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The Techniques of Hides and Skins Preservation -A Technical Manual

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ABSTRACT: This document outlines the significant livestock resources of Ethiopia, which include one of the largest populations in Africa, notably ranking first in cattle. Despite this vast potential for producing hides and skins as essential raw materials for the leather industry, the actual recovery rate is low due to factors like local consumption and illegal trade. A key hindrance to producing quality leather is the improper preservation of hides and skins after slaughter and before tanning. Preservation is a critical treatment intended to protect these materials from bacterial putrefaction by reducing moisture content, thereby maintaining their quality until processing. However, it cannot improve the original quality of a hide. This technical manual provides a comprehensive and practical guide to the fundamental principles and modern practices of raw hide and skin preservation. The immediate and effective preservation of freshly flayed hides is a critical first step in the leather supply chain, directly determining the

quality, value, and usability of the final leather product. It addresses the urgent need to prevent bacterial degradation, enzymatic attack, and putrefaction that begin immediately after slaughter. The manual systematically details the primary preservation methods, including salting (wet-salting and brine curing), drying, and the use of antiseptics. It provides step-by-step instructions, best practices for handling, folding, and grading, and emphasizes the importance of hygiene and infrastructure. Therefore, the objective of this technical manual is to provide key notes on proper preservation techniques to help stakeholders prevent deterioration and maintain quality.

Keywords: *Hide, skin, quality, preservation, techniques.*

INTRODUCTION

Ethiopia is indeed endowed with vast livestock resources, making it one of the largest livestock populations in Africa. According to the most recent official estimates from the Central Statistical Agency (CSA) of Ethiopia and the Food and Agriculture Organization (FAO)**,** the livestock population in Ethiopia is as follows: Ethiopia is a country located in the east of Africa endowed with blessed agro ecological diversity and huge livestock resources. The recent estimates of livestock population in Ethiopia are Cattle 70.3 million; Sheep 42.9 million; Goats 52.5 million; Camels 8.1 million; Poultry (Chickens) 56.53 million; Horses 2.9 million; Donkeys 8.5 million and Mules 0.4 million (CSA, 2022/23). The country ranks 1st in Africa for its cattle population and is among the top countries globally and the livestock sector contributes significantly to Ethiopia's economy, supporting livelihoods for over 60% of the rural population (FAO, 2023). This provides an important renewable locally available resource base (hides and skins) which in turn are essential raw materials for the tanning industries, footwear and leather garment and goods manufacturing industries. The national annual off take/killing rate for Ethiopian cattle, sheep and goats are 10 percent for cattle, 35 percent for sheep, and 38 percent for goats (FAO, 2020; CSA, 2021). Based on population size and off take rate, the number of hides and skins that should be produced annually is expected to be 6.5 million hides, 14 million sheepskins and 19.38 million goatskins. Despite this huge hides and skins production potential, in practice, only relatively low recovery

rates/collection rate are realized which amounts to 26 percent hides (1.3 million), 80 percent sheepskins (11.2 million) and 65 percent goatskins (12.6 million) that reach to the tanning industries; Whereas the rest is either consumed locally or sold illegally through cross border illicit markets (FAO, 2020).

These livestock resources are expected to have significant contribution to export earnings of the country. This huge livestock resource implies that Ethiopia is one of the most promising leather producing countries in Africa (World Bank, 2017).

However, even though the country is gifted with such opportunities, it is not exploited to the desired level due to different factors that hinder the production of quality hide and skins. Among other elements preservation or curing of these hides and shins after the animal is slaughtered and before it reaches the tanning industry is one of the significant contributing factors to the deterioration quality hides and skins production (FAO, 1994).

The objective of this technical manual therefore is to put key notes on the preservation techniques of hides and skins that may help stake holders to conduct proper preservation.

PRESERVATION OF HIDES AND SKINS

Curing or preservation is a certain treatment of hides and skins intended for protecting them from putrefaction it is also called as the name given to a variety of procedures which can be applied to the hides or skins in order to reduce or stop spoilage by reducing the natural moisture content until they are processed in tanneries. It is essential to preserve the protein matrix and also to arrest microbial attack temporarily. The purpose of curing is to remove water from the hide/skin to a level at which bacterial growth is inhibited. The main aim is to stabilize the collagen structure against putrefactive decomposition until the hide/skin is processed in the tannery (Heidemann, 1993).

Preservation or curing can only maintain quality. It can’t improve it. One can’t for example change grade IV in to grade III, simply preserving it properly and keeping the hides and skins in a good condition without putrefaction. If badly spoiled hide or

skin is preserved, the quality will remain bad, irrespective of how well it has been preserved. It follows that a bad preservation will allow deterioration of all skins irrespective of its original quality (Covington, 2009).

Poor curing practices, such as insufficient salt application or allowing hides/skins to get wet during storage, lead to bacterial growth and irreversible damage like "hair slip," "red heat," or "putrefaction," which destroy the collagen structure. Ineffective curing results in bacterial damage. These defects cause significant weakening of the leather, manifesting as loose grain, weak tear strength, and in severe cases, complete gelatinization of the collagen. A high-quality raw hide/skin can be rendered worthless by inadequate preservation methods (Bienkiewicz, 1983).

All hides and skins carry a great number of bacteria while on a living animal; these bacteria typically cause no damage. However, following the death of the animal, under favorable conditions of warmth and moisture, these bacteria multiply and penetrate the tissue, causing damage (Bailey and Licht, 2005).

A primary mechanism of putrefaction is the production of proteolytic enzymes by bacteria. These enzymes hydrolyze and break down proteins like collagen into polypeptides and amino acids. These amino acids are then deaminated by other bacterial enzymes, leading to the production of ammonia and other foul-smelling compounds (Madigan et al., 2021).

Other enzymatic reactions contribute to spoilage. These include the hydrolysis of triglyceride fats into free fatty acids and glycerol by microbial lipases, and the breakdown of carbohydrates (like glycogen) into simple sugars by microbial carbohydrases (e.g., amylases) (Birbir and Bailey, 2000).

To avoid putrefaction, the freshly flayed hide/skin should be cooled as quickly as possible and be free of blood and dirt, fleshed and trimmed before going in to cure. Even the most carefully controlled cure can’t undo the damage caused by putrefaction change before curing (FAO, 1994).

Hides and skins which have just been removed from the carcasses of animals are called green hides and skins. The highest quality durable leather is produced from

green hides and skins, however, such hides and skins can't be stored for a long time, and they deteriorate rapidly and lose their valuable properties, therefore they can't be shipped in a green condition to far located tanneries and should be cured before shipment (Heidemann, 1993).

The quality of cured hides and skins depends on the time which has elapsed since their flaying, on their sanitary condition, on the method and conditions of curing, and on the curing materials applied (FAO, 2020).

Requirements for an acceptable cure

1. Stabilization of chemical and physical properties of the hide or skin; this is the fundamental goal of curing: to halt the natural process of autolysis (self-digestion by enzymes) and putrefaction (bacterial decay) that begins immediately after flaying. This preserves the collagen structure (Covington, 2009; Heidemann, 1993).

