OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

23439

UNIDO

Leather Unit

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO)

Technical Information on Industrial Processes

TYPICAL TANNERY DESIGNS

by

Michael L. Woodley

Leather Technologist

under the UNIDO technical assistance project SF/EGY/97/167

managed by

Ferenc Schmél

Industrial Development Officer

Vienna, 2003

The designation and classification of countries and territories employed, the presentation of material in this study do not imply the expression of any opinion whatsoever on the part of the Secretariat of the UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION (UNIDO) concerning the legal status of any country, territory, city or area, or of its authorities, or concerning the delimitation of its frontiers or boundaries, or regarding the economic system of degree of development.

Mention of the names of firms and commercial products does not imply endorsement by UNIDO.

The publication has not been formally edited.

The original document was prepared in 2000.

Table of Contents

EXPLANATORY NOTES

EGP	- Egyptian Pound US$ 1.00=EGP 3.40 (1 February 2000)
US$	- Dollars of the United States of America
	- square feet, equivalent to 0.929 square metres (m^2)
mio.	- million
Kg	- kilogram
p.a.	- per annum
id	- indirect worker
FG	- Full Grain leather with the original top surface (grain) intact
CG	- Corrected Grain leather with the grain layer removed by buffing.
min	- minute
h	- hour
d	- day
t	- metric tonne (ton) = 1,000 kg
pc	- piece

INTRODUCTION

The range of tannery designs shows different levels of mechanisation and different final products; some of which are only a part of the full leather-making process. All represent a modernisation of the tanning industry in Egypt and would bring consequent benefits to the National leather industry and the economy of the country.

Estimated conversion costs have been made for the operating performance of each production, calculating per piece processed. These will need to be revised according to the actual costs and yields. The cost of the actual leather produced is obtained by adding this conversion cost to the existing raw material price.

The designs show the equipment needed and assume that there will be experienced and capable technicians for the leather making and for the machinery maintenance. The financial estimates also assume that sales will be achieved, as required, so that all the production will be sold without delay. Leathers will not automatically sell themselves, and it is important for tanners to actively sell the products to the buyers rather than wait for the buyers to visit the leather producers. The marketing to achieve this will need to be done as professionally as possible – developing and promoting new leathers and colours – as is done in the co-ordinated European fashion schemes.

Mechanisation is used as a general rule to ensure that there is a quality of production at international standards, adding maximum value and providing a good raw material for footwear and other leather products. The scale and production volume is influenced by customer requirements, in particular minimum order sizes to qualify as a reliable supplier, and by machine utilisation; smaller scale machine working is not economically viable unless it is used as a common facility by a number of producers. *Annex 6* considers the smaller scale units and their investments.

The first requirement for a successful tannery is to have a good quality and uniformity of production. If there is a tradition of low cost production, maintained by a conservative tradition and limited technical knowledge, the leather quality and the tannery profitability will be lower. Costs and productivity will be an important factor in the future once a good quality is established.

The equipment costs are indicative from the manufacturers (*Annex 1*) and subject to confirmation for individual requirements. Chemical costs are considered to be a maximum and allow for further reduction (*Annex 2*). A hide of 22 kg is assumed to yield a minimum of 38 sq.ft (3.5 m^2) finished leather and 10 sq.ft (0.929 m^2) of split leather. The heavy leather yield is assumed at 67%. No allowance is included in the costs for any local duties or taxes.

All of these design examples have effluent pre-treatment plants to protect the environment, and have chrome recovery units where applicable. They do not include biological treatment. Clean technology drums and processes are recommended where possible.

The **productions** shown in the designs are:

1. *Wet-blue starting from raw hides*, with a daily production of 640 wet-blue hides and 640 whole butt splits, available in limed, pickled or wet-blue condition. *Wet-blue* is a semi-processed leather and an international commodity. The cost of equipment needed is US$ 1.5

million, excluding buildings and any local duties and taxes. 29 employees are needed and an area of 2100 m^2, excluding effluent treatment.

2. *Finished leather* from 320 wet-blue hides/day, producing about 12,000 sq.ft. This needs an investment of US$ 1.4 million for equipment, excluding buildings and any local duties and taxes. 59 employees are needed and an area of 2400 m^2, excluding effluent treatment.

3. *Finished leather, including splits*, from 300 raw hides/day. The input, estimated at 6.6 t/day, produces about 12,000 sq.ft grain leather and 3,600 sq.ft split leather. The investment needed is US$ 2.4 million for equipment, excluding buildings and any local duties or taxes. 88 employees are needed and an area of 2500 m^2, excluding effluent treatment.

4. *Finished leather* from 2,000 raw skins/day to produce 10,000 sq.ft. This needs an investment of US$ 1.4 million for equipment, excluding buildings, and any local duties or taxes. 77 employees are needed and an area of 2400 m^2, excluding effluent treatment.

5. *Split leather* from 1000 whole butt splits/day to produce 10,000 sq.ft/day leather, considered as 80% finished and 20% suede. The investment needed is US$ 1.2 million, excluding buildings, and any local duties or taxes. 57 employees are needed and an area of 2400 m^2, excluding effluent treatment. Split leathers are not available at present in Fustat; using a splitting machine provides the opportunity to add value to the hide and to provide a new leather type. The *split* is the lower layer of the hide, which remains after the upper, grain layer has been removed by the splitting machine. These are economic leathers having a good sale in a number of different articles, in either chrome or vegetable tannage. The chrome leathers may be produced as finished, or suede, for shoe uppers and linings, or as suede for garments and industrial gloves. Vegetable tanned leathers can be used in leather goods, soles and insoles, but the processing is not included here.

6. *Heavy vegetable tanned leather* from 150-200 raw hides (4.5 t) per day to make 3.0 t of sole, or similar type, leather. The hides are segmented; the whole Shoulder is tanned separately from the remainder of the hide, which is called a Culatta. The investment needed is US$ 1.05 million for equipment, excluding buildings, and any local duties or taxes. 36 employees are needed and an area of 2750 m^2, excluding effluent treatment.

A comparative table of the conversion costs in the different tanneries is shown in *Annex 3*.

TANNERY DESIGNS

1. Wet-blue production from raw hides

This design is for a large-scale mechanised tannery, working in whole hides to produce wet blue hides as a marketing commodity for home use, or for export.

