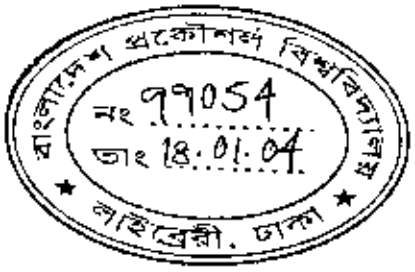
ANALYSIS OF LEATHER PROCESSING NEEDS OF SMALL TANNERIES AND PROFITABILITY OF COMMON FINISHING FACILITIES CENTER



A Project Thesis

By

UTTAM KUMAR ROY

Department of Industrial & Production Engineering
Bangladesh University of Engineering & Technology
Dhaka-1000

October, 2003

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Submitted to the Department of Industrial & Production Engineering, Bangladesh University of Engineering & Technology, Dhaka, in partial fulfillment of the requirement for the degree of **MASTER IN ADVANCED ENGINEERING MANAGEMENT**

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The thesis titled **Analysis of Leather Processing Needs of Small Tanneries and Profitability of Common Finishing Facilities Center**, submitted by Uttam Kumar Roy, Roll No. 100008121P, Session October 2000, has been accepted as satisfactory in partial fulfillment of the requirement for the degree of **MASTER IN ADVANCED ENGINEERING MANAGEMENT (AEM)**.

BOARD OF EXAMINERS

1. _____

Dr. Nikhil Ranjan Dhar — Chairman (Supervisor)
Associate Professor
Industrial & Production Engineering Department
BUET, Dhaka.

2. _____

Dr. Md. Golam Mohiuddin — Member
Professor & Head
Industrial & Production Engineering Department
BUET, Dhaka.

3. _____

Dr. Md. Fazlul Karim — Member
Professor & Principal
Bangladesh College of Leather Technology
Hazaribagh, Dhaka.

Department of Industrial & Production Engineering
Bangladesh University of Engineering & Technology
Dhaka-1000

October 2003

Declaration

I do hereby declare that this work has been done by me and neither this thesis nor any part of it has been submitted elsewhere for the award of any degree or diploma except for publication.

Countersigned

Dr. Nikhil Ranjan Dhar
Supervisor & Associate Professor
Industrial & Production Engineering Department
BUET, Dhaka

Uttam Kumar Roy

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Author

Abstract

Bangladesh is abundant with hides and skins. Among them, goatskins of her western part are a world famous. Tannery operations for hides and skins used in this country and related machinery and various controlling activities involve both in chemical and mechanical operations. After tanning both the physical and chemical properties of Leather are determined, performing different tests and thus, proper specifications are made. If modern technology is applied to the existing tanneries and proper attention is taken in both the manufacturing of Leather and its products and making positive exporting policy to other countries, huge amount of foreign currency may possible be earned from this sector.

Analysis of leather processing needs of small tanneries and profitability of Common Finishing Facilities Center (CFFC) is a subject to know how from the wet-blue of cowhides and goatskins by variation of products, we can maximize the profit per year than the traditional method. From this analysis we can also find out the processing needs of small tanneries, which can be solved by the CFFC with the earning of revenue. The content is constructed and edited mainly for the purpose of maximizing the profit of tannery-industries regarding the Global Market achievement. CFFC now as Finishing Department of Bangladesh College of Leather Technology, Dhaka is used as applicable research field.

Tha CFFC is used as service center for small and medium types leather industries of the country. Here customer comes with wet-blue from cowhides and goatskins use service facilities to increase value by producing crust leather and finished leather. So the profit is the service charges of the different machines. On the other we analyze the leather processing needs of small tanneries.

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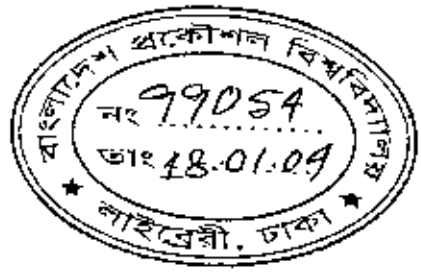

Introduction

Leather industry in Bangladesh is a highly potential sector. But this could not prosper much because of proper planning and patronization. Its history and background is vast and vivid what intended to be explained here in brief and attempts have also been made to explain how leather industry of Bangladesh has developed in the post liberation period.

In the pre liberation period the Bangladesh tannery owners mainly sold their home made leather to non-locals for various reason. But after liberation around later part of 1972 the Bangladesh entrepreneurs organized themselves and stared wet blue export on co-operative basis. This leather industry was in fact the first foreign exchange earner sector for the newly born Bangladesh The entrepreneurs of this tanning sector faced lot of complications while exporting wet blue of international standard. They didn't have proper technological and infrastructure support to meet the demand of international market. Yet they continued their wet blue / export ignoring the odds they were facing and saved the way for earning more foreign exchange from easily decomposable raw hides and skins. In the year 1974-75 the government first introduced duty draw back system to encourage the exporters and this was a positive step towards export earning Our leather in the meantime became popular in the world market. But unfortunately the duty draw back system for wet blue export did not last long. The government in 1976-77 had withdrawn the system from wet blue export and imposed 15% custom duty thereon which was subsequently reduced to 10%.

In the face of this decision of the government the tannery owners did not stop business. They rather continued wet blue export incurring huge loss. But before they could over come, they had to face other debate causing immense losses due to recession in the price of international market in 1979-80. The price of Bangladesh leather reduced drastically to the extent of 45%. The most crucial situation came heavily after 1990 when the government without any infrastructure development causing many tanneries to close down their production and export banned wet blue export. In consequence the owners became loan defaulters. There after government made a plan for BMRE of 25 tanneries to encourage crust leather export out which BMRE of only 13 tanneries into production from 1992 through a defective policy. At this stage some 10-12 tanneries other than the government-approved schemes were involved in the export business. Subsequently due to recession and price imbalance many of them were shut down and turned to Loan defaulter. The available statistics show that there are as many as 220 small, medium and large size tanneries all over the country. Out of them 174, have been closed down due to environmental and other problems now being treated as sick and of them 46 belong to modern & semi-modern tannery group and out this 46 tanneries 13 belong to BMRE project of the government. The Tannery owners and the commercial exporters now earn foreign exchange of TK.1500.00 corers in a year. This earning may be increased to 2-3 times if the stuck-up tanneries under BMRE scheme are made operation because of a national policy, which is yet to be framed .In addition condition imposing down payment from 2.5-10% has made it difficult for repayment of loan by the tannery owners. Such rule should be withdraw condition should imposed as lum-sum token money, for which tannery owners may survive. As well as Bank also return back their outstanding liabilities. It also note that govt. has decided to shifting the leather sector a new proposed area in Savar. In this connection, Stuck-up Tanneries must be started their production by the help of government created facilities. Otherwise govt. shifting plan will not be implemented. So in this circumstance, all related concern should think and help to the stuck–up Tanneries for solve their problem.

In fact, the problems of this potential and value-added sector have not originated from a single source. The sector has suffered set back time and again on different causes. The government was apprised both in writing and verbally on many occasions to solve the problems but not tangible progress could be achieved. The sector could not be developing due to specific policy guideline, which has become indispensable If infrastructure facilities under proper policy guide line are provided the export earning of this value added sector would definitely increase manifold The tannery owners have by now switched over to the production of leather goods and footwear with the leather they produce and some of them have done well in the international market. We have great demand in the quality leather and leather products. Leather is undoubtedly a highly prospective and potential sector. This has been lagging behind bacause of proper guideline This sector will certainly earn huge foreign exchange if government provides necessary help with banking facilities under a policy guideline

Bangladesh produces considerable amount of hides and skins. Goatskins from the western part of the country are world famous. There are about 206 tanneries in the country. A major part of these tanneries operate at small scale using low-technology process machinery. Many of them process hides and skins for limited number of operations out of sixteen operations required to produce finished leather. These tanneries do not complement each other in the total value chain because of capital intensity of machinery for certain operations. Big tanneries have hardly any extra-capacity to handle others processing. Realizing this difficulty, the government established a common finishing facilities center (CFFC) at Hazaribagh area to cater to the needs of small-scale tanneries. The center is now handed over to Bangladesh College of Leather Technology (BCLT) to run it on a self-earning basis.

The CFFC established in 1987 with the IDA assistance at Leather college campus to facilitate production of finished leather by smell-scale leather producers for local supply. A committee headed by the Principal of BCLT with representatives of small-scale private sector leather industries. Leather

Research Institute (LRI), Ministry of Commerce and Leather Technologists Society manage the operations of the center.

After its establishment, CFFC started functioning on a trial-run basis. The center is also used for training the students of the College. The annual income of the center was estimated to be Tk.77.40 lakhs with the operating/ recurring cost of Tk.55.19 lakhs. CFFC is operating on trial-run basis and mainly functioning as the training for the students. Major installed machine (about 50%) are not in working condition. Due to the unavailability of CFFC, some private tanneries started and picked up the market.

At present the principal & project director of renovation, re-organization & modernization of BCLT, Dhaka for the project period 1997 to 2004 have recovered and replaced the non-working machine facilities of CFFC. The project director has proposed to run the center on Job-work basis at economical ratio so that it can run instantly from its own earning. At the same time the center will continue to train its students as apprentice. The center will serve the small and medium sized tanneries as planned.

However, running such facility on self-earning basis requires assessment of its customers, prediction of demand and optimal use of resources. Although there are number of studies on leather sub-sector, there is no specific study on the possibility of running the CFFC.

1.1 Low, Medium and High Technological Tanneries in Bangladesh

There was an unplanned rapid growth of leather processing industry in Bangladesh particularly in Hazaribagh during 1970s and 1980s without expansion of supporting infrastructure facilities. There are now 206 small, medium and large tanneries in Bangladesh out of which 186 are located at

Hazaribagh in an area of only 70 acre of land. About 94% of the total supply of hides and skins of the country is processed here. Land owned by individual tannery at Hazaribagh varies from 0.05 to 3 acre and any further development or expansion of tanneries is not possible at this place due to space limitation.

According to site consideration there are three types of tanneries in Hazaribagh like small, medium and large. These tanneries operate using different level of technology. Fig.1.1 shows type of tanneries along with level of technology.

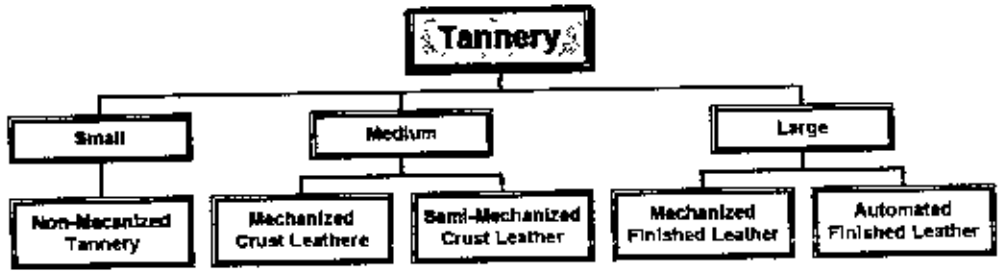

Fig. 1.1 Types of tanneries in Bangladesh

1.2 Characteristics of Small, Medium and Large Scale Tanneries

The large-scale tanneries processing the leather from flaying to finished leather. So they can complete their whole Job. Therefore there are no processing needs for the large-scale tanneries. The medium scale tanneries can process leather from raw hides & skins to crust-leather. There are two types of medium scale tannery like (a) Mechanized crust leather tannery where leather can be processed from flaying to toggle drying for crust leather and (b) Semi-mechanized crust leather tannery where leather can be processed from flaying to vacuum drying for crust leather.

The small-scale tanneries have facilities for processing wet blue leather only. They are non-mechanized tanneries. In this type of tenneries, leather can be processed from flaying to tanning for wet-blue.

The above mentioned processing needs of the different tanneries in Hazaribagh area can be completed in common finishing facility center established in 1987 with the IDA assistance in Leather College, Dhaka to facilitate production of finished leather by small-scele leather producers for local supply.

1.3 Objectives of the Present Work

As mentioned, the CFFC is an important institutional support for small and medium scale leather processing industries. However, this type of government facility extending services on commercial basis be must run on profit motive. This research looks at the potential customers of the center, assess the demand for services and optimize its resources utilization for profit. This project work was carried out with the following objectives:

- Study the type and nature of the small scale tanneries at Hazaribagh, Dhaka and identify and quantify the processing needs of those tanneries

- Study the Common Finishing Facilities Center (CFFC) provisions and optimize the product mix considering different constraints and

- Assess the beneficial impact of the center on leather processing in the area

A survey of the small-scale tanneries of Hazaribagh area will be carried out and simple statistical analysis will be done to determine the nature of processing operations and their demand. Linear programming exercises will

be carried out to optimize the profitability of the center Finally a qualitative/ quantitative analysis will be done to asses the impact of the center.

Chapter-2

TECHNOLOGY OF LEATHER PROCESSING

In leather processing, the animals are slaughtered in butcher shops then flayed to hides and skins to reach the tannery. By using chrome tanning, the following processes are used to get finished leather from animals.

Animal→Slaughtering→Flaying→Curing→Soaking→Liming→Un-hairing→ Fleshing→Deliming→Bating→Pickling→Chrome-tanning→Basicification→ Sammying→Splitting→Shaving→Washing & Neutralization→Retanning, fatliquoring & dyeing→Setting→Vacuum-drying→Drying & moistening→ Vibration-staking→Toggle-drying→Buffing (if necessary)→Polishing (if necessary)→Finishing-coats→Hydraulic-pressing→Ironing & embossing→ Measuring→**Finished leather**

2.1. Leather Tanning & Finishing Operations

Bangladesh is a country of cultivation. She grows a lot of animals likes cow, buffalo, goat, sheep etc from which huge quantities of hides and skins are obtained and then raw hides and skins are turned into leather by tanning. Without tanning it cannot be used, because very soon raw hides and skins are started to putrefy. If the raw hides and skins are dried by means of any process, it lost its flexibility and softness and became very hard and brittle, which cannot be used in any application. To overcome these problems, raw hides and skins are tanned. Tanned leather does not putrefy. Even after

drying and wetting. It does not become hard and brittle, but remains flexible and workable in all respects.

Tanning may be of different types like vegetable tans, mineral tans, synthetic tans, etc. Their applications depend on the types of hides and skins and the requirements on the production of quality leather. Most of the heavy-duty machinery used in the tanneries is operated with hydraulic system. Medium and small duty machinery are operated with pneumatic system. Some machinery is also operated with both the hydraulic and pneumatic system or in combine. The controlling systems of these machinery are either electrical or electronics or both the electrical-electronics in combine. Electric power is supplied to this machinery from an A.C source. Inverter is used to some machinery to control the rotations.

For the production of quality leather accurate pH value and concentration of chemicals for different operations of every stage of a complete operation must be maintained. Exact rotation of machine element and appropriate temperature and pressure of the chemicals using in different operations must be controlled to get the desired production. Safety control for all stage or every section of a complete operation must be maintained. Appropriate plant layout, factory layout, machine layout must be followed during the construction of factory building and installation of machinery. Proper motion study, work-study and time study must be applied in every stage of production. Taking proper statistical report from man, materials, machines, power supply, transportation, etc a resultant methodical specific production schedule should make, which will yield the smooth and continuous production of quality leather in time. So, proper ergonomic study and its controls is a must for quality production.

In the tanneries, the raw materials go through different chemical and mechanical operations and finally come out as finished leathers. Tannery operations can be broadly divided into three categories, which are illustrated in the following headings.

2.1.1. Pre-Tanning Operations

Tanning may be performed in many ways, like vegetable tans, chrome tans, oil tans, etc. The pre-tanning operations of different tans are not similar but vary a little bit. The pre-tanning operations (in a normal sequence) are discussed in the following ways [1-3].

Flaying: This is known as removing the skin or hide from the animal. Proper methods and more attention should be given in this operation. The animal should be in a clean, dung-free, healthy condition and the slaughter rapid and efficient. Bruising should be avoided. It is then bled to remove blood from the carcass and also from the small arteries and veins of the skin. If this is not done quickly, the blood clots therein, readily putrefies, giving rise to blue-black markings in the skin and areas of putrefaction in these regions. It is usual to hang the beast up by the hind shanks on a transporter rail for this purpose.