2. Control of bacterial activity; this is the mechanism by which point 1 is achieved. Curing methods work by creating an environment (e.g., dry, salty, acidic, toxic) where bacteria cannot thrive (Haines, 2006; BLC, 1997).

3. Production of stock which is convenient to store and transport;

4. Production of stock which can be efficiently stored; these are practical and economic requirements. A successful cure prevents hides from sticking together, reduces weight (in the case of drying), and allows them to be stacked, palletized, and shipped globally without degradation (Lefèvre and Schloeder, 2019; BLC, 1997).

5. The cure should be easily reversible and should not restrict the choice of tannage; a good cure should not permanently alter the hide's chemistry in a way that interferes with subsequent tanning processes (e.g., chrome tanning, vegetable tanning). The curing agents (like salt) must be easily removed in the beamhouse operations (soaking) (Covington, 2009; BLC, 1997).

6. Effluent produced by curing or in subsequent process should be of acceptable volume and quality; this is a modern and critical environmental requirement. Traditional salt curing (wet-salting) produces huge volumes of highly saline (chloride-rich) effluent, which is difficult and expensive to treat. This point drives research into low-salt and salt-free curing methods (Lefèvre and Schloeder, 2019; Thanikaivelan et al., 2004).

7. The cure must be economical; this encompasses the cost of the curing agent (e.g., salt), labor, infrastructure, storage space, and transportation. An uneconomical cure, even if technically perfect, is not viable for the industry (BLC, 1997; Lefèvre and Schloeder, 2019).

Factors to be considered while selecting preservation methods

1. Type of raw material (hide or skin to be preserved); the intrinsic properties of the raw material, such as its thickness, fat content, sizes, and ultimate end-use, are critical. Heavy buffalo hides require a more robust method like salting to draw out enough moisture, whereas delicate sheepskins might be better suited to chilling or less aggressive techniques to avoid fiber damage that would affect their value for garment leather. The method of preservation must be suited to the type of skin or hide; heavy hides require thorough salting to prevent bacterial damage in the thicker parts (FAO, 1994).

2. Availability of preserving materials; the consistent and cost-effective supply of preserving agents is a major practical consideration. In coastal regions or countries with salt mines, salt (sodium chloride) is the obvious choice. In landlocked areas, the cost of salt may be prohibitive, making alternative methods like drying or chilling more viable. Similarly, the availability of electricity and refrigeration infrastructure dictates the feasibility of chilling or freezing (Thanikaivelan et al., 2004).

3. Season and local climatic conditions; ambient temperature and humidity directly influence the rate of putrefaction and the effectiveness of certain methods. In hot and humid climates, biological activity is high, requiring faster and more effective preservation (e.g., wet-salting). In hot, dry climates, sun-drying can be

highly effective and economical. In colder seasons or climates, the natural slowdown of decomposition may allow for longer holding times before preservation is needed (Heidemann, 1993).

4. Economic and technological level of the country; the capital investment, operational costs, and technical expertise required vary greatly between methods. Basic sun-drying requires almost no technology but results in lower-quality, brittle leather. Sophisticated refrigeration systems require significant investment and reliable power. The choice is often a compromise between the desired quality of the final leather and the economic reality of the production region (Covington, 2009).

The different curing (preservation) methods are mentioned as follow;

Air drying method of curing

The air drying method is a traditional curing process predominantly employed in regions characterized by hot and arid climates, such as many parts of Africa and the Near East. This technique involves the natural dehydration of hides and skins by exposing them directly to the sun and wind, completely omitting the use of salt or other chemical preservatives. The objective is to rapidly reduce the moisture content within the hide to a stable level, typically between 10% and 14%, through evaporation (FAO, 1994).

The fundamental principle behind this method is microbiological control. By removing the water essential for their metabolic functions, the growth and destructive activity of bacteria and other microorganisms are effectively inhibited. This prevents the hide from undergoing putrefaction, which would cause irreversible damage like hair slip and collagen degradation. A critical factor for success is the extremely short timeframe between the animal being flayed (skinned) and the commencement of drying. In warm climates, where bacterial proliferation is accelerated, this process must begin immediately—interpreted industrially as within 2 to 3 hours post-flaying—to prevent the initiation of bacterial decay (Bienkiewicz, 1983).

The products cured using air drying is often of poor quality due to weather conditions not conducive to satisfactory desiccation by spontaneous evaporation. Adverse weather (high humidity, rain, or extreme heat that case-hardens the exterior) leads to putrefaction, discoloration, or insect damage. The main disadvantage of this drying is that the hides and skins can be damaged by putrefaction and insect attack during the slow drying process, especially in humid climates. Furthermore, if drying is too rapid, a hard layer forms on the surface which prevents the moisture in the inner parts of the hide from escaping; the inner part may then putrefy (FAO, 1991).

Sheep skins are in better quality than hides because of their difference in thickness; this compares the drying outcomes of sheepskins (skins from smaller animals like sheep, goats, etc.) to hides (from larger animals like cattle, buffalo). The thinner nature of sheepskins allows for more uniform and faster drying, reducing the risk of internal spoilage. The chapter 5-Preservation of Hides and Skins of this reference document, explains that the thinner structure of sheepskins and goatskins makes them more suitable for air-drying methods compared to the thicker, denser hides of cattle, which are more prone to spoilage in the center if not dried correctly (FAO, 1994).

These techniques of air drying include drying on the ground “The simplest and most common method...very unsatisfactory”; drying by suspension (Frame drying) "A considerable improvement is to stretch the hides on portable frames made of wood or wire”; by suspension over cords or wires” A better method is to hang the hides over ropes or wires strung between posts or trees"; tent and parasol (sunshade) drying "The best results are obtained by drying under a simple roof which protects from rain and direct sunlight but allows free passage of air"(FAO,1991).

Air drying method of curing hides and skins is simple and cheap, but it has also some disadvantages mentioned below as follow: -

Risk of Putrefaction and Bacterial Damage

If the drying process is not initiated quickly enough or drying is slow or is done in humid conditions, the inner layers of the hide can remain at a moisture level that allows bacteria to thrive, especially in the thick parts of the hide. This can cause

irreversible damage, including hair slip, foul odor, and a weakened fiber structure and a consequent weakening of the final leather (Covington, 2009).

Non-Uniform Drying and Case Hardening

Case hardening is a typical fault of air drying; the surface shrinks and becomes impervious, sealing water in the center of the hide. When the hide is subsequently soaked, the surface absorbs water and putrefies, while the center may remain dry and horny. This is one of the most common and serious defects. The outer surface of the hide dries much faster than the inner corium layer, forming a hard, impermeable shell that traps moisture inside. This prevents the even drying of the inner layers and can lead to spoilage. Later, during the tannery's soaking process, the hardened exterior rehydrates quickly and becomes gelatinous, while the interior remains tough, leading to inconsistent leather quality (Haines, 2006).