The *input* consists of the processing equipment, personnel and the chemicals required, to convert the raw cattle hides into wet-blue leather for individual customers. The buildings need to have specific construction for supporting the process drums and for the drainage channels, as planned for effluent pre-treatment.

The *final products* is wet-blue, whole hide grain leather, which has been split in the limed condition and a whole hide flesh split, available in the limed, pickled or wet-blue condition. It is reasonable to value the split at 10% of the hide value. Limed fleshings and trimmings can also be a source of income. Buffalo hides will yield 2, or more, flesh splits of which the middle split can be further processed for dog chews.

Production quantity is based on 640 hides/day and a reasonable use of 3000 mm working width machines. The input is 14 t/day to yield 192,000 hides/year wet-blue hides and a similar number of whole hide. General split yield is estimated at 25% of input weight.

Capital required is US$ 1.5 million for equipment, without allowances for bank costs, buildings and any local duty or tax. Full production needs a working capital of US$ 177,000 plus the cost of the raw hides in store and for 7 days work in progress. A conversion cost of US$ 5.29 per hide (about US$ 0.14/sq.ft) is estimated, excluding the raw material.

Area required is 2100 m^2: 1600 m^2 are for production and 500 m^2 are for non-production.

Personnel required are 29, of whom 9 are indirect. These have to include at least 1 leather technician (liming and tanning), 1 engineer (machinery maintenance and effluent plant) and 1 laboratory technician (control laboratory, chrome recovery and effluent standards).
The costs are calculated at two different rates, US$ 4/day (EGP 13/day) and US$ 9/day (EGP 30/day), with 30 days/month. These rates represent the range of pay for calculations and it should be understood that it does not assume that all indirect workers are paid at the higher rate.

Production schedule, showing the Work in Progress, is as follows, for hides and for splits:

Workday	Process	Comments
1	Soak	Overnight
2	Lime	Overnight
3	Fleshing, split, delime, pickle, tan	Overnight
4	Unload	Horse overnight
5	Rest	
6	Sammy, sort	
7	Pack	

Estimates in work days – Wet-blue 6, Pack 1: **total of 7 workdays.**

Equipment costs are in US$ thousands, 'id' refers to indirect worker. The power and working time required are shown in kW and hours per day.

Operation	Worker	Equipment	Cost	Power	Time	Detail
			US$	*kW*	*h/day*	
Store	4/1 id	Handcarts				Check and sort
Handling	1	Forklift; electric 4 t loads	50		16	
Soak	2	2: 4×4 m drums	163	60	24	Fitted for hair-save
Lime	1 id	2: 4×4 m drums	163	60	24	
Flesh	2	1: 3100 mm	123	75	6	+ cleaning
Split	6	1: 3000 mm	119	25	6	+ cleaning
Tan	2/1 id	4: 3×3m drums	140	120	24	10 t hides, 4 t split
Handling		Hand pallet trucks	3			2 t loads
Sammy	2	1: 3000 mm through feed	75	25	5	
Sort/pack	1/1 id	Table and lights				
Office	2 id					
Laboratory	1 id	Basic control tests	20			Production/effluent
Batch water		Flow at 1 m^3/day	17	15	16	for 5 drums
Scales		5 t	12			
Scales		2 t	8			
Scales		300 kg	2			
Scales		30 kg	1			
Boiler	1 id	3 t steam/h 2 or 25 bar	40	15	16	
Effluent		400 m^3/day	300	250	24	Pre-treatment
Chrome	1 id	Recovery for 14 t input	90	15	8	
SUBTOTAL	*20/9 id*		*1,326*			
Add 15%		7% spares, 8% shipping	199			and installation
TOTAL			**1,525**			

Technology is fully mechanised to allow for a production to international market standards. The unhairing and liming system (hair-saving) in the drum is designed for clean technology and to reduce the cost of treating the effluent by 30-40%. Splitting introduces a new process (*Annex 4*) and is done in the lime. This allows a more efficient and separate chrome tannage for sides and splits, yielding a larger and more valuable split, with chrome-free waste, and easier disposal. An allowance is made for the daily input of 14 t to be 15-16 t fleshed weight. This is split to 10 t grain hides, 3-4 t flesh splits and 2 t waste. (Basis is of a 22 kg cattle hide to be 25 kg pelt weight

yielding a 16 kg grain, 5 kg flesh split and 3 kg waste. A 35 kg buffalo hide is 38-40 kg limed and yields 10 kg grain split at 2.2 mm, 15 kg middle split, 7 kg flesh split and 8 kg waste. The middle split has a good sales outlet as dog chews). A chrome recovery unit and a full effluent pre-treatment plant are included. The chrome recovery can reduce the chrome costs by 25% with a payback period of 3 years. The estimated total tannery effluent volume of 400 m^3 (14 t x 28 m^3) is treated to remove sulphide by aeration and to reduce solids by precipitation and centrifuge.

Costings

CHEMICALS are estimated to cost US$ 0.08/, or US$ 3.04/hide, to the wet-blue state (see *Annex 1*).

LABOUR COSTING

From above	20 direct workers at US$ 120/month	=	US$ 28,800/year
	9 indirect workers at US$ 270/month	=	US$ 29,160/year
	Total		US$ 57,960/year

FIXED OVERHEAD COSTING

Depreciation of machinery (estimated cost of US$ 1.5 mio.) over 10 years is	US$ 150,000/year
Maintenance, budgeted at 3% of cost is	US$ 45,000/year
Total	US$ 195,000/year

VARIABLE OVERHEAD

1. The cost of power input at 240 kWh/t of daily input is calculated at EGP 0.18/kWh and taken for 300 days/year. This is a total of US$ 53,000/year (EGP 181,000/year).
2. Water usage is 20-27 m^3/t of rawhide input. The cost is EGP 0.60/m^3. The 300 days annual charge is calculated from 350 m^3/day (14 t $\times$ 25m^3). This is US$ 18,500/year (EGP 63,000/year).
3. Effluent charges for complete tannery operation are at 4% of operating costs in Italy, which is 10% excluding the raw material. As the wet blue operations require 75% of the pollution control, the costs here are estimated at 7.5%.

Conversion costs for the TOTAL annual production of 192,000 hides and splits (all figures in US$).