Curing: It is a temporary preservation of hides and skins during transportation or storage. It is not always possible to send the hides and skins during transportation or storage. It not always possible to send the hides and skins to tanneries immediately after flaying because the source of collection and the tanneries are not generally located in the same area. The time gap between the flaying operation and the start of tanning operations vary from one or two months. If hides and skins are not cured just after flaying, they get completely putrefied within 2/3 days. Curing may be done in many ways like curing by controlling temperature, pH value, using toxic meterials, sun drying, salting-wet salting, brining and dry salting, etc.

Soaking: Soaking is a treatment with water to restore 'cured' hides and skins to a natural raw condition. This is actually the first tannery operation. During curing hides and skins lose large quantity of its physiological content of weter

and unless the former regains this water during soaking operation good quality leather cannot be produced. Fig.2.1 shows the soaking operation [4].

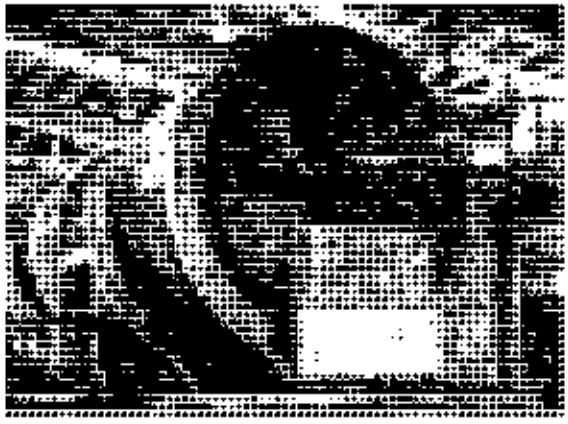

Fig.2.1 Soaking operation [4]

Liming: In this operation (Fig.2.2), the hides and skins are treated with milk of lime with the addition of sharpening agents like sulfide, etc. The objects of this operation are mainly to,

- remove the hairs, nails, hooves, and other keratinous matters
- remove natural grease and fat
- swell up and to split up the fibbers to desired extent and
- bring the collagen to a proper condition for satisfactory tanning.

Fig.2.2 Liming operation [5]

Unhairing: This is an operation (Fig.2.3), which is used to remove the hair. Different processes like sweating, enzymeing, painting or using in an unhairing machine also do unhairing. This operation may be performed using a single pit system, three pit system, or in drum.

Fig. 2.3 Unhairing operation [6]

Fleshing: This is the next operation where unwanted fat and flesh from the hides and skins are cut away. This operation may be done by hand with the help of a knife or using a rubber roll fleshing machine. After liming the unhaired and fleshed hides and skins are known as pelts.

Deliming: Pelts are taken for the next operation called deliming. The object of deliming is to remove lime and other alkalis from the limed pelt by chemical treatment. The removal of alkalis from the pelts before tanning is important and essential for the production of good quality leather.

Bating: Limed and partially delimed pelts sometimes required additional treatment known as bating as shown in Fig.2.4. According to the class of leather it is intended to make In this operation pelts are treated with a solution of proteolytic enzymes derived from different sources. The hides or skins are delimed to a pH of 8.0-8.5 and washed. This is the degree of alkalinity at which most enzymes show greatest digestive power. The goods are then usually paddled or drummed in

300-500% water at 37^{O}C with a 1-2% addition of the powdered enzyme mixture. It is important to maintain the p^{H} and temperature accurately, as slight variations give a great loss of bating power During bating operation of different classes of leathers temperature, duration of bating, strength and p^{H} value of bating liquor must be considered as important factors for the production of quality leather.

Fig.2.4 Bating operation [7]

Pickling: The use of liquors containing acid and salt is referred to as pickling, which is commonly carried out in the usual wooden paddles and drums or processors. The salt stage of pre-tanning operation is the Pickling. In this operation delimed or bated pelts are again treated with a solution of acid and salt. This is the most important and essential operation, which bring the hides of skins to the right acidity for the next operation tanning.

Tanning: The tanning process converts the protein of the rawhide or skin into a stable material, which will not putrefy and is suitable for a wide variety of purposes. There is a vast array of tanning methods and materials and the choice depends chiefly on the properties required in the finished leather, the cost of the alternative materials, the plant available, and the type of raw material. Tanning may be done in many ways like mineral tanning (Chrome tanning, Alum tanning, Iron tanning, Zirconium tanning etc.), Non-mineral tanning (Aldehyde tanning, Oil tanning, Resin tanning, Synthetic tanning, Combination tanning etc. actually). Tanning is a bast technology, on which

the quality leather productions are widely depended. During tanning the p^H value, concentration and temperature of using chemical or its mixture must be seriously controlled. But to get the leather of good quality chrome and vegetable (as used in large scale) tanning materials are not sufficient such as chrome tanning materials can produce leather shrinkage temperature but not the fullness of leather. On the other hand, vegetable tanning materials procedure leather with good fullness handle and excellent buffing property but at the cost of grain tightness, light & colorfastness and elasticity. In this operation proper penetration of tanning materials, P^H Value and fixation or basification is maintained.

Wet-blue: Freshly tanned chrome leather which has not been dried out, etc., is referred to as being "in the blue" (from the color, which goes much paler on drying). It is very important to remember that all blue leather develops acidity on standing or ageing.

Blue chrome leather has a very strong affinity for many dyes, fat-liquors and vegetable tans, but this becomes much less after drying, owing to changes which occur in the chrome sulphate complex during drying or ageing. Wet-blue chrome leather is leather is exported in large quantities, especially from countries where there is not a highly developed industry making finished leather articles such as fashion shoes, clothes or bags.

2.1.2. Post-Tanning Operations

Post tanning operations may be divided into two major classes like crusting operations and finishing operations, which are illustrated in the following ways.

2.1.2.1. Crusting Operations

Scouring: scouring is the operation where excess tan liquor to drain from the hides or skins, and to keep them in a damp condition for a day or more.

Where flat leathers are required, the skins are drained flat to avoid any tendency for the fibbers to set a creased condition. Common methods are horsing up and piling.

Sammying: The next operation is sammying as shown in Fig.2.5 where excess water is removed from the hides and skins, passing through the roller . of the hydraulic or mechanical operated sammying machine. Setting out-where wrinkles are removed and flatten the leather. Oiling–where, to make the leather grains flexible and have good color.

Fig.2.5 Sammying operation [8]

Splitting: In splitting operation (Fig.2 6) the leather may be split into different layers (If the hide or skin is thick enough e.g. 3mm may be split into two layers–a grain layer of 2mm and a flesh layer of 1mm.). The band knife splitting machine is almost universally used today

Shaving: Shaving operation makes even thickness from the uneven thickness of hides or skins. The quality of finished leather depends to a great extend on the degree of uniformity in shaving. If the thickness of the leather is not uniform throughout the area; the mechanical effects during finishing operation like staking, glazing, ironing pressing etc. will be non–uniform on

the leather surface and the total absorption of season by different portions of the leather surface will be different.

Fig.2.6 Splitting operation [8]

Washing and Neutralization: This is a tanning step (Fig.2.7). The pH is raised 4 0 to 6.5 by removing free acids that are present in the wet blue. This step determines many of the properties of the leather when processing is ended. Vegetable extracts and syntans can be added to give the leather its desired feel when made into the final product. Retanning can make the leather softer or firmer

Fig.2.7 Neutralization operation [7]

Sammying-Setting: In this operation where the rollers of this machine compressed the leather and make it firm and flat. Sometimes sammying and Setting are done together in a single machine.

Drying: The final step of crusting operation is drying (as shown in Fig.2.8) Drying of leather means removal of water from sammying leather by thermal means at e temperature far below the boiling point of water. It may broadly be classified into two categories like (i) evaporating (vacuum) drying and (ii) convective drying (tunnel drying).

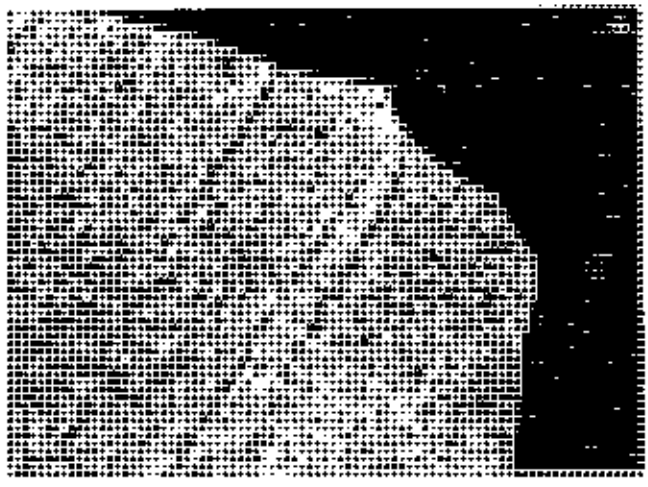

Fig.2.8 Drying operation [8]

Vacuum Drying: The normal atmosphere exerts a pressure of about 14 lb per square inch when water boils at 100°C. If the pressure is reduced the boiling point and can be evaporated more easily and quickly in a vacuum. Here vacuum pressure created is 53 mm of mercury. At this low pressure the water in the leather readily evaporates with the heat, and the water vapour is sucked through the porous felt into the vacuum systems. Here drying may be completed in two or three minutes, when the vacuum is stopped, and the head assembly rose usually by a preset time switch. The evaporative temperature would be 70-80°C. In case of evaporating drying leathers are kept in a leak proof closed room and the air pressure of the room is reduced by means of pumping to maintained a certain negative pressure (vacuum). For creating vacuum in the room boiling temperature of water remains in

leather reduced and evaporated from its surface; Vacuum dryer works on this principle. Besides this, some alternative methods of drying like radiant heat drying, high frequency drying, heat pump drying, fluid bed drying, high velocity air drying, solve drying, etc are used in different cases.

Tunnel Drying: In convection drying, leathers are hanged in a room and the air temperature of the room is always maintained at a certain degree higher than the temperature of the leather by means of ventilating fans or opening louvers Tunnel drying. Where the only control on a drying plant is the dry bulb temperature of the inlet air, it is often found that the drying is faster, or the leather drier, in winter, with cold external air may be 30°C and either 25% RH or 90% RH giving either very good drying or very poor drying.

During drying, the leather tends to shrink in area, particularly after the water content has dropped below about 25%, and these shrinkage forces can be quite strong. Vegetable-tanned leather usually shrinks less than the other types. Normally, higher drying temperatures produce greater shrinkage and crust leather. If temperatures on the wet leather are too high, they can cause "burning" or permanent shrinkage to a hard, cracky state. Vegetable-tanned leather is usually dried below 50° C, chrome leather below 70° C and chamois below 45° C.

2.1.2.2. Finishing Operations

Finishing operation of leather are performed in many ways and varied on different factors like types of leather, requirement of the leather goods, etc. The most common finishing operations are illustrated below.

Vibration-Staking: vibration-staking is the softening operation, which jacks the leather flex and soften in many ways like hand staking, using slocomb staking machine, Svit Molissa system, Vibrating Staking, etc. This system is the pummeling and flexing action of a series of tools, which vibrate vertically against the horizontal skin. The skin is conveyed through the system by

laying it (sandwich-wise) between the upper and lower elastic conveyor bands The speed of throughput can be controlled by the speed of these conveyors. The vibrating tools then act externally on the conveyor bands holding the skin between them. The pressure and working action of the tools can be adjusted to suit different skins and even different parts of skins (e.g. differences between flank and backbone). Once the machine has been adjusted it is capable of a very high output with unskilled labor.

A variation of this vibrates the tools horizontally as well as vertically, giving a more vigorous two dimensional action less prone to leaving small round tool marks on the leather. Care must be taken in adjustment to avoid excessive wear in the expensive transport bands

Toggle Drying: After staking the leather is dried under stretched condition, so that the fiber bundles, which have been separated from each other by staking, may not stick together again. It is done by toggle dryer. The simplest method is to set out the skin well and then nail it out flat on boards. This enables it to be stretched out and the shape adjusted to some extent. It gives flat leather but there is a tendency for shrinkage strains to make the skin thinner and harder and to distort or weaken the looser flank areas. It is commonly used for vegetable-tanned light leathers and skivers. Drying tends to be slow and limited to one side, the board inhibiting drying on the other side. Toggling is similar in principle but the wooden board is replaced by toggling frames, either of heavy gauge wire meshes or perforated metal Toggles hold the skin which "spring clip" on to the skin and peg into the holes in the frames.

A major merit of tension drying systems is that the leather can be stretched out to give maximum area yield, which is the basis on which most leathers are sold. Tension drying can, in some cases, increase the area by 15%. Errors in judging tha amount of tension needed, without losing handle, etc., are of prime financial importance. A significant factor can be the loss of area

caused by the necessity to trim off the toggle or nail marked areas of the leather.

Jaw Staking: This machine flexes and softens the skin of leather. The two jaw arms open as the crank moves,them forward. The skin is laid between them and is held by the clamp against the clamping bar. In some designs of this machine is omitted and the operator holds the skin against a bolster bar with his body. On the outward stroke the arms close and the skin is trapped between the roller on the top jaw and the blades on the bottom jaw. As the arms move back, the skin is stretched and flexed at an acute angle over these blades. The degree of staking given may be increased by depressing treadle, which raises the bottom arm and jaw. This machine can give a very vigorous softening action. It requires skill to get the best results, e.g to avoid pleating, tearing or bagging and is more commonly used for the softer types of mineral tannage, e.g. glace kid and, particularly, gloving leather.

Finishing or Seasoning: This is the operation, which improves the appearance of the leather surface. In many cases a transparent film or coating may be applied which modifies the skin. The mixture of water with a very small amount of egg albumen, lined mucilage or cellulose ethers abate most common seasoning solutions. The other seasoning additives are oil addition, wax, etc.

Buffing: Buffing is the best operation, which consists of grinding the leather surface with an abrasive, and is akin to sandpapering which is shown in Fig.2.9. It is used on the grain to remove surface blemishes and thus provide a more uniform surface, to which pigment and other finishers can be applied. It may be performed using a number of machines like throat type buffing machine, lightening type-buffing machine etc.

The buffing cylinder is of metal about 7-9 inches diameter and may be of various widths from 10-24 inches. It rotates at about 1000 rpm. In case of all buffing machines the surface of the cylinder is covered with buffing paper

(coated with abrasive girt) clamped tightly and uniformly in position. It is important to keep the paper free from accumulations of leather buffing dust. A revolving brush below the cylindar does this. The cylinder is encased and a fan draws a strong blast of air past it, carrying the dust along ducting to a dust collecting system. In most cases the rotating cylinder is also given a small, sideways, oscillating movement to prevent long scratch lines being formed on the nap. Normal Swedes are buffed on the flesh side, while Ooze and Nubuck or velvet Swedes are buffed on the grain side with finer papers. "Snuffing" is a term, which denotes finer buffing on the grain side, while "fluffing" denotes removal of surplus flesh. For coarse, heavy work buffing papers of 80 grit sizes are used. 220 or 320 are common for shoe Swedes, whilst 400 is for the finest work.

Fig.2.9 Buffing operation [6]

Polishing: Polishing is used to polish the surface of the leather before and after spraying of pigments as necessary. Here a roller and polishing brush rotary type.

2.1.2.3. Coating

Coating is done by three methods like; pad coating, spray coating and curtain coating. Pad coating end spray coating are generally used in combination with one another; whereas recently devaloped curtain coating is an independent system, which is suitable in a tannery where daily production is very high.

Spraying: In this technique the season or finish solution is fed to a spray gun by gravity or compressed air where it is ejected from a fine nozzle or orifice by pressure as a spray of fine atomized droplets which are blown onto the leather surface. Spraying are two types like hand-spray and rotary spray

Hand spraying: Hand-spraying is the operation used for small-scale production It is desirable that these droplets should then flow together to give a continuous wet film on the leather before drying. Failure to flow out may result in poor anchorage, poor rub-fastness, and loss of gloss, poor film strength or non-smooth film surfaces, e.g. "orange-peel" effects.

Here the compressor supplies compressed air to the reservoir at pressures between 40-70 lb per square inch. From here it passes through a pressure regulator and filter, which removes any trace of compressor oil or water, and thence to the spray gun. The finish is fed into the gun by gravity or by pressure and is projected from the nozzle as a fine, "atomized" spray on to the leather The leather is normally hung or laid on a frame. An exhaust fan behind the frame removes surplus spray.