Hardening and Hornification of Fibers

Excessive dehydration causes the collagen fibers to lose their natural flexibility and stick together irreversibly in a hardened state. This process, known as hornification, makes subsequent rehydration in the tannery extremely difficult and can result in leather that is stiff, brittle, and of low quality (Sreeram and Ramasami, 2003).

Vulnerability to Insect and Pest Damage

Air-dried hides, often stored in open or semi-open areas, are highly attractive to insects, beetles, and rodents. These pests feed on the dried protein, creating holes, scores, and surface damage that drastically reduce the usable area and value of the hide and finally make it unfit for high-quality leather (FAO, 1991).

Inefficiency and Space Requirements in Humid Climates

The air-drying method is highly dependent on ambient weather conditions. In humid or rainy climates, the drying process can be prohibitively slow, increasing the risk of bacterial damage. Furthermore, the processes require large, shaded, and well-ventilated areas to layout or hang the hides, which can be a constraint, and can cause the risks of putrefaction and discoloration are high (Thanikaivelan, 2005).

Inconsistency in Final Product Quality

The major drawback of traditional air-drying is the lack of control over the drying parameters, which results in uneven and non-standardized moisture content across and between hides. Due to the uncontrolled nature of the process—variations in temperature, humidity, air flow, and drying time—the resulting cured hides are highly inconsistent. This lack of uniformity creates significant challenges for tanneries during processing, as each hide may rehydrate and accept chemicals at a different rate, leading to a non-uniform final product (Bienkiewicz, 1983).

Reduction in Hide Substance and Yield

The severe dehydration of air-drying causes the hide to shrink considerably, both in surface area and thickness. Air-dried hides undergo significant shrinkage (up to 40% in weight and 15% in area), some of which is not fully recoverable during soaking. This can result in a lower yield of finished leather per original raw hide weight compared to brine-cured or wet-salted preservation." While the weight is reduced for transport, the irreversible tightening of the fiber structure can lead to a lower yield of usable leather after tanning compared to other methods like wet-salting (Heidemann, 1993).

Ground drying

Ground drying is the method of drying hides and skins on the ground under direct sunlight. In many regions of Ethiopia, farmers dry their hides and skins on the ground. In this condition the raw material is placed with the flesh uppermost (figure1 B) sometimes it is pegged along the edges (see figure 1A) and then left for drying in the sun. The result of this drying is extremely bad, leading to contamination, putrefaction, staining, and heat damage that severely degrade the quality and value of the leather (FAO, 2011; UNIDO, 2007). This practice has been identified as a primary factor in the significant economic losses experienced within the Ethiopian hide and skin sector (Mekuria and Yared, 2017).

This drying method shows the following features;

- Fast drying on the flesh side due to higher temperature and sufficient air circulation, however, the hair side takes longer time to dry and these occurs defects of putrefaction and gelatinization due to high temperature with no air circulation and trapped temperature. The hide or skin in this condition is placed on the ground with its flesh uppermost; the moisture in it cannot escape from the hair side, at the same time the flesh side is strongly heated by the sun and burns instead of drying. Putrefaction starts from the hair side (FAO, 1986).

- The degrees of putrefaction recognized on the ground dried hides or skins are: - swelling of the derma, hair slip, grain loss, blistering, complete grain damage and complete hide substance damage. In addition to high degree of putrefaction seen on ground dried hides of skins, other defects such as ball drying defect, hornyness, over drying defects, etc are recognized and the hide or skin is contaminated with dirt (Kronick and Hemmons, 1958).

- Generally, grounds drying, tacking, smoke drying methods are not good preservation methods because they result to give rejected hides or skins and consequences in great additional lose of a reject or bad quality leather after processing. Sun dried hides and skins should be removed to the shade before they are over dried that make them crack when folded and it becomes very difficult to soak these stocks in the tanneries. Sheep skins are very sensitive to heat damage (FAO, 1994).

A) A pegged ground drying	B) B un pegged ground drying

Figure 1: A) Pegged ground drying; B) B un pegged ground drying

Frame drying

Also known as frame drying or toggling/ suspensions (see figure 2), is a traditional method for drying hides and skins after they have been cured (e.g., with salt) and washed. It involves stretching the hides tautly onto large, mobile rectangular frames or fixed nets made of wood or metal, often mounted on wheels (FAO, 1991).

Key Advantages and Process of Frame drying:-

Superior Quality: - When performed correctly, this method produces the highest quality of dried raw material compared to alternative methods like ground drying or pole drying. By stretching the hide, it dries flat and even, preventing putrefaction in thick folds and minimizing wrinkles and shrinkage. This results in a larger, more uniform hide for the tannery.

Controlled Environment: - The best results are achieved when the frames are placed under shade in a well-ventilated condition. Direct sunlight is detrimental as it can case-harden the hide (making the surface brittle while the inside remains wet) and cause discoloration.

Critical Air Circulation: - Balanced air circulation is the most important element in this case. The shed must be designed to allow air to flow freely over both sides of the suspended hides/skins. This ensures uniform moisture evaporation without bacterial growth. Forced air fans are often used in modern operations to optimize this air circulation process.

Drying Time: - The process is not rushed. Under optimal conditions of low humidity and good airflow, drying can be completed in 3 to 5 days. In more humid climates, it will take longer. The slow, controlled drying is key to preserving the hides/skins fibrous structure.

Drying should never be done in direct sunlight:-The best dried hides and skins are obtained by drying in the shade in a well-ventilated drying shed. The aim is to achieve a slow, uniform drying process. If drying is too rapid, as occurs in direct sunlight, the outside of the hide dries and shrinks while the inside remains wet. This is known as case-hardening and leads to spoilage (FAO, 1991).

Table 1: frame sizes of Ethiopian standard

Frame sizes			
For hides(Ethiopian standard)		**For skin(Ethiopian standard)**	
Small	2.5m x 2.5m	Small	1.2mx1.2m
Medium	2.75mx2.75m	Medium	1.3mx1.3m
Large	2.75mx3.0m	Large	1.5mx1.5m
Extra large	3.0mx3.0m	Extra large	

The minimum distance between frames need to be around 0.3048 meter or 30.5 cm to allow air circulation and to permit an operator to pass between two frames and the gaps of frames from the wall need to be 40-50 cm in cold area and 30-35 cm in hot and that is important for air circulation and Operator Safety and Access.

Frame Types

The frames can be either fixed or movable types;

- Fixed frames are those which can't move from place to place (figure 2 A) but;
- Movable frames are those that can be moved from place to place (figure 2 B).

The holes made on a hide or skin for framing should be as far as possible minimized in number and parallel to the edges.

Framing Guidelines

The recommended number of holes and their placement for framing animal hides and skins;

1. by Size and Type of Hide/Skin:

- Medium Hides: Should have 15–20 holes.
- Large Hides: Should have 20–25 holes, up to a maximum of 30**.**
- Skins: Should have 10–12 holes.

2. Hole Placement:

- Distance from Edge: Holes should be placed approximately 2–3 cm from the edge of the hide or skin.

- Positioning: Holes must be symmetrically placed to ensure even tension and prevent distortion during the drying process.

