CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter presents the conceptual framework of the study and the philosophical foundation upon which the entire research is built. Systematically, it outlines the background to the study, statement of the problem, research questions, objectives, delimitation, limitations, definition of terms, assumptions, importance of the study, and finally, arrangement of the rest of the chapters.

1.2 Background to the Study

Globally, in modern civilisation, the leather industry has made enormous impact on every sphere of man's life – economically, industrially, socially, religiously, and politically. From the Stone Age to the beginning of the Egyptian civilization through the Romans' domination till today, man has regarded skins and leather as dependable materials for meeting his basic needs such as making footwear, tents, shields, sheaths, containers for liquids, boats and even armour (Landmann, 2003; Hamilton 1971, as cited in Atiase, 2004; Kite and Thomson, 2007). Ever since, Leatherwork has characteristically been regarded as a major contributing factor in the economic development and industrial transformation of several countries including the United Kingdom, Italy, Germany, United States of America, and France (De Haas 1925; Landmann, 2003; UK Leather, 2004; Kite and Thomson, 2007; http://business.highbeam.com/industry-reports/textiles/leather-tanning-finishing). Currently, China, India, Pakistan, Turkey, Kenya, South Africa, Brazil, and Argentina are counted among the global industrial giants in the field of leather production which are beefing up their economic development and stability with enormous revenues generated from exportation of various forms of cured raw hides, skins, finished leather and leather artefacts (De Haas, 1925; FAO Agricultural Services Bulletin 67, 1986; Leather International, October 2007; World Leather, December /January 2008/2009; World footwear, March/April 2008). Records on leather's economic utility show clearly that apart from using leather for domestic purposes such as clothing, sofas and containers, the automobile, aviation, railway (trains, trams, undergrounds) and marine industries rely on leather to express luxury and comfort through upholstery and interior decoration (Leather International, Jan./Feb. 2006; World Leather, Dec./Jan. 2008/2009; www.leathermag.com). This is a venture that has made the material an indispensable factor of dependability for building capacity towards revenue generation to support economic development.

In Ghana, Leatherwork has been an old vocation practised over a century. Its practice is concentrated in the northern parts of the country and spreads southwards– through the Ashanti and Greater Accra regions. The industry serves as the lifeline for the livelihood of several people across the country (Boahin, 1994; 2005; 2008; Atiase, 2004), nevertheless, its economic impact has not been felt much since it is practised on small scale. Fundamentally, the industry holistically is built highly on leathers tanned by indigenous methods and techniques, and focuses on the production of leather and leather artefacts to serve both aesthetic and utilitarian needs of Ghanaians and beyond. Though the artefacts are conventionally made, and attract some patronage locally and by tourists, Boahin (2008) has emphasised that they leave much to be desired since the material's defects and inefficiencies manifest particularly through the emission of offensive odour, mould development and poor finishing. This appalling situation has generally rendered artefacts made with the local leather a limited competitive ability which is impairing their capabilities to penetrate the global market economically and rub shoulders with products of same or similar status from other countries.

Boahin (2008) has emphasised that the Ghanaian indigenous leather industry serves as a source of inspiration to the study of Leatherwork in schools; meanwhile, lack of refinement has rendered the industry virtually redundant, unattractive and uninspiring since the dependability on the local vegetable tanned leather is limited. As a result, Leatherwork in the country is unable to contribute significantly to revenue generation to support the economic development of the nation in spite of leather's versatility as a material and inherent economic potentials amidst the high global demand for leather and leather goods; as well as government's support for non-traditional export products through AGOA and Centre for Cultural Initiative (CISP).

The researcher is of the view that in this era of modernity, technological explosion and industrial adventure, the current deplorable state of the indigenous leather industry is intolerable, since it is disincentive to mobilisation and consolidation of national efforts towards harnessing indigenous cottage industries in support of national development and improvement of livelihood holistically.

1.3 Philosophical Foundation of the Study

The study thrives philosophically on the foundation that **solving the cause rather than the effect; towards improved delivery of quality leather prerequisite for industrial utilisation, job creation and revenue generation for economic improvement and poverty alleviation in Ghana.**

1.4 Statement of the Problem

Ghana's leather industry, although indigenous and operates on small scale, potentially produces artefacts which bear the concepts, ideas and cultural values of the people, and also attract some tourists patronage; its economic contribution to national development, however, has been a mirage. The industry produces leather from animals slaughtered in the country as well as conventional artefacts which provide job opportunities for several people in the country, especially the northern zone. The researcher has observed that the local vegetable tanned leather, not withstanding its cherished nativity and distinctiveness, is facing hostility in the major economically productive sectors of artefact manufacturing where its highest economic relevance in terms of end use and consumption rate is realised on the global market.

Observations made in such sectors as footwear, upholstery, bag making, garment and clothing accessories production and exhibition shops in Kumasi, Accra and Takoradi show that the local leather is not a material of choice and its significance is very limited or unknown for such utilities as shoe, sofas, bags, jackets, gloves, car seats, car seat backs and spare tyre covers which are commonly used by Ghanaians. The production sectors of these artefacts such as footwear, upholstery, decoration garment and clothing accessories, however, depend massively on imported leather, leatherette and fabric at high cost although most of these materials lack imperative properties such as resilience breathability, perspiration and durability as emphasised by Sharphouse (1995) and Boahin, (2005). Meanwhile, such artefacts, despite their ergonomic limitations are sold to Ghanaians at the price of leather.

Again, the local leather is not fancied for garment and clothing, or even for export to the temperate and arctic regions of the world to generate revenue to support national development. Meanwhile, business reports on leather issues and allied commerce from sources such as Leather International, October 2007, Vol. 207; World footwear, March/April, (2008), Vol. 22 and World Leather, Dec./Jan. (2008/2009), Vol. 21, show that in order of economic significance, Leatherwork generates its highest revenue from the massive utility of leather for the production of footwear, upholstery (furniture and automotive), and clothing (garment and gloving). In affirmation, the chart in *Figure. 1.1 (page 5),* shows statistically that, in 2004, the footwear industry consumed 55% of the world share of leather, 20% by the furniture and automotive (upholstery) sector and 15% by the garment and glove sector. Other end uses occupied 10% of the total quantity of leather produced that year globally (UK Leather, 2004). The leather utility distribution trend has been consistent for several years as recounted by De Haas (1925) and World Leather, December (2008).

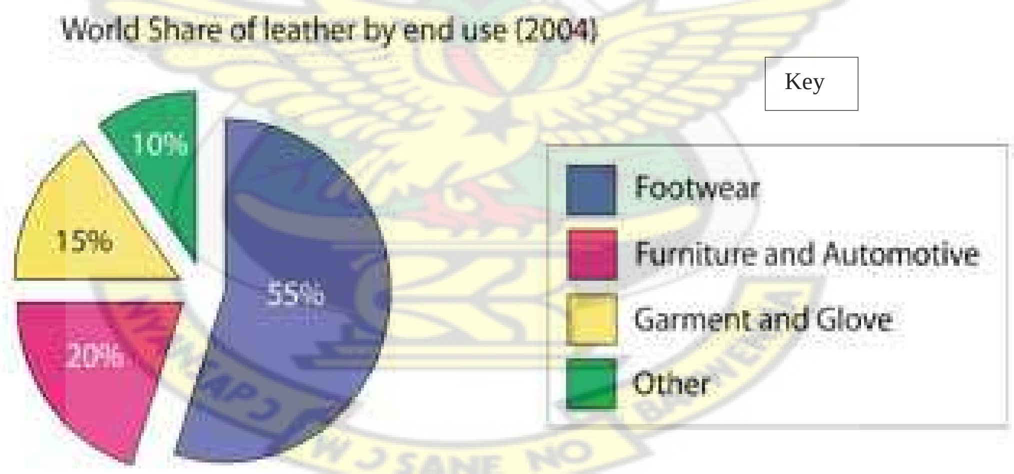

Figure 1.1: Quantitative distribution of the world share of leather by end use (UK)
(Source: UK Leather, 2004)

The situation being faced by the local leather is deleterious to the progress of the indigenous leather industry, as well as the aspiration of the country's national agenda to attain a middle income status. Also, available evidence signifies that the introduction of Leatherwork into the formal Ghanaian schools system as a subject or course of study from 1999, according to Boahin (2008), was inspired by the desire of government through the Ghana Education Service (GES) to provide the opportunity for practical vocational education which would be relevant directly to the livelihood of the learner as well as society holistically in the sphere of entrepreneurial skills development that depends on local available resources and upgrade local technology relevant to increase production capacity and salvage the disappearing indigenous art industry (Edusei, 1991; Amenuke, 1995; Oti-Agyen, 2007, Boahin, 2008).

Although meticulous and persistent efforts have been exerted by researchers to rectify the situation, it has been noted that fewer premiums have been placed on probing into the competence of the physical properties of the local leather in relationship to its deficiencies, causes, causations and effects as a means to identify lasting solution to improve upon quality to increase the economic value of indigenous Leatherwork.

It has therefore become imperative to examine the quality standards and the overall aptness of the locally tanned leather for the production of quality and economically viable artefacts. This would help in the identification of the shortfalls of the local leather and galvanise the discovery of alternative avenues toward making qualitative improvement to attain leathers that are enterprising and bear quality assurance that satisfies the footwear, clothing, containers, office accessories and upholstery needs of Ghanaians and beyond.

1.5 Research Questions

1. Does the Ghanaian indigenous vegetable tanned leather possess the properties requisite to assure quality in the production of contemporary leather artefacts such as shoes, upholstery, clothing and garment and containers?

2. What are the causes and causations of the local leather's intrinsic and extrinsic deficiencies that result in its inefficiencies in meeting the properties requisite for quality Leatherwork in Ghana?

3. What possible alternative strategies are relevant to the improvement of the quality of Ghanaian indigenous leather to augment the economic relevance of its utility and application in artefact production at the industrial sphere?

1.6 General Objective

To investigate into the nature and economic suitability of the Ghanaian indigenous vegetable tanned leather and ultimately identify and propose alternative strategies to improve upon its properties to augment the economic significance of Leatherwork practised and studied in Ghana.

1.6.1 Specific Objectives

1. To examine and establish the quality standards of the Ghanaian indigenous vegetable tanned leather to corroborate the suitability of its properties for industrial utility and domestic applications in producing artefacts to meet contemporary leather needs of Ghanaians and beyond.

2. To critically analyse the impact of the operations of the Ghanaian animal husbandry system, abattoir practices and indigenous tanning technologies in correlation to leather manufacturing towards unearthing the remote causes and causations of the deficiencies militating against the economic potentials of the local leather.

3. To propose alternative strategic methods and technologies to improve upon the properties of the locally tanned leather to enhance quality and augment its acceptability, dependency and utility in manufacturing artefacts such as footwear, upholstery, office accessories, bags, garment and clothing accessories at the industrial sphere.

1.7 Delimitation

The researcher took cognisance of the two focal points of Leatherwork as expressed by Sharphouse (1995); Atiase (2004) and Boahin (2008) thus, (1) making quality leather from animal pelts, and (2) processing leather into valuable artefacts. Since leather is the imperative material in Leatherwork, the study focused mainly on investigations into the nature of the Ghanaian indigenous leather: its quality standards and general suitability for industrial utility in artefact production. Leather samples from Bawku, Bolgatanga, Tamale, Kumasi and Accra traditional tanneries are in focus. A visit to Burkina Faso to acquire a fair view of connections and approaches regarding animal husbandry practices and Leatherwork is also within the scope for comparative studies between Ghana and the Sahel countries.

It is important to state that this study does not focus on animal science; however, since Leatherwork survives on the biological material (pelt) which is processed into leather by chemical and mechanical means, the researcher employed applicable natural scientific principles to describe intrinsic, extrinsic and instinctive phenomenon encountered as the investigations progressed.

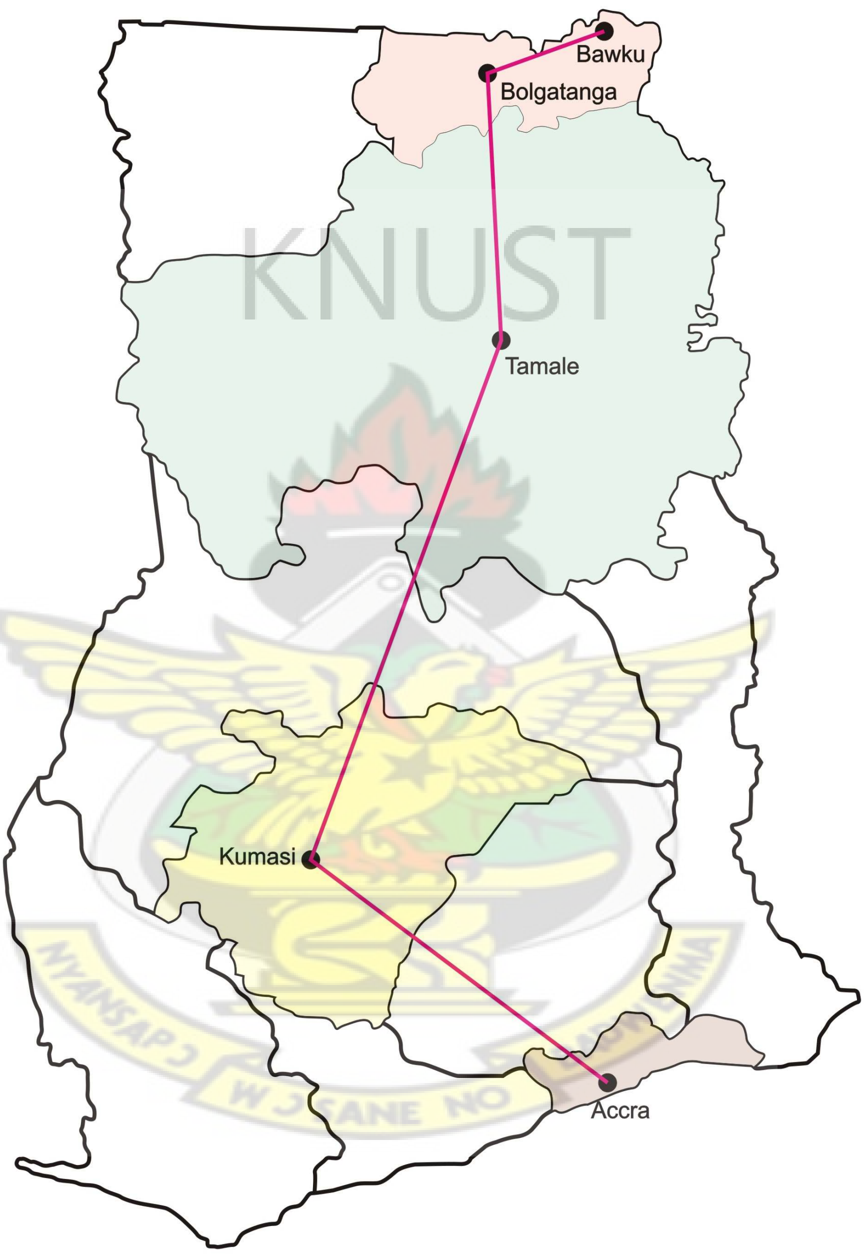

Figure 1.2: The five selected local tannery zones indicated on the map of Ghana.

1.8 Limitations

Due to poor documentation on indigenous activities in Ghana, paucity of literature on the indigenous leather industry made the review of related literature arduous and frustrating, secondary data collected on the local content of Leatherwork were restricted. Again, access to information from government offices such as Ghana Export Promotion Council and Ghana Standards Board was difficult. This limited the secondary data obtained to support the analysis of the primary data collected.

1.9 Definition of Terms

The following terms are defined and explained according to their appropriate applications and implications to the study conducted.

Autolysis: Self release of bacteria to breakdown organic tissues for natural recycling of energy.

Cause: A factor, phenomenon or circumstance, natural or artificial that results in an effect(s).

Causation: The process by which a cause leads to an effect and render leather poor quality.

Caprine: Refers to hair goats or wool goats with sour smell emanating from the presence of hexanoic acid, commonly known as caproic acid.

Curing: The process of causing dehydration in pelt for preservation against autolysis.

Hydrolysis: Decomposition of protein fibres by chemical reaction with water.

Kraal: An enclosure or shed serving as housing unit for livestock.

Pelt: A collective term for skins and hides in their raw state.

Tanner: A person who is engaged in converting pelt into leather.

Tanning: The operation of subjecting pelt to chemical processes to render them resistant to putrefaction and shrinkage resulting from temperature.

Tannages: These are materials containing the required astringency for cross-linking collagen fibres of pelts into leather.

1.10 Assumptions

1. The local vegetable tanned leather is devoid of up to scratch economic recognition and industrial utility because it lacks the specific properties essential for the production of specific quality leather artefacts; hence faces hostility in the industrial realm of artefact production.

2. There are several defects and deficiencies faced by the indigenous vegetable tanned leather which impede its efficacy in the production of footwear, upholstery, clothing accessories and containers that assure quality.

3. The causal reasons underlying the economic viability of the indigenous leather industry are multi-sectorial and multi-factorial.

4. Lack of cutting-edge livestock keeping practices is a major hindrance to the economic significance of Leatherwork studied and practised in Ghana.

6. The cultural practices in most livestock slaughtering centres in Ghana are horrendous and disincentive to the attainment of quality pelt competent to promote the economic development of standardised Leatherwork in the country and beyond.

7. Animal skins and hides generated in Ghana lack adequate recognition as raw materials mandatory for Leatherwork.

8. The methods and technologies employed in the production of leather in the indigenous setting are obsolete to result in leathers that bear solutions to contemporary leather needs.

9. The conventional recipes followed in tanning leathers are not purposeful and dynamic for achieving specific leather properties prerequisite for specific end use.

10. The current state of the Ghanaian indigenous Leatherwork cannot fully encourage the study of Leatherwork in Ghanaian schools.

1.11 Importance of the Study

The following outline the importance of this study.

1. First of all, since literature on Leatherwork as an industry and a course of study is scanty in Ghana, this dissertation being an embodiment of knowledge, serves as a vital reference material for students, researchers, teachers, tanners, government, veterinary officers, animal scientists, livestock farmers, material scientists and people who are interested in Leatherwork in general.

2. Secondly, through the diagnosis of the fundamental problems facing the Ghanaian indigenous leather industry, this study creates awareness of the cause-and-effect relationship of the predicaments the native leather is encountering as a stimulation to researchers, students, artisans and interested parties in academia and industry to channel their attention to pursuance aimed at finding strategic problem

solving technologies to engender transformation and dynamism into progress in Leatherwork and render the industry competent to generate revenue to support national development.

3. The results of this study are therefore serving as a wakeup call and awareness creation to government, livestock policy formulators, farmers, and other able bodies to build capacity towards integrating the development of the economic relevance of Leatherwork and its allied businesses significantly under the six priority areas of National Development of government in the following sectors: Ministry of Education Youth and Sports and Science and Technology, Ministry of Food and Agriculture, Ministry of Health, Ministry of Information, Ministry of Trade and Industry, Ministry of Culture and Tourism, Ministry of Employment and Social Welfare.

4. Again, the results of the study draw a serious attention to the correlation between the development of the leather industry and other core allied sectors: livestock farming, animal transportation, abattoir and meat industry, curing, tanneries and leather artefacts processing. The need for collaboration, co-operation and integration to express economic interdependency in these production sectors has been revealed by this study, hence, creating raw material dependency awareness.

5. In addition, the proposed alternative strategies further serve as a means of inducing the confidence and competence prerequisite to projecting significantly the economic potentials of the local leather industry in a developing country that needs to consolidate and mobilise all possible potential resources towards improving the livelihood of the people through job and wealth creation.

1.12 Organisation of the Rest of the Text

Sequentially, this dissertation has been arranged in six chapters to give logical meaning to the study conducted. Chapter two contains the theoretical and empirical literature reviewed. The methodology is presented in chapter three. Chapter four comprises data presentation, analysis and interpretation of findings. The alternative strategies proposed to intercept the causes of the deficiencies associated with the local leather are discussed in detail in chapter five. Finally, the summary of the entire research, conclusions and recommendations made are presented in chapter six.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Overview

With the exception of the historical overview of the development of the Leather industry and the nature of Leatherwork in Ghana, the related literature reviewed aimed at building theoretical and empirical foundation for the progress of the study by making frantic efforts to identify and understand the underlying theoretical perspectives and existing research findings regarding the problem at hand (Leedy & Ormrod, 2005). Various scholarly writings by authors from diverse backgrounds in the field of indigenous and modern leather technology, animal science and animal husbandry, and abattoir operations have been organised, evaluated and synthesised logically to deduce the necessary ideas to support the primary data of the study.

The related literature reviewed in this chapter has been arranged under two major topics 'Theoretical review' and 'Empirical review'. Under each broad topic is found various sub-topics which provide additional critical in-depth conceptual framework and basis for the logical sequence of the entire study.

2.2 Historical Overview of the Development of the Global Leather Industry

Man's relentless quest to leather's discovery, unprecedented versatility inherent its properties, and the truth behind its ubiquitous acceptance and survival through generations and dispensations of humankind is found in several accounts of human history – archaeological, anthropological, ethnological, and forensic studies –

which have unveiled manifold controversial philosophies, principles and ideologies through research as basic means of improving global modern Leatherwork (De Haas, 1925; Britannica Junior Encyclopaedia, 1975; NIV Holy Bible, 1976; Encyclopaedia Britannica, 15th Edition, Vol.10, 1977; Holt et al., 2005; Boahin, 2005 and 2008).

In tracing the origin of Leatherwork and the use of leather, various schools of thought are confronted. According to Holt et al., (2005) and Boahin, (2008), Leatherwork is an old industry known to mankind. Hamilton (1971), as cited in Atiase (2004), shares a similar view as he suggests that although the potter's craft is very old, man out of his own philosophy imagined, fashioned and used leather mugs (black jackets) to drink from poaches, and to keep his food in and even bottles of a type to store long before recorded history begun, leather art therefore predates nearly all other art forms and articles. O'Brien and Andrews (1946) in accordance affirm that Leatherwork is a very old vocation with worldwide influence and its development dates as far back as the prehistoric era when man made conscious effort to find something to cover himself and store water for mobility. In their opinion, the prehistoric people who lived during the Ice Age some 500, 000 years ago were likely the first to have used the skins of animals to protect their bodies from bad elements of the weather and the environment.

Writers who possess comprehensive understanding of the philosophy of leather making and its development such as Maddox (1940) and Boahin (2008) have noted that the choice of pelt by the early man brought about serious efforts to improve upon its quality and comfort in usage, which accordingly brought about the leather industry. This aspiration to render the skin obtained from the animals hunted more durable, pliable, water resistant and suitable to wear on the body coincidentally was widespread among people of different geographical locations. Even though he employed uncivilised methods such as smoking, drying, scrapping with flint tools, and application of fats and animal brains at different periods in his expeditions to finding improved technologies, the objective of alleviating the rate of undesirable putrefaction process and instability of skins to temperature was somehow attained, especially when man accidentally discovered vegetable tannins from plants (Procter, 1936; O'Brien et al., 1946). With that as basis, the technology of leather manufacturing has evidently gone through dynamic revolutions over the past centuries; although, the basic principles for production have remained the same. This affirms that the results of the early man's efforts still remain as some of the oldest methods and techniques employed in leather processing even today.

The significant value accorded leather in the early civilised societies such as the Egyptians, Greeks, and the Romans, accelerated the vigorous endeavours by various genesis researchers to find varied approaches to improve the preservation of the material and enhance its ergonomic significance (Wilson, 1923; Procter, 1936; Maddox, 1940; O'Flaherty et al., 1956; Sarkar, 2005, Boahin, 2008). Further unrelenting efforts exerted by prolific researchers yielded fruitful results which enhanced the economic viability of Leatherwork in a more applicable manner in national development. Significant among the contributors include Samuel Parker (American) who invented a splitting machine in 1809, Augustus Schultz, an American dye salesman, brought into being the popular chrome tanning process in 1884. The advent of chrome tanning, comparative to vegetable tanning, has allowed more attractive and flexible leathers to be produced at a much faster rate to meet the high demands faced by tanners for both domestic and industrial utility (Sharphouse, 1995; Sarkar, 2005).

Currently, the utility of leather is increasingly exploded and supply due to various reasons is not parallel with demand. As a result, polymer researchers have developed leatherettes which though closely resemble leather and have many uses, are still incomparable to leather. Such synthetic materials lack the natural ability to breathe, that is, to allow perspiration to escape without letting in water from the outside. Leather, according to Boahin (2005), therefore continues to be the material of choice for many people, not just for corporate and domestic furniture but also for footwear, clothing and garment, automobile, aviation and marine interior applications as well. The universal acceptance of leather has reinforced the industry to possess the ability to contribute massively to impact on the economic development of countries that are intuitively and consciously adhered to its everyday dynamisms, standards and development. Revenues generated by Italy, Germany, China, India, Pakistan, Brazil, Argentina, South Africa, Kenya and other countries are reported in international magazines, journals and world wide web including World Leather , Leather International and leathermag.com.

2.3 The Nature of Leatherwork in Ghana

Since finding improvement strategies is pivotal in this study, it is imperative to discuss the origin of the trade at this juncture to facilitate the understanding of what Leatherwork connoted from its fundamental institution in the country, although documentation on the leather field is very limited. In Ghana, like many other countries, though livestock – sheep, goat, cattle and horse – are not reared purposefully for the production of leather, the universal inseparability of leather and man, vis-à-vis the irresistible desire to benefit from the availability of the animal skins and hides have orchestrated the adoption of vegetable tanning process which capitalizes on propitious local natural resources. The inexhaustible nature of such resources mainly plant parts such as fruits, twigs, leaves, seeds, barks and stems, and even the animal skin which is converted into leather make the leather industry auspicious, even in its predominantly indigenous state. Leatherwork in Ghana basically surrounds the production of leather and leather artefacts to serve diverse purposes, economically, socially, religiously and economically (Boahin, 1994, 2005, 2008, Obeng-Nyarko, 2000; Atiase, 2004). Production processes are conventional and ethnocentric/ethnographic, which make the practice of Leatherwork concentrated within specific geographical locations of the country.

Historically, it is believed that the recognition of the industry in Ghana is beyond a century old, although its practice might have been introduced by trading settlers or indigenes who had existed already in areas around Salaga in the Gonja land and Yendi in the Dagomba land as a result of the Trans-Saharan Trade. However, according to Bawa Tanko's personal communication (2009), it is supposed that Hausa peasant farmers or nomads from Northern Nigeria who settled in Ghana grounded the industry firmly: first in the coastal south, probably Accra, and later Kumasi, before establishing in Tamale (Hausa Zongo Majema), and then spreading into Bolgatanga, Bawku, Nandom and Pusiga. The spread towards the north could have been upon realisation that accessibility to skins and hides was easier because of the widespread Savannah grassland (Atiase, 2004). Since the presence of natural resources often determines the patterns and distribution of activities within a geographical zone, another factor explaining the concentration of local tanneries in the northern parts of the country is the ready availability and accessibility of Bagaruwa (*Acacia nilotica*), which serves as the chief dependable source of astringency for vegetable tanning in Ghana (Boahin, 2005). Tanning ideas and methods employed in the local tanneries are therefore staunch in the culture of the Hausa people as handed down to their generations through apprenticeship, and creating the semblance of the Hausa-Fulani tanning methods in Northern Nigeria.

In its indigenous form, the industry follows a humanistic tradition which controls nature for survival: by depending on local raw materials to focus on the production of leather artefacts to project and protect the cultural legacy of the people and also to serve the needs of Ghanaians and tourists who visit the country (Fiero, 1995; Boahin, 2008). With local methods and techniques, skins and hides are tanned into leather for the production of artefacts ranging from containers, clothing, and upholstery to decoration (Boahin, 2005; 2008) to serve both domestic and economic purposes. Key among them includes skins for all kinds of drums, sunshields for farming in the dry season, talisman and amulets, traditional bags, slippers, wallets, footrest, and knife sheaths.

Although Leatherwork stands as one of Ghana's indigenous industries capable of job and wealth creation to help curb poverty and the high unemployment situation, for one reason or other, the industry according to Boahin (2005) lacks economic motivation, confidence and market penetrative competence which probably stem from poor technological approaches employed in the production of leathers. As a result, the nation has not been able to harness the full economic potentials of the industry to its advantage. This amplifies the crises in which the industry is and the urgent need for pragmatic problem solving ideas (Boahin 2005, 2008); hence, the appropriateness of this study which seeks to identify militating factors and apposite alternative strategies to curb them.

2.4 Theoretical Review of Leatherwork

Fundamentally, the global Leatherwork thrives on the theoretical foundation which relates the functions of the ante-mortem functions of the animal skin to its post-mortem roles that it can play once the right treatment is given at the beamhouse, tanyard and finishing yard. In finding the appropriate approaches to make the pelt much more useful, array of theories have been propounded by researchers which a careful review is necessary to the success of this study.

A theory according to The Hutchinson Encyclopaedia, (2000); Twumasi, (2001), and the Collins English Dictionary, (2008), is defined as a coherent group of general prepositions, a set of ideas based on evidence and careful reasoning, or a set of concepts, principles, or methods used to explain a phenomena or a wide set of observed facts. From the perspective of the researcher, the scientific method of investigation goes beyond the detection of a problem and the mere collection of unconnected facts.

In Twumasi's (2001) view, there is a basic inter-relation between theory and research and that without theory, the researcher will not be able to operate effectively; his data collection techniques will be sterile. The notion of what data to collect therefore emerges precisely from the theoretical position of the researcher, especially, in a study of this kind which is deeply entrenched in natural science enquiry (i.e. a phenomenological evaluation of the status of a local leather material in relation to the causes and effects of its flaws from a cross-sectional viewpoint). The result when correlated to industrial utility of the material and economic significance of Leatherwork accordingly, will reveal pragmatic perspectives to the identification of alternative strategies prerequisite to improve on the quality of the material. It is deemed crucial to review related literature which identifies theoretical orientations regarding Leatherwork and all its symbiotic mandatory allied segments of raw materials and technology generation crucial to the acquisition of quality leather. This will consequently serve as a foundation in the development of perspectives toward enquiring into the various sectors of the study holistically and also to establish firm grounds for arguments and comparisons.

2.4.1 Theoretical Foundation of Leatherwork in Ghanaian Formal Education System

The need to identify problem solving strategies to enhance the socio-economic relevance of Leatherwork is directly dependent on human resource development and capacity building, especially, when critical thinking is mandatory and in philosophical realms premium is placed on the human brain as the first resource of consideration in creating possibilities. It is against this backdrop that Leatherwork is being studied in Ghanaian schools as a means to catalyse technocratic approaches to its upgrade (Atiase, 2004; Boahin, 2008). The need to assess available literature on the study of Leatherwork in Ghanaian formal educational sector to finding alternative avenues for quality Leatherwork to serve the needs of the people in the country and beyond is imperative in this study.

As cited in Boahin (2008), a statement emphasised in the Structure and Content of Education for Ghana (Ministry of Education (MOE), 1990:3) states:

> *... any system of education should aim at serving the needs of the individuals, the society in which he lives and the country as a whole. In particular, the system in a country like Ghana, aims at instilling in the individual, an appreciation of the need for change directed towards the development of the human and material resources of the country.*

This pedestal of education in Ghanaian indigenous Leatherwork is not farfetched because the philosophy of education, since the dispensations of the ancient Egyptians, Greeks and Romans, has constantly surrounded on training humanity to perpetuate the cultural values of society which would fit one very well into the society (Edusei, 1991; Amenuke, 1995; Asiamah and Adentwi, 2006; Archer et al., 2008; Oti-Agyen, 2007; 2008). In training, one is required to go through some well defined activities to build capacity to develop proficient knowledge and skills, and the technical know-how prerequisite to face the realities of life.

In a common view, Edusei (1991), Amenuke (1995), Oti-Agyen (2007) and Asiamah and Adentwi (2006) define education as the preparation of a child to fit into his/her society. They further explain that for a child to fit into society, he/she needs to be taught the things of the society, such as his/her culture. This makes culture the determinant of the content of education, as it contains the needs of society. Although Ghana's formal education system is traced to the Castle Schools, factors such as growth, conformity to the demands of time and dynamism in societal needs have necessitated various education reforms leading to a number of changes in the structure, curricula and governance of education (Edusei, 1991; Oti-Agyen, 2007; Asiamah and Adentwi 2006). Upon realisation that vocational education through the study of art could serve as a vehicle for rapid transformation of Ghana's economy, one of such significant changes is the introduction of vocation oriented system of academic training aimed at making education more functional and relevant to the needs of the immediate community and the ever advancing technological competitive world at large (Amenuke, 1995; Anamoah-Mensah, 2002).

Leatherwork being one of the Visual Art subjects at the high school level and Industrial Art programmes at the tertiary level is regarded as one of the alternative pathways provided for students which are enshrined in the broad principle of education. This moves away from a purely academic focused training towards one that combines skill acquisition and attitude formation to purposefully transfer culture smoothly from one generation to another (Amenuke, 1995). Unfortunately, Leatherwork has been perceived as a trade belonging to a particular group of the northern parts of the country.

However, Boahin (2008) emphasises that the recognition given for the study of Leatherwork and some other indigenous vocations, such as Woodwork, Rattan and Bamboo work, and Clay work in Ghanaian education system is a great effort for all to harness the potentials within these vocations to support the economic development of the nation. He writes further that in the Visual Art Syllabus for Senior High Schools, it is stated clearly that Art should be taught in the schools to preserve, transmit, improve and promote indigenous art technologies. The object of this study is to discover avenues to improve the indigenous technologies in Leatherwork to safeguard sustainability and maximise economic advantages inherent the sector, and since the introduction of Leatherwork into the education system takes inspiration from the indigenous background, the formal school is considered as a potential channel to build capacity towards the development of expertise in various core and functional sectors of the industry.

2.4.2 Theoretical Foundation and Principles of Global Leatherwork

It is known that the art of tanning and Leatherwork was practised long before the Christian era. According to O'Brien et al., (1946), existing evidence show that Leatherwork had reached a remarkable standard of perfection in the highly advanced cultural societies of Ur, Babylon, Egypt and ancient India and China around three thousand years or more B.C. Today, as a result of research activities aimed at meeting the high demand, changing social needs and standard upgrades, the field of Leatherwork is so broad and concerns the art of leather and leather artefacts production and all phases of chemistry as well as related physics, biophysics, biology and engineering. Since leather is a product made by stabilising the proteins of animal skins and hides through tanning, the various processes involved in leather making contribute to conditioning and enhancing the protein fibres against putrefaction and temperature towards upgrading the ergonomics of leather as a material and its related artefacts. The industry's high dependency on animals crucially requires synchronised knowledge and technical know-how in animal keeping, transportation, slaughtering and flaying, skin preservation, tanning and marketing in relations to attaining quality leather to meet the needs of society (Sharphouse, 1995).

The definition of leather poses difficulties to writers due to its varied properties which give the material insurmountable abilities for various possibilities. However, efforts by writers mostly result more descriptions than definitions. The World Book Encyclopaedia Vol. 12 (1972) states that as a material, leather is strong and durable, and possesses the ability to stretch, to be as flexible as clothe or as stiff as wood. Some kinds are thick and heavy, others are thin. Leather can be dyed, polished until it has a glossy finish, or it can be embossed (decorated with raised figures). Based on its vast properties writers such as O'Flaherty et al., (1956) and Ward (1977) find it difficult to define leather as a single material, they however describe it to include materials as different as the stiff sole leather of a heavy boot, the soft and yet tenacious leather of ladies fashion gloves, the flexible membrane which undergoes repeated distortion for perhaps forty years in a gas metre, mouldable leathers used as oil seals and pump washers.

According to Sharphouse (1995), the reasons for the large differences in mechanical behaviour characteristics of leather types originate partly from the natural structure of the skin and partly from the choice of the manufacturing process. With such a wide range of variability there cannot be any clearly defined and measured properties of "leather" as such but only the properties of particular types of leather. Perhaps, the most striking common feature of many types of leather is the ability to withstand repeated flexing without failure. The vamp region of shoe uppers provides an appropriate illustration of this point.

Ward (1977), states that the mechanical properties of leather are encountered by members of the general public many times each day, although they are usually accepted without thought. However, the scientific study of those properties was until recently, limited to investigations carried out by leather scientists. Scientist concerned with the uses and behaviour of leather, and the structural reasons which permit that behaviour have become important to some polymer technologists, whose objective has been to make materials able to replace leather in some of its main uses.

2.4.3 Principles and Theories on Leather as a Material

The early Palaeolithic, Mesolithic and Neolithic prehistoric people's principle of finding protection within their environment has been the underscoring factor for the development of leather from skins of animals to render services which transcend socio-cultural, religious, political and economic boundaries of diverse races of humankind. As a material, leather is known to be the lifeblood of Leatherwork, and its primary raw material being the pelt from animals which Lawson (1990) acknowledges are inexhaustible renewable natural resources capable of sustaining the leather industry to continuously serve man.

It has been proven both theoretically and empirically that, generally, the origin of the skin or hide in addition to the manufacturing method define the material 'leather' (Sharphouse, 1995; SLTC, 1999); although the end-use dictates the direction of its processing. Fundamentally, leather as a material is made for specific applications such as bags, shoes, clothing and upholstery and must be made as such. De Haas (1925); O'Flaherty et al., (1956) and Sharphouse (1995) all agree that each end use requires leather though, but with specific applicable properties prerequisite to the functionality of the intended product. Attainment of such intent properties in leather has been the pragmatic responsibility of most material researchers through applied science in Biology, Physical Chemistry, Mathematics and Physics. Their relentless efforts have concentrated on understanding the structure of the animal skin in relation to its chemical and mechanical reactions towards the conditioning to possess particular properties.

Through histology and critical studies of the fibre structure of leather, several possibilities have been created to complement the natural properties of the skin and increase the capabilities of leather. Conscious improvement efforts in leather technology through science and technology are well appreciated by leather users globally since it is an attempt to meet their needs.

The basis of material science involves relating the desired properties and relative performance of a material in a certain application to the structure of the atoms and phases in that material through characterisation. The major determinants of the structure of a material and thus of its properties are its constituent chemical elements and the way in which it has been processed into its final form. These characteristics, taken together and related through the laws of thermodynamics, govern a material's microstructure, and thus its properties. Since the properties indwelt a material justify its aptness for utility, Halliwell and Lambert (2004) posit that working out the properties of materials relates to preparing, processing, manipulating and combining. Many natural materials are amorphous, not possessing any long-range order in their atomic arrangements; leather, however, partially exempts itself by its structure shown as **hide/skin – fibre bundles – fibres – fibrils – microfibrils – macromolecules – collagen molecules (tropocollagen)**.

Since the global leather industry depends solely upon raw skins and hides for its survival, understanding the nature of the pelt cannot be overlooked as Sharphouse (1995) claims especially when the term material is generally seen as synonymous with substance, and referred by Wikipedia, (http://en.wikipedia.org/wiki/material_science) as anything made of matter. Basic science, meanwhile, explains matter as anything that has weight and volume (occupies space). That means a material can be anything: a finished product in its own right or an unprocessed raw material (http://en.wikipedia.org/wiki/matter). These bases classify pelt and leather among organic and nonorganic materials that can be input into production of tangible goods.

It is noteworthy to mention that the material of choice of a given era is often its defining point, and that time defines its value. O'Brien et al., (1946) have therefore realised that for a material to stay resolute and be on the edge against dispensational demands like leather, continual research matters a lot. Leather as a material is used to illustrate a group of materials in which the biological origin and manufacture combine to give the properties required in the end use. Leather therefore becomes a generic name given to a group of materials.

Sequentially, in terms of material classification, skins/hides obtained from animals are categorised as primary materials, but when processed they turn into a secondary material appropriately called leather. However, when the leather is used as input by commercial artists, students and craftsmen to make variety of finished products it becomes a tertiary product, which Boahin (2005; 2008) categorises into clothing, upholstery, containers, decoration and stationery accessories. Artefacts found in any of these categories serve both industrial and domestic needs of society in diverse ways. In terms of world production and distribution of leather, the majority of materials come from bovine group followed by ovine and then the caprine. In terms of world leather production, the share by type of animal is illustrated in Figure 2.1. *(Page 30).*

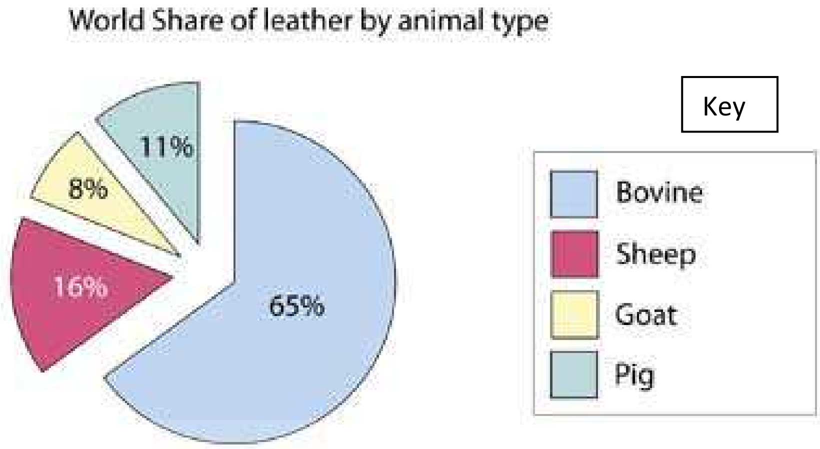

Figure 2.1: Quantitative distribution of world share of leather by animal type (UK)

(Source: UK Leather, 2004)

2.4.4 Histology and Ontogenesis of Skins and Hides

The structure of the skin as the largest single organ of the animal, its physiology and inherent advantages have received a lot of attention in terms of research in wide array of disciplines regarding biology and its allied areas. Nevertheless, for the purpose of leather making much more has been done to ensure proper utility of the animal skin. Generally, the skin is defined as or referred to as the external covering of the body of a vertebrate that mediates between the outer environment and the internal environment. However, its functions enormously surpasses just covering the body to include a lot more as revealed in the medical and biological spheres of enquiry as well as the field of leather technology. Accounts are evident in Wilson (1923); De Haas (1925); Gustavson (1956); O'Flaherty et al. (1956); Powitt (1977); Thorstensen (1976); Bienkeiwicz (1983); Fritz et al. (1999); SLTC Leather Technologists Pocket Book (1999); Sharphouse (1995); the Hutchinson Encyclopaedia (2000); Sarkar (2005); Kite and Thomson (2006) and the

FAO Agricultural Development Papers and Bulletins, as well as papers presented in the JALCA and SLTC Journals.

From Dermatological perspective, Powitt (1977); Bienkeiwicz (1983); Sharphouse (1995) and Sarkar (2005), all emphasise that the skin, as the largest single organ of the animal, plays variety of exceptionally important biological functions on the living body of an animal as the medium of thermostatic control, expiration of waste products, harbouring the tactile nerves, excretion of hormones to provide a valuable detoxification of chemicals that have ingested or metabolised to help in the identification of illness through body odour. The skin also serves as enclosing barrier giving shape to the body and preventing the entry of micro-organisms. The tanner's basis of dependency to provide unique leather to serve diverse needs of society therefore seems to depend highly upon the skin's intrinsic and extrinsic physiological competence of mediating between the internal environment and the immediate external environment of the body as a result of its natural architectural integument. Comparatively, the skin's ability to function as protection, absorption, sensitivity, regulation of body temperature, secretion and excretion as Powitt (1977) outlines, are analogous to the functions of the resulting leather with complimentary versatility rendered from the tanner's application of tannages and finishes.

From the anatomical structural composition, the mammalian skin or hide consists of water, protein, fatty materials, and some mineral salts. Of these, the most important for leather making is the protein, although water is the highest constituent. This protein, according to Sharphouse (1995) consists of many types, and the essential ones are *collagen* which, on tanning, gives leather and *keratin*, which is the chief constituent of hair, wool, horn and the epidermal structures mostly removed during leather making. Figure 2.2 classifies the composition of a freshly-flayed hide or skin as outlined by Sharphouse (1995) and Kite and Thomson (2007).

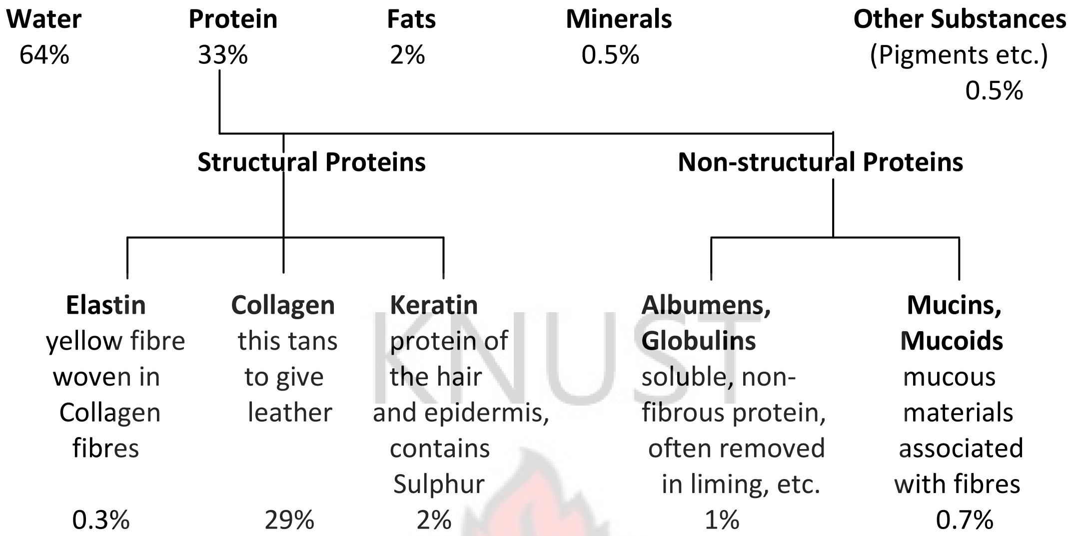

Figure 2.2: The constituents of freshly-flayed skin of animals
(Source: Sharphouse, 1995)

Although all animal skins follow this basic pattern, and are made up of the above constituents, some factors may cause the figure for keratin or fatty substances or water to vary considerably depending on the source of the skin.

The cross-section of skins and hides has attained much attention by researchers, since the understanding of the structure is known to be vital to the quality of leather produced eventually. As presented by Sharphouse (1995); Sarkar (2005), Thorstensen (1976), FAO Agricultural Services Bulletin 67 (1986); Kite and Thomson (2006), of a typical cross-section of mammalian skin, there are two main layers composed of epidermis (upper layer) and dermis (lower layer), and a number of tissues which can be further subdivided as shown in *Figures 2.3(a) and 2.3(b)*

Figure 2.3(a): Diagrammatic representation of the structure of a typical mammalian skin

(Source: Powitt, 1977)

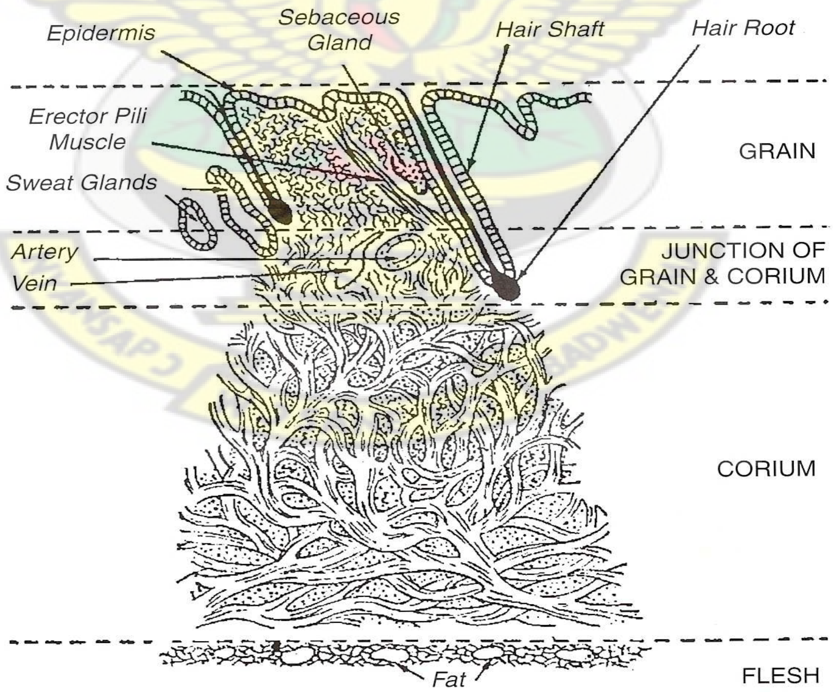

Figure 2.3(b): Diagrammatic representation of the structure of a typical mammalian fresh skin

(Source: Sharphouse, 1995)

2.4.4.1 The Epidermis

In describing the epidermis layer, O'Flaherty et al., (1956), write that the epidermal layer is that portion of the fresh skin or hide which contains the hair, the hair follicles, the epidermis and its appendages such as the sebaceous glands and the sudoriferous glands, which are surrounded and supported by a collagenous fibre bundle structure. Also, throughout this structure, collagenous fibre bundles are dispersed as a network of elastic tissue fibre, erector pili muscles, blood vessels and nerves. From Sharphouse's (1995) perspective of skin structure in correlation to leather making, the epidermis is a protective, hard-wearing layer of keratinous cells. Those on the outside are dead and, on drying and shirking, fall off the skin as scurf or dandruff. On the underside, next to the "skin proper", Sharphouse explains further that they consist of soft, jelly-like living cells, which have little resistance and are readily attacked by bacterial action or enzymes, as occurs with stale skins or in enzyme unhairing. Because the epidermis is loosely connected with the derma during life, Felsher (1946) (as cited by O'Flaherty et al., 1956), in a study of the adherence of human skin, observes its ease of separation or disintegration from the corium by acids, bases and sodium thiocyanate. Separation as a result of swelling caused by these agents can be reversed by shrinking agents, such as sodium citrate and sodium acetate, which result in an increase in adherence.

2.4.4.2 Dermis

In his perspective, Bienkiewicz (1983), a physical leather chemist says that the dermis consists of two layers: the papillar, called thermostatic (*stratum papllare seu termostaticum*) and reticular (*stratum reticulare*). The reticular layer passes without a clear limit into the subcutaneous tissue (*tela subcutanea*). In the corium cells, the fibril-forming ones-prevail. Beside them in the skin, there occurs the intercellular substance (matrix) and two kinds of fibres: collagen and elastin. He acknowledges that quantitatively, the major part of the solid substance is collagen fibres.

According to Sharphouse's (1995) theoretical description of the dermis, the "skin proper" or corium, consisting of a network of collagen fibres, is very intimately woven together, and in the grain layer these fibres become very thin and tightly-woven, and so interlaced that there are no loose ends on the surface beneath the epidermis. Thus, when the epidermis is carefully removed, a smooth layer is revealed–sometimes known as hyaline layer–which gives the characteristic grain surface of leather. In a common acknowledgement of the role of the dermis layer of the skin, writers such as Wilson (1923), Bienkiewicz (1983), Sharphouse, (1995) and Kite and Thomson (2006), emphasise that the corium is the basis of leather making, since it contains the strength properties of leather. Towards the centre of the corium, the fibres are coarser and stronger, and the predominant angle at which they are woven can indicate the properties of the resultant leather. When the fibres are more upright and tightly-woven, one expects a firm, hard leather with little stretch, whereas a soft stretchier leather is expected when they are more horizontal and loosely-woven. The corium is generally the strongest part of the skin. The flesh side of the corium, i.e. next to the meat, where the fibres have a more horizontal angle of weave, a fatty (or adipose) tissue may also be present.

Again, Sharphouse (1995), O'Flaherty et al., (1956) and the Leather Technologists Pocket Book (1999), explain further that in the living skin, all these collagen fibres and cells are embedded in a watery jelly of protein-like substance. The living collagen fibres are formed from this substance, which consequently ranges in constitution from the blood sugars to substances which are almost collagen. The latter have been called "inter-fibrillary" proteins, also known as non-structural proteins or pro-collagens as shown in figure 2.3(a) and 2.3(b). These are essential for the growth of the skin and also render the fibre structure non-porous. When the skin is dried, they dry to a hard, glue-like material, which cements together all the corium fibres and makes the skin hard and horny. In making leather which is to be soft or supple, it is most important to remove these inter-fibrillary proteins.

The BASF Pocket Book (1999: 77) describes the collagen as the true skin for leather making and explains its fibrous structure as follows:

> *Fibre bundles composed of fibres (20 – 200 μm in diameter) which in turn consist of elementary fibres (about 5 μm in diameter), and these of fibrils (10 – 100 nm in diameter), and these of microfibrils (about 5 nm in diameter), and these of macromolecules. The collagen molecules (tropocollagen) are about 280 nm long, about 1.5 nm in diameter and have a molecular weight of about 300000. They are composed of three polypeptide chains which are twisted together in form of a helix (triple helix) and which consist of amino acids that are linked together by peptide bonds. 1 kg raw skin has a reactive inner fibre surface area of 1000 – 2500 m^2.*

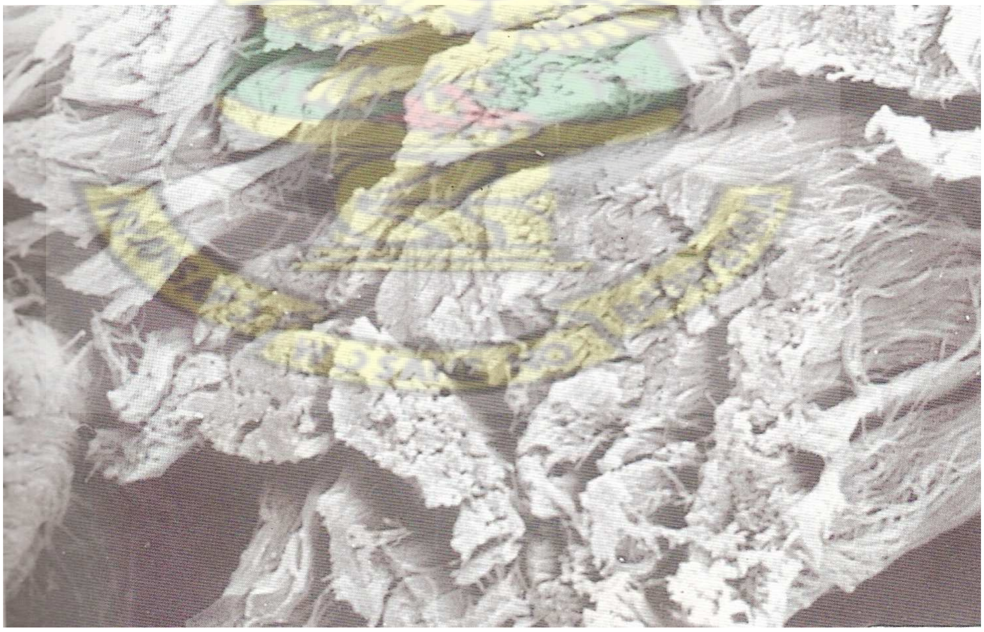

Plate 2.1: Fibre and fibril bundles of collagen

(Source: Kite &Thomson, 2006) (Magnification:×45)

2.4.5 Physical and Chemical Properties of Collagen and Grain Surface of Leather

Skin is primarily made of innumerable fibres of a protein called collagen. The word "collagen" itself derives from Greek 'kolla', glue. Collagen fibres weave together to form a permeable, very strong, yet highly flexible structure which has yet to be equalled by any man-made fabric. Generally, leather falls into two distinct layers; the grain layer, which contains the structures such as the hair follicles and sebaceous glands, and the corium which is made almost entirely of large bundles of collagen fibres which interweave each other. It is this interwoven structure of the corium which gives the leather its strength. As the grain layer does not have such large interweaving, fibre bundles is relatively weak compared to the corium**.** The way in which the collagen fibres and hair follicles are angled varies from one species to another and it is this variation which gives leather made from the skin of different animals their own special characteristics and uses. The grain is the pattern, characterised by the pores and the hair follicles and peculiar to the animal concerned, visible on the surface of a hide after the hair has been removed. Grain leather has the grain layer substantially intact and is finished on the grain side.