Item	*cost per year*	*Costs per hide*	*% cost*	*Comment*
Chemicals	614,000	3.20	60.6	
Labour	57,960	0.30	5.7	
Overhead 1	195,000	1.02	19.2	Fixed: machinery. No buildings.
Overhead 2	71,500	0.37	7.0	Variable – power and water
Overhead 3	76,090	0.40	7.5	Variable – effluent
Total	**1,014,550**	**5.29**	**100.0**	

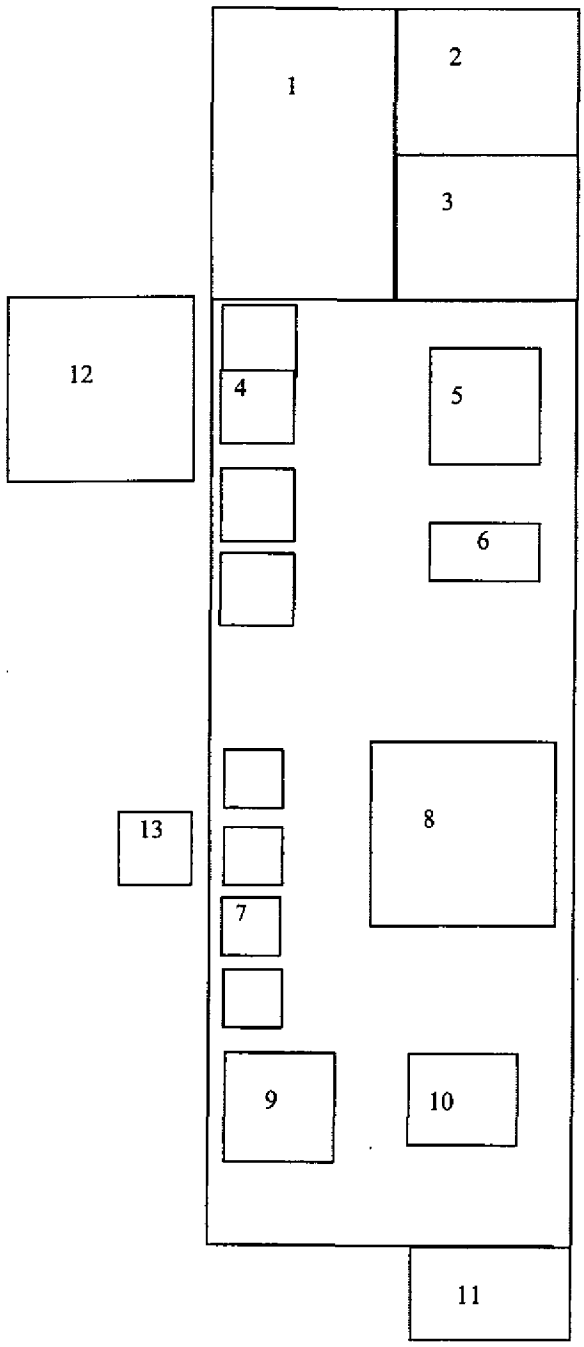
Working capital is needed for

1.	Raw hides store for 2 weeks.	
2.	Hides in work for 7 days.	
3.	Chemicals for 3 months (including order, delivery etc.)	US$ 153,500
4.	Conversion costs of work in progress for 7 days	US$ 23,700
		US$ 177,200

Suggested layout for wet-blue tannery from raw hides

Production area of 1600 m^2 (25 m × 64 m)

Approximate scale 1:500



Key to plan

	Operation
1	Raw hide store
2	Chemical store
3	Boiler 3 t steam 2 or 15 bar/services
4	4 soak/lime drums 4×4 m
5	1 fleshing machine 3,100 mm
6	1 splitting machine 3,100 mm
7	4 tanning drums 3×3 m
8	Horsed overnight
9	1 sammying 3,000 mm through
10	Despatch area
11	Office
12	Effluent pre-treatment 400 m^3
13	Chrome recovery 14 t input

2. Finished leather production from wet-blue hides

This model takes a wet-blue hide, already split in the lime, from a wet-blue producer, as the raw material. It has 75% less pollution than a complete tannery operation and has the possibility of adding much more value, and profit, by optimising quality and having a flexible production.

The *input* consists of the processing equipment, personnel and the chemicals, which are required to convert the wet-blue cattle hides into finished leather for individual customers. The buildings need to have specific construction for supporting the process drums and for the drainage channels, as planned for effluent pre-treatment.

The *final product* is finished cattle hide for footwear or leather goods, processed as sides, with an estimate of 90% corrected grain (CG). The thickness is generally between 1.2 and 1.8 mm. There is no split production.

Production quantity is based on 320 hides/day (640 sides/day), or 96,000 hides/year. This has optimum machine use, normally 1800 mm working width for 8 hour/day, to produce about 12,000 sq.ft/day. The raw input is taken at 7 t/day, calculated as 3.2 t shaved weight for retanning.

Capital required is US$ 1.37 million for equipment without allowances for bank costs, buildings and any local duty or tax. Full production needs a working capital of US$ 560,000 plus the cost of raw hides in store and for 16 days Work in Progress. A conversion cost of US$ 22.74/hide (about US$ 0.60/sq.ft) is estimated, excluding the raw material.

Area required is 2,400 m^2: 1,700 m^2 are for production and 700 m^2 are for non-production. The production area is 50 m $\times$ 34 m, with the wet end section, up to the vacuum drier, being separated from the crust and finishing areas by a 15 m long wall.

Personnel required are 59, of whom 12 are indirect. These have to include at least 2 leather technicians (wet work and finishing), an engineer (machinery maintenance and effluent plant) and a laboratory technician.

The costs are calculated at two different rates, US$ 4/day (EGP 13/day) and US$ 9/day (EGP 30/day), with 30 days/month. These rates represent the range of pay for calculations and it should be understood that it does not assume that all indirect workers are paid at the higher rate.

Production schedule, showing the Work in Progress, is as follows:

Workday	*Process*	*Comments*
1	Sort, shave, weigh	
2	Retan, horse	
3	Set out, vacuum dry	
4	Hang dry	Over night
5	Condition	Wrapped overnight
6	Stake, toggle	
7	Crust sort	
8-11	Finishing FG	
8-14	Finishing CG	

Workday	Process	Comments
12	Sort and measure FG	
13	Pack FG	
15	Sort and measure CG	
16	Pack CG	

Estimates in work days – Crust 7, Finished CG 7, Sort and pack 2: **total of 16 work days.**
Basic pattern for finishing:-
FG: Polish, 2 coats pigment; print and I coat pigment; spray 2 coats; plate; spray. = 4 days
CG: Buff & dedust; impregnate; dry; rebuff & dedust; finish as above (no polish) = 7 days

Equipment costs are in US$ thousands, 'id' refers to indirect worker. The power and working time required are shown in kW and hours per day.