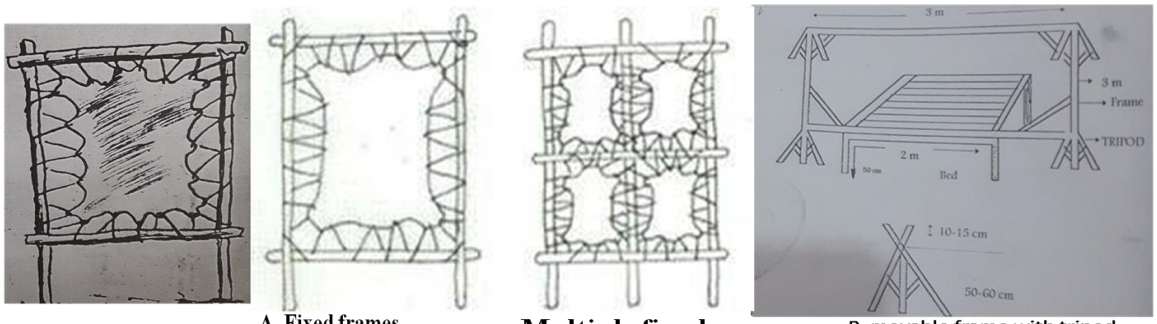


Figure 2 frame types

Large frames meant for hides can be adopted for skins also, using four skins in the metal frame. In suspension drying, sun is not very dangerous, provided the temperature of the hide does not reach the point of degradation of collagen. Sun dried hides and skins should be removed to the shade before they are over dried that make them crack when folded and it becomes very difficult to soak these stocks in the tanneries. Sheep skins are very sensitive to heat damage and have to be tried in the multiple frames (FAO, 1984; Lefèvre and Oesterreich, 2000; Proctor, 2012).

The sheds afford facilities for close supervision, protection from theft and damage from vermin. The drying sheds will have three portions namely.

1. **Working Place: -** This area has a sloping floor (crucial for draining water and chemicals used in the preparation process) and tables where the hides and skins are physically handled (e.g., fleshing, trimming) before they are hung up to dry.

2. **Drying Space: -** This is the main area of the shed. The calculation is based on a seven-day drying cycle. If a tannery processes 10 hides per day, it needs enough frames to hold 7 days' worth of production (10 hides/day x 7 days = 70 frames). The same logic applies to smaller skins (40 skins/day x 7 days = 280 frames, though the text specifies 70 frames, likely referring to the hide example or a miscalculation; the principle of a 7-day capacity is the key point).

3. **Store: -** This is a dedicated area for storing the dried hides/skins before they are sold or moved to the next production stage. The slatted wooden platform raised

six inches (15.24 cm) is critical as it keeps the finished products away from damp floors and allows for air circulation, preventing mold and deterioration (UNIDO, 1984).

The good points about suspension drying are: -

1. It allows free flow of air on both sides of the hide or skin.
2. The rain drains off the surface and does not collect in puddles on the hide.
3. The sun's rays strike obliquely not directly.
4. It permits the hide to cool off rapidly since heat is lost through surfaces.
5. Neither hair slip nor putrefaction sets in as there are neither folds nor points of contact between the hide and any solid object. But during rainy season, due to still air and high relative humidity, a large percentage of hides get putrefied and to some extent skins also while frame dried(Sarkar, 1984).

Other advantages of frame drying are: -

1. Better grading possibilities as every cut, bruise or parasite damage shows up better on a dry hide.
2. Dried hides and skins can be stored for a longer duration than salted hides.
3. Transportation is cheaper as the weight is only half of the salted hides.
4. Corrosion is avoided as in case of salted hides, the containers and vehicles get corroded.

The main problems are: Difficulty in soaking back involving extra cost and often in loosing hide substance leading to holes, uneven shape by improper stretching during drying and loss of area by the cuts for lacing and consequent trimming. One has to make sure the hides and skins are not overstretched as it affects the structure of the hides and skins and the method of stretching and securing to the frame is called lacing. The best materials to be used are the strips from waste hides. Ropes are used very commonly. Often the slits made by knives are very long and much inside the

hide or skin wasting a good percentage of raw materials. It is better to use a punch for lace holes (Lefèvre, 1992).

Pole (line) or wire drying

Pole drying method is the drying by hanging the hide or skin on the wooden pole. Depending on the diameter of the material there is the problem of putrefaction on the back bone line of hide or skin. Due to the low ventilation on the flesh side there also occur putrefaction problem on the hair side of the skin. This drying system makes little difference which the side is in contact with the pole but the poles' diameter and orientation (Placing the hide with its backbone line in contact with the pole is advised) of the hide or skin in contact are important. The part of the hide or skin in contact with the pole will inevitably dry more slowly than the rest of the pieces. Accordingly, if the diameter of the pole is too great (>10 cm), a larger part of the hide or skin will be in contact with the pole and may be spoiled. Conversely if the pole is too small (<10 cm), the two sides of the hide or skin will touch, there by slowing down drying of the whole pieces. For this reason, the optimum diameter of the pole for drying hides is about 10 cm. If the hide is placed with its back bone in contact with pole, any damage that does occur can be trimmed out in the tannery where the hide is cut in to two sides(UNIDO,1996) (see figure 3 A).

Wire drying is almost similar to pole drying but with the addition of wires or strings to support the hide and keep it flat and tight in order to improve air circulation problem on the hair side the three ropes or wires system of drying by hanging is almost replacing the line drying system (see figure 3 B). This procedure is however, relatively complicated, time consuming and better avoided in favor of frame drying. It is an improvement that uses tension to enhance airflow, reducing but not eliminating the risk of spoilage. It is also called *tent drying* system (UNIDO, 1996).