The collagen fibre structure of the skin does not only vary from one species to another, but also varies within the skin; different locations have a different structure according to the purpose of the skin at a given location during the life of the animal as shown in fig. 2.4. The neck and shoulder region tend to be thicker than the rest of the skin, while the bellies and particularly the axillae (the armpits) have a very thin, loose structure. The area termed as the butt (the back and rump area) is the most densely fibred area and is generally thicker than the remainder of the skin. It yields the best leather, having a taut grain structure and a very durable corium layer. The butt area has the most uniform structure and is the prime cutting area for leather goods. The shoulder area is less densely fibred and the surface has grown wrinkly, produced by the movement of the animal's head while alive (Kite and Thomson, 2007).

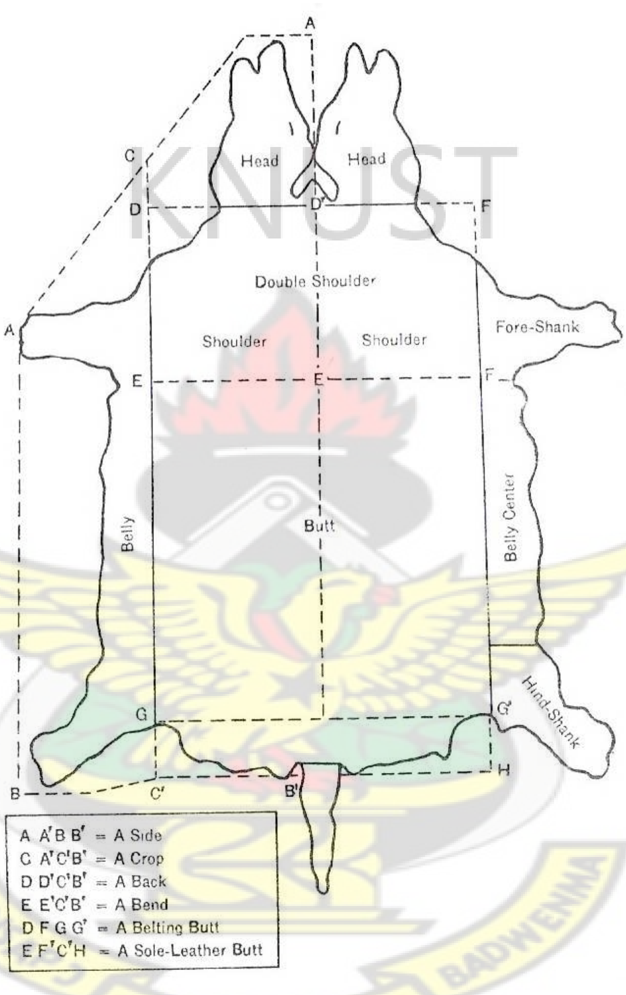

Figure 2.4: Parts of the quadrupedal animal's skin

(Source: FAO Bulletin 67, 1986)

2.4.6 Raw Skin Types, Properties and Impact on Leather Production

Comparatively, the physical structure of raw skin demonstrates that different types of animals slaughtered possess varied properties; hence, different types of leathers and leather products. Obviously, the size and thickness of skins vary enormously, e.g. from an elephant to a mouse, as does their shape, e.g. from a giraffe to a pig. Sharphouse (1995) explains that there are differences due to breed, sex, age, life-style, health nourishment and even climatic conditions under which the animal was raised. Kotla (1996); O'Flaherty et al., (1956) and Boahin (2005) assert that the hide or skin of each type of animal has its own unique characteristics which are different from those of any other species. Some of the variable characteristics pertinent to any leather manufactured include thickness, length, width, fibre structure, and grain surface. Usually, the younger animals have small and thin skins resulting in smooth and a fine grain structure (Sharphouse, 1995). Similarly, the female skin usually has a finer grain structure than the male. This results in softer and more elastic leather. Cattle, sheep, goat, pig, horse, and reptile skins are the primary source of hides used in the production of leather. Most animal hides represent 7-10% of the animal's body weight (Heidemann, 1993).

The properties of leather vary considerably depending upon the type and quality of both the raw material and the tanning process employed. Every piece of leather has individual markings which relate to its origins and add character to each skin. De Haas (1925) states that the most distinct quality for which a tanner looks to the grain of his raw stock is a smooth, firm and attractive surface for dressing – whether for display with its natural pattern or as a foundation for some artificial finish. With the passing of time and use, it develops a patina which enhances its beauty. Leather breathes, insulates (can be warm and cold), resists abrasion, and has individual characteristics which make each hide unique. De Haas (1925) and Sharphouse (1995) conclude that leather will always bear the marks of its natural origin and these characteristics can show as healed scars, growth marks, areas of differing fibre density and hair pores structure. These hallmarks together with the natural architectural integument of the skin or hide give distinctive characteristic features of leather from different animals.

2.4.7 Aesthetic and Utilitarian Characteristics of Quality Cattle Hide Leather

The cattle hide is probably the most commonly used skin for leather manufacture. According to O'Flaherty et al., (1956) and Sarkar (2005), when the surface of leather made from cattle hide is viewed under a microscope, the pattern that the hair follicles make can be easily seen. In cattle hides the hair follicles are of fairly uniform size, they are closely packed together and there is no distinct pattern to their alignment (Wilson, 1923; Thorstensen, 1976). When viewed in cross- section the fibre structure of the leather can be easily seen. The grain layer containing the hair follicles makes up about one fifth of the total thickness in cattle hides. The corium contains large interweaving collagen fibre bundles which give the leather its strength. Its relatively great thickness allows it to be split into two layers; the outer layer, known as the grain split, is normally used for footwear or upholstery, whilst the inner layer, the suede split is used for clothing or industrial gloves. *(See Plates 2.2(a) and (b).)*

Plate 2.2(a): Cross-section of leather made from matured cattle (Magnification: x45)
(Source: Haines, 1981)

Plate 2.2(b): Hair follicle pattern of cattle hide leather (Magnification: x45)

(Source: Haines, 1981)

2.4.8 Aesthetic and Utilitarian Characteristics of Quality Calfskin Leather

Male dairy calves are slaughtered at the best economic age for reasonable yield in meat. The European practice generally is to kill the calves at the younger age than in the United States. As a result, European calfskins may be a bit smaller with limited area value and utility. It has been proven that calfskins will have the same number of hair follicles as mature skins. The main difference, then, between calfskins and cattle hides, from a structural point of view, is the fineness of grain. Since the hair follicles are much smaller, collagen bundles are smaller and the follicles are much closer together. As a result, calfskins have a very fine structure, especially, the grain surface, as compared to cattle hides and are useful for the finest of leather (O'Flaherty et al., 1956). The skin is highly valued because of the fine structure and usually commands three to five times the price of heavy cattle hides. *(See Plates 2.3(a) and (b)).*

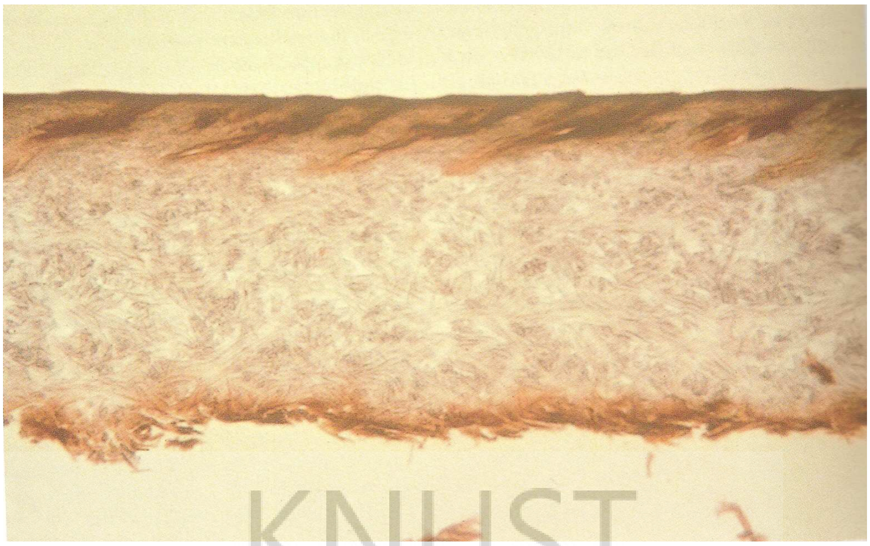

Plate2.3 (a): Cross-section of leather made from calfskin (Magnification: x45)

(Source: Haines, 1981)

Plate 2.3(b): Hair follicle pattern of calfskin leather (Magnification: x45)

(Source: Haines, 1981)

2.4.9 Aesthetic and Utilitarian Characteristics of Quality Sheepskin Leather

When the surface of leather made from sheepskin is examined microscopically it can be seen how different the hair follicle pattern is to that of cattle hide. The hair follicles are arranged in groups with spaces in between. These spaces present a relatively large uninterrupted surface which enables the tanner to give leather made from sheepskins a good "polish" resulting in a pleasant glossy appearance. It is not possible to do this on leather from cattle hides without applying a finish (a plastic coating) to the surface to fill in the hair follicles. Consequently, the surface of sheepskin leather can be made quite shiny without any significant loss of its natural feel. *(See Plates 2.4(a) and (b)).*

When viewed in cross-section, it is noticed that the fibre structure of sheepskin is very different from that of cattle hide. Because sheep are much smaller animals than cattle, the size of the collagen fibre bundles in the corium is also much smaller. This enables a finer suede to be made from sheepskin than can be achieved with cattle hide. The other most distinguishing feature of sheepskin, as asserted by O'Flaherty et al., (1956), is the ratio of the amount of grain to corium. In cattle hide the total thickness consists of one fifth grain layer; in sheepskin it is more like half the total thickness. Because the fibre bundles are smaller and the ratio of grain to corium is greater in sheepskin, this type of leather is much weaker than cattle leather per unit of thickness (Wilson, 1923). Consequently, it is not suitable to use where a high degree of strength is required e.g., in footwear. However, its smaller structure means that it will make a softer, more flexible leather and is therefore ideally suited for clothing (British Leather Confederation, 1989).

Another notable feature of domestic sheepskin is the transition between the grain and corium layers. In cattle hide there is a gradual transition from one layer to another. In domestic sheepskin the two layers are very distinct; there is a sudden change from one layer to another. Sheep are by nature very fatty animals and sometimes they deposit a layer of fat cells in the skin in a layer between the grain and corium. When the skin is processed into leather, the subsequent removal of this fat can create a void in the structure between the grain and corium causing the two layers to separate. This is called looseness and is a particular problem in sheepskin leather.

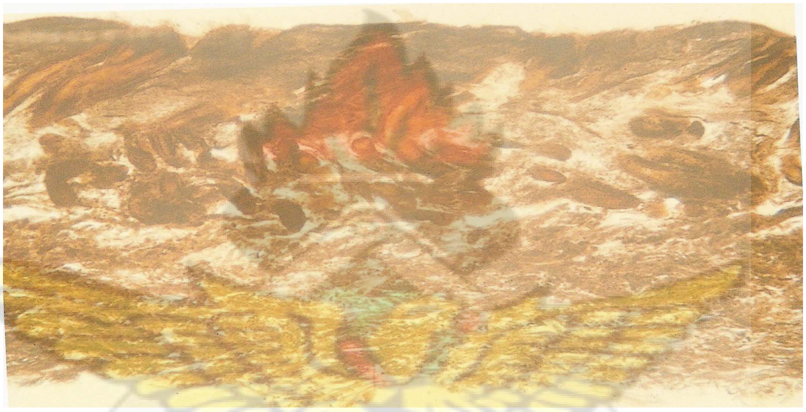

Plate 2.4(a): Cross-section of leather made from sheepskin (Magnification: x45) (Source: Haines, 1981)

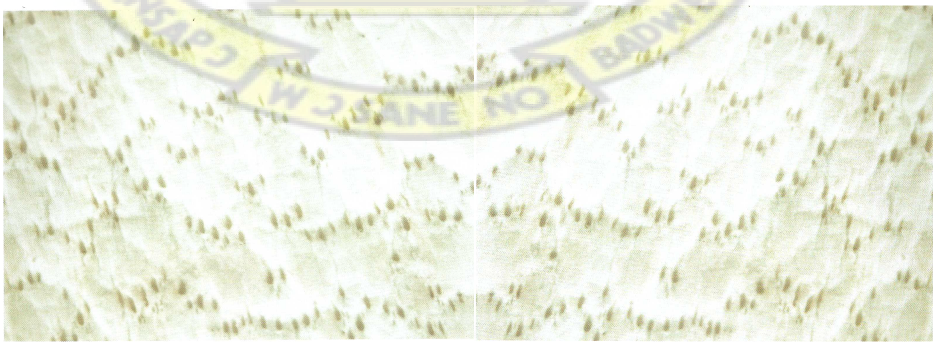

Plate 2.4(b): Hair follicle pattern of sheepskin leather (magnification: x30) (Source: Haines, 1981)

2.4.10 Aesthetic and Utilitarian Characteristics of Quality Goatskin Leather

Goatskins, as compared to sheepskins, have a very tight fibre structure and are easily recognized. O'Flaherty et al., (1956) perceive that the tight-natured fibre of goatskin allows its use in the more durable type of applications in the manufacture of gloves and shoes. *(See Plates 2.5(a) and (b).)*

Plate 2.5(a): Cross-section of leather made from goatskin (Magnification: x45)
(Source: Haines, 1981)

Plate 2.5(b): Hair follicle pattern of goatskin leather (Magnification: x30)

(Source: Haines, 1981)

2.4.11 Aesthetic and Utilitarian Characteristics of Quality Pigskin Leather

There is very little pigskin leather manufactured in the UK because they tend to eat it. However, pigskin leather is made in more substantial quantities in other countries such as Japan. The structure of pigskin really is very different from any of the other skin types looked at so far. Pigs are not very hairy animals; normally, they have only a few sparse bristles and their hair follicle pattern reflects this. In some locations of the skin, the follicles are arranged in a "trio" pattern–so often reproduced in printed imitations. Because the skin surface is not protected by a good covering of hair like most other animals, the skin takes on a rough textured pattern which is not particularly pleasing to the eye and consequently pigskin is usually made into suede (Wilson, 1923; Sharphouse, 1995).

Perhaps the biggest difference in pigskin leather becomes apparent when it is viewed in cross section. (*See Plate 2.6 on page 47*). The most noticeable feature is that the hair follicles are not confined to the outer layer of the skin; they penetrate through the full thickness, from one side through to the other. This feature gives suede made from pigskin its own special character because the follicle pattern is visible on both sides. However, it does have some disadvantages; it is not easy to make water-proof pigskin leather because the follicles easily channel water through, and when the suede surface is buffed the finer fibres surrounding the hair follicles sometimes behave differently giving rise to a "fisheye" effect where there is a pale ring surrounding the central hair follicle. Because the follicles are not confined to the outer layer of the skin, there is no distinction between grain and corium; the structure is quite uniform throughout and the fibre bundles are small and compact. This enables fine suede to be produced and the uniform structure allows the leather to be split very thinly without loss of strength. This makes pigskin useful where thin, strong leather is required, e.g., gloving and shoe linings. In a thicker form however, it is equally suited for clothing and even sufficiently hardwearing for suede shoes.

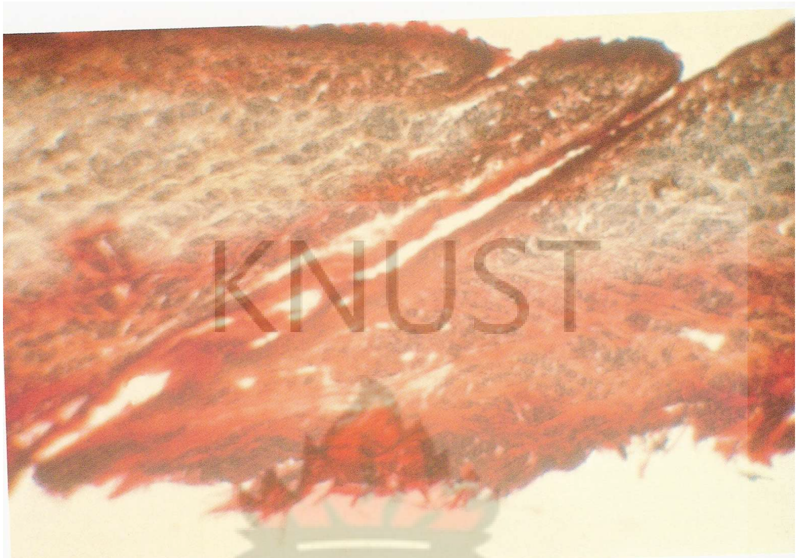

Plate 2.6: Cross-section of leather made from pigskin (Magnification: x30)
(Source: Haines, 1981)

2.4.12 The Cause-and-Effect Theory

To every cause there is an effect, to every effect there is a cause. The theory of cause-and-effect can be traced from intellectual perception by Greek thinkers who in the ancient world where most people saw themselves at the mercy of forces they could not comprehend ceased the opportunity to lay the foundations of Western philosophic and scientific enquiry. According to Fiero (1995) and Oti-Agyen (2009), instead of making nature the object of worship, they made it the object of study to probe deep into problems of human existence, and the understanding gained eventually enabled them engage in vigorous creative activities into wealth creation and improved quality livelihood by taking issues with those who explained devastating natural events such as earthquakes and lightening an expressions of the anger of the gods. Those Greek philosophers argued that such events as devastating natural events such as earthquakes and lightening had natural, or supernatural causes than being the expression of the anger of the gods as claimed, and challenged all prevailing myths. They therefore made the speculative leap from supranational to natural explanations of the unknown.

It is known that Although the Greeks were not the first to believe in a natural order (the ancient Chinese, for instance, had viewed the universe as the interaction between two forces, the *yin* and the *yang*, and the Hindus of ancient India had stressed the oneness of all aspects of the universe, however they embraced the wholeness of nature). They subjected nature to close analysis, a process that separates the whole into its component parts, claimed intellectual detachment and objectivity, thus, the fundamentals of the scientific method to find reason to the occurrence of events than its effects. It was as a result of the Greeks glorification of reason that Fiero (1995) again says is a notable contrast to the Hebrew's emphasis on faith. There is therefore a relationship between the reason behind a happening and the impact of the happening. Any effort to justify the effect consequently requires pursuance of the causation through systematic analysis and critical examination of fundamental components of the whole. This systematic and rational endeavour originated from Greece in the 6th century BC (The Hutchinson Encyclopedia, 2000), and it requires the pragmatists philosophy which Oti-Agyen (2006) asserts has been variously referred to as Instrumentalism, Empiricism and Experimentalism, and is fundamentally an epistemological undertaking identified by its theory of truth and meaning.

The pursuance of the cause or the effect of a situation towards problem solving is analogous to the pursuance of truth and meaning, and it requires the application of intelligence to interaction between man and his mind with his environment (Oti-Agyen, 2006, 2009:60). Oti-Agyen therefore explains further that truth can only be known only through its practical consequences.

In the same manner, Holt et al., (2005) from their perspective, believe that events in every situation or activity cause a reaction in a certain manner and to some magnitude. They explain further that cause-and-effect patterns show the relationship between results and the idea or events that made the results occur, and one can represent cause-and-effect relationships as one cause leading to multiple effects, or a chain of causes-and- effects as shown in *Figure. 2.5.*

Looking at the cause-and-effect theory from a philosophical perspective, the Hutchinson Encyclopaedia (2000) states that causality in philosophy is a consideration of the connection between cause and effect, usually explained as the relationship between cause and effect, and must follow that every event is caused.

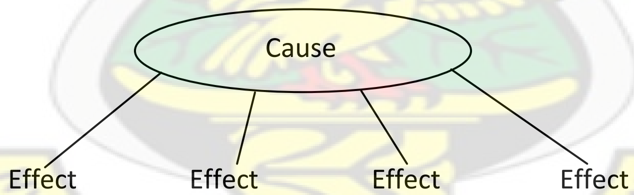

Figure.2.5: Schematic illustration of several effects possible to result from a cause

(Source: Holt et al., 2005)

2.4.12.1 The Fish-Bone Theory of Cause and Effect Relationship

It is difficult if not impossible to solve complicated problems without considering many factors and the cause-and-effect relationships between those factors, particularly when the pursuance of militating factors against the progress of

Leatherwork is the focal point. Again, since an effect of a phenomenon is possible to emanate from several sources and causes, identifying the cause-effect relationship is well represented diagrammatically by the fishbone theory. According to Ishikawa (1990), defining and displaying those relationships with diagrams helps. The first of such cause-and-effect diagram was used by Kaoru Ishikawa in 1943 to explain to a group of engineers at the Kawasaki Steel Works in Japan how various work factors could be sorted and related. In recognition of this, these diagrams sometimes are called Ishikawa diagrams. They are also called fishbone diagrams, because they look like fish skeletons as illustrated in *Figure. 2.6 (Page 51).*

According to the fishbone theory, causes should be derived from brainstorming sessions which can be applicably illustrated in a generic Ishikawa fish-bone. Then causes could be sorted through affinity-grouping to collect similar ideas together. The groups could then be labelled as categories of the fishbone. They would typically be one of the traditional categories mentioned above but may be something unique to the application of this tool. Causes should be specific measurement and controllable. Of each of the large bones there may be smaller bones highlighting more specific aspects of a certain cause, and sometimes there may be a third level of bones or more. These can be found using the '5 Whys' technique. When the most probable causes have been identified, they are written in the box along with the original effect. The more populated bones generally outline more influential factors, with the opposite applying to bones with fewer "branches". Further analysis of the diagram can be achieved with a Pareto chart (http://en.wikipedia.org/wiki/Brainstorming, 05/08/2008).

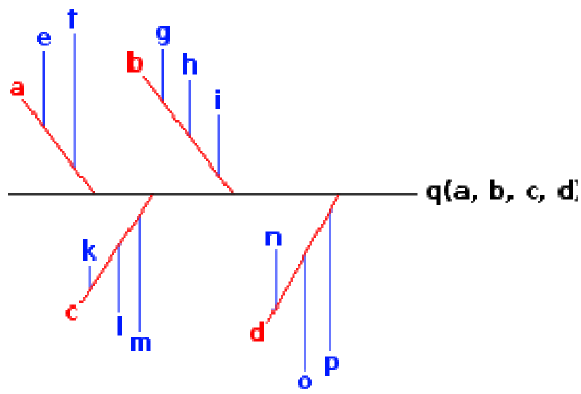

Figure 2.6: A generic Ishikawa diagram showing general (red) and more refined (blue) causes for an event. *(Source:* Ishikawa, *1990)*

Ishikawa (1990) concludes that problems related to quality are typically not simple, especially when the problems generate from multi sources. They often involve the complex interaction of several causes. A cause-and-effect diagram will help to define and display the major causes, sub-causes and root causes that influence a process or a characteristic; provide a focus for discussion and consensus and visualise the possible relationships between causes which may be creating problems or defects.

2.4.13 Sources and Acquisition of Skins and Hides for Leatherwork

With few exceptions hides and skins are by-products. Animals are reared for meat, milk and wool, not for the value of their skins. As a consequence, the tanner is not able to control the supply of raw hides. Hides are traded as a commodity all over the world on open markets and in competition with other tanners on a global basis. As a result, when demand is high, prices soar. Additionally, even minor variations in economies and currency can cause major fluctuations in raw hide prices. The availability of cattle hides for leather is however fundamentally dependent upon consumer demand for beef, and this is not different from skins from goats and sheep.

Today worldwide, at least half the leather produced goes into footwear and around a quarter into clothing. Only around 15% goes into upholstery and the rest into small leather goods and other consumer products. Because of its durability and comfort, leather has been used for seating purposes throughout the history of transportation and furniture (Wilson, 1923; De Haas, 1925; O'Flaherty et al., 1956, Sarkar, 2005).

The early leathers were made from cowhide, calfskin, pigskin, deerskin, and goatskin either hunted or farmed for food purposes. The present trend is for most upholstery to be made from bovine material (that is to say cattle hides) as this is readily available and best lends itself to the modern demand of designers, producers and consumers. Hides include ox, bull, cow, and buffalo skins, while the reptile skins include snake, lizard, and crocodile skins. In addition to these animals, a number of other exotic animal skins are used to produce specialty leathers. These animals include emus, ostrich, sharks, elephant, kangaroo, bear, elk, turtle feet, and frog skins.

2.4.14 Animal Farming Systems, Raw Hides and Skins Associated Defects

An analogical quotation of an old saying from Sharphouse (1995:26) says:

> *One cannot make a silk purse out of a sow's ear", and it is very true of the leather industry; unless the raw material is brought at the appropriate price and quality, the profitable success of the venture is in jeopardy.*

According to Halliwell and Lambert (2004) quality raw materials are greatly cherished in every sphere of production establishment, which the leather industry is not exempted. Defects associated with skins and hides go beyond reflecting in the eventual leather produced, to the extent of sabotaging the quality of artefacts produced from the leather, hence limiting market potentials. Skins with defects are therefore seen as disincentive to the economic viability of leatherwork (FAO

Agricultural Development Paper No. 68, 1960; Sharphouse, 1995). In affirmation, De Haas (1925) writes that defects limit the utility and overall economic validity of skins and hides as the core raw material in leather making. He laments further that any blemish associated with the material deducts an amount of value and reduces the potentials of the material.

The JSLTC (Vol. 86, September–October 2008) emphasises that a number and distribution of faults on a hides and skins have major commercial implications because they affect area yield and the shape which is available for garment pieces, and hence the overall quality. Sheepskins, goatskins and cowhides with a fine grain appearance have the highest market value for their low level of damages and are important for the production of garment leather, upper leather as well as upholstery leather.

Various writers such as Wilson (1923), De Haas (1965), Thorstensen (1976), Bienkiewicz (1983), Sharphouse (1995) and Sarkar (2005) explicate that defects found with pelts stem from two main causal reasons: during and after the death of the animal. Sharphouse (1995) believes that probably no other damages occurring in tannery practice cause as much confusion and concern as those diseases and defects native to the skin or hide on the stock as it is received at the tannery although others develop in the preparation of hides and skins at the tannery. Sharphouse adds that these defects mar the otherwise beautiful leather, and recognising the various causes and defect types is important to prevent the avoidable ones. Since skins and hides are traded international commodities, the International Standards Organisation has provided the following references for the description of defects: ISO 2820:1974, amendment 1:1996 to ISO 2820:1974, ISO 2821:1974:

1. ISO 2822 –1:1998 –Descriptions of skin defects (cattle)
2. ISO4683 –1:1998 –Raw sheep skins –Descriptions of skin defects
3. ISO7482 –1:1998 –Raw goat skins –Descriptions of skin defects

From the perspective of Sharphouse (1995) and ISO2822 descriptions, defects which may occur on raw hides and skins and also devalue their intentions for tanning include the following: abscess, blind warble hole, brand mark, dung damage, eczema, hump,. hump sore, lice, pox marks, ring worm, fat wrinkles, badly bled skin, badly shaped head and shanks, cut throat, flay cut (scar mark), grain break (grain burst) and holes, discoloration (red heat), vainness as well as sun blisters.

2.4.15 Animal Domestication and Husbandry as Integral Part of Leatherwork

Leatherwork, as the name depicts, depends solely on leather for its survival, and the outer cover of the animal (skin and hide) serves as the only source of raw material for leather manufacturing, therefore, the existence and availability of animals serve as the lifeblood of Leatherwork. O'Flaherty et al., (1956) assert that the animal skin is a by-product of the meat industry in most instances; in its absence there is nothing like Leatherwork. This lays emphasis on the integral role animal husbandry plays in the sustenance of viable Leatherwork.

Logically, simple production management principles suggest that manufacturing should be located near its source of raw materials (Smith, 1993). Accordingly, Okonkwo and Ihuoma (JSLTC Vol. 86, 2005) observe that traditional tanning activities are concentrated in areas where livestock activities are predominant in Ghana for the sake of proximity to hides and skins, thus, the Northern Region and Upper East. Development of knowledge in livestock domestication is vital to this study to serve as practical basis for correlating the life patterns of animals to the quality of their pelts. This brings to mind Acker's (1991) assertion that the kinds of feed the animals utilise, their size in relation to product volume, and their susceptibility to stresses– extreme temperatures, parasites and diseases– largely determine where each species will flourish or the type of land or facility where they can be efficiently produced. The habitats impact so much on animals' adaptation in terms of environmental influence, which usually determines the system of farming to be adopted and to a large extent the mode of feeding. Therefore, policies and emphasis laid on quality animal husbandry practices are of major interest to the leather industry. The general welfare of animals therefore becomes a major consideration in the area of total quality Leather, hence, domestication and animal husbandry practices.

2.4.15.1 Domestication of Animals

The present civilisation has its roots in the domestication of animals. Various accounts on humanity and development of civilisation are found to lay emphasis on the indispensability of domestication of animals to the survival of humanity, especially from the Neolithic period (8000B.C. into 3500B.C.) when man had realised the need for settlements and developed tools for agriculture (Maddox, 1940; The World Book Encyclopaedia Vol. 12 1972; Student Information Finder, 1981; The Hutchinson Encyclopaedia, 2000; Holt et al., 2005). Domestication was therefore a means to an end to the earlier stages of livelihood epitomised by nomading and wandering in hunt of animals for food. To domesticate means to adapt the behaviour of animals to fit the needs of people. The domestication of animals began when early humans had contact with wild animals, which they hunted for food and skins. After a period of time these early people began to confine some of these animals to ensure a steadier supply of food and clothing. These animals were bred in captivity to replace those which were used. However, it is significant to identify that in order to harness the benefits of the animals, the early man created the enabling environment for his welfare which resembled the original environment of the animals (Chartten and Amdul, 1943).

Although domestication (from Latin ‘*domesticus*’) or taming is the process whereby a population of animals or plants, through a process of selection, becomes accustomed to human provision and control, the defining characteristic of domestication is an artificial selection by humans. Humans learned to select animals with certain desirable characteristics to use for breeding purposes. As a result of selective breeding, identifiable breeds began to be developed. Some species such as the Asian Elephant, numerous members of which have for many centuries been used as working animals, are not domesticated because they have not normally been bred under human control, even though they have been naturally tamed. Humans have brought these populations of various animals under their care for a wide range of reasons. These are to produce food or valuable commodities (such as skin, leather, wool or fur), for help with various types of work (such as transportation by pulling or drawing carts), for the protection of themselves and livestock, for amusement, thus, to enjoy as companions or ornamental plant, and for scientific research, such as finding cures for certain diseases (http://en.wikipedia.org/wiki/Pet).

There is a debate within the scientific community over how the process of domestication works. Some researchers give credit to natural selection, where mutation outside human control makes some members of a species more compatible to human cultivation or companionship. Others have shown that carefully controlled selective breeding is responsible for many of the collective changes associated with domestication (http://en.wikipedia.org/wiki/Selective_breeding). These categories are not mutually exclusive and it is likely that natural selection and selective breeding have both played enormous significant role in the processes of domestication throughout history (http://en.wikipedia.org/wiki/Domestication).

The Hutchinson Enclyclopedia (2000) records that cattle are identified to have first been domesticated in the Middle East during the Neolithic period, about 8000 BC., for meat, milk and as power animals. Goats are found in domestic varieties which are said to have descended from the scimitar-horned wild goat. Goats according to records have been kept for over, 9,000 years in Southern Europe and Asia. Domestic breeds of sheep classified *Ovis aries* are descendants from wild sheep of the Neolithic Middle East, about 8000 B.C.

2.4.16 Impact of Animal Breed Quality on Economic Survival of Leatherwork

The species or genus of animals available in one's geographical location have a major influence on the economic value of Leatherwork practised, since it affects the nature of leather available in terms of skin/hide size, physical, chemical and mechanical properties, nature of defects and their influence on quality of leather produced. Kotla (1996) emphasises that within each species of animal, these characteristics vary depending on the age, sex and the habitat of the animal. Acker (1991), an animal scientist, affirms that the characteristics of animal species influence their adaptation to geographical areas or production systems and productivity. Since the quality of raw materials have major reflection in the finished product, quality leather artefacts depend on the availability of quality leather. For this reason, De Haas

(1925), Procter, (1936), Sarkar, (2005) assert that the source of hides or skins used for the production of leather is a matter most concerned to the tanner.

All mammal skins follow a basic pattern, but they vary in size from the hide of the elephant or ox to the skin of the mouse or rabbit, and also in shape and thickness. Some animals have little hair or wool and a thick epidermal layer, while others, such as the sheep, have a heavy fleece with curly hair follicles and a thin epidermis (Sharphouse, 1995). Different breeds of animals generate different sizes of skin or hide, and since size is appreciated in determining the economic cutting value of leather, some species are priority in economic viability of Leatherwork (De Haas, 1925; Sharphouse, 1995).

The skins of certain animals, at certain times in their lives, also contain quantities of fat in globular cells, which lie approximately in the middle of the corium. Noteworthy examples are sheep and pig. Sheepskins may contain fat of this type (i.e. inside the skin, not merely on the flesh layer) amounting to 25% of their weight. Such excessive growth of fat cells disrupts and weakens the corium fibre structure to such an extent that some sheepskins may be readily split into two layers along the "sandwich" line, where the fat is located. There are great variations even in one skin. The hair is usually denser and coarser on the back than the belly, and the skin and epidermis thicker and tougher on the more exposed parts than on the sheltered places in the limb joints. These variations are affected by age, sex, breed, health and nourishment of the animal.

2.4.16.1 Theories and Principles of Animal Breeding and their Impact on Leather Production

In biology, breeding concerns the crossing and selection of animals and plants to change the characteristics of the existing (breed or) cultivar (variety) or to produce a new one (The Hutchinson Encyclopaedia, 2000). Breeding is an activity purposely aimed at modification and developing animal characteristics to suit different requirements–meat production or specific quality, wool, skins, milk or fur appearance. Therefore, to trigger breeding in a conscious manner, certain valued and desirable characteristics are expected in livestock involved in the activity. Research has revealed the following characteristics as desirable: hardiness and early maturing like the Divon, ability to produce good calves when crossed with less promising cattle, ability to withstand various degrees of temperature and diseases like the various breeds of Zebu *(Bos indicus),* tendency of animal to produce lean meat or less fatty meat, or meat to meet required taste, like the French Limousin and Charolais cattle, ability to produce high quality and quantity of milk and ability to utilise readily available feed to maximize body size or increase population for rapid return on investment.

Breeding may also be a dependable means to develop animals for adaptation, that is, to fit into specific geographical and climatic conditions. The Hereford cattle of the English, for example, are the premier English breed ideally enhanced to be suited for rich lowland pastures. It serves as a means to end less endowment in animal economic qualities and productivity. The Aurshire is a smaller breed of cattle purposed to be capable of staying outside all year. A breed raised and improved in many countries for dairying is variously known as the Friesian, Holstein or Black and

White, which can give enormous milk yields, up to 13,000 or 3, 450 gallons in a single lactation.

When a breed of animal lacks the characteristics requisite for specific utility, breeding techniques stand reliably as the direct solution to inducing such necessary characteristics into the animal. Scientists have depended on breeding to enhance the characteristics of various animals to man's advantage. The merino sheep, which is popularly known for its profound economic contributions to mankind in the area of wool production, is a development through breeding. Various attempts have been made to train zebras for riding since they have better resistance than horses to African diseases. However most of these attempts failed, due to the zebra's more unpredictable nature and tendency to panic under stress. For this reason, great effort was made in crosses between any species of zebra and a horse, pony, donkey or ass, and the resultant enhanced breed was called zebra-mules or zebroids which are preferred over pure-bred zebras.

In Leatherwork, the source of skin or hide employed in leather making for specific end uses is considered critical to meeting the requisite properties. For this reason the breed of animal that produces the skin is also critical to the attainment of the prerequisite for the end use. It is well known that there are various factors that influence the pelt obtained from various breeds of animals. Even animals of the same species are not considered to generate skins that yield leathers with same characteristics such as weight, spread, thickness and substance. Therefore, the end use purposed for a particular leather production should dictate the animal from which the skin or hide should be obtained. Breeding of animals with consideration of yielding pelts for economically viable leather production requires the practical considerations as described by De Haas (1925).

2.4.17 Relationship between Feeding, Quality Skins and Economic Value of Leatherwork

Acker (1991) is of the view that inadequate diets affect productivity. He opines that Ghana as well as most parts of the world depend on animal products such as skins and hides, leather, wool, fur, meat, feathers, shells, scales, gelatine, plant sources, to mention a few, for exportation, income generation, feeding and economic stability. Their inability to maintain sustainable production directly inhibits their livelihood, especially, feeding patterns and efficiency of human resource. Though in most less developed countries (LDCs) of which Ghana is not exempted, about 50 to 85 percent of the people who work are farmers, yet their GDP and GNP (gross national product) are low. Acker believes that, perhaps, many people in such countries have such inadequate diets that their productivity, both physical and mental, is severely limited. Such poor and fragile economic hardships transcend human nutritional conditions to affect animals and even plants within the ecosystem.

Food, according to Acker (1991), is the natural product of agriculture approximating any natural fibres, such as wool, mohair, and cotton; skins, fur, leather; oils, plastics and certain pharmaceuticals which are also important agricultural products, valuable to society and the economy. Since most sources of food are based on renewable natural resources, well organised management activities towards sustainability are essential to national development, and this makes animal farming management systems very critical for the sustenance of food security in animal protein supply as well as other crucial allied viable economic ventures such as the leather industry, gelatine manufacturing and fur/wool production. On that basis, Ghana's hopes of attaining better livelihood is not independent on prudent agricultural resources management policies which ensure sustainability and inexhaustibility to the benefit of all players of the country's ecosystem, of which plants and animals are core due to their natural inter-dependency.

According to Koney (2004), feeding of farm animals is not independent on the farming system practised – extensive (free range), semi-intensive or intensive – and the farming system determines the general wellbeing of animals, as well as the quality of their products (meat, skins, hide, fur/wool, feathers, and eggs). In the case of proper or improper feeding, the skin being the external organ of the animal serves as a determinant- the growth, texture of the hair and other keratins, the contours, curvatures and shape of the animal's body revealing in the skin and projected undulations in the outer cover of the animal. Furthermore, the thickness, weight, texture and amount of substance of the skin also determine the feeding and growth situations faced by the animal when alive (Sharphouse, 1995; Koney, 2004).

In West Africa and Ghana in particular, despite the availability of the savannah grassland, animals are basically reared under the extensive system where the free-range method of feeding is predominant. Koney (1992) and Iwena (2008) assert that animals are either followed to graze, by nomads or peasant farmers, or left roaming in search of pasture. Beside the poor nutritional contents of the pasture, the animals hardly find supplementary nutrients for a balanced development of their cells to avoid the consequences of malnutrition leading to diseases and poor economic value of the animals and their products. Sometimes in the dry season, animals hardly find pasture since farmers lack the practice of making hay and fodder for storage.

Gillespie (1992:44) upon realising the enormity of the impact of feeding on animals' growth uses the word 'must' to stress the necessity and relevance of decorous feeding to the normal growth of animals as he says:

> *A nutrient is defined as a chemical element or compound that aids in the support of life. A nutrient becomes a part of the cells of the body. Nutrients are necessary for cells to live, grow and function properly. Many different kinds of nutrients are needed by animals. In addition, they must have the right nutrients in the proper balance. Too much of one nutrient and not enough of another may result in unhealthy stock and high feed costs. A lack of one or more nutrients may slow normal growth or production.*

The species in the Bovidae family which serve as the main source of skin and hide supply occupy a wide variety of habitat types: from desert to tundra and from thick tropical forest to high mountains. Most members of the family are herbivorous, except most duikers, which are omnivorous. Like other ruminants, bovids have a four-chambered stomach which allows them to digest plant material, such as grass, that cannot be used by many other animals. Such plant material includes much cellulose, and no higher animal can digest this directly. However, ruminants (and some others such as kangaroos and rabbits) are able to use micro-organisms living in their guts to break down cellulose by fermentation (The Hutchinson Encyclopedia, 2000).

For quality skins and hides, livestock need to be provided with diet formulated to balance in nutrients requisite to tissue development, strong bone formation, energy generation and productive activities, lactation and general maintenance of their system. Animal feed must therefore contain proteins with added vitamins, minerals and carbohydrates to provide a balanced nutritional solution (Koney, 2004; Iwena, 2008). Apart from calves which require special diet of milk-based or diet of milk replacer for the first 6–8 weeks, grain-based diet (mostly corn-based), that contain many vitamins and minerals, Free raised livestock are bred on an open pasture to gain access to grass and fresh water. Hay is usually prepared to feed livestock during seasons where access to pasture is limited. The method of feeding farm animals has direct result in the quality of products obtained. The Scottish Aberdeen Angus beef cattle breeds produce a high quality meat through intensive feeding methods. Poor feeding however, directly causes poor quality of animal product which the skin is not exempted.

It has been noted theoretically and empirically that majority of such animals dependable for leather fall within quadrupedalism, that is, a form of land animal locomotion using four limbs or legs. Animals moving in a quadrupedal manner are termed quadruped, meaning "four feet" (from the Latin *quad* for "four" and *ped* for "foot"). Most walking animals are quadrupeds, including mammals such as cattle and cats, and reptiles, like lizards. The mode of movement is critical to the feeding patterns of most animals irrespective of the ecology. Because of the size and weight of their complex digestive systems, many bovids have a solid, stocky build – the more gracile species tend to have more selective diets, and be browsers rather than grazers (http://en.wikipedia.org/wiki/Grazer). For this reason, the vegetation in which such animals are raised is a concern.

2.4.18 Principles of Abattoir Practices and Hide and Skin Quality

The most direct means of obtaining hides needed for leather manufacturing is the local butcher, although hunting, trapping or raising one's own livestock cannot be overlooked (Back to Basics of Reader's Digest, 1981). However, it is this same place that skins and hides, due to various reasons, may lose their economic qualities for leather manufacturing. It has been appreciated by writers including Procter (1923), De

Haas (1925), O’Flaherty et al., (1956), Bienkiewicz (1983), Heidemann (1993), Gerhard (1996), Sharphouse (1995), and Sarkar (2005) that the place of slaughter results several defects in the skin leading to reduction in quality. The first edition of 1998–11–01, reference number ISO 282–1:1998(E), part of ISO2822 recognises some post-mortem defects which occur to raw cattle hides at the slaughter centre.

In principle, since the leather industry depends on the meat industry and priority is given to the meat than the skin, the value of the carcass, according to Sharphouse (1995), is often ten times the value of the hide or skin, and this ratio governs the degree of care given in flaying to the hide and to the carcass. Although the emphasis on slaughtering is bleeding, poor bleeding results in blood clotting in the skin vessels and leads to accelerated microbial putrefaction (SLTC Pocket Book (1999). To avoid attack from micro-organisms, the slaughter centre should ensure that the animal is in a clean, dung-free, healthy condition and the slaughter should be rapid and efficient. For this reason, flaying should be carried out while the animal is hoisted by the hid shanks on a transporter rail.

2.4.19 Impact of Flaying on Hides and Skins Quality

Flaying as a process in relation to the production of quality leather is a major concern which cannot be overemphasised. Principally, good flaying is carried out such that the economic potentials of the skin are preserved. The process therefore means a lot to the tanner and holistic stakeholders of the leather industry, especially when the production of quality leather to meet specific demands is in question (O’Flaherty et al., 1956). Though the hide or skin is known to be a by-product of the meat industry, its further applications are uncountable; outstanding among them is converting it into leather by the tanning process which raises the economic value of the pelt enormously and creates a chain of employment for several people. The above economic reasons render the removal of pelts imperative and flaying technology impeccable (Reader's Digest; Back to Basics, 1981; Kite and Thomson, 2007).

The object of skinning is to remove the animal's pelt cleanly, neatly, and with minimum damage or none to either the hides or fur. This intention makes it possible for full utility and enhances further applications including leather making, drumheads, lashings, saddles, knife handles, sandals, snowshoe thongs, and leather, to mention but a few. Since any damage caused tarnishes the quality status of the material, expertise is prerequisite to flaying. According to Back to Basics of the Reader's Digest (1981:30), to skin an animal perfectly requires experience. It explains further that for the first time, one is almost certain to damage the hide by slicing too close or else by cutting too cautiously and leaving large chunks of flesh that will mean extra work during the fleshing operation. According to ISO2822 description of defects, poor flaying may lead to defects such as gouge marks, holes, cuts, scratches, scores, poor trimming and bad shaping of the skin. Sharphouse (1995) advises that flaying is much easier while the carcass is warm and since heat is lost rapidly the chances of putrefaction is reduced.

2.4.20 Principles of Flaying Quadruped Animals

Through domestication and husbandry, most of the animals forming the bulk source of skin and hide supply are known to be quadrupedals and flaying such animals follow laid down procedures to guarantee the maintenance of the economic relevance of hides and skins (Sharphouse, 1995; Boahin, 2005). Most oxen, calves, horses, buffaloes, sheep and goats are flayed by making ripping cuts in the skin only with a pointed knife. The legs are severed at the knee joint and the ripping cut should be up the inside of the leg. The skin is peeled away from the belly line with round-bladed knives, which minimise the danger of cutting either the skin or carcass in the belly areas. The legs are then flayed. The beast should be hung up by the rear shanks and the skin pulled or punched away from the carcass with as little use of the knife as possible. Machines are available for this purpose which grip the edges of the skin and pull it away from the carcass. They do not only reduce the manual effort required but give a cleaner operation, either by a downward pull or by an upward pull.

Especially in the case of smaller animals, compressed air may be blown into the zone between skin and carcass through a small hole made in the hind shank, thus facilitating removal of the skin. O'Flaherty et al., (1956) and Sharphouse (1995) caution that as soon as the skin is removed from the carcass it should be taken from the slaughter-house floor where it is always a potential source of infection of the carcass by dirt, dung and bacteria with which it is contaminated. In good abattoirs it is immediately removed and washed in plentiful supply of cold water to remove dirt, blood, etc., and to cool it. It is then drained and cured for preservation to maintain all its leather properties.

2.4.21 Theories and Principles on Curing and Preservation of Raw Hides and Skins

To ensure continuity of life, bodies of living organisms have been programmed by nature to begin decomposing shortly after death, through a cascade of processes that go through distinct phases. The process is essential for new growth and development of living organisms because it recycles the finite matter that occupies physical space in the biome. It may be categorised in two stages by the types of end products. The first stage is characterised by the formation of liquid materials; flesh or plant matter begins to decompose. The second stage is limited to the production of vapours. The animal's carcass as a biological or organic material is susceptible to decomposition as a result of microbial activities; and the skin being a system of organic tissues of proteins, lipides, some carbohydrates, inorganic salts and water is not exempted (Mader, 1994; Fritz et al., 1999; Hougham,2006).

Relentless efforts by researchers into skin preservation and protection have revealed that any microbial attack on the skin as a result of poor preservation is possible to render it less useful for the production of leather possessing desirable qualities. Curing, by SLTC definition is a temporary treatment of the hide/skin so that micro-organisms cannot break it down for food. It has therefore been proposed that skins, when flayed must be preserved as soon as possible so that all of its leather potential are retained or protected against the action of micro-organisms and autolytic enzymes as well as chemical hydrolysis (Wilson, 1923; Sharphouse, 1995; SLTC Pocket Book, 1999). The preservation process according to O'Flaherty et al., (1956) is accomplished by process of removing moisture or by replacing moisture; however, water is dehydrated in each case. Salting or drying or both are employed to dehydrate water from the skin, and once water is dehydrated and temperature made unfavourable, microbial activities are reduced drastically. In principle, curing skins and hides intended for leather production is for the following purposes:

(1) To prevent putrefaction,

(2) To prepare or stabilise the raw material for transport (local or international),

(3) To prepare or stabilise the raw material for storage,

(4) To lower the weight for transport and/or storage.

The preservation methods mainly employed are categorised under, Dehydration, thus, drying: sun drying, shade drying, shed drying; or Salting: wet salted, dry salted, raceway brining, drum, brining; or Refrigeration/Cooling: Chilling. Toxicity: Antiseptic, Radiation and Partial Processing: Pickling, Wet blue, "Wet white" are other modern acceptable approaches to pelt preservation.

2.4.22 Principles of Putrefaction and Deterioration of Organic Fibres

Theoretically, the principles regarding the breakdown of biological or organic bodies have attracted several authors and researchers as a result of the enormity of relevance of the subject to various fields of life. In Forensic Anthropology and Medicine, it is dependable for studying Complementary Sciences from Recovery to Cause of Death; in Modern Mummification, it has been employed to study the Preservation of the Human Body in the Twentieth Century; and in Forensic Taphonomy, it has been important to the study of Postmortem Fate of Human Remains.

In leather technology, due to the undesirable impact of autolysis on skins and hides meant for leather production, much attention has been given to the area. Consequently, accounts of research findings on decomposition have led to the discovery of curing methods and techniques relevant for sustainable fresh skin and hides requisite for the production of quality leather (Sharphouse, 1995; Bienkiewicz, 1983). The activities of Leather making therefore typify a fight against the action of autolysis. Adequate knowledge on decomposition then becomes imperative to the curer, and the tanner, and is also necessary to the acquisition and processing pelt into leather (O'Flaherty et al., 1956).

Etymologically, the Greek word *taphos,* which means *grave*, emanated from the word *taphonomy*, that is the science which generally studies decomposition. In

1762, *de-* + *compose*, suggesting the sense of "putrefy" was first recorded and affirmed by researchers in 1777 (Online etymology Dictionary, 2001-2010).

Organic materials such as forest and animal products (wood, bamboo, rattan, meat, milk, to mention a few), are liable to deterioration by biological organisms. Oteng-Amoako (2006) has stressed that different types of biological organisms, including fungi, borers and termites can cause varied deteriorations in organic materials. However, bacteria cannot be left out, especially when putrefaction of animal products such as skins and hides are being discussed. Generally, the length of time any organic material will last in service depends largely on many factors, including the type of hazard that the material is exposed to. Wikipedia, the free encyclopedia says that a dead body that is exposed to the open elements, such as water and air, will decompose more quickly and attract much more insect activity than a body that is buried or confined in special protective gear or artefacts. Oteng-Amoako (2006) again adds that apart from the above causes, biological materials can also be destroyed by chemical and physical agents. Identification and knowledge about the organisms and conditions that cause deterioration and the causation of the ultimate destruction of skins and hides is crucial to skin/hide preservation for the purpose of leather making. Different types of compounds decompose at different rates. This is dependent on their chemical structure.

2.4.23 Decay and Decomposition Theory

The theories on decay and decomposition mostly surround key words such as deterioration, disintegration, putrefaction, rotting, breakdown, lose quality, go bad, go off, atrophy, degeneration, waste away, crumble, fading, to mention a few. Influence from any of such actions is tantamount to causing defects, hence, reducing the relevance of the skin for leatherwork. Decomposition begins at the moment of death, caused by two factors: autolysis, the breaking down of tissues by the body's own internal chemicals and enzymes, and putrefaction, the breakdown of tissues by bacteria. These processes release gases that are the chief source of the unmistakably putrid odour of decaying animal tissue.

According to Bienkiewicz (1983) and Sarkar (2004), most decomposers of pelt are bacteria or fungi. Scavengers play an important role in decomposition. If the body is accessible to insects and other animals, they are typically the next agents of decomposition. Decomposition which in this study is best represented by 'putrefaction,' is the process by which tissues of a dead organism break down into simpler forms of matter. The progression of decomposition of the flesh of the dead organisms and carcasses has been viewed also as four phases:

1. Autolysis (fresh)
2. Putrefaction (bloat)
3. Decay (putrefaction and carnivores)
4. Diagenesis (dry)

Autolysis (fresh): The fresh stage of decomposition of biological bodies occurs during the first few days following the death. There are no physical signs of decomposition during this time. However, homeostasis of the body would have ceased, allowing cellular and soft tissue changes to occur as a result of the process of autolysis; the destruction of cells and organs due to an aseptic chemical process. At this point, the body enters algor mortis, the cooling of the body's temperature to that of its surroundings. When the body's cells reach the final stage of autolysis, an anaerobic environment is created, that is, an environment wherein oxygen is not present. This allows the body's normal bacteria to break down the remaining carbohydrates, proteins, and lipids. The products from the breakdown create acids, gases, and other products which cause volatile organic compounds (VOCs), and putrefactive effects. VOCs are produced during the early stages of human decomposition.

Putrefaction (bloat): Odour, colour changes, and bloating of the animal's body during decomposition are the results of putrefaction. The lower part of the abdomen turns green due to bacteria activity in the cecum. Bacteria break down haemoglobin into sulfhemoglobin, which causes the green colour. A formation of gases enters the abdomen which forces liquids and feaces out of the body. The gases also enter the neck and face, causing swelling of the mouth, lips, and tongue. Due to this swelling and misconfiguration of the face, identification of the body can be difficult. Bacteria also enter the venous system causing blood to hemolyse. This leads to the formation of red streaks along the veins. This colour soon changes to green, through a process known as marbelisation. It can be seen on the shoulders, chest and shoulder area, and thighs. The skin can develop blisters containing serous fluid. The skin also becomes fragile, leading to skin slippage, making it difficult to move a body. Body hair comes off easily. The colour change of the discoloration from green to brown marks the transition of the early stage of putrefaction to the advanced decomposition stages.

