COURSE TITLE: – HIDES AND SKIN MANAGEMENT

Course number:–AnPS3105
Credit hour:–2; Venue Room 03
contact time Friday 8:30–10:30 am;

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General course content(Topics to be covered)

- Definition of hide and skin and its sources
- Components of mammalian skin and its function
- Hides and skins production systems & marketing
- Constraints to H&S production and leather processing
- Defects types in hides/skins (Pre-slaughter; peri-slaughter and Post slaughter defects)
- Preservation and the methods
- Hide and skins processing(the Tanning operations)
- Quality control and grading standards
- Storage and transportation
- Environmental impact and mitigation opportunities of the Leather Industries

1. Definition of hides & skins

- **Hides** are broadly defined as the **external integuments of large animals**, While;
- **Skins** are provided by **smaller animals**.

- **Sources:-**The best sources of hides and skins are:-
  - **Domesticated animals** (hides from cattle, buffalo, horse, camel etc) and (skins from sheep, goat, pig), and
  - **Non domesticated animals** (elephant, Impala, Rabbit, mink, snake, Frog, Ostrich, shark etc) (FAO, 1995).

2. Function and components of mammalian skin

2.1. Function

- Its primary function is as a **barrier from environmental factors (protection and cover)**, such as **viruses, bacteria, chemicals** and **UV radiation** (Rao et al., 2002).

- It prevents **rapid loss of water and is involved in thermoregulation** (walawsaka et al., 2000).

- Furthermore, it resists physical stresses and continually repairs itself. The repair mechanisms vary depending on the type and the depth of injury (Cabeza et al., 1998).

2. Function and components of mammalian skin

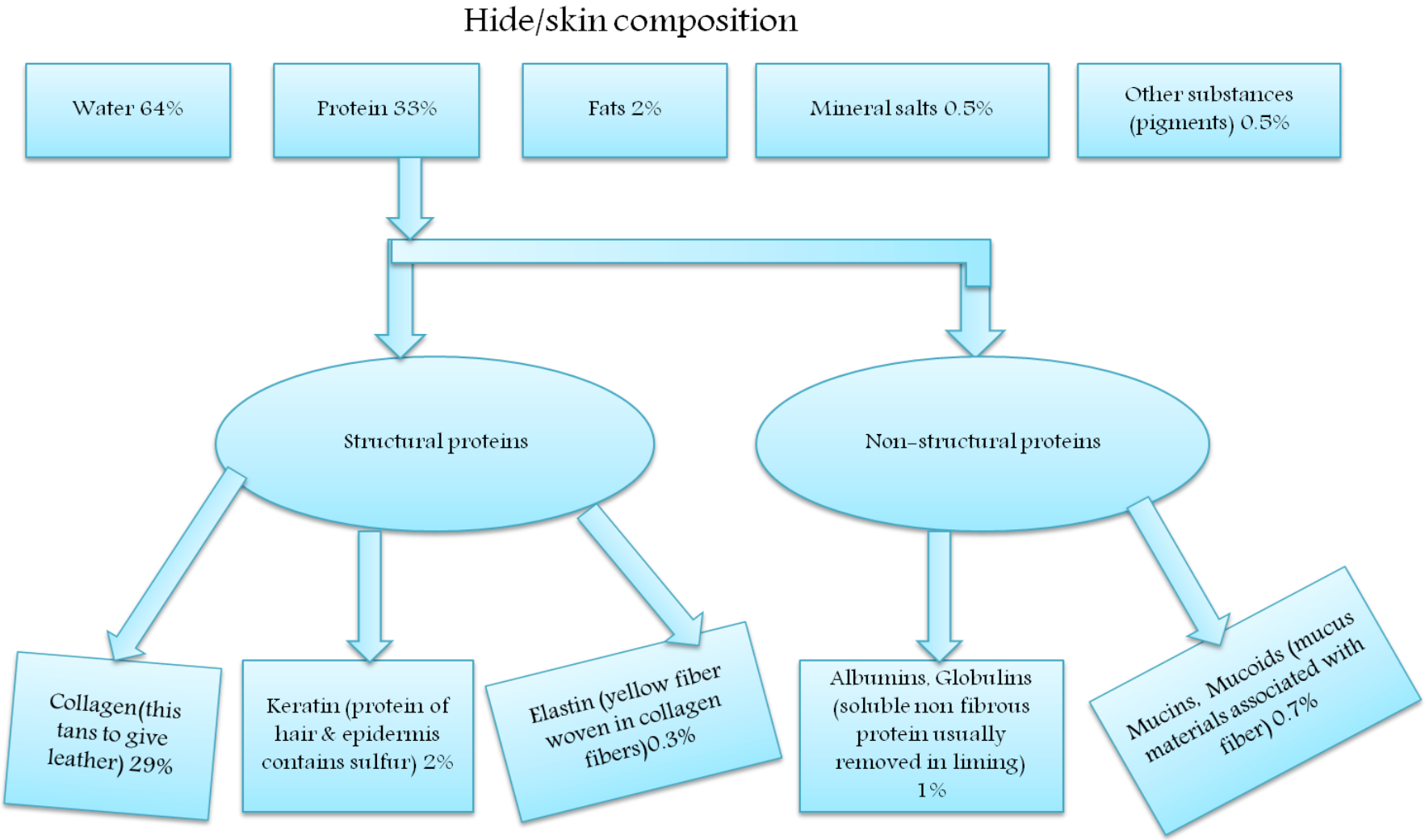
2.2. Chemical and anatomic structure of hide and skin

Chemical structure of hide and skin

- Though the relative proportions of these materials vary from skin to skin depending upon the **species, age, breed, feeding and other habits of the animals**,

- Fresh raw hides or skins consist of **water** (64 %), **protein** (33%), **fatty materials** (2%), **mineral salts**(0.5%) and **others**(0.5%).
- Of these, the most important for **leather-making** is **protein(structural and none structural)**.
- This protein may consist of many types. The important ones are **collagen** which, on tanning, gives leather & keratin, which is the chief constituent of hair, wool, horn and the epidermal structures (Sharphouse, 1983; Brown et al., 1997)

Chemical structure of hide and skin



➢**Figure1**. The approximate composition of animal hide/skin adapted from leather technicians hand book (Brown et al., 1997 and Sharphouse1983)

2. Function and components of mammalian skin …

2.2. Chemical and anatomic structure of hide and skin…

Anatomic structure of hides and skins…

- Anatomically the hides and skins have multilayered structure and mainly consist of **three** distinct layers,

- The grain (epidermis) or thin outside layer,

- A second thicker layer known as the corium or the central (dermal layer) and

- The inner subcutaneous tissue (hypodermal layer) of adipose tissue or flesh layers (figure 2) (Daniels, 2003; Baily, 2003).

2. Function and components of mammalian skin …

Anatomic structure of hides and skins…

- In the process of tanning, the **first** and **third layers** are removed.

- The **epidermis** is made up of cells an under layer of living epithelial cells and an outer layer of dead cells.
- It is a thin top layer covering about 1-2% of the total thickness of the entire skin.

- This outer layer consists mostly of an insoluble protein, keratin, and affords surface protection to the body (Bailey, 2003).

2. Function and components of mammalian skin …

•Anatomic structure of hides and skins…

•The layers of epidermis

➢The epidermis is the outer layer of the skin and is composed of four layers of varying cell thicknesses.

➢The **stratum corneum** is the surface aspect of the **epidermis** and consists of several layers of dead cells full of the insoluble protein keratin (Brown et al., 1997), which varies in thickness depending on **age** (Maeser, 1960).

2. Function and components of mammalian skin …

- Anatomic structure of hides and skins…

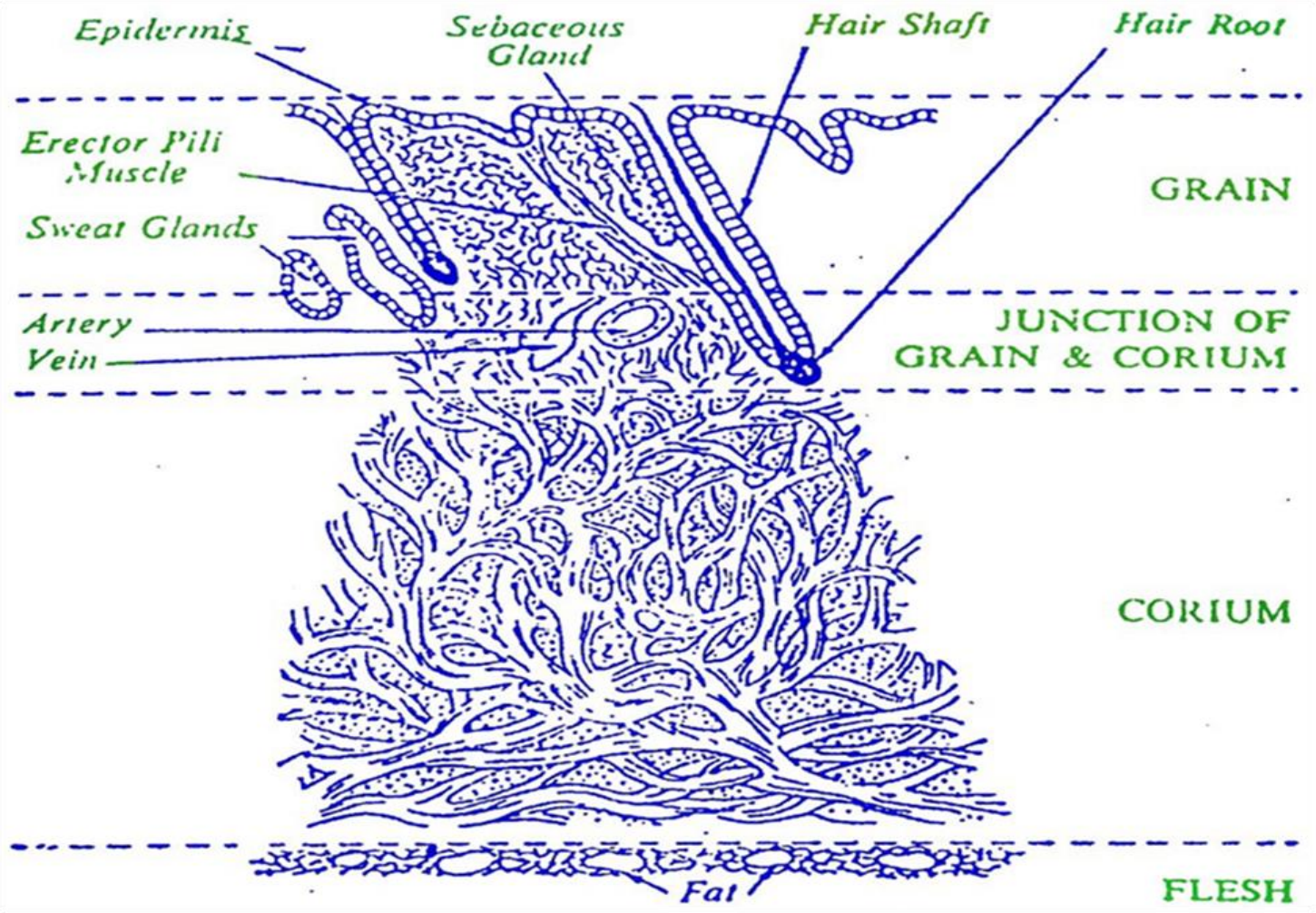
- **The layers of epidermis …**

➢ The next layer is the **stratum granulosum**, then the **stratum spinosum** and the **stratum basale**.

➢ The **epidermal layer** is removed during processing, thus exposing the **dermal layer** to environmental pressures (Baily, 2003; Kronick and Buechler, 1986; Newton and Meek, 1998).

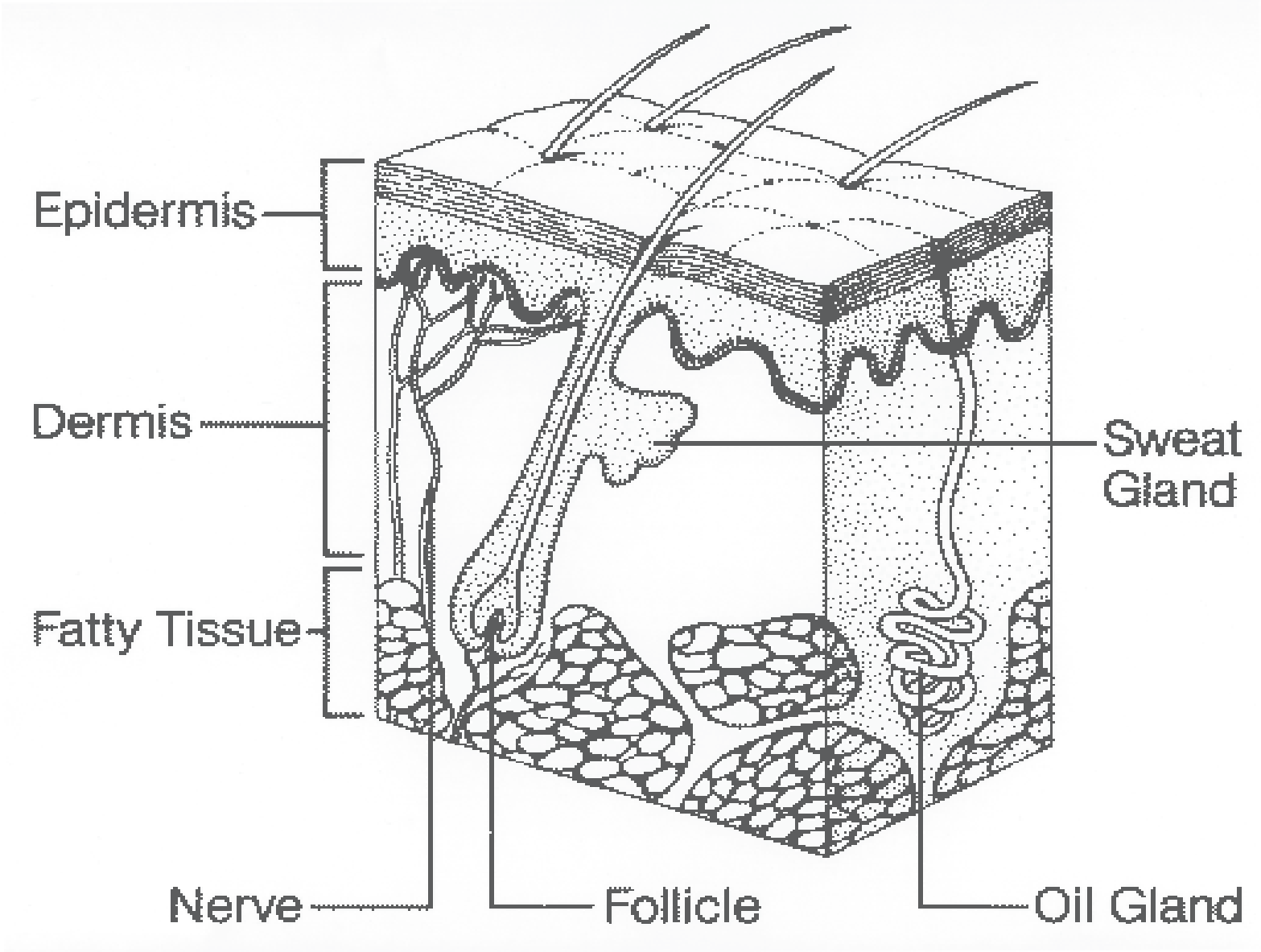
➢ This epidermal layer consists of **fat glands**, **sweat gland hooves**, **Horns nails** etc(Mwinyihija, 2006).