Operation	Worker	Equipment	Cost	kW	H/d	Detail
Store	4+1 id	Handcarts				check and sort
Sammy	1	1: 1800 st. thro	61	25	6	
Shave	1	1: 1800 mm	76	55	6	
Retan/dye	4+1 id	2: 2.5×1.8 m	68	30	16	180 sides (900kg) 2×/day
Retan/dye		1: 2.0×1.5 m	27	10	17	100 sides (500kg) 2×/day
Water feed		1 m^3/min	17	15	16	Serves 5 drums
Trial drum		1: 1.2×0.8 m	12	5	8	
Control lab	1 id	Lastometer, pH	10	10	8	Basic tests
Setting out	2	1: 2,400 mm	80	45	8	Wider machine better
Vacuum	4	1: 2 table 4×3 m	50	35	8	
		Chiller for vac.	18	10	8	Essential in hot climates
Hang dry	2	1: 100m conv.	35	2	8	Capacity 1000 sides/day
Condition	2	1: 1800 mm	14	2	4	Wrapped overnight
Stake		1: 2000 mm	58	17	4	
Toggle	4	1: 1800 mm con.	94	25	16	
Crust sort	1+1 id					
Buffing+dedust	4	1: 1800 mm +dedust	82	40	16	Only CG. Normally 3×
Polish	1	1: 1800 mm	40	25	4	
Coater/drier	2+1 id	1: 1800 mm	55	15	10	
Spraying	4	1: 1800 mm	61	25	16	
Hand spray	1	Ventilated cabin	5	5		
Press print	4	1: 1370×1000 mm	97	40	16	
Rotary Iron	2	1: 1800 mm	90	28	4	
Measuring	2	1: 1800 mm	25	4	4	
Sorting	1 id	Table and lights				
Pack	2	Table				
Stores	1 id					
Scales		1: 300 kg	2			
Scales		2: 30 kg	1			
Compressor		1: 5 m^3/min	23	15	16	7 bar
Boiler	1 id	1: 3t steam/h	40	15	16	2 or 15 bar
Effluent	1 id	80 m^3/day	50	10	16	Pre-treatment

Operation	Worker	Equipment	Cost	kW	H/d	Detail
Office	3 id					
SUB-TOTAL	*47/12 id*		*1,191*	*508*		
Add 15%		7% spares+ 8% shipment	179			
TOTAL			**1,370**			

Technology allows for a mechanised production, to international market standards. The retanning drums have filters to clean the drum effluent. The effluent is treated to remove chromium and solids by precipitation and centrifuge.

Costings

CHEMICALS are estimated at US$ 0.49/sq.ft. (See *Annex 2*, showing wet-blue to crust cost of US$ 0.21/sq.ft and finishing cost of US$ 0.28/sq.ft).

Total here = US$ 0.49/sq.ft

LABOUR COSTING

From above 47 direct workers at US$ 120/month = US$ 67,680/year
12 indirect workers at US$ 270/month = US$ 38,880/year
Total US$ 106,560/year

FIXED OVERHEAD COSTING

Depreciation of machinery (estimated cost of US$ 1.37 mio.) over 10 years is US$ 137,000/year
Maintenance, budgeted at 3% of cost is US$ 41,000/year
Total US$ 178,000/year

VARIABLE OVERHEAD

1. The cost of power input at 460 kWh/t of daily input is calculated at EGP 0.18/kWh and taken for 300 days/year. This is a total of US$ 51,000/year (EGP 174,000/year).
2. Water usage is 10-13 m^3/t of wet-blue hide input: the cost is EGP 0.60/m^3. The 300 days annual charge is calculated from 80 m^3/day (7 × '10-13'). This is US$ 4,200 (EGP 14,400).
3. Effluent charges for complete tannery operation are at 4% of operating costs in Italy, which is 10% excluding the raw material. A retanning effluent is estimated to have a cost at a quarter of this full level so that a charge here is made of 2.5%, excluding raw material.

Conversion costs for the TOTAL annual production of 96,000 hides (192,000 sides) – all figures in US$.

Item	Cost/year.	Cost/hide	% costs	Comment
Chemicals	1,788,500	18.63	81.9	Average from above: retan and finish
Labour	106,500	1.11	4.9	
Overhead 1	178,000	1.85	8.1	Fixed – equipment. No buildings.
Overhead 2	55,200	0.58	2.6	Variable – power and water
Overhead 3	55,000	0.57	2.5	Variable – effluent
Total	**2,182,200**	**22.74**	**100.0**	