Black putrefaction: After the body goes through the bloating stage it begins the black putrefaction stage. At this point the body cavity ruptures, the abdominal gases escape and the body darkens from its greenish colour. These activities allow for a greater invasion of scavengers, and insect activity increases greatly. This stage ends as the bones become apparent, which can take anywhere from 10 to 20 days after death depending on region and temperature. This period is also dependent on the degree to which the body is exposed. During the black putrefaction stage of decomposition, insects can be found living in the body. The types of insects will differ based on where the body is, although Diptera larvae can be found feeding on the body in almost all cases.

Butyric fermentation: After the early putrefaction and black putrefaction phases have taken place, the body begins mummification, in which the body begins to dry out. The human carcass is first mummified, and then goes through adipocere formation. Adipocere (grave wax) formation refers to the loss of body odour and the formation of a cheesy appearance on the cadaver. Mummification is considered a post-active stage because there is less definite distinction between changes and they are indicated by reduced skin, cartilage, and bone. Mummification is also indicated when all of the internal organs are lost due to insect activity.

Dry decay: When the last of the soft-tissue has been removed from the body, the final stage of decomposition, skeletonisation, occurs. This stage encompasses the deterioration of skeletal remains, and is the longest of the decomposition processes. Skeletonisation differs markedly from the previous stages, not only in length, but in the deterioration process itself. The strength and durability of bone stems from the unique protein-mineral bond present in skeletal formation. Consequently, changes to skeletal remains, known as bone diagenesis, occur at a substantially slower rate than stages of soft-tissue breakdown. As the protein-mineral bond weakens after death, however, the organic protein begins to leach away, leaving behind only the mineral composition. Unlike soft-tissue decomposition, which is influenced mainly by temperature and oxygen levels, the process of bone breakdown is more highly dependent on soil type and pH, along with the presence of groundwater. However, temperature can be a contributing factor, as higher temperature leads the protein in bones to break down more rapidly. If buried, remains decay faster in acidic-based soils rather than alkaline. Bones left in areas of high moisture content also decay at a faster rate. The water leaches out skeletal minerals, which corrodes the bone, and leads to bone disintegration.

2.4.24 Factors Affecting Deterioration by Bacteria

Once death occurs, human decomposition takes place in stages. The process of tissue breakdown may take from several days up to years. Bacterial growth and microbial activities on organic materials such as skins and hides require the support of some preservative media or agents (Bienkiewicz, 1983; Sharphouse, 1995; Oteng-Amoako, 2002 and Sarkar 2004).

1. *Ambient temperature*: Ultimately, the rate of bacterial decomposition acting on the tissue will depend upon the temperature of the surroundings. Colder temperatures decrease the rate of decomposition while warmer temperatures increase it. *Warmth* determines the speed of organic material decay, with the rate of decay increasing as heat increases, e.g. fresh skin in a warm environment will decay over a shorter period of time.

2. *Water or moisture* is another factor that promotes bacterial growth and activities.

The theoretical review of decomposition and its related processes is directly related to curing of fresh skins and hides to maintain their leather production potentials and also maintain their quality status.

2.4.2.5 Leather Making Principles and Theories

The craft of tanning, according to the Reader's Digest 'Back to Basics' (1981), is older than civilisation itself, and chemical tanning existed at least 5, 000 years ago. In tracing the point of origin of leather making, its universal recognition and acceptance, one is likely to come across various opposing schools of contemplation. However, numerous accounts on leather processing attest that tanning came about as a result of the prehistoric man's realisation of skin's abilities and durability – in comparison to broad leaves and tree barks which he had earlier discovered – which galvanised his desire to condition the skin of the animals he hunted into a material convenient to wear on his body for protection against harsh weather and unfavourable environmental conditions (The Reader's Digest, Back to Basics, 1981).

In the arena of leather science and technology, tanning has attained extensive research attention; key among them is found in Wilson (1923); O'Flaherty et al., (1956); Bienkiewicz (1983); Heidemann (1993); Sharphouse (1995); SLTC Leather Technologists Pocket Book (1999) and Kite and Thomson (2006). According to Thorstensen (1976), artefacts made of leather or more properly, of cured animal hide (from mammals, reptiles, birds, even some fish), most conveniently fall into four categories of tannage. Non-tanned leathers include rawhide, parchment, and vellum. Semi-tanned leathers are oil-tanned or alum-tawed, wherein the skin is simply soaked in either oil or potash alum. Native-tanned leathers include smoke-tanned and brain-tanned, and fully-tanned leathers are tanned with extracts of plants (vegetable tannage) or with salts of metals (mineral tannage). Factually, leather's industrial and domestic decorum as well as its versatility are inherent the natural integument of the skin, however, the manufacturing techniques and skills employed by the tanner cannot be overemphasised.

Proctor (1923), states that the object of tanning is to render animal skin imputrescible and pliable. Ward (1977), feels that even Procter's description does not give proper or adequate criteria of leather. He considers the process of tanning to be prudently directed to *Imputrescibility* and *pliability* which he believes are perfect criteria since leather is by no means permanently imputrescible. Meanwhile, O'Flaherty et al., (1958) state that leather differs from pelt based on justification that it does not putrefy and is stable to temperature. Pelts when turned into leather, exhibit satisfactory properties such as softness, pliability, hardness, mouldability, suppleness and good strength properties which justify the intended purpose for which it was made (Gerhard, 1996). To render the animal skin into leather with economic implications and industrial utility, leather chemists and technologists including Wilson (1923), O'Flaherty et al., (1958), Bienkiewicz (1983) and Sarkar (2005) agree that tanning is directed primarily at the dermal layer, specifically at the collagen fibrils. Chemically, it fixes the ionisable side groups of the collagen fibrils by increasing hydrogen bonding between collagen molecules. This links the open network of fibres, leaving the leather pliable, and occupies all areas that otherwise would allow the leather to rot.

2.4.26 Tanning Processes and Purposes

Tanning is basically a stage in leather production where pelts turn into leather after they have been subjected to tannages which could be vegetable based or mineral based. Tannins are natural chemical products found in certain parts of trees such as chestnut, oak, and hemlock, using the bark, wood, leaves, and fruit. In indigenous small scale tanneries, the tanning process involves the skins being moved through a series of vats. The first vat will have a weaker solution of tannin than the final vat. Hides are placed on frames and hung in vats of tannin, which is where 'tanning' got its name. According to Wilson, (1923) O'Flaherty et al., (1958) and Sharphouse (1995), in a generic local or industrial tannery, production processing activities are in three main stages before a leather possessing the requisite properties for its end use is obtained.

1. Beamhouse Operations

The activities carried out are set of operations particularly aimed at removing unwanted parts of the pelt for tanning. Irrespective of the condition in which the skin/hide enters the tannery, soaking is the first major process to carry out in water to result cleaning and purposely rehydrate the pelt (O'Flaherty et al, 1956, 1958). Liming which leads to swelling and opening up of the skin fibres, as well as cause depilation of the pelt is accomplished by immersion in a bath of saturated lime and "sharpeners" which may be sulphides, amines or reducing agents. Deliming and bating as recorded by Sharphouse (1995) depend on ammonium salts with proteolytic enzyme at elevated temperature to cleanse the pelt from liming chemicals, deswelling, and reduction of pH to support the subsequent process. Pickling which is usually performed prior to chrome tanning of pelt is performed in a bath of salt and acid to neutralise the residual lime and set the right pH requisite for tanning (Sarkar, 2005).

2. Tanyard Operations

These are a set of operations in the tanyard aimed at converting the pelt into leather. Tanning is carried out at the tanyard for the following functions. First of all, it is performed to stabilise the collagen fibres of the skin or hide to temperature. Secondly, the tanyard activities are carried out to stabilise collagen fibres to prevent putrefaction of the raw material. Again, Sharphouse (1995) states that the operations are aimed at introducing the properties required in end the product. Lastly, to prepare the material as basis for other chemicals during further treatments.

Tanning chemicals used as main tannages include: Chromium tanning salts, Zirconium tanning salts, Vegetable tannins e.g., Replacement/phenolic syntans, Glutaraldehyde, Aluminium tanning salts. According to O'Flaherty et al, (1956); Bienkiewicz (1983); Sharphouse (1995) and Sarkar (2005) any tannage employed renders a specific shrinkage temperature to the collagen fibres of the leather as follows: i) Chromium: >100ºC ii) Aluminium:~75ºC iii) Glutaraldehyde: ~75ºC iv) Vegetable: 75-85ºC

3. Finishing Yard Operations

Generally, post-tanning techniques are carried out after the tanning process to induce additional properties desired in the leather to make it more applicable for the intended utility. Finishing, as expressed by O'Flaherty (1956), Bienkiewicz (1983), Sharphouse (1995) and Boahin (2005) is a requisite process performed to give a final touch to the leather to improve its aptness for the intended purpose. Through finishing activities extra properties such as softness, flexibility, water resistance, abrasive resistance, grain correction and aesthetic appeal can be upgraded to make the leathers much more useful (Landmann, 2003; Sarkar, 2005). After tanning, leathers are frequently dressed, or treated with fatty substances through tumbling, to improve their flexibility and resistance to water and wear. Heavy-weight vegetable-tanned leather is curried with cod oil and tallow, worked in mechanically. Alum-tawed leather is stuffed with flour, egg yolk, or oils. Chrome-tanned leather is filled by fat-liquoring with an emulsion of sulphated oil and water. As a result of tanning and dressing, leathers are acidic, although the degree of acidity is determined by the specific tannage and dressing, achieving the correct pH in the finished product. According to O'Flaherty et al. (1958), Wilson (1923), De Haas (1925), and Thorstensen (1976), it is necessary to maintain the stability of the tannage and the collagen. Any process carried out as part of finishing takes precaution of that.

Good finishing plays a major role in the quality and the utility of leather as a material for garment, shoe upper, clothing accessories, bags, upholstery and decoration. Sharphouse (1995) emphasises that appropriate finishing improves leather's value, suitability, durability and market penetrative ability. According to Caroline Leather Works of Fleecewood N.C (2008), "Like a fine wine, a good quality leather garment should improve with age". Though the natural elasticity of each hide means it is flexible and will stretch and return to its original shape, a desirable fashion effect is attained through finishing. Guthrie-Strachan (Leather Science Lecture Notes, 2008, BSLT, UK), adds that finishing aims at enhancing appearance and introducing desirable properties – these two major functions become possible in shoe upper, upholstery and garment leather through the application of category of finishing chemicals such as resins, protein binders, fillers, handle modifiers and auxiliaries (cross linkers). The resulting leather may be full grain for aniline or semi aniline or corrected grain (pigmented), depending on the grain quality

2.4.27 Theories and Principles of Quality Standards and Quality Assurance in Leatherwork

Quality standards and assurance, despite the numerous explanations and applications in diverse spheres of mankind's endeavours, are theoretically rooted in the expression of concern to value life as a basic requirement to exist. In every humanistic civilisation, once the quality of any aspect of human life becomes a concern, setting standards for measurement becomes critical. In history, Fiero (1995) opines that the Ancient Greeks because of their deep concern with the value and quality of human life put up standards to measure how much acts assured competence to meet the diverse needs of time, and this was expressed in their art, literature and even religion. They therefore established standards to assure quality at various stages namely: Archaic, Classical and Hellenistic (Amenuke et al., 1991).

As an abstract word, thinkers have always found it unwise to represent quality in a confined definition. However, its meaning and implication in a particular field gives it a definition. From research perspective, Gummesson (1936) refers to quality as the choice of criteria used for assessment. From his experience, he sees the selection of criteria as arbitrary and difficult to apportion weights to the criteria and then add them up to produce a final assessment. However, assessment of quality becomes a problem since he sees ambiguity in the lists of quality criteria for the assessment of a research activity such as reliability, validity, objectivity, relevance.

The Times Newspapers Ltd and MBA Publishing Ltd (1995-2010) posit that quality is a momentary perception that occurs when something in our environment interacts with us, in the pre-intellectual awareness that comes before rational thought takes over and begins establishing order. Judgment of the resulting order is then reported as good or bad quality value. When good quality value exceeds the bad, it is seen as positive and a progress is said to have been made. However, when the bad value supersedes the good, effort is made to rectify the situation. In a similar manner, the quality digest, (http://www.qualitydigest.com/html/qualitydef.html), defines quality as fundamentally relational and it is the ongoing process of building and sustaining relationships by assessing, anticipating, and fulfilling stated and implied needs. The American Heritage Dictionary, (1996) also defines quality as an inherent or distinguishing characteristic, a degree or grade of excellence. Quality leather or leather artefact can therefore be explained as an error-free, value-added care and service that meets and/or exceeds both the needs and legitimate expectations of its aesthetic and utilitarian end uses.

The International Standards Organisation (ISO) exists purposely to protect quality and ensure 'fitness for purpose'. The ISO considers Standardisation as establishing and applying an agreed set of solutions intended for repeated application directed at benefits for stakeholders and balancing their diverse interests (http://en.wikipedia.org/wiki/Quality_(philosophy). According to Halliwell and Lambert (2004), the organisation has ISO 9000 which is regarded as the internationally agreed set of standards for the development and operation of a quality management system (QMS). ISO 9001 AND ISO 9002 are international standard for quality management systems representing the mandatory parts of the ISO 9000 series which specify the clauses manufacturers have to comply with in order to achieve registration with the standard. When a firm is certified to International Standard ISO 9001, the certificate indicates to potential customers that the organisation has continual improvement processes in place for the specific purpose of enhancing customer satisfactions. From this, consumers can reasonably infer that such businesses are able to deliver the promised quality product or service consistently.

However, since quality is achieved and maintained not by doing different things but by doing things differently and consistently, therefore, the manufacture/distribution of a product/service which provides both tangible(quality product/service) and intangible (customer satisfaction) value to the internal and external customer, attainment of set quality standards requires a carefully planned and systematic action or execution necessary to exceed the customers' product or service expectations in the leather by delighting them. Internationally, the production of leather follows the process which is described as Total Quality Management (TQM), and it seeks to follow tentative actions towards achievement and maintenance of quality leather consistently. Three stages in the development of quality are identified as: 1. Quality control 2. Quality assurance 3. Total Quality Management.

1. ***Quality Control is an old idea***. It is concerned with detecting and cutting out components or final products which fall below set standards. This process takes place after these products have been produced. It may involve considerable waste as defect products are scrapped. Quality control is carried out by Quality Control Inspectors who inspect every aspect of production to ensure safe delivery of products and services. Inspection and testing are the most common methods of carrying out quality control.

2. ***Quality Assurance*** **(QA)** occurs both during and after the event, and is concerned with trying to stop faults from happening in the first place. Quality assurance is concerned to ensure that products are produced to predetermined standards. The aim is to produce with 'zero defects'. Quality assurance is the responsibility of the workforce, working in cells or teams, rather than an inspector (although inspection will take place). Quality standards should be maintained by following steps set out in a Quality Assurance system

3. ***Total Quality Management goes beyond quality assurance***. It is concerned with creating a quality culture, so that every employee will seek to delight customers. The customer is at the centre of the production process. Companies such as BIC and Audi have been following this policy for a long time. It involves providing customers with what they want, when they want it and how they want it. It involves moving with changing customer requirements and fashions to design products and services which meet and exceed their requirements. Delighted customers will pass the message on to their friends (http://thinkexist.com/dictionary/meaning/quality/).

2.4.27.1 Implications of Quality Assurance on Leather Artefact Processing and Marketing

Operationally, the word "quality" as expected in leather represents Conformance to Customer Specified Requirements (CCSR) in terms of properties prerequisite for specific end uses and applications to augment the inherent value of the product (Gerhard, 1996). This is achieved by meeting or exceeding established process guidelines so that, regardless of the type of leather produced, a consistent outcome can be predicted. This requires the provision of adequate confidence consciously instilled in the leather to satisfy given requirements. Sharphouse (1995) adds that meeting such standards has massive implications in customer acceptance, receptiveness and application of the leather in any utility.

2.4.27.2 Basic Quality Standards Tests for Leather

Quality is abstract and hard to open to one definition. However, as far as the global leather industry is concerned, different needs are expected in leather by different users at different costs. In order to indicate the level of performance as required in leather by diverse countries and races and to settle disputes, “quality” is all about measurement of properties prerequisite to a particular leather need. Testing quality standards of leather is dependable on accepted Official Methods for analysing the properties, either physical or chemical (O’Flaherty et al., 1965)

Society is the originator of the "Official Methods of Analysis" which are in accord with ISO and various countries’ guidelines. These methods are updated regularly with international approval and they remain the methods used to settle disputes about specifications. On that basis, quality assurance is measured through subjecting samples from a batch of leather meant for a particular end use to a set quality standards tests for that particular end use. The tests may aim at determining the performance of the physical or chemical properties of the leather. Nevertheless, it is the performance recorded that determines the level of acceptance of the leather for the intended purpose. There are varied standard tests meant for diverse purposes.

2.4.27.3 Basic Principles and Standards of Skins, Hides and Leather Testing

Even for one category of leather, however, every substantial difference in properties in samples are observed in practice so that inter-laboratory comparisons are not readily made particularly, as many properties vary with the location of the material of the test samples on any animal slain. So any attempt to establish physical relations and laws requires statistical planning and intensive replication of measurements.

Unlike most textile materials, the fibre structure of skin and leather exhibits little regularity. Pronounced differences in fibre structure are observed as one proceeds from the outer epidermal surface, through the grain layer to the main fibrous structure of the remainder of the skin. So theoretical studies relating properties to structure are made difficult and the extensive work on the structure and properties of textile materials carried out by textile physicists or engineers can only rarely be used as a basis for work within leather.

This embodiment of knowledge (research) cannot attempt a comprehensive review of the whole subject of leather properties in relation to the manufactory of materials categorised as containers, upholstery, clothing and decoration; the researcher has therefore investigated and considered manufactory suitability of the locally made leather in terms of properties as a case study in order to generalise the findings to illustrate or explain why the material is unsuitable for specific production of artefacts.

In testing leathers for fitness of properties for intended purpose of manufacturing, it is a principle that Official Sample in accordance with ISO2418.5 measurements should be taken and distributed. Sample prepared for other tests are cut into various standard shapes of specimens/samples. Three measurements to be taken are distributed across the sample. The material is made ready for tensile resistant test / tearing / elongation / aging /sample, and other tests by usually, conditioning the sample in a chamber of 65% humidity and 20 centigrade condition room before the leather is subjected for testing.

2.4.27.4 Some ISO Standard Criteria for Assessing Skins, Hides and Leather Quality for Economic Utility

Being an international commodity found on the stock market, leather and its allied businesses are governed by standards including the following:

1. ISO 2820:1974 leather Amendment 1:1996 to ISO 2820:1974 – Rawhides of cattle and horses –method of trim
2. ISO 2821:1974 –Presentation by stack salting
3. ISO 2822 –1:1998 –Descriptions of skin defects (cattle)
4. ISO4683 –1:1998 –Raw sheep skins –Descriptions of skin defects
5. ISO7482 –1:1998 –Raw goat skins –Descriptions of skin defects
6. ISO7482 –2:1999 parts 2; Guidelines for grading on the basis of mass and size
7. ISO7482 –3:2005 –Guidelines for grading on the basis of defects
8. ISO2419:2006 –physical and mechanical tests –Sample preparation and conditioning
9. ISO2420:2002 – physical and mechanical tests –Determination of apparent density.
10. ISO2588:1985 –Sampling number of items for gross sample
11. ISO2589:2002 – Leather – physical and mechanical tests –Determination of thickness.
12. ISO3376:2002 – Leather – physical and mechanical tests –Determination of tensile strength and percentage extension.
13. ISO3377 –1:2002 – leather – physical and mechanical tests –Determination of tear load. Part 1 and 2 (single edge and double edge)
14. ISO3378:2002 – Leather – physical and mechanical tests –Determination of resistance to grain crackling and area index

15. ISO3379:1976 –leather –Determination of distension and strength of grain – ball burst test.
16. ISO3380:2002 –leather – physical and mechanical tests –Determination of shrinkage temperature up to 100°c.
17. ISO22288:2006 –Leather – Determination of fibre resistance by the ramp flex method.
18. ISO2589:2002(E) Sampling and sample preparation
19. IS: 5914 – 1970: Method of physical testing of leather (flexing endurance)

2.5 Empirical Review

The overwhelming improvement which the global leather industry has witnessed since the industrial revolution in Europe and North America is unprecedented, especially, during the 19th and the 20th centuries respectively. The ubiquitous impact has made research activities in the area of leather production and utility gain adequate attention. It is vital at this juncture to analyse some of the results of research activities to build capacity for pragmatic problem solving approaches which employ theoretical bases. Areas such as the practical utility of leather and development of leather technology are in focus.

2.5.1 Inventions and Development of Leather Manufacturing Technology

The earliest tanning tool was flint, it was used to scrap off flesh; hair and flesh were removed by a curved blunt or sharp knife over a wooden beam. Leather was shaved to the required thickness with a sharp knife. Such hand tools were improved constantly. Machines were introduced in the early 19th century; a splitting machine was invented in 1809 by Samuel Parker an American inventor. This machine allowed workers to make two skins out of one thereby doubling production. Until then it took one work man an entire day to divide four hides. Now he could split one hundred in the same length of time. Fleshing and unhairing machines were invented shortly afterwards. Manufacturers did not begin producing leather for a large market until the 1880s where leather became more widely available as the standard of living rose. As more cattle began to be consumed for meat, more hides became available for tanning. Augustus Schultz, an American dye salesman, invented a chrome tanning process in 1884. The method was perfected about 10 years later by Martin Dennis. Chrome tanning allowed more attractive and flexible leathers to be produced at a much faster rate (O'Flaherty et al, 1956, 1958, 1962, 1965; Sharphouse, 1995; Sarkar, 2005).

2.5.2 Some Research Results on Leather Properties in Relation to Utility

Research towards ensuring leather's dominance in utility among other materials has been massive over the 20th century till now. Landmann (2003) posits that the many uses of leather have largely relied on the range of mechanical properties which it can provide, according to the raw material employed in its manufacture and the manufacturing processes themselves. The contrasting behaviour of a stiff sole leather and of a fine gloving leather exemplify this point. The last twenty years have seen intensive investigation of many mechanical properties of leather and the design of test methods now accepted internationally.

At ambient temperatures and humidities most types of leather show mainly elastic behaviour, although delayed elastic effects may give the semblance of plasticity. The stress relaxation-time relation for constant linear strain shows the stress decaying linearly with log (time). The stress decay becomes discontinuous after sufficient time. The stress-strain relation for extension of leather strips is often markedly non-linear even at low strains (<2%). Two dimensional extension of leather has been analysed using an instrument allowing independent extension in two perpendicular directions. To a first approximation each stress component is linearly related to the two elastic strain components in the perpendicular directions.

According to O'Flaherty et al, (1956, 1958, 1962) and Sarkar (2005) research has shown that as with other materials of biological origin, the mechanical behaviour of leather varies from place to place in the skin, not only over its area, but also through its thickness. The extent of variation is briefly discussed and related to the underlying fibre structure.

Careful studies into the mechanical properties have shown that leather which has been strained and then subjected to either heat alone or heat and moisture, shows much more extensive plasticity than occurs at lower temperatures. This behaviour has been used to enable leather to be given appropriate shapes, as in the heat setting of upper leathers. Quantitative studies of heat setting are reported and the influence of such variables as temperature, moisture content of the applied air stream, the air stream velocity and the duration of treatment are discussed. The plastic deformation obtained in this way is contrasted with "run" in gloving leather.

A research by White (1999), has found out that to increase the use of exotic skins in the textile industry, physical properties must be identified by establishing appropriate test methods and techniques. Test results established a database from which appropriate textile end uses could be recommended. The purpose of this research was to determine appropriate testing techniques for emu skins. The skin was subjected to a series of textile and leather tests. Scanning electron microscopy served as a tool to relate mechanical to structural properties. Drape, an important property for apparel applications, was measured using bending, compression, shearing, and textile tests of Kawabata KES. Based on preliminary results, image analysis seems to be a promising technique to visually characterise the skin, and to evaluate abrasion resistance. Drape, important for apparel applications, was evaluated with Kawabata testing and resulted in data that would be useful to apparel designers and manufacturers.

When skin/hide stock is received at the tannery varying amounts of flesh are found adhered to the different areas of the skin, depending upon the skill exercised by the flayer. The flesh is composed of varying amounts of fatty adipose tissue, blood vessels, nerves and voluntary muscles which serve as a barrier to salt penetration and cause a poor cure. Strandine, DeBeukelaer and Werner, as cited in O'Flaherty et al., (1956), having studied the extent of the hindrance find that the salt solution penetrates rapidly through the flesh side of a properly fleshed skin or hide while it diffuses slowly through the grain side. They conclude that water passes very rapidly from both the hair side and the flesh side but if excess adipose is left on the flesh side not even water will pass through the fatty adipose much less the salt used for curing. Adequate fleshing is therefore an essential operation preceding curing (Sharphouse, 1995).

O'Flaherty et al., (1956) presents a study report on an unhairing process with hydrogen peroxide and amines *by Marsal*. In this work, the feasibility of an unhairing process with hydrogen peroxide and amines as an alternative to the conventional unhairing process is considered. A second order central rotatable design for two variables is applied to study the influence of both hydrogen peroxide and amine offers on the characteristics of chromed tanned leather. Likewise, the possible float recycling after protein precipitation and separation by filtration from the unhairing bath is considered. Subsequently, a study on the quantification of water consumption and analysis of the resulting waste water is carried out for a given hydrogen peroxide and amine offer.

Hoven (1999) as seen in O' Flaherty et al., (1958) also investigated leather processing and resolves that neutralisation, retanning, dyeing and fatliquoring when applied in compact formulations require a special selection of products and/or product combinations that are compatible. Such decisions do not only bear economical advantages such as time reduction, higher production capacity utilisation but also ecological benefits like saving of water. In addition to these advantages, the performance and the final use of leather should not be overlooked. The theoretical background for achieving satisfactory results and practical hints are discussed in this presentation. Special focus is given to upgrading of lower quality leathers.

2.5.3 Vegetable Tanning Materials and Extracts

According to Howes (1953), Sharphouse (1995) and Sarkar (2005) assert that the origin of vegetable tanning is hidden in the mists of antiquity; since it was discovered in the prehistoric times that the properties of pelts would undergo a radical change when they are brought into contact with the aqueous extracts of certain roots and herbs. The results from further vigorous studies as presented by Procter (1922), Wilson (1923), O'Flaherty et al, (1958), Tanning Extract Producers Federation of Switzerland (1974) and Sienkiewicz (1983) expose in-depth knowledge in the chemistry of vegetable tanning materials. Tannins are very widely distributed in the vegetable kingdom, and Howes (1953) notices that the number of plants that contain tannin is legion. He explains that tannins are mostly uncrystallisable colloidal substances with astringent properties and with the ability to precipitate gelatine from solution and to form insoluble compounds with gelatine-yielding tissues. It is this property which enables them to convert hides and skins into leather. Categorically, tannins are usually considered to consist of two groups – the hydrolysable tannins (pyrogallol group) and then condensed tannins (catechol group). It has become glaring that tannins extracted from plants quite frequently bear the characteristics of both groups: which are actually a mixture of pyrogallol and catechol tannins.

The hydrolysable tannins may be hydrolysed by acids or enzymes and include the gallotannins (from plant galls) and the ellagitannins which produce 'bloom' on the leather and which are characteristic of myrabolans, velonea and divi-divi to mention a few. The condensed or catechol tannins are not hydrolysable and are characteristic of most of the important commercial tanning materials such as Wattle or mimosa, quebracho, mangrove and hemlock. According to Howes (1953), they are more astringent (tan more rapidly) and have larger molecules, but are less well buffered than pyrogallol. In West Africa and most tropical countries, acacia plant species such as *Acacia senegal, Acacia nilotica*, *Acacia Arabica* and *Acacia Farnesiana* are widespread. The tannins present in these may be considered to be of a mixed nature (both pyrogallol and catechol tans).

2.5.4 Importance of the Review of Related Literature to the Study

The review of literature related to the subject area has been a learning exercise covering a broad horizon of the leather industry. Specifically, the theoretical and empirical reviews of documented information have been the focal points of the exercise. Subsequently, areas delved into include the historical overview of Leatherwork, the histology of pelt, properties of leather, leather production theories, domestication of animals, slaughtering operations, pelt preservation and leather manufacturing process from beamhouse operations to finishing, pelt and leather quality standards and physical properties tests. Since the commitment of this study dwells on finding alternative strategies to improve on the quality of leathers made locally, pragmatic and theoretical problem solving issues regarding pelt, leather and leather products have also been given attention.

The exposure to documented data regarding Leatherwork , has expanded the competence of the researcher in identification and assessment of concepts, ideas and approaches based on principles and theories regarding animal husbandry practices, abattoir practices, skins and hides preservation, pre-tanning, tanning, re-tanning and post-tanning (finishing) techniques. This gives adequate referential support and edging ability for the pursuance of the research objectives.

CHAPTER THREE

METHODOLOGY

3.1 Overview

This chapter expounds the research methodology which served as the structure for the procedures followed to congregate the expectations of this study to give a perspective of logical reasoning. It presents the research methods employed, the industrial and library researches conducted, the population for the study, sampling techniques and samples employed and the systematic application of research tools to obtain the data crucial to answer the research questions and achieving the set objectives.

3.2 Research Design

A systematic investigation to collect information on a subject to establish facts is what Twumasi (2001), Collins English Dictionary (2008) and Adentwi and Amartei (2009) regard as research. Cohen et al., (2007) assert that research design is governed by the notion of 'fitness for purpose', and the purpose of the research determines the methodology and design of the research. When choosing the appropriate research methods as means to reveal the truth regarding the nature of leathers tanned locally as a vehicle to galvanise the identification of alternative avenues to improve upon the economic value of Leatherwork in Ghana, the researcher prudently considered the major implications and impacts a chosen method of research could have on the nature of data to be collected in the resolution of issues regarding the aptness of the local leather and the causations of its defects. On that note, an architectural plan to serve as a procedure and general strategy for operationalising the research questions and the objectives towards solving the identified problem became imperative (Leedy & Ormrod, 2005; Cohen et al., 2007). Meanwhile, Gummesson (1936:11), realising this cautions that there are three main challenges of an academic research that one should be mindful of in selecting a method(s) for a particular study – access to reality, pre-understanding and understanding, and quality. He explains his concept as follows: *"Access refers to the opportunities available to find empirical data (real-world data) and information."*

Pre-understanding in Gummesson's view refers to people's insights into a specific problem and the environment of the problem before they start a research programme or assignment; this is the input. The understanding refers to the insights gained during a research programme/assignment; this is the output. This output in turn acts as pre-understanding before the next task. Regarding quality, he writes that researchers must be able to substantiate their findings and produce a report in which it is possible for the reader to follow a certain line of reasoning and resulting conclusions. He concludes that the research methods used are therefore considered to be of critical importance.

With the understanding of the above insightful caution, a careful consideration of the characteristic features of the various research methods has been carried out in relation to the composite nature of the research problem to be solved, vis-à-vis the characteristics of the varied intrinsic components of the phenomenon to be studied in a probing manner. This demanded, testing the efficiency of the local leather, assessing the level of deficiencies, investigating the causes and causations of the deficiencies from animal husbandry practices, abattoir practices, curing activities, leather manufacturing processes and technologies in relation to quality leatherwork, and finally, the proposal of alternative strategies to improve on quality. Consequently, it was imperative to collect data from multiple sources towards solving the research questions, hence, the employment of the triangulation approach, which is a mixed-method design in which both quantitative and qualitative data are collected to answer a single research question (Leedy & Ormrod, 2005; Cohen et al., 2007). The approach to answer research question two is a typical example. Both qualitative and quantitative research methods were therefore found paramount in this study, as complementary components of the research process.

Qualitative research as explained by Gummesson, 1991, Seale, 2004, Leedy & Ormrod, 2005 and Cohen et al., 2007, is a systematic approach used to answer questions about the complex nature of phenomena, usually with the aim of describing, analysing and interpreting insights discovered to understand the phenomena from his own point of view. In this study, since understanding of the nature of the leather made locally has been the focal point, the data needed had to cut across varied facets of the research problems to consolidate insightful facts to galvanise the proposal of the alternative strategies. The approach to data collection has reasonably been qualitative dominated, than quantitative; however, the quantitative method has been invaluable in dealing with the data statistically in the form of numbers, charts and averages. In the data collection, both research approaches have been employed in the following manner.

3.3 Case Study Research

A case study, according to Tryfos (1996); Leedy and Ormrod (2005) and Cohen et al., (2007), is a description of a real situation that lends itself to the application of methods and also invites reflection and provides an opportunity for discussion. In this study, the requisite qualities expected in leather for the production of artefacts such as footwear, upholstery, garment and clothing, and containers, as categorised by Boahin (2005, 2008), needed to be ascertained in the local leather by testing its physical properties for comparison with globally accepted quality standards. The researcher, nevertheless, resorted to experiments on the physical test standards for shoe upper as a case study.

In order to examine and ascertain the general suitability and quality standards of the Ghanaian indigenous vegetable tanned leather for specific applications in the four categories of leather products: upholstery, clothing, decoration and containers (Boahin, 2005; 2008), the researcher has found it appropriate to test the properties required in any leather for the production of such artefacts. However, since every end use of leather has its own established test standards and procedures, and as the researcher had restricted access to standardised equipment for other tests, he has resorted to the physical test standards for shoe upper leather as a case study; the footwear industry is known to be the highest consumer of the bulk of leathers manufactured globally (UK Leather, 2004), and the shoe upper leather stands prominent in footwear manufacturing. The results have been analysed and compared with the quality standards expected in any leather for other end uses.

3.4 Experimental Method

In a quantitative manner, the experimental method has employed mainly to gather data to answer research question one and also meet the demands of objective one, thus, a selected laboratory tests have been conducted towards ascertaining the competence of the local leather as a material for the production of quality leather artefact at the industrial level in the country and beyond. However, the processes, measurements and results are explained vividly by the descriptive qualitative approach. Experiments well monitored should not be devoid of increasing efficiency, accuracy and precision of measurement when attempting to understand increasingly complex systems. The efficiency, accuracy and precision of equipment and specimens of leather have been checked with strict cognisance for validity and reliability during the experimentation of the physical properties of the local leather (Leedy and Ormrod 2005).

3.5 Cross-Sectional Survey

Survey is a careful scrutiny of a demarcated geographical area in order to have a comprehensive view of the nature and composition of the core natural conditions surrounding a particular phenomenon. To have a fair view of the causal reasons surrounding the poor quality state of the locally produced leather, a cross-sectional survey has been carried out to investigate the activities of animal husbandry systems and processes by which skins and hides are generated and turned into leather (Kumekpor, 2002; Cohen et. al., 2007). This was a means indispensable to make the participatory survey aspect of the study a reality. The researcher, in order to gather firsthand information through direct observation and interviews, travelled across five regions of the country to the various fields where animals are raised, marketed, slaughtered and flayed; skins and hides markets as well as local tanneries. It is important to state that the descriptive method of qualitative research has been used to describe sequentially the logical facts and ideas observed during the study. Specifically, it served as an invaluable tool in presenting a vivid perspective of the data collected, thus the processes and results of the experiments conducted for research questions one and two in relation to empirical concepts, ideologies, and theories to develop logical reasons and implications which have been translated into findings as basis for drawing and generalising conclusions.

3.6 Library Research

To have a good general overview of the research topic and develop the insight prerequisite to understanding the concepts, theoretical perspectives, empirical evidence and crucial references regarding the study area, the researcher conducted both theoretical and empirical review of literature related to the topic, and made judicious use of information from resources such as books, lecture notes, unpublished theses, pamphlets, catalogues, museums, the World Wide Web, academic presentations, editorials, journals and other periodicals. The following libraries were therefore visited:

1. Main Library, Kwame Nkrumah University of Science and Technology, Kumasi
2. Reference Library, Dept. of General Art Studies, KNUST, Kumasi
3. Main Library, University of Cape Coast, Cape Coast
4. Reference Library, Ghana Standards Board, Accra
5. Manhyia Palace Museum, Manhyia, Kumasi
6. University of Northampton Libraries, Park and Avenue Campuses, UK
7. Northamptonshire County Libraries, Town Centre and Kingsthorp, UK
8. Northampton Museum and Art Gallery, UK
9. Greater Manchester City Council Library, UK
10. Lewisham Council Libraries, Catford, Lewisham, UK
11. Bromley Council Library, Bromley, UK

12. Southwark Council Libraries, Peckham, Dulwich and Camberwell, UK
13. Westminster Libraries, Victoria, Central London, UK

3.7 Industrial Research

It is noteworthy to mention that the study commenced with a survey conducted in August 2006 to corroborate the level of industrial dependability on the local leather in Kumasi, Accra and Takoradi, which revealed the level of anecdotal and hostility the locally tanned leather faces at the industrial front in terms of utility, dependability and economic worthiness. Places visited included Victory Shoes in Kumasi, Makola footwear shops, Central Market footwear and bag making shops, Kumasi Central Market, Kpogas Furniture in Accra, upholstery shops at Angloga in Kumasi and Market Circle in Takoradi. The researcher also visited livestock farms, abattoirs and slaughter houses, local and industrial leather tanneries in Burkina Faso, Bawku, Bolgatanga, Tamale, Afram Plains, Kumasi and Accra and United Kingdom respectively. Besides, visits to the British School of Leather Technology, University of Northampton, UK, also exposed the researcher to modern approaches and cutting-edge technologies in leather processing, especially, in raw material treatment, tanning chemicals and their applications, as well as finishing approaches. Moreover, a trip to Northampton County Museum, Northampton in the UK was a magnificent exposure to antique utility of leather.

To really identify the conventional approaches to the use of the local leather, some master craftsmen were visited at the National Art Centres in Accra, Kumasi, Tamale and Bolgatanga in the Upper East Region. Lastly, consultations with animal science experts at the KNUST Animal Science Department, Veterinary specialists, abattoir specialists and tanners enhanced the researcher's knowledge and insights on concepts and principles related to indigenous leather making techniques, sources, types and uses of tanning materials, livestock breeds in the country, practices and purposes, and abattoir activities in Ghana.

3.8 Population for the Study

A population is the group to which the result of the study is intended to apply (Tryfos, 1996; Twumasi 2001; Leedy and Ormrod, 2005). Holme and Solvang, (1997) as quoted in Ofori, (2008) emphasise that it is of great importance to find the right respondents to get the right information for the attainment of research objectives. In this study the population have been found to be heterogeneous in nature, due to the multi-sectorial characteristics of the study. It comprised a large group of materials (skins, hides, leather, tannins), livestock animals (Capron group, ovine group, bovine group, equine), animal farming systems, markets (livestock markets, skin and hides markets), animal slaughter centres (abattoirs, slaughter houses, slaughter slabs), tanneries, livestock experts and consultants (leather tanners, animal scientists and veterinary officers).

The target population involves all stakeholders of the local leather industry. However, due to the heterogeneous nature of the population for the study, that is, the varied characteristics and geographical differences in their locations as well as the wide-ranging environment being studied, the population is reduced to make control and accessibility easy for the researcher to comprehensively assess the activities of the various target core sectors of the indigenous leather industry and correlate their impact on the producing leather with qualities prerequisite for specific industrial needs (Tryfos, 1996; Twumasi, 2001; Cohen et al. 2007).

3.9 Sampling Techniques Employed

According to Tryfos (1996), Twumasi (2001) and Cohen et al., (2007), the process of sampling makes it possible to limit a study to relatively small portion of the population. A sample is thus a subset of the population and consists of representative group of individuals, objects or events that form the population of the study. Since it was not possible to deal with whole target population due to accessibility, effort was made to sample a reasonable number of people, which gave a representation for the research. The multi-sectorial and heterogeneous nature of the population required the application of different sampling techniques to select the samples appropriate to represent the population for the various sectors of the study.

Random Sampling: was used for the selection of livestock as well as leathers for the experiments conducted.

Convenience Sampling: was used for the selection of farms, animal markets, slaughter centres, and experts such as tanners, animal scientists, and leather artists.

Cluster Sampling: Units areas of investigation comprising tanneries were grouped into clusters and five units of clustered tanneries were selected randomly for the study (Kumepkor, 2002).

Purposive Random Sampling: was used to select leather samples from areas such as Accra, Kumasi, Tamale, Bolgatanga and Bawku purposively for assessment; however, the leathers were selected randomly from the tannery sources.

Again, the purposive sampling technique was employed in selecting a total of ten experts in the fields of animal farming, animal science, veterinary officers, skin and hides dealers and tanners.

3.10 Sample Size for the Study

Table 3.1: Distribution of local vegetable tanned leather sampled for assessment

Total Quantity of Local Vegetable Tanned Leathers Sampled = 2000			
Tannery Sources of Leathers Assessed	Bovine Leather	Ovine Leather	Capron Leather
Malam Market Tannery	20	100	100
Asawase Tannery	100	200	150
Tamale Zongo Tannery	20	200	150
Bolgatanga	20	250	150
Bawku	20	100	100
Burkina Faso (Pougtinga)	20	150	150
Total	200	1000	800

Table 3.2: Distribution of livestock sampled for assessment

Total Quantity of Livestock Sampled = 2 500				
Livestock Group and Quantity Surveyed	Percentage Quantity %	Management System & Sample Size		
		Extensive	Intensive	Semi-intensive
Bovine group = 700	28%	350	100	250
Ovine Group = 850	34%	500	100	250
Capron Group = 850	34%	500	100	250
Equine & Hog Group = 100	4%	20	30	50
Total = 2 500	100	1 370	330	800

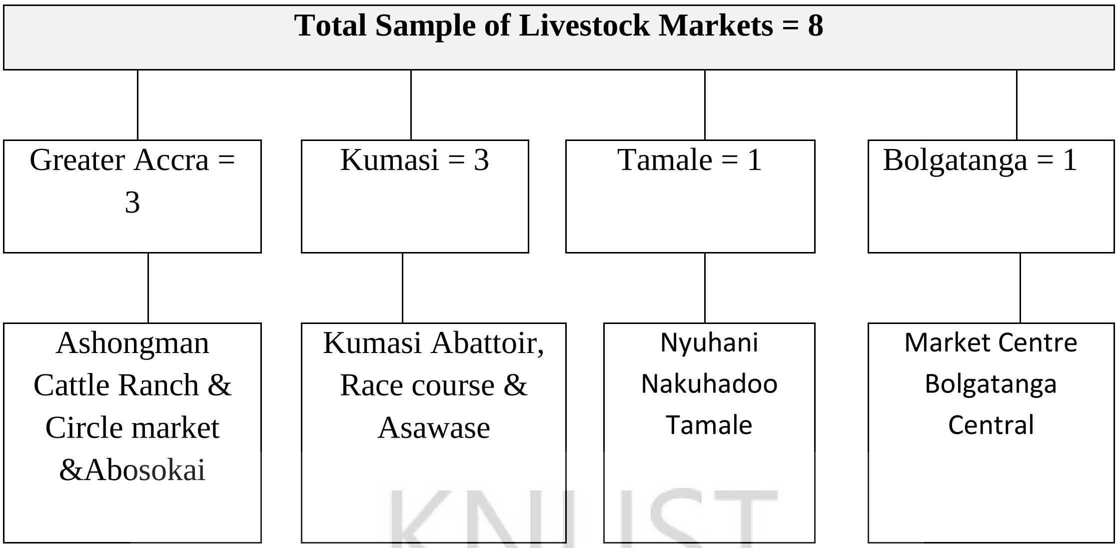

Figure 3.1: Distribution of livestock markets sampled for assessment

Table 3.3: Slaughter centres sampled for assessment

Total Sample of Slaughter Centres = 12				
Category of Slaughter Centres Surveyed	Greater Accra Region	Ashanti Region	Northern Region	Upper East Region
Abattoir	1	1		
Slaughter House	1	1	1	1
Slaughter Slabs	2	2	2	1
Total Distribution	3	4	3	2

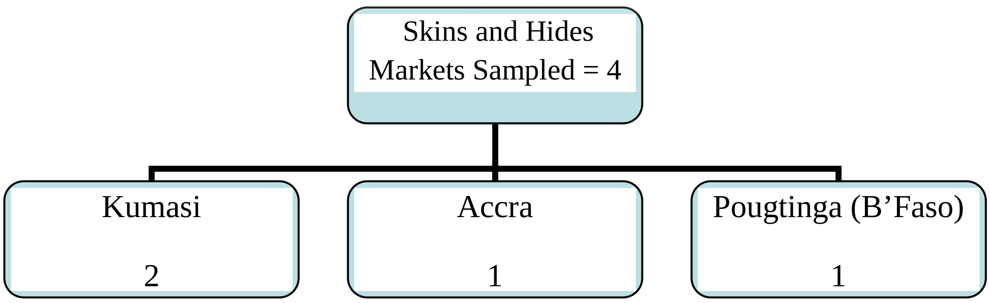

Figure 3.2: A Schematic diagram of hides and skins markets sampled for the study

Table 3.4: Distribution of indigenous tanneries sampled for the study

Total cluster sample of tannery locations selected in four regions = 5				
Greater Accra	Ashanti Region	Northern Region	Upper East Region	
1 Tannery	1 Cluster	1 Cluster	1 Cluster	1 Cluster
Malam Market	Asawase	Hausa Zongo Tannery	Bolgatanga	Bawku

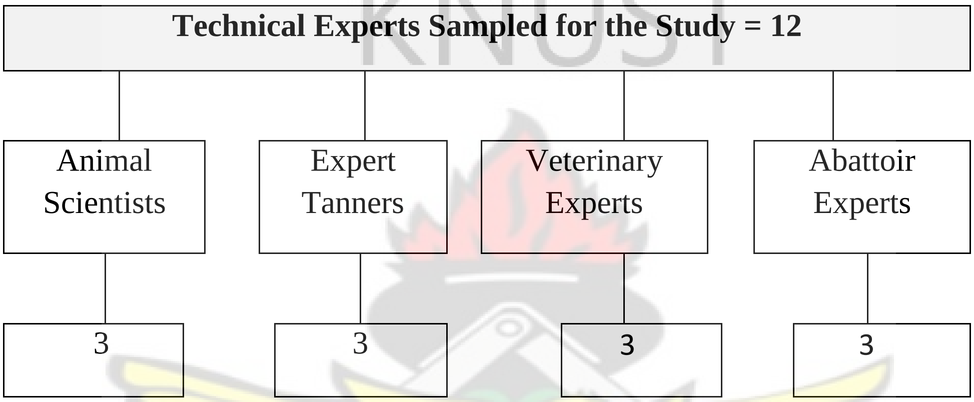

Figure 3.3: Schematic diagram of technical experts sampled for the study

3.11 Instruments for Data Collection

To facilitate and make the collection of data effective and more meaningful to answer the research questions and subsequently meet the demands of the set objectives for the study, and also draw astute conclusions upon which the researcher could base to propose insightful alternative strategies to improve upon the quality of Ghanaian indigenous Leatherwork; observation and interview were employed as instruments for data collection.

Direct Observation: To make on-the-spot observation of the phenomenon under study (Kumekpor, 2002; Cohen et al., 2007), the researcher directly participated in the laboratory experiments carried out to determine the quality standards and the general suitability of the properties of the local leather for the production of quality artefacts. Likewise, visits to livestock farms, ranches, livestock markets, slaughter centres, skin preservation yards, tanneries and leather markets to pursue the causal reasons behind the deficiencies found with the leathers examined gave the researcher the opportunity to make direct observation, and objectively record firsthand information from the activities of the respondents.

Interviews Conducted: As data observed were being recorded in a descriptive manner expected in most qualitative dominated research, the researcher used interviews harmoniously to seek further clarification of events observed through asking probing question in both formal and informal manners, since most of the respondents at the places visited could not read or write in English. Interestingly, that served as a mechanism of fraternisation between the researcher and the interviewees; and that was a great advantage to acquire the essential data for the study which included animal farmers, animal merchants, transporters, butchers, curers, hide and skin merchants, tanners and leather traders. It is necessary to mention that the connoisseurs, such as the veterinary, animal scientists, abattoir managers and leather experts were interviewed with a structured guide to obtain the requisite data to support the study.

3.12 Validation of Data Collection Instruments

In order to control bias and ambiguity, and ensure the objectivity of the data collected and to instil a high level of reliability, the validity of the instruments employed were measured (Cohen et al., 2007). In the first place, standardised instruments were used in the examination of the physical properties of the leathers and data recorded as observed. Also, to validate the reliability of the test process, the test-retest reliability method was employed where series of a particular test were conducted with seven specimens (Leedy & Ormrod, 2005).

In addition, the data recorded through direct observations and interviews were bounded with guides to regulate their directions. In the validation process, interview and observation guides and checklists were prepared based on the research questions and objectives of the study. Copies were made available to colleagues, peers, animal husbandry experts, veterinaries and leather experts for review and contributions. The constructive criticisms and suggestions received propelled a further modification of the interview and observation guides and checklists. A final vetting was conducted and endorsed by the supervisor for operation. Also, the researcher recorded information on the field as objective as possible with tape recorder (where necessary), camera and notes writing.

3.13 Sources of Data Collected

Two main sources of data were imperatively utilised in this study. These are Primary Data and Secondary Data.

3.13.1 Primary Data

These were indispensable data obtained through the application of the research tools employed: interview and observation. The physical testing laboratory of the British School of Leather Technology served as an invaluable resource for gathering primary data on the physical properties of the local leather. Experts and knowledgeable people were interviewed on the pertinent subjects of the research and their views were invaluable when interpreted in view of the objectives of the study. In pursuance of the causes and causations of the defects and deficiencies affecting the quality of the local leather, various observations were made and analysed to form integral part of the research findings, upon which the proposed alternative strategies of improving quality surrounded.

3.13.2 Secondary Data

From the various libraries visited, adequate secondary data related directly to Art Education, Leatherwork, animal husbandry, animal feeding in relation to skin quality, abattoir practices and quality standards, were gathered from several documented literary materials from sources such as: books, journals, encyclopaedias, catalogues, magazines, ISO pamphlets, tabloids and the internet. Sincerely, literature on indigenous Leatherwork technologies in Ghana was found fragmented and scanty, though some local researchers have made the effort to fill the gap. The researcher's experience at the British School of Leather Technology, University of Northampton readily facilitated direct access to related literature on general global home-grown leather making techniques, quality standards and testing methods of physical properties, mainly by international authors. On the local front, information from Boahin (1994; 2005; 2008), Atiase (2004), Amenuke (1995), Kumekpor (2002) and Adentwi & Amartei (2009) were of priceless value to the study. The secondary data served as referential pedestal for comparison of developed issues with existing theories, principles in the analysis of the primary data, findings and alternative strategies recommended.

3.14 Data Collection Procedure

To gather the primary data, the researcher transported a sample of locally made leathers to the British School of Leather Technology, University of Northampton UK and carried out laboratory experiments on the physical properties of the local to corroborate their general suitability for making leather artefacts. Since several deficiencies were found with the material, further investigations into the activities of livestock farming, abattoir operations and local tanning technologies were carried out to identify the causal reasons underlying the deficiencies. Interviews were carried out and observations were recorded for interpretation. To develop adequate insight into the subject area and also organise referential support, visits were made to some local and international libraries, and museums for secondary data. Interrogation of the causes and causations of the defects associated with the local leather, also made the researcher visit livestock farms, livestock markets, cattle ranches, abattoirs, tanneries, hide and leather markets, physical testing laboratory (British School of Leather Technology) to obtain the primary data.

3.15 Validation and Reliability of Data Collected

Leedy & Ormrod (2005) say that different research problems lead to different research designs and methods, which in turn results in the collection of different types of data as well as different interpretations of those data. With the vivid understanding of the research problem and cognisance of distractive factors, a careful selection of research design and prudent application of the data collection instruments (interviews and observation), as well as the consistent reference to the research questions in relation to the objectives, justified the credibility of the data collected.

Again, since the researcher visited the fields personally to collect the data, participant observation was the chief means of data collection. The interviews were also one-on-one bases and carried out with vetted interview guides for both the literate and illiterate interviewees. Data were recorded objectively and supported with field photographs.

3.16 Data Analysis Plan

The Data collected from both primary and secondary sources have been assembled mostly in tables, synthesised statistically and analysed critically based on standard characteristic features of quality expected in any leather for specific uses towards meeting the needs of modernity. Based on the findings generated, conclusions have been drawn to give rise to the proposal of the alternative strategies recommended for improving quality delivery of local leather possessing inherent value and desirable qualities to meet the demands for industrial utility and applications.

3.17 Validation and Reliability of Findings

The methodology followed in this study characterised discourse of research and lays out the logical reasoning of research in a way that could be drawn on to justify claims and procedures leading to the findings made. The findings therefore, are the empirical facts justifiable by the logical nature of the investigations carried out; the appropriate use of both specific and general criteria of data collection procedures, presentation, analysis, interpretation and the exhibition of theoretical and practical coherence in connecting the diverse phenomenon in the composite nature of the research problem.

3.18 Data Collection for Research Question One

Does the Ghanaian indigenous vegetable tanned leather possess the properties requisite to assure quality in the production of contemporary leather artefacts such as shoes, upholstery, clothing and garment and containers?

The objective of this research question is to examine and identify the quality standards of the Ghanaian indigenous vegetable tanned leather to corroborate the suitability of its properties for the production of artefacts to meet contemporary leather needs of Ghanaians and beyond. Since standard wise every end use of leather has its own standard tests and expectations, the expectations for shoe upper leather has been used as a case study (standard) to measure the performance of the leather. Nevertheless, the outcomes have been generalised in the discussion to also cover the leather's aptness for manufacturing artefacts such as upholstery, bags, garment and clothing accessories as well as decorative items. Below are the details of the physical properties tests conducted.

3.18.1 Tools and Equipment Employed in the Experiments

These are standardised and approved gadgets which aided in the carrying out of the experiments to ascertain the aptness of the local leather's properties for industrial utility. Generally, all guidelines and procedures for the tests conducted were rooted in standardised procedures. Also, all specimens were cut from the Official Sampling Position (OSP) when necessary.

1. **An Electronic sanding machine**: It was used to sand excess flesh from the flesh side of the local leather for assessment.

2. **Scudding equipment**: A wooden device used for dehairing, defleshing and scudding. It was employed as a support for sanding excess flesh from the leather for assessment.

3. **Electronic cutter**: Equipment used for cutting leather samples from the Official Sampling Position (OSP) for testing.

4. **Cutting blades**: These are metal square, rectangular, dog bone and circular shaped blades with one edge Sharpened. They were used for cutting the shapes for the test specimens.