•Anatomic structure of hides and skins...



Cross-section of bovine hide

Figure 2. schematic cross-section of bovine hides (Sharphouse, 1971)


Epidermis
Dermis
Fatty Tissue
Sweat Gland
Nerve
Follicle
Oil Gland

2. Function and components of mammalian skin …

•Anatomic structure of hides and skins…

•Dermis

- The dermis, or **central layer** also called **corium**, is of most important one, as it is the part of the hide which remains after treatment.

- The papillary layer (**grain**) contains fine fibers and four times as many polysaccharides than the coarser fiber containing reticular layer (Cabeza et al., 1998).
-
- The aesthetic value of leather comes from the grain layer.

2. Function and components of mammalian skin …

•Anatomic structure of hides and skins…

•Dermis…

- The **corium layer** gives leather its strength and resiliency. It is rich in the protein collagen.

- Individual collagen molecules combine together in the corium to form very small fibrils that are in turn bound together to form collagen fibers, which are visible under the microscope.

- i.e. **collagen molecules** ⇨ **very small fibrils** ⇨ **collagen fibers**

- The strength of the skin and of leather is due to **cross weaving of these fibers** (Behailu, 2015).

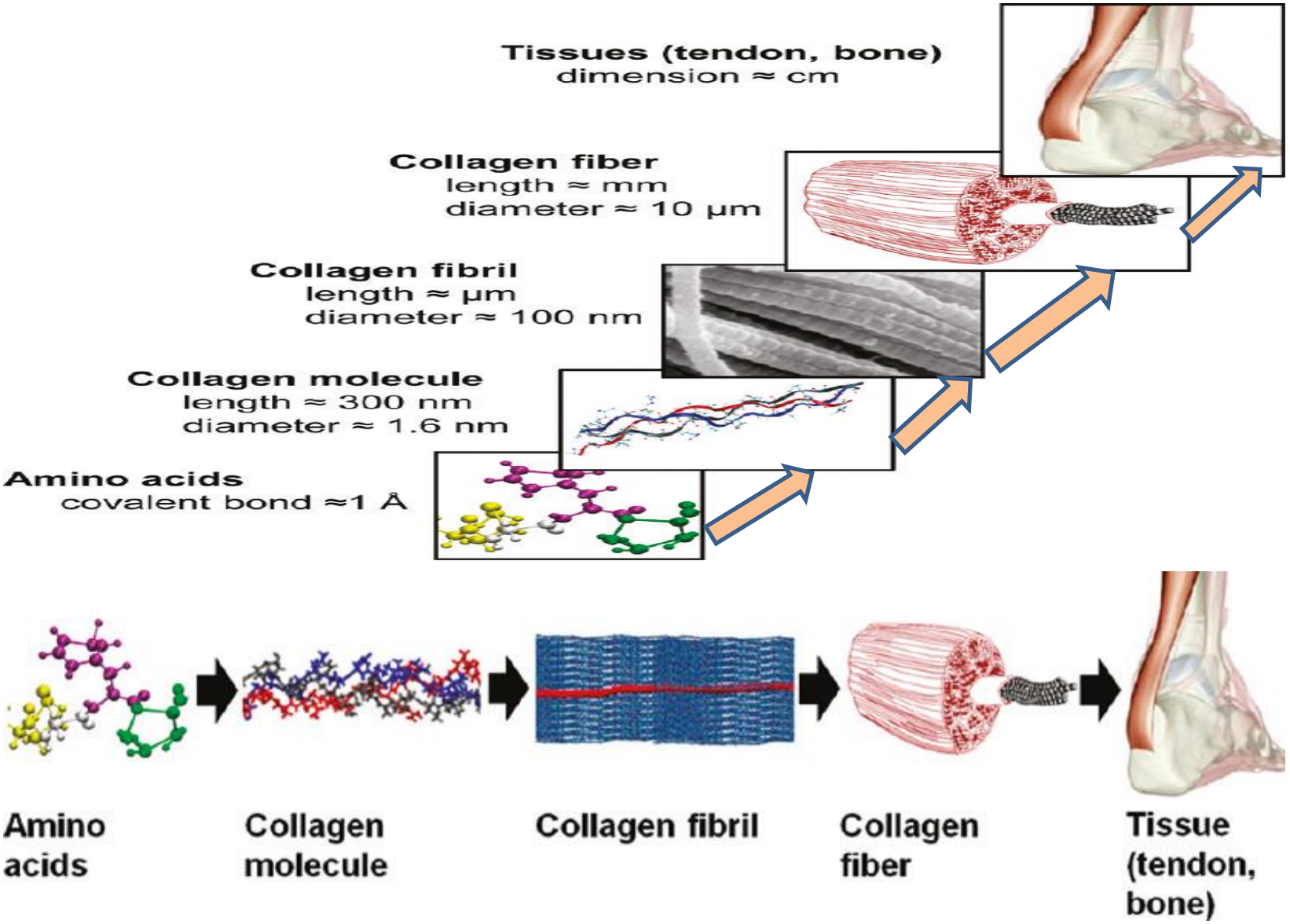


Figure3. collagen hierarchy

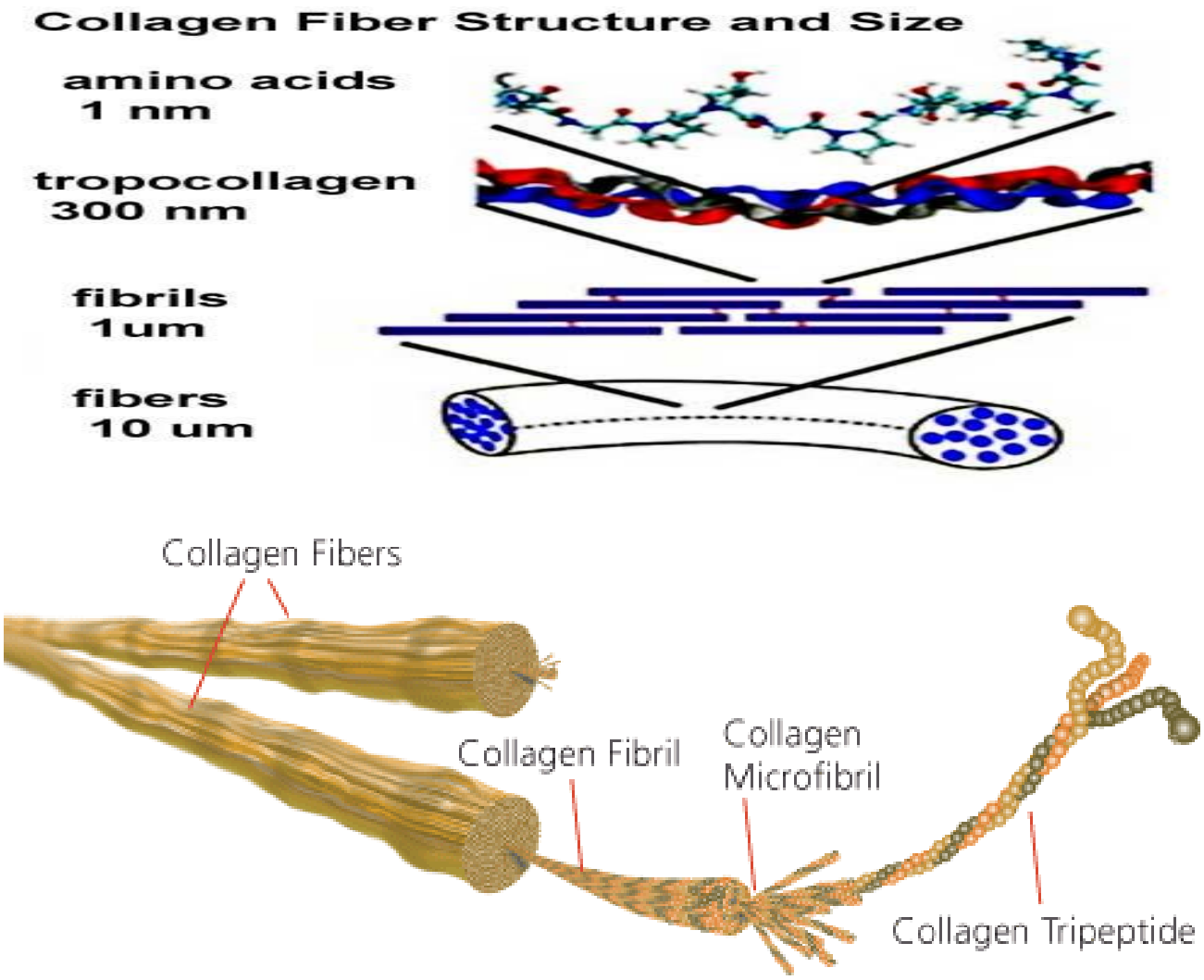


Figure4. collagen hierarchy

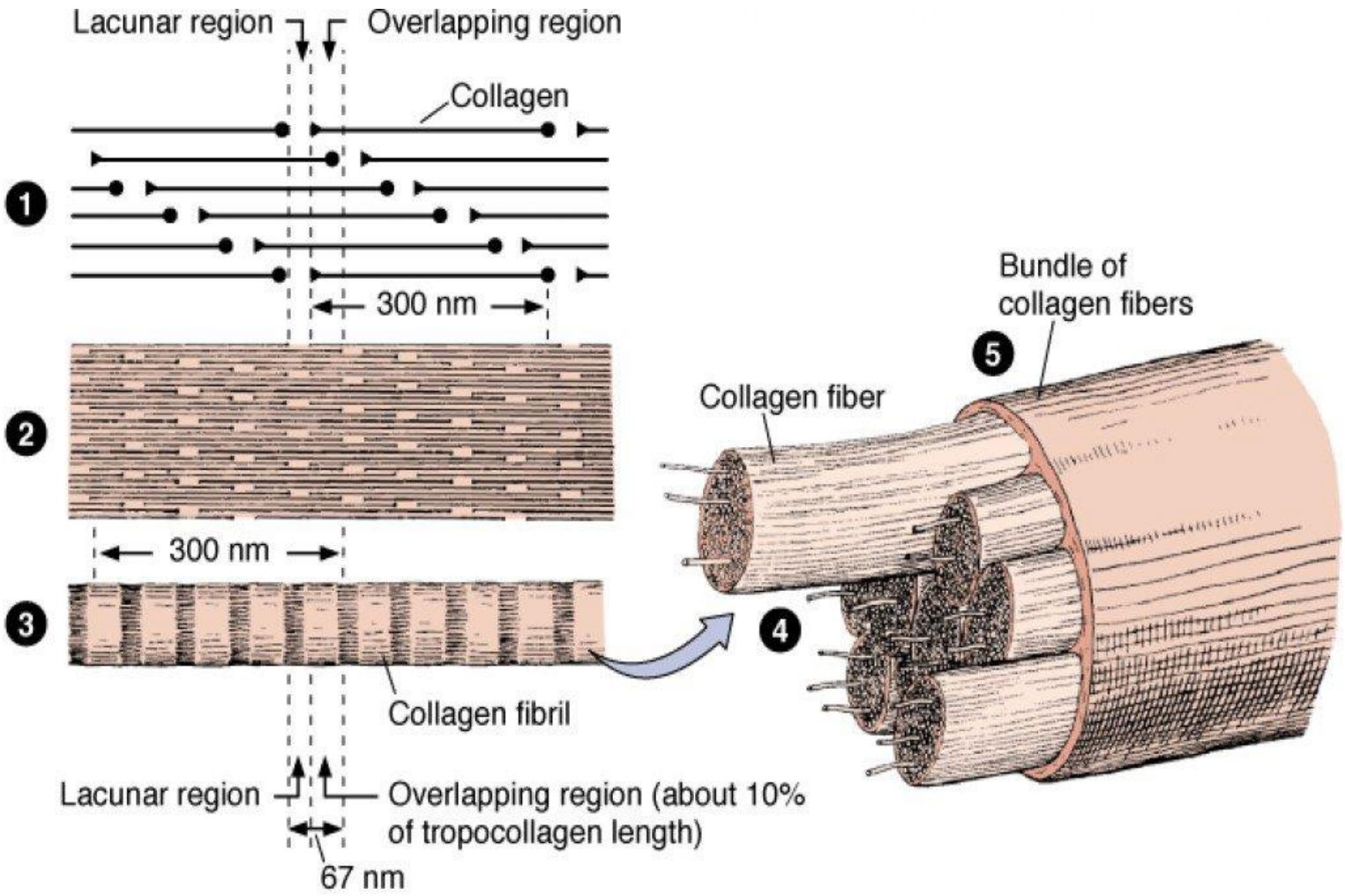


Figure5. collagen hierarchy

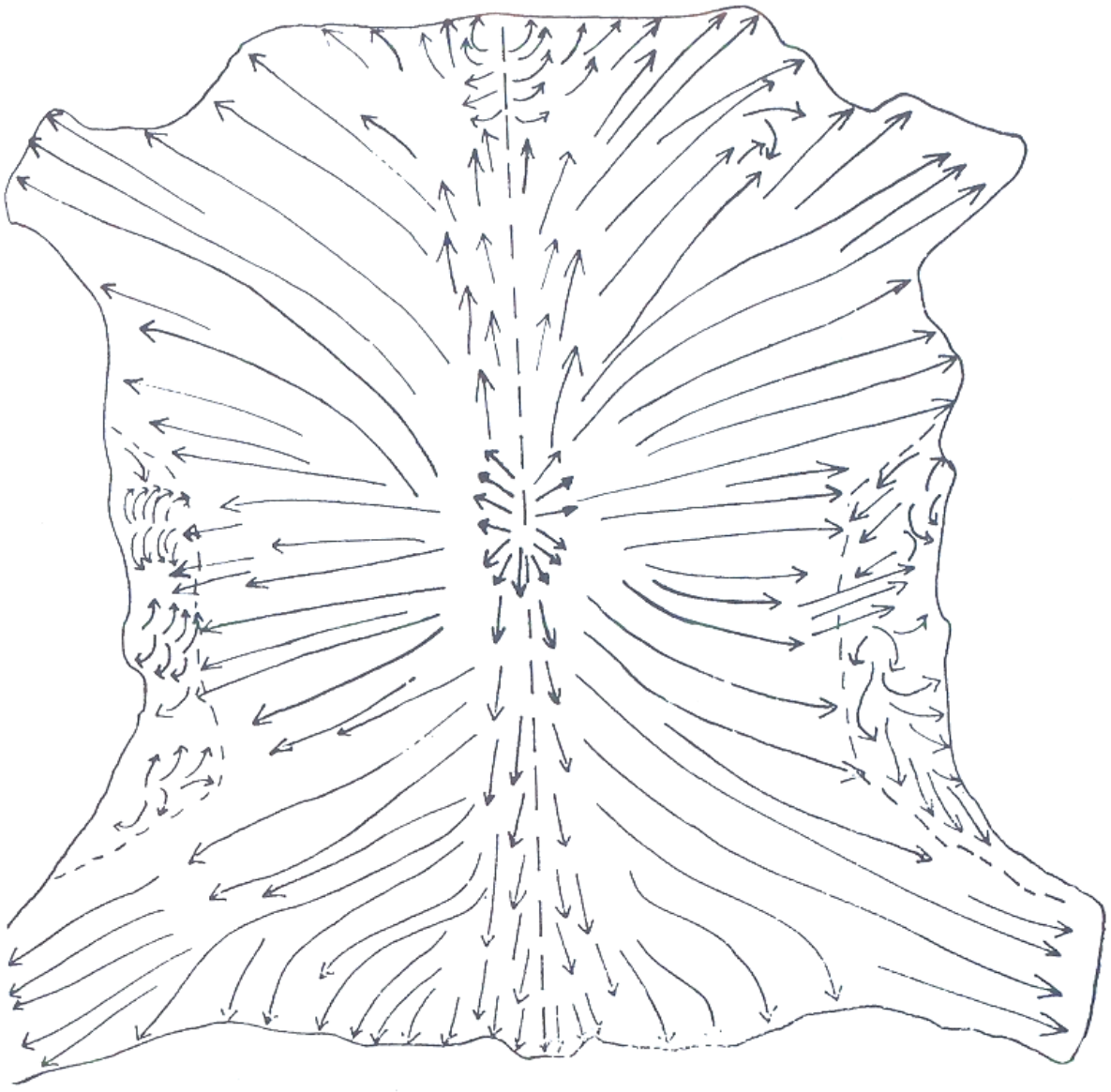


Figure 6. Anisotropy of fiber structure over the hide or skin (Covington, 2009)

- **2. Function and components of mammalian skin …**
- **Anatomic structure of hides and skins…**

- **Dermis…**

➢Chemically, the derma consists of fat cells, water, proteins, carbohydrates, and minerals, the exact proportions varying between individuals and species.