Auto spraying: Auto-spraying is the operation used for bulk production. Here the guns are mounted on the arms of a rotor, which rotates above the conveyor band. Once again the spraying of the guns is limited to the period of time when leather is actually beneath them, by mounting sensing elements on the rotor arms so that they will sense the incidence of leather beneath them just before it comes beneath the adjacent spray gun. These sensing elements may be of the photoelectric eye type or the ultrasonic beam type.

Uniform dosage of the leather surface is important and this can depend not only on the amount being sprayed from the gun, which is adjustable by needle and air settings on the gun, but also on the spray pattern of the guns and the speed of the conveyor moving at 11 meters per minute, an overlap pattern is obtained

Glazing: Glazing is a high pressure polishing, done in rolling machine. Kid and calf leather, whose finishing mixture are always prepared with protein binders, are glazed under a glazing machine for a high degree of glace. Glazing produces a high gloss and also smoothes out and flattens the grain surface. The friction momentarily produces a very high temperature on the jack, and the machine is used in conjunction with specially compounded finishes, which are designed to give a high gloss under these conditions.

Rotary ironing: Rotary ironing is a process where the leather is passed over a polished and heated steel cylinder, thermostatically controlled at a pre-set temperature, producing an ironing effect. The Finiflex machine resembles a setting out machine, the leather surface being pressed against a smooth top cylinder heated internally to a pre-set temperature This gives a smooth, glossy surface by the combination of pressure, heat and friction which is caused between the faster moving periphery of the heated cylinder and the slower moving leather surface. It also has some softening action on the leather, in contrast to plating.

Embossing and hydraulic-press plating: In this operation leather is placed in the embossing die setting tangible of the hydraulic press Pressure is applied through the ram on the leather and the fiber structure of the leather surface becomes distorted so that on release, it retains the mirror image of the hard surface. For the better result the leather is little bit heated and some times moist The art of tooling leather by hand with hot tools has been used for many decorative purposes. There are certain obvious precepts, the softer the leather the easier it is to emboss but the less permanent the emboss to subsequent flexing or handling of the leather. It is known that the leather at the normal 14% moisture content becomes more plastic at higher temperatures, embosses better and retains the imprint better than when the leather is cold. At higher moisture contents the effect is even more pronounced. These damp, thermoplastic properties have been exploited not only by the hand tooled but also by the shoemaker in shaping the sole and lasting the upper. If moisture and heat are used in lasting the shoe toe and

heel, a reversal of the phenomena may occur, i.e. the embossed pattern of the leather may be lost. Traditionally, vegetable-tanned leather was chosen for ease of embossing and retention of pattern as opposed to the more elastic nature of full chrome leather, which requires higher pressure and temperature, greater humidity and longer dwell time to achieve equivalent.

Measuring: Measuring is the operation to measure the square feet of leather. It is a light-scanning process measuring by computer.

Dyeing: Dyeing is an important finishing operation. It may be done by different methods like drum dyeing, paddle dyeing, tray dyeing etc. Dyeing performance mostly depends on the theory of color production Dyes may be classified according to their chemical nature (Sulfur-dyes. Notrp-dyes etc.) or according to their application (Acid dyes, Basic dyes, Vat dyes etc.). The quality production of leather mostly followed the resultant of the finishing operation. So, in the competitive market, all the leather manufacturing industry should be taken special attention on this operation for selling or exporting their goods.

2.2 Quality Control Activities of Leather in Chemical and Mechanical Operations

Many types of chemical and mechanical operations are simultaneously performed for quality leather production. All types of involved operations must be accomplished according to particular scientific degree of control exceeding this limit or at all not reaching the degree may cause detrimental effect to the leather. Some of the controlling parameters are discussed in the following headings:

Revolution control: Revolution (rpm) of drums or paddles in different operations is controlled for different operations are performed in different rpm

of the machine. The rate of chemical reactions are vigorously conducted by this type of examples are given in Table-2.1.

Table-2.1 Revolution (rpm) control for different operations [1]

Machine	Operation	R.P.M
Paddle	Soaking and Liming	2 to 3
Drum	Soaking→Liming	2 to 3
	Deliming→Tanning	7 to 8
	Retanning	12 to 16
	Dry milling	14 to 20

P^H value control: Using P^H meter, P^H or hydrogen ion concentration is checked and thereafter controlled for different chemical operations in quality leather production. Some typical controls of P^H ranges by P^H meter are listed in Table-2.2.

Table-2.2 P^H value control for different processing [2]

Processing	P^H Meter Control
Soaking	P^H (7.0-8.0)
Liming	P^H (11.0-12.5)
Deliming	P^H (7.8-8.2)
Bating	P^H (8.3-8.5)
Pickling	P^H (2.5-3.2)
Chrome Tanning	P^H (3.5-4.0)
Neutralization	P^H (4.5-5.5)
Retanning	P^H (4.0-4.5)
Dyeing	P^H (4.5-5.5)
Fatliguoring	P^H (4.5-5.5)
Impregnation	P^H (6.0-7.5)

Temperature control: Temperatures are obviously controlled for different chemical reactions to ensure quality product. Temperatures are measured using different thermometers, among them thermocouple thermometer is more reliable and sensitive, and temperature may easily be controlled using temperature controller either analog or digital type. A list of applying temperature ranges for some operations in the production quality leather is given in Table-2.3.

Table-2.3 Temperature control during different operations [3]

Operation / Machine	Temperature (°C)
Tunnel drying	45-50
Vacuum drying	60-65
Dyeing for tanned upper leather	50-55
Bating	37
Ironing / plating	80

Pressure control: Pressure control is a must for different mechanical operations involved in quality leather. Working pressures of fleshing machine, sammying machine, setting out machine, glazing machine, hydraulic press, roto press, ironing machine are seriously controlled other wise quality of product may not be maintained. Here some examples are given illustrating pressure control in Table-2.4.

Table-2.4 Pressure control during different operations [3]

Operation / Machine	Pressure (bar)
Sammying (for cow)	60.0
Sammying (for goat)	70.0
Plating	50.0

Concentration control: Barkometer is commonly used for controlling vegetable tanning operetions by adjusting the density of tan liquor. Twaddle hydrometer is designed for specific gravity determination of different acid like H_2SO_4, HCl, and HCOOH etc, which are extensively used in quality leather production.

Shaving control. Shaved thickness is of great care for quality leather production. Manufacturers shaved their leather thickness according to its final use. There is a strict and particular specification for shaved thickness of different leathers. Some specifications are given in Table-2.5 according to final use for shaving control.

Table-2.5 Thickness of different leathers for different uses [1]

Leather	Fields of using	Thickness
Heavy	Bottom leathers for men's outsole bends	3-4 mm
	Bottom leathers for women's outsole bends	3-4 mm
	Bottom leathers for Insole shoulder and bellies	3–4 mm
Leathers	Upholstery hides	1.5 – 2 mm
	Split hides for travel goods	3 – 4 mm
	Dressing hides for saddler	4 – 5 mm
Gloving Leathers	Dress gloves (ladies)	0.3-0.5 mm
	Dress gloves (men)	0 7-0.8 mm
	Industrial gloves	0.4 – 2.0 mm

Drying control: Different types of drying methods are used practically. These methods have their typical control of different factors.

Vacuum drying: Vacuum drying process is quick takes only 2-10 minutes, but care must be taken regarding to heat of plates, time of dwell under vacuum pressure of the hood of leather, etc. Some specification of vacuum drying of different leather is given in Table-2 6.

Table-2.6 Temperature and time control during vacuum drying [2]

Type	Temperature (°C)	Time (sec.)
Goat skins full crome leather	65-70	45
Goat skins full vegetable leather	45-50	30
Cow full chrome leather	60-65	35
Cow full vegetable leather	45-50	30

Tunnel drying: During Tunnel drying time, pressure, temperature, humidity should be strictly controlled for quality leather production Some specific controlling in tunnel drying is given in Table-2 7.

Table-2.7 Temperature and time control during tunnel drying [2]

Type	Temperature (°C)	Time (hours)
Full chrome leather (cow)	60-65	2-4
Full chrome leather (goat)	60-68	2-4
Full vegetable leather (goat)	40-45	3-5

Machine capacity control: The machinery and equipment are using in leather processing industries, should be operate within their capacity limit. Every machine should operate at their capacity ranges to get the maximum possible efficiency. Specifications of some sorts of machinery including their horsepower and capacities are given in Table-2.8.

Table-2.8 Capacity control of different machines [1-3]

Machines	H.P	Capacity
Paddle	7.5	750-800 Kg
Liming drum	10.0	1000 kg
Deliming, Bating and Pickling drums	10.0	1000 kg
Fleshing machine for hides	12.0	90 hides/hr.
Fleshing machine for skins	10.0	200 skins/hr
Chrome tanning drum	10.0	1000 kg
Samming machine (Hydraulic & pneumatic)	20.0	60 hides/hr; 100 skins /hr
Splitting machine (mechanical)	20.0	85 hides/hr; 100 skins /hr
Shaving machine (hydraulic)	40.0	80 hides/hr; 100 skins /hr
Putting out machine	15.0	25 hides/hr; 50 skins/hr.
Dyeing drum	7.5	100 hides/hr; 150skins /hr
Putting out machine	15.0	100 hides/hr.; 200 skins/hr
Reversible setting machine	20.0	80 hides/hr; 100 skins /hr
Reversible setting machine	12.5	150 hides/hr.
Vacuum dryer	15	45 hides/hr; 90 skins /hr
Cabinet dryer (25 frames)	5	100 hides/hr.; 200 skins/hr
Slocomb staking machine	5	60 hides/hr; 120 skins/hr
Vibration Staking machine	15	150 hides/hr; 200 skins /hr
Dry milling drum (high speed)	10	300 kg/hr.
Lighting buffing machine	20	60 hides/hr; 90 skins /hr
Buffing machine	5	30 hides/hr; 90 skins/hr
Air blast dusting machine	17	400 hides/hr.
Dust collector	10	———
Polishing machine	12.5	80 hides/hr; 100 skins /hr.
Auto spray unit	10.0	400 hides/hr; 800 skins /hr.
Compressor	10.0	———
Spray booth	1.0	150 hides/hr.
Glazing machine	3.0	60 hides/hr; 120 skins/hr.
Hydraulic press (600 tons)	25	85 hides/hr; 100 skins /hr
Fini flex	60	90 hides/hr.
Measuring machine (Electronics)	1.0	200 hides/hr; 200 skins /hr
Ironing & Embossing		80 hides/hr; 100 skins /hr
Toggle drying		80 hides/hr; 100 skins /hr
Tunnel drying		200 hides/hr; 250 skins /hr

Some other controlling activities involve in mechanical operations are staking control, toggling control, control in air-conditioning, buffing control, safety control, time control, ergonomics and its control, etc. So, all the leather manufacturers have to bear in mind that all these specifications for controlling the machines for performing mechanical operations efficiently to ensure quality leather production and to enhance proper supply of quality leather products in the competitive market.

2.3 Processing Needs of Medium and Small-scale Tanneries

In Bangladesh there are now 206 small, medium and large tanneries out of which 186 are located at Hazaribagh. About 94% of the total supply of hides and skins of the country is processed here. Out of 206 tanneries, 112-116 (small scale tanneries) units have facilities for processing wet blue leather only, which are located at Dhaka. From the survey questionnaire (based on capacity and employment condition) of 116 small-scale tanneries at Dhaka, the production capacity of wet blue leather of 51 small-scale tanneries is about 60 million square feet per annum but the actual production rate is about 40 million square feet per annum.

On the other hand, about 50 small-scale tanneries which are closed due to the lack of the capital-investment, technological knowledge, high-cost of machinery facilities for producing crust & finished leather after the ban of wet-blue leather production at the year of 1990. About 10 tanneries are converted into the chemical business supplying leather chemicals to the tanneries. Table-2.9 and Table-2.10 show the present situation of small-scale tanneries and the capacity of wet-blue production of 51 mall-scale tanneries in Dhaka city. Table-2.11 shows the employment data of the 51 tanneries of the wet-blue production and the production capacity data of 51 small-scale tanneries is shown in Table-2.12.

Table-2.9 Present situation of small-scale tanneries

No of small tanneries	No. of small tanneries on running	No. of small tanneries closed	No. of small tanneries converted to business	No. of small tanneries not to investigated
116	51	50	10	5
100%	44%	43%	9%	4%

Table-2.10 Overall capacity of wet-blue production of small-scale tanneries

Total surveyed tanneries on running	Capacity of the small-scale tanneries (million square feet)	Actual capacity of the small-scale tanneries (million square feet)
51	60	40
	100%	66.67%

Table-2.11 Employee serving in 51 small-scale tanneries

Total number of employees	Manager	Accountant	Technologist	Technician	Skilled worker
936	50	49	46	63	728
100%	5.34%	5.23%	4.91%	6.73%	77.8%

Table-2.12 Categorized capacity of small tanneries

Category of small tanneries	Production range (50-150 pieces/day)	Production range (151-250 pieces/day)	Production range (251-500 pieces/day)
Small tannery	30	10	11
% Involve	58.8%	19.6%	21.6%
Production (ft^2/day)	82000	44000	74000

The medium scale tanneries can process leather from raw hides & skins to crust-leather. There are two types of medium scale tanneries for the processing needs like mechanized crust leather tannery and semi-mechanized crust leather tannery. Fig.2.10 and Fig.2.11 show the processing needs from crust to finished leather for mechanized and semi-mechanized crust leather in tannery. The small-scale tanneries have facilities

for processing wet blue leather only. It is also known as non-mechanized tanneries.

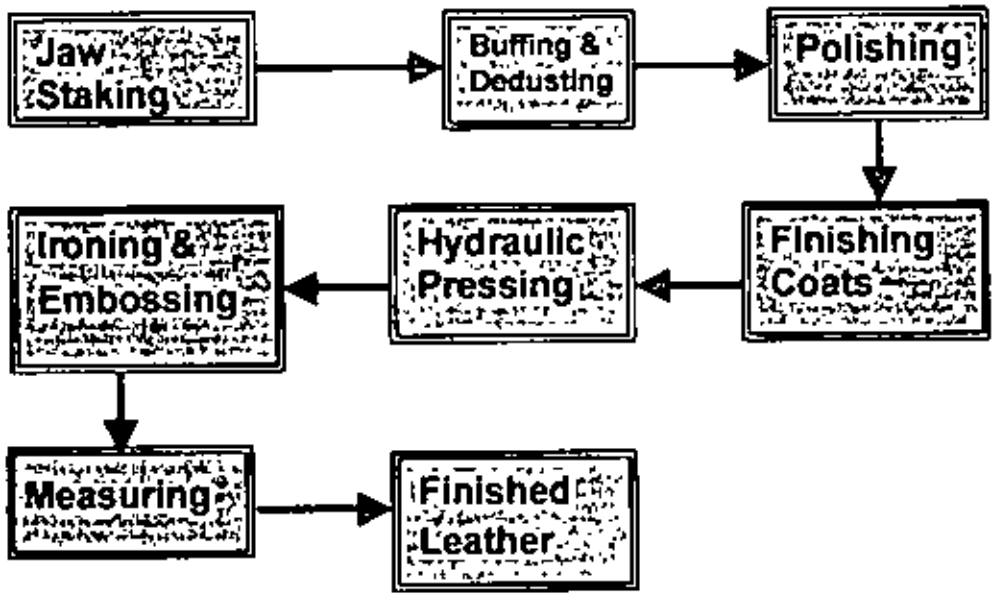

Fig.2.10 Processing needs from jaw-staking to finished leather in mechanized crust leather tannery [2]