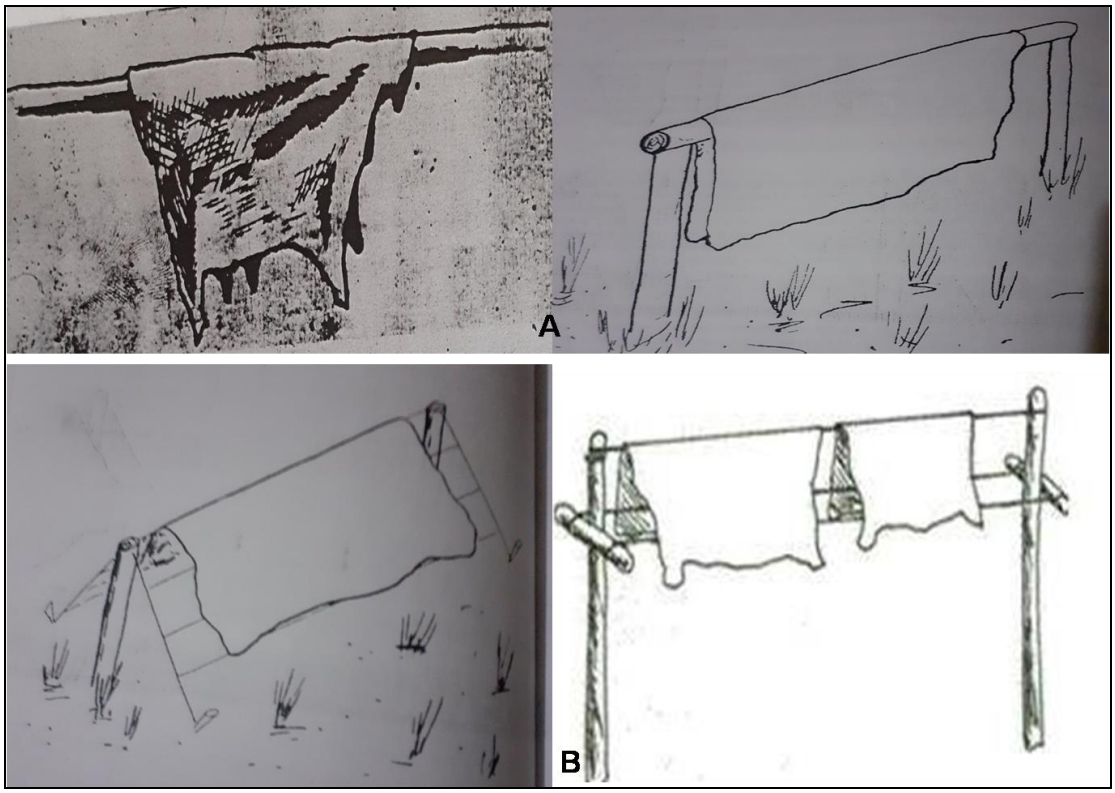


Figure 3: pole and wire drying systems;

Smoked drying

For drying of hides and skins during the rainy season, farmers sometimes hides/skins are hung in cooking huts or near fires (sometimes specifically made for this purpose) to dry them quickly using heat and smoke. In these cases, the hides and skins become hard and brittle due to the combination of rapid, uneven drying and the deposition of smoke particles. They are called ***smoked*** hides or skins. Their flesh side becomes dark-yellow or light brown (discoloration). If hides or skins were fumigated with smoke for a long time, the resultant effect is that they become unsuitable for leather production and are referred to as "rejects". This method of drying is very harmful and should be avoided. It is better to leave a hide to dry longer, rather than to use fire for drying it (UNIDO, 1996).

2.4. Salting method of drying (preservation)

Salting is better method of preserving hides and skins compared to air drying because;

a) It gives improved quality raw material;

b) It allows easy processing;

c) It gives higher production.

Salt serves as preservative due to

a) The dehydration quality it has;

b) The bacteriostatic characteristic it has.

The following situations need to be taken into consideration in salting method of preservation to obtain improved raw material.

a) Salting should be done immediately (not later than 2 hours);

b) Sufficient amount of salt should be applied during salting;

c) Reutilization of salt should be avoided;

d) Required salt size should be applied;

e) The method of application as a whole should be perfect.

The type of salt used for preservation is common salt with chemical formula of NaCl and it could be; a) Sea salt; b) Rock (mineral salt). This salting method of preservation can be applied as; wet salting; brining and dry salting (UNIDO, 2010).

Method	Preserved H or S	water composition
Wet salting	wet salted hide/skin	40-50%
Brining	Brined hide/skin	40-50%
Dry salting	Dry salted hide/skin	20-25%

Sea salt contains halophilic bacteria (salt tolerant). If the salt contains such bacteria, the salted skin will have *pinkish colour* at the flesh side what we call it *red heat* which is aggravated if there is high humidity and high temperature in the stores. So to avoid this before preservation the salt need additives for better preservation such as 1% boric acid and 0.1% naphthalene per 100 kilogram of salt.

Other additives used in salt preservation method- zinc chloride, sodium silicofloride, sodium trichlorophenate, preventol, parachloro metacresol, etc. 3-4% of these chemicals on the weight of salt will give complete protection against bacteria and mould damage. Generally, 0.1-4% additives can be applied as denaturant in salt preservation method.

A salt with additive in it is called *Denatured salt*. The quantity of salt that should be used for curing is between 35 and 50% on the green weight of the hides or skins. Calf, goat and sheep skins require more salt (50% on their green weight) than cattle and other hides (where 35% salt on green weight is applied) because the former contains more moisture. Denatured salt contains other substances which make it inedible.

Denaturing substances (chemicals) are those chemicals which give the salt a bitter taste, a strong smell and colour (UNIDO, 2010).

Wet salting method of curing

Method: Involves applying dry salt directly to the flesh side of the hide or skin. The hides are then typically stacked in piles, where the extracted moisture dissolves the salt to form a saturated brine solution that permeates the hide.

Principle of Preservation: The method does not necessarily destroy all bacteria but creates a dehydrating environment with a high salt concentration (bacteriostatic effect) where bacteria cannot function, multiply, or cause spoilage.

Popularity & Advantage: It is a traditional, widely trusted method used for many years across the world, particularly in developed countries with established hide collection systems (e.g., USA, UK, and EU). Its key advantage is that it reduces the curing time while reliably maintaining high quality.

Salt Application Rate: The recommended amount of salt is 35-50% of the green (fresh) weight of the hide/skin. For optimal preservation and to ensure enough salt is present even for thick parts, applying 50% is strongly recommended.

Salt Crystal Size: This is a critical technical detail.

Skins (goat, sheep): require a finer crystal size of 0.5 - 1 mm for better adhesion and penetration.

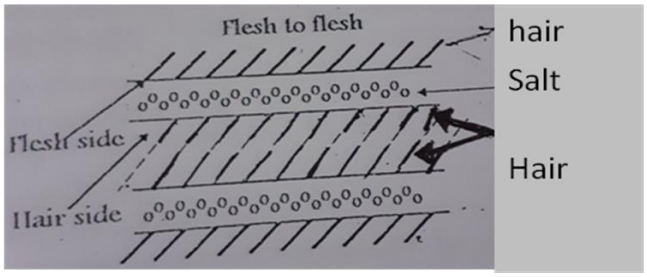
Hides (cattle, buffalo): require a larger crystal size of 1.15 - 3 mm to allow for slower dissolution and deeper penetration into the thicker tissue.

Practical Mix: A common practice is to use a mixture of crystal sizes (e.g., 25% fine 0.5mm salt with 50% coarse 1-2mm salt) to balance initial adhesion with sustained penetration.

The specific recommendations on crystal size are crucial; salt that is too fine can dissolve too quickly on the surface and run off, while salt that is too coarse may not adhere well or penetrate effectively, leading to putrefaction in thick areas like the neck(UNIDO, 2010).