➢The protein in the derma largely consists of collagen, and most of the carbohydrate matter is glycogen.

➢ Collagen is the principle structural protein found in the bone, hide, and muscle of animals(Mills and Raymond, 1994).

2. Function and components of mammalian skin …

- **Anatomic structure of hides and skins…**
- **Hypodermis – skin support**

- The **hypodermis** (subcutaneous layer) is below the dermis and contains fat (lipid) containing adipose cells and larger blood vessel and nerve cells.

- The amount of **fat varies** depending on age, species and health of animal.

- The subcutaneous layer connects the **skin to the muscle and bones**. Other than providing energy & storage, this layer acts as a cushion and gives the skin its shape and contour (Clark, 2007).

3.1.. Hides and skins Production Systems in Ethiopia

3.1.1. Traditional production system

- 90% of shoat and 70% cattle are slaughtered informally in homesteads for consumption by the owner or in a small community where no formal slaughtering facilities exist.

- Generally, these informal slaughtering activities are largely beyond the reach of government considerations (USAID, 2013).

3. 1. Hides and skins Production Systems in Ethiopia …

3.1. 1. Traditional production system…

- **But why homestead kill rates are high?**

  - One probable reason for **informal slaughter** could be due to widespread dissatisfaction of existing abattoirs are **not efficient in their services**,
  - The slaughter fee is too high and there is improper take-out of meat cuts.

  - **Or it may be**
  - owing to traditional and religious customs,
  - lack of slaughtering facilities and transportation &
  - scattered settlement of the farmers(MoARD, 2007).

3. 1. Hides and skins Production Systems in Ethiopia …

3.1.1. Traditional production system…

- This system results in a substantial amount of inferior quality grades and rejects of outputs.
- because preservations often start after celebrating a feast, when the hides and skins have started putrefaction (Tedesse, 2005).
- An unacceptable practice such as pecked drying methods of hides/skins, flaying cuts, drying by burning fire underneath are major defects practiced in some remote areas of the country.
- In particular, smoked hides and skins are graded as rejects as they are partially tanned with chemicals in the smoke and cannot produce good leathers (MoARD, 2007).

3. 1.Hides and skins Production Systems in Ethiopia …

3.1. 2. Modern production system

Rural slaughter slabs

- **livestock slaughter in rural slaughter slabs is;**
- Done under poorly equipped slaughter points (slab of concrete, under a shade or using poles for hoisting carcasses). scattered in rural towns and often without adequate supervision.

- The tools used are rudimentary & inferior qualities causing damage to the H & S during flaying/slaughter.

- H&S are not watered off after slaughter and most often, all operations are carried out on the floor(MoARD, 2007).

3. 1. Hides and skins Production Systems in Ethiopia …

3.1. 2. Modern production system…

Municipal Slaughter Houses (Bigger and Medium Abattoirs)

- Hides are recovered by hand from the carcass, causing extensive damage in the form of **deep cuts** and **holes** & cause a loss of (20-30%) of the hide's value. Where as in machine-flayed hide, **no cuts** or **holes**,

- The Static Flaying Frame (SFF) assists flaying and can produce, at very little cost, there are no special requirements, maintenance, nor power needed (MoARD, 2007).

3. 1. Hides and skins Production Systems in Ethiopia …

3.1. 2. Modern production system…

Municipal Slaughter Houses (Bigger and Medium Abattoirs)

- The greatest appeal of the SFF is that artisans without external supplies can produce it cheaply and locally.

- They are bigger in size and often located in medium to bigger towns.

- They are also relatively better equipped than rural slabs as far as water provision is considered (MoARD, 2007).

3.1. Modern production system…

3.1. 3. Mechanized Abattoirs (Export Abattoirs)

- The five existing export abattoirs having a potential processing capacity of 60,000 cattle and 1.5 million sheep and goats (18,000 tons of beef meat and mutton) per annum and plan to export 30,000 tons of meat and mutton annually in the future.

- However, they are apparently operating at less than 20% of capacity.

- They do not kill until they have orders, which is a major organizational problem.

3.1.Modern production system…

3.1.3. Mechanized Abattoirs (Export Abattoirs)…

- The flaying is done with skilled work force and appropriate tools along with the water availability, and peri-slaughter damage are almost completely avoided.

- However, currently the abattoirs are mainly slaughtering lowland sheep as they are cheaper than the highland ones.

- Many concerned leather technologists have often complained that lowland sheepskins are inferior to the highland sheepskins mainly used for lining leathers(MoARD, 2007).

Table 1 Distribution of slaughtering facilities by regional states

Description / Geographic area	Bigger Slaughter Houses(including commercial ones)	Medium Municipal Slaughter House	Rural Slaughter Slabs	Sub Total/ Grand Total
Tigray	4	15	6	25
Afar	-	1	-	1
Amhara	2	10	20	32
Oromiya	9	25	40	74
Somali	-	1	1	2
Benshangul Gumuz	-	-	6	6
S.N.N.P	14	15	-	29
Gambella	N.A	N.A	N.A	-
Harare	-	2	-	2
Addis Ababa	3	-	-	3
Dire dawa	1	-	-	1
Sub Total/Grand	33 (5 commercial)	69	73	175

Source: – MoARD, (2007) as computed from data base of MoARD 2004/2005 and personal communication

➢3.2. Marketing of hides and skins in Ethiopia

➢3.2.1. Market Structure…

➢The marketing of hide and skin starts at the producer/consumer level and passes through a chain of middlemen until it reaches the tanneries (Fig.7).

➢The market chain for raw hides and skins consists of the primary producers/consumers, who are:-

- ➢ The initial sources (individual meat consumers, rural slaughter slabs, municipal slaughter houses, abattoirs, meat processing plants),

- ➢Agents of traders, collectors, local tanners, regional medium/small traders,
- ➢ Regional/Addis Ababa big traders and tanneries (Ahmed, 2000).

3.2. Marketing of hides and skins in Ethiopia…

3.2.1. Market Structure…

- The individual consumers who kill animals in their backyard sell the H&S either to agents, collectors, or directly to regional small/medium traders.
- After preservation, the H & S are passed on to big traders and then to the tanneries. or
- The tanneries can be supplied directly from the slaughter premises, regional big traders or Addis Ababa big traders as well.
- The tanneries then process the HS either in the green (fresh), air dried or wet salted states to semi-finished or finished stages for both local and export markets Fig.7 (Ahmed, 2000).

3.2. Marketing of hides and skins in Ethiopia….

3.2.1. Market Structure….

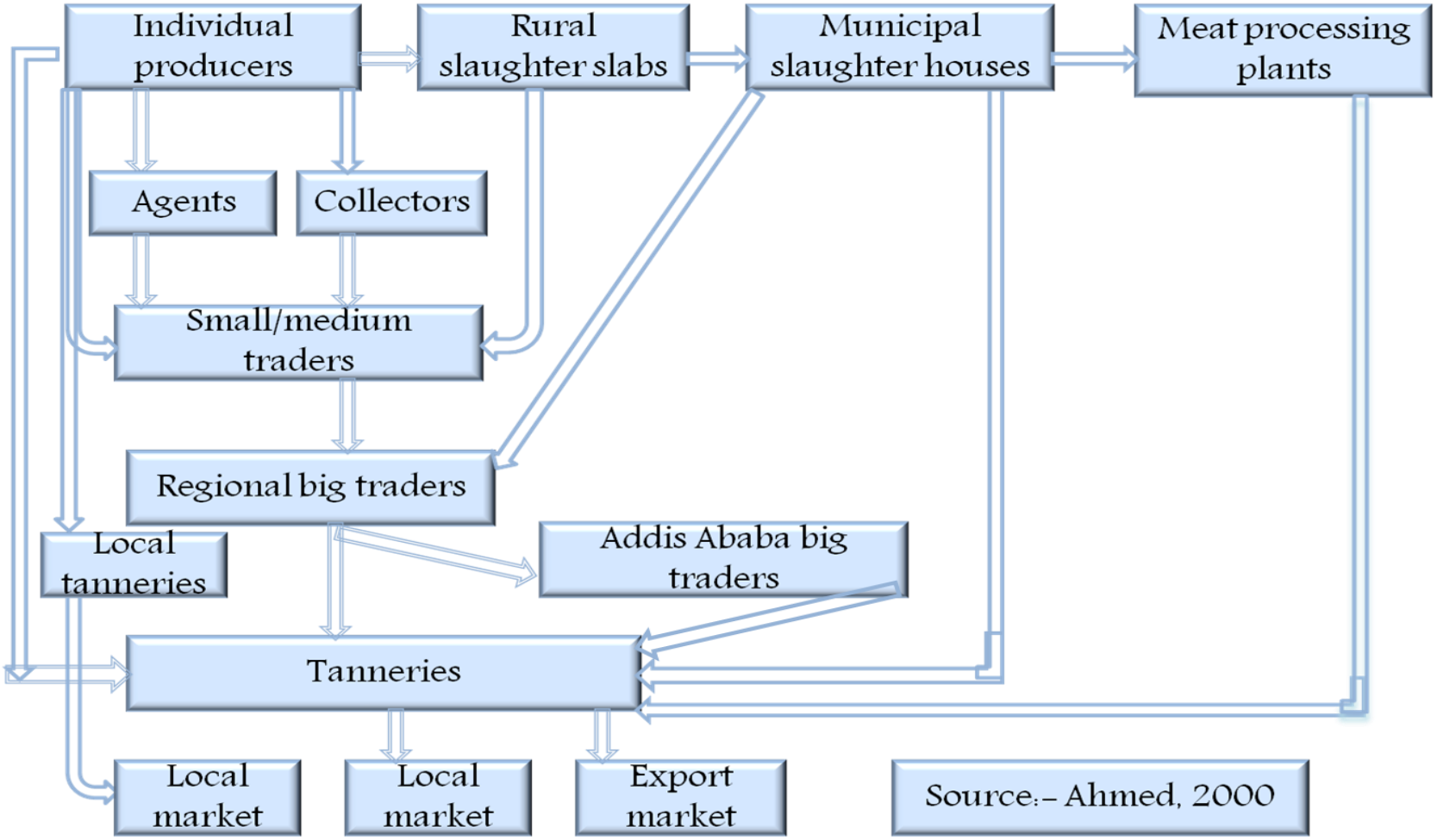


Figure 7:- Ethiopian hides and skins market structure flow chart

3.2. Marketing of hides and skins in Ethiopia….

3.2.1. Market Structure…

Individual Household Producers:

- The major producers of H&S are individual householders residing across Ethiopia.

- About 90 to 95% of the hide and skin production is derived from urban as well as rural backyard slaughters, while the remaining (5 to 10%) from major urban slaughterhouses and export abattoirs (Ahmed, 2000).

figure 8 Source FAO, 2009; Hides and skins market in a rural area of Ethiopia (Photo by I. Leach)

3.2. Marketing of hides and skins in Ethiopia….

3.2.1. Market Structure…

Rural and Urban Slaughter Operators:

- The operators in rural slaughter slabs produce a sizable volume of H & S, second to the individual household.

- Theses operators use poorly equipped slaughter points, where the infrastructure is sometimes a slab of concrete, under a shade or using poles for hoisting carcasses.

- located in small towns adjacent to butcheries in various trading centers 81% (54% in Oromia and 27% in Amhara Regional State).

3.2. Marketing of hides and skins in Ethiopia….

3.2.1.Rural and Urban Slaughter Operators…

- **Such facilities :–**
- scattered in **rural towns** and often no **adequate supervision**.

- **Rudimentary** and of **inferior qualities**

- In the **Rural and Urban Slaughter & municipal slaughtering operation** cattle hides are **recovered by hand from the carcass**, causing extensive damage in the form of **deep cuts** and **holes causing 20–30% loss** of the hide's value(USAID, 2013). .

3.2.Constraints of Hides and Skins Marketing in Ethiopia

3.2.2. What adversely affects production and marketing of hides and skins?

- **Shortage of raw material**;
- **Quality deterioration**;
- Inadequate numbers of **abattoirs, slaughter slabs and proper flaying equipments**;
- Gap between **demand and potential supply**; and
- Lack of procurement of H&S based on **quality grades & no incentive system** to suppliers motivating them to provide quality raw material (ESGPIP 2009)

4. Constraints to H&S production and leather processing

4.1. what affects quantity of raw material supply (H&S production) ? & how ?

- carelessness in **breeding**, **feeding**, **living condition**, **diseases**, parasites, handling, slaughtering, preservation, storing and transportation (NPC, 1981).
- **poor/inconsistent feed** availability;
- Lack of **efficient disease control** and **extension services**;
- Absence of **organized marketing system** for livestock (MoA and ILRI, 2013).

4.2. what affects quality of leather and leather products manufacturing? & how ?

- Low capacity utilization in the tanning industry;

- The poor economic infrastructure.

- Inefficient infrastructure and bureaucratic structures significantly raises the transaction costs of firms, making it difficult to compete nationally or internationally;

- The technology employed is not updated regularly, in particular the lack of learning in production management;

- Lack of hard currency to purchase spare parts and inputs; and the relative lack of export support and/or promotion services (Berhanu and Kibre,2002).

5. Hides/skins defects types and their classification (Pri, peri and post slaughter)

- The quality of hides and skins is influenced by factors throughout the production chain including animal husbandry and disease management.

- Most hide and skin are affected by pre slaughter defects accumulating during the life of the animal.

- The commonly observed **pre slaughter** defects can be **natural** (poor nutrition, age and sex, breed and climate effects), **mechanical damage** (brand mark, scratches, horn rake, yoke mark etc), or **defects due to disease** that can be viral, fungal or parasitic etc (Teklay, 2010).