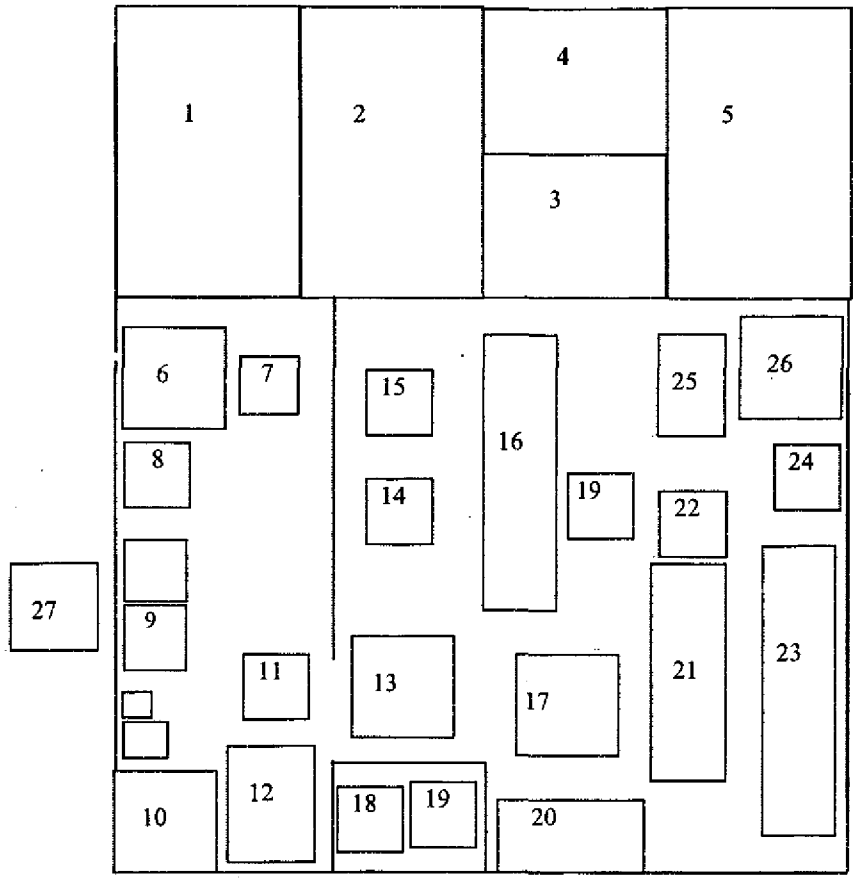
Working Capital is needed for

1.	Wet blue hides in store for 2 weeks.	
2.	Hides in work for 16 days.	
3.	Chemicals store for 3 months (including order, delivery etc.)	US$ 446,500
4.	Conversion costs of Work in Progress for 16 days	US$ 116,500
	TOTAL	**US$ 563,000**

Suggested layout for finished leather tannery from wet-blue hides

Production area of 1700 m^2 (50 m $\times$ 34 m) with the wet end section, up to the vacuum drier, being separated from the crust and finishing areas by a 15 m long wall.

Approximate scale 1:500



Key to plan

	Operation		Operation
1	Wet-blue hide store	15	Staking 2000 mm machine
2	Chemical stores	16	Toggling conveyor 1800 mm
3	Services – boiler 3 t steam	17	Crust sort
4	Personnel	18	Buffing/dedusting 1800mm
5	Offices	19	Polishing 1800 mm machine
6	Wet-blue sort area machine	20	Finishing office, colour mix
7	Sammying 1800 mm	21	Roller coater 1800 mm
8	Shaving 1800 machine	22	Rotary press 1800 mm
9	Dye and retan drums: 2 of 2.5×1.8 m, 1 of 2.0×1.5 m and 1.2×0.8 m	23	Spraying 1800mm
10	Dye house office and laboratory	24	Hydraulic press
11	Setting out 2,400mm machine	25	Measuring 1800mm
12	Vacuum drier 4×3 m, 2 table, + chiller	26	Sorting and despatch
13	Dried leather	27	Effluent pre-treatment
14	Conditioning 1,800 mm		

3. Finished leather production from raw hides

This design is a medium scale mechanised tannery working with whole hides, split in the lime, to produce finished leather. The retanning and finishing is in side leathers, with the splits being finished in the tannery to maximise earnings.

The *Input* consists of the processing equipment, personnel and chemicals, which are required to convert the raw cattle hides into finished leather for individual customers. The buildings need to have specific construction for supporting the process drums and for the drainage channels, as planned for effluent pre-treatment and chrome recovery.

The *Final Products* are finished side leather and a whole hide flesh split, as finished or suede. The products are for footwear or leather goods. Limed fleshings and trimmings can be a source of income; dog chews are produced from buffalo splits.

Production quantity is based on 300 hides/day, assumed to be an input of 6.6 t to yield 11,400 sq.ft finished upper leather and a 3,000 sq. ft. of whole butt splits each day. This is a total of 4.3 million sq.ft/year: 3.4 million sq.ft/year of upper and 0.9 million sq.ft/year of splits. The daily quantity of 600 sides and 300 whole butt splits gives a good machine utilisation – 120 pieces/h – with some double shifts.

Capital required is US$ 2.34 million for equipment, without allowances for bank costs, buildings, and any type local duty or tax. Full production needs a working capital of US$ 856,000 plus the costs of the raw hides in store and for 22 days Work in Progress. A conversion cost is estimated at US$ 25.32/hide and US$ 6.69/split, excluding raw material.

Area required is 3,500 m^2: 2,500 m^2 are for production and 1,000 m^2 are for non-production.

Personnel required are 88, including 15 indirect. These must include at least 2 leather technicians (liming/tanning and finishing), 1 engineer (machinery maintenance and effluent) and 1 laboratory technician (control laboratory, chrome recovery and effluent standards) and more supervision.
The costs are calculated at two different rates, US$ 4/day (EGP 13/day) and US$ 9/day (EGP 30/day), with 30 days/month. These rates represent the range of pay for calculations and it should be understood that it does not assume that all indirect workers are paid at the higher rate.

Production schedule, showing the Work in Progress, for sides and for splits is as follows:

Workday	*Process*	*Comments*
1	Soak	Overnight
2	Lime	Overnight
3	Fleshing, split, delime, pickle, tan	Overnight
4	Unload	Horse overnight
5	Rest	
6	Cut into sides, Sammy , sort	
7	Shave, weigh	
8	Retan, horse	
9	Set out, vacuum dry	
10	Hang dry	Overnight
11	Condition	Wrapped overnight

Workday	Process	Comments
12	Stake, toggle	
13	Crust sort	
14-17	Finishing FG	
14-20	Finishing CG	
18	Sort and measure FG	
19	Pack FG	
21	Sort and measure CG	
22	Pack CG	

Estimates in work days – Wet blue 6, Crust 7, Finished CG 7, Sort and pack 2: **total of 22 workdays.**

Basic pattern for finishing:

FG: Polish, 2 coats pigment; print and I coat pigment; spray 2 coats; plate; spray. = 4 days

CG: Buff & dedust; impregnate; dry; rebuff & dedust; finish as above (no polish) = 7 days

Splits: Coater (or hand padding) – 2 coats, smooth plate, coat/pad, haircell print, top spray.

Equipment costs are in US$ thousands, 'id' refers to indirect worker. The power and working time required are shown in kW and hours per day.