5. **Digital scale:** It is a weighing scale with digital Indicators for general weighing. It was used to determine the weight of the square specimens.

6. **Digital external calliper:** An electronic measuring instrument consisting of two steel legs hinged together and a digital display screen for easy reading. It was used to measure the width of the dog-bone specimens.

7. **Thickness gauge**: A standard SATRA digital thickness measuring device. It was employed for measuring the thickness of the leather samples.

8. **Lastometer**: An instrument with digital display reading used for testing the `lasting' qualities and endurance of upper leathers. In these experiments, the lastometer was used to test to determine the distension and strength of grains of the locally tanned leather samples.

9. **Flexometre:** For assessing the flexing endurance of leather. In this study the equipment was use to test the ability of light leathers and leather-cloth used in manufacture of shoe uppers, gloves, and garments to withstand repeated flexing without cracking.

10. Tensometre: An electronic strength pulling machine used with different loads to examine and determine the tensile strength (tear strength and resistance) of the local leather.

3.18.2 Physical Properties Tests Conducted

The physical properties of the local leather samples were assessed as follows:

3.18.2.1 Experiment 1: Assessment of Degree of Tannage by Boil Test and Enzymatic (depilation) Test

Technical Reference: Bienkiewcz (1983) and Sharphouse (1995)

Purpose: To establish the extent to which the local leather has been tanned and level of resistance to decay and shrinkage.

Procedure: For the boil test, the butt, shoulder and belly specimens were cut and labelled from a total of 15 leather samples (3 each) from the five tannery sources and subjected to boiling in turns for monitoring until shrinkage began. The average temperatures at which the specimens started to shrink were recorded in °C for assessment. The enzymatic test on the other hand depended on depilation by microbial activities. In this test, a decomposition friendly environment was created in a humid room in a warm condition of 22-30°C. A total of 15 sheets of leather (2.5sq.ft each) were kept in the room for 30 days, and observed daily for microbial actions and effects. Daily records were kept.

3.18.2.2 Experiment 2: Average Area Size Quality Assessment

Technical Reference: De Haas (1925) and ISO 7482-2:1999, part 2,

Purpose: To determine the average cutting value of the local leather.

Procedure: A total of 1000 sheets of leather samples were selected randomly from the five tannery sources and laid flat on a table in turns with the grain side up. With a ruler, the surface area was measured by length and breadth, and recorded critically in square foot (sq.ft.). The area was calculated for size defects possible to inhibit the economic cutting value and utility of the local leather during clicking stage of shoe production process.

3.18.2.3 Experiment 3: Grain Surface Quality Assessment

Technical Reference: Sharphouse, 1995, John, 1997 and ISO 282–1:1998(E), part of ISO2822.

Purpose: To determine quality of the grain surface of the local leather.

Procedure: A total of 1600 sheets of leather were selected randomly from the five tannery sources and laid flat on a table with the grain side up. The surfaces were assessed critically one after the other with the aid of magnified lens for defects possible to inhibit the aesthetic quality and utility potentials of the leathers. The identified surface defects were recorded and tabulated.

3.18.2.4 Experiment 4: Assessment of Fleshing and Defleshing Quality (Scudding Test)

Technical Reference: Secondary Treatment of Leather, Atiase (2004); Boahin (2005)

Purpose: To determine the extent of defleshing and quality of the flesh side of the local leather.

Procedure: The researcher selected 60 sheets of leather samples from the various local tanneries, laid them flat on scudding equipment. An electronic sanding machine was used to sand the flesh side until velvet or downy feel which is an indicator of quality flesh surface was attained. The 60 leather samples were treated in the same manner and the amount of time taken to attain the downy feel was recorded in minutes for each sheet of leather. The excess flesh residue obtained was also weighed on a balance scale in grams and recorded against the time taken to sand.

3.18.2.5 Experiment 5: Assessment of Fullness (Bending Length, Flexural Rigidity and Bending Modulus Assessment)

Technical Reference: Potter (2008), and Gerhard (1996)

Purpose: To determine the angle at which the local leather bends by its own weight.

Procedure: Seven square pieces of sides 15cm were cut from the OSP of three leather samples each from the five tannery sources. They were arranged on angle measuring device fixed with a protractor to measure the angle (in degrees) of bend 8 times repeatedly. An overhanging length of 11cm was measured in four different directions on the device, i.e. with each of the four sides of the 15cm square samples overhanging in turn. The grain uppermost were measured, and then the flesh side. The arithmetic mean was taken for the eight determinations. The average thickness values recorded in experiment 6 were employed to support the assessment of the fullness of the leather samples.

3.18.2.6 Experiment 6: Assessment of Thickness

Purpose: To assess the average thickness of the local leather.

Technical Reference: SLP 6, Potter (2008) and De Haas (1925)

Procedure: 7 dog-bone or dumbbell shaped specimens were cut from three each of leather samples from the five tannery sources, and in a standard thickness gauge, they were measured in three different spots (left end, middle and right end). 15cm square shaped specimens were also cut and measurements were taken in four positions. The readings were taken after 5 seconds and the average thicknesses were recorded in millimetres.

3.18.2.7 Experiment 7: Flex Resistance Test (Vamp Flex Method)

Purpose: To determine the flexual resistance and endurance of the local leather.

Technical reference: SLP 14 and 39; Bordoli (1936); O'Flaherty (1965)

Procedure: In this test, the 7 rectangular shaped specimens from three samples each of leather samples from the five tannery sources were cut with the electronic cutter. They were folded and clamped firmly in a set of grips of the flexometre to maintain them in a folded position; one of the grips fixed while the other is able to oscillate. The movement of the oscillating grip causes the fold in the test specimen to run along its centre. This operation is carried out repeatedly for three days and the test specimens inspected periodically (first hour and every 20 hours). With a hand magnified lens the grain surface was assessed for damages produced, thus, wrinkles, breaks, folds, weakness, cracks and looseness.

3.18.2.8 Experiment 8: Distension and Grain Cracking Test (Ball Burst Test)

Instrument: Lastometer

Technical References: ISO: 5914-1970 method of physical testing of leather, LP: 13, resistance to grain cracking, ISO 33798:2002, SLP 9, Mesurement of Distension and Grain Cracking, Gerhard (1996).

Purpose: To test the distension, cracking endurance and strength of grains of the local vegetable tanned leather.

Procedure: Seven defined disk specimens of leather were cut from each three leather samples selected from the five tannery sources. With the 7 defined discs specimens of the local leather, the thickness were measured in three positions on the grain side in accordance with SLP 4. Using the lastometer with a determined Load (kgf) and Distension (mm) at 10 kgf intervals to a maximum of 80 kg for samples from the Official Sample Position; butt, shoulder and belly. The load and distension figures at grain crack and burst were recorded.

3.18.2.9 Experiment 9: Assessment of Elongation and Tensile Strength

Equipment: Tensometer

Purpose: To test the tensile strength and the local leather's elongation to break.

Technical Reference: ISO 3376:2002, ISO 3377-1:2002, SLP6/lUP 6, SLP 2, SLP 3.

Procedure: The local vegetable tanned leather specimens were conditioned at 65% RH and 20 degrees celcious for 48hours. The standard dumbbell or dog-bone shaped specimens were cut perpendicular and parallel to the backbone from the five tannery sources, and the thickness measured in three different positions (mid point and other two midway). Since seven specimens were measured repeatedly, the average values were recorded (mm). The widths of the specimens were also measured with vernier callipers to obtain the mean width (mm) to pave way for the acquisition of values to support the calculation of the strengths of the samples. A scale of 20 interval and a maximum force of 500N head to break the specimen were selected. The tensometer was set at zero after clamping the specimen firmly in the jaws. The machine was ran until the a break of the specimen. Elongation at break, average elongation at break and percentage elongation at break were calculated as well as the tensile strength.

3.19 Data Collection for Research Question Two

What are the causes and causations of the local leather's intrinsic and extrinsic deficiencies that result in its inefficiencies of meeting the properties requisite for quality Leatherwork in Ghana?

The object of this research question was to probe into the causative factors and the processes that possibly result in the defects associated with the local leather as a vehicle of finding empirical grounds to propose the alternative means to improve upon the quality of the local leather's properties to befit the production of valuable leather artefacts and Leatherwork holistically. Since the leather industry whether indigenous or contemporary, highly depends on the meat industry, the researcher carried a critical cross-sectional investigation into the core allied sectors serving as the pedestal upon which the leather industry survives. The researcher based on participant observation and interviews to critically assess impact of such parameters as the nature of livestock species in Ghana, system of animal husbandry, livestock markets, the impact of the operations of the meat industry, abattoir and slaughtering activities, the skin and hide market as well as the indigenous tanning sector.

The impact of policies, operations, cultural practices and traditions existing in the sectors mentioned were also assessed in relation to the provision of economically viable skins for manufacturing leathers which possess the qualities desirable for industrial utility. This was a further pursuance to identify the remote causes and causations of deleterious conditions that encumber the acquisition of qualities suitable for the production of quality leather to meet the demands of contemporary leather needs in industrial uses such as footwear, upholstery, garment and clothing and bag making.

Since the researcher operated on the supposition that the cause rather than the effect is the problem, finding alternative strategies to improve on the quality of leather made locally to eventually add economic value to the indigenous Leatherwork in Ghana deeply concerned diagnosis into the causative factors and their causations. This is the means by which the causes lead to the effects seen on the leather as defects or deficiencies, hence, poor quality. By such comprehensive knowledge, interceptive strategies could be formulated and proposed as alternative avenues to salvage the local leather and improve on its quality to support and uplift the economic significance of Leatherwork practised and studied in the country.

3.19.1 Assessment of the Nature of Livestock Species and Skin Quality

The nature of livestock breeds in Ghana in relation to the aptness of skins/hides for wealth creation through leather making and leather utility was the main focus of this survey. Through interviews and personal observations, the researcher examined 2500 livestock across 5 regions in the country, (the total excludes the Afram Plains). The examination surrounded on the breed types, anatomy and physiological status: shape and contours, body size in relation possible skin yield, skin damages, age, growth patterns and sex (Koney, 2004; Iwena, 2008; MoFA, 2009).

3.19.2 Assessment of the Nature of Livestock Farming Systems and Skin Quality

The researcher assessed the impact of farm management systems on the animals' productivity of skins and hides with economic relevance for manufacturing quality leather. Three categories of farm management systems (extensive, intensive and semi-intensive) were visited and assessed in four regions: Upper East, Northern region, Ashanti, Eastern Greater Accra plus the Afram Plains. At any farm visited in each zone, a particular attention, through observation and interview, was paid to the causes and causations of skin and hide defects by comparing the nature of housing, feeding practices, breeding system, healthcare conditions purpose of farming, geographical and climatic conditions and general maintenance of animal welfare to the ability to yield pelts with requisite qualities for Leatherwork.

3.19.3 Impact Assessment of Livestock Marketing and Transportation

Any activity capable of hurting the animal's skin in a way is considered as a cause tangible to having adverse implication in the delivery of quality leather. The researcher assumed that how animals are traded in open markets and transported to slaughter centres could pose several threats to the attainment of quality skins and hides. Activities in 8 sampled livestock markets and loading points were observed and impact marketing and transportation activities were assessed critically. Assessment was based on types of animals sold, purposes for selling, prices of animals, profit margins, means of keeping and feeding livestock on sale. The means of loading and transportation were also examined (Koney, 2004; Iwena, 2008).

3.19.4 Impact Assessment of Operations at Livestock Slaughter Centres

Bleeding in theory and principle is said to be the object for slaughtering animals (ISO 2822, part 2, no.1; FAO Animal Production and Health Series No. 7, 1955; FAO Agricultural Development Paper No. 49, 1955). However, the negative impact of other abattoir operations on skins and hides quality besides bleeding need not be underemphasised (ISO 2820:1974; ISO 7482-1:1998; De Haas, 1925; Gerhard, 1996; ISO 2822-1:1998; ISO 4683-1:1998). The researcher, through participant observation and interviews, assessed the activities of 12 slaughter centres in the country: 2 abattoirs (Kumasi and Accra), 4 slaughter houses (Kumasi, Greater Accra, Tamale and Bolgatanga), and 7 slaughter slabs in the same areas respectively. Core parameters examined comprised breed types and health conditions of animals slaughtered, processes of slaughtering and bleeding, time lag of bleeding and flaying, process of flaying, post flaying treatments of the skin/hides: washing, chilling and curing, tools and equipment employed as well as general facilities available to ensure quality delivery of skins/hides competent to maximise by-product revenue generation and support Leatherwork practised in the country. A total distribution of 40 bovine, 50 ovine and 30 caprine fresh pelts were measured in area and weight.

3.19.5 Impact Assessment of Pelt Preservation and Marketing

Due to the massive negative impact of microbial activities on fresh skins and hides meant for leather, preservation is regarded in high esteem by tanners (ISO 2820:1974; Gerhard 1996; Sharphouse, 1995; ISO 2822-1:1998(E)). The researcher devoted adequate time to follow the various means of curing skins and hides against putrefaction at the various slaughter centres and skin hide markets in Ghana.

The activities at four skins and hides marketing centres (2 in Kumasi, 1 in Accra and 1in Pougtinga (Burkina Faso) were visited for assessment. Once again, the researcher interviewed and observed both the dealers and the retailers on issues regarding types of skins and hides dealt in, sources of acquisition, curing conditions, availability, accessibility and affordability, price conditions and means of transportation. Possible negative effects on pelt quality in relation to leather quality and general economic development of Leatherwork were noted.

3.19.6 Impact Assessment of Indigenous Tannery Activities

The researcher visited clusters of local tanneries in Accra, Kumasi, Tamale, Bolgatanga and Bawku respectively to assess the impact of the activities of the tanners on leather production. Parameters observe included tannery settings, materials used, tools, equipment, tanning methods and techniques, water quality, health and safety regulations and maintenance, finishing technologies and finished leather. To augment the quality and validity of information gathered, photographs were taken in addition to voice recorders used to record the details of responses from interviews conducted with the tanners and tannery experts.

3.20 Data Collection for Research Question Three

What possible alternative strategies are relevant to the improvement of the quality of Ghanaian indigenous leather to augment the economic value of its application in Leatherwork?

In order to propose the alternative strategies to improve on the quality of leatherwork in Ghana, the researcher depended on the cause-and-effect theory to relate the causative factors of leather defects and their causations to concepts, theories, principles, methods and technologies gathered through the review of the related literature, observations at the various farms, abattoirs and tanneries, experiments and ideas from experts consulted. Some of the ideas developed into alternate strategies were tested and proposed while others were possible strategies identified and proposed as means of enhancing quality of leather to make Leatherwork more enterprising in Ghana and beyond, suited to the production of quality footwear, upholstery, bags and clothing accessories as well as maximise its industrial utility.

The proposed alternative strategies are presented and discussed in chapter five of this dissertation.

CHAPTER FOUR

PRESENTATION AND DISCUSSION OF FINDINGS

4.1 Overview

The data congregated from the field have been assembled and presented in this chapter for deliberations. The findings have been discussed. To facilitate the analysis, and also establish superior implications of the data in relation to the research problem and set objectives, charts and tables have been used to synthesise the data into a logical organisational structure. References to theories and principles sieved from the related literature reviewed have been employed as bases for argument, observations and claims throughout the discussions.

4.2 Discussion of Results for Research Question One

Does the Ghanaian indigenous vegetable tanned leather possess the properties requisite to assure quality in the production of contemporary leather artefacts such as shoes, upholstery, clothing and garment and containers?

The objective of the data collected for research question one was to test the physical properties of the local leather to corroborate its quality status and also establish its general suitability for the production of leather artefacts valuable to the needs of contemporary livelihood. The results have been quantified statistically, thus, reduced to averages and percentages, and interpreted qualitatively in a formal and scientific manner using the passive voice and impersonal language to give vivid description (Leedy & Ormrod, 2005). Although the standard tests of the physical properties of the leather were limited to the standards for shoe upper leathers, the data obtained are analysed and generalised in comparative with the quality standards expected in any leather for such end uses as upholstery, clothing/garment and containers.

4.2.1 Results of Experiment 1: Assessment of the Degree of Stability of the Local Leather to Putrefaction and Temperature (Boil test and enzymatic/depilating test)

O'Flaherty et al., (1956; 1958), Thorstensen (1976), Bienkiewicz (1983), Hiedemann (1993), Sharphouse (1995) and Sarkar (2005) have stated clearly that the level of stability or resistance of any type of leather (whether vegetable or mineral tanned) to putrefaction and temperature defines its degree of tannage. Lollar has emphasised in O'Flaherty et al.,(1958) that commercial evaluation of leather quality is dependent upon the estimation of a number of subjective characteristics, such as fullness or roundness, grain break, smoothness of grain surface and cracky grain, which can be referred to as "leathery feel." The degree of tannage is pertinent to achieving such characteristics as well as attaining other commercial characteristic quality indexes for shoe upper leather, such as temper, roundness, solidity, flexibility to mention a few. The purpose of this experiment was to determine the extent of stability possessed by the local leather to shrinkage when in contact with temperature and also its level of resistance to putrefaction, thus, its ability to remain imputrescible. By this, the potency of the vegetable tannage employed could be defined and its level of competency to convert pelts into economically relevant leathers could also be determined. The leather samples (average size of 2.5 sq.ft.), three pieces from each tannery source were subjected to enzymatic test (depilation) to measure resistance to putrefaction and boil tests for measuring resistance to shrinkage.

After the thirty days of subjecting the leather samples (average size of 2.5 sq.ft.) to a decomposition friendly environment in the depilation or enzymatic test, it was recorded through critical observation that the local leathers had not become susceptible to microbial attack of any form that could lead to decomposition; although 2 out of the 15 sheets had the colours disturbed by moulds. The grain surfaces were intact with no holes or deterioration of any kind. The material did not sustain fibre looseness, or surface peelings. This intactness of the features observed signified the ability rendered to the local leather by the vegetable tannage employed to develop resistance to putrefaction; a major factor that differentiates pelts from leather. This was a confirmation that the pods from the acacia plant (*Acacia nilotica*), commonly known as "Bagaruwa" in Hausa, which serves as the main source of tannins for converting pelts into leather in the indigenous tanneries possess potent astringency (tannic acid) requisite for tanning (Wilson, 1923; O'Flaherty et al, 1956; Tanning Extract Producers Federation, 1974).

The shrinkage test conducted by subjecting cut specimens of the butt area of the leather samples to boiling to determine resistance to shrinkage also revealed that the leathers made locally possess an average shrinkage temperature of 75.3 ºC. As can be found in table 4.1, that practically meant that the local vegetable tanned leather averagely has the capability to resist shrinkage up to 75.3 Degrees Celsius, a record which is within the range of standard shrinkage temperature of 75ºC – 85ºC expected in vegetable tanned leathers (Wilson,1923; Sharphouse 1995). Although the *Acacia nilotica* (Bagaruwa or Egyptian mimosa) is the predominant vegetable source of tannage in both Burkina Faso and Ghanaian indigenous tanneries, the samples from Burkina Faso recorded average shrinkage temperature as high as 79ºC as compared to 75.3°C average shrinkage temperature recorded by leather samples from Ghana, despite the fact that the samples from Bolgatanga alone recorded 78ºC as the highest from Ghanaian local tanneries.

The observations recorded from the stability test as shown in *Table 4.1 (page 127)* reveals that by virtue of the vegetable tannage sourced from the acacia plant (*Acacia nilotica*), locally known as 'Bagaruwa' (*Acacia nilotica*), local leathers possess adequate stability to putrefaction and shrinkage; the two basic properties required in any leather for utility of any form: footwear, bag, upholstery, garment and clothing accessories.

Table 4. 1: Results of shrinkage temperature assessment (Boil test)

Expected Shrinkage Temperature: 75°C - 85°C		
Source of leather	**Shrinkage Temperature (°C)**	**Observation made**
Mallam Market	70 °C	Leather began folding up
Asawase Market	75 °C	Leather started folding up into a roll after 75°C
Tamale Hausa zongo	76.5 °C	Leather began shrinking into a roll after 75.5°C
Bolgatanga	78 °C	Leathers stayed flat till 78°C
Bawku	77 °C	Leathers started folding up slightly after 78°C
Burkina Faso	79 °C	Resisted shrinkage till about 79°C
	Average shrinkage temperature recorded (Only Ghanaian tanneries)=75.3 °C	

(Source: Experiment conducted by researcher, April, 2008)

4.2.2 Results of Experiment 2: Area/Size Quality Assessment

Size and shape are basic properties commonly used as measure of quality in physical determination of the economic value of leather in footwear, upholstery, bag and all artefact production, especially when it is evident that size variation is a common feature among different species and breeds of animals which reflect significantly in skins/hides generated (De Haas, 1925; Bordoli, Vol.1, 1936; Sharphouse, 1995). The purpose of this assessment was to determine the average economic cutting value of the local leather samples based on area size. From the test results as presented in *Table 4.2*, out of the total 1000 sheets of bovine, ovine and caprine leathers assessed by measurement of area size (length x breadth) in square foot, the local leathers proved disappointing; since the majority could not meet the basic size quality standard expectation in economically viable leathers.

Table 4.2: Results of area/size value and quality assessment of local leathers

Tabulated Results of Economic Cutting Value of the Local Leather							
Expected average size (sq.ft): Ovine: 2.5, Caprine: 2.5, Bovine: 6							
Animal source of leather	Quantity Assessed	No. On Average (Sq.ft)	%	No. Above Average (Sq.ft)	%	No. Below Average (Sq.ft)	%
Ovine	580	200	34.5	65	11.2	315	54.3
Caprine	400	110	27.5	80	20	210	52.5
Bovine	20	6	30	2	10	12	60
Total	**1000**	316		147		537	

(Source: Assessment conducted by researcher, May 2007- April 2008)

According to the records presented in table 4.2, out of the 580 ovine leathers examined, as much as 315 (54.3%) of them fell below the 2.5 sq.ft. average size basic for cutting a pair of footwear (shoe), although 200 (34.5%) and 65 (11.2%)

respectively were on and above average. The 400 caprine leathers tested also recorded 52%, thus 210 pieces falling below the average size of 2.5 sq.ft., with 110 (27.5%) being on average, and 80 (20%) above the average size expected. Due to scarcity of the bovine leather in the local tanneries, only 20 pieces of hides were assessed, as high as 12 sheets which represented 60% failed to meet the 6 sq.ft. average size which according to De Haas (1925) and Sharphouse (1995) is a property usually demanded in leathers with quality economic cutting value and industrial utility. Although 30% (6pieces) were on average only 2 (10%) were above the average size expectation.

The results brings the discussion to a conclusion that most leathers produced locally, irrespective of the source of animal are relatively smaller in size if compared to records available in leather business journals such as Leather International, World Leather and Tandy Leather. Area value is a property cherished so much in footwear manufacturing, especially during 'clicking', that is the process of cutting of the various sections for the upper parts, and it requires judicious usage of cutting area of leather and avoidance of waste (Bordeli, Vol. 3, 1939, De Haas; 1925). For the sake of economical cutting in shoe parts, as shown in *Figure 4.1(a) and (b) of page 130,* clicking requires the arrangement of standard patterns/templates on leather which must fulfil the number of pairs of footwear demanded because when a pair of shoes is cut from different leathers from same species of animal, their properties vary greatly (Bordeli, Vol. 3, 1939; Lyon, 1994). The shoes will not represent a perfect pair since the leathers render them different looks in terms of physical properties such as softness, textures, strengths, and ergonomics to a large extent. Size is a property prerequisite in any leather with positive economic implications in upholstery, garment and clothing leathers since such production require fashionable leathers of large areas

(≥6sq.ft.) of leather with uniform colour and thickness, softness, flexibility, and good drape (Sharphouse 1995).

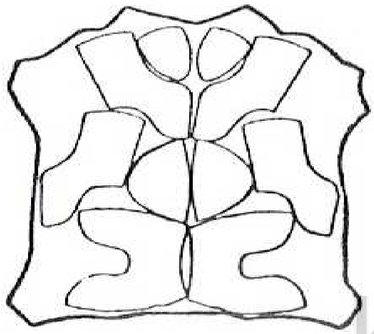

Figure 4.1(a)

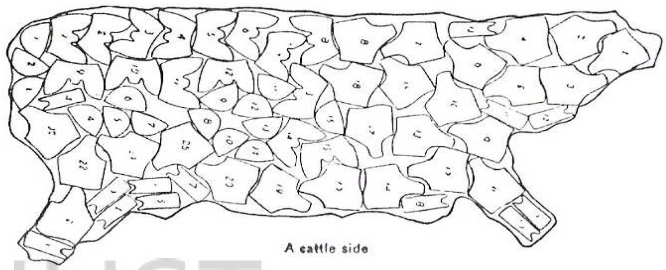

Figure 4.1(b)

Figures 4.1(a) and (b): Economic cutting value displayed by the arrangement of shoe upper patterns on leathers for clicking.

(Source: Bordeli, Vol. 3, 1936)

4.2.3 Results of Experiment 3: Grain Surface Quality Assessment

Leather's aesthetic appeal emanating from the national integument of the animal is articulated through the nature of grain surface quality it possesses (Sarkar, 2005). Sharphouse (1995) has stressed that the grain surface of a particular piece of leather, however, reflects the beauty rendered by the leather to the end use which it is put to. This experiment was aimed at determining the quality of the grain surface of the local leather as a means of establishing the impact of its aesthetic appeal on utility and economic value in footwear production.

Table 4.3: Grain surface quality assessment results

Source of leather	Quantity assessed	No. With cuts and scratches	No. With wrinkles & coarse grain	No. With grain peeling	No. With stains	No. without defects
Burkina Faso	450	150	100	100	50	50
Bawku	200	100	55	23	12	10
Bolga.	500	350	80	15	40	15
Tamale	100	40	20	12	20	8
Kumasi	300	95	80	50	70	5
Accra	50	35	7	3	5	0
Total	**1600 (100 %)**	**770 (48.1%)**	**342 (21.4%)**	**203 (12.7%)**	**197 (12.3%)**	**88 (5.5%)**

(Source: Assessment conducted by researcher, February 2007- May 2008)

According to the results presented in *Table 4.3*, out of the 1,600 sheets of bovine, caprine and ovine leathers sampled randomly from the various indigenous tannery sources as well as Pougtinga in Burkina Faso, only 88 pieces representing 5.5% were found without defects of any kind. Even out of the 88, pieces, only 38 were from the five tanneries in Ghana while 50 pieces were from Pougtinga tannery. The rest of 1,512 pieces, representing 94.5%, were littered with unpardonable grain surface defects ranging from scratches, to holes, growth marks (wrinkles), stains, grain coarseness, and patched/uneven colouration, which according to Sharphouse, (1995) and Boahin, (2009) are considered highly disincentive to quality and industrial utility**.** As much as 770 (48.1%) of the leathers were full of holes and scratches, as 342 (21.4%) possessed grain coarseness and wrinkles.

In correlating the results obtained, the quality standards expected for shoe upper production, Bordeli, (1936, Vol.3), and Lyon (2004) have concluded that surface defects are regarded as *'limitations to clicking'* since they pose difficulties and hindrances to economic cutting of the various parts by the use of standard patterns or templates. The extent of grain surface deficiency identified can be said to be in opposition to Leather's ubiquitous versatility in utility and irresistible aesthetic admiration deeply rooted in the appearance of the grain surface. It is therefore concluded in accordance with Bordeli (1936, Vol.3) and Lyon's (2004) submission that poor grain surface quality of the local vegetable tanned leather cannot follow the normal trend of autonomously defining, justifying or dictating its economic value or utility in footwear, upholstery, garment and clothing accessories manufacturing.

4.2.4 Results of Experiment 4: Flesh Surface Quality Assessment (Sanding Test)

The intent of this experiment was to corroborate the surface quality of the flesh side of the local leather through sanding (abrasion) to assess the amount of excess flesh contained. In all, 60 sheets (10 from each tannery source) of 2.5 sq.ft. vegetable tanned ovine and caprine leathers sampled from the five indigenous tanneries, as well as Pougtinga in Burkina Faso for comparison were used in the experiment (Atiase, 2004; Bobie, 2008). Having sanded 10 sheets of leather samples from each tannery source, the time spent against the quantum of excess waste collected is presented in *Table 4.4 (page 133).* It is noticed that very 2.5 sq.ft. of leathers from Mallam Market Tannery in Accra produced 480g of waste and took 45mins to sand. Same size from Asawase in Kumasi produced 470g of waste in 30 minutes, whilst those from Bolgatanga and Bawku respectively produced 430g each in 15 minutes. The same size from Tamale generated 450g of waste which took 20 minutes to sand off. Comparatively, the same size from Burkina Faso when sanded produced 400g of waste in 10 minutes. On average, leathers from the local tanneries possess 452g which take an average time of 25 minutes to sand off in order to keep the material free from excess flesh.

Table 4.4: Results of flesh surface quality assessment (Sanding test)

Total quantity of leather: 60 sheets; 10 sheets per tanning source Expectation: Suede Effect on Flesh Side of Leather				
Source of Leather (Ovine and Caprine)	Average size per sheet (Sq.ft)	Average sanding time per sheet/sheet (Mins)	Qty. Of Excess flesh/sheet (g)	Total Quantity of Excess Flesh Obtained/10 sheets (g)
Burkina Faso	2.5	10	400	4000
Bawku	2.5	15	430	4300
Bolgatanga	2.5	15	430	4300
Tamale	2.5	20	450	4500
Kumasi	2.5	30	470	4700
Accra	2.5	45	480	4800
Total	**15**	**130**	**2 660**	**26600**

(Source: Assessment conducted by researcher, September-October, 2009)

Since the amount of excess flesh associated with the local leather correlates the quantum of excess residue, impurities and non-structured proteins it contains, the sanding test results brings to light the amount of waste one will have to remove in order to make the local leather clean for the production of footwear, or upholstery, bags, garment or clothing accessories.

4.2.5 Results of Experiment 5: Assessment of Fullness of the Local Leather Samples (Bending Length, Flexural Rigidity and Bending Modulus Assessment)

The aim of this assessment was to determine the fullness of the leather samples as a vehicle to explain the compactness and the impact of fibre substance on bending, thickness, flex resistance as well as softness requisite in footwear manufacturing. With particular reference to the Physical and Fastness Testing of Leather Guide (Potter, 2008), the assessment of fullness requires the determination of three core factors: bending length, Flexural rigidity and bending modulus of the leather. The test results obtained are tabulated in *Tables 1 to 6 of Appendix 5A and Tables 1to 6 of Appendix 5B*, are discussed as follows:

4.2.5.1 Results of Bending Length Assessment

The bending length represents the measure of the draping quality of leather by the length of leather which will bend under its own weight, to a definite extent. The ability of shoe upper leathers or any leather meant for upholstery, garment or clothing accessories to bend within the shortest possible length to a desirable extent is prerequisite in defining the extent of utility aptitude and aptness of the material to serve its intended purpose. In reference to the results obtained (*Table 1 – 6 of Appendix 5A and Table 1 – 6 of Appendix 5B)* as compared to the expected average bending length of 4 or less, the leather samples for both goat and sheep from all the local tanneries failed to meet expectation, although the sheep samples proved relatively better ability to bend under its own weight at an average length of 5cm for butt and shoulder, and 4.40cm for belly respectively, the goat samples which had 5.5cm for butt and shoulder, and 5.0cm for belly performed abysmally. Also, judging from the five tannery sources, the leather samples from Bolgatanga exhibited better bending length while those from Mallam Market and Asawase Kumasi respectively responded poorly.

4.2.5.2 Flexural Rigidity Assessment Results

The flexural rigidity determines the force required to bend a unit length of leather through a unit angle. The operations in the production process of footwear, especially shoes, require bending and moulding of the upper at various parts such as the toe, heel, closing and lasting. Although the degree of flexural rigidity expected in a particular leather depends highly on the end use, it is worth stating that in this study, the lesser the force required to bend a unit length of the local leather samples through a unit angle, the more viable it is considered for shoe uppers since the leather samples were from goat and sheep. As shown in the tabulated results in *Tables 1 to 6 of Appendices 5A and 5B*, the belly specimens of both goat and sheep leather samples proved to require less force to bend through a unit angle than the butt and shoulder samples, although the force required to bend the shoulder specimens were lower than the butt.

It also became significantly obvious that the specimens cut from leather samples from Kumasi Asawase and Mallam Market tanneries respectively recorded the highest figures which means that they need a force in the range of 4.07g/cm – 10.12g/cm for sheep and 4.40g/cm – 8.71g/cm to bend a unit length through a unit angle as compared to the smaller figures recorded by the samples from the three tannery source in the northern part of the country. This shows that leathers tanned in the southern parts of the country have much resistance to bending and will not respond adequately to the manipulations in shoe manufacturing if employed.

4.2.5.3 Bending Modulus Assessment Results

The bending modulus however, is a measure of the intrinsic stiffness of the leather and is the inverse of full, that is, the smaller the bending modulus, the fuller the leather. From the responds gathered through the bending length and flexural rigidity assessments, the dependency of fullness assessment of the local leather samples became more predictable with the amplification of the bending modulus assessment results. Since softness or stiffness of leather depends on the opening up of fibre structure, the belly specimens which responded positively to bending length and flexural rigidity demonstrated affirmation of looseness, high fibre porosity and less fibre compactness of the collagen fibre structure in the belly section of skins (Ward, 1977; SLTC, 1999; Hougham 2006). That meant that the belly sections of the local leather are less full in substance since both goat and sheep belly specimens respectively recorded the highest bending modulus figures as compared to the butt and shoulder specimens (O'Flaherty et al., 1965; Olsheim, 1973). Meanwhile, it was noticed that the butt specimens of the goat leather samples are fuller in substance if put up against the shoulder specimens which proved less filled.

The variable fullness behaviour of the various parts of the leather samples from the local tanneries confirm true manners typical of leather; the collagen structure of a sheet of leather irrespective of the animal exhibit varied fullness which influence the mechanical properties such as softness, flexibility and stiffness, as well as bending and moulding abilities. In a nut shell, although the local leather, generally exhibited poor fullness of substance at the belly and the shoulder portions, the butt parts moderately possess the fullness capable of serving the purpose of shoe uppers.

4.2.6 Results of Experiment 6: Assessment of Thickness

Since the thickness of a material has direct influence on the performance and abilities inherent that material in applications which regard good mechanical properties as prerequisite (Bordeli, 1936; De Haas, 1925; Lyon 1994), it was deemed crucial to subject the leather samples selected from the indigenous tanneries to thickness test as a means to establish the average thickness of the butt, shoulder and belly locations, and relate the results to the obligation thickness in shoe upper leather standards.

In reference to the tabulated results for shoe upper leather in *Appendices 5A and 5B*, it is realised that the butt, shoulder and belly specimens for both sheep and goat leather samples recorded figures which in comparison to the expected average of 1.5mm thickness failed the test. However, it is also significant that comparing the goat leather samples to the sheep in terms of thickness, the sheep leather samples failed the test awfully, especially, when the highest average thickness recorded by the butt, shoulder and belly specimens were 1.23mm, 1.18mm, and 1.14 respectively for samples from Bawku are far below expectation. The belly part of the leathers for both sheep and goat recorded the lowest thickness from all the tannery sources: the goat samples from Mallam Market tannery in Accra recorded 0.76mm on average.

Among the three specimens assessed, the butt and the shoulder parts of the leather samples from all the tannery sources proved to possess the thickest sections. In addition, it is also glaring that the various sections of the leather possess thicknesses which differ from one another, and that each section, be it the butt, shoulder or belly may be useful for specific end uses (Sharphouse, 1995; Sarkar 2005; Hougham 2006). However, based on the results discussed, it can be concluded that leathers made locally fall short of adequate thickness necessary for the production of quality shoe uppers; since it is well established that the lighter the thickness of leather the poorer the tensile strength.

4.2.7 Results of Experiment 7: Flex Resistance Test (Vamp Flex Method)

Since flex is an inevitable encounter for any footwear at the vamp, toe and heel bends, it is a prerequisite for any leather meant for footwear upper to endure a predetermined number of flexes to gain qualification (SLP 14 and 39; Bordeli, Vol.3 1936; Lyon 2004). It is on this rationale that this experiment was carried out to find out the degree of flex endurance of the leather samples. The experiment concentrated on ovine and caprine leathers sampled from the five indigenous tannery sources in Ghana as well as Pouytinga in Burkina Faso. The results of the experiment have been presented in *Tables 1– 6 of Appendix 3A and Tables 1– 6 of Appendix 3B.* However, in *Table 4.5 (page 139)*, there is a presentation of comparative flex endurance recorded among the butt, shoulder and belly parts of goatskin and sheepskin leather specimens tested.

Comparing the performance of the specimens to the expected 10^6 cycles = 1 080 000 flexes, which is equivalent to 60 hours of continuous flexing, the results *in Table 4.5,* shows that all the butt, shoulder as well as the belly parts of the local leathers, whether goat or sheep, have the capability to endure the first 1 hour of continuous flexing (18 000) without sustaining any damages in a form of wrinkles, fibre looseness, tear or grain cracks. However, the belly part of both goat and sheep leather samples proved fragile and weak resistance to flexing since they began deteriorating after 5 hours of flexing, that is, 90 000 flexes.

Table 4.5: Results of the Flex Resistance Test (Vamp Flex Method)

Comparative Flex Endurance Between Sheep and Goat Leather Sections from the 5 Indigenous Tannery Sources in Ghana **Expected Flex Resistance: 10^6 cycles = 1 080 000 flexes**			
Flex Time (No. Of flexes/hr)	Reactions Observed		
	Butt	Shoulder	Belly
1 hr. (18 000 flexes)	No creases, looseness, wrinkles, grain cracks or breaks on sheep and goat leathers.	No looseness, wrinkles or grain cracks on sheep and goat.	No creases, looseness or rain cracks on sheep nor goat.
5 hrs. (90 000 flexes)	No creases or looseness or grain cracks on both.	No wrinkles, fibre or looseness on both sheep and goat leathers.	Minor Creasing in the central fold of sheep leather.
10 hrs. (180 000 flexes)	No wrinkles or grain cracks on both sheep and goat.	No wrinkles or grain cracks on either sheep nor goat	Increased creases or wrinkles on sheep, but minor wrinkles on goat
20 hrs. (360 000 flexes)	No wrinkles, grain cracks or looseness on goat leathers, but sheep sustained minor wrinkles, though both had no grain cracks.	No grain cracks or tear, but some wrinkles on sheep minor creases on goat leather	Projected wrinkles and looseness on sheep, whilst goat experienced increased grain looseness, but no grain cracks
40 hrs. (720 000 flexes)	More wrinkles on sheep leather with no grain cracks or looseness. The goat specimens on the other hand minor creases but no grain cracks	Projected wrinkles on sheep leather with some grain cracks. Creases increased on Goat leather had minor grain cracks.	Both sheep and goat leathers lost resistance to wrinkling, sustained more grain cracks, but without tear
60 hrs. (1 080 000 flexes)	Increased wrinkles at the central fold of sheep leather with no grain cracks. Goat leather had less wrinkles comparatively.	Pronounced grain surface cracks, wrinkles observed on sheep leather samples, but no tears. However, the goat had developed more wrinkles, some looseness and cracks	Both sheep and goat had Massive grain cracks, projected fibre looseness at the central fold, highly wrinkled surface, but no tear

Source: Assessment conducted by researcher, November-December, 2008

It is also glaring from the results recorded that the belly specimens continued to exhibit pronounced wrinkles and fibre looseness; although resisted grain cracks after 360 000 flexes (20 hours). They however gave in to further flex resistance after 40 hours (720 000 flexes). After the final 60 hours (1 080 000 flexes), both sheep and goat belly samples exhibited massive grain cracks, projected fibre looseness at the central fold, highly wrinkled surface, but no tears. The belly area of the local leather demonstrated less worth for the vamp section of shoe upper manufacturing since its endurance to flexing has been found to be feeble.

Comparatively, the butt and shoulder specimens of both goat and sheep leather samples proved high flex resistance from the 1st hour to the 10th hour of continuous flexing, thus, 18,000 to 180 000 flexes, as found in table 4.5 and appendix 2.1–12. Nevertheless, the variations in physical and mechanical properties between goat and sheep leathers as a result of differential biological composition manifested clearly when flexing continued from the 20th to the 60th (360 000 – 1 080 000 flexes). Significantly, it was observed that whilst there were no damages registered on the butt part the goat leather specimens after 20 hours of flexing, the sheep specimens had sustained some wrinkles or creases. Comparatively, after the 40th and 60th hours of further flexing, the butt specimens of the goat leather sustained few wrinkles, without fibre looseness, however, increased wrinkles at the central fold of the butt specimen of the sheep leather, although for both goat and sheep no grain cracks, fibre looseness, or tears were recorded.

The performance of the butt specimens of the goat leather samples, according to the test results, proved worthy for shoe upper production than that of sheep. In addition, even though the shoulder specimens of both goat and sheep leather samples exhibited pronounced damages after 40 hours of flexing, the goat samples were observed to be more resistant to flexing than the sheep leather samples; hence, better impression for footwear manufacturing (Sharphouse, 1995).

4.2.8 Results of Experiment 8: Distension and Grain Strength Assessment (Ball Burst Test)

The intention of this test was to assess the distension and strength of the grain layer of the local vegetable tanned leather samples towards establishing the degree of grain endurance when the material is under flexibility fatigue as found in footwear when walking in them. The test involved the determination of the average load required to crack and also burst the grain surface of the specimens, and the measure of distension of the grain surface. In reference to the results obtained as detailed in *Tables 1 to 6 (Appendix 5A) and Tables 1 to 6 (Appendix 5B),* the butt, shoulder and belly specimens from the 15 sheets of leathers sampled from the five traditional tannery sources across the study regions exhibited varied grain strengths and resistance to grain cracking. However, comparing the performance of the samples to the expected averages of grain crack load (≥30kgf), grain crack distension (≥7), Grain Burst Load (≥35kgf) and Grain Burst Distension (≥8mm), it becomes evident that leathers made in the five local tanneries lack consistency in grain endurance when subjected to flexibility fatigue.

According to the results, the specimens of goatskin leather samples tanned in the southern parts of the country (Mallam Market-Accra and Asawase-Kumasi) recorded the poorest resistance to grain crack and grain burst as compared to those from the northern parts (Tamale, Bolgatanga and Bawku). The belly specimens from Kumasi and Accra failed the test drastically by cracking under force exerted by 17kgf and 20kgf, at average distension of 6.51mm and 6.53mm respectively. At distension of 7.00mm and 6.95mm, the belly specimen both tannery sources had already experienced grain burst. Although the butt specimens of goat leather samples from

Kumasi, Tamale, Bolgatanga and Bawku respectively registered significant range of grain distension within the expected average of 7 or greater, none attained the expected average distension of 8 or greater. The shoulder samples from all the tannery sources were rather disappointing in terms of the distension recorded at grain crack and grain burst; none was able to attain the average ≥7mm expected at grain crack and ≥8mm expected at grain burst.

Surprisingly, the sheep samples from the five tannery sources rather performed incredibly by recording a range of distension at grain crack and grain burst within expectation, in spite of the few anomalies experienced by the shoulder parts. Significantly, apart from the shoulder specimens, the butt and belly samples recorded a range of resistance at grain crack and grain burst at distensions above the expected average of 7mm and 8mm respectively.

Comparing the performance of the sheep and goat leather samples from the local tanneries in Ghana, the test results shows that sheepskin leather samples exhibited better resistance to grain crack and grain burst than the goat, which means that the sheep samples displayed better competence for footwear manufacture. Meanwhile, in theory, goatskin from histological perspective as expressed by Wilson (1923) and Sarkar (2005) has better grain tightness and fibre weave than that of sheep. The abysmal performance of the goat skin may have a link with the manufacturing methods of the leather samples than the architectural integument of the skins used.

4.2.9 Results of Experiment 9: Assessment of Tensile Strength and Elongation

Strength is a basic property prerequisite to most materials' ability to meet their expected efficiency irrespective of the end use they are purposed for. It measures how easy or difficult it is to break, pull apart, tear or crack a given material in relation to its intended utility (Thorstensen 1976; FAO Services Bulletin 67, 1986; Cheng Du, China 2001; Kite and Thomson, 2006; Wilkinson, Lecture notes, 2008). Due to the great force, pressure or streess received by leather when it is employed in footwear manufacturing, it was found prudent to test the tensile strength of the local leather to establish its resistance to mechanical actions such as break, burst, folding, pressing, stretching or fracture in the course of footwear manufacturing or when leather footwear is in utility.

From the comparison of the results presented in *Appendix 5A (Tables 1 to 6) and Appendix 5B (Tables 1 to 6),* it has been realised that the strength behaviour of the various parts such as the butt, shoulder and belly specimens of the local leather's exhibit great variations of tensile strength and elongation to break properties depending on the movement direction of the specimen cut from the leather; whether parallel or perpendicular to the backbone line of the leather as illustrated by Kite and Thomson (2006) in *Figure 4.2 (page 144).*

The leather specimens of both sheep and goat cut parallel to the backbone significantly recorded high tensile strength than those cut perpendicular to the backbone. However, the butt specimens recorded better tensile strength comparatively. The shoulder specimens on the other hand recoreded average range of figures for both parallel and perpendicular specimens which lacked consistency in tensile strength. A correlation established in terms of strength of the leather samples tested reveals that leathers from Bolgatanga have relatively better tensile strength than those from Malllam Market-Accra, Kumasi, Tamale and Bawku respectively. However, relating the results of the tensile strength test to the 15 Mega Pascal to 60 Mega Pascal strength which leathers meant for shoe uppers should be able to meet, depending on the type of shoe to be produced; it can be said that the local vegetable tanned leather relatively possesses weak tensile strength, which in the course of shoe manufacturing will possibly pose problems during toe and heel caps formation as well as lasting. The flexibility of the shoe when in use is also not guaranteed.

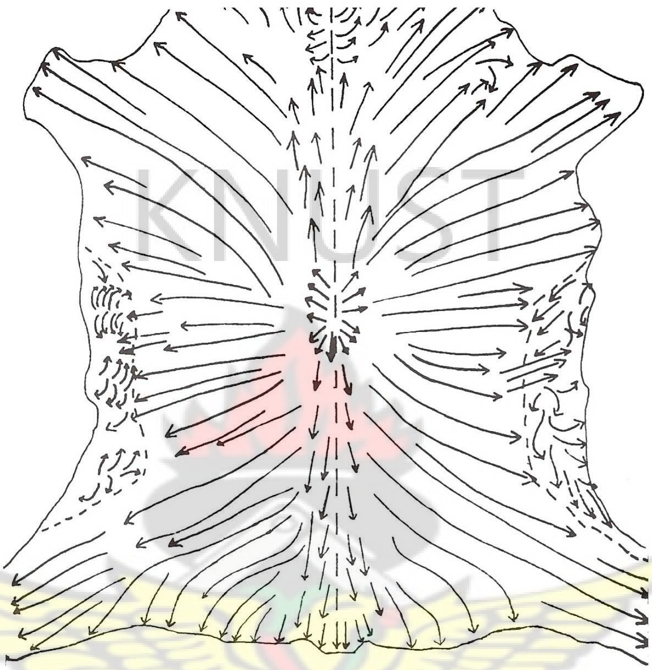

Figure 4.2: Direction of fibre direction and tensile strength movement through a skin

(Source: Kite and Thomson, 2006)

4.3 Analysis of Data for Research Question Two

What are the causes and causations of the local leather's intrinsic and extrinsic deficiencies that result in its inefficiencies of meeting the properties requisite for quality Leatherwork in Ghana?

The objective of data collected was to critically investigate the operations of the various obligatory sectors of animal production in correlation to leather manufacturing towards unearthing the remote causes and causations of the local leather's deficiencies militating against the economic potentials of the indigenous leather industry in Ghana.

Since leather is a product made by stabilising the biological proteins of animal skins and hides through tanning, the source of the animal and its entire background which characterise the insurmountable natural aesthetic and versatile utility of leather is therefore considered a matter of much concern to the tanner, especially when specific qualities are in expectation for specific artefact production. This therefore makes the field of leatherwork so broad to encompass not only the art of leather making and artefact production, but also, to operate far beyond the tannery to liaise with a mandatory multi-sectorial allied endeavours which are crucial to its survival and sustainability (Wilson, 1923; O'Flaherty, 1958). Such core multi-sectors include the livestock farming industry, the meat industry, chemical companies, tannery machinery engineers and operators, as well as all phases of chemistry, physics and biophysics. Therefore, any flaws encountered in these sectors render the industry susceptible to flopping economically. It was this backdrop that instigated the necessity to interrogate the operations of the Ghanaian animal husbandry system, animal transportation, the meat industry (abattoir practices), skin and hide markets, as well as the indigenous tannery approaches and technological standings to unearth the remote causal reasons underlying the numerous intolerable physical and mechanical properties deficiencies identified from the tests conducted to solve research question one of this study.

The data gathered have been presented both quantitatively and qualitatively by the principle of **analogous causes-and-effects analysis** of the direct impact rendered to the local leather by every activity assessed in the operations of the various mandatory sectors in relationship to the deficiencies and inefficiencies faced by the leather. In a comprehensive sense, the causes have been dealt with to surface the causations and resulting effects.

4.3.1 The Nature of Livestock Species in Relation to Skin/leather Quality

It is well established that the existence of the global meat industry is the sustenance of the leather industry; the latter is parasitic of the former in every logical sense. However, both are highly dependants of the animal: its availability, accessibility and affordability. The knowledge of the available livestock species in a geographical location accessible to the tanner is therefore crucial to judging or predicting the economic aptness of the skin or hide for quality leatherwork. It became evident from the observations made that animals predominantly raised in Ghana can be grouped under bovine, ovine and caprine, although some pigs and equine are also available across the country. These animals, as emphasised by Koney (2004) and Iwena (2008), are classified basically as the **"dwarf types"** irrespective of the species; and that implies that they are relatively smaller in body size, and their product yield possess comparatively less economic potentials. As the largest single organ of the animal's composition, the skin which forms the 5th quarter of the animal's meat product is not exempted.

Statistically, out of the total 2 500 livestock surveyed from the various farms five regions of the country, 850 were ovine, 700 bovine, 850 caprine and 100 represented equine and swine respectively. It was noted that out of the 700 cattle assessed, 500 were mainly the West African Shorthorn and N'dama breeds which comparatively looked smaller, although the N'dama appeared a bit bigger. Zebus

(Gudale) which were found relatively bigger occupied 60 of the total, whereas 15 were Sanga breeds known to be a cross-breed of West African Shorthorn and Zebu. The last 5 identified were the Dwarf Lagoon Cattle popularly known as Muturu breed which appeared exceptionally smaller in body size. The quantity of goat and sheep assessed were 1 700 in total (850 each).

From the field data gathered, two main breeds of goat and sheep categories surfaced: the West African dwarf sheep and goat and the Sahelian sheep and goat originally from the Sahel zone of Africa. The records showed that the dominant breeds of goat and sheep native to Ghana and predominantly reared are the West African dwarf sheep (Djalonke) and the West African dwarf goat which recorded 700 and 750 respectively. The Sahelian sheep and goat assessed were 150 and 100 respectively; they appeared taller and reasonably bigger than the local breeds. The local sheep breed measured an average of 40-60 cm and the goat 15-45cm after 6 months of birth.

In correlating the results from the analysis to leather production potentials of the breeds of livestock assessed, it becomes evident that the fairly smaller size nature of the native livestock species does not support the production of large area/size quality leather, especially when compared to the leather size yield of international livestock breeds including the Aberdeem Angus, Galloway, Hereford and Gertrudis cattle, Persian Blackhead sheep, Sahelian sheep breeds, Sokoto Longlegs sheep, British Saanen goat and the Boar goat of South Africa and (Sharphouse, 1995; Koney; 2004, Iwena; 2008). It is therefore concluded that the area size deficiency associated with leathers produced locally emanate from the comparatively smaller size nature of livestock native to Ghana *(See Plates 4.1(a) and (b) on page 148)*. This is because animals with such smaller body size are incapable of generating the area properties usually demanded for economic shoe upper clicking, upholstery or fashion leather articles requiring large areas (6 sq. ft) of leather with uniform colour and thickness, softness, flexibility, and good drape (Sharphouse 1995).

Plate 4.1(a): West African dwarf goat

Plate 4.1(b): West African dwarf goat

Plates 4.1(a) and (b): Example of small size native livestock breeds in Ghana
(Source: Field photographs, September-November 2009)

4.3.2 The Nature of Livestock Management System and Impact on Skin/Hide Quality.

The impact of the farmer and the farming method employed in raising animals to bear skins with properties essential for leatherwork has seen a lot of research over the years in various countries. It is well established by De Haas (1925) and Sharphouse (1995) that the understanding of the animal farming practices evolutes the explanation of most defects associated with the leather. The assessment of the nature of livestock management system was carried out in the light of identifying the impact of the animals' own lifestyle as fashioned by the owner on the productivity of skins and hides which possess the properties prerequisite for the manufacturing of quality leather. For the purpose of the intent of this study, these management systems are classified by the nature of housing, feeding practices, breeding system, healthcare conditions, and general maintenance of animal welfare in relation to the ability or inability to yield skins with qualities requisite for Leatherwork.

Although the study was limited to only 30 farms in five regions of the country, it has created clear picture of the extraordinarily lifestyle of animals in Ghana and also explains better the enormous contribution the farmer makes to the poor quality nature of leathers made locally. In each of the five regions (Upper East, Northern region, Ashanti, Eastern Greater Accra and Volta) it was revealed that farmers raise livestock for subsistence or commercial purpose, however, since the number of animals owed is a major determinant, the subsistence livestock farming is predominant (Koney, 2004). The farmers raise livestock in small group of between 5-10 by individual or in large number of 20-50 or more in some modern farms under three categories of farm management systems identified as the **extensive, intensive and semi-intensive**.

4.3.2.1 The Extensive System: This livestock management system is the predominant farming system of raising animals found in the five regions visited, since it occupied 20 of the 30 farms visited. In this method the animals, especially goat and sheep are basically raised in a free range manner, that is, they are left to roam about day and night to fend for themselves in their communities on a wide range of pastures. There is no special housing unit, no medication or supplementary feed provided in most cases. Cattle on the other hand are found mostly managed by peasant or nomads, especially the Fulani herdsmen, who also roam with the animals in search of pasture and water. The free range method, (*as shown in Plate 4.2)* although the cheapest and commonest, is identified as the chief factor encumbering the generation of quality pelt for Leatherwork. Its impact has been discussed in the subtitle ***'Impact Assessment of the Three Livestock Management Systems on skin/hide quality' on 153.***

Plate 4.2: Livestock roaming to fend for themselves under the free range method of extensive management system.