5. Hides/skins defects types –Classification ;

5.1. Pre–slaughter defects;

5.1.1. Natural (husbandry practices; Nutrition; sex and age; climatic effects; breed/genetics)

Husbandry practices

- Evidence indicates that sizable volumes of these commodities go to **waste** or their **quality substantially deteriorates** in the value chain due to husbandry practices that could be avoided.
- the major issues noted are:–
  - Erratic feed availability.
  - Lack of efficient disease control and extension services.
  - Absence of organized marketing system for livestock and livestock products (MoA & ILRI,2013.)

5. Hides/skins defects types –classification

5.1. Pre-slaughter defects…

Nutrition

- **poor animal nutrition** affects adversely the production of **all animal products**, like meat, milk and others. It is therefore unlikely that **H&S quality** remain **unaffected**.

- **E.g.** animals from the commercial sector produce **better quality hides** because of **better nutrition** than those produced by pastoral, indicating that **nutrition plays a role** in improving both **meat** and **hide quality** (Mohammad *et al*, 2002).

5.1. Pre-slaughter defects …

- **Nutrition…**
  - **Emaciation** is the thinness and friability of H&S derived from animals suffering from prolonged and bitter starvation, leathers produced from such H&S are noted for their dryness and flabbiness.

  - **Diet plays** an important role in the health of the animals and also in the quality of the raw material (Teklay, 2010).

5.1. Pre-slaughter defects …

- **Nutrition…**
- **Poor nutrition-**
  - causes an animal to be **smaller**,
  - the skin **thinner** and of
  - **poorer substance that produce** leather which **lacks elasticity** (ESGPIP, 2009; Teklay, 2010).
- **Fat animals**
  - On the other hand can **cause too much fat content** in the hide, which prevents **curing agents** from **penetrating the hide** (Behailu, 2015).
  - An Intermediate body-conditioned animals produce the **best quality hides** (Wesley and Wright 2002).

Figure 9:- Underfed cow photo taken during field visit in 2010

5.1. Pre-slaughter defects …

Age and sex

- The skins from **male** goats and sheep will be heavy with a coarse grain.
- The **Female** skins will have finer grains and always lighter but better **tensile strength**.

- The skin structure of **young animals** tends to be fine, compact and have tight grain patterns.

- As animals **grow older**, the grain surface becomes **tougher** and **coarser** and also with age animals accumulate more **scars** from brands, diseases, parasites, scratches and other injuries (ESGPIP, 2009; Jean, 1992).

5.1. Pre-slaughter defects …

climatic effects;

- The climate on which an animal is raised has an effect on substance of the skin and on the grain of the leather.
- Animals raised in **warm climate** have a short hair and leather produced has superior substance, smoother and finer grain patterns,

- whereas animal raised in **cooler climate or higher altitude** grow longer wool or hair and resulting leather will be of poor substance and have a coarse/open grained.
- These **climatic effects** are more pronounced on sheep and goat skin than on cattle hide (Tekle, 2009; Teklay, 2010).

5.1. Pre-slaughter defects …
Breed

- In Ethiopia, 99.4% of the total cattle population is composed of indigenous breeds (Belete *et al*, 2010; Solomon *et al*, 2010).

- Desirable or undesirable characteristics of hides and skins can be attributed to certain breeds.

- Cattle hides and sheepskins show more breed characteristics than goats and calf skins (Jean, 1992; NPC, 1981).

5.1. Pre-slaughter defects …

Breed…

- E.g. bovine hides from North America and Europe normally yields flat hides of over 40 sq.ft. (square feet) in area.

- But the typical bovine hide from South America may yield a flat hide of only about 25 sq.ft. area and a Zebu cross-breed from Africa often provides a hide below 25 sq.ft.(FAO,1986).

- Ovine skins such as that of wool bearing merino sheep in Australia can yield a larger skin often above 7sq. ft. area but will not be readily acceptable to the tanners due to the ribbings apparent on them(FAO,1986).

5.1. Pre-slaughter defects …

Breed…

- The small size of skin yielded from sheep of tropical and mountain origin is not considered a **drawback** because of the skin's superior quality of **high tensile strength, compact fiber structure** and **excellent grain**. (ESGPIP, 2009).

- Hides, available from all the beef-producing countries of the world, are very tough and firm, fairly uniform in thickness and having a "square" form, since breeding programs are designed to produce a body conformation with minimal amounts of tissue in the neck, leg and belly regions (Calcutta *et al.*, 2008).

5.1.2. Mechanical damage

- Mechanical damage is primarily the problem on cattle Hide that is Related to farming and handling practices.

- Most noticeable defects on hides and skins like brand marks, scratches, scars and bruises are caused by mechanical means. **Scratches** are very common types of lesion caused mechanically by **thorns, barbered wires** and **horns** (Yacob, 2013).

5.1.2. Mechanical damage

Branding

- Branding is **widespread and indiscriminate** practice of cattle with **hot irons** and it causes **high losses** in the hide and leather industry (Mohammad et al., 2002).
- This practice is used to identify animals especially cattle due to the **prevalence of cattle rustling**.

- Unfortunately most of it is done in the areas of hides, example, **on the back** and **rumps**, which have high value and spoils leather like wounds. **10–40%** of the value of the hide is lost by the unsightly and **irreparable damage** caused by **branding** (Ahmed *et al.*, 2016).
- The loss of value is dependent on the placement of the brand (Patterson and Loren, 2000).

5.1.2. Mechanical damage
Branding

Figure 6:- Branding photo taken during field visit in 2010

5.1.2. Mechanical damage

Bruises and wounds

- Bruises and Wound commonly referred to as **Pre-slaughter defects**. Most **bruises** and **wounds** are inflicted on animals due to **severe beating** especially for **draught animals** and **during transportation on trucks** for slaughter (Mwinyihija, 2010; Abainesh, 2014).

- Although wounds could be healed, they leave a **permanent damage** on hides and skins which remain visible in the **final leather** (Mwinyihija, 2010).

5.1.2. Mechanical damage
Scratches and Horn Rakes

- **Scratches** are amongst the most common mechanical damages found on both hide and skins in Africa including Ethiopia and causing **permanent marks**.

- On cattle hides **horn rakes** are a general problem as animal husbandry practices in the countries discourage **dehorning** (Mohammad *et al.*, 2002).

5.1.3. Defects due to Diseases (viral like LSD, small-pox, rinder-pest), fungal like ring worm or external parasites like tick-damage, sheep ked, louse infestation, mange etc

- Defects due to viral disease
  - **LSD**
  - **small-pox**
  - **rinder-pest**
- Defects due to fungal disease
  - **Ring worm**
- Defects due to parasitic disease
  - **Tick mark**
  - **sheep ked**
  - **louse infestation**
  - **Mange**
- **How disease adversely affects hides and skins?**

5.2. Operational/slaughtering defects;

Flaying :

- **Is simply** " The process of removing the skin from the animal" normally carried out by the **butcher** and the methods used generally give first priority to producing a **good quality carcass** if the animal is to be eaten.

Slaughtering techniques

- **Good slaughter techniques** ensure **proper restraint** of animals **before and during slaughter** to limit struggling and **bruising** during the slaughter process.

5.2. Operational/slaughtering defects; Slaughtering facilities

- It also ensures **proper bleeding** which also leads to **better quality of hides and skins.**

- **Hides & skins** are obtained from **two different sources**,
  - **Controlled** slaughter house in designed operations,
  - as well as **Slaughter** and **death** elsewhere.

- The later includes **significant quantities** of H&S sometimes available from **special festivals** (Leach, 1993).

5.2. Operational/slaughtering defects;

➢H & S from designed slaughtering operations may come from:-

- backyard activities,
- shambles (meat market),
- slaughter slabs,
- slaughter houses, and abattoirs.

➢The facilities available at these vary tremendously. At worst they may consist of no more than small space and a few small items of equipments such as knives.

➢At best they may consist of purpose built structures with all main services (electricity, steam water, effluent treatment etc) and highly trained staff(FAO, 1995).

5.2. Operational/slaughtering defects;

Slaughtering equipment

The basic equipments required according to (FAO, 1995) are:-

1. ***Protective clothing:-***

- boots, dust coat or overalls, hat, chain mail gloves & scabbard for knives.
- These items are required to keep the staff clean, safe and minimize contamination of the products and provide safety.

2. ***Ripping knife:-***

- A sharp pointed knife with straight blade about 150 mm long (Fig 9) should be used for **cutting in to hides and skins** and inserting **ripping lines**. It may also be used for bleeding animals. and carry water, and a wheel barrow to transport materials.

3. ***Flaying knife:-***

- A **blunt tipped knife** with a curved blade of about 150 mm long (fig 9 A) used for cutting hides and skins off carcasses and fleshing.

5.2. Operational/slaughtering defects; Slaughtering equipment …

4. ***Mechanical hoist:*** –

- a lifting device such as pulley or block and tackle (safety tasted for at least one tone) capable of lifting carcasses to a point 3.5m above the floor level.

- A hoist helps in bleeding, flaying and butchery operations.

5. ***Miscellaneous items:***–

- Rope to restrain animals during slaughter, string to tie guts, a bucket to collect blood.

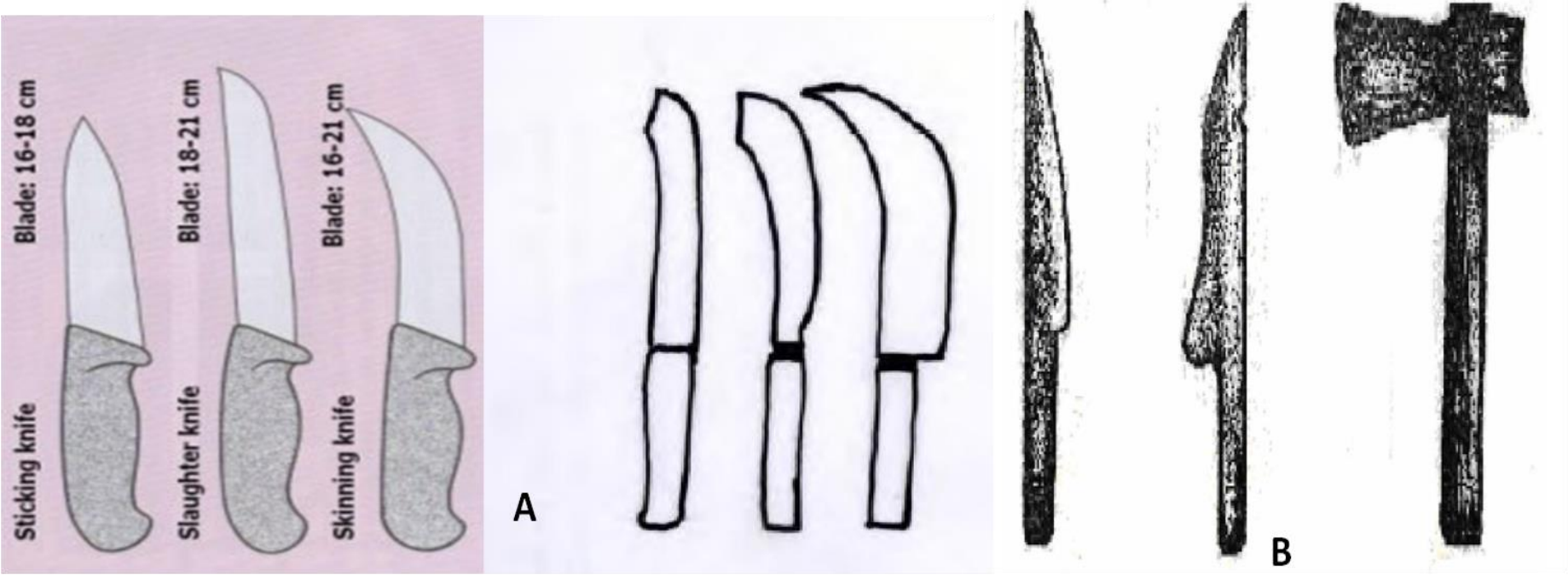


Figure 9:-. A) Proper ripping and flaying knives; B) improper knives used in flaying; Source: (Tekle, 2008).

5.2. Operational/slaughtering defects;

➢Good flaying techniques involve use of proper flaying tools e.g. flaying knives which minimize on defects arising from use of crude tools and kitchen knives.

➢It also entails making of straight and accurate ripping lines resulting to good pattern (Elliot, 1985).

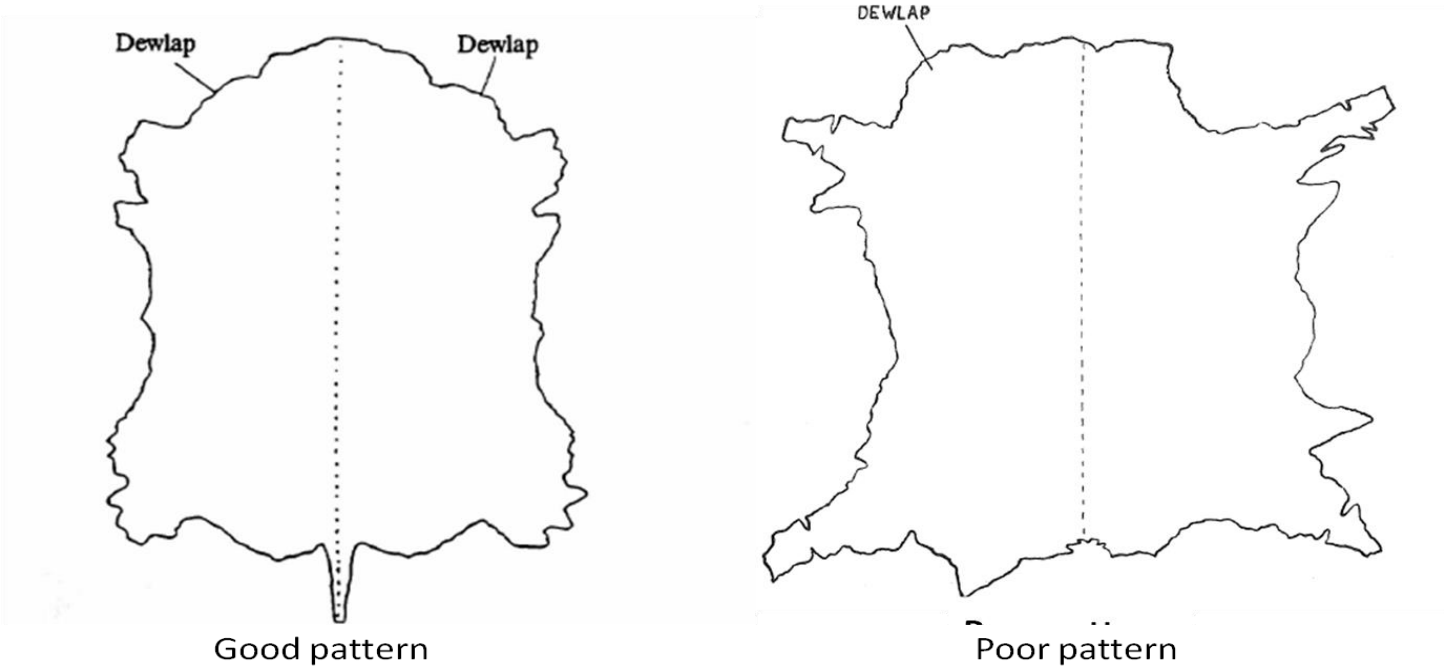


Figure 10:- A. good pattern; B. bad pattern; Source FAO, 1955

5.2. Operational/slaughtering defects;

Rubbed grain

- This damage is produced by dragging the un flayed carcass over rough and uneven ground and can even be caused by rough concrete.