Operation	Workers	Equipment	Cost	KW	H/d	Detail
Store	4 + 1 id	Handcarts				check and sort
Handling	1	Forklift; electric	30		16	2 t capacity
Soak/lime	2 + 1 id	2: 4×4 drums	163	60	24	Fitted for hair-save
Flesh	2	1: 3100 mm	123	75	3	+ clean
Lime split	6	1: 3000 mm	119	25	3	+ clean
Tan	2 +1 id	1: 3.5×3.5 m drum	45	25	24	Grain split (4.8 t)
Tan		1: 2.5×5 m drum	26	25	24	Flesh split (1.5 t)
Handling		4: Hand pallet trucks	3			2 t loads
Sammy	2	1: 1800 mm thro'	61	25	3	
Shave	1	1: 1800 mm	76	55	5	Includes split
Water feed		Batch 1 m^3/min	17	15	16	Serves 5 drums
Retan/dye	4 + 1 id	2: 2.5×1.8 m drum	68	30	16	180 sides: 900 kg
Retan/dye		1: 2.0×1.5 m drum	27	10	16	100 splits: 500 kg
Trial drum		1: 1.2×0.8 m drum	12	5	8	
Control lab	1 id	Lastometer, pH etc.	10		8	Basic tests
Setting out	2	1: 2400 mm	80	45	8	Wide machine
Vacuum	8	1: 2 table 4×3 m	50	35	16	With splits
		Chiller for vacuum	18	10	16	Essential if hot
Hang dry	2	1: 100 m conveyor	35	2	16	1000 sides/day
Condition	2	1:1800 mm	14	2	4	Wrapped overnight
Stake	4	1: 2000 mm	58	17	8	With splits
Toggle	4	1: 1800 mm conveyor	94	25	8	
Crust sort	1 + 1 id					
Buffing	6	2: 1800 mm + dedust	140	80	16	3x: CG and splits
Polish	1	1: 1800 mm	40	25	3	% FG
Coater/drier	4 + 1 id	1: 1800 mm + tunnel	55	15	16	
Spraying	4	1: 1800 mm 1 tunnel	61	25	16	1 cabin

Operation	Workers	Equipment	Cost	KW	H/d	Detail
Hand spray	1	Ventilated cabin	5	5		
Press print	4	1: 1370×1000 mm	97	40		Up to 16 hours
Rotary press	2	1: 1800 mm	124	28	4	
Measuring	2	1: 1800 mm	25	4	4	
Sorting	1 id	Table and lights				
Pack	2	Table			8	
Stores	1 id					
Scales		1: 2 t	8			
Scales		1: 300 kg	2			
Scales		2: 30 kg.	1			
Compressor		1: 5 m^3/min, 7 bar	23	15	16	
Boiler	2 id	1: 3 t steam/h: 2-15 bar	40	15	16	1 extra id for shift
Cr recovery		9 m^3 batch	60	15	8	For 6-10 t input
Effluent	1 id	260 m^3 capacity	220	170	16	Pre-treatment
Office	3 id					1 extra id for shift
SUBTOTAL	*73/15 id*		*2,030*	*923*		
Add 15%		7% spares + 8% shipm.	180			+ installation
TOTAL			**2,335**			

Technology is fully mechanised to allow for a production to international market standards.. Retanning drums have filters to clean the drum effluent.

Splitting introduces a new process (*Annex 4*) and is done in the lime. This allows a more efficient and separate chrome tannage for sides and splits, yielding a larger and more valuable split, with chrome-free waste, and easier disposal.

An allowance is made for the daily input of 6-7 t to be 7-8 t fleshed weight. This is split to 5 t grain hides, 1.5 t flesh splits and 1 t waste (basis is of a 22 kg cattle hide to be 25 kg pelt weight yielding a 16 kg grain, 5 kg flesh split and 3 kg waste).

A chrome recovery unit and a full effluent pre-treatment plant are included. The chrome recovery can reduce the chrome costs by 25% with a payback period of 3 years. The estimated total tannery effluent volume of 260 m^3 (6.6 t × 40 m^3) is treated to remove sulphide by aeration and to reduce solids by precipitation and centrifuge.

Costing

CHEMICAL COSTING is estimated at US$ 21.66/hide of 22 kg and including the processed split (see *Annex 2*).

LABOUR COSTING

From above	73 direct workers at US$ 120/month	= US$ 105,120/year
	15 indirect workers at US$ 270/month	= US$ 48,600/year
	Total	US$ 153,720/year

FIXED OVERHEAD COSTING

Depreciation of machinery (cost estimate US$ 2.34 mio.) over 10 years	US$ 234,000/year
Maintenance, budgeted at 3% of cost is	US$ 70,200/year
Total	US$ 304,200/year

VARIABLE OVERHEAD

1. The cost of power input at 700 kWh/t of daily input is calculated at EGP 0.18/kWh, and taken for 300 days/year. This is a total of US$ 74,000 (EGP 250,000).
2. Water usage is 40 m^3/t of raw hide input. The cost for 1 m^3 is EGP 0.60. The 300 days annual charge is calculated from 264 m^3/day (6.6 $\times$ 40). This is US$ 14,000 (EGP 47,520).
3. Effluent charges for complete tannery operation are set at 4% of operating costs in Italy, equivalent to 10% excluding the raw material. A charge here is made on the basis of 10%, excluding the raw material.

Overall Costs for the total annual production of 90,000 hides and splits – approximately 4.3 mio. sq.ft. (3.4 mio. sq.ft upper with 0.9 mio. sq.ft splits). All figures are in US$.

Item	*Cost p.a.*	*Per hide*	*% costs*	*Comment*
Chemicals:	2,172,600	24.14	75.4	18.07 upper hide; 6.07 flesh split
Labour	154,000	1.71	5.3	
Overhead 1	304,200	3.38	10.1	Fixed (only machinery – no bildings).
Overhead 2	88,000	0.98	2.9	Variable – power and water
Overhead 3	302,100	3.34	10.0	Variable – effluent
Total	**3,020,900**	**33.57**	**100.0**	26.80 upper, 6.70 split