(Source: Field photograph, September-November, 2009)

4.3.2.2 The Semi-Intensive System: Unlike the extensive system, the semi-intensive system is identified as the type of livestock management practice that requires the provision of housing, water and feed for the animals, although the animals are also allowed to move out to graze. This method is common in 7 of the 30 farms visited. It has been emphasised in the submissions of various writers such as Mann (1951), Koney (2004) and Iwena (2008) that this method, in most cases, comprises pasture management to provide adequate feed for the animals, it is found otherwise in the 7 farms. The farmers rather fetch pasture from communal grazelands for the animals and make conscious effort to supply supplementary feed, especially, in the dry season. Healthcare, according to the farmers is attended to when necessary. The impact of this farming method on skins/hides quality has been discussed in the subtitle ***'Impact Assessment of the Three Livestock Management Systems on skin/hide quality' on page 153.***

Plate 4.3(a)

Plate 4.3(b)

Plates 4.3 (a) and (b): Livestock kept under semi-intensive method of farming

(Source: Field photographs, September-December, 2009)

4.3.2.3 The Intensive System: The intensive system happens to be the less practised management system of livestock in the five regions visited, although it emerges as the most favourable management system for quality delivery of economically viable skins and hides for leatherwork. In this system, the animals are found confined within housing units and they have limited access to grazing. The daily needs of the animals such as water, pasture and medication are supplied by the farmers. A careful examination of the animals' skins reveals that this management system is the best practice for maximising skins/hides utility. The animals are well fed on cut forage;

cassava/plantain peels and concentrates which guarantee early maturity for the market. However, due to the intensity and enormity of labour and capital required in this farming system, especially, its **'zero grazing'** nature, only 3 out of the 30 farms visited practise this system. The details of the impact of this method can be found in the subtitle ***'Impact Assessment of the Three Livestock Management Systems in skin/hide quality' on page 153.***

Plate 4.4(a)

Plate 4.4(b) Plate 4.4 (c)

Plates 4.4(a), (b) and (c): Livestock kept under intensive system of farming.

(Source: Field photograph, September-December, 2009)

4.3.3 Impact Assessment of the Three Livestock Management Systems on Skin/Hide Quality

Comparing the mode of operations of the three livestock management systems (**extensive, intensive and semi-intensive)** studied, there is a wide range of common and distinctive impacts of defects inflicted by each of them to encumber animal productivity and quality delivery of skins/hides. The causative factors of defects identified exceedingly emanate from the nature of housing, sanitation, feeding culture, healthcare; medication, disease and pest control, breeding and general maintenance of the animals (Mann, 1951; De Haas, 1956; Elliot, 1986; Sharphouse, 1995; Koney, 2004 and Iwena, 2008).

4.3.3.1 Housing and Sanitation: The method of housing and sanitation management among the three farming systems is seen as a major hindrance to animal productivity and acquisition of quality skins and hides to foster economically viable leatherwork in Ghana. In accordance with the assertions by Koney (2004) and Iwena (2008), it is realised that most of the farmers who practised the extensive method paid very little or no attention to good flock management and upkeep of the animals as compared to the intensive and semi-intensive systems. From the interviews granted by the farmers, the animals in almost every farm visited are left roaming under the scorching sun and heavy rainfall without the provision of shed for any protection. Even in cases where kraals or pens have been provided, as found in the semi-intensive and intensive systems, roofing is found inadequate and kraals sanitation poorly kept. The kraals get filled up when it rains, and since cleaning is not regularly carried on, especially among the semi-intensive system, the animals are left susceptible to cold, bacterial infections, prolong contact with soaked dung and pest infestations leading to skin damages and coarse grains. Housing and sanitation under the intensive system is comparatively encouraging, although not sufficient.

Plate 4.5: Free range homeless livestock sleeping on the street at night
(Source: Field photograph, September-December, 2009)

4.3.3.2. Feeding Culture: Feeding during the dry season is found horrendous for the livestock kept under the extensive and semi-intensive systems, especially, in the Northern and Upper East regions, as well as the northern parts of the Volta region. Facts deduced from the response of the farmers interviewed reveal that most of the farmers keep the animals on subsistence basis or as hobby, although 5 out of the 30 farms visited are on commercial basis, yet the farmers lack knowledge in feeding that could adequately supply the animals with the six classes of food nutrients: carbohydrates, proteins, minerals, vitamins, fats and oil and water. Due to lack of systematic pasture and foliage management practices, feed on communal grazelands are found scarce as expressed by Koney (2004). Even during the rainy season when pasture is available, the animals are found feeding on overgrown grasses which Koney (2004) again says lack crude nutrients to nourish worn out tissues of the skin.

The impact of acute hunger faced by the animals raised under extensive and semi-intensive was critically observed when the skins and hides were mostly found obviously covering depressed bony body structures which according to Sharphouse (1995) and Sarkar (2005), lead to bad skin contours and undulating skin surface which inhibit leather surface setting and flatness.

4.3.3.3 Healthcare and Medication: Animal healthcare management system among the intensive and semi-intensive practices was found unsupportive to the wellbeing of the livestock and generation of quality skins/hides. As a result of the rampant roaming and browsing in search of feed and water as commonly associated with the extensive system, the animals easily become susceptible to parasitic attacks and all kinds of pathogenic infestations such as bacterial, viral, fungal, protozal and helninth leading to various dermatitis that affect and reduce the economic value of the skin (Elliott, 1986; Sharphouse, 1995; Koney, 2004; Iwena, 2008). Although the few farmers practising the intensive management system have knowledge on disease management, the majority of extensive and semi-intensive farmers lack sufficient knowledge in livestock disease identifications based on symptoms, medical care and preventive measures. The farmers complained of high cost of drugs, insecticides, deworming and veterinary services.

Statistically, it was noted that an average of 8 in every 10 animals whose skins were inspected had been affected by dermatitis (***skin infections***) of one form or the other. Commonest disease found included mycotic dermatitis, Lumpy skin disease, Pox, *Dermatomycoses* (Ringworm) or *Dermatophilosis,* which according to Koney (2004) is an acute or chronic exudative dermatitis characterised by scab formation in a wide range of domesticated animals. Menge was also identified as skin damaging disease common among bovine, ovine and caprine species in the various farms, irrespective of the management system. It was identified as very disincentive to the generation of quality pelt for viable Leatherwork.

4.3.3.4 Growth Rate and Maturity: Again, according to the field observation, the feeding pattern of animals raised under the extensive system is identified to retard animal growth, development and maturity. Late maturity of livestock emphasised by FAO Animal Production Series No.7 (1955), Koney (2004) and Iwena (2008), affect meat productivity, as well as skin and hide quality and economic utility. According to De Haas (1925); Sharphouse (1995) and Sarkar (2005), overgrown or late matured animals develop skin wrinkles, coarseness, poor elasticity and tensile strength, as well as diminished aesthetic appeal.

Since most of the animals are found roaming and travelling longer distances for food and water on refuse dumps, communal lands, roadsides, town and city centres, backyard gardens and homes of people to cause nuisance, they spend almost all their energies for growth in walking, trotting and jogging. They almost set out empty stomach and return empty stomach. Meanwhile, a careful watch of the animals show that foods found are insufficient in quantity and imbalanced in the right nutritional content to maintain their anatomical and physiological activities of the animals. Even forage plants such as grasses, legumes and other herbages found on rangelands which the cattle, goat sheep and horses mostly depend upon look overgrown due to lack of pasture control and management. According to Koney (2004) and Iwena (2008), such feeding practices lack the ability to nourish the skins of the animals and promote the entire health of the animal.

4.3.3.5 Breeding System: Among the 30 farms visited, the predominant breeding system encountered was basically natural, indiscriminately and highly uncontrolled, especially within livestock raised under the extensive and semi-intensive systems. The animals were found mating sporadically on the fields while grazing. Such breeding practices are described by Koney (2004) and Iwena (2008) as in-breeding or line-breeding, since it involves making of more closely related animals, e.g., mating of father to daughter, mother to son or brother or sister to brother or even cousin to cousin.

Such indiscriminate breeding is found extremely disincentive to animal productivity and the generation of good quality leather due to the fact that it encourages skin defects such as cuts, scratches and wounds resulting from in-fighting among the males as they struggle to gain accessibility to the females on heat. The animals also end up transferring undesirable characteristics such as diseases, late maturity, uneconomical eating habits, bad physical features such as smaller body sizes resulting in smaller leathers with less area yield, humps and undulating body structure and contours which end up affecting leather surface setting. The According to Koney (2004), in terms of animal health, anatomical and physiological improvement of offspring, in-breeding does not render much support to acceleration and maximisation of animal productivity. Unfortunately, the responses gathered from the farmers reveal that they have less or no knowledge about planned or controlled breeding requisite for improved animal features.

4.3.3.6 General Maintenance of Livestock: In most of the farms, apart from the intensive system, general maintenance of livestock was found poorly and unsupportive to animal health, general productivity and delivery of quality skins/hides. Under the extensive and even the semi-intensive systems, since the animals are characterised by roaming on communal lands and rangelands comprising grasses, shrubs, thorns, and all kinds of forage, they usually are exposed to high rate of acquiring wounds or sores or scratches on their skins when encountered by crop farmers and predators. In a similar manner, animals which roam in urban streets are sometimes knocked down by automobiles, and acquire fatal injuries on their skins or even die leading to losses. Again, during roaming, the animals are mostly regarded as nuisance to human activities; hence, stones are thrown at them leading to injuries on the skin. Young animals that lack the capability to roam after their mothers usually get missing or stolen, leading to losses.

Proper record keeping which has been described as an integral part of successful husbandry operations was non-existent in 27 of the 30 farms visited across the five regions. Records on animal birth, health conditions, weaning, feeding pattern, breeding, mortality rate and castration were not available, and that made it very difficult for the farmers to determine the age differences of the animals as a means to predict time of maturity. Branding which is a common practice in the three farming systems has been identified as disincentive to quality skin/hide deliver, especially, branding at the butt area which is the most essential part of the animal' skin for quality leatherwork. Also, animals which are not dehorned regularly hurt their skins during fighting. This is common among the semi-intensive and intensive management systems where in-fighting is predominant.

4.3.4 Assessment of Livestock Activities at the Afram Plains in the Midlands of the Country

The Afram Plains, a district with grassland vegetation terrain which extends into other districts such as Kumawu, Sekyere Afram Plains District, Drobonso, Asante Akyem North, Kwahu North- Donko Krom, Mampong Nsuta, Adjura Sekyeredumasi, and also stretches across the Volta Lake into the Volta and Northern Regions. The topography is a plane vast land which integrates and represents the northern and southern climatic conditions and vegetations to create a favourable terrain for livestock raising. Animal husbandry activities are found mainly dominated by Fulanis from neighbouring countries in West Africa such as Northern Nigeria, Niger, Mali, and Burkina Faso.

According to the Fulanis interviewed and personal observation, the grassland possesses adequate support for livestock rearing; the terrain is tsetsefly free, which is advantageous for larger breeds such as zebus brought down into the country and can be depended upon for cross-breeding to enhance the size quality of the local breeds. The vegetation is grassland with rich forage, water is available due to the presence of the Afram river and Volta Lake. In spite of all these advantages, there is unquenchable quarrel between crop farmers and livestock farmers, especially the Fulanis, since it is claimed the animals are destructive to crop farms. It was noted that the Fulanis, though possess the expertise and control larger quantities of livestock per herd (100, 500, 1000 per herd), they lack recognition as farmers in the country, hence lack security for themselves and the animals, no veterinary care or incentives from government agencies since they are seen as illegal operators. Meanwhile they are mostly caretakers of livestock owned by Ghanaians rich farmers and the animals they care for are sold and consumed locally.

4.3.5 Assessment of the Equine Group

For the equine group, there was no access to any hide for assessment, since they are slaughtered on rare occasions in Ghana. Koney (2004) has it that some animals domesticated are more economically valuable when alive than dead; animals such as horses, mules, donkeys, camels, asses and giraffe fall under the equine category. However, due to their integration and massive contributions to man's economic and social activities, they are valued alive, hence slaughtered only when aged (too old), sick to death, encounter fatal accidents or reach energy declination stage of life. Animals in the equine group assessed are horses and donkeys found in Greater Accra, Kumasi, Tamale, Bolgatanga and Bawku. The horses found in Accra and Kumasi, were mostly for ceremonial purposes and sporting activities. The chiefs from the northern parts who have migrated to settle down in the Zongo communities display their rich cultural backgrounds during festivals and durbars. The state military also possesses some horses for decoration during state ceremonial activities such as the Independence Day, State Anniversary celebrations and durbars. Racing is the only sporting activity found to involve horses. Notwithstanding, leisure riding, particularly at the beach for amusement or entertainment, has also been found as a growing business in Greater Accra.

Donkeys assessed on the other hand belong to individuals, especially, in the northern parts of the country. The animals are found to be seriously engaged in daily farming and other economic activities which require transporting goods from one point to another. The donkeys pulled carts loaded with firewood, foodstuffs, charcoal and other goods in transit across the Ghana-Burkina Faso boarders. In Accra, the few found are engaged in drawing carriages for collecting garbage.

When the owners were interviewed, it was noticed that the horses receive better welfare in terms of feeding and shelter than the donkeys, although the donkeys are more engaged in daily economic activities. The horses are given supplementary feed and less grazing while the donkeys solely depend on grazing usually between farming hours. However, hides from the equine group are hard to come by. Although 10 pieces was the sample targeted, the researcher came across only one hide and when assessed was wrinkled all over the surface with growth marks, especially around the neck area and on the backbone line.

4.3.6 Impact Assessment of Livestock Marketing and Transportation

Based on the presupposition in this study that any activity capable of hurting the animal's skin in any manner is considered tangible to having adverse implication in the delivery of good quality leather, the possible dangers that could be posed to the attainment of unblemished skins and hides by the mode in which animals are traded in open markets and transported to slaughter centres were assessed. From critical observation of the trading activities transportation operations in the 8 sampled livestock markets and loading points in Greater Accra, Kumasi, Tamale and Bolgatanga and Pougtinga in Burkinga Faso, it became evident that most animals sold in the various markets are transported from one or more destinations to a market source before finally ending up in the slaughter centres. At the Ashaiman cattle ranch in the Greater Accra Region, it was noted that every 9 out of 10 long trucks which offloaded livestock originated from a nearby country, comprising Mali, Niger, Senegal or Burkina Faso. Having travelled such longer distances with less or no feed accompaniment, they were tied to poles together in herds of 10-15 with again little or no supplementary feed. Since the animals are traded in unregulated open markets by middlemen, they are left under the scorching sun and rainfall. Prices lack control, and livestock kept at the markets for more than four days were found skinny and unhealthy due to hunger. The contours of their skins/hides were found undulating and depressed into a hollow butt bone. This situation was not different at the Race Course and Akwatialine in Kumasi, Circle in Accra, Bolgatanga livestock market and Tamale.

In conclusion, since there is no transportation standards set for livestock movement, the means of livestock transportation prevalent at the various loading and offloading points lack regards for animal welfare as well as health and safety. Due to the fact that they are overcrowded in long vehicles, small transporters, car boots, tied on top of busses and even under passenger bus seats, the retched nature of most of these vehicles often leads to all kinds of sores and wounds on the skins/hides of the animals which affect their economic value in Leatherwork.

4.3.7 Impact Assessment of the Operations of Livestock Slaughter Centres

With particular reference to ISO 2822, part 2, no.1, FAO Animal Production and Health Series (No.7, 1955), FAO Agricultural Development Paper (No.49, 1955), Sharphouse (1995) and Koney (2004), bleeding in theory and principle is said to be the object for slaughtering animals, since blood has the capability of accelerating autolysis leading to red meat, however, the negative impact of other abattoir operations on skins and hides quality besides bleeding cannot be overemphasised.

Through participant observation and interviews, the activities of 12 slaughter centres in Ghana were investigated: 2 abattoirs (Kumasi and Accra), 4 slaughter houses (Kumasi, Greater Accra, Tamale and Bolgatanga), and 7 slaughter slabs in the same areas respectively. It was noted at the lairages and holding pens of the two abattoirs, mixed breeds of bovine, ovine and caprine mainly imported from nearby countries were found. The bovine included zebus, West African Shorthorn, Muturus and Gudaris. The goats and sheep comprised mostly the Sahelian types, and few West African Dwarfs, as well as the Fulani types. The story was similar at the slaughter centres and slabs, except that goat and sheep were dominant. At the two abattoirs operations regarding slaughtering, flaying and dressing of animals were found in conformity with international specifications as found in De Haas, 1925, Elliott (FAO Bulletin1982), Gerhard 1996, Sharphouse (1995), ISO 2820:1974, ISO 7482-1:1998, ISO 2822-1:1998, ISO 4683-1:1998, and Koney 2008. Slaughtering, although followed the Mohammedan than stunning with a bolting gun, was quite humane, and the rest of activities such as bleeding, flaying, evisceration, splitting and washing and chilling were all performed with the carcass hoisted on overhead rails at different stations.

The mode of operation at the slaughter houses and slabs however did not follow any particular regulatory procedure although the activities at the slaughter houses were a bit organised, there was not much to be desired. In accordance with Koney's (2004) observation, the animals were found slaughtered on dusty floors with all four feet tied together with rope, bled while lying on one side, flayed in unhygienic conditions and the hide was spread on the floor and the carcass put on it and eviscerated. It is worth mentioning that, statistically, only 2 out of every 10 ruminants slaughtered had the skins flayed; the majority were singed for skin-on meat, especially the caprine and ovine species. For pigs, none of the slaughter centres carried out flaying; the hogs were dehaired in hot water and singed for total consumption. Also, relatively, the weight and area of fresh skins and hides (40 bovine, 50 ovine and 30 caprine respectively) measured recorded values which portrayed lack of size quality, particularly in the dry season. Averagely, the bovine hide recorded 6.5 kg in weight and 4.5 sq.ft. in area; the ovine recorded 2.2 kg in weight and 1.8 sq.ft. in area. The fresh skins of caprine breeds measured and average of 1.6 kg in weight and 1.4 sq.ft. in area. The records signified lack of adequate feeding, skin hydration and replenishment as well as lack of skin substance and probably blood.

Comparatively, the two abattoirs observed possess the capability of quality delivery of skins and hides for economically viable leatherwork, however, due to the general perception that the skin/hide is meant for “kawuro” or “wele” processing, there is little or no attention paid by dressers and flayers. They make unnecessary cuttings and scratches, trim anyhow, fail to wash them, leave them in unhygienic conditions such as blood, dung and dirt which facilitate microbial attack leading to fibre deterioration. The operations carried out at the slaughter centres in Ghana simply do not take into consideration the economic viability of skins and hides as by-products for leatherwork.

4.3.8 Impact Assessment of Pelt Preservation and Marketing

According to ISO 2820:1974, Sharphouse (1995), Gerhard (1996) and ISO 2822-1:1998(E), due to the massive negative impact of microbial activities on fresh skins and hides meant for leather, preservation is regarded in high esteem by all insightful stakeholders such as butchers, flayers, dressers, curers, hide merchants, as well as tanners. The impact assessment conducted at the four skins/hides markets reveal that drying and salting are the two major curing methods employed against putrefaction. Drying, especially sun drying, although renders skins and hides less economically useful, remains predominant in Ghana.

Due to various reasons such as animal protein insufficiency, poverty, delicacy, and taste, as gathered from the respondents interviewed, there is a common trend of influx of imported dried skins and hides on the Ghanaian market from Burkina Faso, Mali, Niger, Northern Nigeria, Senegal, Mauritania, La Cote Devoir and Chad purposely for 'wele' or 'kawuro' to augment animal protein supply, despite its less or non-recognition as viable protein source for consumption. Basically, the activities concerning curing and preservation lack cognisance for skin and hide availability, accessibility and affordability for quality Leatherwork. The tanners therefore compete to find even the worse quality standard pelts at high cost for leather processing.

4.3.9 Impact Assessment of Indigenous Tannery Activities

Theoretically, tanning has been discussed by Wilson, (1923), O'Flaherty (1956; 1958), Bienkiewicz (1983), Sharphouse (1995) and Sarkar (2005) basically as a means of converting putrescible animal pelts into imputrescible leather through chemical applications which form cross-links in the collagen structure and stabilise it against the effects of acids alkalis, heat, water and the action of micro-organisms. The type of tanning materials and technology used, however, control many of the properties of the finished leather and make it more useful for its intended purposes. It is on this backdrop that the operations of the local tanneries in Accra, Kumasi, Tamale, Bolgatanga and Bawku respectively have been assessed to identify how parameters such as tannery settings, materials used, tools, equipment, tanning methods and techniques, water quality, health and safety, as well as finishing technologies affect the generation of finished leathers.

As discussed by Atiase (2004) and Boahin (2005; 2009), the indigenous tanning sector in Ghana is noted as basically the cottage type, and it operates on conventionally time-honoured methods which employ local technologies in terms of tools, materials, skills and methods. Due to its non-automation nature all tanning and post-tanning operations are carried out manually by the pit or vat system at the various tanneries. It was evident that the conventional production methods employed are obsolete, cumbersome and less economically viable, especially when the major equipment used are partially cemented hand-dug pits, mortar and pestle for crushing plant leaves, pods, fruits and seeds to extract tannins; culverts and blunt machetes for beaming (dehairing and defeshing); barrels for soaking and buckets for fetching water. Conventionally, production procedures are rudimentary such as soaking by immersion in water, liming with wood ash and carbide (lime waste) by immersion, dehairing and defleshing, deliming with vegetables such as *Carica papaya* leaves (pawpaw leaves) or *Cucurbita pepo* (pumpkin) or 'kibiwa' in Hausa, Tanning with *Acacia nilotoca* (Egyptian Mimosa), locally called Bagaruwa in Hausa, partial drying on lines (wire or nylon ropes), stretching (pulling) and final drying on nylon ropes lines or nailing on the floor. The predominant post-tanning processes identified encompass fatliquoring by applying vegetable cooking oil on the grain surface with a rug, followed by dyeing with vegetable extracts from the leaves of *Sorghum bicolor* (sorghum plant), locally known as 'karandafi' in Hausa. Water is squeezed out and the leather is pulled while damp and dried.

Although the process generated leathers which are vegetable tanned, the results observed at the beamhouse and tanyard as compared to existing tannery operations revealed several anomalies and inconsistencies in the execution of leather production processes leading to various defect which directly relate to the deficiencies identified in the physical properties of the leather samples tested. As commonly found in indigenous production settings as identified by Edusei (1999), in the first place, since weighing of chemicals is done with the palm or the eye instead of balance scales, there is lack of accurate measurements, equations and estimation of chemical quantities such as weighing of water, lime, tannins and dyes as against the quantum of pelts being processed into leather. In each of the five tanneries, tanning of caprine and ovine skins was not found as separate treatment, although it has been emphasised by Thorstensen (1976), Bienkiewicz (1983) and Sarkar (2005) that ovine skins are fatty and needs separate degreasing treatment to eliminate the fats to foster free movement of the tanning agents within the collagen fibres of the pelt for adequate cross-linking for efficient tanning.

In terms of raw material availability and distribution, the northern parts of the country prove to be favourable for tannery establishments than in the south due to the fact that plant sources including *Acacia nilotica* and *Panicoideae andropogoneae*, as well as *Cucurbita pepo* are readily available in Tamale, Wa, Bolgatanga and Bawku areas. Besides, it has been noted that the nearness of the northern parts to Burkina Faso and the Sahelian countries also makes it possible for effortless importation of tanning materials which are in abundance due to the plant's thriving capacity habitats which are heavy and poorly drained soils or sandy-loamy drained soils. Although the tannins are available in the south, they are expensive and usually of poor quality since the plant when grown in forest vegetations accumulate water in the pods and the water eventually dilutes the tannic acidic content needed for cross-linking the protein fibres of pelts into leathers.

4.4 Discussion of Main Findings of the Study

Having examined the physical properties of the indigenous vegetable tanned leather to corroborate its quality standards and general suitability for the production of quality artefacts, the data analysis revealed several inadequacies in the material's qualities which collectively contribute to its underperformance and justify the hostility it faces in the realms of industrial leather utility of artefact manufacturing, such as footwear, upholstery, clothing accessories and garment sectors. When the researcher probed further into the causal reasons by relating the activities of animal husbandry, abattoir practices and indigenous tannery, the analysis of the data congregated further unearthed comprehensive factors which gave in-depth explanation of the causes, causations and effects resulting in the poor economic value nature of the Ghanaian indigenous Leatherwork. These necessitate the production of quality leather in Ghana to meet the prerequisite properties for industrial utility and applications for revenue generation to support economic development. With reference to the data analysed, this section discusses the findings deduced from the entire study conducted.

4.4.1 Findings for Research Question One

Does the Ghanaian indigenous vegetable tanned leather possess the properties requisite to assure quality in the production of contemporary leather artefacts such as shoes, upholstery, clothing and garment and containers?

With the objective of ascertaining the quality status, general competence and appropriateness of the local leather for industrial utilisation and applications in the high leather consumption sectors of artefact production such as footwear, upholstery, clothing and garment, and containers, the following findings have made.

4.4.1.1 Locally Tanned Leathers Possess Efficient Stability to Putrefaction and Shrinkage Temperature

The enzymatic and boil tests conducted have collectively revealed that the local leather possesses adequate resistance to putrefaction and temperature; that is, the two most important properties basic to pelts successfully converted into leather by crosslinking of collagen fibres and tanning chemicals generically called tannins. This brings to light that by virtue of the potency of the astringency (tannic acid) inherent the vegetable tannage sourced from the acacia plant (*Acacia nilotica*), known locally in Hausa as 'Bagaruwa', the local leathers are rendered with adequate stability to decomposition by microbial attacks, and shrinkage resistance resulting from heat or maximum temperature of ≤ 75.3.

4.4.1.2 The Local Leather is basically the Crust type and Relatively Sub-Standard in Quality for Industrial Utility

This is due to the fact that its physical properties face manifold defects and deficiencies which confirms Boahin's (2005; 2009) assertion that the local leather faces several impediments which leave much to be desired. The deficiencies are discussed as follows:

a. Although, the leathers are tanned to resist putrefaction and shrinkage they still lack adequate pliability, softness, surface smoothness and bending ability which should have been acquired through pretanning, retanning and finishing activities at the tannery. This means that the local tannery operations fall short of pretanning, retanning and finishing operations which according to Sarkar (2005) are techniques prerequisite to adding other essential properties to attain more economically useful leathers.

b. Local leathers are deficient in area size and regular shape leading to less economic cutting value. It has been revealed that generally the leathers produced in the country are relatively smaller in size, and their predominantly irregular shapes violate the standard shapes of full sheet leathers known in the global leather business sector as discussed by Sharphouse (1995). The average size quality assessment results obtained (*Table 4.2, page 129*), show that more than 50% of the 1500 pieces of bovine, ovine, bovine and caprine leather samples respectively failed to meet the expected average size of 2.5 square feet for ovine and caprine, and 6.0 square feet for bovine, although these are critically basic sizes.

The size deficiency associated with the local leathers adversely affects the economic cutting value, restricts the use of templates for pattern cutting and also inhibits broad-spectrum utility and applications of the local leather very much, especially, when cutting surface area beyond 2.5 square feet is needed to cut more than a pair of shoe uppers, or the length of garment or even to cover a wide surface of living room or office sofas (upholstery).

c. The local leathers are deficient in grain and flesh surface quality for direct industrial utility and applications

The results of the grain surface and flesh surface assessment, as found in tables 4.3 and 4.4 respectively, bring to light the unpardonable rampant grain surface defects and excess flesh on the flesh side of the leathers. Defects found range from cuts, holes, scratches, wrinkles or creases, surface peelings, and stains of black and dark brown spots, as well as uneven colouration. These grain surface damages render devoid the local leather the 'true pride' of leather since the grain surface appeal remains as the basic determinant of the aesthetic appeal of leather. In addition, the leather with such high quantum of excess flesh and grain blemishes automatically defines its grade as low, less utility and poor economic value (De Haas, 1956; Sharphouse, 1995; Gerhard 1996). It has also become evident that leathers possessing high quantities of excess flesh also emit stronger unpleasant odour.

d. Local leathers fall short of requisite thickness

From the thickness test conducted, it has been identified that the local vegetable tanned leathers from caprine, ovine and bovine possess poor thicknesses which fall below 1.5mm and 4mm respectively, which the researcher considers appropriate for shoe upper production, splitting to increase economic value and shaving for even thickness. It is relevant to also mention that in spite of the insufficient thickness of the local leathers, they can be employed in the manufacturing of artefacts that require reinforcement.

e. Poor flexing and flex endurance

Flex is a an indispensable property prerequisite in leathers essential for such end uses such as footwear (especially the vamp area), garment and clothing accessories including gloves. It has been identified that the local leathers possess varied cross-sectional properties according to the movement of the fibre weave and fibre bundle. Although the butt sections exhibit encouraging flex resistance, a further enhancement on the materials' flex endurance through sufficient tanning is necessary to guarantee adequate utility in footwear production. Ward (1997) equally asserts that, perhaps the most striking common feature of many types of leather is the ability to withstand repeated flexing without failures. Shoe upper in the vamp region provides an appropriate illustration of this point (Bordeli, Vol.3 1936; Lyon 2004).

f. Leathers made locally possess inadequate fullness

The assessment of the local leathers' fullness has augmented the determination of the degree of compactness and the impact of fibre substance on bending, thickness, flex resistance as well as softness requisite in footwear manufacturing. The local leather, generally exhibit poor fullness of substance at the belly and the shoulder portions, even though the butt parts express moderate fullness capable of serving the purpose of shoe uppers tanning strategies capable of filling the porous fibres of the belly to make it more useful.

The variable fullness behaviour of the various parts of the leather samples from the local tanneries confirmed true manners typical of leather as emphasised by

Sarkar (2005). The collagen structure of a sheet of leather irrespective of the animal exhibits varied fullness which influences the mechanical properties such as softness, flexibility and stiffness, as well as bending and moulding abilities.

g. Weak distension and grain strength

Assessment of the distension and strength of the grain layer of the local vegetable tanned leather samples established that, the degree of grain endurance when the material is under flexibility fatigue is found in footwear when walking in them. The grain surface cracked at mean distension below the basic expectant average of 7mm and burst at distension below 8mm by the exertion of 30kgf and 35kgf respectively. Although the butt sections of the samples preformed appreciably, it became evident that leathers made in the five local tanneries lack consistency in grain endurance when subjected to flexibility fatigue. The sheep samples from the five tannery sources rather performed incredibly by recording a range of distension at grain crack and grain burst within expectation. Comparing the performance of the sheep and goat leather samples, the sheepskin leather samples exhibit better resistance to grain crack and grain burst than the goat, which contradicts the histological perspective expressed by De Haas (1956) that goatskin has better grain tightness and fibre weave than that of sheep.

h. The tensile strength of the leathers are not fully apt for footwear

In terms of strength which according to Thorstensen (1976) is needed to measure how easy or difficult it is to break, pull apart, tear or crack a given material in relation to the force, pressure or stress which it encounters when in utility, it has been ascertained that the local vegetable tanned leather relativelly possesses weak tensile strength, which in the course of shoe manufacturing will possibly pose problems during toe and heel caps formation as well as lasting.

Although the butt zone of the leathers tested proved substantially useful strength for foot wear, the shoulder and belly lacked satisfactory ability to accommodate break, burst, folding, pressing, stretching or fracture in the course of footwear manufacturing or when leather footwear is in utility. Since strength is regarded as a basic property prerequisite to leather's ability to meet its expected efficiency irrespective of the source of animal, mode of tanning or end use for which they are purposed, local tanners should be concerned with strength enhancement to upgrade the leather's ability to stabilise against great force, pressure or stress received by leather when it is employed in footwear manufacturing.

4.4.2 Interpretation of Findings for Research Question Two

What are the causes and causations of the local leather's intrinsic and extrinsic deficiencies that result in its inefficiencies in meeting the properties requisite for quality Leatherwork in Ghana?

The art of tanning is that by which animal skins are converted into leather, a product possessing certain characteristic properties, differing entirely from those of the raw hide or skin, and eminently adapting it to the useful purpose for which it is employed. With substantiations from authors such as Procter (1922; 1936); Wilson (1923); O'Flaherty et al., (1956; 1958; 1962; 1965) and Sharphouse (1995), leather's competency dwells in two major conditions: (1) the kind and source of pelt and (2) the manufacturing process employed. The theories surrounding leather's utility make it glaring that the properties that justify the capacity of leather to meet its intended use suitably are of a physical nature, but attained complementarily by chemical means. Therefore, the source of skin production and the tannery processes are deemed indispensable areas that could characterise particular leather's ability or inability to meet its demands (Thorstensen, 1976). From the impact assessment of the operations and activities of the animal husbandry system, slaughter centres and indigenous tanneries in Ghana the categories of causal reasons found as factors undermining the local leather's quality status such as acceptability by industrial users, intrinsic aesthetic justification, and general economic utility are discussed under the following (5) major topics:

1. Limited scope of national livestock and meat policies and implementation are retrospective factors impeding the productivity and economic significance of Leatherwork.
2. Natural ante-mortem causes and causations of defects rendering the local leathers less economically viable.
3. Man-made ante-mortem causes and causations of defects are too rampant to yield quality skins and hides for economically viable Leatherwork in Ghana.
4. Post-mortem causes and causations of defects occurring through abattoir operations to reduce pelt quality.
5. Post-mortem causes and causations of defects occurring through indigenous tannery operations to hamper leather quality.

4.4..2.1 Limited Scope of National Livestock and Meat Policies and Implementation are Retrospective Factors Impeding the Productivity and Economic Significance of Leatherwork.

1. With reference to Koney (2004) and Dzoagbe et al., (2007), livestock productivity improvement and development policies by various governments since before and after independence (with reference to livestock projects carried out in 1941, 1942, 1958, 1964, 1967, 1974, 1977, 1978, early 1980s, 1985, 1991, 2000, and 2001-2007 at the various breeding stations), it is very significant that the rationale and philosophy regarding policy formulation on livestock management in the country lack the foresight to generate skins and hides prerequisite for sustainable and economically viable Leatherwork in the country. Animal development programmes formed and implemented lack regard for harnessing holistically the economic benefits associated with livestock through systematic farming approaches that synchronise and integrate meat production with quality by-products. Based on the responses from interviews conducted with support from available information from documented sources including Konney (2004) and MoFA Livestock Production Manuals, it is noted that the scope of livestock production is limited to animals for meat or milk production than dual purpose products. The national livestock development concepts so far do not encompass the generation of animals whose products worth and convene economic diversification in utility, apart from wealth generation through meat consumption. With such myopic philosophy, the intention of securing quality animal by-products for economic purposes such as skins and hides for leatherwork and drum heads; none edible offal for gelatine and animal glue production; wool and fur for garment, brushes and clothing accessories; fats for medicinal purposes; blood for animal feed, and dung for manure becomes a mirage.

2. The Ghanaian indigenous leatherwork like the global leather industry depends largely on skins and hides from livestock slaughtered by the meat industry as by-products, especially livestock. However, Ghana's productivity in terms of livestock production to meet the protein needs of the ever growing population has been found abysmal, thereby creating pressure on almost all animal products which skins and hides are not exempted (Koney, 2004). At the various market centres and slaughter houses, it was noted that more than 80% of livestock offloaded for sale or for slaughtering came from the Sahelian countries, especially, Burkina and Mali. It is also evident in the records that Ghana imports 60%-70% of meat products, and produces 30% – 40% locally (TV3 News at 7pm, 28/08/10). This brings to the fore that, currently, the nation lacks the capacity to meet the animal protein needs of the populace. This is due to lack of foresight and accurate projections prudent to mount pragmatic strategies towards food security for the growing population.

3. Again, the nation has not been able to take advantage of the favourable topography and vegetation favourable to boost livestock economically. Geographically, Ghana is a lowland country with the over two-thirds of the land stretching from the midlands to the north being covered by savannah-grassland with scattered trees. Even the southern one-third also is rich in grasses and pasture, yet the nation depends on importation of animal products to survive and that has no support for economically viable Leatherwork in the country.

4. Furthermore, there are no land reserves purposely for raising livestock in the country. Meanwhile, according to Koney (2004) and Iwena (2008), the nature of land ownership follows the land tenure system which practically is a hindrance to

acquisition of large areas of land for commercial livestock farming capable of boosting meat availability and supply, and also augments pelt availability, accessibility and affordability.

5. There is non-existing economic telepathy between the mandatory stakeholders of the country's leather industry such as the farmer, butcher, curer, pelt dealer, tanner and leather users. For this reason, the animals butcher does not operate with the tanners in mind. The skin is therefore handled anyhow, since the economic value attached to it is "wele", "kawuro", "totobi" or "fatta" which lacks standards but has vibrant local market. Economically, it is evident that the value of the "wele" or "kawuro" industry is never comparable to that of the leather industry, yet, priority is given to the former creating a severe price competition of pelts for the leather industry. Meanwhile, the skin is considered to contain inadequate protein nutrients and that the little amino acid deposits receive poor digestion and absorption due to the fibrous nature of the skin. The enormity of the "wele" business posses a grave threat to the supply of skins for the survival and sustainability of the local leather industry.

6. Even though Leatherwork has been included in the curricula of formal education through the school system in Ghana by the government, it is not a factor integrated in the national scope of operation in livestock policy formulation to ensure that animals raised and slaughtered in the country are capable of generating quality pelt to promote the practice and study of Leatherwork and foster its significance in national development.

4.4.2.2 Natural Ante-Mortem Causes and Causations of Defects Rendering the Local Leathers Less Economically Viable.

These were identified as causes, causations and effects emanating from natural phenomenon to invariably impair local breeds of livestock when alive to generate pelt prerequisite for the production of quality leather.

1. Comparatively, the physical features of the indigenous livestock breeds observed at the various farms visited were found to be unsatisfactorily supportive for sustainable economic venture of leather production; especially, when large surface area is prerequisite in the realms of leathers required for industrial utilisation in manufacturing artefacts in the categories of huge pairs of footwear, garment and clothing accessories, upholstery and containers. It was noted that the local breeds are basically the dwarf types which are incapable of generating larger surface skins and hides to augment the economic cutting value requisite in the area size of leather for industrial utility (Sharphouse, 1995; Koney, 2004; Iwena, 2008). Comparatively, since some North American, European and South American livestock, according to Sharphouse (1995) and FAO Bulletin 67 (1986), are capable of generating 22 to 44 sq.ft area from bovine sources; the competitive, marketability and utility of leathers produced locally would be limited on the global scene to making only smaller items since the largest area of local Zebu hide recorded from the size quality test was 7 square feet.

2. The physical anatomy of livestock assessed was found to be inadequately supportive to economically viable Leatherwork in the country. This became evident when the physical appearance of the animals observed was related to the surface flatness expected in leather through setting. Relatively, the body structure of livestock

encountered looked grotesque; relatively irregular and commonly skinny with undulating skin surfaces covering bony structures. From a critical observation of the animals, it was noted that at the butt areas the hip and pelvic bones bulge up the skins and distort the shape of the animals; the backbone line, as well as the ribs also bulges in the skin. These characteristic features varied from one farm to another, and could be attributed to management practices, especially when it was noted that the bony contours revealed in the skin were severe in animals raised under the extensive system. As exhibited in *Plates 4.6 (a), (b) and (c) of pages 180 and 181*, although the animals may look emaciated as a result of poor farming practices the predominant phenomenon of irregular and poor smoothness of body structure were found unprecedented since genetic characteristics could be the underlying factor. The protruding bones overstretching the skins will eventually yield leathers characterised by lighter thickness and resistant to surface setting, as well as increase in economic cutting value (Sharphouse, 1995).

Plate 4. 6(a)

 

Plate 4.6 (b) Plate 4.6 (c)

Plates 4.6 (a), (b) and (c): Undulating body structure and contours of local livestock breeds.

(Source: Field photographs, September-December, 2008)

3. The humps or hunch back possessed by some of the bovine species are identified as disincentive to Leatherwork. It has been observed that apart from breeds such as the N'dama, and West African Shorthorn and the Dwarf Lagoon (Muturu) which are devoid of humps, other breeds which looked a bit bigger including the Sanga and Zebus (Gudales) possess hunches backs or humps which are bulgy and form a kind of pocket on the surface of pelts generated *(See Plate 4.7 on 182)*. Upon conversion into leather the hump area practically obstructs the spreading of the surface to increase economic cutting yield. Meanwhile, when cut off, the area becomes hollow and reduces the economic cutting value of the leather, especially, when the leather is required to have area size advantage to fairly suffice economic utility in upholstery or garment production. Plate 5 illustrates the area occupied by the hump on bovine leather tanned locally.

Plate 4.7: Hunch back pocket areas hindering the spread of leather surface.
(Source: Field photographs, Jan., 2008- Sept. 2009)

4. **Aging and Delayed Maturity:** Delayed maturity and aging resulting from bad feeding culture by extensive and semi-intensive farmers are major causes of poor quality pelt (De Haas, 1925; Iwena, 2008). Due to poor feeding practices and undulating growth patterns, the livestock grow to reach market size late. It was also noted that some farmers intentionally keep animals until the need to meet socio-cultural and religious obligations such as festive occasions and payment of dowry. Although aging improves on area size quality of pelt, it is also factual that the more the animal grows the more its protein fibres become coarse, less elastic and creasy.

Effects on Leather Quality: These include the formation of growth marks and wrinkled grain towards accelerated formation of differences of texture in single sections of the leather. Fattening also leads to creation of cockle, which forms spot-like deposit of fat on the pelt. In sheep, there is formation of nodules on the grain of the skin, mostly in the neck or shoulder area which eventually mars the aesthetic appeal of the grain surface of leather and renders it less useful.

5. **Seasonal Variations:** In the skin and hide business, market value description is based on type, weight classification and time of take-off (De Haas, 1925;

Thorstensen, 1976). Having assessed the size and weight of 200 skins and 50 hides in the two major seasons in the country (rain and dry), pelt weights have been identified to be affected by seasonal variations depending upon the month of take-off. Weight values appreciate in the rainy season and depreciate in the dry season. Consequently, this creates seasonal economic value fluctuations due to dehydration and poor feeding as a result water and pasture scarcity in the dry season. According to Sharphouse (1995), to a large extent, the seasons affect the structural composition of hides and skins through feeding (nutrition), climate changes; and observations made included adjustment in thickness, weight class and surface freshness. Generally, Thorstensen, (1976), Bienkiewicz (1983) and Sarkar (2005), who have done enormous research on skin structure claim that deposition of fat cells, sweat glands and blood vessels as well as density of hair largely determine the texture of the skin and thus the serviceability and the properties of the leather during such climate changes.

4.4.2.3 Man-Made Ante-Mortem Causes and Causations of Defects are too rampant to yield quality skins and hides for economically viable Leatherwork in Ghana

These are causes of defects identified to arise from a great variety of encounters the animals face during their lifetimes. Basically, the causative factors identified were consequence of human errors of commission or omission in the husbandry system employed which expose the animals to environmental conditions resulting in a wide array of defects by **mechanical and pathological consequences** (FAO Bulletin 67, 1986; Sharphouse, 1995; Gerhard, 1996; Koney, 2004). The numerous causative factors identified testify to the daunting number of ways in which pelt quality is tarnished by poor husbandry in the country as follows in the next section.

4.4.2.3.1 Defects resulting from exposure of livestock to traumatic conditions

1. Cause: Roaming and free ranging of livestock

Causation: Scratches and wounds are forms of mechanical damages commonly associated with the animals found in the various farms visited. The free-range method of the extensive system and the semi-intensive system typified such skin damages since in the course of searching for food and water on communal and private lands the animals are usually attacked by predators and crop farmers who stone or butcher them with cutlasses. Other causes found include injuries by sharp awns of plants or chaffing of their bodies against thorn-bushes, building walls.

Effects on Leather Quality: These causes result in open or scarred and irregular scratches marring the surface quality of leather. In their healed form, new skin is formed which may be as strong as the remainder of the hide with fibres growing densely packed together in the region; however, the scars are often hard and raised without hair follicle to support the aesthetic appeal of the grain surface of the leather (Sharphouse,1995). If not avoided unhealed skin may be caused to tear, split or burst as a result of tension exerted on them.

2. Cause: Dung damage and irritation

Causation: Dung accumulates on cattle when they are held in enclosed or confined conditions, especially, insanitary kraals, and open or rugged places where roaming animals rest or pass the night. Consequently, prolonged contact with dung leads to severe irritation of the skin and can lead to infections which take the form of finger-like projections from the grain. Factors affecting dung build up include weather, unsanitary, poor housing and holding conditions and farming system.

Effects on Leather Quality: The irritation to the skin due to prolonged contact with dung leads to surface staining, grain damage, cutting during mechanical operations and increased levels of bacteria.

Plate 4.8: Cattle hides smeared with dung as a result of bad kraal sanitation
(Source: Field photograph, September-December, 2008)

3. Cause: Barbed wire damage

Causation: Scratches and wounds are caused by barbed wire which is usually employed for the purpose of enclosing pasture or stockholding areas. Since the animals encounter several conditions leading to irritation scratching the skin against the wires was found rampant. Besides, efforts made by livestock to break bounds also attract skin scratches and undesirable marks on the skin.

Effects on Leather Quality: Scratches and marks caused by barbed wire boundaries have long been criticised in FAO Bulletin 67, ISO 4683 –1:1998, ISO 2822 –1:1998;, Sharphouse (1995) as source of avoidable damage to the skin of living animals, since the resulting defects persist through the tanned leather and impair quality and utility.

4. **Cause**: Overcrowding, whipping, in-fighting and poor mode of transportation

Causation: Damages to the skin such as wounds, scratches and scars usually occurring when livestock are closely herded in large numbers in kraals or stockholdings in readiness for loading prior to transportation. Overcrowding of animals in transit packed in long vehicle trailers, buses car boots as well as carriers also leave much to be desired since the animals get suffocated, overstressed or scratch one another with their horns as they struggle for breathing space and relieve their stress. Serious damages from wounds also occur from in-fighting with the horns, especially among males in efforts to gain access to crossing females on heat. It is also significant that severe whipping of animals with clubs, sticks, heavy cords, canes and metals in the course of driving, loading or offloading animals also result wounds, scars and scratches on pelts.

Effects on Leather Quality: These causes result in open or scarred and irregular scratches marring the surface quality of leather. In their healed form, new skin is formed which may be as strong as the remainder of the hide with fibres growing densely packed together in the region; however, the scars are often hard and raised without hair follicle to support the aesthetic appeal of the grain surface of the leather (Sharphouse,1995). Unhealed damages if not avoided may be caused to tear, split or burst as a result of tension exerted on these parts.

5. **Cause: Branding and Colour mark stains**

Causation: Branding of Livestock is the main causal reason found. It is the farmers' intention of branding their animals with letters, numbers, figures, symbols or signs for easy identification by means of tattooing with red-hot stamping iron mainly on the butt area of the skin. The use of highly acidic or alkaline colours for marking on the animals' body for identification is found to etch the grain, making it rough or matt.

Effects on Leather Quality: Apart from its inhumane nature the branding practice are identified to leave several visible severe blemishes on the resulting finished leather. Usually these sections are undesirable in artefact production, especially when the cuts frequently go through the entire cross-section of the skin. Unfortunately, the butt area of the leather is the most important part since it has perfect representation of properties of the entire leather.

6. Cause: Animal Traction

Causation: It was found in some parts of the country that animals are used in laborious economic activities such as ploughing and carting goods of all kinds; foodstuff and firewood, to various distant destinations. In some parts of the country, especially in the three Northern Regions and Katamanso, Koney (2004) emphasises that statistically, 50% of farms use bullocks in ploughing and draughting. Though, this is a positive economic venture since it is cheaper, its adverse effects on the eventual products of the animal leave much to be desired. Apart from the meat becoming less tasty, tough and more fibrous due to overstressing and over aging, the pressure exerted on the animals to work through pulling, driving and beating with sharp-pointed goads leave damages on the skin such as wounds, scars, hair removal, wrinkles and scratches. Usually the neck area of the animals where the yoke rests are damaged by thickening, swelling and chafed as a result of faulty or careless adjustment or through the use of a pair of uneven height of animals (FAO Bulletin 67, 1986).

Effects on Lather Quality: Pelt from such animals eventually become less valuable for making quality leather due to rampant defects.

7. Cause: Engagement of Animals in Sporting Activities and Petting

Causation: Usually animals, such as horses, are engaged in sporting activities, or kept as pets as found with cats, dogs, or kept as wealth in terms of sheep, goat and cattle. In that way, the animals are deemed wealthy and more valuable living than dead. The owners are therefore reluctant to sell or slaughter them unless in critical need of money for medical care, festive occasions, school fees and other socio/cultural obligations.

Effects on Leather Quality: Such animals overgrow and develop skins which result in leathers rupture by loose fibres, pronounced growth marks in the neck area and on the backbone line, obvious wrinkles, less supple and poor flexibility. Such leathers' application in artefact manufacturing becomes limited.

4.4.2.3.2 Defects Resulting from Parasitic Infections

1. Cause: Tick Damage

Causation: The mouth parts of blood-sucking parasites cause holes or round recesses which in most cases reach down into the corium layer. Ticks are known to be blood suckers (Ixodes spp. and Argas spp.) and carry bacterial, viral and parasitic infections leading to diseases. They feed off any warm blooded animal and so can transmit disease to man. The mode of feeding is such that the ticks feed by attaching themselves to the animal and suck blood actively leading to fatal anaemia. Among the types of ticks identified is the deadly *Amblyomma* tics which besides damages caused to the pelt also cause heart water or *streptotricosis* leading to the death of the animal. However, other types of the *Boophilus spp.* possess single host while *Hyalomma spp.* may have double or three hosts (FAO Bulletin, 67, 1986).

Effects on Leather: The mouth part punctures or perforates the skins, causing visible damage to the hide and results in holes in leather, especially, in the thinner portions such as the belly where small sores develop from the bites, and when healed, render the grain surface rough and patchy. Additional mechanical damages may be caused by rubbing the skin against trees, building walls and barbed wires due to irritation.

2. **Cause: Lice**

Causation: The arrays of lice which attack livestock identified are basically biting and sucking types: *Lignognthus* and *Haematopinus*. The blood sucking and biting results in intense skin irritation which consequently cause scratching and rubbing of the skin against walls, barbed wires, trees and fences. Since the activities of lice are extremely favoured under cool conditions, they are commonly found rampant in the rainy season. Transmission is through contact with infected animals.

Effects on Leather Quality: Lice cause localised areas of inflammation and possible scar tissue. Injuries caused by infestation by blood-sucking lice results in partial destruction of the grain layer in a form of very small size circular lesions which depending on the presence or absence of secondary infections determine the extent of damage on skins and hides. The areas affected react differently to the dyeing process and leave areas of light spots or "flecks“ which are disincentive to leather quality and utility.

3. **Cause: Screw Worm Fly (*Myasis)***

Causation: Generally, screw worm is attributed to fly species of *Callitroga*, including *Chrysomyia, Sarcophaga* and *Lucillia*. According to the FAO Bulletin 67 (1986), true "screwflies" are obligatory parasites of all wild and domestic, warm blooded animals (including birds) and lay their eggs only in fresh wounds. Since the fly infests cadavers or badly necrosed tissue, the navel of newborn animal, fresh accidental or surgical wounds sustained through castration or dehorning are readily infested as are tick bites and peeling brand marks. The adult female fly lays several white eggs in shingle-like clusters along the edges of the fresh wounds. The larvae hatches in about 12 hours and penetrate the tissue surrounding the wound. Over a period of 5 to 7 days they mature and reach a length of about 2cm, leave the wound and fall to the ground.

Effects on Leather Quality: The screw worms damage pelt by feeding on the tissue as a group while developing on the animal and, at the end of their period of maturation, they will probably have created a cavity of 10 to 12cm diameter which impair leather quality. Secondary infestation by other flies, attracted by the bad odour of the exuding wound, and bacterial infection, sometimes occurs and leads to grain and fibre weakening, especially, when the wound is not given attention.

4. **Cause: Demodex spp. (*Demodectic* or Follicular mange or *Demodicosis***

Causation: Demodex mites invade hides and skins by penetrating the hair follicles and then migrate to deeper parts to live in the sebaceous glands (FAO Bulletin 67, 1986). They encyst and multiply within the follicle or the sebaceous glands to damage by causing skin reaction which leads to proliferation of the epidermis, thickening of the follicle or gland wall. The result is the development of cysts and loss of hair. Severely, goats were found mostly affected. Raised tufts of hair or nodules on the pelt surface can be an indication of infestation. A careful comparison of the livestock species revealed variations in infestation which are considered specific as a result of the mites to cattle (*D.bovis*), sheep (*D.ovis*), goats (*D.caprae*), horse (*D. equi*) and pigs (*D. phylloides*).

Effects on Leather Quality: *Demodicosis* results white spots on goatskins, and collapsed cysts may, as reported by Dempsy (1954) and Haines (1983) as stated in FAO Bulletin 67 (1986), give rise to small depressions of 5-10mm. diameter on the grain surface and that, on occasion, the surface can be spitted. It is observed that the hair follicles are enlarged and remain visible even after tanning. Again, light areas on the dyed hide detracts from the appearance and results in downgrading.

5. Cause: Sarcoptes Scabies (Sarcoptic Mange)

Causation: The causative organism, *Sarcoptes scabiei*, has sub-species specific to the particular host, e.g. *S. Scabiei* var. Bovis and var. Suis, although transference between hosts can also occur. According to FAO bulletin 67 (1986), Koney (2004) and Iwena (2008), the adult mites lay eggs in tunnels which they make in the skin and, when the larvae hatch they may either remain in these tunnels or may migrate to the skin surface where they continue their development as nymphs. The nymphs burrow superficially in the skin and the adult stage is reached about 17 days after the eggs are laid. All stages feed on cutaneous debris, but the adult females cause most damage by burrowing deeply to make the tunnels or galleries, giving rise to inflammation and severe irritation. Although pigs are found mostly affected by this type of mange, infestation in goats, sheep and horses is minimal.

Effects on Leather Quality: *Sarcoptes scabiei* cause recession or holes with formation of pustules in the grain tissue. Their attacks also lead to marked thickening and wrinkling of the skin rather than the formation of scabs; the corium fibres in the affected areas become damaged and the grain surface of a tanned hide can be seen to be rough, corrugated, dull and unsightly.

6. Cause: Psoroptes spp. (Psoroptic mange)

Causation: In accordance with Iwena's (2008) explanations, there are a number of varieties of *Psoroptes* which are more specific than those of *Sarcoptes*, and they are considered as species on biological grounds as clarified by Mann (1951) and FAO Bulletin, 67, (1986), *P.communis ovis* (sheep), *P.c. caprae* and *P.c. cuniculi* (goats), *P.c. bovis* and *P.c. natalensis* (cattle), *P.c. equi* and *P. Hippotis* (horses). Psoroptic mange occurs in all species but, as "sheep scad", it is a disease of major importance, particularly where large numbers of sheep are raised for wool production. Intense irritation leading to scratching the skin against rough surfaces results in various defects.