- The grain is generally rubbed off or 'frizzed' and is a definite cause of loss in value to the tanner.
- Preventative measures can be adopted in the field or slaughterhouses.

- In most cases poor flaying, lack of skills and absence of for instance hide pullers in modern abattoirs lead to production of low quality hides and skins (Mohammad et al., 2002).

5.2. Operational/slaughtering defects;

Bad pattern

- This is caused by indiscriminate ripping. 'Ripping' being the initial opening cuts down the centre of the belly and the four legs.

- The correct method of ripping ensures a uniform pattern, with bellies of equal width, well opened shanks and dewlap, a round butt and adequate tails (figure 7).

5.2. Operational/slaughtering defects;
Flay cuts, scores or gouges

- This damage is caused by the careless use of the knife or by the use of unsuitable knives.

- Flay cuts constitute the most serious mechanical defects on hides and skins.

- Lack of proper tools like the rounded flaying knives, lack of flaying skills and carelessness lead to loss of quality or outright rejection of raw hides and skins (Mohammad et al., 2002)(figure 8).

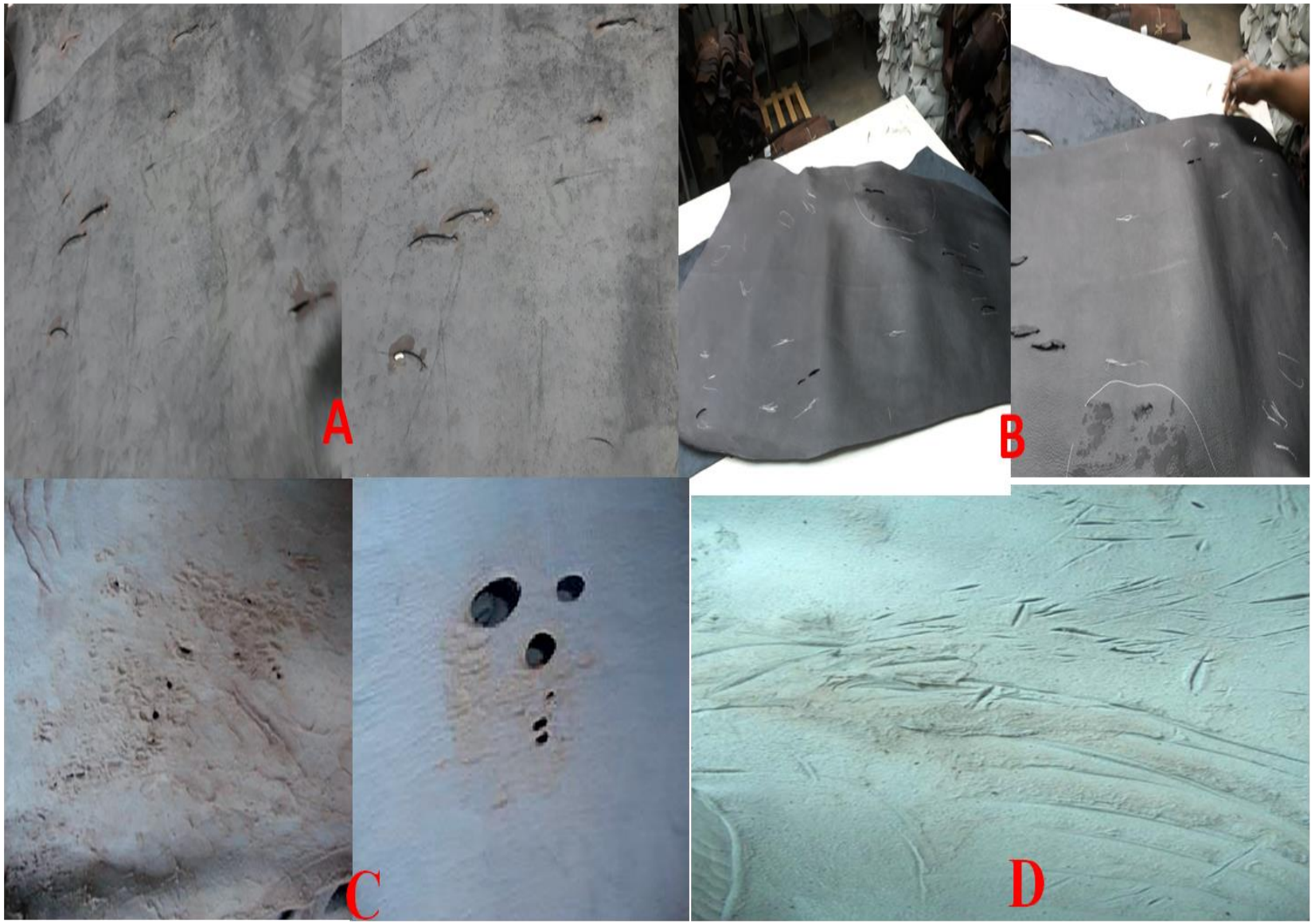


Figure 11:- A. Flay cut of tanned hide at peacock shoe factory from flesh side; B. Flay cut of tanned hide at peacock shoe factory from grain side(during study); C. Flay cuts or scores; D. many knife incisions; source (Kahsay et al., 2015)

5.2. Operational/slaughtering defects; Improper bleeding

- If a carcass is **not bled out properly at the time of slaughtering, blood remains in the vessels** and **capillaries** of the hides and skins.

- This **blood creates ideal condition** for the **growth of bacteria** and **favors putrefaction** along the blood vessels(NPC, 1981).

5.2. Operational/slaughtering defects;

Filth stains (fouling with blood, stomach contents and dung)

➢**Filth stains** are defects **caused by carelessness** at the time of **slaughtering** and **flaying** of the animal.

➢Skins and hides should not be allowed to come in contact **with blood, stomach contents and manure**.

➢These substances **foul the raw material** and are difficult to remove, even by washing, particularly from the hair side, where they cause discoloration and stains on the grain surface.

5.2. Operational/slaughtering defects;

- These "**filth stains**" have a characteristic of mottled/spoted pattern.

- More over, the **dirtiness** of hide and skin **encourages putrefaction** and **reduce** the efficiency of the **curing process**.

- The removal of **stomach** and **intestines** should always be done after **flaying** is completed.

- In Ethiopia, the wide spread practice of **cutting up** all the **meat** and **heaping** it on the hide which is spread out on the ground is common practice that should strongly be **condemned** (NPC, 1981).

5.3. Post slaughter defects

Putrefaction/Spoilage of hides and skins

- Hides and skins consist of mainly **water** and **protein** which make them **vulnerable to Microorganisms attack**.

- The **microorganisms decompose/degrade the protein** which originate from **normal biota** in animal body especially in gastrointestinal tract (Dent et al. 2004; Paczkowski & Schütz 2011), technically called **putrefaction** and eventually make the hides and skins **unsuitable for the manufacture of leather**.

- The proteolytic type of bacteria causes greatest damage to hide (Kanagaraj and Chandra babu, 2002)

5.3. Post slaughter defects

Putrefaction/Spoilage of hides and skins

- The **process of putrefaction** could be accelerated if there are certain ante mortem conditions on the deceased, (either systemic or localized) which will increase the bacteria load in the corpse even prior to invasion of environmental microorganisms (Adams 2009a; Zhou & Byard 2011).

- **Signs of spoilage**
  - Offensive smell
  - Discoloration
  - Slippery or slimy texture and
  - Hair slip (FAO,1995).

5.3. Post slaughter defects

Putrefaction/Spoilage of hides and skins

- **Causes of spoilage**
  - **Chemical decomposition,**
  - **Autolytic enzymes,**
  - **Viruses,**
  - **Fungi (mould and yeast),**
  - **Bacteria and Protozoa.**
- **Course of spoilage**
  - The course of bacterial spoilage in the hides and skins has been studied in some detailed method called **histological techniques**.
  - In this way very thin (2-25 μm) transverse sections of the material are stained with a dye & distribution of bacteria is identified.

5.3. Post slaughter defects…

Putrefaction/Spoilage of hides and skins…

Course of spoilage…

- Stained sections are then observed under the microscope many of the simple structures of hides and skins may be seen under relatively low (100 times) magnification.

- But to see the bacteria, enlargement of 1,500 or 2,000 times may be required.

- If a series of samples are collected over a period of time & submitted to histological examination, the whole sequence of bacterial contamination, proliferation and degradation of the substrate can be followed.

5.3. Post slaughter defects

Putrefaction/Spoilage of hides and skins

Course of spoilage…

- Hides and skins of a healthy living animal only exhibit bacteria on the outer surface of the epidermis.

- After the death & removal of the hide, blood, dirt and bacteria may quickly invade the hypodermis as well .

- As there is huge difference in size between individual bacteria and the structural element of hides and skins, it is impossible to show both clearly on the same scale.

5.3. Post slaughter defects

Putrefaction/Spoilage of hides and skins

Course of spoilage

- Accordingly in most of the following figures, bacteria are presented **collectively by the use of (+).**

- $1cm^2$ of hide surface can contain $1.5x10^8$ (150 millions) of bacteria and the gut $2.0x10^8$ (200 millions) of bacteria per gram (FAO, 1995).

- steady deterioration in the physical structure of the collagen fiber.

5.3. Post slaughter defects

Putrefaction/Spoilage of hides and skins

➢Course of spoilage

➢The speeds at which the spoilage of un preserved hides and skins occurs depend on a number of factors. Some of the most important factors are:-

- **Ambient temperature:-** high temperature promotes rapid deterioration, but low temperature discourages it
- **The extent of contamination** :-higher levels of contaminating bacteria especially collagenolytic anaerobes promote more rapid deterioration of hides and skins
- **The thickness:** - thicker hides spoil more slowly than the thinner ones(FAO,1995).

5.3. Post slaughter defects…
Putrefaction/Spoilage of hides and skins…
Determination of spoilage

- By the time hair slip is observed, the spoilage is already advanced enough to make material useless for the leather manufacture.

- In between production of fresh hide and the appearance of the first visible signs of spoilage, there is a steady transition from a fresh to a spoilage.

5.3. Post slaughter defects…

Putrefaction/Spoilage of hides and skins…

Determination of spoilage

- The histological technique may be used for monitoring purposes. However, is complicated and requires access to well equipped laboratory facilities.

- Therefore, much simpler and more informative technique is based on collection of compounded sample derived from numerous parts of the hide or skin.

- In practice, pieces of H/S are finely chopped, dispersed in nine times their weight of water and shaken for an hour to prepare an aqueous extract. The extracted may then be tested.

5.3. Post slaughter defects…

Putrefaction/Spoilage of hides and skins…

Determination of spoilage…

- The simplest way of assessing the presence of bacteria in an aqueous hide or skin extract is to incubate a small quantity together with an equal volume of 0.1% solution of compound like triphenyl tetrazolium chloride (TTC).

- After about an hour, bacteria turn the **TTC solution red**. The strength of the **redness** is related to the number of contaminating bacteria (Nandy, 1975).

5.3. Post slaughter defects…

Putrefaction/Spoilage of hides and skins…

Determination of spoilage…

- The presence of proteolytic enzymes may be determined by placing drops of extract on the photographic film.

- **The bi-layered Kodak plus X is particularly suitable**.

- If enzymes are present they will gradually destroy the gelatin films used to hold the photographic pigments (Tancous, 1972).

5.3. Post slaughter defects

Putrefaction/Spoilage of hides and skins

Some of the post slaughter defects are:-

Veinnes:-

- The leather defect called "**veinnes**" or "**prominent blood vessel**" arises from the eating away by bacteria of the fibrous region surrounding the veins (NPC, 1981).

- When the leather is glazed, it receives less pressure in the channeled areas and the blood vessel show up (NPC, 1981).

5.3. Post slaughter defects

Putrefaction/Spoilage of hides and skins

Grain crack and stretch marks

Grain crack:-

- Hammer flaying is some times used. The hammer is round-nosed base or wooden mullet.

- This method produces flayed hides with out the common flaying defects-cuts, scores, etc.

- but too heavy blows on the thin skins can cause breakage of the fibers and cracks in the grain surface(NPC, 1981).

5.3. Post slaughter defects

Putrefaction/Spoilage of hides and skins

Stretch marks:-

- This defect results from too much tension on the skin at the time of **flaying, drying or during the leather manufacturing process.**
- Sheepskins are particularly **susceptible to stretch marks.**

- These grain layers **split open as it can't withstand as much strain as the under laying collagen fibers.** The skins are pulled or punched too strenuously (NPC, 1981).

- The leather produced from over stretched materials will have **poor strength** and **fiber structure** (FAO, 1986).

5.3. Post slaughter defects

Putrefaction/Spoilage of hides and skins

Bacterial damage

➢Green hide/skin that contains large quantities of proteins and moisture produces a favorable environment for the development of various microorganisms (Lukin, 1967).

➢All hides and skins carry great number of germs, while the hide is on the live animal, these germs unless there are very exceptional circumstances, don't damage the hide, and this is the result of the protective action of the hair and the horny nature of the epidermis.

5.3. Post slaughter defects…

Putrefaction/Spoilage of hides and skins …

Bacterial damage…

- This is caused due to the loss of **natural defense of the live animal**.

- i.e. after death, animals' natural defenses no longer operate, hence under favorable conditions of temperature and moisture, bacterial multiplication and penetration in to the skin start.

5.3. Post slaughter defects

Putrefaction/Spoilage of hides and skins

Bacterial damage

- Enzymes (especially those secreted by the bacteria) breakdown first the inter-fibrillary material i.e. soluble proteins, sebaceous and sweat glands and later the fiber components of the hide substance.

- As a rule, warmth and moisture favor a multiplication of bacteria, while on the contrary cold and dryness hinder it (NPC, 1981).

5.3. Post slaughter defects

Putrefaction/Spoilage of hides and skins

Bacterial damage

➢Generally **bacteria require moisture and warmth for active growth** but large differences may occur in their requirements.

➢According to their air requirement they can be ***aerobes*** (those which require oxygen) and ***anaerobes*** (those which remain in dormant state, in dirt or excrement for a long time which can't multiply in the presence of air). These cause **putrefactive change in the hide substance** (NPC, 1981).

5.3. Post slaughter defects

Putrefaction/Spoilage of hides and skins

Pest infestation damage…

- Dirt cars or trucks and none cleaned store can become infested with pests which can do immeasurable damage to hides and skins (NPC., 1981, Jean, 1992).

Rodents: –

- even though their damage to hides and skins is not **excessive**, mites and rats are commonly seen.

- Nevertheless persistent attacks by gnawing rodents can reduce good hides and skins to an inferior quality.

5.3. Post slaughter defects

Putrefaction/Spoilage of hides and skins

Pest infestation damage…

- **Precaution against this damage** would include keeping stores clean, periodical rotation of stocks, and use of poison, traps and cats (NPC, 1981).

- Another **objectionable contamination** in this case is the defilement of the stock by rats, bats, and birds manure which does not really damage the hides and skins but they spoil the appearance of the stock (NPC, 1981).

5.3. Post slaughter defects…

Putrefaction/Spoilage of hides and skins…

Mechanical damage (flesh left over)…

These defects can be improper

- ***after cleaning &***
- ***trimming***

After cleaning: –

- is the operation of removing (trimming off) the fatty tissue and meat which is left over attached to hides/skins after flaying.