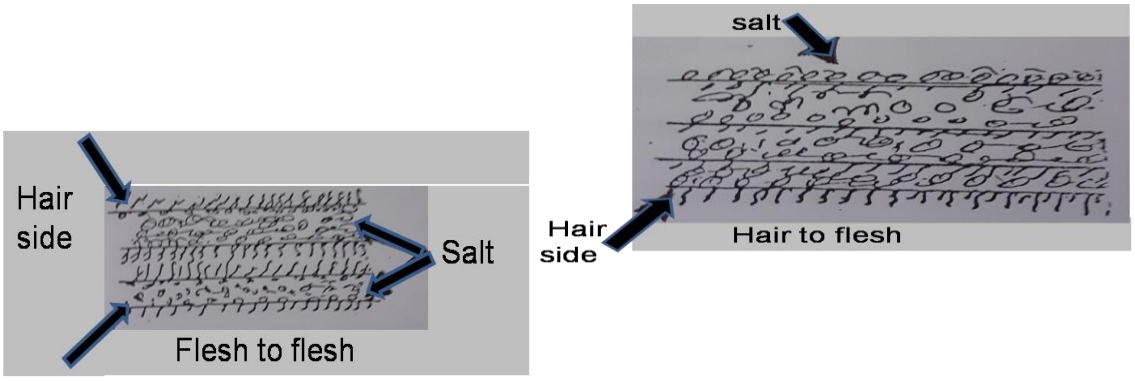
Methods of application

For sheep skin (long hair skin)



For goat skin and hair (short skin)

Both flesh to flesh piling and hair to flesh piling is possible while salting, but the better method will be hair to flesh for it allows both way penetration of salt.



Explanation of the Time Differential in Wet Salting

The practical limitation of the wet salting method are:

For Skins: Wet salting is an excellent and efficient method. Due to their relatively thin thickness, the salt applied to the flesh side can fully penetrate and distribute throughout the entire skin protein structure within a very short time: approximately 24 hours.

For Hides: Wet salting is not an ideal or efficient method for large, thick hides. The immense thickness and density of cattle hides mean that achieving complete salt distribution from the flesh side to the hair side takes an impractically long time: from 20 to 30 days**.** During this extended period, the inner sections of the hide remain unprotected and are highly susceptible to bacterial putrefaction, leading to hair slip and core damage (UNIDO, 2010).

Brining method of curing

The key features and advantages of the brining process are as follow:

Method: Preservation is achieved by completely immersing hides and skins in a pre-prepared, saturated salt solution (brine) held in vats, pits, or rotating drums.

Brine Preparation: The solution is made by dissolving approximately 300 kg of salt per 1000 liters (one ton) of water to achieve saturation. Mechanical mixing is required to accelerate dissolution and ensure a fully saturated solution.

Efficiency & Advantage: Brining is highlighted as the best method, especially for thick hides. Unlike wet salting, where salt penetrates from one side, the brine solution surrounds the hide and penetrates from all sides simultaneously. This forces the salt throughout the entire hide protein structure very quickly, within about 24 hours, preventing the internal bacterial putrefaction that can occur during the slow process of wet salting.

Suitability: The method is noted as being particularly useful for hides and short-haired skins like goat, where full and rapid penetration is critical (UNIDO, 2010).

The density of the solution is checked after dissolving the salt. The density should be 240Be' (Baume), corresponding to 1.2 specific gravity is lower than the required some more salt should be added to the solution. The density of the solution is checked with a hydrometer. After that the solution is taken by tubes in to the vat or paddle where curing will take place.

The Baume degree (°Bé) is a hydrometer scale used to measure the density of liquids. A reading of 24°Bé (corresponding to a specific gravity of 1.2) indicates a fully saturated salt solution, which is essential for effective preservation. A hydrometer is the tool used for this measurement. If the density is too low, more salt must be added until the target density is reached.

When hides are cured in the brine solution, the quantity of the brine must be three times higher than the weight of hides (i.e., a 3:1 ratio of brine to hide). This means for 1 kg of hide, 3 liters of brine are necessary. Before loading a new lot of hides, the solution must be recharged by adding salt in the proportion of 12 percent of the weight of the new hides (Heidemann, 1993). After loading in to the brine hides should be mixed for 15 minutes every one hour. The duration of salting hides is 20 hours when the antiseptics are not applied. Then the hides are taken out of the brine and left for one hour for draining on horses. Some salt must be added before hides are packed into bales (UNIDO, 1971).

Depending on the sanitary treatment of hides and application of antiseptics, the same brine solution may be used several times. If the hides are well washed, the solution may be used four or five times, in this case re-charching of the brine to the required concentration is essential (Lopez et al., 1998). The solution can be used 8 to 10 times when sodium silicofluoride is added to it in the proportion of one gram per liter of brine (Thanikaivelan et al., 2004). However, it is not recommended to use a dirty solution which smells with mustiness and mould(ITC, 2013).

Dry salting method of curing

In hot and dry areas that are far from the tanneries the salted hides and skins in most cases end up drying before 21 days are over. This results with dry salted hides and skins. They are folded, stored, and transported to markets at a convenient time. These products are lighter and easier to transport. The prices offered are different from the

Air –dried and wet salted ones due to difference in water content. The danger of putrefaction during drying of hides can be greatly reduced by salting before proceeding with drying. Material of better quality is produced and the tanner has much less difficulty in soaking this back to normal water content (FAO, 1991).

Dry-salting of a hide or skin is carried out by placing the stock flesh-up on a flat surface and applying salt on the flesh side (about 60% to 70% of green weight), taking care to rub salt in, particularly at the edges. The hide or skin is then folded flesh-to-flesh along the backbone and rolled into a bundle. The treated stock is left for 72 hours before opening, excess salt is shaken off and the material dried by hanging over a beam about 8 to 10 cm in diameter to avoid sharp folding of the hide. Beam direction is usually East West to avoid direct exposure of the hide surface to the sun. The neck and the backbone are placed along the beam and the material is turned over several times on the second day. Dry salted goods are light in weight, can be kept indefinitely in good storage conditions (between 2 and 3 years), are immune to insect attack and are relatively easy to soak back(Lefèvre and Schuster, 2007).

This technique is very similar to wet salting but skins are dried after the initial salting. This method gives the advantage of both drying and salting. This technique is especially well-suited for preparing skins/hides for export and at the same time overcoming the problem of wet salting. The initial steps are the same as in wet salting; however, salting has to be done without any delay after flaying. The quantity of salt used is 10% less than in wet (FAO, 2013). Dry salting method is a combination of any type of wet salting and sun drying, used in hot countries where salt is plentiful and cheap. Here the moisture content is typically reduced to 20–25 %(Haines, 2006).

When this type of curing is applied, a hide is stretched on a concrete floor or a low sloping table with the flesh uppermost and smoothed out. Then salt is spread over its whole surface, no un salted spots should be left. A scoop or a spade can be used for spreading it over the hides. Whereas on skins the salt is spread by hand."(Lefèvre Schloeder, 2011). Another hide is put on it with the flesh uppermost and treated in the same manner. Thus hides are put one upon another and covered with salt, so that a pile is formed containing 50 to 100 pieces (Heidemann, 1993)

Salted hides are left in a pile for 8 to 10 days. The pile must have a small slope on the edges for draining the brine (Covington, 2009) (figure 4).