Effects on Leather Quality: Psoroptes mange considerably downgrade leather quality due to defects in which lesions appear as small, hard, pustular nodes between 3 and 5mm. in diameter and covered by long hairs. On liming the skins, the nodes are lost leaving depressions on the grain and, when tanned, marks like discrete pin holes of different sizes appear on both sides of the backbone. Nandy and Venkatesan (1974) have investigated into the impact of Psoroptic mange and have confirmed that stitch tear resistance of the leather is lowered considerably in the affected area.

4.4.2.3.3 Defects Resulting from Pathogenic Infections

1. Cause: Dermatomycoses (Ringworm)

Causation: Ringworm is a parasitic disease caused by the fungus *Trichophyton spp*. and *Microsporum spp.* Some species appear to be specific and affect one type of domestic animal; e.g. *T. Equinum* and *M.equinum* associated with horses alone. *T. Mentagrophytes* may be found on horses, cattle, sheep and pigs but transmission between species occurs readily. The fungus grows on both the hair and skin and affects their growth. Ringworm was found highly infectious and rampant among animals housed in close proximity to each other or overcrowded, especially, the intensive and semi-intensive management systems. It has been reported that deficiency in dietary factors contributes to the development of widespread and chronic lesions in cattle (Koney). Ringworm is also transmissible to man on contact (Mann, 1951; FAO Bulletin 67, 1986; Iwena, 2008).

Effects on Leather Quality: Ringworm infection causes characteristic circular lesions or small round bald patches on leather that appear either shiny or dull.

2. Cause: Mycotic Dermatitis (*Streptothricosis*)

Causation: This is a dermatitis occurring in all species and is caused by infection with organisms of the genus *Dermatophilus*, thus *D.congolensis* which in the case of sheep it is termed Mycotic dermatitis or lumpy skin/wool disease, however, it is termed ‘streptothricosis’ when it occurs in cattle. When the animal is infested, the epidermis proliferates and forms scabs with a distinct lamellar structure which in sheep, causes matting of the hair/wool. The hair follicles become enlarged and distorted so that pits develop (Mann, 1951).

Effects on Quality of Leather: Mycotic dermatitis creates lesions which can vary widely in depth and spread in several affected areas; scar tissue is formed leading to a general thickening of the hide, and also tarnishing of the grain surface of hide and making it less useful for leather production.

3. Cause: Erysipelas in Swine (Diamond skin disease)

Causation: Erysipelas is an infectious disease of pigs, and in the acute, septicaemic form, it appears accompanied by diamond-shaped skin lesions. These lesions caused by *Erysipelothrix rhusiopathiae*, appear as angular, discoloured elevations which may develop a dry necrosis and scar formation occurs when healing takes place. It has been emphasised in the FAO Bulletin, 67, (1986) that difficulties are encountered in controlling and eradicating this disease, which is known to have some public health significance and human susceptibility to it.

Effects on Leather Quality: The lesions caused by the disease appear as angular, discoloured elevations on pelt, which develop into a dry necrosis and form a scar, especially, when healing takes place. The scar results in grain surface tarnishing and impairs good surface finishing of the resulting leather.

4. Cause: Lumpy Skin Disease

Causation: This according Koney (2004), lumpy pox is a highly infectious skin disease usually affecting cattle. It is caused by a herpes virus and is characterised by the sudden appearance of nodules on all parts of the skin. The virus concerned occurs as at least three strains of which the "*Neethling*" strain causes this disease and the "*Allerton*" strain causes a mild form of it (Alexander et al., (1957), as cited in FAO

Bulletin 67, 1986). During the course of the disease, the affected portion of the skin becomes hard and dry, and separates from the surrounding normal tissues.

Effects on Leather Quality: Upon healing the scars may result in button-like defects reaching into the corium. Secondary infections if not prevented also aggravate the undesirable impact of the disease on pelt and render them poor quality.

5. Cause: Pox

Causation: Various forms of pox diseases associated with domestic animals are considered benign diseases and are characterised by the development of typical pox lesions and are said to be caused by different strains of the *Variola virus* (Nandy and Venkatesan, 1974), as cited in FAO Bulletin 67, (1986). The disease is readily seen on the flesh side in the form of roughly circular spots which vary between 3 and 12mm in diametre. They are often sharply outlined and range in colour from a reddish-brown to black. The lesions are formed as papules, develop into vesicle and then into pustules over which scabs are formed. After healing, a permanent scar remains on the pelt and the low, dome-shaped projections can be felt through the hair but can only be seen where the hair is short. Ovine pox is reported to be the most serious of the pox diseases in animals and is highly contagious (Mann, 1951).

Effects on Leather Quality: after the hide or skin has been tanned, the lesions appear as circular blemishes on the grain, slightly raised and well defined. Some may also be apparent on the flesh side of the leather. In ovine and caprine, the damage caused comparatively is severe, owing to the relative thickness of the skin; the corium is liable to damage by the inflammatory condition caused by the attack.

6. Cause: Trypanosomiasis

Causation: *Trypanosomes* occur in the blood and in some tissue of most vertebrate animals and their life-circle involves an intermediate (vector) host, most often an insect such as flies or fleas, or leeches occasionally which are mainly pathogenic or non-pathogenic. The non-pathogenic types belong to the section *Stercoraria* which includes *T.cruzi* (common in Central America) and *T. theileri* (found in India). However, the pathogenic types which belong to the section *Salivaria* which affect cattle, goat, sheep, horses, antelopes and dogs in Africa, especially in the forest areas and savannah grasslands, have some better known species including *T. vivax* (common in tropical Africa); *T.uniforme* (Central and East Africa); *T.congolense* (rampant in tropical Africa); *T. suis* (Zaire and Tanzania). Since all African trypanosomes have the tse-tsefly as their vector, in Ghana, bites from infected fly may infest the animal with the *T. vivax*, *T. congolensis* or *T. brusei* species leading to the exhibition of clinical symptoms as increased anaemia, dullness, staring hair coat as emphasised by Koney (2004).

Effects on Leather Quality: According to the FAO bulletin 67 (1986) and Iwena (2004), *trypanosomiasis* results in the formation of superficial lymph nodes which enlarges and become prominent on the skin with time. Meanwhile, in cattle, the lesions which develop grow as nodules and hair is shed from the affected areas. Sores sometimes develop due to scratching and rubbing by the animal to ease the irritation, so that the grain surface of the skin becomes abraded or more deeply damaged.

4.4.2.4 Post-Mortem Causes and Causations of Defects Occurring Through Slaughterhouse Operations to Hinder the Attainment of Quality Leather

These are causative factors that render deficiencies in leather qualities as a result of damages caused to pelt by activities which the animal is subjected to after death (Sharphouse, 1995, Koney, 2004). Such damages are found to stem mainly from the ignorance or improper application of satisfactory techniques in the operations at the slaughter centres (De Haas, 1925; Koney, 2004, Kite and Thomson, 2007). They are categorised and interpreted as follows:

1. Cause: Improper Slaughtering and Bleeding Practices

Causation: Bad slaughtering and bleeding are practices found rampant in the slaughter centres visited. Although the two abattoirs (Accra and Kumasi) are exempted due to their well equipped nature and monitoring structure. The slaughter houses and slabs where most livestock are slaughtered highly affect skin quality and leather quality. The International Humane Slaughter Laws (HSL) which require that animals be kept calm and rendered insensitive to pain prior to bleeding by stunning is not commonly known in Ghana. As a result, bleeding, which according to Sharphouse (1995) is the primary objective of slaughtering is usually not attained completely due to shocks, unusual fatigue and unnecessary pressure, stress and fright that the animals go through prior to slaughtering. This results in a large blood supply in the peripheral capillaries (small blood vessels near the skin surface) usually not draining completely from the pelt (Hides and Skins, National Hide Association, 1979, USA).

Effects on Leather Quality: Due to lack of simple hoisting facilities, the animals are slaughtered and the carcases are left on highly unkempt floors in a pool of blood, there is rampant cause of skin-blood binding. Also, delays in washing result bacterial attack through autolysis which possibly leads to fibre damage adjacent to the blood vessels in the skin, and in the worst case, the formation of open channels which only become evident as "veininess" in the resulting leather. Similarly, blood residues in the capillaries may encourage the development of micro-organisms along the blood vein leading to unusual discolouration of the skin and accelerated rate of putrefaction if curing intervention is not sought early (Gerhard, 1996).

2. Cause: Delay in Flaying and Curing

Causation: It has been emphasised by O'Flaherty et al., (1956) and Sharphouse, (1995) raw hides and skins are about 60-70% water and 25-30% protein. In this form hide is susceptible to bacterial activity within hours after being removed from the carcass. The time lag of bleeding-flaying-curing is usually not regulated and any delay in processing the carcass upon the animal's death is susceptible to autolysis towards decomposition by bacteria. The animals after slaughtering are usually found lying on bloody floor to bleed until a flayer is available to dress it; which does not take less time than 40 minutes to an hour. It is noted with regret that in the slaughter houses and slabs, the pelt after flaying, is spread on the floor and the carcase is split into pieces and sold almost all-day before it is gathered and attended to.

Effects on Leather Quality: Such delays usually results in microbial attack leading to fibre breakdown through autolysis.

3. Cause: Flay Cuts

Causation: Unintentional cutting of the skin layers during flaying, and employment of poorly shaped knives with pointed tips instead of rounded tips for flaying cause various degrees of damages to the pelt, especially the most important corium or reticular layer due to carelessness and lack of flaying expertise. The cuts are found to be visible in the skin as holes, thinner layers or grain spoilage of the resulting leather.

Effects on Leather Quality: Pelt flayed at the two abattoirs are of less or no cuts. However, those found at the slaughter houses and slabs are full of cuts of varied magnitude which greatly devalue and sometimes render the pelt worthless. The depth and number of flay cuts render skins and hides uneconomic for leather production, especially when more than 30% has defects (FAO Bulletin 67, 1986).

4. Cause: Rubbed or Dragged Grain

Causation: Due to lack of hoisting facilities, dressers and flayers carelessly drag the carcass, especially, bovine and larger animals over dirty, uneven or rough slaughter house or slab floors in efforts to work out the various parts out.

Effects on Leather Quality: The dragging of the carcass lead to permanent abrasion marks or scoring of the grain. Surface finish of the resulting leather is eventually tarnished.

5. Cause: Bad Pattern Flaying, Inefficient Fleshing and Trimming

Causation: Out of lack of appropriate flaying expertise or carelessness as found in most cases at the slaughter centres, ripping lines are found made at least nearly centrally down the belly side of the carcass; the result is an unequal spread of the flayed hide or skin either side of the backbone line. Lack of square lines across the forelegs and brisket also lead to irregular shaping. In addition, poor fleshing leaves various degrees of fat residue in the flesh side of the pelt.

Effects on Leather Quality: Although the shape of the raw material does not readily affect its conversion into leather, a bad pattern inevitably affects the utilisation of the leather produced, particularly, its economic cutting value in footwear, upholstery or any standard pattern cutting. Similarly, a bad pattern must, from the outset, lower the marketability of the hide or skin. Poor fleshing inhibits adequate curing to preserve the leather qualities of pelt.

6. Cause: Inadequate Cooling and Lack of Chilling

Causation: When the hide or skin has been removed from the carcass, it is important that the residual body heat retained in it shall be dissipated as much and as soon as possible. However, this is not done in any of the slaughter centres visited. Chilling which is prerequisite for maturing dressed carcasses and pelt is absent in the various slaughter houses and slabs; even at the abattoirs where chilling facilities are available; pelts are not subjected to chilling, since its value is limited to ‘wele’ or ‘kawuro’ production.

Effects on Leather Quality: When successive hides or skins are allowed to lie without further treatment, the blood and dung stains on the stock contribute to deterioration by encouraging bacterial growth and consequent damage, particularly, a breakdown of hide tissues as a result of microbial activities.

7. Cause: Overstretching and Pelt Distortion by Drying Lines

Causation: Since sun drying is predominant in curing, when pelt are stretched by nailed on the ground to dry, the force leading to the stretch is over applied to overstretching and deterioration of the of the pelt fibres prior to tanning. In addition, another crude means found is the hanging of pelt over wire, string, rope or chain lines to dry. Consequently, severe damage in the line of hanging over support results in grain and fibre breaks, and sometimes permanent lines on the resulting leather.

Effects on Leather Quality: Overstretching causes shape distortion of pelt and leathers produced from such pelt possess impaired strength and fibre structure (Mann, 1951; FAO Bulletin 67, 1986). A careful observation also revealed that moisture in the raw material is held preferentially along that line and area; the pelt therefore becomes prone to bacterial damage with a resultant clear evidence on the grain side.

8. Cause: Poor Approaches to Pelt Curing/Preservation

Causation: Most of the handling activities by the butcher, flayer and the curer expose the pelt to bacteria and fungi infections leading to the emission of bad odour, hair slip and mould development. As a result of the poorer regard, recognition of skins and hides in Ghana for leather processing than 'wele' or 'kawuro' consumption, there is less or no attention for pelt preservation at the slaughter centres, including the abattoirs in both Accra and Kumasi. There is no washing or removal of adhering dung, long hair, residues of flesh and fat in some sections due to poor fleshing. Nevertheless, in few cases where the pelt is preserved, as found in the northern parts of Ghana, curing is done mainly by sun drying which leads to various complications undesirable for tanning. Even where salting is done in rare occasions, the salt is not granulated to facilitate the osmotic process of preservation. The situation of poor attention for pelt preservation is noticed to stem from the general perception that the eventual utility of skins and hides is 'wele' or 'kawuro' production which has no connections with quality standards.

Effects on Leather Quality: Sun drying usually dries skins permanently and hides partially, leading to degrading and invasion of pelt quality. The impurities such as dung, blood stains, and sand particles usually results in pollution of floats, reduction of chemical concentration and potency, promotion of microbial activities, hindrance to aqueous penetration due to precipitation. Sun drying also delays the soaking process of leather making due to prolonged rehydration.

9. Cause: Folding Damage

Causation: When line hanging, ground stretching or frame stretching is employed for sun or air drying, the pelt usually becomes excessively dried and hard. Excessive pressure is then required in folding which also leads to cracks along the folding lines.

Effects on Quality: The consequent pressure employed in folding produces rupture in the grain with an immediate reduction of marketability of pelt. The situation becomes serious when the folded pelt goes through loading, offloading and transportation due to pressure from pilling and rubbing or frictional damages. Bad folding techniques are disincentive to leather making.

4.4.2.5 Post-Mortem Causes and Causations of Defects through Indigenous Tannery Operations to Hamper Leather Quality

These are factors that result in deficiencies in the local leather's qualities as a result of damages caused to the pelt by activities which the tanner subjects the pelt to in the course of converting them into leather (Anton, 1925, Sharphouse, 1995, Kite and Thomson, 2007). The categories of causative factors identified include:

1. **Unreliable Sources of Skins and Hides Supply**

The first problem facing the tanner as identified is the nature of unreliable pattern of pelt supply due to high dependency on skins and hides as delicacy in the country. Consequently, there is keen competition between the tanner and the 'wele' or 'kawuro' processor, which has raised prices of pelt. It has been noted that the supply pattern becomes much more undulating during the dry season since there is less slaughtering of livestock at the various slaughter centres. Pelts found in the tanneries when assessed critically are mostly cured by sun drying which due to fatty matters cannot be prevented adequately against putrefactive bacteria due to the inability of sun rays to penetrate the excess fatty substances left on the flesh side to cause dehydration. Even the few salt cured ones found have been attacked due to salt insufficiency.

2. Seasonal Availability of Vegetable Tanning Materials

Being the main source of tannage in the local tanneries, the availability of the fruits or pod of *Acacia nilotica*, popularly known as in English as Egyptian Mimosa, or Bagaruwa as known in Hausa, is seasonal in spite of the perennial nature of the plant. The plant has been found to flower in rainy season and mature in dry season; however, since the astringency of the plant's pods is what the tanner depends upon, it is preferable to harvest in the dry season than the wet season to avoid diluting the tannic acidic content of the plant (Arbonnier, 2002). Although the harvest time ensures the maintenance of the plant's tanning potency, it also decreases availability, accessibility and affordability during lean seasons (rainy season). The seasonal nature of plants such as *Cucurbita pepo, Carica papaya, Citrus lemon and Sorghum bicolor* (sorghum) negatively affects the regular availability of vegetable tanning materials.

It is also vital to mention that the Egyptian mimosa (*Acacia nilotica)* is found, beside its rich astringency for tanning, to possess uncountable obscured medicinal significance to human and animal life in almost all its parts. According to Arbonnier (2002), the leaves are for treating chest pains, pneumonia, diarrhoea and dysentery; the shoots are prepared as vegetable; the seeds are for haemorrhoids, gingivitis and numerous magico-religious uses; the is bark for treating haemorrhaging, dysentery and is boiled as coffee; it is browsed for healing wounds and is used as a medical care for domestic animals such as goats, sheep, camels and cattle; the stem is used for healing leprosy. The seeds are also toasted for preparing food supplement for animals; and the gum is sometimes used in confectionery. Unfortunately, in an attempt to harvest the parts for such medical purposes, people naively, unprofessionally and unduly destroy the plants' life. This terribly limits the supply of the pods and creates scarcity, as well as surging prices.

3. Unavailability of Hygienic Water Source for Tanning

Tannery is known globally to be water business, since lots of water is needed at every stage of leather processing. It is noted at the five indigenous tannery that water sources are mainly non-perennial shallow dug wells, streams, large gutters and water bodies which are already contaminated or polluted by all forms of residue including rubbish, faeces (both animal and human beings), algae or spirogyra, sand particles and frogs, and possibly putrefactive micro-organism. These substances are possible macro precipitants in aqueous mixtures and inhibit the free movement of chemicals to and fro the pelt fibres. A simple lather test of 5 litres of water sampled from Asawase tannery exhibited poor lathering which is a sign of water hardness resulting from possibly calcium and magnesium salts and calcium carbonate which can react with vegetable tanning agents to produce insoluble precipitation compounds. This interferes with the penetration of tannins and other chemicals, or lead to colour changes, retarded reactions and staining in many processes of leather production such as soaking, liming, rinsing, washing floats, bating, tanning and fatliquoring (Sharphouse, 1995; Gerhard, 1996).

4. Lack of Purposeful and Organised Recipes for Leather Production

It has become evident from the assessment of leather processing methods employed and underlining perceptions that the indigenous leathers produced in the country lack suitability for specific applications because general tanning methods and techniques are used. These techniques are realised to lack quality standards and do not aim at acquiring specific properties for any specific end use such as footwear, upholstery, bags or clothing and garment. Leather production therefore lack focus as there is no specific recipes to follow. Eventually, leathers made are meant for general utility, and it is rather the buyer (user) who must find utility suitable for the leather based on the properties he identifies in the leather.

5. Lack of Cutting-Edge Technology in Local Tannery Approaches

The nature of the Indigenous Tannery Technologies is detrimental to the Production of Quality Leather Dependency on obsolete conventional technology revolving on poorly structured pits. The best vats found are large size clay pots in Bolgatanga. As a result the following negative impacts are identified.

1. **Lack of Appropriate Control Measurements and Accurate Estimations**

The operational controls and estimation of chemicals requisite to augment the step by step activities of leather production were not found in place. These include:

a. Volume of water to fill pits and vats to a workable float for a particular quantity of pelt to be processed.

b. Determination of the specific weight of skins and hides cured by means of salt. This indicates the progress of demineralisation and shows whether the water should be changed for soaking.

c. Determination of the soaked weight to enables proper check in relation to the green weight and of the water absorption.

d. Lack of float per chemical measurement, hence poor chemicals estimations and concentration determination.

e. Regular temperature measurements (since varied float temperatures are required at various stages of leather processing).

f. Regular pH measurements (to regulate the pH required at varied stages).

g. Determination of degree of swelling and plumping as well as penetration of liming chemicals.

h. Determination of deliming value, buffering capacity and lime dissolving value.

i. Determination of degree of tannage (level of penetration and fixing)

2. Poor Control of Beamhouse Operations

The following Analytical controls required for successful beamhouse operations were not found in place:

Soaking: Bacterial analysis of the soaking liquor impaired due to microbial activity. During soaking the skin becomes susceptible to microbial attack since the rehydration process evacuates the curing chemical which is protecting the skin. Since there is no mechanism for intercepting such attacks, the skins are found to emitting offensive odour after the soaking periods at the various tanneries. Damages caused by microbial activity are basic damage of putrefaction, and are in three classes. These are:

1. Minor putrefaction damage: Not really visible on the soaked pelt, but noticeable by putrid smell and matt, lustreless or blind sections in the grain of the leather. These were common at Bolgatanga, Bawku and Tamale tanneries.

2. Serious bacterial damage: Noticeable on the soaked hide by initial signs of hair-slippiness and/or slippery surface. This is revealed in the leather by loose and grain reduced firmness. The situation is predominant at Mallam market, Asawase and Tamale tanneries.

3. Heavy putrefaction: Noticeable on the soaked hide by pitting, holes, vat putrefaction marks on the grain and also by complete loosening of the grain layer. According to Gerhard (1996) and Sharphouse (1995), temperatures above 20 °C are phenolic to bacterial activities; there is therefore a high possibility of increased microbial activities leading to accelerated decomposition. This is justified by the odour found in the soaked skins which are comparatively stronger in the hot seasons where temperatures averagely exceed 30 °C, particularly in the northern parts of the

country. However, due to the continual usage of floats the odour was stronger even at the Mallam market, Asawase and Tamale tanneries.

Liming: The main purpose of liming is depilation and opening up of the fibres of the skin. Although the combination of wood ash and carbide chiefly employed are alkaline oriented and have the ability of swelling and weakening the skins, the pace of solubilisation to render the skin plump is slow, especially when thick and tough hides are in question.

Poor operational and analytical controls of the liming process and parameters are identified to be a major cause of uneven solubilisation in the local tanneries countrywide. In terms of temperature measurements, test of hair-slippiness, checking the degree of swelling and plumping, degree of cross-sectional penetration of liming chemicals, float per chemical to determine concentration, determination of purity of float and concentration. There is no mechanism available for determining the pH value of the float, meanwhile, during liming, if the pH value is below 11.0 the hair is not attacked or loosened to permit effective dehairing (Gerhard, 1996, Sharphouse, 1995). As a result, uniformity of solubilisation is devoid in the local tanneries, and liming is mostly done adequately or inadequately. This is found a common liming practice across the five tanneries studied in Ghana.

Effects on Leather: Implications of inadequate loosening of hair on quality of leather: Short hairs not removed, results in a rough and uneven grain surface, since the hair roots are not well loosened; the beamster may have to employ excessive force for depilation and this may damage the grain surface of the skin and reflect in the resulting leather as deep cuts, marks or holes.

Implications of liming effect on leather quality: Lack of softness and crack-resistance, tinny leather, hard brittle condition of the grain, loose grain, reduce absorption capacity for tanning agents and inhibition to flow of aqueous solutions to and fro the collagen fibres and inadequate saponification of the skin fat since the fibres are not adequately opened.

Implications of over liming on leather quality: Excessive opening up of the skin as a result of liming for too long adversely causes loose fibre texture, which often leads to sponginess of the leather in pieces of poor substance, loose grain, running grain, crack grain, excessive elasticity, insufficient resistance of the grain to abrasion, reduced firmness and poor handle of the leather.

Prolonged liming also made some ante-mortem defects more prominent:

i. Increased formation of growth marks and wrinkled grain are found to have become prominent after liming the skins, especially in Accra Malam Market, Kumasi Asawase tannery and Tamale Hausa Zongo tanneries. The growth marks are identified on most leathers produced, and the marks stem from the slaughter of over aged animals in the country.

ii. Effects on leather quality: These create wrinkles on the grain side of the leather and great differences of texture in single sections of the leather leading to increased irregular physical properties.

3. Inadequacies in Tanyard Operations and Lack of Post-Tanning Approaches

Tanyard operations practically results the material leather, since the two most important factors, such as resistance to putrefaction and shrinkage temperature, are acquired (Sharphouse, 1995). In the same manner, post tanning activities carried out also add more desirable properties to the material and make it better to serve its intended end use. That notwithstanding, it is noticeable that the local tanneries lack tanning and post tanning approaches such as pretanning, retanning, shaving, and neutralisation and samming.

4. Poor Dyeing and Fatliquoring

Fatliquoring process is poorly executed in the indigenous leather manufacturing process. In the first place, vegetable oils from groundnut, coconut, or sometimes shear butter are employed without emulsification. Although the application of the oil augments softening and facilitates the dyeing process, the manual application from the grain side usually makes the penetration of the fibres becomes difficult and usually results in precipitation of the oils on the surface of the leather. The purpose is therefore not properly articulated in the finished leather resulting in hardening of the leather upon drying.

For dyeing, the usual wine colour highly depends on the engagement of guinea corn leaves (*Sorghum bicolor*) known as ‘Che’ in Gaguani or cooking stick (food and nutrition), which is pounded manually and applied without first stripping off to remove the precipitated or non-fixed tannins from the grain of the leather to enable the dyer to work on a clean surface free from any discoloration that might have occurred during the initial tannage or drying, and also compensates for variations in tan colour between batches of skins.

CHAPTER FIVE

PROPOSED ALTERNATIVE STRATEGIES

5.1 Overview

To improve on quality of Leatherwork practised and studied in Ghana, the source of pelt from which leather (life blood of Leatherwork) is acquired becomes crucial, especially the mitigation of deleterious factors affecting the generation of high standard skins and hides. Unearthing of strategic avenues to addressing these ruinous factors has been the ultimate aim paramount in this study to ensure that the requisite capacity is built to harness the economic potentials inherent the indigenous leather industry in Ghana to the fullest echelon.

This chapter mainly presents the alternative strategies proposed to rectify the identified causative factors hindering the acquisition of quality leather to maximise its industrial utilisation and entire economic relevance in the country and beyond.

5.2 Preamble to the Proposed Alternative Strategies

Theoretically, Gregg-Erzuah (2007) has emphasised that in any creative endeavour, the essential element is the joy of seeing an idea take shape under one's own hands and the pleasure of that work being appreciated by others. However, since appreciation comes out of satisfaction and quality is the cornerstone of satisfaction, seeking satisfaction implies seeking quality. This practically creates every basis for strategic optimisation of the satisfaction rendered by the product in question through every possible available avenue. The progressivity attained so far in the study has established to a large extent that the theoretical and empirical rationalisations which justify the capacity of leather to express its competency to meet its demands are inherent in two major conditions; **(1) the kind and source of skin or hide and (2) the manufacturing process employed in transforming it from pelt to leather**. Following Wilkinson's, lecture notes on physical properties tests at the British School of Leather Technology, (LEA 6001, 2008), emphasis exists that although leather is made by chemistry, it is sold by the physical properties. Therefore, any intervention effort towards the avoidance of causal factors of physical defects in hides and skins as well as the resulting leather is an essential consideration which stays at the forefront in any endeavour towards improving upon quality to instil and maximise utility and dependability. From a logical perspective, the identified underlying causes and causations behind the local leathers' deficiencies have been identified in this study to stem from the periods of the animal's life and after death. Proposed alternative strategies have therefore been designed basically to serve as interventional approaches towards alleviating **ante-mortem** and **post-mortem** causes and causations of defects which militate against the acquisition of quality leather to support the attainment of economically viable leather for improved delivery of economically viable Leatherwork in Ghana.

5.3 Rationale of the Proposed Alternative Strategies

Eradication of the causative factors and causations of effects which render the local leather deficient in serving its socio-economic responsibilities has been the target of the entire study. This study has therefore been thriving on the principle that solving the cause rather than the effect is the problem facing the Ghanaian indigenous leather industry. Having employed the cause-and-effect theory to study the impact of the operations of the mandatory activities of the multi-sectorial stakeholders of the indigenous leather industry to bring to the fore the multi-factorial causes and causations of imperfections associated with the local leather and its production processes, alternative strategies are proposed to curtail and alleviate the identified deleterious factors, as well as their means to result the effects.

The backdrop of the strategies proposed, first of all, dwells on the modus operandi formulation from the critical understanding and in-depth knowledge congregated from the cross-sectional study to identify the defects and their causal reasons.

Secondly, the researcher has conducted various experiments and the best results have been selected and proposed for application. The experiments focused on finding apposite opposing techniques and approaches in slaughtering, flaying, curing, beamhouse operations, tanyard operations and finishing operations to counteract and improve the existing ones.

Lastly, problem solving ideas have also been drawn from secondary sources through a critically correlation and comparison of the causal reasons identified. Existing tested and proven scientific and technological leather concepts, theories, principles and approaches have been assembled from the review of related literature and experts have been consulted.

5.4 Strategies for Alleviating Natural Ante-Mortem Causes and Causations of Deficiencies Associated with the Local Leather

Strategy 1: **Formulation of livestock policies with focus on holistic economic diversification and maximisation of animal products significance.**

Objective: To advocate for a broad-spectrum national animal husbandry policy formulation and planning that encompass and promote livestock production which generate economically diversifiable and viable by-product and also maximise meat production.

Approach: A well planned pragmatic livestock productivity should be made a national priority based on a philosophy and rationale that capitalises on harnessing holistic economic opportunities of livestock raised in the country such that, meat production will be accelerated, and by-products such as hides, skins, furs, horns, dung, bones, blood, and non-edible offal such as tendons, ligaments, cartridges and fats can as well serve other potential economic purposes including leather production, clothing and garment, organic jewellery, gelatine, medicine, cosmetics, tooth and painting brushes, animal feed and compost manufacturing. By such thoughts, the economic emphasis of the animal will not be limited to meat product as it is currently (Koney, 2004), but rather, every component of the animal, especially the pelt, will significantly represent a wealth-chain capable of job creation and poverty alleviation through leatherwork.

Strategy 2: Institution and implementation of national livestock breed quality enhancement schemes at breeding stations

Objective: To enhance the anatomical and physiological characteristics of local livestock to boost meat production and consequently augment and upgrade skins and hides area size quality, shape and thickness.

Approach: First of all, the nation through livestock policy formulators, economic planners and implementers should acknowledge and appreciate that animal husbandry is a core sector in job creation, wealth creation, poverty reduction and attainment of food security as well as the security of public health. The Ministry of Food and

Agriculture should come to realisation of the deleterious dangers posed to the attainment of food security and animal protein supply by the dependency on the natural status of the relatively smaller body-size nature of the native livestock on meat productivity, against the ever-increasing national population. The need to improve on the productivity of native livestock breeds becomes imperative and a concern for all government and non-governmental stakeholders of the country.

Government through the Ministry of Food and Agriculture (Animal Husbandry) together with the Ministry of Science and Technology, Ministry of Health and the Ministry of Trade and Industry, as well as all stakeholders of the agricultural sector should collaboratively stir-up research into enhancing livestock breeding scientifically towards maximising meat availability, accessibility and affordability, as well as generating animals with by-products that possess diversified economic implications, especially the pelt which according to Sharphouse (1995) stands as the largest single organ of the animal capable of creating a job-chain opportunities.

To gain the necessary scientific support in generating improved types of animals for farmers to raise, there is need to adequately resource all government animal research centres and breeding stations: Nungua farms, Pong Tamale cattle, sheep and goats breeding, Ejura sheep upgrade centre, Babile and Nungua pig breeding, Kintampo goats breeding, Legon Farms, KNUST Cattle Research Centre, Aveyime Cattle Research, Yurigu Cattle Research and Savilugu Sheep Research. When such arrangements are well made, then they can serve as central genetic pools from where selection, introduction and breeding approaches such as cross-breeding, selected breeding and artificial inseminations can be carried out.

The Ndama and crosses of West African Shorthorn (WAS) which are the dominant breeds (about 90-96% of the entire cattle population) are known to be less susceptible to trypanosomiasis and tick infestation; they are also accustomed to the climatic conditions of the country. These are sound exhibition of capability of serving as the bases for genetic improvement by the introduction of other Beef Breeds which produce the best hides, e.g. some breeds of Fulani Zebus, Aberdeen Angus, Galloway, Shorthorn, Hereford, Santa Gertrudis and Central European as they are tougher, rather more uniform in thickness and of a "squarer" shape, i.e. less neck, leg and belly. These breeds and cross breeds are found in all the principal beef-producing countries. Brahma and its cross-breeds (e.g. Santa Gertrudis) are the most resistant to tick and pests. Dual Purpose Breeds –Devon, Milking Shorthorn, Red Poll–vary between the beef and dairy breeds as regards quality of hide. This should be part of national agenda towards attaining a generation of livestock with reasonable body size and shape capable of supplying adequate protein needs of Ghanaian and pelt with area size from 11 sq.ft. as found with zebus, to 40 sq.ft. as associated with some European breeds of cattle (De Haas, 1925; Sharphouse, 1995; FAO Bulletin 67, 1986; Prodrack, 2009).

5.5 Alternative Strategies for Alleviating Man-Made Ante-Mortem Causes and Causations of Deficiencies Associated with the Local Leather

Strategy 1: Reservation of viable lands for commercial livestock farming

Objective: To boost land availability for large scale and commercial livestock farming towards meat and pelt availability, accessibility and affordability.

Approach: Animal husbandry as a form of agriculture demands land availability to thrive successfully and make the necessary economic impact. However, since land tenure system of land management practised in the country restricts large scale land availability, it is imperative that government negotiates with custodians of lands viable for livestock production and through parliament passed bills requisite to adjust land ownership policies such that there can be land reservation to promote large-scale livestock farming in the country. In a broader sense, such adjustment of land ownership legislation should also extend to render land leasing by-laws of the country also flexible for lands reserved for livestock production easy to acquire.

Terrains such as the Afram plains, Accra planes and the most viable portions of the vast savannah stretch of grassland should be targeted for reservation in support of commercial livestock farming as a strategy towards actualising the attainment of food security in the various national agenda. The Afram planes which extends from Ashanti, Brong Ahafo, Eastern region into the Volta and the Northern region has been identified as supportive for raising animals due to several factors including the less or tsetsefly-free nature of the place, semi-humid environment, availability of water bodies and possibilities of dam construction, grassland terrain with a feel of savannah, and above all its strategic location in between the northern and southern sectors of the country. In the northern parts, government through the Savannah Accelerated Development Authority should acquire vast lands in the Upper East and West as well as Northern region to support livestock production in large quantities.

Vast land reserves for livestock production, if possible, should be established in every region of the country, and declared mainly for commercial production activities. The lands should be fenced and leased to large-scale livestock farmers on regulated terms. In such confined manner, production activities can be streamlined and monitored to facilitate tax collections.

Strategy 2: Introduction and implementation of silvopastoral and agrosilvopastoral culture

Objective: To boost feed availability for livestock, limit land use and conserve land.

Approach: Amidst the restricted availability of lands for commercial livestock farming, this strategy is advocating for integrated approach to farming and feeding livestock. With reference to the FAO Corporate Document Repository on Integrated Feeding, Integrating Crops and livestock in West Africa is a viable approach. Since tree crop plantations such as coffee and kola, cashew, kapok cocoa, coconut, oil palm, coconut and rubber are found on large scale across the country, agroforestry systems such as silvopastoral and agrosilvopastral structures can be adopted to curtail the acute land pressure faced by the husbandry industry. Such system encourages the integration of livestock and tree crop plantations so that the animals graze under the plantation. According to Nair (1993), in low land sub humid areas, a commercial silvopastoral system for fodder and food production can be promoted to support. Accordingly, in highland humid areas of the country, the agrosilvopastoral culture can be adopted for food production and soil conservation. According to Mohamed (1978), as cited by the FAO Corporate Document Repository on Integrated Feeding, a wide variety of natural plants grows under tree plantations; up to 70 percent of these are palatable (Mohamed, 1978) and readily grazed by livestock. This creates more possibilities for the approach, which if properly co-ordinated, even forest reserves can provide important under-tree grazing and form part of the basis of the country's grazing reserves since cover crops can be planted to feed the animals.

In such integrated practices, it is required that forage that grows under the tree crops should be available for most of the year and be of good quality. Grasses and legumes must be easy and cheap to establish, able to withstand grazing, moderate drought, shade, trampling and diseases and readily adapt to variations in soils and climate (http://www.fao.org/docrep/004/x6543e/X6543E04.htm). Forage cultivation should also compete with weeds but not with the plantation trees for nutrients, respond to fertiliser, withstand low management levels and allow for ease of harvesting of tree crops, e.g. creeping grasses and legumes growing up with young trees or crowding out other useful grasses and legumes; on the other hand the grazing may be killed by shade if the canopy closes. It is necessary to caution that due to its complex nature, successful integration of livestock into plantation cropping depends on its technical, economic and social feasibility:

Technical Feasibility:

The factors included are soil and climate, the size of the plantation, the number of animals it can carry, the availability of fodder, its quantity and quality and whether these can meet the nutritional requirements of the stock for economic growth and performance, the effect of livestock on the performance of the plantation crop, nutrient (especially minerals) deprivation due to forage growth and consumption by the livestock, and direct damage to the crop by livestock.

The acquisition of land for the establishment of plantations and the right to use the land during the economic life of the plantation, which could be as long as 40–50 years for oil palms and 60 for coconuts, may be difficult to negotiate. Plantations established in grazing land can evoke tenurial problems.

Rainfall and its distribution, temperature and soil type dictate the kind of plantation crop that can be grown. In the savannahs, where most of the livestock are raised, plantations of mango, kapok and teak may be established, but the long, hot dry-season will limit grazing to about three months of the year. Under these conditions the carrying capacity may be limited (Oppong, 1971).

Damage to tree crops can be a limiting factor to crop/livestock integration. Apart from young trees being trampled and broken, livestock debark the trunks and expose roots of citrus, cashew, rubber, cocoa and mahogany (Personal observation). Cattle damage leaf tips of palm and eat ripe fruit bunches of oil palms when the trees are small and young; sheep pick and eat young cocoa pods and on heavy soils livestock can cause compaction. In high rainfall areas grazing and confinement at night cause puddling of the soil and adversely affect the root system of oil palms. Herdsmen and technical assistance agencies are required.

Oppong (1971) warns that diseases of plants and animals require careful control. Coccidiosis and tapeworm infestations prove a serious problem in the raising of sheep under tree crops in Ghana (personal observation), while dermatophilosis, brucellosis, mange, footrot, liver fluke infestation, parasitic gastroenteritis, contagious bovine pleuropneumonia and trypanosomiasis can also occur.

Livestock/Plantation Integration under agropastoral or agrosilvopastoral has a number of advantages which enhance productivity (Payne and Smith, 1975, as cited by FAO Corporate Document) such as: increased production of meat without the opening up of large new areas of land; reduced weeding costs; reduced surface erosion; production of organic manure to fertilize the trees and reduced cost of inorganic fertilizers; speeded rate of nutrient cycle through urine and manure; provision of additional income to plantation cultivators through increased productivity per unit of land; and savings in foreign exchange on fertilizer and meat imports. The lower temperature under plantation trees results in increased feed intake, better growth and improved productivity of livestock (Mohamed, 1982).

Strategy 3: Institution and implementation of cutting-edge livestock farming technology in Ghana

Objective: To revolute the obsolete farming methods and alleviate rampant causes of skins/hides defects resulting from bad farming practices.

Approach: As the farm damage is the greatest cause of downgrading, the farmer is the only person in a position to make the change. Extension officers should be empowered adequately on modern techniques of livestock production that do not only see the animal as meat, but also guarantee safe delivery of livestock possessing qualities diversified mutualism conformance capable to generate revenue to the farmer from other equally potent wealth creation by-product ventures, which the leather industry takes the central position. This will strategically position the farmer at an economically commanding position to bargain the sales of the animal based on the value of the carcass as well as the skin. The following should be the underlying factors to actuality:

i. Improvement on agricultural production technology in the sphere of animal husbandry to revolute a shift from subsistence farming to a more commercialised type to foster and maximise ground breaking productivity in animal protein supply as a vehicle to reduce the dependency on skins and hides as a source of protein. This will create a boost in skins and hides availability, accessibility and affordability.

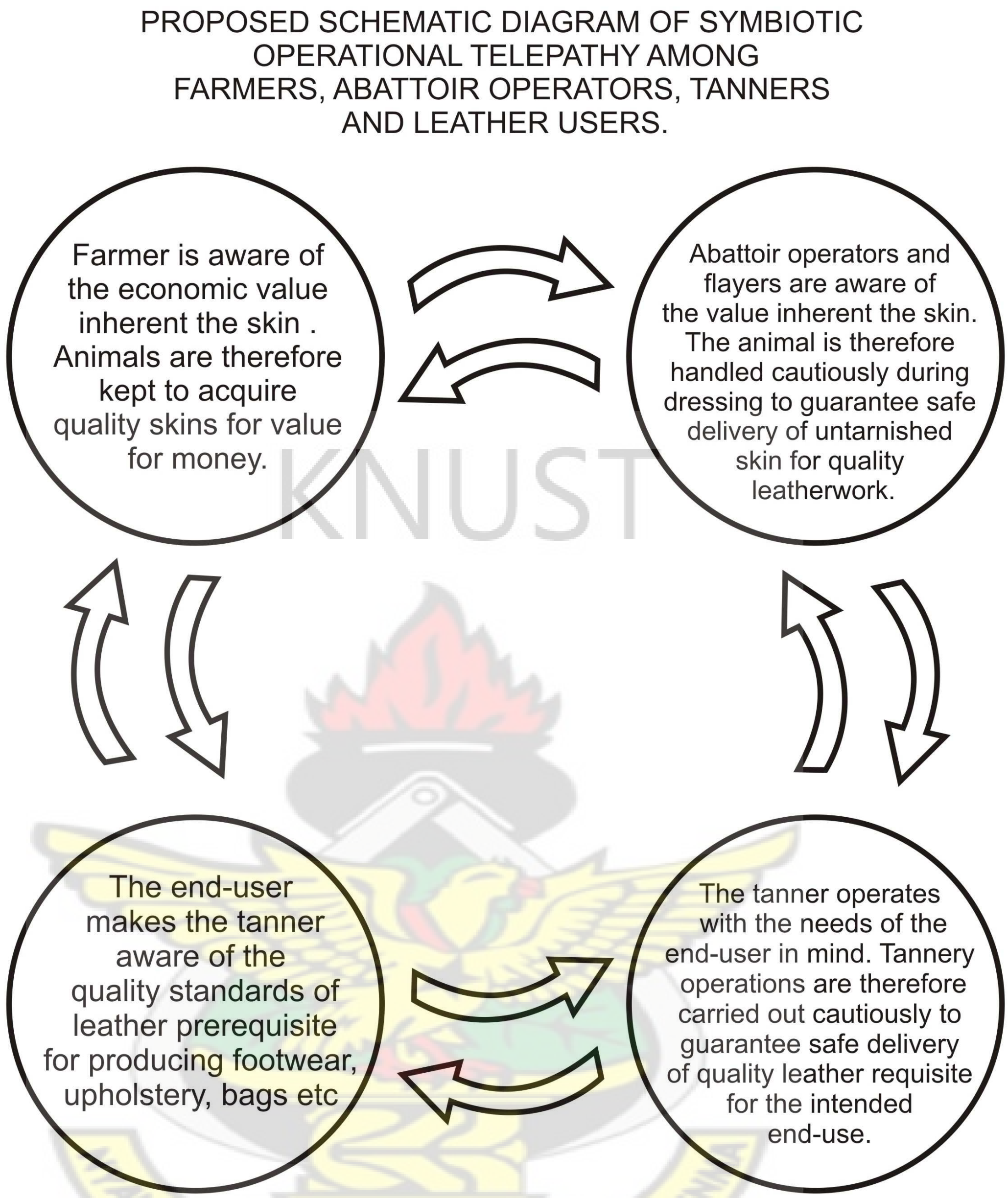

Figure 5.1: Communication channel requisite for improved delivery of quality livestock, pelt and leather

(*Source: Proposed strategy, October, 2009)*

ii. Increased awareness of the economic mutualism among the operations of the mandatory sectors of the leather industry to attain the leather needs of the tanner and the end user in correlation to the economic needs of the farmer and the butcher is prerequisite in ensuring co-ordinated safety delivery of quality pelts and leathers to boost local leatherwork in the country. A communication channel, *as shown in Figure 5.1 (page 224)*, needs to be created to restore operational telepathy among the key players such as the farmer, butcher, curer, tanner and the end user of leathers.

iii. National orientation and awareness of the economic value associated with the animals' skins/hides, especially, in job creation, wealth creation and poverty alleviation should be introduced to farmers and all mandatory sectors of the meat and leather industry. This will ensure reward for skins and hides according to grading at collection centres, and the price of the hide is calculated, and included, in the price paid to farmers for the quality of their stock. If this trend continues, it will ultimately mean animals will have higher value. Therefore, increased awareness to the needs of the leather industry by livestock producers could reverse this trend of bad livestock management practices disincentive to leatherwork.

iv. Again, receptiveness and adherence to standardised livestock management operations which safeguards the well-being of the animal need to be enforced in the country to alleviate the horrendous and traumatic conditions which animals are subjected to. Farmers need to be educated to adapt to improved regular maintenance of animal needs appropriately. According to Koney (2004) and Iwena (2008), successful livestock production depends on overall operational improvement management of housing and shelter, sanitation, feeding, disease control and healthcare, as well as breeding. Invariably, such desirable practices practically result in improved delivery of quality pelt for leatherwork since there is a high tendency of reduced susceptibility of animals to pathological infestations, long contacts with dung, uncontrolled pest attacks and famine.

v. To void the defects brought about by brand marks, it is necessary for farmers to be educated on the negative impact rendered to the animals’ skins and hides by the burning and the use of acid based colours. Alternatively, for the purpose of identification, extension officers and veterinary officers should vigorously educate farmers on harmless and suitable techniques of livestock branding such as plastic ankle straps with numbers, plastic ear tags, plastic neck chain or plastic neck bands.

Strategy 5: Introduction of accelerated national livestock health delivery scheme

Objective: To accelerate animal health and productivity towards boosting meat and pelt availability, accessibility and affordability.

Approach: Introduction of eradication measures against ectoparasites and endoparasites as well as all forms of pathological agents towards quality animal health and productivity is the surest approach to animal health. This will require regular compulsory systematic mass dressing of animals with insecticides and deworming agents. There is need for the institution of national livestock healthcare programme aimed at meat and by-product improvement through eradication of high pathological and parasitic infestations leading to wide range of dermatitis and loss of livestock. Strategically, this can be done through the introduction of affordable or free compulsory systematic mass insecticide spraying, powdering, regular deworming, vaccination, dipping and general health inspections by veterinary officers. This will subsequently require adequate capacity building of veterinary personnel through adequate resourcing and infrastructural building to support national outreach control programme to guarantee animal health.

Strategy 6: **Forage preservation for sustainable livestock feeding culture**

Objective: To promote the availability, accessibility and affordability of good animal nutrition throughout the year.

Approach: This is based on pasture establishment and management to create the availability and easy accessibility of forage for livestock to derive the nutrients prerequisite for maintenance of their physiology and pelt nourishment. Although land availability for livestock keeping has been identified as problematic, it is proposed that government creates the enabling environment to promote investment in animal husbandry and intensification of pasture establishment where vast lands would be reserved and engaged in the cultivation of fodder crops possessing qualities such as high annual yield, persistence to avoid repeated sowing/plant cost, ease propagation, high protein content, resistance to drought, high leaf to stem ratio, multiple harvest by cutting and should be compatible in legume/grass mixture (Koney, 2004; MoFA Manual, 2009).

Existing communal pastures and graze-lands can be conserved and managed by community officials and unit committee members to ensure proper management to maintain the necessary crude proteins and nutrients prerequisite for livestock growth and development. This will require regular weeding, fertiliser/manure application, trimming, harvesting and hay making. Such pastures can serve as avenue for revenue generation through pay-and-graze by farmers. Livestock farmers also need to be sensitised and encouraged to form associations to enable them acquire loans and lands to establish and manage pasture to support good livestock nutrition. Government through the Ministry of Agriculture and private agricultural organisations should embark on vigorous action towards the provision of cheap, adequate and high quality feed throughout the year. Availability of certified and viable seeds is prerequisite.

The nature of livestock production currently requires an urgent need to alleviate leather grain wrinkles, fibre coarseness, looseness, poor elasticity and strength properties, the adoption of pasture management has been proposed as impetus to guarantee the sustainability of growth patterns of animals through accelerated feeding towards achieving early maturity to market size.

5. 6 Strategies for Improving Transportation of Livestock

Strategy 1: National orientation on animal rights and strengthening of enforcement

Objective: To advocate for animal rights and recognition of the animal as a respectable entity in the ecosystem relevant to the sustainability of mankind: socially, economically, culturally, religiously and politically.

Approach: Awareness creation through education based on the enormity of philosophically strategic role of the animal in the sustenance of social life, economic life, religious life, cultural life and political life on earth; hence the relevance of their existence to man. This is an alternative approach to avert the preconceived idea that "an animal is an animal and should be treated as such," a statement heard often at the farms and slaughter centres visited. Intensified education and sensitisation of farmers and animal owners to help them realise the mutualism existing between the recognition of the animal as an entity in relation to the treatment prerequisite to fully harness the socio-economic and cultural benefits inherent the animal. When this mutual psychological accord is reached by the farmer, there will be a systematic effort to support the animal to exhume its inherent socio-economic, religious, cultural and political significance to be tapped to support the sustenance of the owner and mankind. Consequently, the protection and welfare of animal groups such as ovine, bovine, caprine, equine, swine and even other pets, will be held in high esteem, and that will translate into improved productivity of animal which the skin is not exempted.

Institution and enforcement of livestock transportation policies should also emphasise prescriptions and description of vehicle types certified for transiting animal types. Vehicular loading capacity should be determined by the ratio of animal body size and weight to vehicular space capacity.

There is also an urgent need for the institution of intense animal rights protection laws to cater for the welfare of the animal. Such legislation should be formulated to spell out the position of the animal in the economic, social, cultural, religious and political structure of the country; hence the treatment deserved by the animal and punishments associated to breaking them. This will help eradicate the cruelties animals are frequently subjected to such as unnecessary whipping with clubs, wires, sharp-pointed goads; negligence; overcrowding; suffocating; overstressing in retched vehicles, and unhealthy mode of transportation in long vehicles, buses, car boots and upper carriers. When such by-laws are instituted and implemented, mechanical defects such as cuts, marks and wounds mostly sustained by animals will consequently reduce.

It is necessary that Ghanaians are encouraged to form animal rights protection organisations to support, maintain and fight for the sustenance of the animal to the benefit of mankind's existence. This will accelerate the enforcement of animal welfare protection legislations. Alternatively, school clubs, church organisations, workers unions, church leaders and social organisations can spearhead such responsibilities to support government agencies.

5.7 Strategies for Reducing Dependency on Pelt as Protein Source

Strategy 1: Diminution of high dependency on skins and hides as source of protein

Objective: To reduce the existing keen competition in pelt acquisition.

Approach: Education towards aversion of acquired pelt delicacy taste of Ghanaians.

Awareness creation through education of the masses towards (1) averting acquired taste in pelts, (2) cultivation of good nutrition/eating habits, (3) proclamation of the enormity of economic benefits inherent in skins and hides when engaged in the leather industry than the 'wele' or 'kawuro' production, and creating a boost in meat availability, accessibility and affordability through revolutionalisation of livestock farming from subsistence to large-scale commercialised type. Government through the Ministries of Health, Employment and Social Welfare as well as Trade and Industry, first of all needs to appreciate the adverse effects of the high dependency on pelt as a protein source and the implications on public health, child development, human resource development and stabilisation of other animal by-product industries of which Leatherwork stays at the forefront. This should trigger an immediate education programme which lays emphasis on sensitisation to create awareness on the job chain and wealth creation opportunities the leather industry offers.

Such an educational programme will also package the leather industry to attract investors to boost its economic significance, especially in pelt preservation, salt mining for curing, pelt transportation, pelt exportation, establishment of modern tanneries, tannery implement manufacturing, tannery chemical manufacturing and sales, employment of tannery technicians and tanners, leather transportation, leather sales, engagement of leather in artefact manufacturing in sectors such as footwear (shoes, sandals, slippers and safety boots), upholstery (sofas, chairs, car, train, aeroplane and ship interior decorations), garment/clothing (jackets, coats, ties, trousers, hats, gloves and helmet) and containers (bags, files, portfolios, journals, wallets, picture frames, cases to mention a few).

5.8 Strategies for Alleviating Post-Mortem Causes and Causations of Deficiencies Emanating from the Slaughter Centres in Ghana

Strategy 1: Provision of appropriate and well-equipped slaughter centres in the regional and district capitals of the country

Objective: To guarantee improved delivery of quality skins and hides for leathers possessing qualities prerequisite for industrial utilisation.

Approach: First of all, a national sensitisation and enforcement programme on the need for quality delivery of wholesome and hygienic meat through approved slaughter centres is prerequisite to improved delivery of quality skins and hides. This will require policy formulation, implementation and enforcement which streamline meat processing activities to ensure that people with the requisite expertise and certified technology and accredited establishments are involved in animal farming, trading, transportation, slaughtering, dressing and holistic meat delivery.

To augment and accelerate the attainment of positive impacts through the programme provision of appropriate infrastructure to support the operations and activities occurring at the various slaughter centres, especially, the slaughter houses and slabs is imperative. Sourcing of funds and investment in the meat production sector should be done through government initiatives and accentuated by private partnership programmes at the international, national, regional and district levels.

Improvement in the quantity of abattoirs in the country is necessary. Also, the standard of district and local community slaughter slabs need to be uplifted operate with improved facilities such as approved structures, lairage, stunning box, slaughter floor, chilling rooms, condemnation yard and laboratory. To ensure safe delivery of skins and hides through reduced bacterial contaminations, gambrels and tail grips are needed for hoisting animals for proper bleeding (*Figure 5.2*), flaying and dressing need to be carried out on cradles as supported (*Figure 5.3, page 231*), flaying should be done with mechanical flaying wheels or knives with curved shaped blades, water availability for washing, pallets for stacking pelt in piles for salt curing and storage (*Figure 5.4, page 231*) and stretchers for air drying when necessary.