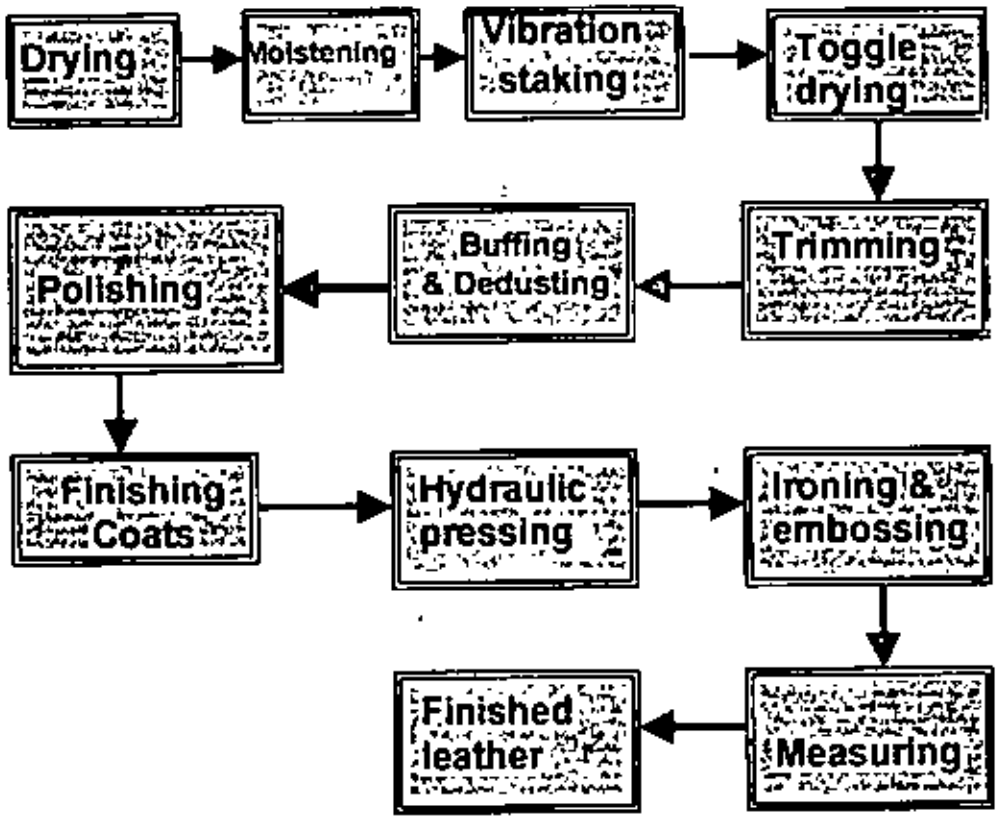

Fig.2.11 Processing needs from tunnel drying to finished leather in semi-mechanized crust leather tannery [3]

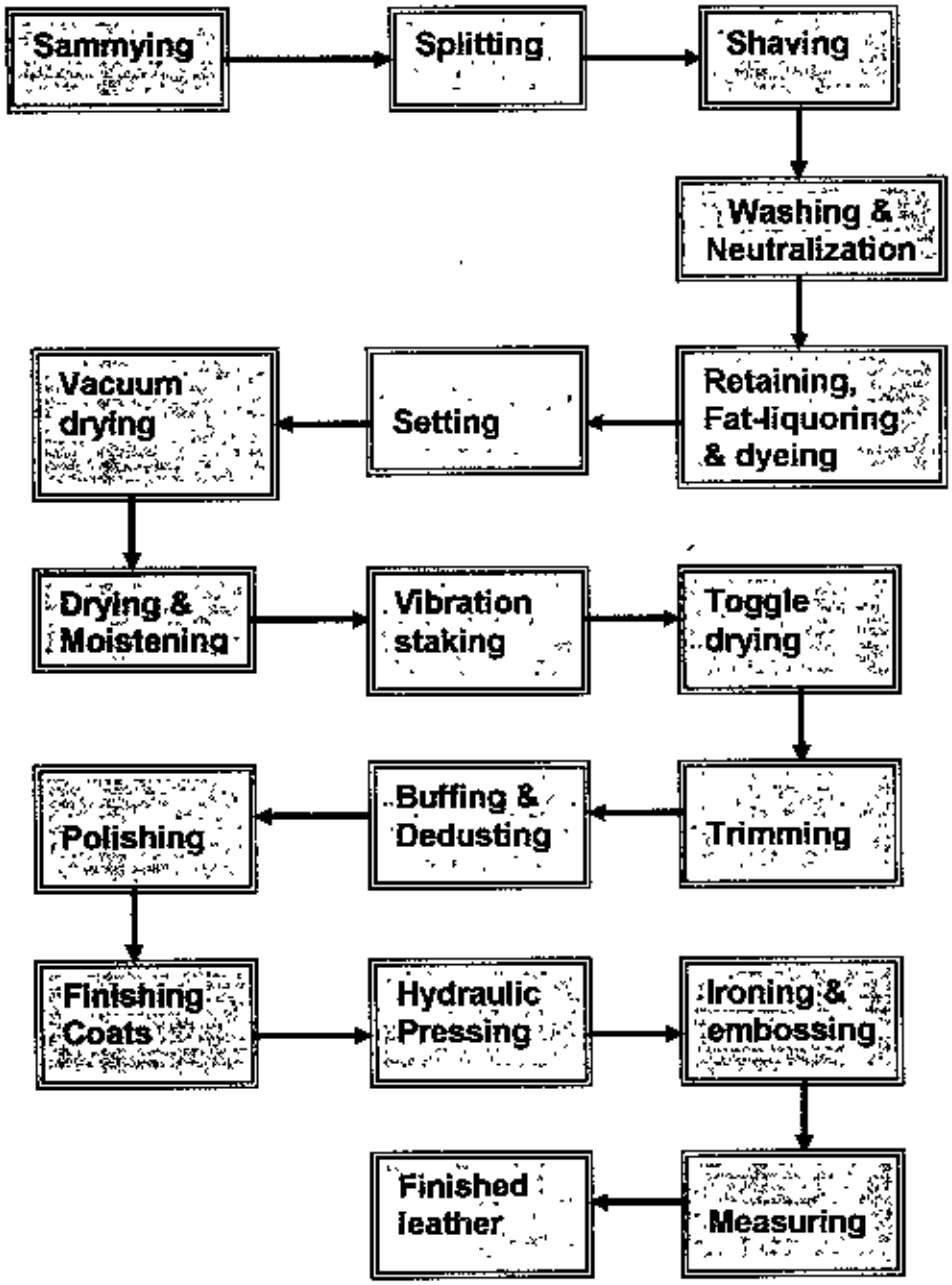

Fig.2.12 Processing needs from wet blue to finished leather in non-mechanized crust leather tannery [3]

The above-mentioned processing needs of the different tanneries can be completed in CFFC established in 1987 with the IDA assistance in Leather College, Dhaka to facilitate production of finished leather by small-scale leather producers for local supply.

Chapter-3

DEMANDS OF HIDES & SKINS AND NEEDS OF COMMON FINISHING FACILITIES CENTER

Hides and skins are derived as by-products of the meat industry. In Bangladesh cow, buffalo, sheep and goat are slaughtered for meat all over the country. Annual data on population and availability of hides and skins in Bangladesh is given in Table-3.1.

Table-3.1 Annual data on population and availability of hides and skins in Bangladesh [9,10]

Species	Population (million)	Availability of hides & skins (million pieces)	Availability of hides & skins (million square feet)
Cow/buffalo	24.31	5.31	116.00
Goat/sheep	32.70	19.70	64.00

The collection, trading and marketing of hides and skins operates through a long established network of butchers, small and large agents, and traders. Weekly markets that serve for collection, and major merkets that directly serve the tanning industry exist throughout the country.

Large traders in the major markets have their agents in small feeder towns and villages. These agents receive hides and skins either through dealers or directly from butchers. Often villagers transport hides and skins to reach the

tannery from the time of their removal from animals. Sometimes it may take longer.

3.1 Demand of Hides and Skins

Hides and skin, constituta one of the major source of foreign exchange earnings of Bangladesh. The economic potential of these resources in terms of value addition, export earning and employment still remains unutilized for lack of appropriate processing and product diversification. In view of the shifting of leather and leather products manufacturing base from developed to developing countries for cost competitiveness, Bangladesh having local supply of hides and skins and a large pool of cheaper working force can increase the export earning and employment by several folds through conversion of hides and skins into various consumers products for export, the following measures have been suggested for a sustained development of the leather sector industries.

With limited domestic resources and narrow export base, the economy of Bangladesh is dependent greatly on foreign loans and grants. Agriculture shares about 36% of Gross Domestic Product (GDP), while menufecturing sector eccounts for about 18% end the tertiary sector shares about 46%. The major export items of Bangladesh are readymade garments; jute & jute products, frozen food, leather & leather products, vegetable and tea that account for ebout 90% of the total export earnings of the country [11].

Hides and skins, the basic raw materials of leather end leather products industries occupy important position in the industrial sector in terms of manufacture, value addition, export and employment. The economic potentials of these resources heve been remaining under utilized for went of pragmatic development policy and product diversification. Bangladesh heving a sizeable surplus exports about 180 million square feet hides and skins in the form of leather and leather products, the major being crust leather, en intermediate product which is used as raw material by finishers in

importing countries. Having local supply of quality hides and skins and large pool of educated cheap work force. Bangladesh can easily enhance export earning and employment of leather sector by several folds by converting the available hides and skins into leather products.

In 1977, the Government of Bangladesh adopted a development strategy to advance the leather industries for production and export of value added crust and finished leather and leather products to increase the foreign exchange earning of this potential sector. Despite concerted efforts made by the successive government over two and a half decades under coverage of tax incentive policy measures including imposition of ban on semi processed wet blue leather export from 1990, the industry could not achieve the desired development and about 60% of the sector export still consists of crust leather, an intermediate product. The government finally decided to impose ban on crust leather export from July 2003.

Given these perspectives, the present study has been undertaken to examine the present manufacturing status of leather sector industries including supply, collection and preservation of hides and skins, processing capacity, manufacturing know-how, infrastructure facilities, institutional and government policy supports, management and marketing etc., identify problems of industries, and to asses needs for a susteinable development of this sector for optimum utilization of economic potentials of available hides and skins.

Bangladesh has about 59.81 million heads of live stock population consisting of 23.25 million cow heads, 0.85 million buffalo heads, 34.59 million goat heads and 1.12 million sheep heads. The growth rate of cattle has declined during 1995-2000. However, there was a steady increase in the growth of goat and sheep population. In addition, the country imports more than 1.00 million live cattle's from neighboring countries per year to meet the local demand of meat proteins.

The annual supply of hides and skins in the country is about 187 million square feet consisting of 64.83% cowhides, 2.25% buffalo hides, 31.82% goatskins and 1.10% sheepskins. Hides and skins of Bangladesh are thinner in substance and smaller in size but they have good reputation in internationel market owing to fine fiber structure and good grains.

Hides and skins of Bangladesh suffer from various pre-mortem and post-mortem defects due to lack of proper management and health care of live animals and correct flaying and preservetion of raw stocks causing a loss of about US$ 150.00 million per year. There is no mechanized slaughterhouse in Bangladesh. Only 12%-15% of the slaughter takes piece in semi-mechanized slaughter houses at district headquarters and the rest of the slaughtering including entire Qurbani sacrifices, being 35%-40% of the annual slaughters in Bangladesh is done by unskilled personnel outside slaughterhouse at hats, bazaars, villages and by road sides resulting into irregular shape and knife cuts. The slaughterhouse by-products, except hides/skins are thrown away in open space causing severe damage to the environment. Hides and skins are collected in Bangladesh from remote slaughtering points and take longer time to reach to tanneries for process. Crude sea salt is used for preservation of raw stocks.

There are about 170 commercial exporters in leather processing sub-sector of Bangladesh. They do not have permanent leather processing esteblishmant. They procure export orders time to time with the help of buying agents, some times sharing with them and process leather in different tenneries particularly in ones. Having no establishment cost and some times by use of sub-standard chemicals, they offer 15-20 percent less price per square-feet. Compelling the established tanneries to export at a reduced price, often at a loss causing a loss of sizeable amount of export earning of the country. They also damage the trade and image of the country by short supply and delivery of substandard goods. In case of any claim for faulty delivery, they disappear from the market and frustrate the claim of the

importers. On the other hand, commercial exports discourage technology and product development in the country.

Buying agents work mainly for the interest of buyers but realize commission from exporters at the rate of 4%-6% of the CIF value of exported goods. They compete among themselves to attract foreign buyers offering low price and often obtain transferable L/C, bargain with exporters and settle price with a margin for themselves. Buying agents are supposed to check quantity and quality of export consignments on behalf of buyers before delivery of goods. But they assume no responsibility of claims for bad deliveries.

Adopt a long-term leather policy for sustained development of leather sector industries for full use of the export potentials of this sector. The present state of affairs of the industries like production capacity, supply of consumables, manufacturing knowledge, management, marketing expertise, export marketing, finance, infrastructure facilities, duty structures, policy implementation regimes, etc. are to be taken into accounts while formulating the policy.

A central fund of US$ 500 million is to be created to finance development of leather sector industries. A soft loan may be arranged from international donors like World Bank, IMF, IDA and Asian Development Bank for this purpose. [12,13]

3.2 Export Performance and Formulation of National Leather Policy

Qualitative change in export earnings of leather industries is found in the last one decade. Exports of crust leather as well as finished leather and leather products including leather footwear significantly increased. Since the ban of wet-blue leather in 1990, the Pail at which tenneries are being modernized, according to that space, export earnings are not increased. During the last 5 years exports of finished leather remained static in a piece. Lack of

infrastructure facilities, obstruction in flourishing technical know-how, overall discouraging in profiteering the export of finished leather and crust leather are the causes of the inability of the Government. Table-3.2 shows the export performance of the leather sector in last one decade 1990-2002. Fig.3.1 shows the export demand established in different years.

Table-3.2 Export performance of the leather sector in last one decade 1990-2002 [14]

Year	Tk in Crore	US$ (million)
1990-91	483.54	137.13
1991-92	566.66	148.85
1992-93	616.27	158.63
1993-94	765.18	192.02
1994-95	903.77	225.33
1995-96	986.31	241.15
1996-97	945.52	222.06
1997-98	1081.46	233.75
1998-99	1072.25	223.49
1999-2000	1252.11	249.93
2000-2001	1668.50	290.68
2001-2002	1449.62	252.50

There is no alternative of value addition in export to increase the export earning in leather industries. The Government should have a role in this value addition process. The key way of the Government role in developing or flourishing any industry is the government policy regarding that industry. Several times steps have been taken to formulate a National Leather Policy to manifest leather industries, but never come to existance.

As there is no Government Policy for leather industry, the works to develop the leather industry and control of the pollution have been impeded again and again. Even after Government there is no policy in leather industry, the unwritten policies, which are followed, were not favorable to the industry.

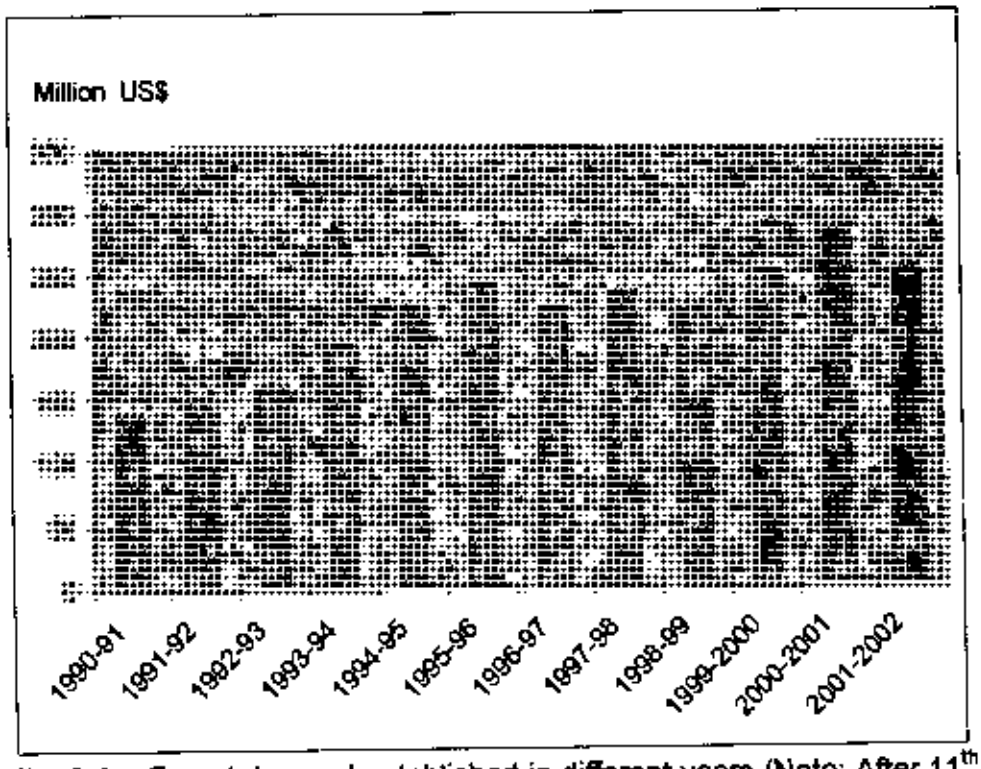

Fig. 3.1 Export demand established in different years (Note: After 11th September'2001 incident in USA, the world leather market become very slow and the total export have reduced to13% than that of previous year) [15,16]

3.3 Needs of Common Finishing Facility Center (CFFC)

The processing needs of the medium & small scale tanneries can be completed in CFFC established in 1987 with the IDA assistance in Leather College, Dhaka facilitete production of crust & finished leather by small scale leather producers for local supply. The medium scale tanneries also get fecility to process leather from crust to finished stage if necessary, because the crust leather itself has demand in export market. According to the country paper Bangladesh in SAARC Workshop by Fakrul Alam [17,18], in 2001-2002, export of crust / finished leather was 184 million square feet, export of leather footwear and goods (including domestic consumption 15% on export quantity) was 220 million square feet. Table-3.3 shows the hides and skins from different species in 2001-2002. Major slaughtering of animals happens during Qurbani Eid season i.e. 50% within 3 days, rest 50% in whole year.