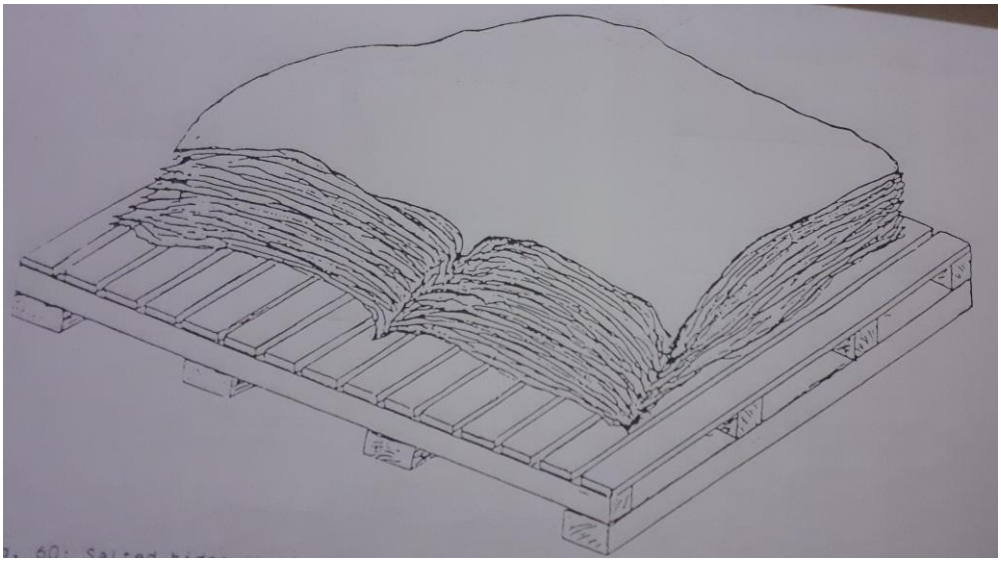


Figure 4: Salted skins stacked in pile on a pallet

As a rule, hides of the same weight are selected in one lot, so that their size does not differ much. If some hides are very large in size, their edges are spread with salt and folded inside. The consumption of salt for this type of curing is about 50 percent of their green weight. After salting, hides are folded and labeled for shipment (Heidemann, 1993) (figure 5).

salted skins Wet blue hides

Figure 5: Folded for hides/skins shipment

Cooling (by lowering temperature)

Cooling (by lowering temperature) is another way of preserving hides and skins. If the hides are stored at 2–3°C, they will remain fresh for up to three weeks. Quality of the preservation depends on the temperature during the transfer period. Cooled hides

and skins should be kept in a well-insulated store room and in piles to get the best results. In practice, one of the following methods is adopted to bring about refrigeration of the skins and hides (FAO, 1991).

Table 2: preservation time as a function of temperature

Storage Hide Temperature in ^{0}C	Maximum Storage time
0	3 weeks
5	2 weeks
10	5 days
15	2 days
20	1 day
35	6 hours

Freezing

Refrigeration of hides either by chilling or freezing, significantly improves the storage life of green stock but requires substantial capital outlay in facilities for the initial cooling and maintenance of low temperature during subsequent transportation and storage. Freezing of hides below 0oC has been reported to give storage periods of many months without detriment to final leather quality, but suffers from the disadvantages that frozen stock is impossible to handle and sort and it takes a considerable time to thaw. Both chilling and freezing also pose problems in achieving rapid reduction of initial hide temperatures in that they necessitate suspending the material to expose both surfaces to pre-chilled moving air in specially designed chambers. Costs of refrigeration increase rapidly with lower storage temperatures (Blackshaw and Smith, 1987).

Because of the reason that hides and skins are dirty and covered with varying amounts of hair and wool, freezing is not particularly uniform. Ice crystals are formed with in the fiber structure and the resultant leather is loosen and softens because of the distortion this causes (Thorstensen, 1993).

Freeze drying

Using low temperatures and low pressures, meets all the technical requirements but is considered too much expensive for use on hides and skins (UNIDO, 2010).

Chilling

The skin temperature has to be rapidly reduced to 2-3^{0}C. Then the material can be placed in cold store for 7-14 days. The rapid cooling is achieved by immersing or hoisting with cold water, or more efficiently by subjecting the skin to cold water or more effectively by subjecting the skin to a blast of cold air in the cooling case tunnel (Haines, 2006).

Pickling (tannage) method of preservation

Pickling is treating hides and skins with acid and salt solution. During the last few years many tanneries started pickling the raw material. This method of curing enables to retain the wool in a good condition and ensure the more correct determination of the quality of unwooled skins. The idea of this method is to treat the skin with "pickle" which is the acid solution of (either sulfuric-H2SO4 or hydrochloric acid-HCL) and salt solution (sodium chloride-Nacl) in water. As a rule, sheep and goat skin are treated with pickle (Kannan et al., 2018). Pickling in tanneries is used either for preservation or as preparation for immediate tanning (Covington, 2009).

Pickling for tanning

- Salt amount ……8-10 %(NaCl)
- Acid amount …….... 0.5-1%(H_2SO_4 or HCL)
- Ph to be adjusted depending on the type of tanning material to be used.

Pickling for preservation

- Salt amount ……10 -15%

- Acid amount …….... 1.5-2%
- Ph higher & below…….1(Covington, 2009).

The treatment consists of several operations which are: -

(1) Soaking of skins in water to complete rehydration. If skins are fresh, they are washed for 15 to 25 minutes in water to get rid of the blood and contamination.

(2) Fleshing of skins either by knife or on a fleshing machine. The subcutaneous tissues and pieces of flesh and fat removed in the course of this operation (Heidemann, 1993).

(3) Removal of hair. For this operation it is necessary to prepare a mixture of sodium sulphide and calcium carbonate taken in the ratio of 8 -10 and 20 -25 grams per liter of water respectively. Lime is added to the mixture to bring its specific gravity to 1.2. The temperature of the mixture is 30 to 35 ^{0}C. The prepared mixture is a solution which resembles the milk of a dark grey colour.

This mixture is painted on the flesh side of the skins with a brush. Then the skins are folded along the back bone with the hair out side and piled one upon the other to lay in the piles of 0.5-meter height. The hair is removed after 2-4 hours of laying. A skin is put on the table and the hair is removed from it with a blunt scraper. The worker should have rubber gloves on his hands during this operation. Skins which are free from hair or wool are called *pelts*. They are washed in water solution which contains 1.5 percent ammonium salphate for 20-30 minutes (Sharphouse, 1983).

A solution is prepared which contains 20 percent of sodium chloride; 5 percent of ammonium sulphate and 0.4 percent of naphthalene to the weight of pelts. Pelts are loaded into this preserving solution, are treated in it for two hours and then are taken out.

(4) Pickling. A solution is then prepared which contains 20 percent of sodium chloride and 2 percent of sulfuric or hydrochloric acid. This solution is put in to a vat or a drum. Pelts are loaded into this solution and are treated in it for one

hour under constant stirring. As a rule, three parts of the solution are taken for one part of the pelts.

