - ✓ 12 to 16 hours for pigs and
 - ✓ 24 to 30 hours for sheep carcasses.
- ✓ Failure to bring down the internal temperature quickly will result in rapid multiplication of bacteria deep in the meat resulting in off-odors and bone-taint.
- ✓ High air speeds are needed for rapid cooling but these will lead to increased weight losses due to evaporation unless the relative humidity (RH) is also high.
- ✓ However, if the air is near to saturation point (100 percent RH) then condensation will occur on the carcass surface, favoring mould and bacteria growth.

6.4.5. Refrigeration and handling carcasses (cont..)

- A compromise between the two problems seems to be an RH of about 90 percent with an air speed of about 0.5 m/second.
 - As animal gets older, internal fat depots increase
- ✓ The cooler should not be overloaded beyond the maximum load specified by the manufacturers and spaces should be left between carcasses for the cold air to circulate.
- ✓ Otherwise cooling will be inefficient and the carcass surface will remain wet, favouring rapid bacterial growth.

Thank you