Here leather used domestically for leather products is almost 15% of the total annual leather processing.

Table-3.3 Hides and skins from different species in 2001-2002 [9,10].

Species	Availability of hides & skins (million square feet)	%
Cow	132.00	60
Goat	66.00	30
Buffalo	9.90	4.5
Sheep	12.10	5.5

Now we can analyses the capacity of the small-scale tanneries to face the local demand of 33 million square feet of finished leather. Table-3.4 shows the production statistics of different tanneries in Bangladesh.

Table-3.4 Production statistics of different tanneries in Bangladesh [12,13]

Number of tannery	Installed production capacity (million square feet)	Actual production (Million square feet)	Deficiency
Large = 13	65	40	Nil
Medium=61	110	95	Nil
Small=132	75	45	Nil
Total 206	250	180	Nil

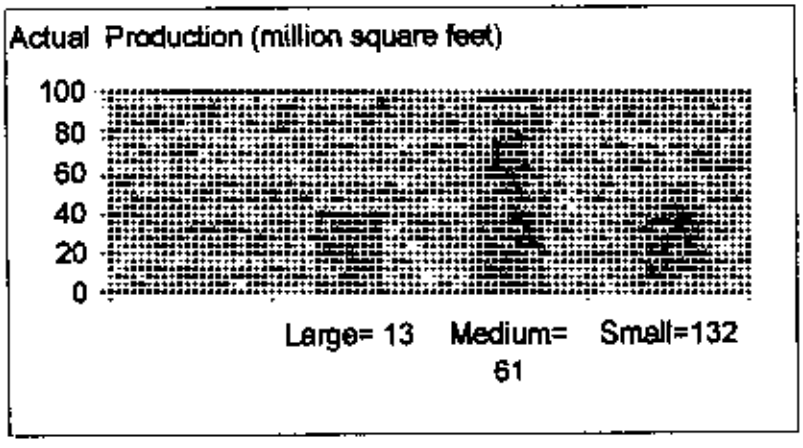

Fig. 3.2 Actual production of different types of tannery [14]

On the above statistical analyses in table.3.4 and fig.3.2 show the local demand for finished leather is 33 million square feet and the capacity of the small-scale tanneries to process wet-blue leather actually is 45 million square feet. So to meet these 33 million squere feet finished leather demand the CFFC, Hazaribagh, Dhaka facilitates the 116 small-scale tanneries to process their leather from wet blue to crust and finished leather on Job basis.

Until 1980, hides and skins were used to export mainly in the form of wet-blue. With the introduction of Government incentive policy measures in 1977 and finally imposition of ban on wet blue export in 1990, there has been a significant development in crust leather, finished leather and leather products capacity in the country. But these small tanneries are not capable of producing high quality finished-leather by using modern technology due to lack of the capital. For this reason small-entrepreneurs take one or two technical assistance from the big tanneries. Small-scale leather producers for local supply established thinking about this matter the CFFC in 1987 with the IDA assistance in Leather College to facilitate production of finished leather. The average capacity for the CFFC is about 500 cowhides per day (10000 square feet per day). So for modernization of tannery zone and to face the nation economy for leather the CFFC at Hazaribagh, Dhaka for the existence of small-scale tanneries is essential. On the other hand to face the demand of small-scale tanneries the maximization of production/income also has to be done.

Chapter-4

STUDY OF CFFC AND OPTIMIZE THE PRODUCT MIX CONSIDERING DIFFERENT CONSTRAINTS

There are about 206 tanneries in Bangladesh, but most of them are using traditional technology in their production. Very few of them are applying modern technology partially in their manufacturing. Though, Bangladesh is abundant with hides and skins. Among them, goatskins of western part of the Bangladesh are world famous. Tannery operations for both hides and skins used in Bangladesh and related machinery and various controlling activities involve both in chemical and mechanical operations are shortly illustrated in Chapter-2. After tanning operation, both physical and chemical properties of leather are determined by performing different tests and thus, proper specifications are made. If modern technology is applied to the existing tanneries and proper attention is taken in both the manufacturing of leather and its products and making positive exporting policy to other countries, huge amount of foreign currency may possible be earned from this sector.

Wet-blue through crust to finished leather is a rapid value addition process in tannery industry. Currently, Bangladesh produces nearly about 180 million square feet of hides and skins, where 130 million square feet of cow and buffalo per annum and 50 million square feet of goat and sheep per annum. Out of them, only 15% are consumed by the local market and the rest are exported in the form of crust and finished leather. Value-addition of this

higher manufacturing stage is about 200-300% and requires high skill of manpower including upgraded technology. So it is very important for tannery industries to maintain optimum production of crust and finished leather from the wet-blue of cowhides and goatskins. Consequence of non-optimal proportion of these products will result in improper production planning, leading to a loss through output. This research work addresses the problems and shows how to overcome the problems by adopting linear programming (LP) approach. A comparison in terms of production volume between the current production planning approach and linear programming method has been made.

4.1 Common Finishing Facilities Center (CFFC)

The Common Finishing Facilities Center (CFFC) was established in 1987 for the small and medium types leather industries of the country particularly located at Hazaribagh, Dhaka. The purposes of CFFC are to provide leather finishing facilities to the cottage and small scale tanning units at Hazaribagh, technical and in plant consultancy services to the tanning industry of the country including laboratory testing/quality control facilities in order to enable them to produce export quality finished leather.

Hides and skins constitute a potential resource of the country and ranks second to Jute in respect of foreign exchange earnings. The annual availability of hides and skins in the country is about 3.35 million pieces of cowhide, 9.0 million pieces of goatskin, 0.16 million pieces of sheepskin and 0.07 million pieces of buffalo hide. About 20% of these hides and skins are processed within the country into low-grade finished leather mainly for domestic consumption and the rests exported in wet blue condition [19,20]. Wet blue is only the first stage of leather processing and considered to be the better preservation for transport. Sizeable export potential exists in processing wet blue to crust and finished leather. Net foreign exchange earning are minimum 60% higher for crust and 120% higher for finished-leather manufacturers.

There were about 170 small and medium types of tanning units in the private sector of which about 145 were located at Hazaribagh, the traditional tanning centar of Dhaka. Only a few units can be said large and modern in processing or in equipment's. The leather industry of the country is still geared up mainly with wet-blue processing. The small and medium types of tanning unit having no equipment's to process finished leather for local use in crude and unscientific methods and for obvious reasons their sub-standard products cannot fetch proper prices. The leather manufacturing industries except a few footwear units are at the family manufacturing stage and disorganized.

The major constraints in the development of leather industry of the country are lack of infrastructures, equipment's and technical know-how required for processing and development. While some of the tanning units have mechanized in certain phases, most of the units work with drums, paddle not having technicians/technologists who understand chemical processes involved in leather making. Methods are passed on traditionally without modification or adoption of improved techniques. The Government desires to develop the leather industry for optimum utilization of the potentials of raw hides and skins and thus to increase export earnings of the country. The objectives can be best achieved by assisting in improving and modernization of the private tanneries. Since the leather processing involve costly imported machineries and equipments and the scale of the most tanneries is insufficient to justify vertical integration with finishing facilities, establishment of a common finishing facility and services center is proposed to help in producing quality leather and staady development of the leather industry.

International Development Association (IDA) agreed to help establish common finishing facilities and technical services center under the existing Bangladesh College of Leather Technology (BCLT), Dhaka. Third Small Scale Industries (SSI-III) would help establish a program to provide common finishing facilities and technical services for small and medium scale tanneries under BCLT. The facilities and services would be owned and

operated by BCLT under a management committee, which would include representatives of small private tanneries. Active private participation in management would help ensure proper selection and use of the machinery/ equipment. The BCLT has strong contacts with private tanneries and technical know how useful in developing the industry. The finishing facilities could be established on the premises of the College. The finishing facility, which would be used exclusively for private tanners, would have a full time plant manager and skilled operators. The finishing facility would not be used for training purposes; graduates of the institute's training program would use the equipment only when the Principal has determined that they are skilled operators. Main function of the common facilities center would be to provide at commercial rates:

- Common hides and skins finishing facility services to private tanneries.
- Technical services particularly for private sector tanneries including laboratory testing and quality control and
- Effective in-plant consultancy services with the assistance of consultancy services with the assistance of consultanta.

A two-phase system would be adopted; consultancy for the technical services would be made available immediately. Half of the total equipment costs would be made available during 1st year of oparations; this would be sufficient to finish about 500 hides and skins per day. After 18 months, there would be a joint review by the Ministry of Education, BCLT and IDA to determine the capecity utilization of equipment's; the extent to which smaller tanneries heve been helped and the optimum investment of remaining funds in expanded and/or up-graded facilities for finishing or leather-goods, edditional technical assistance and reallocation to other components. Estimated costs would include, common finishing facilities with capecity of 500 pieces hides par day (US$ 1.63 million); 48 man-months in advisors for training in tanning and for assistance in managing the common finishing facilities

The CFFC would be owned and operated by the Bangladesh College of Leather Technology (BCLT), under a seven member management committee comprising of the Principal of the college, three representative from the privete tanneries including chairman Bangladesh Tanneries Association (BTA) and one representative each from the Ministry of Education, Directorate of Technical Education (DTE) and BCSIR, the chairman would be nominated/selected by the Ministry of Education. The CFFC would be exclusively used for the tanning industry. The trainees of the college will be allowed to use the machineries or equipment's only when the principal is satisfied that they are skilled operators.

The main object of CFFC is to provide services to the small and medium type private sector leather industries to enable them to convert wet-blue into value added finished leather for export and thus to earn more foreign exchange for the country and not intended to be a profit making organization like tanneries. However, the cost of the project will be recovered through the sale of the services to the tanneries at a commercial rate to be fixed by the management committee of CFFC. The center will process minimum 500 pieces of finishad leather of various types per day from wet blue. The export price of finished leather is usually 200-300% higher than that of wet blue. The finished leather from CFFC is used as raw materials for the footwear workshop and leather-products workshop of BCLT and the local market consumes the rests.

The CFFC will have the facilities to process minimum 500 pieces of wet-blue cowhides into different types of finished leethers per day. The price of finished leether is usually 200-300% higher than that of wet-blue. This CFFC is self-financing tannery i.e. tannery which earn revenue through sale of output (goods and / or service). These may also be called directly productive tannery. Table-4.1 shows annual value of output directly attributable to the tannery. Here the annual income of the CFFC is estimated to be Tk.77.70 lakhs with the operating/recurring cost of Tk.55.19 lakhs. So, the net profit per year is Tk.22.51 lakhs. By adopting LP approach, the nat profit per year

can be maximized with variation of product mix and compare it with the result obtained by traditional method.

Table-4.1 Annual value of output by traditional method [19, 20]

Items of output	Minimum capacity (Pieces/day)	Rate (Taka)	1987-88 (Taka)	1988-89 (Taka)	1989-90 (Taka)
Sammying	500	2.50	1250	1250	1250
Splitting	500	12.50	6250	6250	6250
Shaving	500	3.50	1750	1750	1750
Retaining, fat liquoring and dyeing	500	2.00	1000	1000	1000
Setting out	500	3.00	1500	1500	1500
Tunnel drying	500	3.00	1000	1500	1500
Vacuum drying	500	4.00	2000	2000	2000
Vibratory staking	1200	2.00	2400	2400	2400
Toggle drying	500	1.50	750	750	750
Jaw staking	400	1.00	200	400	500
Buffing	500	3.00	1500	1500	1500
Polishing	500	1.00	100	500	500
Hand spraying	150	1.00	150	150	150
Auto-spraying	500	1.50	-	375	750
Hydraulic pressing	500	6.00	1500	3000	3000
Dry drumming	500	1.00	250	500	500
Measuring	1200	0.50	600	600	600
Daily output			22,200	25,425	25,900
Annual output			**66,60,000**	**76,27,500**	**77,70,000**

4.2 Product Mix Analyses

Production and business systems are key building blocks in the structure of modern industrial societies. Different human activities and the prosperity of whole nations are highly dependent on the performance of production and business systems. Companies and industrial firms, through which production and business operations are usually performed, represent the major sector of today's global economy. Therefore, in the last decade, companies have made the continuous improvement of production and business systems a milestone in their strategic planning for the new millennium. To remain competitive, companies have to maintain a high-level of performance by maintaining high quality, low cost, low manufacturing lead times, and high

customer satisfaction. It is usually asserted that production and business operations have the potential to strengthen or weaken a company's competitive ability. Therefore, and as a result of fierce competition and decreasing business safety margins, efficient and robust production and business operations become a necessity for survival in the marketplace.

Because of this, improving the performance of production and business systems has been the primary interest of decision-makers and engineers. Indeed, Industrial Engineering (IE), as a profession and a science, plays a central role in the efforts towards improvement in these systems. Many industrial engineering subjects such as Operations Research, Quality Control, and Systems Modeling offer robust and efficient design and problem-solving tools with the ultimate aim of performance enhancement. Examples of this performance can be the throughput of a factory, the quality and reliability of a product, or the profit of an organization [21-23].

Designing flexibility into production and business systems is, therefore, a key matter for success and survival in today's market. Businesses have inevitable obligation to deal with supply and demand fluctuations, changes in work scope, and trend dynamics of the market. Therefore, lean production and business systems demand continuel improvement of delivery times, operating costs, capacities, material utilization, and information flow.

Dynamic changes in demand, supply, and manufacturing strategies force companies to make continuous changes to the product-mix. Making such changes gracefully and effectively can be only accomplished when systems design is based on flexible production and business operations. The issue becomes even more challenging when the frequency of product-mix change increases. Therefore, under such conditions, determining the optimum product-mix and analyzing its implications as an integral part of the design process become essential for achieving robust and flexible production and business systems [24,25].

4.2.1 Product Mix Decision

An organization's product-mix is the percentage of total output devoted to each product [13]. In production, for example, in finished leather manufacturing might have a product-mix of 70% cowhides and 30% of goatskins. Product mix analysis focuses on determining the optimum product-mix and highlights the implications of varying the percentage of each product on different production and business activities. Since different products have different production rates, the capacity requirements for each mix of products may, in some cases, drastically change. For example, increasing the proportion of a certain product in a production schedule may require duplicating a certain machine tool to cope with the rate of production, which may eventually lead to adding a parallel processing line and a new line of products to make use of the added capacity. Therefore, product-mix analysis aims at answering the question. How does product-mix changes affect system capacity? System capacity can be defined in terms of buffer sizes and manufacturing resources types, set-up, utilization, and availability.

Product-mix decisions are usually influenced by the product selection decision. When a firm has e current market for two or more products, e decision is usually taken to introduca more than one product to the market in an effort to increase market share and profitability. Deciding to produce more than one product type or to provide more than one-service leads to the issue of product-mix selection. Product selection decision is usually based on the organization goals, environment, and the organization's production, marketing, and financing strategies. Onca product types are selected, decisions must again be made within each product line with respect to which mix of products to produce and which production processes to use in view of cost, capacity, and the theory of constraints. Product-mix decisions are typically dependent on merket research and marketing strategies. Therefore, the product-mix in a production plan is nof usually fixed. The mix may change dynamically at different time periods.