After that, pelts are taken out and left for draining. Then they are selected by grades, folded in bundles and packed in to wooden barrels. The bottom of each barrel must be covered with salt, which is also put on the top of the pile in the barrel before it is sealed. A label is then inscribed on the cover of the barrel, which shows the type, quantity, grade, and method of curing of the pelts. In this condition pickled skins are ready for shipment either for export or to a tannery. The wool from sheep and goats' skins is dried and sold separately (O'Flaherty et al., 1956).

Conclusion and recommendation

Conclusion

The effective preservation of hides and skins is a critical and economically vital link in the leather production chain. It is not merely a preparatory step but a decisive factor in determining the final quality, value, and usability of leather. As demonstrated throughout this manual, raw hides and skins are highly perishable commodities, susceptible to rapid bacterial degradation, enzymatic attack, and chemical damage from poor handling practices.

The fundamental principle of all preservation methods is the creation of an environment unsuitable for microbial growth, primarily through the removal of water (drying) or the application of bacteriostatic agents (salting, pickling). While traditional methods like air-drying and wet-salting remain prevalent, technological advancements have introduced more efficient and environmentally considered techniques such as chilling, controlled drying, and the use of chemical preservatives.

The choice of preservation method is not universal; it must be tailored to factors such as the animal species, local climate, available infrastructure, intended storage duration, and final leather quality desired. However, irrespective of the method chosen, the evidence is clear: the greatest damage occurs in the abattoir and during the first few hours post-flaying. Therefore, the emphasis must always be on promptness and hygiene at the slaughterhouse level. A poor preservation technique

cannot salvage a hide that has already been compromised by bacterial colonization or physical abuse.

In conclusion, investing in proper preservation is an investment in the entire leather industry. It reduces economic losses, conserves resources, enables longer storage and transport, and provides tanneries with a reliable, high-quality raw material essential for producing superior leather goods in a competitive global market.

Recommendations

Based on the technical principles outlined in this manual, the following recommendations are provided for stakeholders across the supply chain, from abattoir operators to traders.

1. for Slaughterhouses and Primary Producers:

- **Implement Immediate Pre- and Post-Flaying Care:** Hides must be washed free of blood and dung immediately after flaying. They should be handled carefully to avoid cuts, scores, and flesh marks, which become foci for bacterial attack (Heidemann, 1993).
- **Prioritize Rapid Cooling:** Where infrastructure exists**,** chilling (to 2-4°C) is the gold standard for short-term preservation of fresh hides, as it drastically slows bacterial growth without the use of salt (Lefèvre et al., 2019).
- **Standardize Salt Curing Practices:** For wet-salting, use only clean, fine-grained salt (NaCl) with a purity of over 98%. Apply a minimum of 40-50% salt relative to the green hide weight, ensuring even distribution, particularly on thick folds and edges. Hides must be stacked flat on a sloping, sanitized surface for adequate brine drainage and curing (FAO, 2020).
- **Explore Eco-Friendly Alternatives:** Investigate and adopt less salt-intensive methods, such as semi-curing (using ~15% salt combined with biocides like sodium metasilicate) or the use of potassium chloride blends, to reduce the environmental impact of Total Dissolved Solids (TDS) in tannery effluent (Covington, 2009).

2. For Hide Traders and Transporters:

- **Ensure Proper Packaging:** Salted hides must be tightly packed in secure, breathable containers to prevent rehydration and fungal growth ("salt burn") during transport and storage. Avoid using plastic sheets that trap moisture.
- **Maintain Storage Conditions:** Storage facilities should be cool, dry, and well-ventilated. Piled hides must be inspected regularly for signs of heating or putrefaction. For dried hides and skins, protection from moisture and insects is paramount.

3. For Tanneries and Processors:

- **Establish Quality-Based Procurement:** Develop and implement a strict raw material quality assessment protocol. Incoming hides should be graded based on preservation quality (e.g., smell, texture, moisture content, hair slip) to segregate and process batches accordingly.
- **Invest in Pre-Tannery Rehydration:** For dried and heavily salted hides, employ efficient soaking procedures with appropriate wetting agents, disinfectants, and alkalis to ensure thorough and safe rehydration without further damage to the collagen structure (Bienkiewicz, 1983).

4. for Policymakers and Industry Bodies:

- **Develop and Enforce Standards:** Establish and enforce national and international quality standards for raw hides and skins, defining acceptable preservation methods and maximum defect levels.
- **Promote Training and Awareness:** Fund and organize training programs for abattoir workers, brokers, and farmers on the economic impact of good hide preservation and the correct application of techniques.
- **Support Research and Development:** Encourage R&D into novel, low-cost and environmentally sustainable preservation technologies, such as the use of plant-based antibacterial agents, irradiation, or hyperspectral imaging for early quality detection.

Final Note: *The preservation of hides and skins is a science that demands as much attention as the tanning process itself. Adherence to these recommended practices will significantly reduce material wastage, enhance leather quality, improve economic returns, and lessen the environmental burden of leather manufacturing.*

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5. Definition of terms

Wet Salting- refers to a curing method, in which the cooled flayed hide or skin, which has been fleshed to remove meat and fat, trimmed to shape, washed with water, drained and weighed, is spread out flesh side up, on a concrete self draining floor and well sprinkled with salt (common salt).

Hide- means the outer covering of a mature or fully grown bovine, equine, camel or other domestic or wild animal of a larger kind;

Skin- means the outer covering of a goat, sheep, game animal, reptile, bird or any other domestic or wild vertebrate of smaller kind;

Slaughter defects- refer to cuts or holes and gorges to the hides and skins making them unfit for the subsequent use up the value chain mainly due to poor slaughtering facilities, inadequate flaying skills and motivation and poor illumination during slaughter

Flaying refers to removal of hide or skin from an animal and in this context the animals referred are cattle, goats and sheep.

Frame dried sometime referred as suspension drying refers to suspending, with string, hides and skins under tension out in an open-sided, covered shed, designed to keep off the direct heat of the sun but to allow good ventilation, and protect the hides or skins from rainfall. The medium of suspension is called a "**frame"**. Frames are either movable or fixed type.

Ground dried refers to drying by pegging, under tension, hides or skins on the ground (flesh side up) under direct sunlight. This method is prohibited by law since leads to poor quality hides and skins

Hides and skins grading refers to an activity that puts hides into categories according to quality, thereby facilitating pricing. Hides and skins grading may aid monitoring and auditing of hides and skins improvement in the sub sector.

Leather- means a hide or skin with or without hair which still retains its original fibrous structure more or less intact and which has been semi-tanned so as to be imputrescible even after exposure to water;

Wet blue leather- refers to intermediate products/ semi-processed hide/skin.

Livestock units- refers to a standardized animal unit to which different ages, types or species of livestock can be related for the purpose of matching forage availability or comparing different livestock types

Branding- refers to a practice used to identify animals especially cattle due to the prevalence of cattle rustling. Unfortunately, most branding is done using hot irons on areas of hides, e.g. on the back and rumps, which have high value.

Curing- refers to the process (physical or chemical) of arresting or averting microbial degradation of the hide or skin to allow for the lapse of time between slaughter and processing by the tanner.