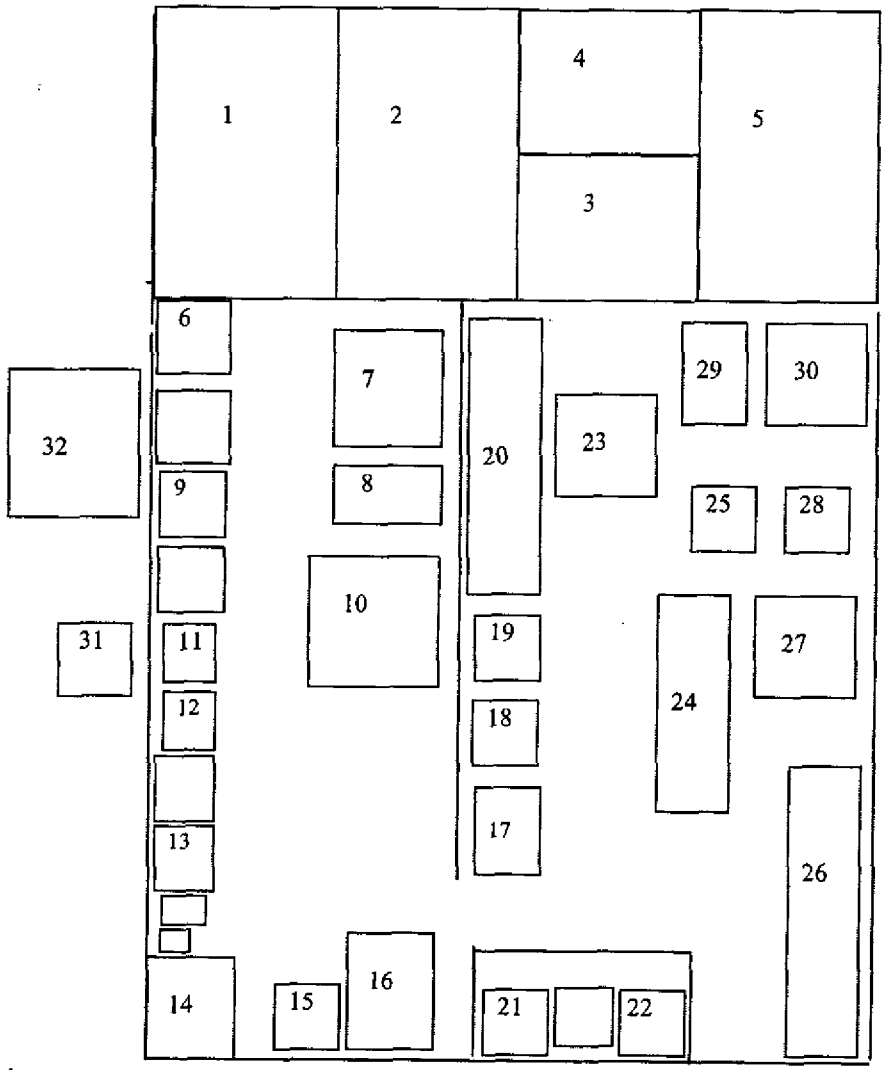
Working Capital is needed for

1.	Raw hides in store for 2 weeks.	
2.	Hides in work for 22 days.	
3.	Chemicals for 3 months (including order, delivery etc.)	US$ 644,500
4.	Conversion costs of Work in Progress for 22 days	US$ 211,400
	Total	**US$ 855,900**

Suggested layout for finished leather tannery from raw hides

Production area of 2500 m^2 (50 m $\times$ 50 m) with the wet end section, up to the vacuum drier, being separated from the crust and finishing areas by a 40 m long wall.

Approximate scale 1:500



Key to plan

	Operation		Operation
1	Raw hide store	17	Dried leather
2	Chemical stores	18	Conditioning 1800 mm
3	Services – boiler 3 t steam/ h	19	Staking 1800 mm machine
4	Personnel	20	Toggling 1800 conveyor
5	Offices	21	Buffing/dedusting 1800mm
6	Soak/lime 2 drums 4×4 m	22	Polishing 1800 mm machine
7	Fleshing 3100 mm machine	23	Crust sort
8	Splitting 3000 mm machine	24	Roller coater 1800 mm
9	Tanning 2 drums: 3×3 m, 2.5×2.5 m	25	Rotary press 1800 mm
10	Horsed overnight	26	Spraying 1800mm
11	Sammying 1800 mm machine	27	Finishing office, colour mix
12	Shaving 1800 machine	28	Hydraulic press 1370×1000
13	Dye and retan drums: 2 of 2.5×1.8 m, 1 of 2.0×1.5 m and 1.2×0.8 m	29	Measuring 1800mm
14	Dye house office and laboratory	30	Sorting and despatch
15	Setting out 2400mm machine	31	Chrome recovery for 9 m3
16	Vacuum drier 4×3 m, 2 table	32	Effluent pre-treatment 260 mm

4. Finished leather production from raw skins

This model is a complete tannery for processing grain sheep, or goatskins, from raw to finished state. It does not allow for any suede production, which is more specialised and more expensive. Allowance has been made for a part of the production to be dried without the vacuum drier.

The *Input* consists of the processing equipment, personnel and chemicals, which are required to convert the raw skins into finished leather for individual customers. The buildings need to have specific construction for supporting the process drums and for the drainage channels, as planned for effluent pre-treatment and chrome recovery.

The *Final Product* is a top finished sheep, or goat, skin suitable for footwear, leather goods and clothing. Lower grades will be for lining leathers and may be sold in the dyed state without further finishing. Chrome tannage is the normal process but a vegetable tannage could be given.

Production quantity is based on 2000 sheepskins/day (2-2.5 t/day) for optimum machine use; these are normally 1500 or 1600 mm working width and some of these are used for a 16 h/day. The output is about 10,000 sq.ft/day, yielding 3 million sq.ft/year.

Capital required is US$ 1.4 mio. for equipment, without allowances for bank costs, buildings, local duty or tax. Full production needs a working capital of US$ 240,000 plus the cost of the raw skins in store and for 18 days work in progress.

Area required is 2400 m^2 of which 1600 m^2 are for production and 800 m^2 are for non-production.

Personnel required are 77, of whom 14 are indirect. These have to include at least 2 leather technicians (wet work and finishing), 1 engineer (machinery maintenance and effluent plant) and 1 laboratory technician (control laboratory, chrome recovery and effluent standards).