- Good flaying should not need this cleaning, but many hides and skins do have adhered fat and meat (particularly around the tail area) and should be removed before curing to avoid some defects.

5.3. Post slaughter defects…

Putrefaction/Spoilage of hides and skins…

Mechanical damage (flesh left over)…

After cleaning: –

- During air drying, the grease is absorbed by the fibrous tissues on the corium and is most difficult to remove in leather manufacture causing greasy stains which will not take the dye and will show up on the finished.

- During salt curing, the **fatty tissue** and **meat** obstruct **salt penetration** and the curing may be delayed sufficiently to permit local putrefaction.

5.3. Post slaughter defects…

Putrefaction/Spoilage of hides and skins…

Mechanical damage (flesh left over)…

After cleaning: -…

- The after cleaning should be applied only when necessary for the risk of gauging, scoring and cutting is very great.

- The cleaning of the flesh should be done on a flat smooth table (not when the hide is suspended in frames) with a very sharp and curve-edged knife(NPC, 1981).

5.3. Post slaughter defects…

Putrefaction/Spoilage of hides and skins…

Mechanical damage (flesh left over)…

Trimming: –

- properly cleaned hides/skins must be trimmed before curing. Dewclaws, tendons (sinews), cartilage, horns, skull bones and ears are usually removed on the slaughtering floor.

- These extraneous tissues will not make the leather and can be used to the best advantage before the hide is cured or put trough tannery process.

5.3. Post slaughter defects…

Putrefaction/Spoilage of hides and skins…

Mechanical damage (flesh left over)…

Trimming: –

- If left on the hide these materials may prevent parts of the hide from receiving adequate amount of salt in the curing operation.

- The "heal piece" or cartilage can damage the tannery machinery (Jean, 1992).

Fleshing beam

Fleshing using a fleshing knife

5.3. Post slaughter defects…

Putrefaction/Spoilage of hides and skins…

Vulture marks

- Fallen cattle are often left lying on the field.

- The vultures pray upon the carcass puncturing the hide with their sharp claws.

- Hides are thus seriously damaged. In similar way jackals and dogs also damage the hide(NPCS,2011).

5.3. Post slaughter defects…

Damage during Curing, Storage & Transportation…

Curing

- Since the freshly flayed hides and skins are very liable to be attacked by many types of bacteria and molds already existing on the slaughtered animal or on those coming from the various external sources such as dust, dirt, dung, soil, air, water, fodder, insects, distended animals etc,

- To **avoid any enhancement** of putrefaction, the curing process should start not later than four hours after flaying when the natural body heat escaped(NPC, 1981)

5.3. Post slaughter defects…

Damage during curing, Storage & transportation…

Storage defects

- Some of the common factors concerned with un wanted conditions responsible for stale hide substance defects during storage of salt cured stock are:-

- **temperature, time, humidity, air circulation, drainage, length of hair, pressure in pack, and amount, size and re-use of salt** (Jean, 1992).

5.3. Post slaughter defects…

Damage during curing, Storage & transportation…

Storage defects

Temperature: -

- when the temperature is too warm, there is an increase in the rate of deterioration even with good salting. There fore the Storage temperatures for salted skins and hides should be cool (NPC, 1981).

Time: -

- Leaving stock for along period in storage, in most instances result in stains or discolorations.
- Green salted hides and skins are more susceptible to stain and discolorations than those brine cured (Jean, 1992).

Humidity: –

- High humidity which allows for the moisture to be absorbed by the stock may encourage staling and spoilage.

- On the contrary a very low humidity can bring about an uneven drying out of the stock that could interfere with soaking & "hard spots" may be found in leather (Jean, 1992).

Air circulation: –

the maintaining of uniform air circulation in storage space is desirable(Jean, 1992).

Brine damage: –

- a slightly inclined floor is desirable. A pack should not drain too fast.
- No H/S should be soaked in dirty, bloody brine as this condition can bring about stains in leather (Jean, 1992).

Drainage: –

- solid (preferably concrete) floor and proper drainage (FAO, 1995).

Length of hair: –

- the long hair stock usually carries more dirt or filth that works against the best cure.

Pressure in pack: –

- poor cure is obtained in too high pressured pack.

Salt: –

- very large crystals of salt or large irregular foreign matter, besides retarding the cure, cause depressions or pits in the grain.

- Fine salt tends to form a mass or crust and does not penetrate the hide or skin rapidly; it gives a slow and poor cure.

- The use of dirt or used salt is very unsound and has no advantage;

- it contributes to all unwanted conditions encountered in stale stock (Jean, 1992).

5.3. Post slaughter defects…

Transportation defects

- Careless handling of hides and skins at the time of transportation can result in damage of the leather.

- Among the damages include mechanical and **delayed transit damages, excess heat and cold damages, sun and rain damages**, and **Water caused defects**.

Mechanical and delayed transit damages: –

- in developing countries many forms of transport such as **Motor lorry, bullock cart, and animal transport, bulls, camels and donkeys** are used to convey hides and skins to more important markets.

5.3. Post slaughter defects…

Transportation defects…

Mechanical and delayed transit damages: –

- H&S are often loaded singly on to lorry transport and on tied in to loose bundles.

- Consequently any movement will make the surface **rub together and cause considerable damage, especially to the grain, folded edges and corners**.

- Cars and trucks should be cleaned to all loose objects and materials before being used for H&S (NPC, 1981).

5.3. Post slaughter defects…

Transportation defects…

Mechanical and delayed transit damages: –

➢Nails, bolts, or other objects which can tear or puncture the stock cause damage in the leather.

➢Metallic salts and **rust picked up from car or truck will cause metallic stains**. Such materials as metallic filings and coarse sand can become **imbedded in the stock**.

➢These can **cause grain abrasion** and do much damage to the machinery at the tannery (Jean, 1992).

5.3. Post slaughter defects…

Transportation defects…

Excess heat and cold damages:-

- exposure of H&S to either **heat or cold for prolonged time can result in dehydration of the stock**.

- Later in the soaking operation, rewetting becomes difficult and result hard spots in the leather.

- These spots have raspy fibers because the stock will not tan properly (Jean, 1992).

5.3. Post slaughter defects…

Transportation defects…

Sun and rain damages: –

- sun shining directly on the H&S can **cause over dehydration and hide separation**.

- It causes the natural grease to migrate and coat the fibers of the stock.

- **Rain coming in contact with cured stock** through leaking cars' or trucks' roofs can wash out salt and allow bacteria to grain entrance. Grain damages result and in extreme cases, areas become completely rotten (Jean, 1992).

5.3. Post slaughter defects…

Transportation defects…

Water caused defects: –

- **No matter how well hides or skins has been cured or stored, if water or excess moisture accidentally comes in contact with**, it result with defects such as **grain damages and rotten spots**,
- Water and moisture re-hydrate the stock, wash out the salt and allow autolysis and bacterial degradation to continue at rapid rate (Jean, 1992).
- All piles of the H&S should also be kept clear of floor by stacking on rakes to raise the bottom H/S at least 10 cm from the ground.
- In many areas, simple shed will give sufficient protection (NPC, 1981).

5.4. Preservation

- **Preservation/curing** is the name given to a variety of procedures, which can be applied to H&S to:-
  - **reduce, or stop spoilage (putrefaction)**.
  - it can **only maintain quality**.

- bad preservation will allow deterioration of all a skin, irrespective of its original quality (Leach, 1995).
- is accomplished either by:-
  - **destroying active bacteria,**
  - **preventing bacterial activity or**
  - **preventing bacterial contamination**.

- avoid from usage of toxic materials as **they can cause negative health effect s to environment & society** (Riga 2015).

Preservation methods

➢The **most common methods** of preservation are drying, salting, brining or the use of other chemicals (see the Table below).

➢ Refrigeration, freezing and mechanical drying methods can be used, but they are expensive and tend to be reserved for more valuable skins in particular situations (FAO, 2009).

Suspension drying of large cattle hides (FAO, 2009)

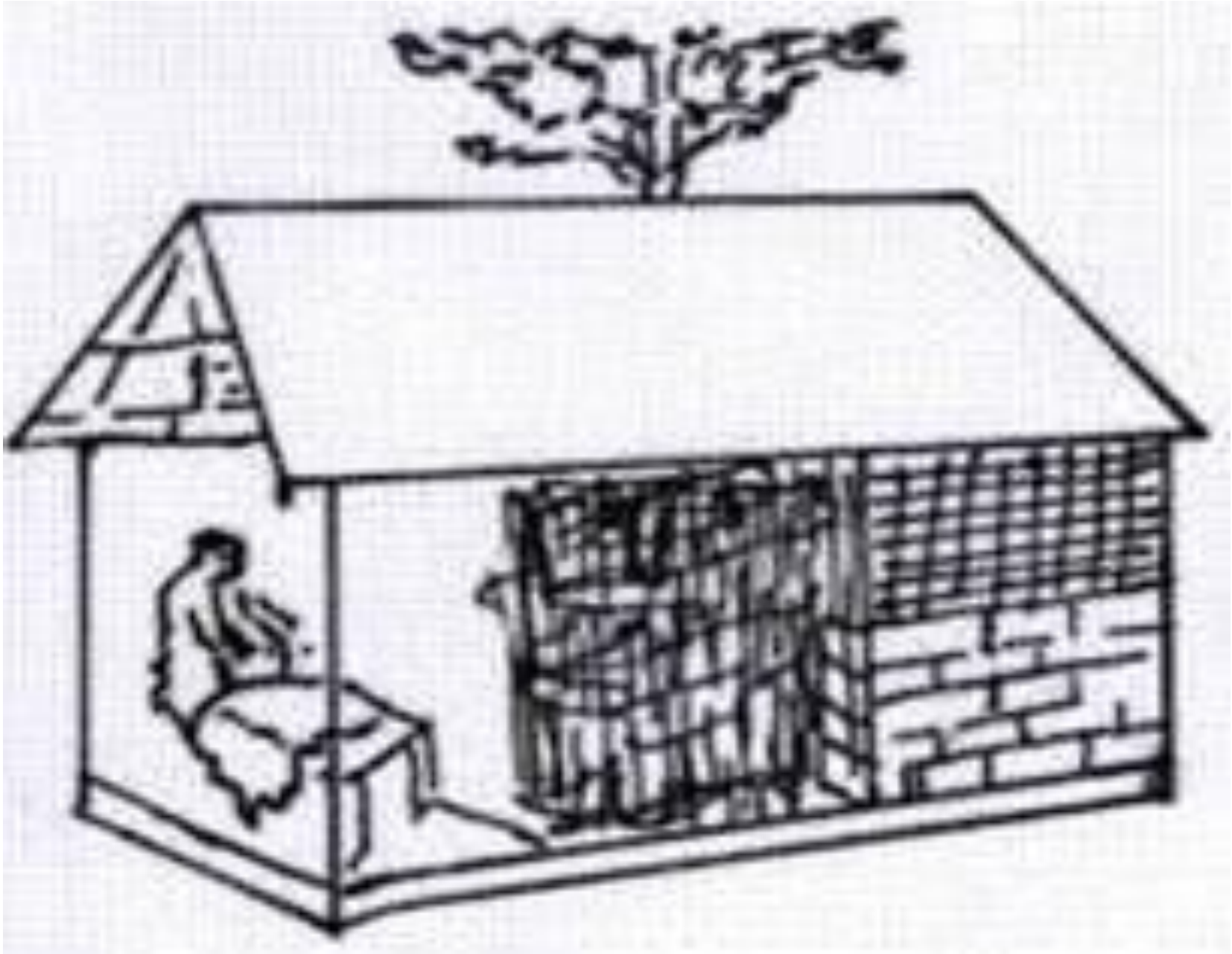
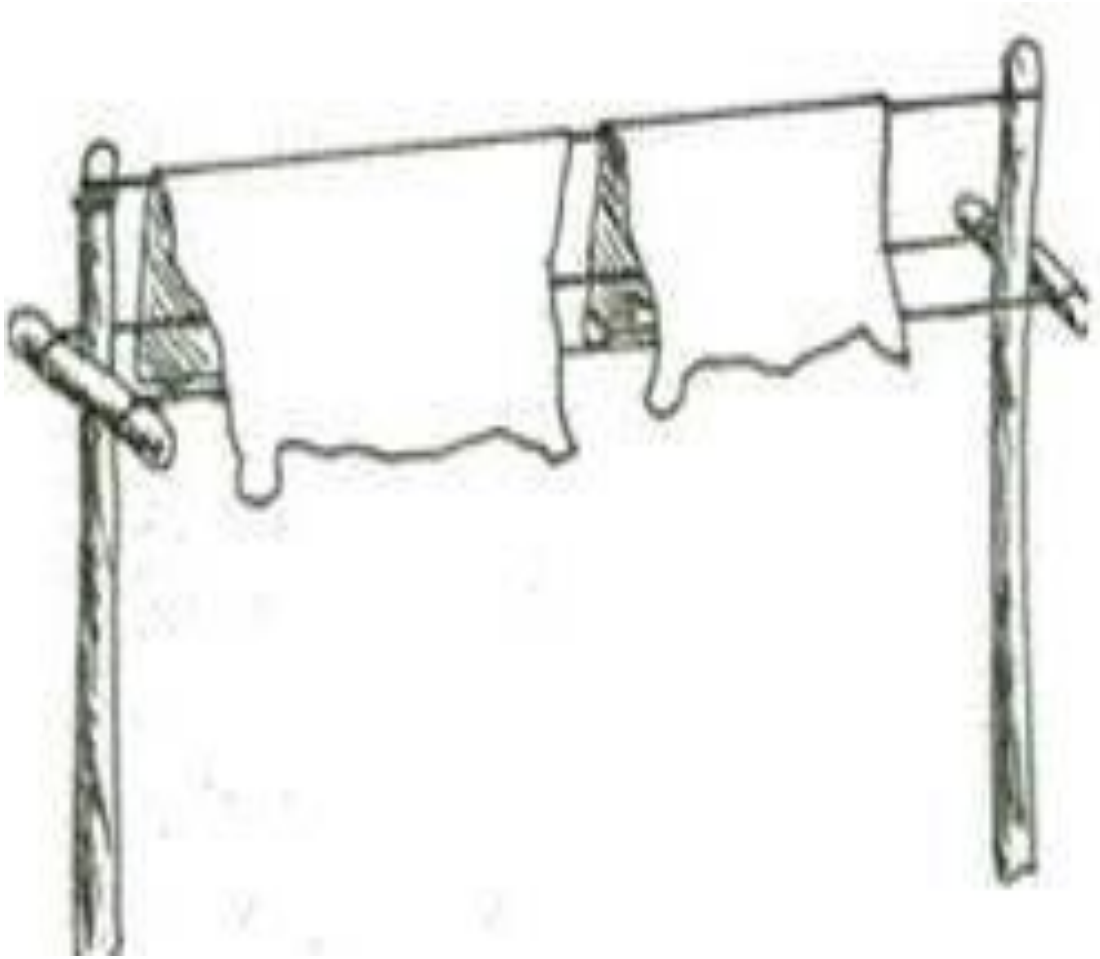
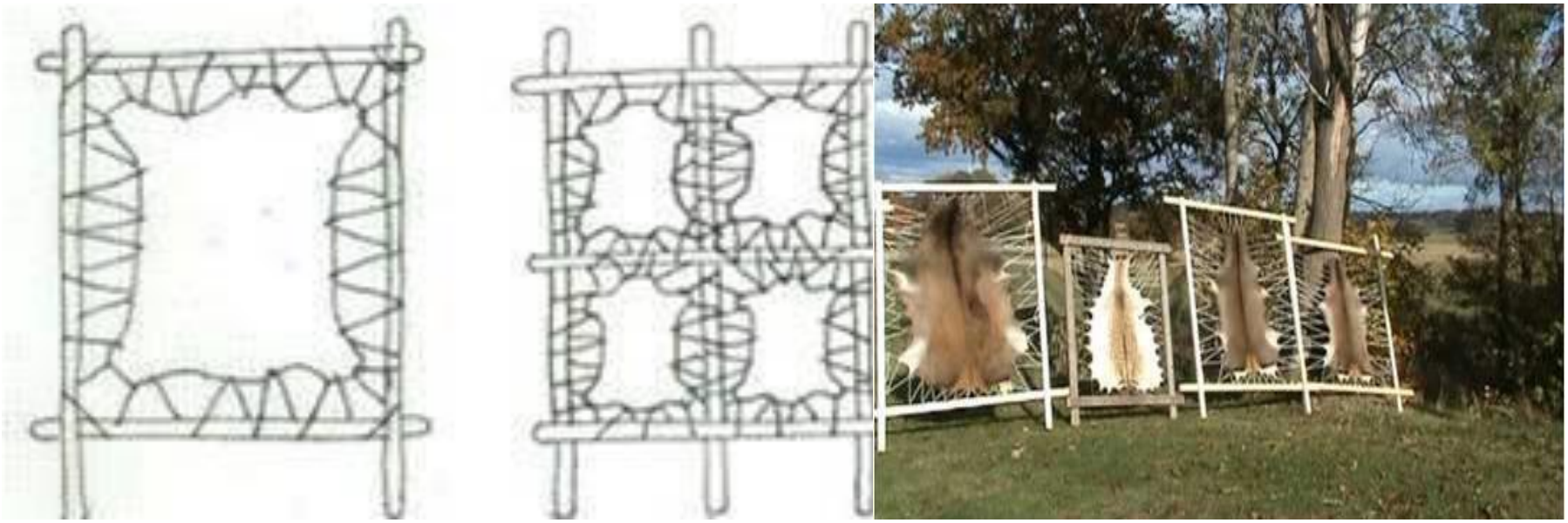