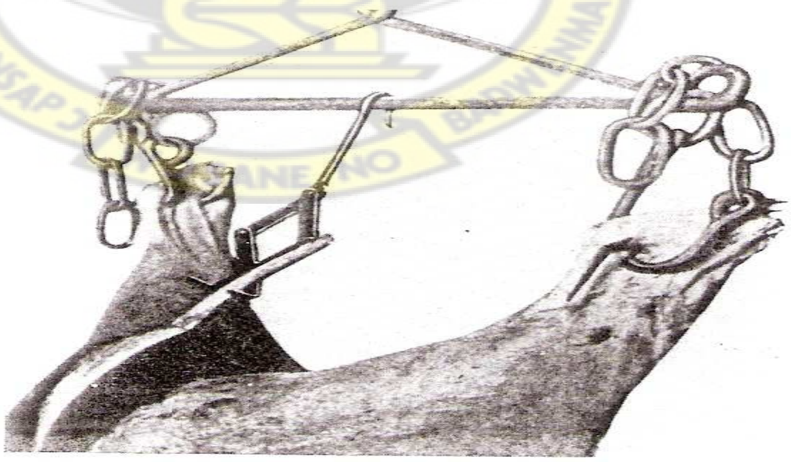

Figure 5.2: Simple gambrel for hoisting ruminants for adequate bleeding (Elliot, FAO of the UN, 1986)

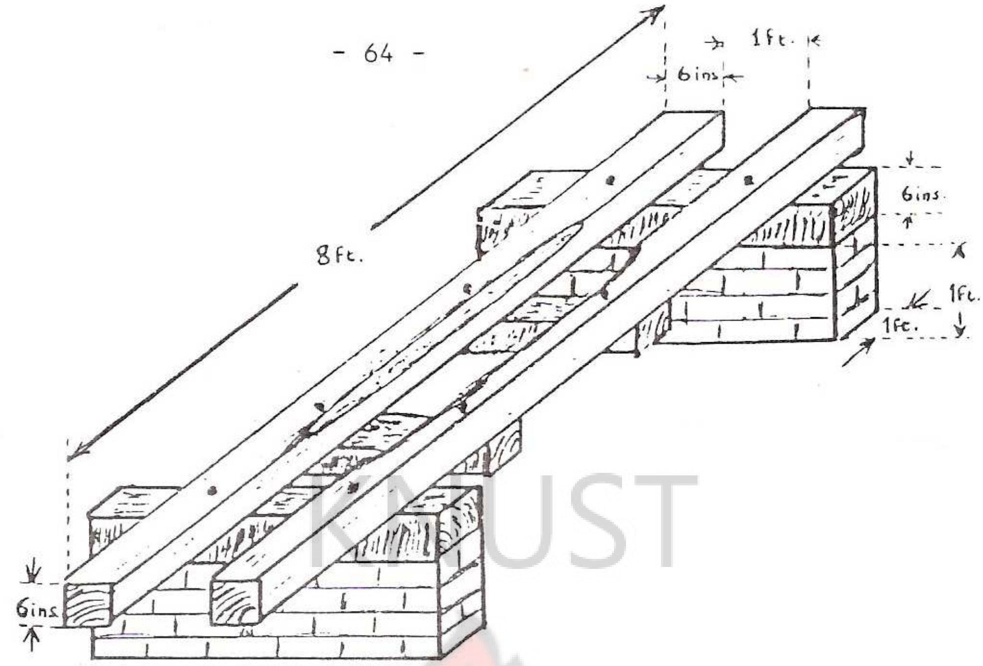

Figure 5.3: A simple cradle to support flaying at the slaughter houses and slabs.

(Source: FAO Service Bulletin, 67, 1986)

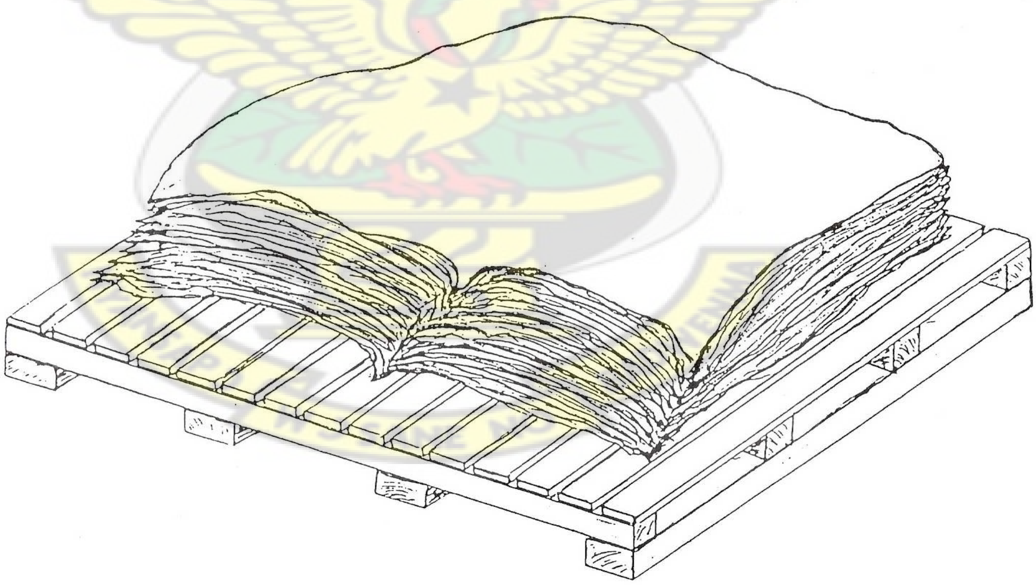

Figure 5.4: Pelts stacked in piles on a pallet for salt curing and storage.

(Source: FAO Service Bulletin, 67, 1986)

Strategy 2: Education on standard folding methods of skins and hides for storage and transportation

Objective: To avoid folding damages and ease bailing of pelt for transportation.

Approach: Presentation in terms of bailing and folding after grading is important for good marketing of skins and hides. In general strategic folding terms, the first two folds are made roughly one-fifth of the full width of the skin and parallel to the backbone line, the third fold is made about two-fifths of the distance from the neck end to the tail folded toward the tail at right angles to the backbone and the fourth fold is made along the line of the backbone *(Figure 5.4).*

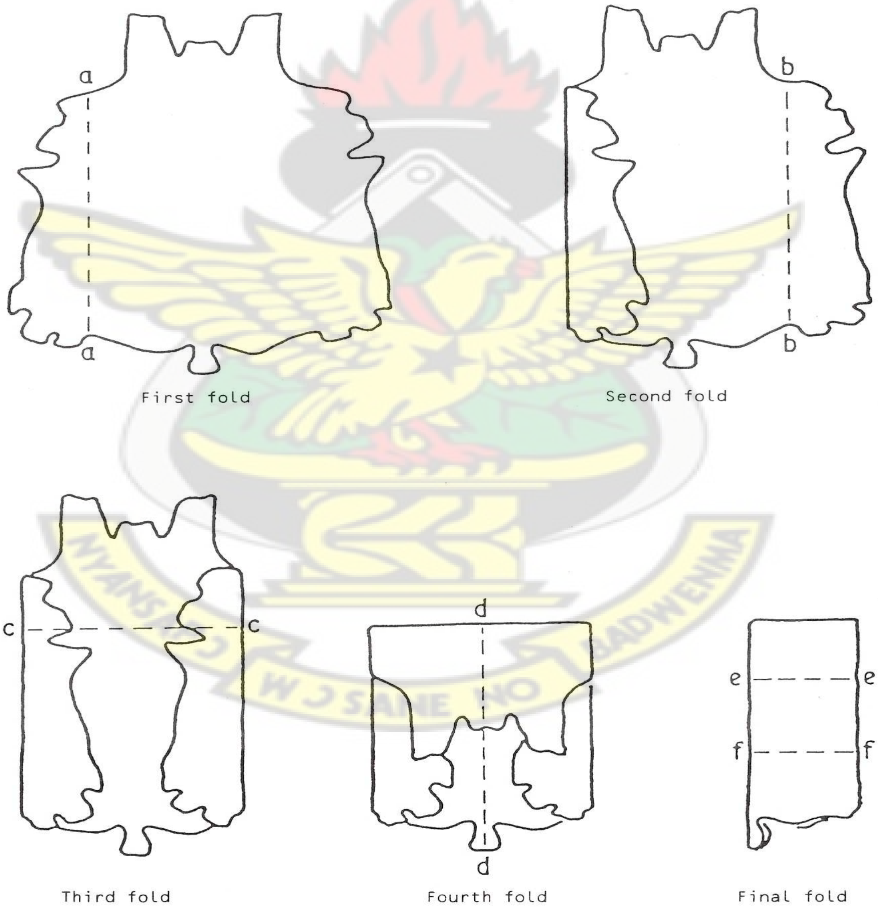

Figure 5.5: Folding pattern for hides and skins after curing
(Source: FAO Bulletin 67, 1986)

Strategically, since sodium chloride (common salt) is in abundance on the coasts of Ghana, it is an advantage to skin and hide preservation against bacterial or enzymic activity to maintain their leather properties. It has been proven that water held in the tissues of pelt after flaying amounts to about 60% of the total green weight and dehydration effectively reduces the risk of tissue breakdown when efficiently performed because the residual water content is insufficient to sustain the preferred conditions for microbial activities. When sodium chloride is employed in curing it also acts as a bacteriostat if present in adequate concentration, and it can be made even more effective by the presence of additives such as boric acid and naphthalene. It is proposed that government pays critical attention to boosting the animal husbandry sector to boost skins and hides availability to positively affect and create a boost in the salt mining industry to advance the nation's economic development.

5.9 Strategies for Curtailing Post-Mortem Causes and Causations of Deficiencies Emanating from Local Tannery Operations in Ghana

Strategy 1: Provision of tannery equipment and enhancement of tanning methods

Objective: To upgrade and eliminate obsolete tannery approaches

Approach: To accelerate tanning manufacturing which results in leather with requisite properties to meet industrial utility, an upgrade of production methods and technologies is prerequisite. First of all, the tannery environment needs to be cemented to avoid contaminations with sand and micro-organisms, effluent treatment facilities to accommodate liquid waste and control air pollution needs to be in place. Drainage system at the tanneries is needed to augment the effluent treatment. Again, to control bacteria and fungi attacks and facilitate leather manufacturing processes such as beamhouse, tanning and post-tanning and finishing activities, the following facilities need to be provided.

Provision of financial and infrastructural support to tanners and leather artefact producers is necessary to boost the indigenous leather sector as part of Small and Medium Scale local industry improvement support for job and wealth creation towards poverty alleviation. This will help the tanners to invest in improved tannery facilities by cementing their vats, obtaining paddles, drums to facilitate the liming, deliming, bating, pickling, tanning, post-tanning and finishing processes. Again, with assisted financial support, tanners can purchase horses *(Figure 5.6, page 235, shows a design of a horse)* for holding pelt and leathers at the tannery to prevent dust and microbial contaminations when kept on the tannery floors. Both electronic and manual scudding devices can also be purchased for dehairing and defleshing to facilitate the beamhouse operations. Local raw materials can equally be engaged in tannery equipment construction for tanners to facilitate and ease the tediousness of manual operations and also catalyse the production process of leather.

Also, since tanners work in clusters, it is proposed that automated machinery such as electronic drums, paddles, driers, millers and tumbling equipment are installed at the tanneries to operate for appropriate fee or service charge. Water as well is imperative in the entire tanning process; provision of water free from impurities which react with processing chemicals is also prerequisite. By proclaiming the enormity of economic benefits indwelt the leather industry to Governmental bodies, banks and financial institutions as well as the entire private sector, partnerships can be formed to encourage such ventures to promote Leatherwork in Ghana.

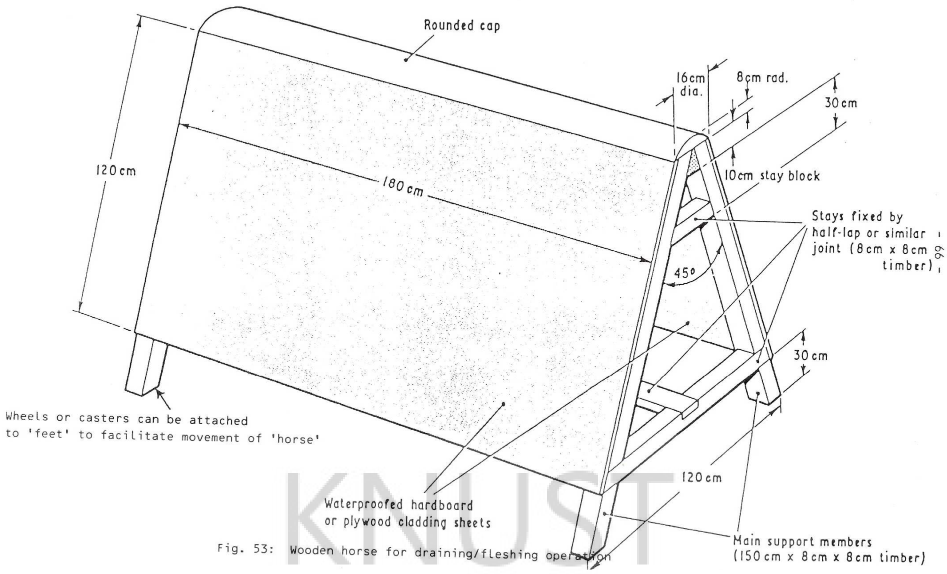

Figure 5.6: Proposed device for horsing pelt and leather at the tannery to avoid dust, stain and bacterial contamination

(Elliot, FAO of the UN, 1986)

Strategy 2: Recipe proposed for shoe upper leather production

Objective: To manufacture leather purposefully tanned to possess the qualities necessary for shoe upper production

Approach: Specific manufacturing procedures known as recipes need to be formulated as guides for tanners to follow towards generating leathers with specific properties to meet specific industrial utility and applications. With this strategy, different recipes are designed for leathers meant for different end uses such as footwear, upholstery, bags, clothing accessories and garment. Since leather is said not to be made unless its end use is known, the recipe is designed by the following procedures:

Identify the end use of the leather to be made, choose pelt from the right source (goatskin, sheepskin, cattle hide, horsehide, pigskin or ostrich skin), choose the right equipment, right combination of chemicals and quantities based on the quantity of pelt to be processed. Specify the production process to follow including the specific processing time, temperature, control and operational checks required for every activity,

It is important to mention that due to the technicalities involved in recipe formulations, tanners need to be educated to become more oriented, circumspective and receptive to follow recipes for leather production. An example of proposed recipe for shoe upper leather is presented as follows:

Caution: ***The recipe below has been designed in conformity with processing drums due to the mechanical action it impacts on the tanning activities to facilitate the process. Adjustment is required in the quantity of chemicals and time required for the activities. The recipe designed in Appendix 6 is favourable for the pit/vat method.***

Table 5.1: Recipe Designed for Tanning Pelts for Footwear Upper

Raw Material: Cowhide **End Use: Footwear**

Weight: 60 Kilos **Equipment: Rotating drum, paddle**

Process	**Quant.**	**Chemical**	**Temp.**	**Time**	**Comments**
Dirt Soak	200%	Water	25		
	×	Surfactant			
	×	Bactericide		1hr	
Drain					
Main Soak	200%	Water	25		
	×	Surfactant			
	×	Bactericide		5hr	
Drain					
Flesh					Trim and Reweigh
New weight:					
Unhairing	80%	Water	20		
	1%	Lime			
	0.5%	Sodium Sulfide 60%		30’	
+	0.5%	Sodium Sulfide 60%		15’	
+	50%	Water	20		

	1%	Lime			
	1%	Sodium Sulfide 60%			
Swelling +	100%	Water	20		
	1%	Sodium Sulfide 60%			
	1%	Lime			
	×	Degreaser		O/N	pH 12.5
Drain					
Wash	100%	Water	20	10’	
Drain					
Wash	100%	Water	35	10	
Delime	50%	Water	35		
	3%	Ammonium sulfate			
	0.5%	Sod. Met. bisulfite			
	×	Degreaser		60’	Check pH 8-9
					Check Ø, PT slight pink
	×	Formic acid	10		Only if pH is >9
Bate +	×	Pancreatic bate		×’	
Drain					
Wash	100%	Water	Cold		
Drain					

Process	**Quant.**	**Chemical**	**Temp.**	**Time**	**Comments**
Pickle	80%	Water	Cold		
	6%	Salt			
	0.8%	Sod. formate		10’	Check Bé 6-8
+	1.8%	Sulfuric acid 98%			
	×	Fungicide		90’	80% Pickle +20% wash
					Check pH 2.5-3.0
					Check Ø BCG yellow
		CTS (25%, 33%)		90’	Check Ø
Basify		Magnesium oxide		O/N	
					Increase T slowly to 40
					pH 3.7-4.0 (masking)
					Check Boil test or T
Drain					
Wash	100%	Water	40		
	×	Fungicide		10’	80% pickle + 20% wash
Drain					

Process	**Quant.**	**Chemical**	**Temp.**	**Time**	**Comments**
Wet back	300% =39L	Water	35		10-15rpm
	0.5% =65g	Surfactant		20	Check after 10’
Drain					
Neutralise	100% =13L	Water	35		

	1% =130g	Sodium formate		10’	
+	0.25%=32.5g	Sodium bicarbonate		30’	Check Ø BCG, ph4.6-4.8
Drain					
Wash	200%=26L	Water	35	5’	
Drain					
Retan	100%=13L	Water	35		
	3% =390g	Replacement synthan			
+	3% = 390g	Veg. Tannin (Mimosa)		20’	Check pH
+	20%= 260g	Water	35		
	3% = 390g	Acrylic Synthan		20’	Check pH
Drain					
Wash	200% = 26L	water	50	5’	
Drain					
Dye/Fatliquor	100% =26L	Water	50		
	1% = 130g	Dye		10’	Paste if necessary
+	4% =520g	Sulfated/sulfited fat 1			Emulsify (1:4)
	2% = 260g	Sulfated fatliquor 2			Emulsify (1:4)
	2% =260g	Sulfated fatliquor 3			Emulsify (1:4)
Fix	1% =130g	Formic acid		20’	pH 3.6-3.8 (0.5+0.5)
Drain					
Wash/Rinse	100% =13L	Water	50	5’	
Horse up					
Samm-set					
Vacuum					
Toggle					

Explanation of the processes in the recipe

Curing: a. Avoid degradation, thus rotten, putrefaction, bacteria attack.

b. To permit or allow storage of raw hides/skins.

c. make rehydration easy at the beamhouse

d. make transportation easy

e. preservation should be reversible–it should not cause any chemical change of the raw hide

Soaking: 1. Removal 2. Rehydration

a. Removal of wash – fat, blood, dirt, manure, salt, unstructured protein/soluble proteins
b. Rehydration, to allow water to transport chemicals into the collagen fibres
c. To attain flexibility of fibres
d. Open fibre structure

NB: For purposeful soaking: It is where soda ash is added to raise the pH to support or begin the liming process. Some other chemicals may be added to start swelling.

Liming/unhairing

1. Removal 2. Swelling 3. Saponification 4. Raise pH

1. Removal: a. Keratin removal
   (i) epidermis (proteins–soluble or unstructured
   (ii) hair/scales/wool
2. Saponification: convertion of fats into soaps for easy removal–fats are insoluble in water.
3. Swelling: opens up fibre structure to allow in and out of chemicals
4. Raise pH: a. Causes swelling
   b. saponification
   c. hair, removal–conversional S^{2-} process (sulphide, sulphite, sulfate).

Deliming

1. Removal: of liming chemical (if calcium is not properly removed will react with other chemicals in the subsequent processes)

Basically, this deliming process is the point where liming chemicals are fleshed out of the skin for further processing to prevail or make way for further processing

2. Lowering pH: when the pH is lowered, it causes
    a. Deswelling which leads to or introduces flexibility into the skin

Bating

1. Cleans and conditions grains
2. Softness, flexibility, suppleness (are introduced)
3. Opens up the structure of the collagen fibres

NB: Thumb test or balloons tests are done here

Pickling

ACID: a. Lowers pH. NB: low pH collagen is (+), high pH collagen is (-).

b. Reduces the reaction between tanning agents and collagen. The acid reduces the astringency of the tannins. This allows the penetration of tanning materials avoiding them to precipitate on the surface of the skin.

SALT: stabilises the material (skins) to allow pH. With most organic materials (like collagen), acid degrades them so salt is added to stabilise them.

If salt is added:

a. Grains can be more pronounced
b. Swelling reduces and stabilised
c. Fibres can be opened

Preservation

a. Pickling is done to preserve the skin
b. For tanning, pickling is done to different pH depending on the tanning materials to be used. e.g.: At a low pH collagen permits high/proper penetration of tanning agents. High pH reduces the penetration of the tanning agents

   At low pH collagen is (+)

   At high pH collagen is (-)

Tanning (pretan, tanning, retan): Vegetable tan or Mineral tan

i. To fix specific properties required by the end product.
ii. Penetration of tanning chemicals is done during tanning
iii. Skin is changed into leather
iv. Leather becomes stabilised to putrefaction
v. Leather becomes stabilised to temperature–shrinkage temperature

Basification

i. For fixing the tanning chemicals (Cr), Alum (Al), Zr.
ii. Basification –is about raising pH but raising the temperature does the fixing
iii. Basification is not mentioned in vegetable tanning which already requires temperature of 4.5–5.0
iv. GTA–tanning chemicals can be forced to penetrate by raising the pH. It can be allowed to penetrate slowly.

Horse–up (ageing)

a. Serves as temporary storage
b. It serves as a holding pattern

c. Allows fixing of chromium, binding, retanning chemicals with collation
d. Allows oxidation
e. Allows chemicals to mature

Samming/setting

a. Squeezes water out leaving collagen with about 45% moisture content
b. Water out makes the material firmer during splitting. This makes the leather less likely to stick to the rollers in the splitting machine
c. Setting
    i. Removes folds (spreads leather out)
    ii. Removes creases/pleats
    iii. Spreads, flattens the grains or areas.

Splitting (close to correct thickness)

a. To obtain two sellable leathers for economic grains
b. Ensure that close to correct thickness is achieved to make shaving easier a not more than 0.5mm

Shaving

a. Adjust the thickness
b. Separates and opens up the fibre structure
c. More accurate thickness 0.2mm or ± 0.1mm

Wetting back

a. Rehydration
b. Checks how much water is needed based on how much dehydrated the leather is.
c. Removes

i. Shavings (dusts)

ii. Greases (decreasing agent is added)

iii. Iron stains (from the blades of splitting, shaving machines)

Retan

Chemicals – aluminium (Al), glutaldehyde (GTA), Vegetable (Zr), Zerconium gives thighter and white leather.

a. Retan is to add specific properties
b. Retan chemical agent depends on the properties required

Rechroming

Chemicals–Cr, salt, syntan

a. Helps to give even Cr content across collagen
b. Results soft leather
c. Increases chromium content in the collagen and makes it more stabilised

Neutralisation

a. Aims at making the collagen neutral and free from all charges.
b. Makes the leather or collagen more anionic (negatively charge [-]) and less cationic(positively charge [+])
c. Controls the penetration and fixing of chemicals. E.g. dyes, fatliquoring materials
d. Fixes the retanning and rechroming chemicals (materials)
e. Neutralisation really influences dyeing, thus, surface,deep, cross–section
f. To neutralise
    i. Raise pH
    ii. Lower pI (IEP)

Retanning

i. Boiling kills collagen but does not affect elastin.

ii. Acid at pH of 4 will cause elastin to detach from the grain and the grain surface relax

Process parametres

a. Refers to the equipment used conditions, processes and their influence on the manufacturing of leather
b. Drums speed
    i. Increases temperature/ heat build up
    ii. Cause mechanical cation

NB: maximum mechanical action speed–MMAS can cause damage to collagen

1. Time
    i. Longer time results high penetration
    ii. Short time results in low or poor penetration
    iii. Dyeing require high temperature for high penetration and low fixing
    iv. Temperature increases the rate of diffusion of chemicals
2. **pH:** It is used to control collagen charge or control swelling and collagen charge

Amount of chemicals

i. The amount of chemicals used has a lot of influence

ii. High chemicals means:

High concentration → high penetration → results high reaction

iii. Chemicals used depends on the following:

Float, Reaction required, Penetration required, Weight of skins (raw materials)

Strategy 3: Adoption of corrected grain finishing approach

Objective: To upgrade the surface quality of local leathers spite of the manifold surface defects.

Approach: Since the grain surface of leathers made locally are associated with several defects, they cannot qualify for grade 1 aniline finish or grade 2 semi-aniline finish. The pigmented approach which depends on grain correction (corrected grain) is proposed to nullify grain defects such as scratches, grain peelings, wrinkles, growth marks, stains and undesirable marks to make the leathers more useful. The corrected grain approach requires that prior to finishing; the leather should be thoroughly conditioned, staked and lightly buffed to level out the flesh side. Skins and hides exhibiting many grain defects should be lightly snuffed on the grain side before finishing chemicals are applied. Coats of resins and pigments can be sprayed on the surface for grain filling and tightness but should still provide the leather with good softness and roundness. Coating, platting and embossing equipment can be constructed locally to support such surface finishing to upgrade the value of the local leather.

CHAPTER SIX

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 Overview

This chapter, being the final chapter of the dissertation, presents the summary of the research conducted, the conclusions drawn and recommendations from the findings. In addition, the alternative strategies proposed have also been presented to intercept the causative factors and to improve the economic significance of the local leather. The implications of the study for further research are also outlined.

6.2 Summary

The global leather industry has been an unprecedented contributing factor in mankind's economic, social, religious, cultural and political civilisation since antiquity. It has played significant role in the progress of almost every industrialised country known, including Italy, China, United States of America, the United Kingdom, Germany and France (De Haas, 1925; FAO Agricultural Services Bulletin 67, 1986; Leather International, October 2007; World Leather, December 2008). Currently, emerging nations such as China, India, Brazil, Argentina, South Africa to mention a few, are reaping enormous revenues to supporting economic development (Kite and Thomson, 2007; World footwear, March/April, 2008, Vol. 22).

In Africa however, according to the African Platform of the Leatherworld (http//:www.leatherworld_africanplatform), the economic potentials inherent leatherwork are still untapped. Meanwhile, the alleviation of the high level poverty, hunger and economic insecurity associated with the people of Africa of which Ghana is no exemption is possible only when value is added to locally available resources to transform into dependable commodity capable of revenue generation (Awelenna, 2008).

According to Boahin (1999; 2005; 2008), although leather artefacts produced attain some local and tourists patronage, the leather industry has not been able to make any significant transformation in its production approaches. This has led to lack marketing potency and penetrative capacity of the artefacts to uplift the economic significance of the Leatherwork in Ghana.

It has also been observed that leathers produced locally face hostility in utility in the major leather consuming production sectors in Ghana such as the footwear, upholstery, bag making and clothing and accessories. There are less or no exportation avenues for leathers or even pelts to the arctic and the temperate zones of the world as a means of revenue generation to support national development. The situation has been seen as a hindrance to the economic significance of Ghanaian leatherwork and impairment to the study of Leatherwork as a course in the country, since it takes inspiration from the local leather industry. Considering the enormity of job and wealth creation potentials inherent in Leatherwork on the global perspective, the researcher found the situation of the indigenous leather industry unacceptable. Investigations to ascertain the causal reasons behind the situation as a means to find alternative avenues to unravel militating factors and improve upon the socio-economic status of the industry therefore became necessary.

Since the research problem arose out of the anxiety to identify the reasons behind the limitations in utility associated with the local leather at the industrial sphere, three research questions were set against three objectives, and a wide range of triangulation research approaches were employed to examine the economic utility aptness of the physical properties of local leather samples selected from five tannery sources across five regions in the country. The quality standards of the footwear industry (shoe upper) were used as a case study and a measure to assess the physical properties of the local leather. The results generated were discussed to cover other end uses including upholstery, bag making, and garment and clothing accessories. Upon realisation that the local leather samples were deficient in manifold indispensable desirable properties prerequisite for industrial utility, a further probe into the causes and causations of the defects was conducted to stimulate the identification and proposal of pragmatic and proactive alternative strategies for implementation to address and transform the industry into an economic significant type.

6.3 Summary of Major Findings

The main findings revealed by the study are as follows:

1. Leathers tanned locally have been identified to possess sufficient stability to putrefaction and shrinkage temperature due to the potent astringency of the vegetable tannage (*Acacia nilotica*) locally known in Hausa as Bagaruwa; although, its seasonal availability is problematic to tanners.

2. It has become glaring however that the causal reasons underlying the industrial hostility and poor receptivity faced by the leather in the footwear, upholstery, bag making, and garment and clothing accessories production sectors emanate from the following:

a. The leathers tanned locally are crusty and its physical properties are littered with manifold unpardonable defects and deficiencies which render them sub-standard and less economically useful in industrial sense to support the production of artefacts with articulated economic implications.

b. The significant deficiencies identified include: less economic cutting value, poor thickness, flexibility, grain resistance, tensile strength. The grain surface appeal, the quality which serves as the core determinant of leather's aesthetic class, was as found abysmal; comprising scratches, holes, growth marks (wrinkles), scars, and patched/uneven colouration.

c. The flesh side is highly occupied by unnecessary excess flesh and impurities which make the leathers not readily useful; further processing referred to by Atiase (2004) and Boahin (2008) as "secondary treatments" is therefore required as expressed before usage.

3. The manifold deficiencies in the physical properties of the local leather have been revealed to emanate from secluded multi-factorial and multi-sectorial causes and causations categorised as follows:

a. There are natural ante-mortem causes and causations of physical defects impairing the economically viable. These include:

i. The relatively smaller size nature of livestock breeds native to the country is the cause of the poor area size quality of leathers tanned locally and their attributed deprived economic cutting valued. The bovine, ovine and caprine breeds were identified as the dwarf types which generate fairly smaller size leathers possessing less economic cutting yield for industrial utility.

ii. The anatomical and physiological orientations of the local breeds of local livestock resist the operation of leather surface flattening. For example, the hump of the bovine is highly undesirable in surface flatness of leather.

iii. The grotesque body structure of most livestock slaughtered is another natural phenomenon which renders the local leather undulating surface and resistant to leather surface setting for enhanced cutting value.

b. Man-made ante-mortem causes and causations of defects were also identified to emanate from the following:

i. Poor farm management approaches employed in raising livestock in the country have been identified as disincentive to the production of quality leather. The practices, especially, the extensive system were revealed as the worst practice which cause serious forms of dermatological damages through unnecessary roaming, poor housing and sanitation, predator attacks, dung stains and stealing.

ii. Again, as a result of bad husbandry practices, the animals in the country easily become susceptible to diverse pathological infestations which lead to a wide range of dermatitis including trypanosomiasis, menge, pox, lumpy skins to mention a few.

iii. Due to bad feeding and nutrition culture emanating from lack of well managed rangelands pasture, lack of supplementary feed during the dry season, and irregular supply of water, livestock in the country grow malnourished since their tissues are not well nourished and replenished. Their growth patterns therefore become irregular and slow leading to late maturity to market size.

Their skins development more grain surface wrinkles, fibre looseness and coarseness; hence less economically useful for leather.

iv. Bad breeding culture found in the livestock farms also lead to the replication of undesirable features, such as smaller body size, grotesque anatomical and physiological shape, and undulating body contours, from parents to offspring.

v. Branding and tattooing with hot metal for the purpose of identification is another serious cause of skin/hide damages, since the hot metals used leave permanent undesirable marks on the skin, especially at important areas such as the at the butt, shoulder and belly.

vi. The mode of transporting livestock in the country remains as core causative of dermatological infirmities which hinder the attainment of quality leather for leatherwork. The vehicles are rugged and the animals are also crowded leading to skin/hide scratches and wounds due to in-fighting for space.

c. Post-mortem causes and causations of defects in skins and hides: These are man-made causes of defects which occur from operations carried out after the death of the animal. Defects caused by post-mortem activities were found to emanate from two major sources: (1) the slaughter centres, and s(2) the tanneries.

The Post-mortem causes of defects identified at the slaughter centres included lack of humane slaughtering technology, bad bleeding, unwholesome carcass dressing, high magnitude of flaying and shape trimming unprofessionalism and exposure of pelts to microbial hydrolysis through unhygienic environments. The slaughter centres also lack cutting-edge curing technology to fight against autolysis for safe delivery of quality pelts for leatherwork.

Post-mortem causes of defects emanating from indigenous tannery operations included the following:

i. Poor beamhouse operations such as: insufficient soaking practices, under/over liming of pelts leading to over swelling or difficulties in defleshing and dehairing' insufficiency of deliming and bating, lack of proper pickling techniques.

ii. Poor application of tanning approaches such as: lack of pretanning methods, misapplication of tanning techniques and lack of retanning methods.

iii. Lack of adequate post-tanning techniques capable of inducing into the leather additional properties such as softness, pliability, strength, and grain corrections prerequisite for the intended end use.

iv. Lack of the appropriate technology for tanning and finishing operations to result leathers which possess internationally acceptable quality standards to meet industrial demands. It was noted that leathers produced are not purpose oriented.

v. The geographical segmentation and seasonal nature of vegetable tanning raw materials creates limited availability, accessibility and affordability of tannins obtained from Bagaruwa (Acacia nilotica).

d. It also became evident that there is no telepathy existing between livestock farmers, slaughter house operators, curers, tanners and leather end users; hence lack of cohesion for comprehensive consideration of needs in attaining quality leather.

4. Limited scope of national livestock policies and implementation have been found as essential impediments to the economic significance and productivity of Leatherwork in the country. They are explained as follows:

i. National policies on livestock lack foresight in harnessing the economic benefits of the animal holistically, especially, by-products such as skins and hides, fur, wool, bones, dung, and even blood for animal feed.

ii. There is lack of vision and national orientation in diversification of agro-based economic resources; therefore skins and hides produced are simply eating as meat in spite of their fibrous nature.

iii. Lastly, the study identified that there is unparallel animal production to household animal protein needs in the country which has resulted insecurity in animal protein needs. This has created high dependency on skins and hides as alternative source of protein supply; the indigenous leather industry is facing undue competition leading to limited pelt availability, accessibility and affordability.

6.4 Summary of Proposed Alternative Strategies

Since the cross-sectional study identified multi-factorial causes and causations undermining the attainment of quality leather to safeguard the promotion and economic progress of the indigenous leather industry, widespread apposite alternative strategies have been proposed to intercept the causative factors identified. The Proposed alternative strategies are simplified as follows:

1. Improvement of area size and economic cutting value of local leathers through pragmatic and proactive national livestock breeds improvement programmes towards

enhancing the anatomical and physiological characteristics of bovine, ovine, caprine, pigs, and equines native to the country. The genetic improvement is based on eradication of inbreeding and encouragement of cross-breeding, selected breeding, artificial insemination of desirable characteristics of other exotic and hybrid animals is a favourable alternative strategy.

2. Introduction of national programme on livestock productivity and sustainability through the application of apposite farming technology. This will require financial and infrastructural support from government, banks, NGOs and the private sector to augment the provision of good housing and sanitation, nutrition, medical and healthcare, as well as holistic animal welfare security.

3. To alleviate leather grain wrinkles, fibre coarseness, looseness, poor elasticity and strength properties, the adoption of pasture management has been proposed as impetus to guarantee the sustainability of growth patterns of animals through accelerated feeding towards early maturity. This requires hay, silage and fodder preparation and preservation.

4. Adjustment in the current land tenure system and land acquisition legislation is also another strategy to enable the government reserve economically viable planes and savannah grasslands such as the Afram Plains, Accra Planes and portions of the savannah in the northern parts purposely for large-scale livestock commercial farming. This will create a boost in meat availability, accessibility and affordability, and reduce the dependency on skins and hides as source of meeting protein needs.

5. Institution of national livestock healthcare programme aimed at meat and pelt improvement through eradication of high pathological and parasitic infestations leading to wide range of dermatitis. This requires the introduction of affordable or

free compulsory systematic insecticide spraying, regular deworming and general health inspections by veterinary officers.

6. Abattoir and slaughter house infrastructural development for enhanced meat and quality delivery pelts to support leatherwork. It is imperative that government creates the enabling environment for public and private sector investments in wholesome meat processing which indirectly will affect quality skins/hide delivery.

7. Creation of a well-tailored customer-centred sensitisation education towards civilising the farmer, the butcher, the curer, the tanner and leather end users to synchronise their activities through material need awareness to boost the sales of their end-products (unblemished animals, delivery quality pelts, delivery of quality leather, delivery of quality artefact).

8. National orientation on the recognition of the economic relevance of leatherwork in revenue generation for national development has been proposed. This is to avert gradually the general perception that the skin is for consumption as meat than by-product for leatherwork. Continuous public education on the economic opportunities inherent the pelt when engaged in leatherwork, needs to be embarked upon through media such as schools, public seminars, workshops and employment forums by government and individuals.

9. Provision of financial and infrastructural support to tanners and leather artefact producers has been proposed towards boosting the indigenous leather sector as part of Small and Medium Scale local industry improvement support for job and wealth creation towards poverty alleviation. This will help the tanners to invest in improved tannery facilities such as cemented vats, dehairing and defleshing devices, quality raw materials and even automated machinery such as drums, paddles, driers and millers

for tumbling. Governmental bodies, banks and financial institutions are therefore encouraged to look into this equally economically viable sector for investment.

10. Industrialisation of the leather sector is an alternative strategy proposed to uplift the face of leatherwork in Ghana. Government and national employment policy formulators are required to be enlightened to mount strategies which create the enabling environment for investments in tanning and leather related businesses in the country. This will create economic boost in the utility of skins and hides and introduce value for money through grading.

6.5 Conclusions Drawn from the Study

The realisation of the enormous contribution rendered by Small and Medium Scale local industries that depend highly on local resources for transformed economy potent to support quality livelihood has led to relentless efforts by governments across the globe to institute pragmatic measures favourable to create enabling environment to harness opportunities. Salvaging and encouraging the Ghanaian indigenous leather industry to producing enhanced value leather artefacts to meet the needs of modernity and boost local and international marketability to galvanise the generation of revenue to support the development of the economy has been a major concern of Ghana government and the international community. This has been the rationale for the introduction of Leatherwork into Ghanaian formal school system to pursue apposite approaches to revolute and accelerate the harnessing of the economic opportunities inherent in the local leather industry towards job and wealth creation.

This study has identified Leatherwork as one of such local industrial sectors capable of creating wealth and job opportunities to improve upon the livelihood of the people of Ghana, especially when the industry depends on the by-product of animals that are classified as inexhaustible renewable natural resource. However, it has also become glaring from the findings made from the cross-sectional investigations conducted in this study that there are multi-sectorial factors militating against the development of the Ghanaian indigenous leather industry from attaining such economic status where its revenue generation capacity can be felt as a major factor in national development. The industrial utility rejection being faced by the local leather in the major leather artefact production sectors such as the footwear industry, upholstery and furniture, leather garment and clothing accessories is proof of physical reflection of the manifold militating factors associated with the local leather and the industry holistically. Nevertheless, the Ghanaian indigenous leather industry, in spite of the prevailing disincentives identified, still exhibits economically promising potentials projected by the following conclusions:

1. The nation possesses some native humpless livestock breeds, such as the West African Shorthorn, N'dama, Dwarf Lagoon Cattle and West African Dwarf sheep and goat which are tripanotolerant and also have the capacity to be enhanced through controlled breeding to exhibit desirable qualities such as body size, body contours, shape and skin thickness for improved meat and quality leather production.

2. Amidst the fast rate of deforestation, there is almost two-thirds, countrywide Savannah grassland vegetation, which possess nutritious tropical grasses and leguminous species such as guinea grass (*Panicum maximum*), Elepahant grass (Pennisetum), buffalo grass, *Stylosanthes guianensis*, and *Clitorial ternatea*, which have the capability to support commercial livestock production if proper measures towards pasture improvement and grazing regulations are instituted.

3. The strategic geographical location of Ghana with sister Sahelian nations such as Burkina Faso, Mali, Niger and Northern Nigeria which are important source of skins and hides is a great opportunity and asset that can be harnessed to augment leather production in the country and boost the economic benefits of Leatherwork.

4. From the study conducted, it has been known that though there is a high dependency on skins and hides, once proper measures are put in place to stimulate a boost in meat availability, accessibility and affordability, the dependency on skins and hides as a psychological means of meeting protein needs in Ghana would be alleviated, and that would create a boost in raw materials available for leather manufacturing.

5. The existence of the two abattoirs in Kumasi and Accra is a sign of hope that with improved methods resulting in a boost in livestock production, animals can be slaughtered in the most humane, wholesome and apposite manner to yield skins with less or no defects for the production of quality leather. Nevertheless, the rampant engagement of most slaughter houses and slabs in unhygienic meat processing environments is horrendously generating unwholesome meat and pelts which lack support for public health as well as Leatherwork.

6. The availability and abundance of salt in Ghana is a major hope for the indigenous leather industry, since with proper education and awareness creation, salt curing (wet and dry) would be projected and gain adoption as a preferred method for preserving skins and hides for revenue generation as against sun drying.

7. Also, due to posterity and the tenacious nature of Leatherwork, there are tanners and workers in the indigenous leather industry who are committed to working no matter the economic conditions prevailing to ensuring that the industry which they

inherited from their forefathers is preserved and sustained since they take pride in the lineage connotation and identity attached to the profession.

8. The introduction of Leatherwork into the formal system of education in the various levels of academic institutions in Ghana as a course or subject of study is a further impetus to eventually yield expertise into the leather business sector to boost the human resource capacity development.

9. The local leather industry remains tenacious as long there is high dependency on livestock as a major source of animal protein for most Ghanaians. The industry only requires consolidation of conscious efforts towards creating quality pelt that would be available, accessible and affordable.

10. The indigenous leather industry is still operating, but with obsolete technology which needs face-lifting in modern sense.

It is believed that with active collaboration and participation of all stakeholders, the viable unexploited economic opportunities indwelt Ghana's native leather industry would be harnessed once the proposed alternative strategies and the recommendations are implemented to reduce defects in the local leather and its domestic while industrial utility competency is also improved.

6.6 Recommendations

Wealth creation in the Small and Medium Scale indigenous industries amounts to economic growth which is also largely synonymous with poverty reduction (Awelenna, 2008). This is because the potential for growth regarding human and physical resources are often abound in countries, although underutilised in the

Ghanaian economic setting. The availability of livestock breeds in the country represents non-exhaustible renewable natural resource which can be sustained and engaged in large-scale meat and leather production to facilitate the industrial growth prerequisite for socio-economic development of the nation. However, since quality standards and assurance are integral conditions set by humanity and lived by humanity daily, any growth and production strategies adopted in pursuance of transformed economy through Leatherwork needs to be based on the concept of modernisation, repackaging, integration approaches and restructuring to develop the locally available resources.

The following recommendations are presented based on the findings of this study to augment a successful implementation of the alternative strategies proposed to mitigate the unpardonable mortem and ante-mortem causes and causations of deficiencies which render the local leather less economically useful in the country and beyond.

1. Ideas from the wide range multi-sectorial alternative strategies proposed should be adopted and integrated in planning national developmental programmes by policy formulators in government ministries such as the Ministry of Food and Agriculture, Ministry of Health, Trade and Industry, Tourism, Education, Science and Technology towards animal protein food security, maximisation of revenue from improved local raw materials, animal by-product harnessing for job wealth and job creation.

2. An adjustment and expansion of the scope/vision of national livestock rationale needs to be adjusted from a single purpose to a broad-spectrum dual purpose philosophy which lays emphasis on yielding animals with products possessing varied

qualities prerequisite for diversified economic opportunities such as meat and milk production as well as generation of highly useful by-products such as quality skins/hides for leatherwork, blood for animal feed processing, bones, tendons, ligaments and cartilages for gelatine manufacturing, dung for manure.

3. There is need for a **well-planned and achievable long term national standing livestock goal** which puts an end to animal husbandry manifesto politics for a national policy that supports the infrastructural needs of livestock farmers and guarantees the welfare of animals. This would boost meat and skin availability, accessibility and affordability towards alleviating the unnecessary pressure on the skins and hides as sources of protein in this country.

4. With the husbandry system in Ghana remaining as the primary source of raw materials, and also the premier causation of poor quality skins and hides for leather manufacturing, improvement practices through the farmer will be the surest alternative avenue to make the necessary change towards alleviating the rampant defects associated with pelts generated from livestock in the country. The government and the private sector should therefore embark on revolution of farming practices which eradicate subsistence livestock farming but motivate and encourage the large-scale commercial type.

5. With the ever increasing population of the nation, there is need for the realisation that rudimentary livestock farming practices which yield less economic opportunities belong to the past since it cannot sustain the national industrial growth and food security being expected. Through the Ministry of Food and Agriculture, farmers need to be supported to adopt modern husbandry technology to safeguard quality delivery of meat and pelt.

6. It is recommended that the presence of livestock activities of the Fulani herdsmen in the country is recognised, streamlined and managed by a regulatory body to benefit national development through taxing, payment of royalties to land owners and compulsory internal sales of animals. This would create the advantage of harnessing their expertise and also selectively cross-breed native breeds with the exotic breeds brought into the country to maximise meat and pelt availability accessibility and affordability.

7. Awareness of the economic opportunities indwelt the Ghanaian indigenous leather industry needs to be articulated to attract support from investors for infrastructural development in the tannery sector. This will help alleviate the predominant obsolete approaches to leather production, improve on quality and accelerate the acceptance of locally made leathers for industrial utility.

8. To boost the sustainability and economic relevance of the Egyptian mimosa (*Acacia nilotica*), locally known as "Bagaruwa," which serves as the main vegetable tannage in the Ghanaian local tanneries and West Africa at large, it is imperative that the plant is adopted and promoted nationwide for mass plantation and commercialisation to boost its availability, accessibility and affordability throughout the year. Since the plant has been identified to possess numerous medicinal capabilities across its various parts for healing various diseases, its availability wouldalso promote and augment herbal medicine in Ghana and elsewhere.

9. Since the country lacks quality standards for skins and hides, leather and leather goods, the market serves as a dumping site for poor quality pelts, leathers and second-hand leather goods which lack adequate dependency for national growth and poverty alleviation. It is recommended to the Ghana Standards Board to derive from

the ISO leather quality standards or criteria for measuring user dependability and satisfaction in skins and hides leather and leather goods brought into the country. This will put a check on influx of hides and skins, leather and leather goods imported and also alleviate unnecessary competition with the country's indigenous leather products.

10. Again, it is recommended that the study of Leatherwork as a course/subject of study should be tilted towards consolidation of entrepreneurial resources to build capacity towards tapping the manifold economic potentials inherent in skin/ hide as a primary material, leather as secondary raw material and Leatherwork a whole profession.

11. The government, authorities of research institutions, NGOs and corporate Ghana are being called upon to help establish a well-resourced centre for integrated and collaborative studies to serve as a common place for collaborative research activities where cross sectional and multi-sectorial investigations such as this study can be co-ordinated to make direct links to technical assistance and in-depth knowledge acquisition possible for students and researchers irrespective of their academic area. This would help encourage the artist to seek scientific knowledge to develop the requisite materials and create avenue for academic interdependency, idea sharing and inter-disciplinary research which would engender accelerated development of local raw materials and local technologies.

6.7 Implications for Further Research

Since the findings of the study have laid bare the multi-factorial defects and deficiencies emanating from multi-sectorial mandatory operations such as husbandry practices, mode of livestock marketing and transportation, slaughter centres, curing and pelt preservation as well as tannery activities, the need to stimulate research activities to find further improvement approaches to maximise the job and wealth creation opportunities inherent the indigenous leather industry has become imperative.

Again, to increase local tannery productivity, collaborative research among Leatherwork and Mechanical Engineering students should be encouraged in Ghanaian Universities and Polytechnics to develop reliable tannery automation system required to enhance quality leather production, reduce processing time, cost, cumbersomeness and also make tanning attractive to inspire and ginger youth involvement. Inspirations can be deduced from the tannery equipment such as the scudding, tanning, milling (tumbling) and drying equipment designed and produced by Boahin in 2008.

Finally, since it has become glaring that grain surface defects are rampant on the leathers produced locally, it is imperative to encourage research into corrected grain techniques of finishing where synthetic chemicals such as resins and pigments will be employed through coating, spraying, plating and heat transfer, to seal grain defects and improve on the acceptance and utility of the leathers.

6.8 Contribution to National Development

1. The final outcome of this study has been the proposed alternative strategies to mitigate the causative factors impeding the economic significance and progress of the indigenous leather industry.

2. The strategies are to serve as means of propagating interventional approaches to consolidate inexorable national and individual efforts to stimulate a comprehensive multi-sectoral restructuring action towards nurturing and managing the operations of the various mandatory sectors of the indigenous

leather industry to play tactical supportive role in achieving the economic transformation of the nation from its subsistence orientation to a commercially attractive, viable, dynamic and diversified sector, vital for the achievement of sustained growth through job creation and poverty reduction.

REFERENCES

ALCA , (1999). Journal of the American Leather Chemist Association. Vol. CIV, Number 7.

Marsal, *ALCA* (2000). *Journal of the American Leather Chemists Association.* Vol. CIV, No 5. January 2009, No. 6.

A, S. M. (2007). *Environmental Aspects of VOCs Evolved in the Early Stages of Human Decomposition.* doi:10.1016/j.scitotenv.2007.07.003.PMID 17669473: Sci. Total Environ.

Acker, D. (1991). *Animal Science and Industry, Fourth Edition.* USA: Prentice-Hall Inc.

Adentwi, K. I. & Amartei A. M. (2009). *A Practical Approach to Doing Educational Research. Kumasi: Eben Press.*

Adjei, H. (31/07/10). *Department of Nutrition, Ghana Health Services* . Accra: Issues of Life, TV3 Healthy Life Programme.

Amenuke, S. K., Dogbe B. K., Asare F. D. K., Ayiku R. K. & Baffoe A (1991) *General Knowledge in Art.* Ministry of Education. London: Evans Brothers Ltd.

Amenuke, S. K. (1995). *Notes on General Knowledge in Art and Vocational Skills for Senior Secondary Schools and Teacher Training Colleges.* Kumasi: KNUST Press.

Anamoah-Mensah, J. (2002). Fifteen Years of the New Educational Reforms; The Way Forward. *National Council for Tertiary Education, Tertiary Education Series, Vol. 2 No.3,* Pp 1-4.

Animal Breeding. http://en.wikipedia.org/wiki/Selective_breeding Retrieved on November 2, 2008

Arbonnier T. (2002). *Trees, Shrubs and Lianas of West African Dry Zones.* Netherlands: Margraf Publishers BMBH.

Archer, F. K., Adentwi K. I. & Sam, F. K. (2008). *Educational Management & School Administration.* Kumasi: Ernest Press.

Asiamah & Adentwi, K. I. (2006). *Educational Management and School Administration.* Kumasi: Eben Press.

Aten, A. I. (1955). *Flaying and Curing of Hides and Skins as a Rural Industry, FAO Animal Production and Health Series No. 7, FAO Agricultural Development Paper No. 49.* Rome: FAO of the United Nations.

Atiase, E. K. (2004). *Leather as a Medium for Sculpture Works.* Kumasi: Unpublished M.A. Thesis, KNUST, Kumasi: Dept. of Art Education.

Awelenna, A. (2008). *Upgrading the Economic Potentials of Raw Materials.* Ibadan: Upper Room Publishers.

BASF, (1999). *Pocket Book for Leather Technologist, Fouth Edition, Revised and Enlarged.* Germany: BASF Aktiengesellschaft. Pp 17.

Bienkiewicz, K. (1983). *Physical Chemistry of Leather Making.* Malabar, Florida: Robert E. Krieger Publishing Company.

Boahin, J. O. B. (2005). *Leatherwork Techniques and Principles for Senior Secondary Schools and Colleges.* KNUST, Kumasi: University Printing Press.

Boahin, J. O. B. (1994). *Leatherwork; Techniques for Senior High Schools.* KNUST, Kumasi: Unpublished MPhil.Thesis, Department of Art Education.

Boahin, J. O. B. (2008). *Technical Problems and Solutions in the Indigenous Leather Industry: Implications for Art Education in Ghana.* KNUST, Kumasi: Unpublished Ph.D Dissertation, Dept. of General Art Studies.

Bordoli, E. (1936). *The Boot and Shoe Maker, A complete Survey and Guide, Vol. I.* London: The Gresham Publishing Company Limited.

Bordoli, E. (1936). *The Boot and Shoe Maker, A Complete Survey and Guide, Vol. III.* London: The Gresham Publishing Company Limited.

Briggs, P. S. (1981). *Gloving, Clothinig and Special Leathers.* London: Tropical Products Institute, Overseas Develoment.

Britannica Junior Encyclopaedia, (1975). Ready Reference.USA: Britannica Inc.

Farming and Abattoir Practices Leading to Impaired Leather Quality (1989), Information Document ID-114. Northampton: British Leather Confederation.

Encyclopaedia Britannica, (1977). 15th Edition, Vol.10. USA: Britannica Inc.

Caroline Leather Works of Fleecewood N.C (2008). Retrieved August 7, 2008

Chartten & Amdul, (1943) Biological Issues on Deterioration. Retrieved on January 24, 2007.

Churchil, U. J. (1983). *The Complete Book of Tanning Skins and Furs.* Harrisburg: Stackpole Books .

Cohen, L., Manion L. & Morrison K. (2007). *Research Methods in Education, Sixth Edition.* London & New York: Routledge Taylor and Francis Group.

Collins English Dictionary. (2008). Bishopbriggs. Glasgow: HarperCollins Publishers.

Collins, H. (1999). *Design Technology Foundation Course, Resistant Materials Systems & Control.* London: Harper Collins Publishers.

Connolly, P. (2007). *Quantitative Data Analysis in Education, A Critical Introduction Using SPSS.* London: Routledge Taylor & Francis Group.

Definition and meaning of quality. Retrieved on January 13, 2009 from http://thinkexist.com/dictionary/meaning/quality/

De Haas, J. A. (1925). *Raw-Material Markets, Hides and Skins.* USA: A. W. Shaw Company.

Domestication of animals. Retrieved May 23, 2008, http://en.wikipedia.org/wiki/Domestication

Dzoagbe, G. S. (July-Dec. 2007). Women in Livestock Production in the West Gonja District of the Northern Region. *The SAVANNAH FARMER, A magazine on Sustainable Agriculture, Vol. 8, No. 2* , 21-27.

Edusei, K. (1991). *Significance of Ghanaian Educational Innovations and Landmarks and Their Socio-Cultural Impact.* Kumasi: Unpublished Ph.D Dissertation, Dept. of Art Education, KNUST.

Elliot, R. G. (1986). *Hides and Skins Improvement in Devleoping Countries, FAO of the UN 67.* London: Tropical Development and Research Institute, Overseas Development Adminitration.

Etymology of Decomposition. Retrieved July 13, 2007, from Online etymology Dictionary, 2001-2010.

FAO Agricultural Services Bulletin 67. (1986). London: Tropical Development and Research Institute, Overseas Development Adminitration.