4.2.2 Product Mix Decision via. Linear programming (LP)

LP is a quantitative method of product-mix analysis with extensive in the applications in the production and business Arenas. Many firms have found that Linear Programming (LP) methods are useful techniques for assisting in the product-mix decisions. LP is an analytical approach that is utilized to determine the optimum product-mix so that a certain criterion is met. Using LP an objective function is maximized or minimized subject to a certain set of constraints. In most cases, the least costly mix of products is obtained from the solution of the LP problem Other LP applications beside product-mix determination include capital budgeting, financial planning, work scheduling, and line balancing. Therefore, product-mix determination can be considered as one application of LP for short-term scheduling. LP problems can be solved using graphical method or using simplex method. Most large-scale problems nowadays are solved using software tools by the computer. However, it is always essential to gain at least a basic understanding of the solution methodology along with the knowledge of how to formulate and set up the problem, interpret the results, and draw the right inferences. Johnson and Montgomery [28] presented a Mathematical formulation for the product-mix problem as a constrained LP model. They also illustrated two approaches for dealing with uncertainty in demand. Applying the LP model requires the following information:

- Revenue obtained from selling one unit of each product type.
- Unit variable cost of producing a unit of each product type.
- Required minimum production level of each product type in the Planning period.
- Maximum potential sales of each product type in the planning period.
- Number of units of each resource that are required to produce one unit of each product type.
- Amount of each resource available during the planning period.

Here in this problem between the two categories of product (cowhides and goatskins) which product in the same series of machines should be produced in which quantity to ensure maximum income as well as maximum profit, a linear programming analysis is done. With several constraints (demand, supply ratio, capacity and non-negative), the objective is to maximize total income.

4.3 Linear Programming

In operation research mathematical models, the decision variables may be integer or continuous, and the objective and constraint functions may be linear or nonlinear. The optimization problems posed by these models give rise to a variety of solution methods; each designed to account for the special mathematical properties of the model. The most prominent and successful of these techniques is linear programming, where all the objective and constraint functions are linear, and all the variables are continuous. Other techniques that deal with other types of mathematical models are dynamic programming, integer programming, nonlinear programming, goal programming, and network programming, to mention only a few [26-28].

Practically all operations research techniques result in computational algorithms that are iterative in nature. This means that the problem is solved by iterations, where each new iteration bringing the solution closer to the optimum. The iterative nature of the algorithms typically gives rise to voluminous and tedious computations. It is thus imperative that the computer executes these algorithms.

Linear programming (LP) is a mathematical modeling technique designed to optimize the usage of limited resources. Successful applications of LP exist in the areas of military, industry, agriculture, transportation, economics, health systems, and even behavioral and social sciences. The usefulness of the technique is enhanced by the availability of highly efficient computer codes. Indeed, LP, because of its high computational efficiency, is the basis

for the development of solution algorithms of other (more complex) types of Operation Research models, including integer, nonlinear, and stochastic programming. Although different and more general types of constrained decision-making models exist, it is nevertheless true that in many applications linear programming is most useful. It has been successfully applied to literally thousands of different types of managerial decision-making problems.

Linear programming (LP) deals with the problem of allocating limited resources among competing activities in the best possible (i.e. optimal) way. This problem of allocation can arise whenever one must select the level of certain activities that complete for scares resources necessary to perform those activities. The variety of situations to which this description applies is diverse indeed renging from the allocation of production facilities to products to the allocation of national resources to domestic needs, from portfolio selection of shipping patterns, from agricultural planning to the design of radiation therapy and so on. However, one of the common ingredients in each of these situations is the necessary for allocating resources to activities.

The Linear programming, as in any operation research model, includes three basic elements like decision variables that we seek to determine, objective (goal) that we aim to optimize and constraints that we need to satisfy.

The computations in linear programming, as in most operation research models, are typically voluminous and tedious, and, hence, require the use of computer. The user-friendly EXCEL-SOLVER add-in program package is designed to solve this computational burden. The proper decision of the decision variables is an essential first step toward the development of the model. Once the variables are defined, the task of constructing the objective function and the constraints should not be too difficult.

4.3.1 Overview of Solver

Solver is an add-in package to Excel that numerically optimizes constrained models, such as an LP model. In doing this, Solver uses a technique called a mathematical programming algorithm to efficiently find the optimal decisions for a given spreadsheet model. An algorithm is simply a computer code that follows an iterative recipe for finding the optimal decisions. For LPs Solver uses a very efficient optimization algorithm that works only on LP models called the simplex method. Not surprisingly, to benefit from this powerful capability there is some prices to pay. We must set up the spread-sheet model in the appropriate form so that solver can optimize it; we must adhere to certain technical restrictions imposed on your spreadsheet model by solver, and most importantly, we must understand the limitations of optimization models to properly interpret Solver's results.

Solver can optimize both linear and nonlinear models. For now, we will focus only upon linear models because they are far less prone to technical difficulties. For LP optimization every formula in our model that includes the decision variables directly (or indirectly via a chain of cell reference) and that directly or indirectly affects the objective function cell must be linear. The restriction (linearity) is imposed by Solver's Simplex linear programming method that works correctly only for spreadsheet formulas involving linear relationships.

The solver add-in package consists essentially of two programs. The first is an Excel Visual Basic program that translates your spreadsheet model to an internal representation used by the second program. The second program, residing in memory outside of Excel as a separate software module, carries out the actual optimization and returns the solution to the first program for updating of the spreadsheet. The two communicate by means of Microsoft's application programming interface, the details of which need not concern us. Upon choosing the "Solver" item from Excel's Tool menu, you evoke the first Solver program that prepares your spreadsheet for optimization and calls the

second optimizer program. The following steps should be considered during using the solver.

- Start Excel and perform spreadsheet-modeling operations normally. You can develop your Excel model perform "What if"? And debugging analyses and print results in the usual way.

- Once the model is developed and debugged (and saved to disk!), you optimize it by choosing the Solver item from Excel's Tools menu.

- The Solver add-in and its optimization module will be loaded into memory. When the loading is finished, Solver brings up a dialog box to collect information for the optimization process.

- After specifying certain housekeeping details, such as which cell contains the objective function formula to be optimized and which cells contain decision variables, you click the dialog's "Solve" button.

- Solver will then translate your model and begin the optimization process. For small LP models this takes several seconds, or for big models, several minutes or longer.

- Assuming there are no errors in your spreadsheet LP model, Solver will bring up a Solver Results dialog box in which you can request reports and have Solver up-date your original model with the optimal decision cell values. Solver creates each requested report on a seperate worksheet in your workbook that you can save or print.

- At this point, you are now in a position to continue "What if" projections to, for example, perform sensitivity analyses in the neighborhood of the optimum decisions. Fig.4.1 shows the diagrammatic view of the steps in using solver.

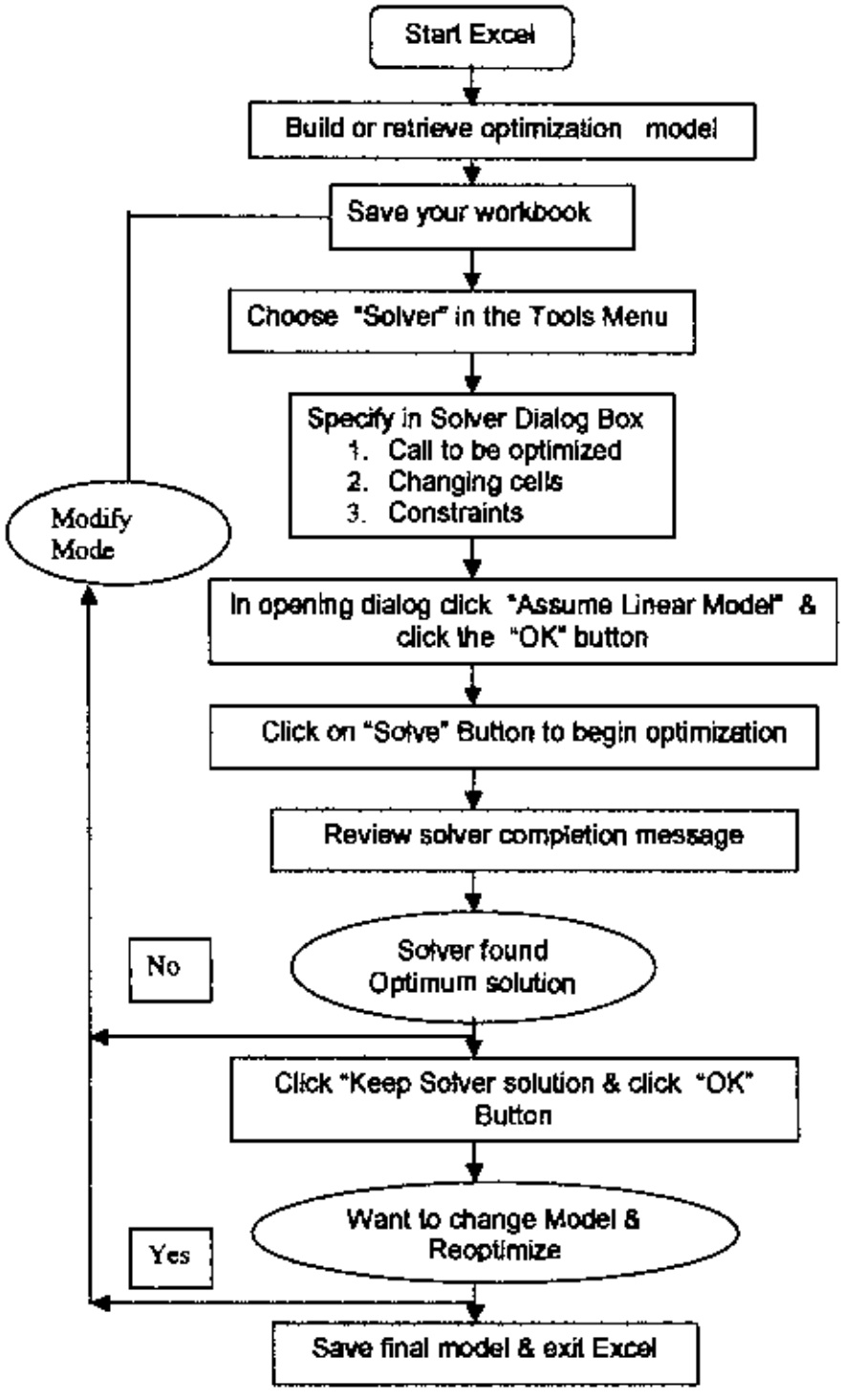

Fig. 4.1 Solution process of MS Excel solver [29]

4.3.2 Formulation of Linear Programming

X_{ij} refers to the number of random production per day, where i refers to the machine and j =1, 2: 1 as cowhides and 2 as goatskins.

t_{ij} refers to the expected processing time of j=1,2 where 1 refers cowhides and 2 refers goatskins in i^{th} machine.

C_{ij} refers to the processing cost per unit of j= 1,2 where 1 refers cowhides and 2 refers goatskins in i^{th} machine. Here working time is 8 hours a day.

Table-4.2 Processing time and maximum capacity of the machine [19,20]

Processing Name	Processing unit, (units/hr)		Processing time, (min/unit)		Capacity of the m/c
	Cowhides	Goatskins	Cowhides	Goatskins	(production/day)
Sammying	60	100	1	0.6	800
Splitting	85	100	0.706	0.6	800
Shaving	80	100	0.75	0.6	800
Dyeing	100	150	0.6	0.4	1200
Setting-out	80	100	0.75	0.6	800
Tunnel drying	400	500	0.3	0.24	2000
Vacuum drying	45	90	1.33	0.66	720
Vibration staking	150	200	0.4	0.3	1600
Toggle drying	80	100	0.75	0.6	800
Jaw-staking	60	90	1	0.66	720
Buffing	60	90	1	0.66	720
Polishing	80	100	0.75	0.6	800
Spraying	400	800	0.15	0.075	6400
Pressing	85	100	0.706	0.6	800
Ironing & embossing	80	100	0.75	0.6	800
Measuring	200	200	0.3	0.3	1600

Table-4.3 Processing time, processing cost and processing units

Processing Name	Processing time, t_{ij}, min/unit		Processing cost, C_{ij} (Tk/unit)		Processing units, X_{ij}, (units/day)	
	Cowhides	Goatskins	Cowhides	Goatskins	Cowhides	Goatskins
Sammying	1	0.6	2.50	1.00	X_{11}	X_{12}
Splitting	0.706	0.6	12.50	8.00	X_{21}	X_{22}
Shaving	0.75	0.6	3.50	2.00	X_{31}	X_{32}
Dyeing	0.6	0.4	2.00	1.50	X_{41}	X_{42}
Setting-out	0.75	0.6	3.00	2.00	X_{51}	X_{52}
Tunnel drying	0.3	0.24	3.00	2.00	X_{61}	X_{62}
Vacuum Drying	1.33	0.66	4.00	3.00	X_{71}	X_{72}
Vibration staking	0.4	0.3	2.00	1.50	X_{81}	X_{82}
Toggle drying	0.75	0.6	1.50	1.00	X_{91}	X_{92}
Jaw staking	1	0.66	1.00	1.00	X_{101}	X_{102}
Buffing	1	0.66	3.00	2.00	X_{111}	X_{112}
Polishing	0.75	0.6	1.00	1.00	X_{121}	X_{122}
Spraying	0.15	0.075	1.50	1.00	X_{131}	X_{132}
Pressing	0.706	0.6	6.00	4.00	X_{141}	X_{142}
Ironing & embossing	0.75	0.6	1.00	0.50	X_{151}	X_{152}
Measuring	0.3	0.3	0.50	0.50	X_{161}	X_{162}

Objective function

Maximize income = $\sum C_{ij} X_{ij} = Z$

Max. $Z=2.5 X_{11} + 1.0 X_{12} +12.5 X_{31} +8.0 X_{22} +3.5 X_{31} + 2.0X_{32} + 2.0 X_{41} +1.5 X_{42} + 3.0X_{81} + 2.0X_{52} +3.0X_{61} +2.0X_{62} +4.0X_{71} +3.0X_{72} +2.0X_{81} +1.5X_{82} +1.5X_{91} +1.0X_{92} + 1.0X_{101} +1.0X_{102} +3.0X_{111} +2.0X_{112} +1.0X_{121} +1.0X_{122} +1.5X_{131} +1.0X_{132} +6.0X_{141} + 4.0X_{142} +1.0X_{151} +0.50X_{152} +0.50X_{161} +0.50X_{162}$

Constraints

Now for cowhides

$2.5X_{11}+12.5X_{21}+3.5X_{31}+2.0X_{41}+3.0X_{51}+3.0X_{61}+4.0X_{71}+2.0X_{81}+1.5X_{91}+1.0X_{101}+3.0X_{111}+1.0X_{121}+1.5X_{131}+6.0X_{141}+1.0X_{151}+0.50X_{161}=(70/100)\ Z$

$\rightarrow 0.75X_{11}-0.7X_{12}+3.75X_{31}-0.7X_{22}+1.05X_{31}-0.7X_{32}+0.6X_{41}-0.7X_{42}+0.9X_{51}-0.7X_{52}+0.9X_{61}-0.7X_{62}+1.0X_{71}-0.7X_{72}+0.6X_{81}-0.7X_{82}+0.45X_{91}-0.7X_{92}+0.30X101-0.7X_{102} +0.9X_{111} -0.7X_{112} +0.3X_{121} -0.7X_{122} +0.45X_{131} -0.7X_{132} +1.5X_{141} -0.7X_{142}+0.3X_{151}-0.7X_{152}+0.15X_{161}-0.7X_{162}=0 \quad (1)$

For goatskins

$1.0X_{12} + 6.0X_{22} + 2.0X_{32} + 1.5X_{42} + 2.0X_{52} + 2.0X_{62} + 3.0X_{72} + 1.5X_{82} + 1.0X_{92} + 1.0X_{102} + 2.0X_{112} + 1.0X_{122} + 1.0X_{132} + 4.0X_{142} + 0.50X_{152} + 0.50X_{162} = (30/100)\ Z$