Figure …skin drying shed

Figure ……Ground drying results in serious, irreparable damage to skins.



Figure…..suspension drying over a cord



Figure……Frame drying of skins

Figure……Before and after fleshing

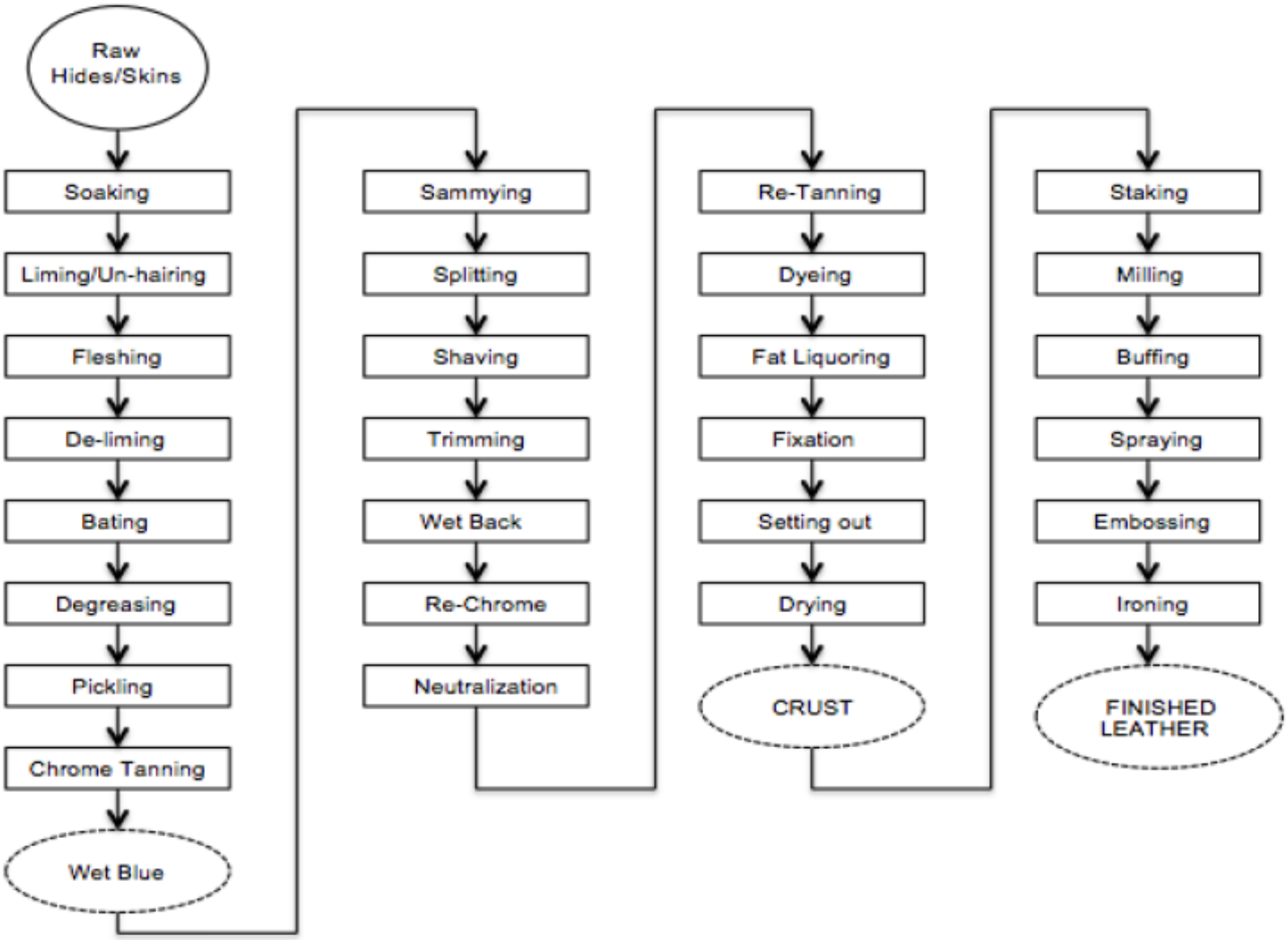
Drying	***Sun drying:*** in direct sunlight and usually on the ground. ***Frame drying:*** in a large frame. ***Shade drying:*** in a roofed shelter and usually in a frame and is the recommended way. ***Suspension drying:*** in a large frame, over a pole or even on a porous wall.
Salting	***Pit salting:*** using an excess of salt and preventing any loss of moisture by retention in a pit. ***Stack/wet salting:*** using an excess of salt and allowing excess moisture to drain away. ***Dry salting:*** using an excess of salt followed by drying.

Source:- FAO, 2009

Brining	***Static/pit brining:*** by immersion in saturated brine with little or no agitation. ***Raceway brining:*** by immersion in saturated brine with considerable agitation.
Chemical	Chemicals (other than salt) provide preservation lasting days, weeks, months or years

Source:- FAO, 2009

6. Hide and skins processing(Tanning process) process flow chart



6. Hide and skins processing(Tanning process)

➢Hide and skin reception and storage

Sorting

➢Sorting may be carried out in the slaughterhouse, by dealers, and/or in the tannery.

➢ On receipt, hides and skins may be sorted into several grades by size, weight, or quality.

➢Hides are also sorted by sex. Materials unsuitable for the particular type of leather manufactured may be sold to other tanners.

6. Hide and skins processing(Tanning process) …

- **Hide and skin reception and storage…**

Trimming

- **Trimming** is generally carried out during the sorting process. Some of the edges (legs, tails, face, udders, etc.) of the raw hides and skins can be cut off.

- This process step may be carried out in the slaughterhouse, but it can also be carried out in tanneries.

- It produces a waste which is subject to control under the **Animal By-Products Regulation**.

6. Hide and skins processing(Tanning process) …

- Hide and skin reception and storage…

Curing and storage

- Curing is a process that prevents the degradation of hides and skins from the time they are flayed in the slaughterhouse until the processes in the beam house are started [Andres 1997;Frendrup 1999].

- Curing is carried out at the slaughterhouse, at the hide dealer's premises, at the hide market, or at the tannery.

- The methods for curing for long-term reservation (up to six months) are: **salting, brining, drying and salt drying**.

6. Hide and skins processing(Tanning process) …

Curing and storage

➢Long-term preservation methods are used when hides and skins are traded, particularly for inter-continental trading.

Methods for short-term preservation (2 – 5 days) are cooling, using crushed ice or refrigerated storage, and biocides.

These methods are used where direct deliveries are made from relatively local sources.

6. Hide and skins processing(Tanning process) …

Beam house (or lime yard) operations

- The operations carried out in that part of the plant known as the beam house or lime yard are often carried out in the **same processing vessels, with changes of float and chemicals**.

- In modern practice the vessels are either mixers(A &B)

A mixer or inclined processor

Drums

6. Hide and skins processing(Tanning process) …

Soaking

- Soaking is carried out to allow hides and skins to reabsorb any water which may have been lost after flaying, in the curing process, or during transport.

- Soaking also cleans the hides and skins (removal of dung, blood, dirt, etc.) and removes interfibrillary material.

- depending on the state of the hides, the process is mostly carried out in two steps: a dirt soak to remove the salt and dirt, and a main soak.

- The duration of soaking can range from several hours to a few days.

6. Hide and skins processing(Tanning process) …

Un hairing and liming

- The aim of un hairing and liming is to remove the hair, epidermis, and to some degree, the interfibrillary proteins, and to prepare the hide or skin for the removal of adhering flesh and fat by the fleshing process.

- Hair removal is performed by chemical and mechanical means. The keratinous material (hair, hair roots, epidermis) and fat are traditionally eliminated from the pelts mainly with sulphides (NaHS or Na2S) and lime.
- Enzymatic preparations are sometimes added to improve the performance of the process

6. Hide and skins processing(Tanning process) …

Fleshing

- Fleshing is a mechanical scraping off of the excessive organic material from the hide (connective tissue, fat, etc.).

- The pelts are carried through rollers and across rotating spiral blades by the fleshing machine [BLC ,1995].

- Fleshing can be carried out prior to soaking, after soaking, after liming or after pickling. The process of fleshing is called green fleshing if the removal is done prior to liming and unhairing.

If fleshing is performed after liming and unhairing, it is called lime fleshing.

6. Hide and skins processing(Tanning process) …

Splitting

- The aim of the splitting operation is to produce hides or skins of a set thickness.

- They are split horizontally into a grain layer and, if the hide is thick enough, a flesh layer.

- Splitting is carried out on splitting machines, fitted with a band knife. Splitting can be done in the limed condition or in the tanned condition.

6. Hide and skins processing(Tanning process) …

Deliming

- After the liming process, the lime or other alkali in the skin is no longer required, and, in most cases, it has a detrimental effect on subsequent tannage.

- The deliming process involves a gradual lowering of the pH (by means of washing in fresh water or by weak acidic solutions or by salts such as ammonium chloride or sulphate or boric acid), an increase in temperature and the removal of residual chemicals and degraded skin components.

6. Hide and skins processing(Tanning process) …

Bating

➢The unhairing process leaves the surface of the skin or hide clean, however, some hair roots and pigments are still not removed during unhairing, which is not desirable for certain types of leather.

➢The removal of these hair roots and pigments is achieved by the **bating process**.

➢Bating uses commercially available **proteolytic enzymes**.

6. Hide and skins processing(Tanning process) …

Tanyard operations

The operations carried out in that part of the plant known as the tanyard are often carried out in the same processing vessels, with changes of float and chemicals. In chromium tanning, the vessels are usually drums (see Figure).

6. Hide and skins processing(Tanning process) …

Degreasing

- Degreasing is most relevant in processing sheepskins, where the natural fat content is about 10–20 % of dry weight. not usual for bovine hides.

- The nature of this fat makes it difficult to remove because of the presence of glycerides and a high melting temperature that;

- may interfere with uniform penetration of tan or dye, causing difficulties in the finishing processes and creating dark and greasy patches on the finished leather

6. Hide and skins processing(Tanning process) …

Degreasing…

Degreasing of greasy skins is particularly important before chrome tannage as the chromium salts can react with the greases and form insoluble chromium soaps, which are very difficult to remove subsequently [Sharphouse 1983].

The three different methods commonly used for degreasing are:

1. degreasing in an aqueous medium with an organic solvent and a non-ionic surfactant
2. degreasing in an aqueous medium with a non-ionic surfactant
3. degreasing in a solvent medium.

Tanning

- **Tanning** is the **process of converting perishable** raw H&S , by the use of tanning materials, into the permanent and durable form of leather.

- In this process, the collagen fibres are stabilized by the cross-linking action of the tanning agents.

- After tanning, the hides or skins are not subject to putrefaction, their dimensional stability, resistance to mechanical action, and heat resistance increase [Andres 1995; HMIP 1995].

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Tanning…

- The majority of tanning agents fall into one of the following groups:
  1. mineral tannages
  2. vegetable tannins
  3. syntans
  4. Aldehydes
  5. oil tannage.

- The most commonly used tanning agent is basic chromium sulphate ($Cr(OH)SO_4$).

- A high proportion (80 – 90 %) of all the leather produced today is tanned using chromium(III) salts.

Draining, horsing, samming, and setting

- After tanning, the leathers are drained, rinsed and either horsed up (piled onto a 'horse') to 'age' (allow further fixation of the tan and setting out of the fibers to occur), or

- reduce the moisture, prior to further mechanical action, such as splitting and shaving.

- The setting-out operation can be carried out to stretch out the leather.

- Machines exist which combine the sammingand setting action, then grading continues after which they are processed further or sold on the market.

Shaving

- The **shaving process** is carried out to reduce and/or even out the thickness throughout the hide or skin.

- Shaving can be carried out on tanned or crusted leather.

- The small pieces of leather which are shaved off are called shavings.

Neutralization

- Neutralization is the process by which the tanned hides are brought to a pH level suitable for the process steps of retanning, dyeing and fatliquoring.

Bleaching

- Vegetable tanned skins and leathers with wool or hair may need to be bleached in order to remove stains, or to reduce the colouring in the hair, wool, or leather prior to retanning and dyeing.

Retanning

The retanning process can be carried out with the following objectives:

- To improve feel and handle;
- To fill the looser and softer parts
- So that more uniform physical properties and with more economical cutting value to the customer will be obtained;

Retanning…

- To assist in the production of corrected grain;
- To improve the resistance to alkali and perspiration;
- To improve the 'wetting back' property (susceptibility to rehydration) of the hides which will help the dyeing process.

➢A wide variety of chemicals can be used for the retannage. They can generally be divided into the following categories: mineral tanning agents ;vegetable tanning extracts, syntans, aldehydes, and resins.

Dyeing

- The dyeing process is carried out to produce consistent colouring over the whole surface of each hide and skin, and for exact matching between hides in a commercial pack.

- Typical dyestuffs are water- based **acid dyes**. Basic and reactive dyes are less commonly used.

Fatliquoring

- Leathers must be lubricated to achieve product-specific characteristics and to reestablish the fat content lost in the previous procedures.