FAO Agricultural Development Paper No. 68. Kenya: FAO of the United Nations.

FAO Animal Production and Health Series No. 7, (1955), Rome

FAO Agricultural Development Paper No. 49, (1955), *Flaying and Curing of Hides and Skins as a Rural Industry*. Rome: UNFAO

FAO Corporate Document Repository on Integrated Feeding. Retrieved September 8, 2008, from (http://www.fao.org/docrep/004/x6543e/X6543E04.htm)

Fiero, G. K. (1995). *The Humanistic Tradition, Second Edition 1; Origins of the Humanistic Tradition: The First Civilisations and the Classical Legacy*. USA: Brown & Benchmark Publishers.

Footwear Constructions and Materials, A Manual for the Retailer, Second Revision. (1975). UK: Shoe and Allied Trades Research Association.

Ford, E. D. (2001). *Scientific Ecological Research.* UK: Cambridge University Press.

Fritz, S. Paholsky K. & Grosenbach M. J. (1999). *Mosby's Basic Science for Tissue and Movement Therapies.* St. Louis: Mosby, Inc.

Gerhard, J. (1996). *Possible Defects in Leather Production, Definitions, Causes, Consequences, Remedies and Types of Leather*. Hemsbach: Druck Partner Rubelmann GmnH.

Gillespie, J. R. (1992). *Modern Livestock and Poultry Production, Fouth Edition.* USA: Delmar Publishers Inc.

Grazing livestock, Retrieved July 20, 2008, from http://en.wikipedia.org/wiki/Grazer

Gregg-Erzuah, P. (2007). *Quality and Satisfaction of Goods and Services.* Brasilia: Allan & Co Publications.

Gummesson, E. (1936). *Qualitative Methods in Management Research*, Revised Edition. Sage Publications, London: The International Professional Publishers.

Guthrie-Strachan J, (2008) *Leather Science Lecture Notes*: British School of Leather Technology, University of Northampton, UK.

Gustavson, K. H. (1956). *The Chemistry and Reactivity of Collagen* New York: Academic Press Inc.

Haines, B. M. (1981). *Leather Under the Microscope.* Northampton, UK: British Leather Manufacturers' Research Association.

Halliwell, J. & Lambert B. (2004). *Revise for Product Design: Graphics with Materials Technology*. Oxford: Heinemann Educational Publishers.

Heidemann, E. (1993). *Fundamentals of Leather Manufacture*. Darmstadt: Edward Roether KG Drukerei und Verlag.

Holt, Rinehart & Winston (2005). *World Reference Holt history, the Human Journey, Annotated Edition.* New York, USA: A Harcount Education Company.

Hougham, P. (2006). *The Atlas of Miind, Body and Spirit.* New York: Octopus Publishing Group Ltd.

Howes, F. N. (1953). Vegetable Tannin Materials: Butterworths Scientific Publications, London.

International Standards Organisation Reference Document for the description of defects Skins and Hides Defects: ISO 2820:1974, amendment 1:1996 to ISO 2820:1974, ISO 2821:1974. Ghana Standards Board Reference Library.

International Standards Organisation, the first edition of 1998–11–01, reference number ISO 2822–1:1998(E), part of ISO2822. Ghana Standards Board Reference.

International Standards Organisation 4683 – 1: 1998.

ISO 9001//International Standard for quality in business processes and products//2354. Retrieved on February 20, 2008.

Ishikawa, K. (1990). *Introduction to Quality Control*. Brainstorming Retrieved on August 5, 2008 from http://en.wikipedia.org/wiki/Brainstorming

Iwena, O. A. (2008). *Essential Agricultural Science for Senior Secondary Schools, 6th Edition.* Ibafo, Ogum State: Tonad Publishers Limited.

Journal of the Society of Leather Technologists and Chemists (JSLTC) Vol. 86, September–October 2008, No.5 page 183. UK

Journal of the Society of Leather Technologists and Chemists (JSLTC) Vol. 90, July-August 2006, No.4 page 183. UK

Journal of the Society of Leather Technologists and Chemists (JSLTC) Vol. 85, November–Decembern2001, No.6 page 183. UK

Kite, M. & Thomson R. (2006). *Conservation of Leather and Related Materials.* London, New York, Boston, Paris, Singapor, Sydney and Tokyo: Elsevier Ltd.

Komacek, S. A. (1990). *Manufacturing Technology*: Delmar publishers Inc., Canada.

Koney, E. B. (2004). *Livestock Production and Health in Ghana, Second Edition.* East Legon: East Legon Veterinary Centre.

Kotla, V. R. (1996). *Tanning Emu Skins: An Assessment of the Processes, the Leather Properties, and the Potential for Chromium Reduction.* Australia.

Kumekpor, T. K. (2002). *Research Methods & Techniques of Social Research, Revised Edition, Sections 1-3.* Adenta, Accra: SonLife Printing Press & Services.

Landmann, W. (2003). *The Machines in the Tannery, A Reveiw of Leater Producing Machinery and Equipment in Current Use.* West Yorkshire, UK: World Trades Publishing.

Lawson, A. (1990). *Skins and Hides for Leather, 3rd Edition; AAK Publishers Alba.*

Leaf, M. K. (2005). *The IULTCS Official Methods of Analysis.* UK: International Union of Leather Technologists and Chemists Society.

Leafe, M. K. (1999). *Leather Technologists Pocket Book.* East Yorkshire, UK: The Society of Leather Technologists and Chemists.

Leather International. (2007, June). *Survey: India, Technology: Footwear Leather, Vol. 209, No. 4776* , pp. 6-44.

Leather International. (2007, October). *Technology:Fire Resistance, Machnery: Conveying, Vol. 209, No. 4779* , pp. 5-46.

Leather International.Vol. 208, No. 4762. (2006, January/February). *Survey: India Special, Technology: Chrome Tanning* , pp. 6-42.

Leatherworld, African Platform. Country statistics and Leather Production. Retrieve December 15, 2008 from http//:www.leatherworld_africanplatform

Leather Tanning and Finishing. Retrieved 17 March, 2008 from http://business.highbeam.com/industry-reports/textiles/leather-tanning-finishing

Leedy, P. D. & Ormrod J. E. (2005). *Practical Research Planniing and Design, 8th Edition.* New Jersey, USA: Pearson Education Inc.

Livestock Production Manual for Livestock Specialists (APD). Livestock Development Project, Ministry of Food & Agriculture (MoFA).

Low External Input and Sustainable Agriculture. (2006, December). *LEISA Magazine on Low External Input and Sustainable Agriculture, SPECIAL ISSUE* , pp. 4-35.

Lyon, D. (1994). *A Modern Approach to Footwear Pattern Cutting.* Leicester, England: David Lyon.

Maddox, W. A. (1940). *Historical Carvings in Leather, A Lost Art Reclaimed.* San Antonio: The Naylor Company.

Mader, S. S. (1994). *Inquiry into Life, Seventh Edition.* Oxford, England: Wm. C. Brown Publishers.

Mann, I. (1951). *A Handbook on Hides and Skins.* Kenya: Colony and Protectorate of Kenya, Department of Veterinary Services.

Mann, I. (1960). *Rural Tanning Techniques, FAO Agricultural Development Paper No. 68.* Kenya: FAO of the United Nations.

MoFA Livestock Production Manual, for Livestock Specialists (2009). Livestock Development Project.

Merriam-Webster. *"quality assurance".* Retrieved on 12 Appril 2009, from http://www.merriam-webster.com/dictionary/quality...assurance

Michael, V. (1993). *The Leatherworking Handbook, A Practical Illustrated Sourcebook of Techniques and Projects.* London: Cassell Villiers House.

Miller, R. G. (1966). *Manual of Shoemaking, 6th Edition.* Bristol: C. & J. Clark Ltd.

Minnoch, J. J. (1979). *Hides and Skins, Third Edition.* Sioux City : National Hide Association.

Nair, P. K. (1993). *An Introduction to Agroforestry.* USA: Kluwer Academic Publishers.

Obeng-Nyarko, M. (2000). *Leather as an Alternative Medium for Picture Making.* Kumasi: Unpublished Thesis, Dept. of General Art Studies, KNUST.

O'Brien, G. E. & Andrews H. A. (1946). *Looking at Leather.* London: Staples Press Limited.

O'Flaherty, F., Roddy W. T. & Lollar R. M. (1965). *The Chemistry and Technology of Leather, Vol. IV-Evaluation of Leather*. Florida: Krieger Publishing Company.

O'Flaherty, F., Roddy W. T. & Lollar R. M. (1962). *The Chemistry and Technology of Leather, Vol.III-Control of Leather Quality*. Florida: Krieger Publishing Company.

O'Flaherty, F., Roddy W. T. & Lollar R. M. (1958). *The Chemistry and Technology of Leather. Vol.II-Types of Tannages. American Chemical Society Monograph Series.* New York and London: Reinhold Publishing Corporation and Campman & Hall, Ltd.

O'Flaherty, F., Roddy W. T. & Lollar R. M. (1956). *The Chimistry and Technology of Leather. vol. 1-Preparation for Tannage.* Florida: Litton Educational Publishing Co.,Inc.

Okonkwo, E. M. & Huoma A. A. Engendering Technological Innovation in the Nigerian Traditional Tanning Sector. *Journal of the Society of Leather Technologists and Chemists, 2005.* Vol. 86 ,No. 65.

Ofori, D. I. (2008). *Research Methods and Approaches.* Roddys Publishers, Kumasi.

Oppong, Y. (1971). *Under Tree Feeding of Livestock*, CITA Press, Kumasi

Olsheim, L. (1973). *The Complete Book of Handicrafts, A Step-By-Step Guide to Popular Handicrafts.* Hong Kong: Mandarin Publishers Ltd.

Oteng-Amoako, A. A. (2006). *Non-Pressure Rural Wood Preservation for the Tropics.* Kumasi: KNUST.

Oti-Agyen, P. (2006). *Fundamentals of Philosophy in Education.* Adu Press: New Tafo, Kumasi.

Oti-Agyen, P. (2009). *Philosophical and Sociological Foundation of Education, An Introduction.* Old Tafo, Kumasi: Hannob Printing Press.

Oti-Agyen, P. (2007). *The Development of Education in Ghana.* Kumasi: College of Technology Education.

Pet and Animal Diseases. Retrieved on October 14, 2007, from http://en.wikipedia.org/wiki/Pet

Potter, P. (2008). *Physical and Fastness Testing of Leather, 4th Edition.* Northampton: British School of Leather Technology, University of Northemapton.

Powitt, A. H. (1986). *Hair structure and Chemistry Simplified.* Bronx, New York: Milady Publishing Corp.

Procter, H. R. (1936). *Leather Manufacture, Second Edition.* Haymarket S.W. I: E. & F. N. Spon Limited.

Procter H. R. (1922). *Principles of Leather Manufacture.* D. Van Nostrand Co., New York.

Prodrack (2008), *West European Cattle Breeds and Raw Materials,* Class Presentation, Raw Materials, BSLT.

Properties of Matter. Retrieved on May 5, 2008, from http://en.wikipedia.org/wiki/matter

Quality (1995-2010). *The Times Newspapers Ltd. and MBA Publishing Limited.* Retrieved on Jauary 26, from http://www.thetimes100.co.uk/theory--quality--256.php

Rastogy, S. (2008). *Essentials of Animal Physiology*. India: New Age Internal Publishers Ltd.

Reader's Digest 'Back to Basics. (1981). USA: The Reader's Digest Association, Inc.

Reader's Digest, Crafts & Hobbies, A Step-By-Step Guide to Creative Skills. (1979). New York/Montreal: The Reader's Digest Association, Inc.

Sam, F. K. (2009). *Organising and Managing Educational Resources.* Kumasi: Kumsi Cathoic Press Ltd.

Sarkar, K. T. (2005). *Theory and Practice of Leather Manufacturing.* Kolkata: Neelachal Abasan Bishaka A.1, and ACP Publications.

Seale, C. G. (2004). *Qualitative Research Practice.* London, Thousand Oaks and New Delhi: SAGE Publications.

Sharphouse, J. H. (1995). *Leather Technician's Handbook, LPA 75th Anniversary Edition.* Northampton, UK: Leather Producers' Association.

SLTC Leather Technologists Pocket Book (1999); The Society of Leather Technologists and Chemists, UK.

Stohlman, A. P. (2006). *Leatherwork Manual.* Northampton: Tandy Leather Factory.

Streatfield, N. (1972). *A First Book Shoes.* London: Franklin Watts Ltd.

Tanning Extract Producers Federation, 1974, USA

The American Heritage, Stedman's Medical Dictionary, . (2002, 2001, 1995). Houghton Mifflin Company, USA.

The Holy Bible, New King James Version. (1990). New York: Thomas Nelson Inc.

The Hutchinson Encyclopedia, The Best Selling Full Colour Edition. (2000). Sheffield: Helicon Publishing.

The Philosophy of Quality. Retrieved on March 26, 2007, from http://en.wikipedia.org/wiki/Quality_(philosophy)

The Quality Digest, Retrieved September 5, 2008. http://www.qualitydigest.com/html/qualitydef.html

The Times Newspapers Ltd and MBA Publishing Ltd (1995-2010), Retrieved on February 8, 2008.

The World, Student Information Finder, Language Arts and Social Studies. (1981). Chicago, USA: World Book Inc.

Thorstensen, (1976). *Practical Leather Technology.* Huntington, New York: Robert E. Krieger Publishing Company.

Tryfos, P. (1996). *Sampling Methods for Applied Research, Text and Case Study.* USA: John Wiley and Sons, Inc.

TV3 News @ 7pm (28/08/10). *State of Methods and Statistics on Meat Production in Ghana.*

Twumasi, P. A. (2001). *Social Research in Rural Communities, Second Edition.* Accra: Ghana Univerties Press.

UK Leather (2004). *Production and Statistics,* Retrieved on December 9, 2007 from *ukleather.com (Leather information 2004)*

Ward, H. (1977). *Leather Production and Skins and Hides Quality, Fourth Edition,* Charles and Kook Inc. Queens Town.

White, G. M. (2000). *Diseases of the Skin, A Colour Atlas and Text.* Harcoourt Publishers Limited.

Material Science, Retrieved on May 13, 2008, from http://en.wikipedia.org/wiki/material_science

White, H. (1999). *Practical Tannery Techniques; Holmes and Holmes, India*

Wilson, J. A. (1923). *The Chemistry of Leather Manufacture.* New York, USA: The Chemical Catelog Company, Inc.

World Book Encyclopaedia (1972). Field Enterprises Educational Corporation, Chicago.

World Footwear Journal, March/April, 2008, Vol. 22 No.2

Leather Business, *World Leather Magazine*. Retrieved June 6, 2008, from www.leathermag.com

World Leather; The World's No.1 Magazine for the Leather Industry, Vol. 21, No. 8. (2008/2009, December/January). *Aquoeous Finishing for Waterproof Footwear, Benchmarking: Options to Reduce waste, Yield: Factors Within Wet Processes and Operations* , pp. 3-48.

Yeboah, A. K. (2006). *An Introduction to Sociology and Education.* Kumasi: University of Education-Winneba.

APPENDICES

Appendix 1a

Interview Guide (Open-ended questions)

Objective: To acquire data on animal husbandry system

1. What type of animals do you Keep and how by what method?
2. How did you obtain them?
3. How do you feed them?
4. How do you attend to their medical needs?
5. For what purpose do you keep the animals?

Appendix 1b

Interview Guide (Open-ended questions)

Objective: To acquire data on livestock marketing and transportation system.

1. What type of animals do you transport,
2. From what origins to what destinations do you transit the animals?
3. How do you load and offload the animals?
3. What is the nature of care do they receive when in transit?
4. Are there regulations on animal transportation?
5. Do you receive animal health and safety inspectors before leaving and on arrival?

Appendix 1c

Interview Guide (Open-ended questions)

Objective: To acquire data on the impact of abattoir operations on pelt quality.

1. What type of animals and meat do you do here?
2. What is the nature of animals brought in for slaughter (source, sex, age, health conditions and means of transportation)?

3. Could you describe the approaches operations?
4. What is the state of skins and hides in the operations of this slaughter centre?

Appendix 1d

Interview Guide (Open-ended questions)

Objective: To access the impact of indigenous tanning operations on leather quality.

1. How did you become a tanner? Is tanning economically beneficial?
2. What type of pelt do you usually tan and who are the end users?
3. What methods do you employ and how easy/difficult is tanning such pelt?
4. Do you have any financial support for tanning materials and equipment?
5. What challenges do you face as a tanner, especially in this tannery?

Appendix 2

Observation Guide

Objective: To systematically follow the activities at the livestock farms, markets, slaughter centres, pelt markets and indigenous tanneries.

1. Observe the environmental set up and settings.
2. Observe the attitude of work and conducts.
3. Observe Operational procedures.
4. Observe tools, materials, usage and impact
5. Take statistics of staff, animals, materials and approaches observed
6. Observe customers reactions in relation to the producers'

Record Observation 1

....

....

....

....

....

....

....

....

Record Observation 2

....

....

....

....

....

....

....

....

Appendix 3A

Tabulated Results for Shoe Upper Leather Test, Goatskin. (Flex Resistance/Endurance Test by Vamp Flex Method)

Table 1: Results for Sheepskin Leather Samples from Mallam Market Tannery, Greater Accra Region

Experiment 3: Measurement of Flex Resistance by Vamp Flex Method Source of Leather: Sheepskin from Mallam Market Tannery, Greater Accra Region Expected Flex Resistance: 10^6 cycles = 1 080 000 flexes			
Flex Time (hour)	Reactions Observed		
	Butt	Shoulder	Belly
1 hr. (18 000 flexes)	No creases, looseness wrinkles, grain cracks nor breaks.	No creases, looseness wrinkles, grain cracks or breaks.	No creases, looseness wrinkles, grain cracks.
5 hrs. (90 000 flexes)	No creases or grain cracks	No wrinkles or surface cracks	Minor Creasing in the central fold
10 hrs. (180 000 flexes)	No wrinkles or grain cracks	No wrinkles or grain cracks	Some wrinkles but no grain cracks
20 hrs. (360 000 flexes)	No grain cracks or tears but minor wrinkles	No grain cracks of tear, but some wrinkles	Some wrinkles, looseness, but no grain cracks or breaks
40 hrs. (720 000 flexes)	Some wrinkles at the central fold, looseness but no grain cracks	Several looseness, more wrinkles but no breaks or surface cracks	Projected looseness, wrinkles and creases but no grain cracks
60 hrs. (1 080 000 flexes)	Surface cracks but no tears	Some surface cracks, projected wrinkles but no tears	Acute Grain cracks, Looseness at the central fold, no tears but highly wrinkled surface

Source: Assessment conducted by researcher, November-December, 2008

Table 2: Results for Sheepskin Leather Samples from Asawase Tannery, Kumasi

Experiment 3: Measurement of Flex Resistance by Vamp Flex Method **Source of Leather: Sheepskin from Asawase Tannery, Kumasi Ashanti Region** **Expected Flex Resistance: 10^6 cycles = 1 080 000 flexes**			
Flex Time (hour)	Reactions Observed		
	Butt	Shoulder	Belly
1 hr. (18 000 flexes)	No creases, looseness wrinkles, grain cracks nor breaks	No creases, looseness wrinkles, grain cracks or surface breaks	No creases, looseness wrinkles, grain cracks
5 hrs. (90 000 flexes)	No creases or grain cracks	No wrinkles or surface cracks	Minor Creasing in the central fold
10 hrs. (180 000 flexes)	No wrinkles or grain cracks	Minor wrinkles or grain cracks	Some wrinkles but no grain cracks
20 hrs. (360 000 flexes)	Minor grain cracks or tears but minor wrinkles	Some grain cracks of tear, but some wrinkles	More wrinkles, looseness, but no grain cracks or breaks
40 hrs. (720 000 flexes)	Some wrinkles at the central fold, looseness but no grain cracks	Increase looseness, more wrinkles but no breaks or surface cracks	More looseness, wrinkles and creases but no grain cracks
60 hrs. (1 080 000 flexes)	Two surface cracks but no tears	Surface cracks, projected wrinkles but no tears	Acute Grain cracks, Looseness at the central fold, no tears but highly wrinkled surface

Source: Assessment conducted by researcher, November-December, 2008

Table 3: Results for Sheepskin Leather Samples from Tamale Tannery, Northern Region

Experiment 3: Measurement of Flex Resistance by Vamp Flex Method **Source of Leather: Sheepskin from Tamale, Northern Region** **Expected Flex Resistance: 10^6 cycles = 1 080 000 flexes**			
Flex Time (hour)	Reactions Observed		
	Butt	Shoulder	Belly
1 hr. (18 000 flexes)	No creases, looseness wrinkles, grain cracks or breaks	Creases, looseness wrinkles, grain cracks did not start showing	No creases, looseness wrinkles, grain cracks.
5 hrs. (90 000 flexes)	No creases or grain cracks	No wrinkles or surface cracks	Minor Creasing in the central fold
10 hrs. (180 000 flexes)	No wrinkles or grain cracks	Creases begin to turn into wrinkles or grain cracks	Some wrinkles but no grain cracks
20 hrs. (360 000 flexes)	No grain cracks or tears but some wrinkles	Some grain cracks of tear, but more wrinkles	Visible wrinkles, looseness, but no grain cracks or breaks
40 hrs. (720 000 flexes)	Some wrinkles at the central fold, looseness but no grain cracks	Little looseness, more wrinkles but no breaks or surface cracks	More looseness, wrinkles and creases but no grain cracks
60 hrs. (1 080 000 flexes)	Minor surface cracks but no tears	More but visible surface cracks and projected wrinkles but no tears	Increased Grain cracks, Looseness at the central fold, no tears but highly wrinkled surface

Source: Assessment conducted by researcher, November-December, 2008

Table 4: Results for Sheepskin Leather Samples from Bolgatanga Tannery, Upper East Region

Experiment 3: Measurement of Flex Resistance by Vamp Flex Method

Source of Leather: Sheepskin from Bolgatanga Tannery, Upper East Region

Expected Flex Resistance: 10^6 cycles = 1 080 000 flexes

Flex Time (hour)	Reactions Observed		
	Butt	Shoulder	Belly
1 hr. (18 000 flexes)	No creases, looseness wrinkles, grain cracks nor breaks	No creases, looseness wrinkles, grain cracks nor surface fractures	No creases, looseness wrinkles, grain surface cracks
5 hrs. (90 000 flexes)	No creases or grain cracks	No wrinkles or surface cracks	Minor Creasing in the central fold
10 hrs. (180 000 flexes)	No wrinkles or grain cracks	No wrinkles or grain cracks	Some wrinkles but no grain cracks
20 hrs. (360 000 flexes)	No grain cracks or tears and wrinkles	No grain cracks of tear, but some wrinkles	Some wrinkles, looseness, but no grain cracks or breaks
40 hrs. (720 000 flexes)	Minor wrinkles at the central fold, looseness but no grain cracks	Little looseness, more wrinkles but no breaks or surface cracks	More looseness, wrinkles and creases but no grain cracks
60 hrs. (1 080 000 flexes)	Two surface cracks but no tears	One surface cracks, projected wrinkles but no tears	Grain cracks, Looseness at the central fold, no tears but highly wrinkled surface

Source: Assessment conducted by researcher, November-December, 2008

Table 5: Results for Sheepskin Leather Samples from Bawku Tannery, Upper East Region

Experiment 3: Measurement of Flex Resistance by Vamp Flex Method **Source of Leather: Sheepskin from Bawku, Upper East Region** **Expected Flex Resistance: 10^6 cycles = 1 080 000 flexes**			
Flex Time (hour)	Reactions Observed		
	Butt	Shoulder	Belly
1 hr. (18 000 flexes)	No creases, looseness wrinkles, grain cracks nor breaks	No creases, looseness wrinkles, grain cracks nor surface breaks	No creases, looseness wrinkles, grain cracks
5 hrs. (90 000 flexes)	No creases or grain cracks	No wrinkles or surface cracks	Minor Creasing in the central fold
10 hrs. (180 000 flexes)	No wrinkles or grain cracks	No wrinkles or grain cracks but more wrinkles	Increased wrinkles but no grain cracks
20 hrs. (360 000 flexes)	No grain cracks or tears but minor wrinkles	No grain cracks of tear, but increased wrinkles	More wrinkles, looseness, but no grain cracks or breaks
40 hrs. (720 000 flexes)	Some wrinkles at the central fold, looseness but no grain cracks	Some looseness, more wrinkles but no breaks or surface cracks	More looseness, wrinkles and creases but no grain cracks
60 hrs. (1 080 000 flexes)	Acute surface weakness but no tears	Minor surface cracks, projected wrinkles but no tears	Grain cracks, Looseness at the central fold, no tears but highly wrinkled surface.

Source: Assessment conducted by researcher, November-December, 2008

Table 6: Results for Sheepskin Leather Samples from Pougtinga, Burkina Faso

Experiment 3: Measurement of Flex Resistance by Vamp Flex Method **Source of Leather: Sheepskin from Pougtinga, Burkina Faso** **Expected Flex Resistance: 10^6 cycles = 1 080 000 flexes**			
Flex Time (hour)	Reactions Observed		
	Butt	Shoulder	Belly
1 hr. (18 000 flexes)	No creases, looseness wrinkles, grain cracks nor breaks	No creases, looseness wrinkles, grain cracks nor surface splits	No looseness wrinkles, grain cracks
5 hrs. (90 000 flexes)	No creases or grain cracks	No wrinkles or surface cracks	Minor Creasing in the central fold
10 hrs. (180 000 flexes)	No wrinkles or grain cracks	No wrinkles or grain cracks	Weak surface but no grain cracks
20 hrs. (360 000 flexes)	No grain cracks or tears but minor wrinkles	No grain cracks of tear, but some wrinkles	Increased wrinkles, looseness, but no grain cracks or breaks
40 hrs. (720 000 flexes)	Some wrinkles at the central fold, looseness but no grain cracks	Some looseness, more wrinkles but no breaks or surface cracks	Acute looseness, wrinkles and creases but no grain cracks
60 hrs. (1 080 000 flexes)	Increase surface but no tears	One surface cracks, projected wrinkles but no tears	Serious grain cracks, Looseness at the central fold, no tears but highly wrinkled surface

Source: Assessment conducted by researcher, November-December, 2008

Appendix 3B

Tabulated Results for Shoe Upper Leather Test, Goatskin (Flex Resistance/Endurance Test by Vamp Flex Method)

Table 1: Results for Goatskin Leather Samples from Mallam Market Tannery, Greater Accra Region

Experiment 3: Measurement of Flex Resistance by Vamp Flex Method Source of Leather: Goatskin from Mallam Market Tannery, Greater Accra Region Expected Flex Resistance: 10^6 cycles = 1 080 000 flexes			
Flex Time (hour)	Reactions Observed		
	Butt	Shoulder	Belly
1 hr. (18 000 flexes)	No creases, looseness wrinkles, grain cracks nor breaks	No creases, looseness wrinkles, grain cracks nor surface damages	No grain cracks, creases or looseness
5 hrs. (90 000 flexes)	No creases or grain cracks	No wrinkles or surface cracks	Minor wrinkle in the central fold
10 hrs. (180 000 flexes)	No wrinkles or grain cracks	No wrinkles or grain cracks	Some wrinkles but no grain cracks
20 hrs. (360 000 flexes)	No grain cracks or tears and wrinkle	No grain cracks of tear, but some wrinkles	Some wrinkles, looseness, but no grain cracks or breaks
40 hrs. (720 000 flexes)	Minor wrinkles at the central fold, looseness but no grain cracks	Some looseness, more wrinkles but no breaks or surface cracks	More looseness, wrinkles and creases but no grain cracks
60 hrs. (1 080 000 flexes)	No surface cracks and no tears	Some surface cracks, projected wrinkles but no tears	Acute cracks, Looseness at the central fold, no tears but highly wrinkled surface

Source: Assessment conducted by researcher, November-December, 2008

Table 2: Results for Goatskin Leather Samples from Asawase Tannery, Kumasi, Ashanti Region

Experiment 3: Measurement of Flex Resistance by Vamp Flex Method **Source of Leather: Goatskin from Asawase Tannery, Kumasi-Ashanti Region** **Expected Flex Resistance: 10^6 cycles = 1 080 000 flexes**			
Flex Time (hour)	Reactions Observed		
	Butt	Shoulder	Belly
1 hr. (18 000 flexes)	No creases, looseness wrinkles, grain cracks nor breaks.	No grain surface damages found.	No creases, looseness wrinkles or grain cracks
5 hrs. (90 000 flexes)	No creases or grain cracks	No wrinkles or surface cracks	Minor Creasing in the central fold
10 hrs. (180 000 flexes)	No wrinkles or grain cracks	No wrinkles or grain cracks	Little wrinkles but no grain cracks
20 hrs. (360 000 flexes)	No grain cracks or tears but minor wrinkles	No grain cracks of tear, but little wrinkles	Some wrinkles, looseness, but no grain cracks or breaks
40 hrs. (720 000 flexes)	Little wrinkles at the central fold, looseness but no grain cracks	Little looseness, more wrinkles but no breaks or surface cracks	More looseness, wrinkles and creases but no grain cracks
60 hrs. (1 080 000 flexes)	Some surface cracks but no tears	Increased surface cracks, and wrinkles but no tears	Severe Grain cracks, Looseness at the central fold, no tears but highly wrinkled surface

Source: Assessment conducted by researcher, November-December, 2008

Table 3: Results for Goatskin Leather Samples from Tamale Tannery, Northern Region

Experiment 3: Measurement of Flex Resistance by Vamp Flex Method **Source of Leather: Goatskin from Tamale, Northern Region** **Expected Flex Resistance: 10^6 cycles = 1 080 000 flexes**			
Flex Time (hour)	Reactions Observed		
	Butt	Shoulder	Belly
1 hr. (18 000 flexes)	No creases, looseness wrinkles, grain cracks nor breaks	No creases, looseness wrinkles, grain cracks or surface breaks.	No creases, looseness wrinkles, or grain cracks.
5 hrs. (90 000 flexes)	No creases or grain cracks	No wrinkles or surface cracks	Minor Creasing in the central fold
10 hrs. (180 000 flexes)	No wrinkles or grain cracks	No wrinkles or grain cracks	Some wrinkles but no grain cracks
20 hrs. (360 000 flexes)	No grain cracks or tears but minor wrinkles	No grain cracks of tear, but some wrinkles	Some wrinkles, looseness, but no grain cracks or breaks
40 hrs. (720 000 flexes)	Some wrinkles at the central fold, looseness but no grain cracks	Looseness, more wrinkles but no breaks or surface cracks	More looseness, wrinkles and creases but no grain cracks
60 hrs. (1 080 000 flexes)	One surface cracks but no tears	Few surface cracks, projected wrinkles but no tears	Grain cracks, Looseness at the central fold, no tears but highly wrinkled surface

Source: Assessment conducted by researcher, November-December, 2008

Table 4: Results for Goatskin Leather Samples from Bolgatanga, Upper East Region

Experiment 3: Measurement of Flex Resistance by Vamp Flex Method **Source of Leather: Goatskin from Bolgatanga, Upper East Region** **Expected Flex Resistance: 10^6 cycles = 1 080 000 flexes**			
Flex Time (hour)	Reactions Observed		
	Butt	Shoulder	Belly
1 hr. (18 000 flexes)	No creases, looseness wrinkles, grain cracks nor breaks	No creases, looseness wrinkles, grain cracks or surface damages.	No creases, looseness or grain surface cracks.
5 hrs. (90 000 flexes)	No creases or grain cracks	No wrinkles or surface cracks	Minor Creasing in the central fold
10 hrs. (180 000 flexes)	No wrinkles or grain cracks	No wrinkles or grain cracks	Little wrinkles but no grain cracks
20 hrs. (360 000 flexes)	No grain cracks or tears but minor wrinkles	No grain cracks and tears but little wrinkles	More wrinkles, looseness, but no grain cracks or breaks
40 hrs. (720 000 flexes)	Some wrinkles at the central fold, looseness but no grain cracks	Some looseness, more wrinkles but no breaks or surface cracks	More looseness, wrinkles and creases but no grain cracks
60 hrs. (1 080 000 flexes)	No surface cracks and tears but projected wrinkles	No surface cracks, projected wrinkles but no tears	Increased grain cracks, Looseness at the central fold, no tears but highly wrinkled surface

Source: Assessment conducted by researcher, November-December, 2008

Table 5: Results for Goatskin Leather Samples from Bawku Tannery, Upper East Region

Experiment 3: Measurement of Flex Resistance by Vamp Flex Method **Source of Leather: Goatskin from Bawku, Upper East Region** **Expected Flex Resistance: 10^6 cycles = 1 080 000 flexes**			
Flex Time (hour)	Reactions Observed		
	Butt	Shoulder	Belly
1 hr. (18 000 flexes)	No creases, looseness wrinkles, grain cracks nor breaks.	No creases, looseness wrinkles, grain cracks nor grain breaks or tears.	No creases, looseness wrinkles nor grain cracks.
5 hrs. (90 000 flexes)	No creases or grain cracks	No wrinkles or surface cracks	Minor Creasing in the central fold
10 hrs. (180 000 flexes)	No wrinkles or grain cracks	No wrinkles or grain cracks	Some wrinkles but no grain cracks
20 hrs. (360 000 flexes)	No grain cracks or tears but minor wrinkles	No grain cracks of tear, but some wrinkles	Some wrinkles, looseness, but no grain cracks or breaks
40 hrs. (720 000 flexes)	Little wrinkles at the central fold, looseness but no grain cracks	Some looseness, more wrinkles but no breaks or surface cracks	More looseness, wrinkles and creases but no grain cracks
60 hrs. (1 080 000 flexes)	No surface cracks but no tears	Minor surface cracks, projected wrinkles but no tears	Lots of Grain cracks, Looseness at the central fold, no tears but highly wrinkled surface

Source: Assessment conducted by researcher, November-December, 2008

Table 6: Results for Goatskin Leather Samples from Pougtinga, Burkina Faso

Experiment 3: Measurement of Flex Resistance by Vamp Flex Method **Source of Leather: Goatskin from Pougtinga, Burkina Faso** **Expected Flex Resistance: 10^6 cycles = 1 080 000 flexes (300 flexes/min.)**			
Flexes/hour	Reactions Observed		
	Butt	Shoulder	Belly
1 hr. (18 000 flexes)	No creases, looseness wrinkles, grain cracks nor breaks	No creases, looseness wrinkles, grain cracks nor grain damages	No creases, looseness wrinkles, or grain damages
5 hrs. (90 000 flexes)	No creases or grain cracks	No wrinkles or surface cracks	Minor Creasing in the central fold
10 hrs. (180 000 flexes)	No wrinkles or grain cracks	No wrinkles or grain cracks	Some wrinkles but no grain cracks
20 hrs. (360 000 flexes)	No grain cracks or tears but minor wrinkles	No grain cracks of tear, but some wrinkles	Some wrinkles, looseness, but no grain cracks or breaks
40 hrs. (720 000 flexes)	Less wrinkles at the central fold, minor looseness but no grain cracks	Minor looseness, more wrinkles but no breaks or surface cracks	Some looseness, wrinkles and creases but no grain cracks
60 hrs. (1 080 000 flexes)	Minor wrinkles and Minor grain surface cracks but no tears	Few surface cracks, projected wrinkles but no tears	Several Grain cracks, Looseness at the central fold, no tears but highly wrinkled surface

Source: Assessment conducted by researcher, November, 2008

Appendix 4

List of Formulas Employed in calculating the results of the physical properties examinations

1. THE BENDING LENGTH, C.

$$C = l \sqrt[3]{\frac{Cos(a/2)}{8 \tan a}}$$

Where l = the overhanging length in cm

a = the angle of droop in degrees

2. THE FLEXURAL RIGIDITY, G

The flexural rigidity is the force required to bend unit length through unit angle

$$G = W C^3$$

Where C = bending length

W = weight per unit area of the sample (g cm^{-1})

3. THE BENDING MODULUS, q

$$q = \frac{12G}{d^3}$$

Where G = the flexural rigidity

d = the thickness of the sample mm

The units of the bending modulus are kg cm^{-2}

4. TENSILE STRENGTH

$$\text{Tensile strength} = \frac{\text{maximum breaking load}}{\text{cross sectional area}}$$

Unit s in Pascals (Nm^{-2})

(Cross sectional area = mean with x mean thickness)

5. PERCENTAGE ELONGATION AT BREAK

$$\text{Percentage Elongation} = \frac{\text{final free length – initial free length}}{\text{Initial free length}} \times 100$$

Appendix 5A

Tabulated Results for Shoe Upper Leather Tests (Goatskin Leather Samples). Tables 1 to 6, contain the results of (1) Thickness test, (2) Fullness Test (Mean bending length, Flexural rigidity and Bending modulus), (3) Tensile Strength, (4) Distension and Grain Cracking Test (Ball Burst Test)

Table 1

Type of Tannage and Leather: Vegetable Tanned Goatskin Leather

Source Tannery: Mallam Market, Accra, Greater Accra Region

Test	**Position**			**Expected Mean**
	Butt	**Shoulder**	**Belly**	
Mean Thickness (mm)	0.94	0.80	0.76	**≥ 1.5**
Mean Bending Length (cm)	6.38	6.08	5.47	**< 4**
Mean Flexural Rigidity (g/cm)	8.71	7.33	5.24	**Varies**
Mean Bending Modulus ($kg\ cm^{-2}$)	125.80	171.89	143.20	**The smaller the fuller**
Mean Tensile Strength para. (MPa)	22.0	16.4	15.1	**≥15 - ≤60**
Mean Tensile Strength perp. (MPa)	14.7	14.8	13.9	**≥15 - ≤60**
Mean Grain Crack Load (kgf)	25	23	17	**> 30**
Mean Grain Crack Distension (mm)	6.00	5.86	6.51	**≥ 7**
Mean Grain Burst Load (kgf)	29	28	28	**≥35**
Mean Grain Burst Distension (mm)	7.40	6.70	7.00	**≥ 8**

Source: Experiments conducted by researcher, November - December 2008

Table 2

Type of Leather and Tannage: Vegetable Tanned Goatskin Leather

Source: Asawase Tannery – Kumasi, Ashanti

Test	**Position**			**Expected Mean**
	Butt	**Shoulder**	**Belly**	
Mean Thickness (mm)	1.14	1.03	0.80	**≥ 1.5**
Mean Bending Length (cm)	6.14	5.73	5.15	**< 4**
Mean Flexural Rigidity (g/cm)	7.81	6.18	4.40	**Varies**
Mean Bending Modulus (kg cm^{-2})	63.25	67.90	103.21	**The smaller the fuller**
Mean Tensile Strength para. (MPa)	25.1	17.4	15.5	**≥15 - ≤60**
Mean Tensile Strength perp. (MPa)	15.0	18.3	17.4	**≥15 - ≤60**
Mean Grain Crack Load (kgf)	30	18	20	**> 30**
Mean Grain Crack Distension (mm)	7.16	5.71	6.53	**≥ 7**
Mean Grain Burst Load (kgf)	32	28	27	**≥35**
Mean Grain Burst Distension (mm)	7.49	6.71	6.95	**≥ 8**

Source: Experiments conducted by researcher, November - December 2008

Table 3

Type of Leather and Tannage: Vegetable Tanned Goatskin Leather

Source of Leather: Hausa Zongo Tannery, Tamale, Northern Region

Test	**Position**			**Expected Mean**
	Butt	Shoulder	Belly	
Mean Thickness (mm)	1.17	1.11	0.86	**≥ 1.5**
Mean Bending Length (cm)	5.62	5.60	5.05	**≤ 4**
Mean Flexural Rigidity (g/cm)	6.05	5.75	4.17	**Varies**
Mean Modulus kg (cm^{-2})	45.32	50.48	78.67	**The smaller the fuller**
Mean Tensile Strength para. (MPa)	25.0	20.1	14.5	**≥15 - ≤60**
Mean Tensile Strength perp. (MPa)	15.0	16.4	17.2	**≥15 - ≤60**
Mean Grain Crack Load (kgf)	29	28	27	**> 30**
Mean Grain Crack Distension (mm)	7.4	6.85	6.75	**≥ 7**
Mean Grain Burst Load (kgf)	30	32	30	**≥35**
Mean Grain Burst Distension (mm)	7.16	7.31	7.73	**≥ 8**

Source: Experiments conducted by researcher, November - December 2008

Table 4

Type of Leather and Tannage: Vegetable Tanned Goatskin Leather

Source of Leather: Bolgatanga Tannery, Upper East Region

Test	**Position**			**Expected Mean**
	Butt	**Shoulder**	**Belly**	
Mean Thickness (mm)	1.24	1.17	0.91	**≥ 1.5**
Mean Bending Length (cm)	5.57	5.43	5.00	**≤ 4**
Mean Flexural Rigidity (g/cm)	5.90	5.27	4.24	**Varies**
Mean Bending Modulus (kg cm^{-2})	37.11	39.47	67.52	**The smaller the fuller**
Mean Tensile Strength para. (MPa)	22.6	24.5	16.6	**≥15 - ≤60**
Mean Tensile Strength perp. (MPa)	15.4	14.8	16.4	**≥15 - ≤60**
Mean Grain Crack Load (kgf)	30	28	27	**> 30**
Mean Grain Crack Distension (mm)	7.42	6.85	7.00	**≥ 7**
Mean Grain Burst Load (kgf)	33	32	30	**≥35**
Mean Grain Burst Distension (mm)	7.60	7.31	7.45	**≥ 8**

Source: Experiments conducted by researcher, November - December 2008

Table 5

Type of Leather and Tannage: Vegetable Tanned Goatskin Leather

Source of Leather: Bawku, Upper East Region

Test	**Position**			**Expected Mean**
	Butt	**Shoulder**	**Belly**	
Mean Thickness (mm)	1.25	1.16	0.95	**≥ 1.5**
Mean Bending Length (cm)	5.63	5.36	5.01	**≤ 4**
Mean Flexural Rigidity (g/cm)	6.10	5.08	4.09	**Varies**
Mean Bending Modulus (kg cm^{-2})	37.50	39.08	57.31	**The smaller the fuller**
Mean Tensile Strength para. (MPa)	16.3	15.2	20.2	**≥15 - ≤60**
Mean Tensile Strength perp. (MPa)	14.0	11.5	11.8	**≥15 - ≤60**
Mean Grain Crack Load (kgf)	28	25	25	**> 30**
Mean Grain Crack Distension (mm)	6.22	6.56	6.50	**≥ 7**
Mean Grain Burst Load (kgf)	30	30	30	**≥35**
Mean Grain Burst Distension (mm)	7.42	7.00	7.68	**≥ 8**

Source: Experiments conducted by researcher, November - December 2008

Table 6

Type of Leather and Tannage: Vegetable Tanned Goatskin Leather

Source of Leather: Pougtinga Tannery, Burkina Faso

Test	Position			Expected Mean
	Butt	**Shoulder**	**Belly**	
Mean Thickness (mm)	1.24	1.17	1.02	**≥ 1.5**
Mean Bending Length (cm)	5.41	5.21	4.41	**≤ 4**
Mean Flexural Rigidity (g/cm)	5.45	4.83	3.89	**Varies**
Mean Bending Modulus ($kg\ cm^{-2}$)	34.28	36.15	43.98	**The smaller the fuller**
Mean Tensile Strength para. (MPa)	16.7	17.6	16.5	**≥15 - ≤60**
Mean Tensile Strength perp. (MPa)	16.7	17.1	18.5	**≥15 - ≤60**
Mean Grain Crack Load (kgf)	29	30	30	**> 30**
Mean Grain Crack Distension (mm)	7.33	7.41	7.44	**≥ 7**
Mean Grain Burst Load (kgf)	33	31	31	**≥35**
Mean Grain Burst Distension (mm)	8.00	7.67	8.20	**≥ 8**

Source: Experiments conducted by researcher, November - December 2008

Appendix 5B

Tabulated Results for Shoe Upper Leather Tests (Goatskin Leather Samples). Tables 1 to 6, contain the results of (1) Thickness test, (2) Fullness Test (Mean bending length, Flexural rigidity and Bending modulus), (3) Tensile Strength, (4) Distension and Grain Cracking Test (Ball Burst Test)

Table 1

Type of Leather and Tannage: Vegetable Tanned sheepskin Leather

Source of Leather: Mallam Marker Tannery, Greater Accra

Test	Position			Expected Mean
	Butt	Shoulder	Belly	
Mean Thickness (mm)	1.06	0.97	1.00	≥ 1.5
Mean Bending Length (cm)	6.02	5.98	4.76	≤ 4
Mean Flexural Rigidity (g/cm)	9.56	9.12	4.07	Varies
Mean Bending Modulus ($kg\ cm^{-2}$)	96.29	119.86	48.87	The smaller the fuller
Mean Tensile Strength para (MPa)	21.2	16.2	17.2	≥15 - ≤60
Mean Tensile Strength perp (MPa)	14.9	18.9	15.0	≥15 - ≤60
Mean Grain Crack Load (kgf)	28	25	30	> 30
Mean Grain Crack Distension (mm)	7.05	6.28	7.55	≥ 7
Mean Grain Burst Load (kgf)	30	30	31	≥35
Mean Grain Burst Distension (mm)	7.25	7.89	8.00	≥ 8

Source: Experiments conducted by researcher, November - December 2008

Table 2

Type of Leather and Tannage: Vegetable Tanned Sheepskin Leather

Source of Leather: Asawase Tannery, Kumasi, Ashanti Region

Test	**Position**			**Expected Mean**
	Butt	**Shoulder**	**Belly**	
Mean Thickness (mm)	1.16	1.05	0.99	**≥ 1.5**
Mean Bending Length (cm)	6.04	5.79	4.78	**≤ 4**
Mean Flexural Rigidity (g/cm)	10.12	8.80	3.97	**Varies**
Mean Bending Modulus (kg cm^{-2})	77.79	91.19	49.11	**The smaller the fuller**
Mean Tensile Strength para (MPa)	21.65	15.04	15.72	**≥15 - ≤60**
Mean Tensile Strength perp (MPa)	15.32	18.07	14.10	**≥15 - ≤60**
Mean Grain Crack Load (kgf)	30	25	30	**> 30**
Mean Grain Crack Distension (mm)	7.44	7.34	7.20	**≥ 7**
Mean Grain Burst Load (kgf)	31	30	33	**≥35**
Mean Grain Burst Distension (mm)	8.15	8.00	8.35	**≥ 8**

Source: Experiments conducted by researcher, November - December 2008

Table 3

Type of Leather and Tannage: Vegetable Tanned Sheepskin Leather

Source of Leather: Hausa Zongo Tannery, Tamale, Northern Region

Test	Position			Expected Mean
	Butt	Shoulder	Belly	
Mean Thickness (mm)	1.18	1.10	1.09	**≥ 1.5**
Mean Bending Length (cm)	5.64	5.55	4.47	**≤ 4**
Mean Flexural Rigidity (g/cm)	8.37	7.94	3.72	**Varies**
Mean Bending Modulus (kg cm^{-2})	61.16	71.61	34.48	**The smaller the fuller**
Mean Tensile Strength para. (MPa)	18.86	14.78	18.69	**≥15 - ≤60**
Mean Tensile Strength perp. (MPa)	14.15	17.97	18.73	**≥15 - ≤60**
Mean Grain Crack Load (kgf)	25.0	31.0	30.0	**> 30**
Mean Grain Crack Distension (mm)	7.00	7.88	7.38	**≥ 7**
Mean Grain Burst Load (kgf)	29.0	34.0	31.0	**≥35**
Mean Grain Burst Distension (mm)	7.04	7.90	8.17	**≥ 8**

Source: Experiments conducted by researcher, November - December 2008

Table 1

Type of Leather and Tannage: Vegetable Tanned Sheepskin Leather

Source of Leather: Bolgatanga Tannery, Upper East Region

Test	**Position**			**Expected Mean**
	Butt	**Shoulder**	**Belly**	
Mean Thickness (mm)	1.20	1.14	1.13	**≥ 1.5**
Mean Bending Length (cm)	5.49	5.43	4.40	**≤ 4**
Mean Flexural Rigidity (g/cm)	7.73	7.46	3.78	**Varies**
Mean Bending Modulus (kg cm^{-2})	53.74	60.44	31.45	**The smaller the fuller**
Mean Tensile Strength para. (MPa)	27.35	19	27.63	**≥15 - ≤60**
Mean Tensile Strength perp. (MPa)	20.17	20.96	22.75	**≥15 - ≤60**
Mean Grain Crack Load (kgf)	31.0	28.0	30.0	**> 30**
Mean Grain Crack Distension (mm)	7.76	6.85	7.87	**≥ 7**
Mean Grain Burst Load (kgf)	34.0	32.0	33.0	**≥35**
Mean Grain Burst Distension (mm)	8.11	7.31	8.38	**≥ 8**

Source: Experiments conducted by researcher, November - December 2008

Table 4

Type of Leather and Tannage: Vegetable Tanned Sheepskin Leather

Source of Leather: Bawku Tannery, Upper East Region

Test	**Position**			**Expected Mean**
	Butt	**Shoulder**	**Belly**	
Mean Thickness (mm)	1.23	1.18	1.14	**≥ 1.5**
Mean Bending Length (cm)	5.38	5.46	4.42	**≤ 4**
Mean Flexural Rigidity (g/cm)	7.31	7.58	3.87	**Varies**
Mean Bending Modulus (kg cm^{-2})	47.15	55.40	31.32	**The smaller the fuller**
Mean Tensile Strength para. (MPa)	18.58	13.70	21.22	**≥15 - ≤60**
Mean Tensile Strength perp. (MPa)	15.02	16.13	19.40	**≥15 - ≤60**
Mean Grain Crack Load (kgf)	31	25.0	30	**> 30**
Mean Grain Crack Distension (mm)	7.76	6.84	7.87	**≥ 7**
Mean Grain Burst Load (kgf)	34	32	33	**≥35**
Mean Grain Burst Distension (mm)	8.11	7.91	8.50	**≥ 8**

Source: Experiments conducted by researcher, November - December 2008

Table 1

Type of Leather and Tannage: Vegetable Tanned Sheepskin Leather

Source of Leather: Pougtinga, Burkina Faso

Test	**Position**			**Expected Mean**
	Butt	**Shoulder**	**Belly**	
Mean Thickness (mm)	1.27	1.20	1.15	**≥ 1.5**
Mean Bending Length (cm)	5.27	5.36	4.23	**≤ 4**
Mean Flexural Rigidity (g/cm)	6.74	7.17	3.41	**Varies**
Mean Bending Modulus (kg cm^{-2})	39.46	49.82	26.91	**The smaller the fuller**
Mean Tensile Strength para (MPa)	24.61	16.26	20.07	**≥15 - ≤60**
Mean Tensile Strength perp (MPa)	17.57	19.47	19.26	**≥15 - ≤60**
Mean Grain Crack Load (kgf)	30	28	30	**> 30**
Mean Grain Crack Distension (mm)	7.78	6.85	7.88	**≥ 7**
Mean Grain Burst Load (kgf)	32	32	33	**≥35**
Mean Grain Burst Distension (mm)	8.12	8.49	8.55	**≥ 8**

Source: Experiments conducted by researcher, November - December 2008

Appendix 6

Recipe Designed for Tanning Skins for Shoe Upper

Raw Material: Domestic Goat, Sheep or Calf Skin **End Use: Shoe Upper**

Weight: 33 Kilos **Equipment: *Pit/vat method.***

Process	Quant.	Chemical	Temp.	Time	Comments
Dirt Soak	300%	Water	25		
	×	Surfactant			
	×	Bactericide		24hrs	
Drain					
Main Soak	200%	Water	25		
	×	Surfactant			
	×	Bactericide		12-24hrs	
		Degreaser			Degrease tanning sheep
Drain					
Flesh					Trim and Reweigh
New weight:					Reweigh
Unhairing	80%	Water	20		
	1%	Lime			
	0.5%	Sodium Sulfide 60%		6hrs	Wood ash could be used
+	0.5%	Sodium Sulfide 60%			
+	50%	Water	20		
	1%	Lime			
	1%	Sodium Sulfide 60%		6hrs	Wood ash could be used
Swelling +	100%	Water	20		
	1%	Sodium Sulfide 60%			Wood ash could be used
	1%	Lime			
	×	Degreaser		2 hrs.	pH 12.5
Drain					
Wash	100%	Water			Wash properly
Drain					
Wash	100%	Water	35		Wash properly
Delime	50%	Water	35		
	3%	Ammonium sulfate		6 to 8hrs	Pawpaw Leaves and Pumpkin can be used
	0.5%	Sod. Met. bisulfite			
	×	Degreaser		2hrs	Check pH 8-9

	×	Formic acid	10	5hrs	Only if pH is >9
Bate +	×	Pancreatic bate			
Drain					
Wash	100%	Water	Cold		
Drain					
Pickle	80%	Water	Cold		
	6%	Salt		2-5 hrs	
	0.8%	Sod. formate			Check Bé 6-8
+	1.8%	Sulfuric acid 98%			
	×	Fungicide			
					Check pH 2.5-3.0
					Check Ø BCG yellow
					Check Boil test
Drain					
Wash	100%	Water	40		
	×	Fungicide		30mins	
Drain					
					Horse up and move for tanyard activities
Wet back	300% =39L	Water	35		
	0.5% =65g	Surfactant		1hr	Check after 10'
Drain					
Neutralise	100% =13L	Water	35		
	1% =130g	Sodium formate		1.30mins	
+	0.25%=32.5g	Sodium bicarbonate			Check Ø BCG, Ph 4.6-4.8
Drain					
Wash	200%=26L	Water	35		Wash properly
		Weak veg. Tannin solution			
tan	100%=13L	Water	35		
+	3% = 390g	Veg. Tannin		6 hrs.	Check pH
+	20%= 260g	Water	35		
	3% = 390g	Acrylic Synthan		2-3hrs.	Check pH
Drain					
Wash	200% = 26L	water	50		
Drain					
Dye/Fatliquor	100% =26L	Water	50		By rotating drum

					For adequate tumbling
	1% = 130g	Dye			
+	4% =520g	Sulfated/sulfited fat 1			Emulsify (1:4)
	2% = 260g	Sulfated fatliquor 2			Emulsify (1:4)
	2% =260g	Sulfated fatliquor 3			Emulsify (1:4)
Fix	1% =130g	Formic acid		20'	pH 3.6-3.8 (0.5+0.5)
Drain					
Wash/Rinse	100% =13L	Water	50	5'	
Horse up					
Samm-set					
					Never sun drying
Air drying					
Vacuum					
Toggle					

NOTE: Recipe can be modified to project the properties requisite for the end use