$\rightarrow -0.30X_{11} + 0.7X_{12} - 0.30X_{21} + 5.6X_{22} - 0.30\ X_{31} + 1.4X_{32} - 0.30X_{41} + 1.05X_{42} - 0.30X_{51} + 1.4X_{52} - 0.30X_{61} + 1.4X_{62} - 0.30\ X_{71} + 2.1X_{72} - 0.30\ X_{81} + 1.05X_{82} - 0.30\ X_{91} + 0.70X_{92} - 0.30\ X_{101} + 0.7X_{102} - 0.30X_{111} + 1.4X_{112} - 0.30X_{121} + 0.70X_{122} - 0.30X_{131} + 0.70X_{132} - 0.30X_{141} + 2.8X_{142} - 0.30X_{151} + 0.35X_{152} - 0.30X_{161} + 0.30X_{162} = 0$ (2)

For each machine total running time:

$\sum X_{ij} \cdot t_{ij} \leq$ (total running time of the machine-machine stoppage time)$\leq$450. Here, total running time of the machine=8 hours per day=480 minutes. Machine stoppage time=machine-to-machine carry delay of the hides & skins and lunch break=30 minutes. From Table-4.3 the constraints are as follows:

$1.000X_{11} + 0.600\ X_{12} \leq 450$ (3)

$0.706\ X_{31} + 0.600\ X_{22} \leq 450$ (4)

$0.7500X_{31} + 0.600\ X_{32} \leq 450$ (5)

$0.600\ X_{41} + 0.400\ X_{42} \leq 450$ (6)

$0.750X_{51} + 0.600\ X_{62} \leq 450$ (7)

$0.300X_{61} + 0.240X_{62} \leq 450$ (8)

$1.330X_{71} + 0.660X_{72} \leq 450$ (9)

$0.400X_{81} + 0.300X_{82} \leq 450$ (10)

$0.750\ X_{91} + 0.600X_{92} \leq 450$ (11)

$1.000X_{101} + 0.660X_{102} \leq 450$ (12)

$1.000X_{111} + 0.660X_{112} \leq 450$ (13)

$0.750X_{121} + 0.600X_{122} \leq 450$ (14)

$0.150X_{131} + 0.075X_{132} \leq 450$ (15)

$0.706X_{141} + 0.600X_{142} \leq 450$ (16)

$0.750X_{151}+0.600X_{152}\leq 450$ (17)

$0.300X_{161}+0.300X_{162}\leq 450$ (18)

Now for $X_{ij} \leq$ ((Total running time of the machine-machine stoppage time)/ (expected processing time, t_{ij})). The constraints obtained from Table-4.3 are as follows:

$X_{11}\leq ((480-30)/1.000) \leq 450$ (19)

$X_{12}\leq ((480-30)/0.600) \leq 750$ (20)

$X_{21}\leq ((480-30)/0.706) \leq 637$ (21)

$X_{22}\leq ((480-30)/0.600) \leq 750$ (22)

$X_{31}\leq ((480-30)/0.750) \leq 600$ (23)

$X_{32}\leq ((480-30)/0.600) \leq 750$ (24)

$X_{41}\leq ((480-30)/0.600) \leq 750$ (25)

$X_{42}\leq ((480-30)/0.400) \leq 1125$ (26)

$X_{51}\leq ((480-30)/0.750) \leq 800$ (27)

$X_{52}\leq ((480-30)/0.600) \leq 750$ (28)

$X_{61}\leq ((480-30)/0.300) \leq 1500$ (29)

$X_{62}\leq ((480-30)/0.240) \leq 1875$ (30)

$X_{71}\leq ((480-30)/1.330) \leq 338$ (31)

$X_{72}\leq((480-30)/0.660) \leq 682$ (32)

$X_{81}\leq(480-30)/0.400)\leq 1125$ (33)

$X_{82}\leq ((480-30)/0.300) \leq 1500$ (34)

$X_{91}\leq ((480-30)/0.750) \leq 600$ (35)

$X_{92}\leq((480-30)/0.600)\leq 750$ (36)

$X_{101}\leq ((480-30)/1.000)\leq 450$ (37)

$X_{102}\leq ((480-30)/0.660)\leq 682$ (38)

$X_{111}\leq ((480-30)/1.000) \leq 450$ (39)

$X_{112}\leq ((480-30)/0.660) \leq 682$ (40)

$X_{121}\leq ((480-30)/0.750)\leq 600$ (41)

$X_{122}\leq ((480-30)/0.600) \leq 750$ (42)

$X_{131}\leq ((480-30)/0.150) \leq 3000$ (43)

$X_{132}\leq ((480-30)/0.075) \leq 6000$ (44)

$X_{141} \leq ((480-30)/0.706) \leq 637$ (45)

$X_{142} \leq ((480-30)/0.600) \leq 750$ (46)

$X_{151} \leq ((480-30)/0.750) \leq 600$ (47)

$X_{152} \leq ((480-30)/0.600) \leq 750$ (48)

$X_{161} \leq ((480-30)/0.300) \leq 1500$ (49)

$X_{162} \leq ((480-30)/0.300) \leq 1500$ (50)

$X_{11}, X_{12}, X_{21}, X_{22}, X_{31}, X_{32}, X_{41}, X_{42}, X_{51}, X_{52}, X_{61}, X_{62}, X_{71}, X_{72}, X_{81}, X_{82}, X_{91}, X_{92}, X_{101}, X_{102}, X_{111}, X_{112}, X_{121}, X_{122}, X_{131}, X_{132}, X_{141}, X_{142}, X_{151}, X_{152}, X_{161}, X_{162} \geq 0$ (51)

4.4 Results and Discussions

The annual income of the CFFC with random job work from wet-blue to finished leather we can find as Excel sheet of maximization of income, Answer sheet, Sensitivity Analysis sheet and Limit analysis sheet are given below:

Table-4.4 Maximum production rate of cowhides and goatskins per day

Processing Name	Processing cost, C_{ij} (Taka/unit)		Number of production (per day per machine)		Total (Taka)
	Cowhides	Goatskins	Cowhides	Goatskins	
Sammying	2.50	1.00	X_{11}=450	X_{12}=0	1125
Splitting	12.50	8.00	X_{21}=637	X_{22}=0	7962.5
Shaving	3.50	2.00	X_{31}=600	X_{32}=0	2100
Dyeing	2.00	1.50	X_{41}=0	X_{42}=1125	1687.5
Setting-out	3.00	2.00	X_{51}=600	X_{52}=0	1800
Tunnel drying	3.00	2.00	X_{61}=1500	X_{62}=0	4500
Vacuum drying	4.00	3.00	X_{71}=0	X_{72}=682	2046
Vibration staking	2.00	1.50	X_{81}=1125	X_{82}=0	2250
Toggle drying	1.50	1.00	X_{91}=600	X_{92}=0	900
Jaw-staking	1.00	1.00	X_{101}=0	X_{102}=682	682
Buffing	3.00	2.00	X_{111}=0	X_{112}=682	1364
Polishing	1.00	1.00	X_{121}=0	X_{122}=750	750
Spraying	1.50	1.00	X_{131}=0	X_{132}=6000	6000
Pressing	6.00	4.00	X_{141}=637	X_{142}=0	3822
Ironing & embossing	1.00	0.50	X_{151}=600	X_{152}=0	600
Measuring	0.50	0.50	X_{161}=1500	X_{162}=0	750
Total			25809.5	12529.5	38339

Daily income of CFFC is Tk.38339.00. So, the annual income (assuming 300 working days) of CFFC = 38339 .00X 300 = Tk.11501700.00

Here, The annual income from cowhides=25809.5 X 300 =Tk.7742850.00 and the annual income from goatskins=12529.5 X 300 =Tk.3758850.00. So, the net profit per year =11501700-5519000 =Tk.5982700.00

The values obtained by using Excel solver program have been rounded off. There are some alternative solutions but total production remains same. The result of the LP model shows that, optimal production of the year 1989-90 would be Tk.11501700 of which cowhides Tk.7742850 and goatskins Tk.3758850. But by the traditional method the production during the year of 1989-90 wes Tk.7770000 and the net profit was Tk.2251000 but the by LP model it could be Tk.5982700. So, there had been a scope to produce about an additional amount of Tk.3731700 of hides and skins by utilizing the same facilities.

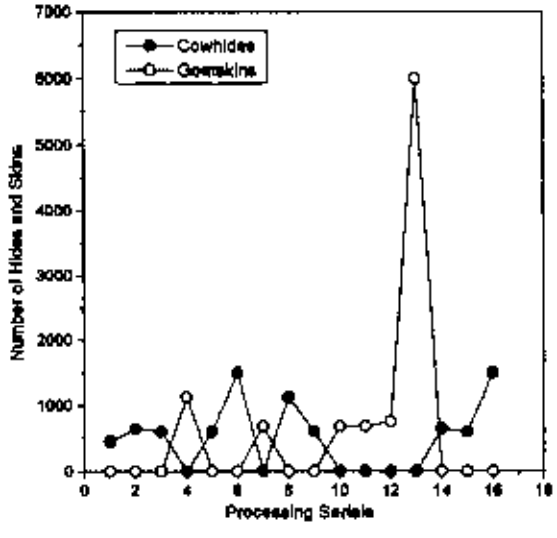

Fig.4.2 Production maximization of cowhides and goatskins by LP model

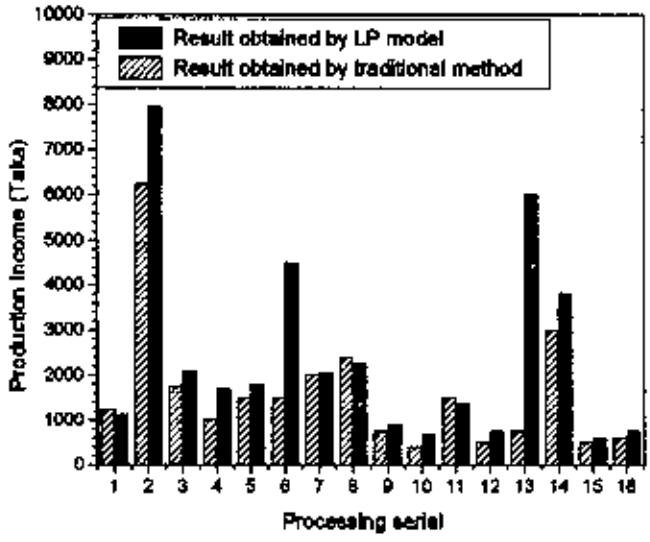

Fig.4.3 Comparative study of production income by LP model and traditional method

It is evident from Fig.4.3 the maximization of product-mix with LP model by Excel solver is greater than the production rate of cowhides by the traditionel method. The main cause of this reduced production is due to non-optimal production planning and machine capacity utilization.

The reliability of the date in any mathematical model is important to obtain a useful solution for practical problems. Some of this date are influenced owing to the instability and uncontrollability of certain aspects such as urgent order, machines problem, operator's lagging, unavailability of raw materials and poor quality of the supplied raw materials. On basis of those limitations optimum production may vary.

Chapter-5

CONCLUSIONS

This research work presented a practical approach for conducting product-mix analyses. The approach suggests starting the analyses with a Linear Programming (LP) model to determine the optimum product-mix than the traditional production method that meets the business targets as well as the processing needs of small-scale tanneries. In this way the Common Finishing Facilities Center (CFFC) becomes profitable. The study also measured the market demand, supply and local demand of the customer.

LP model is more tight schedule calculated program than the traditional method so the service volume becomes wide for the small-scale tanneries and more profitable. LP model can be utilized to enhance system parameter settings and process configuration so that the optimum product-mix is reached. Finally, the LP model is used to adapt the system design to most possible combinations of the product-mix. This approach can be implemented at the production system micro-level as well as the tenneries macro-level from the operations of wet blue to finished leather.

LP model can be applied in any leather processing industries from wet-blue to finished-leather production to maximize the profit. It will help to prepare an early profitable production plan to get maximum production-profit or set a standard production-profit target for tannery. By using LP model, tannery can evaluate the job-basis work by varying cowhides and goatskins in each machine to maximize production-profit.

LP model by Excel Solver is a superior method in planning of production schedule. Sensitivity analysis can be performed to take into account of the variation of resource level. Limit report analyses can be performed to take into account the lower limit and upper limit.

From this study, it was concluded that the small-scale tanneries produce about 45 million square feet of wet blue leather. But by the traditional method CFFC can process the wet blue leather to finished leather for 300 days in a year about 3 million squara feet. On the other hand, optimizing by LP model for 8 hours per day and for 300 days per year time, the processing of wet blue to finished leather on average 9 million square feet, which is triple, the amount as produced by the treditional method. If the working time extends upto 12 hours per day and the same 300 days per year, the processing of wet blue leather to finished leather increases upto 13 million square feet, which can meet the one third of the processing needs of the small-scale tanneries. From the above discussion, it is concluded that another two/three CFFC are needed to meet the local demands of 33 million square feet of finished leather.

Chapter-6

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Appendix

Appendix-A

SMALL SCALE TANNERIES

The small-scale tanneries have facilities for processing wet blue leather only. This type of tanneries is a non-mechanized tannery. The names and addresses of this type of tanneries are:

1. Shahajada Tannery, Hazaribagh, Dhaka
2. Mamun Traders, Hazaribagh, Dhaka
3. City Leather, Hazaribagh, Dhaka
4. Muslim Tannery, Hazaribagh, Dhaka
5. Chinese Overseas Tannery, Hazaribagh, Dhaka
6. A.B.M. Tannery, Hazaribagh, Dheka
7. Martin Brothers Tannery, Hazaribagh, Dhaka
8. Sonali Tannery, Hazaribagh, Dhaka
9. Beraid Leather Complex, Hazaribagh, Dhaka
10. Sobuz Corporation, Hazaribagh, Dhaka
11. Rahaman Overseas Export, Hazaribagh, Dhaka
12. Sandip Tannery, Hazaribagh, Dhaka
13. Great Eastam Tannery, Hazaribagh, Dhaka
14. Zahir Tannery, Hazaribagh, Dhaka
15. M. S. Tannery, Hazaribagh, Dhaka
16. G. N. Tannery, Hazaribagh, Dhaka

17. Ismail Leather Corporation, Hazaribagh, Dhaka
18. Tipara Tannery, Hazaribagh, Dhaka
19. Jakir Hussein Tannery, Hazaribagh, Dhaka
20. S. Tannery, Hazaribagh, Dhaka
21. Belal Tannery, Hazaribagh, Dhaka
22. Abul Basar Tannery, Hazaribagh, Dhaka
23. Globe Tannery, Hazaribagh, Dhaka
24. Poiran Tannery, Hazaribagh, Dhaka
25. Jalal Tannery, Hazaribagh, Dhaka
26. Sumon Tannery, Hazaribagh, Dhaka
27. G. A. Leather, Hazaribagh, Dhaka
28. Atik Tannery, Hazaribagh, Dhaka
29. Golden Tannery, Hazaribagh, Dhaka
30. Sadar Tannery, Hazaribagh, Dhaka
31. Mohin Tannery, Hazaribagh, Dhaka
32. Nabaran Tannary, Hazaribagh, Dhaka
33. Millat Tannery, Hazaribagh, Dhaka
34. Dil Bihar Tannery, Hazaribagh, Dhaka
35. Shadesh Tannery, Hazaribagh, Dhaka
36. Sher-e-Bangla Tannery, Hazaribagh, Dhaka
37. Feni Tannery Limited, Hazaribagh, Dhaka
38. Eastern Lether Corporation, Hazaribagh, Dhaka
39. Kamal Brothers Tennery, Hazaribagh, Dhaka
40. Jubili Tannery, Hazaribagh, Dhaka
41. Anwar Tannery, Hazaribagh, Dhaka
42. Meri Enterprise, Hazaribagh, Dhaka
43. Hossen Brothers Tannery, Hazaribagh, Dhaka
44. Metro Tannery, Hazaribagh, Dhaka
45. Roni Overseas, Hazaribagh, Dhaka
46. Rubi Enterprise, Hazaribagh, Dhaka
47. Shahi Tannery, Hazaribagh, Dhaka
48. Paruma Leather Corporation, Hazaribagh, Dhaka
49. Islima Tannery, Hazaribagh, Dhaka