Fat liquoring…

- The oils used may be of animal or vegetable origin, or may be synthetics based on mineral oils.

- Stuffing is an old technique used mainly for heavier vegetable-tanned leather. The sammed leather is treated in a drum with a mixture of molten fat. [Heidemann 2000].

- The retanned, dyed, and fatliquored leather is usually washed before being piled onto a 'horse' to 'age' (letting the fat migrate from the surface to the interior of the material).

Drying

- The objective is to dry the leather whilst optimizing the **quality and area yield**.

- Drying techniques include samming, setting, hang drying, vacuum drying, toggle drying and paste drying.

- Generally samming and setting are used to reduce the **moisture content mechanically** before another drying technique is used to dry the leather further.

- After drying, the leather may be referred to as **crust**. Crust is a **tradable intermediate product**.

Dry finishing operations

The overall objective of finishing is to **enhance the appearance of the leather** and to **provide the performance characteristics** expected of the finished leather with respect to:

- **Colour**
- **Gloss**
- **Handle**
- **Flex**
- **Adhesion**
- **Rub fastness,**

➢Dry finishing operations

➢Other properties required for the end use, include:

- extensibility
- break
- light fastness
- water vapour permeability, and
- water resistance.

➢Generally, finishing operations can be divided into mechanical finishing processes and coating

Mechanical finishing processes

- A wide range of mechanical finishing processes may be carried out to improve the appearance and the feel of the leather. However, commonly used are:

  - Conditioning (optimizing the moisture content in leather for subsequent operations);
  - Staking (softening and stretching of leather);
  - Buffing/dedusting (abrading of the leather surface and removing the resulting dust from the leather surface);
  - Dry milling (mechanical softening);
  - Polishing;
  - Plating (flattening);
  - Embossing a pattern into the leather surface.

Applying a surface coat

- The purpose of applying a surface coat is:
  - To protect from contaminants (water, oil, soiling);
  - To provide colour;
  - To provide modifications to handle and gloss;
  - To provide attractive fashion or fancy effects;
  - To meet other customer.

7. Storage and transportation

- After the compilation of preservation procedures, hides and skins must be **stored** and subsequently delivered to hide and skin merchants (tanners) premises.

- The period of storage should be kept minimum avoid some degree of deterioration.

- Prompt **storage and transportation** of hides and skins will also minimize capital expenses that can be deployed in the maintenance of large stock of raw materials.

- An appropriate **storage and transportation** procedures vary according to the methods of preservation that has been used (FAO, 1995)

7. Storage and transportation

- Subject to the wool on sheep, most skins are conventionally tied in bundles of about fifty to one hundred pieces. Because of their relatively small size, skins should not be folded (FAO1995).

- The bundling & tying of hides and skins can be done manually with ropes or mechanically using a proper press and straps.

- However, before the bundling and storage of dried hides and skins is undertaken, they should be dusted, sprayed or fumigated with appropriate insecticides

7. Storage and transportation…

Dried hides and skins

- To facilitate storage and handling, cattle hides should be **folded hair side to hair side**, along the line of the **back bone & tail**.

- In this way the delicate surface under the hair is protected against **abrasion**, **bundles of about ten dried hides** should be t**ightly/firmly** tied together prior to being transported.

- If the hides are not tied, they may **rub against each other and cause abrasion damage.**

7. Storage and transportation

- According to studies of (Golob et al., 1992; corning et al.,1993) effective and relatively safe insecticides include etrimphos, carbarry, perimiphos-methyl (acetylic) & chloryriphos-methyl (Reland).

- If dried materials are not protected with an insecticide, they will almost certainly become infected with hide leather insects such as dermestes maculates species. These are extremely veracious & can quickly consume the whole dermis leaving only the hair and epidermis.

7. Storage and transportation

- The store room for dried materials & should be **weather and rodent proof**.

- The ventilators should be **fitted with nets or meshes to guard against insects**.

- While it is possible to damage with natural earth floor, **concrete provides better working condition**.

- Irrespective of the nature of the floor the bundles of hides and skins should not be placed on it because of the risk of "**sweating**" and **condensation**.

7. Storage and transportation

- Instead pallets or spacers of some sort should be used to keep hides and skins **off the floor**.

- Thereafter the bundles of hides and skins may be simply **stacked on top of each other**.

- At various intervals between the stacks, more spaces may be provided to **prompt fresh air circulation in the room**.

- Dried hides and skins in storage should be examined regularly to confirm everything is satisfactory (FAO, 1995).

7. Storage and transportation

Salted hides and skins

- The storage of **dry salted skin** is essential the same as those materials dried **without salt**.
- Salted materials tend to be less susceptible to insects, but are **not entirely free of risk**.
- Accordingly, dry salted hides and skins should be **checked during storage**.
- This particularly applies to those treated with a **mixture salt and naphthalene**.
- The **naphthalene** sometimes used to protect the hides and skins against insects is available & so will alternatively disappear & must be replaced if the storage of hides and skins is protracted (FAO, 1995).

Quality of hides/skins(pelts)

- Hides and Skins quality is then primarily defined by the **absence of damage to the grain layer of the skin** (Hadly, 2001).

- The quality of H&S plays a decisive role in the quality of the leather to be produced and it constitutes about 50–70% of the cost of production,

- The raw material is then the most valuable and important of the production elements (Sharphouse, 1995).

Quality of hides/skins(pelts)

- The characteristic features for measuring the quality of hides and skins include the following: -

  - The thickness and the evenness of the surface of the skin;
  - The weight of the hide or the skin;
  - The density of the hide or the skin and;
  - The presence or absence of different defects on the surface of the skin.

Quality of hides/skins(pelts)…

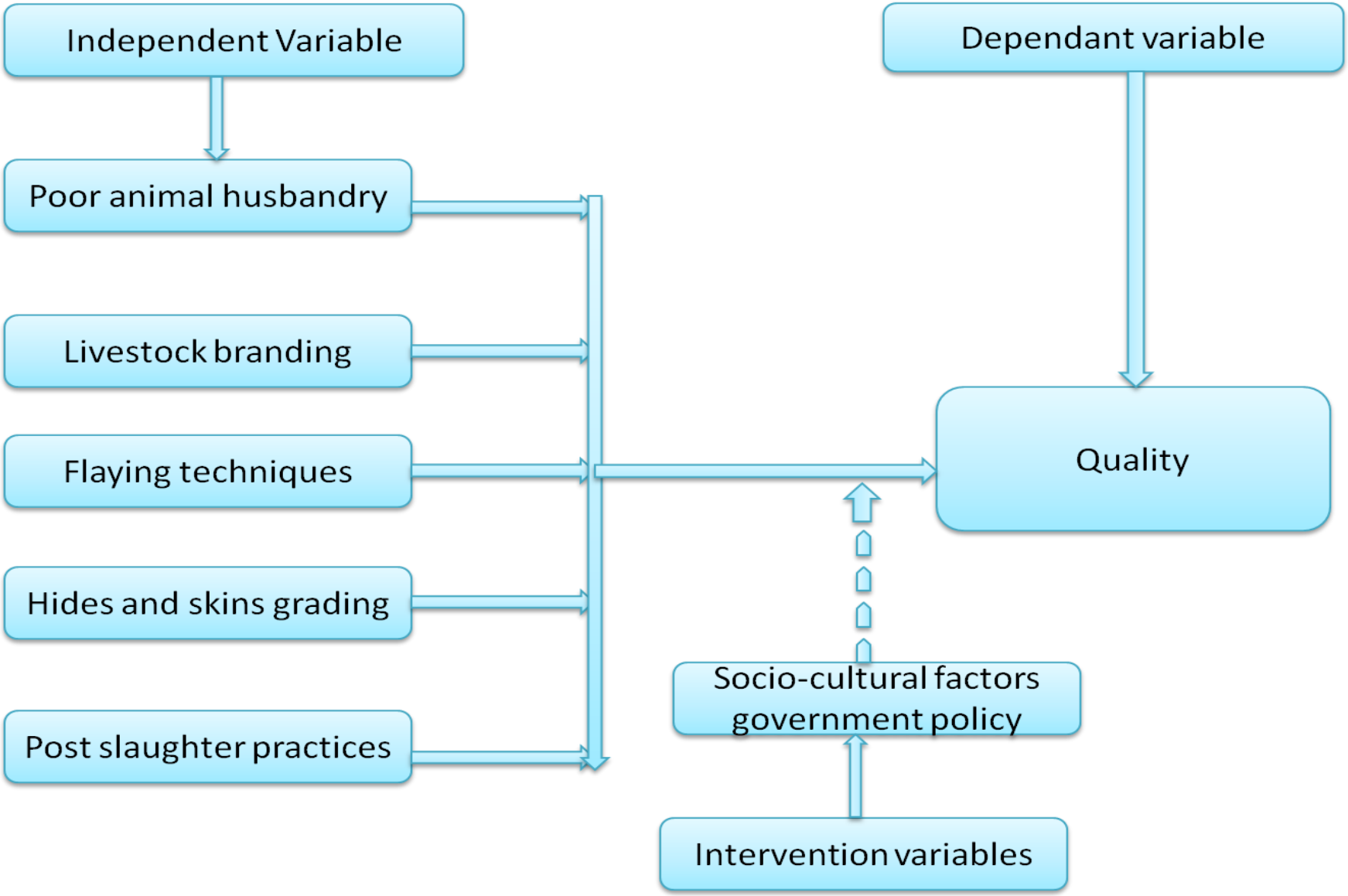
- According to (Adugna, 2004), there is a direct relationship between the **dependent variables**

- (livestock husbandry, livestock branding, hides and skins grading, flaying techniques, post-slaughter practices) and;

- independent variable (quality).

- The dependent variables influence the quality of and skins (see Fig below).

Quality of hides/skins(pelts)…



Quality control

Hides and skins grading

- The quality of skins and hides is defined by its grade though a process called **grading**.

- Grading of hides and skins refers to the number of defects it has. A hide or skin with **no defect** would be designated **Grade I** (perfect), while another with many serious defects would be **Graded IV** (imperfect) and is simple discarded.

- Anything of intermediate quality is **Grade II or III** (Delgado *et al.*, 1999).

Quality control

- The position of a defect is **also significant**, at least in hides. For example, defects in the **butt are considered more serious** than those in the shoulders, because the butt is normally expected to provide the best physical characteristics.

- Conversely, a defect in the **belly or shanks** would not be considered very serious because these parts provide softer, weaker leathers, and defective areas here are easily removed by trimming.

- A **third** and **final aspect** of grading is the intensity of the **defect**.

Quality control…

For example, a shallow butcher's cut on the flesh surface may be dismissed as unimportant, but if the cut penetrates and **perforates the dermis**, it would be considered more serious(CFC project, 2001).

Environmental impact and mitigation options of the leather industry

➢Chemicals used in the industry

Consumption pattern of chemicals in leather processing

Sl.No.	Chemical	In Kg per ton of hide/skin process
1	Soaking aids	1.0 – 2.5
2	Preservative	2.5-5.0
3	Lime	80-200
4	Sodium sulphide	20-30
5	Sodium chloride	80-100
6	Ammonium salts	10-15
7	Sulphuric acid	12-20
8	Sodium formate	5-12.5
9	BCS	60-120
10	Al (Al_2O_3)	1-20
11	Zr(ZrO_2)	0-15
12	Vegetable tannins	10-220
13	Synthetic tanning agents	20-60
14	Fatliquors	25-100
15	Dyes	2.5 –20
16	Binders	20-45
17	Pigments	10-25
18	Top coats	20-45
19	Wax emulsions	2.5-5.0
20	Feel modifiers	1-2

- **Types of wastes are generated from the tanning industry**
  - The leather industry throughout the world has been identified closely with the generation of **air**, **liquid** and **solid waste** pollution.
  - These huge wastes **emit obnoxious** smell caused by the degradation of protein material of skin and generation of gases such as NH3 and H2S and CO2(Kanagaraj et al. 2006).

Impact of these wastes on environment

- Pollution occurs when detrimental changes, resulting from human contact in the natural composition, content or quality of the water, air or soil, arise.[1]

- Environmental impact of tannery wastes containing wastewater; hazardous chemicals such as chromium, synthetic tannins, oils, resins, biocides, detergents; careless disposal of solid wastes and gaseous emissions creates a negative image of leather industry, although it has significant economic influence (Jerry, 2011; Shakir et al., 2012; Islam et al., 2014).

Mitigation options

1. Cleaner technologies

A)Physical-chemical treatment (primary)

- the removal of settle able organic and inorganic solids by sedimentation, and the removal of materials that will float (scum) by skimming.

- Approximately 25-50% of the incoming biochemical oxygen demand (BOD5), 50- 70% of total suspended solids (SS), and 65% of the oil and grease are removed during primary treatment.
- 65% of the oil and grease are removed during primary treatment. The effluent and sludge from primary sedimentation are referred to as primary effluent and sludge)(Metcalf and Eddy, 2003).

Mitigation options

B)Biological treatment (secondary)

- In most cases, secondary treatment follows primary treatment, its goal being the removal of biodegradable dissolved and colloidal organic matter using aerobic biological treatment processes.
- Aerobic biological treatment is carried out in the presence of oxygen by aerobic micro-organisms (principally bacteria) that metabolize the organic matter in the wastewater, thereby producing more micro-organisms and inorganic end products (principally CO2, NH3, and H2O)(Metcalf and Eddy, 2003).

Mitigation options

C) Advanced (tertiary) treatment

- Tertiary or advanced wastewater treatment is employed to reduce residual COD load and/or when specific wastewater constituents are not removed by previous treatment stages.

- Tertiary treatment consists of chemical oxidation, pressure sand filter and activated carbon filter. Effluent from biological treatment is passed through chemical oxidation tanks, where Hydrogen Peroxide dosing is done(Metcalf and Eddy, 2003).

Mitigation options

2. Industrial ecology

- Industrial ecology introduces the possibility to learn from natural ecosystems to design and engineer industrial systems to reduce the ecological impact of human activity to levels natural systems can sustain.

- In ecological systems the flow of materials is cyclic, the wastes are recycled and energy is cascading (Jelinski etal., 1992).

Mitigation options

3.Eco-Industrial Parks

- Eco-industrial parks pay attention to material and energy exchanges between companies in local and regional economies.

- It concentrates on closing the loop of materials and enhancing energy cascading in industrial areas.

- Close synonyms for eco-industrial Park are e.g. industrial ecosystem, industrial symbiosis, eco-industrial estate, eco industrial network, eco-industrial development, etc.
- Different concepts imply different objectives, operational characteristics and system boundaries (Chertow, 2000).

Health hazards of workers

What health hazards can we face ?

- The tanning industry poses many dangers to **both the environment and those that work within it**.

- Exposure to Chemicals in the air or in solution baths can be hazardous to workers. skin irritations, dizziness and breathing problems, cancer problems.

Health hazards of workers…

How do we face these health hazards?

- **Inhalation** in form of airborne substances (gases, dust, vapors, mist and fumes)

- **Ingestion** (when workers are eating, drinking or smoking in the work area, without washing contaminated hands)

- **Skin absorption** (generally through pores or cuts/wounds of unprotected hands, arms, body)

Safety issues of workers

- Provide safety equipment such as face masks, rubber gloves and boots For workers.

- Small improvements can increase worker safety dramatically and improve long-run productivity.

Thank you!!!