50. Salam Tannery, Hazaribagh, Dhaka
51. Oahid Tannery, Hazaribagh, Dhaka
52. Kustia Tannery, Hazaribagh, Dhaka
53. Popular Tannery, Hazaribagh, Dhaka
54. Juliat Enterprise, Hazaribagh, Dhaka
55. Bengal Tannery, Hazaribagh, Dhaka
56. H. N. Brothers, Hazaribagh, Dhaka
57. Morshed Brothers Tannery, Hazaribagh, Dhaka
58. T. Ahmed Brothers Tannery, Hazaribagh, Dhaka
59. Gindabahar Tannery, Hazaribagh, Dhaka
60. Shohel & Shakil Tannery, Hazaribagh, Dhaka
61. Anjuman Tannery, Hazaribagh, Dhaka
62. Mitali Tannery, Hazaribagh, Dhaka
63. S. B. S. M Leather Complex, Hazaribagh, Dhaka
64. Manik & Shohag Brothers, Hazaribagh, Dhaka
65. Noakhali Tannery, Hazaribagh, Dhaka
66. Alea Tannery, Hazaribagh, Dhaka
67. Ibrahim Tannery, Hazaribagh, Dhaka
68. Moon Tannery, Hazaribagh, Dhaka
69. Royal Bengal Tannery, Hazaribagh, Dhaka
70. Madhab Tannery, Hazaribagh, Dhaka
71. Janata Tannery, Hazaribagh, Dhaka
72. Comilla Tannery, Hazaribagh, Dhaka
73. Guljar Tannery, Hazaribagh, Dhaka
74. Nuru Bhai Tannery, Hazaribagh, Dhaka
75. Chadpur Tannery, Hazaribagh, Dhaka
76. Toufiq Tannery, Hazaribagh, Dhaka
77. Overseas Tannery, Hazaribagh, Dhaka
78. Al-Amin Tannery, Hazaribagh, Dhaka
79. Banas Enterprise, Hazaribagh, Dhaka
80. Capital Tannery, Hazaribagh, Dhaka
61. Chayanika Leather, Hazaribagh, Dhaka
82. Mamun Leather Corporation, Hazaribagh, Dhaka

83. Farhad Leather Corporation, Hazaribagh, Dhaka
84. B. T. I. Tannery, Hazaribagh, Dhaka
85. Abbas & Sons, Hazaribagh, Dhaka
86. A. H. Enterprise, Hazaribagh, Dhaka
87. Dhaka Nagar Tannery, Hazaribagh, Dhaka
88. Aziz Brothers Tannery, Hazaribagh, Dhaka
89. Masum Leather, Hazaribagh, Dhaka
90. Sunlight Tannery, Hazaribagh, Dhaka
91. Kamalia Tannery, Hazaribagh, Dhaka
92. Shajahan Tannery, Hazaribagh, Dhaka
93. Yusuf Tannery, Hazaribagh, Dhaka
94. Prince Tannery, Hazaribagh, Dhaka
95. Five star Tannery, Hazaribagh, Dhaka
96. Khokon Tannery, Hazaribagh, Dhaka
97. Shathi Leather, Hazaribagh, Dhaka
98. Haque Tannery, Hazaribagh, Dhaka
99. Kasem Tannery, Hazaribagh, Dhaka
100. Shohid Tannery, Hazaribagh, Dhaka
101. United Tannery, Hazaribagh, Dhaka
102. Nabipur Tannery, Hazaribagh, Dhaka
103. Greenways Tannery, Hazaribagh, Dhaka
104. Kohinur Tannery, Hazaribagh, Dhaka
105. Island Tannery, Hazaribagh, Dhaka
106. Gokul Tannery, Hazaribagh, Dhaka
107. Kamala Tannery, Hazaribagh, Dhaka
108. Amanat Tannery, Hazaribagh, Dhaka
109. B. Rahman Enterprise, Hazaribagh, Dhaka
110. Ahsan Habib Brothers, Hazaribagh, Dhaka
111. Leather Complex Private Limited, Hazaribagh, Dhaka
112. Sharif Tannery, Hazaribagh, Dhaka
113. S. S. Tannery, Hazaribagh, Dhaka
114. Pioneer Tannery, Hazaribagh, Dhaka

MEDIUM SCALE TANNERIES

The medium scale tanneries can process leather from raw hides and skins to crust-leather. There are two types of medium scale tanneries like mechanized crust leather tannery and semi-mechanized crust leather tannery.

Mechanized Crust Leather Tannery: The names and addresses of this type of tanneries are:

1. Amin Tennery, Hazaribagh, Dhaka
2. Ayub Brothers, Hazaribagh, Dhaka
3. Chinese Leather Industries, Hazaribagh, Dhaka
4. Earth International, Hazaribagh, Dhaka
5. Green Arrow Tannery, Hazaribagh, Dhaka
6. Helal Tannery, Hazaribagh, Dhaka
7. Jamila Tannery, Hazaribagh, Dhaka
8. Kalam Brothers, Hazaribagh, Dhaka
9. Kid Leather, Hazaribagh, Dhaka
10. M. B. Tannery, Hazaribagh, Dhaka
11. Milon Tennery, Hazaribagh, Dhaka
12. Mizan & Sumon Tannery, Hazaribagh, Dhaka
13. Mukti Tannery, Hazaribagh, Dhaka
14. Nur Trading Corporation, Hazaribagh, Dhaka
15. Pragati Leather Complex, Hazaribagh, Dhaka
16. Rana Leather Complex, Hazaribagh, Dhaka
17. Samata Leather Complex, Hazaribagh, Dhaka
18. Surwar Leather Corporation Limited, Hazaribagh, Dhaka
19. Vulua Tannery, Hazaribagh, Dhaka
20. Yusuf Leather Corporation, Hazaribagh, Dhaka

Semi-Mechanized Crust Leather Tannery: The names and addresses of this type of tanneries are:

1. Abul Khair Tannery, Hazaribagh, Dhaka
2. Al-Madina Tannery, Hazaribagh, Dhaka
3. Bikrampur Tannery, Hazaribagh, Dhaka
4. B.M.Leather, Hazaribagh, Dhaka
5. Chrome-base Tannery, Hazaribagh, Dhaka
6. Dhaka Tanneries Limited, Hazaribagh, Dhaka
7. Fancy Leather Complex, Hazaribagh, Dhaka
8. Gulshan Tannery, Hazaribagh, Dhaka
9. International Tannery, Hazaribagh, Dhaka
10. Kalu Leather, Hazaribagh, Dhaka
11. Curshaj Tannery, Hazaribagh, Dhaka
12. Luna Tannery, Hazaribagh, Dhaka
13. Mahtab Tannery Limited, Hazaribagh, Dhaka
14. Maizdy Tannery, Hazaribagh, Dhaka
15. M. R. Tannery, Hazaribagh, Dhaka
16. Nishat Tannery, Hazaribagh, Dhaka
17. Pubali Tannery, Hazaribagh, Dhaka
18. Rawshan Tannery, Hazaribagh, Dhaka
19. Royal Tannery, Hazaribagh, Dhaka
20. Samina Tannery (Pvt) Limited, Hazaribagh, Dhaka
21. Udayan Corporation, Hazaribagh, Dhaka

Appendix-B

DIRECT SURVEY OF SMALL SCALE TANNERIES

In Bangladesh there are now 206 small, medium and large tanneries out of which 186 are located at Hazaribagh. About 94% of the total supply of hides and skins of the country is processed here. Out of 206 tanneries, 112-115 (small scale tanneries) units have facilities for processing wet blue leather only and they are located at Hazaribagh, Dhaka. Now we show the survey questionnaire about the identification of some small-scale tanneries:

INDUSTRIAL SURVEY OF
SMALL SCALE TANNERIES IN BANGLADESH

QUESTIONNAIRE

1. Name of organization:
2. Address i) Office:
   ii) Factory:
3. Year of establishment:
4. Factory Area i) Land acre
   ii) Covered sq. ft.
5. Annual production capacity:
   i) Crust (million sq. ft.)
   ii) Finished (million sq. ft.)
6. Key personnel i)
   ii)
   iii)
7. Legal status: Proprietorship/ Partnership/ Private limited company/ Public limited company/others
8. Type of ownership: Domestic/Joint venture/Fully foreign/ Others
9. Trade membership:

i Chamber of commerce

ii Bangladesh finished leather & leather goods exporters Association ☐

iii Bangladesh Tanners Association ☐

iv Others ☐

10. Product line: Cow crust leather (%)
Cow finished leather (%)
Goat crust leather (%)
Goat finished leather (%)

11. Source of raw materials:

Raw hides & skins: Local (%)
Imported (%)
Country (%)

Chemicals

Country	Major Products	Market Share (%)	Country	Major Products	Major Share (%)
Italy			Switzerland		
U.K.			U.S.A		
Germany			China		
Taiwan			India		
France			Kenya		
Holland			Turkey		
Brazil			Spain		
Mozambic			Others		

12. Output growth (million sq. ft):

Product	1998-1999	1999-2000	2000-2001	2001-2002	2002-2003
Cow crust leather					
Cow finished leather					
Goat crust leather					
Goat finished leather					
Total					

13. Growth of sales (million Taka):

Year	Annual turnover (Million Taka)	Percentage of growth
1998-1999		
1999-2000		
2000-2001		
2001-2002		
2002-2003		

14. Number of employees:

Management and office stuffs ☐

Qualified leather technologist

i. Local ☐

ii. Foreign ☐

Skilled worker ☐

Semi-skilled worker ☐

Unskilled worker ☐

Female manpower ☐

15. Country of major export:

Country	Market Share (%)	Country	Market Share (%)
Hong Kong		Uruguay	
Italy		U.K.	
Spain		Germany	
Japan		India	
China		Singapore	
France		Philippines	
Brazil		Vietnam	
Taiwan		Others	

16. Please mention the name of Italian buyers:

17. List of existing machineries:

Name of the Machine	Model	Number	Brand name	Country of origin	Year of acquisition	Existing condition	Remarks
Soaking/liming drum							
Soaking/liming paddles							
Fleshing m/c							
Liming spiting							
Tanning/retanning drum							
Sammying							
Splitting mic							
Shaving m/c							
Setting out m/c							
Vacuum m/c							
Tunnel drying							
Conditioning m/c							
Vibration staking							
Jaw staking							
Toggle driver							
Buffing m/c							
De-dusting m/c							
Spray coater							
Roller coater							
Glazing m/c							
Hydraulic press							
Polishing m/c							
Roto press							
Ironing m/c							
Milling drum							
Electronic measuring m/c							
Generator/sub station							
Boiler							
Compressor							
Deep tube well							
Workshop machinery							

18. Year of modernization:
19. Way of BMRE/modernization: Self financed / Bank financed / ADB finance / Others
20. How will you purchase your machinery?

21. Do you need further BMRE? Yes ☐ No ☐

22. If yes, please specify the area and the type of machinery you need.

23. If government imposed ban on crust leather export, how will you upgrade your production base?

Through self finance ☐
Through bank finance ☐
Expecting technical/ financial assistance ☐
Others

24. Do you agree to relocate your industry according to government plan?
Yes☐ No☐

25. If yes, do you think that your existing machinery will work smoothly after re-installation? Yes☐ No☐

26. If no, how these can be overcome?

27. Do you seek any technical assistance? Yes☐ No☐
If yes, please specify the area

28. Do you seek any marketing assistance? Yes☐ No☐
If yes, please specify the area

29. Do you seek any production assistance? Yes☐ No☐
If yes, please specify the area

30. Do you have any problems with regard to bank loans?
Yes☐ No☐

If yes,

Difficulties in fulfilling bank formalities ☐
Loan availed but amount is inadequate
Loan eveiled but repayment schedule could not be maintained ☐
Stuck-up capitals ☐
Any other problem (specify) ☐

31. What are the major policy incentives, which you have availed?

32. Please list major policy incentives, which you would like to avail?

33. Do you have any shot and long-term investment program?

Yes☐ No☐

If yes, please specify the area.

34. Do you think that relocation of this sector from Hazaribagh is essential?

Yes☐ No☐

35. If yes? How will you arrange financial and technical support needed for relocation of your unit?

36. Please mention major problems, which your firm has faced?

37. Do you think that leather manufacturing have huge export potentialities?

If yes, how these can be exploited? Yes☐ No☐

PROCESSING NOTE

All wet processing is carried out in a plastic bin or rubbish bin. At all times, it is essential that the skins be fully immersed in the processing liquors. The volume recommended throughout this article is 20 liters per skin. However, if the skins will not easily immerse then the volume can be increased until the skins ere covered. For any increase in the volume of weter used, all chemicals must be increased proportionally - this is why all amounts are calculated "per liter" of water used. Agitate skins by moving gently with e smooth stick or gloved hands.

Table-A3 Processing Sequence

Step No		Details	Time
1.	Flaying	Remove skin as soon as possible after slaughter avoiding knife cuts on the flesh side and minimizing amount of fat and muscle removed with the skin.	Time of slaughter
2.	Washing	Wash in 3 changes of cold water (20 liter per skin) each of about 20 mins. Remove blood and loose dirt.	Time of slaughter
3.	Fleshing	Place skin on table or board and cut off fat and muscle etc by scraping parallel to the skin surface so as not to cut into the skin structure. Wash and drain for about 30 min.	Time of slaughter
4.	Curing	Lay the skin on a flat drained surface (shearing shed floor is ideal) and spread fine salt over the complete surface until about 1 cm deep end rub salt into the flesh. Allow drying in shade. The skin is safe for months if kept dry. Note: Owing to bacterial attack on skin and subsequent loosening of "hair" and putrefaction, the skin must be salted on the same day as slaughter and as soon as possible during summer.	Time of slaughter

5.	Washing	Wash 20 liter per skin with cold water and soak for a few hours. Drain.	After storage
6.	Scouring	Scour skins at 38°C for 1 hour in a bath containing 4 gram/liter of a scouring paste. Drain and repeat scour in a fresh bath. Agitate frequently and gently for lambs and sheep - the longer and finer the wool the more care required preventing felting. 60's wool is usually the finest wool handled by commercial tanneries and finer wool requires very careful handling. Re-flesh if necessary. Note: Never exceed 40°C in any bath with untanned skins.	
7.	Rinse	20 liter per skin at 38°C. Drain	
8.	Pickle	Prepare a bath of 40 gram/liter salt and 6ml per liter of 33% sulphuric acid (battery acid) (refer safety notes). Add skins to salt/acid mixture and agitate occasionally over 2 days. Remove skins and drain back into rubbish bin if pickle liquor to be re-used (see later). Drain for a few hours. Note: do not wash skins or even splash with water when in the pickled form.	Days 1 & 2
9.	Tan	Prepare in advance a bath containing 24 gram/liter of chrome tanning powder, 40 gram/liter of salt and 20 gram/liter of aluminum sulphate. Add skins and agitate as frequently as possible (say 1 minute every few hours) during the day over 3 days. At the neck end, make a cut about 4 cm long and 1 cm in from edge of skin and check that the skin is green through the complete thickness of the skin. If not, continue tanning until this is so. Remove skins and drain until this is so. Remove skins and drain back into the bin to collect tanning liquor if it is to be re-used.	Day 3 to Day 8
10.	Rinse	Three rinses with 20 liter water per skin cold, each rinse about 30 minutes and draining between rinses.	
11.	Neutralis	To further stabilize the tannage, make up a fresh batch of water at liter per skin containing 1 gram/liter sodium bicarbonate. Agitate occasionally for the rest of the day and stand overnight.	Day 6
12.	Drain	Drain overnight over a pole or similar support.	Day 7
13.	Fatliquor	For each skin about the size of a lambskin, use 100 mls of fat liquor. Increase or decrease amount	Day 8

		for larger or smaller skins. Prepare the fat liquor by stirring it into 2 times its volume of hot water to give a homogeneous milky product. Paint onto flesh side of skin and allow soaking in. Repeat application.	
14	Dry	Hang, or stretch and nail out on a board to dry (this must be in the shade).	Day 9+
15	Stake	When still slightly damp (1-2 days), draw flesh side of skin over the edge of a table, fence etc and work until soft and flexible. Allow drying fully and staking the skin again.	Day 9+
16.	Finish	Comb wool or "hair" and trim off edges for appearance.	
17.	Dry Clean	If fat patches appear in the skin or on the surface, or if the skin has an unpleasant odor, it is recommended that the skin be commercially dry-cleaned. It must be established with the dry-cleaner whether any fine-wool led skins are safe to dry-clean without the risk of felting.	
18.	Re-finish	Comb and soften as necessary for appearance.