Production schedule, showing the Work in Progress, is as follows:

Workday	*Process*	*Comments*
1	Soak	In paddle overnight
2	Drain, Paint, Unhair, Lime	170 skins in each painted pile. In paddle overnight
3	Lime	In paddle overnight
4	Flesh, Bate, Tan	In drum overnight
5	Rest	Horsed overnight
6	Sammy, sort, shave, weigh	
7	Retan and dye, horse	
8	Set out, vacuum, hang dry	Hung overnight
9	Rest	
10	Condition	Wrapped overnight
11	Stake, toggle	
12	Crust sort	
13-16	Finishing FG	
17	Sort and measure FG	
18	Pack FG	

Estimates in work days – Wet blue 5, Crust 7, Finished FG 4, Sort and Pack 2: **total of 18 workdays.**

Basic pattern for finishing as all Full Grain:

FG: Spray ground, 2 coats pigment, plate, spray, plate. Options to polish, dry shave and mill as required = 4 days.

Equipment costs are in US$ thousands, 'id' refers to indirect worker. The power and working time required are shown in kW and h/day.

Operation	*Workers*	*Equipment*	*Cost*	*kW*	*H/d*	*Detail*
Store	4 + 1 id	Handcarts				Check and sort
Soak		1 paddle: 7.5 m^3	20	10	20	
Lime paint	12 for	Manual			2	Or machine: cost 38
Unhair	Area	Manual			2	Or machine: cost 53
Liming	1 id	2 paddles: 7.5 m^3 ea.	40	20	24	
Flesh	2	2: 1600 mm	100	36	4	Limited time for transfer
Tanning	2 + 1 id	1: 2.5×2.5 m	26	20	20	2.5 t load
Water feed		1 m^3 per min.	17		16	Serves 5 drums
Sammy	1	1: 1800 mm	52	15	10	
Shave	1	1: 1300 mm	58	40	10	
Retan/dye	4 + 1 id	1: 2.5×1.8 m	34	15	8	1000 skins (900 kg)
Retan/dye		1: 2.0×1.5 m	27	10	16	600 skins (500kg)/2×/day
Trial drum		1: 1.2×0.8 m	11	5	8	
Setting out	1	1: 1600 mm.	48	15	10	
Vacuum	4	1: 1 table 4×2.6 m	34	20	8	8 skins/plate: 240/h
Chiller		For vacuum water	14	10	8	Essential for hot climate
Hang dry	2	1: conveyor	35	2	10	Capacity 3000 skins/day
Condition	2	1: 1800 mm	14	2	6	Wrapped overnight
Stake	2	1: 1600 mm	53	17	8	Through feed
Toggle	8	1: 1800 mm	94	25	16	Conveyor
Crust sort	1 + 1 id					
Coater/drier	4 + 1 id	1: 1800 mm	65	15	16	For soft leathers
Spraying	4	1: 1800/2 cabins	101	50	8	May need up to 16 hours
Polish	1	1: 1800 mm	40	25	8	Includes other roller
Milling	2	1: 2.5×1.7 m	30	8	16	
Rotary press	2	1: 1800 mm	90	28	16	
Measuring	2	1: 1800 mm	25	4	8	
Sorting	1 id	Table and lights			8	
Pack	2	Table			8	
Control lab	1 id	Basic tests	10		8	
Stores	1 id					
Scales		1: 2000kg	8			
Scales		1: 300 kg	2			
Scales		2: 30 kg	1			
Compressor		1: 5 m^3/min	23	15	16	7 bar
Boiler	1 id	1: 3 t steam/h	40	15	16	2 or 15 bar
Cr recovery		4 m^3 batch	30	15	8	2-3 t input of skins
Effluent	1 id	For 150 m^3/day	100	120	16	Pre-treatment

Operation	Workers	Equipment	Cost	kW	H/d	Detail
Office	3 id					
SUBTOTAL	*63/13id*		*1,222*	*557*		
ADD 15%		7% spares + 8% shipment/install.	183			+ installation
TOTAL			**1,405**			

Technology is modern and mechanised except for the manual painting and unhairing of the skins. Although this is an unpleasant job requiring protective clothing, it is retained here because it will produce a finer quality grain than drum unhairing and a less polluted effluent, as well as giving more employment with a worker taking 1.5 h for painting a pile of 170 skins. The pile is left to stand for 3-4 h and the unhairing by hand will take another 1.5 hours. The manual operation is also cheaper; a cost comparison is shown in *Annex 5*. No hand padding has been included in finishing although this could replace the roller coater for the initial coats; however the machines provide more opportunity for raising quality and reaching international standards.
A chrome recovery unit and a full effluent pre-treatment plant are included. The chrome recovery can reduce the chrome costs by 25% with a payback period of 3 years. The estimated total tannery effluent volume of 150 m^3 (2.5 t $\times$ 60 m^3) is treated to remove sulphide by aeration and to reduce solids by precipitation and centrifuge.

Costings

CHEMICALS are estimated at US$ 0.23/sq.ft (see *Annex 2*). It is assumed that all leathers are full grain, and that possibly a third of the production may be lower grade and sold as unfinished leather (linings or similar). This will mean that the average finishing cost is calculated as US$ 0.11/sq.ft, and the overall average is US$ 0.23/sq.ft.

LABOUR COSTING

From above	63 direct workers at US$ 120/month	=	US$ 90,720/year
	14 indirect workers at US$ 270/month	=	US$ 45,360/year
	Total		**US$ 136,080/year**

FIXED OVERHEAD COSTING

Depreciation of machinery (estimated cost US$ 1.4 mio.) over 10 years is	US$ 140,000/year
Maintenance, budgeted at 3% of cost is	US$ 42,000/year
Total	**US$ 182,000/year**

VARIABLE OVERHEAD

1. The cost of power input at 700 kWh/t of daily input is calculated at EGP 0.18/kWh and taken for 300 days/year. Taking input as 2.25 t/day, this is a total of US$ 25,014 (EGP 85,050).
2. Water usage for skins, and using paddles, is calculated at 60 m^3/t of input. The cost for 1 m^3 of water is EGP 0.60. The 300 days annual charge is calculated from 135 m^3/t/day (60 $\times$ 2.25). This is US$ 7,150 (EGP 24,300).
3. Effluent charges for complete tannery operation are at 4% of operating costs in Italy, equivalent to 10%, excluding raw material. The charge here is calculated on that 10% basis.

Overall Costs for the total annual production of 600,000 skins (about 3 mio. sq.ft). All figures in US$.

Item	*cost p.a.*	*per skin*	*% costs*	*Comment*
Chemicals	690,000	1.15	59.7	A third has no finish
Labour	136,080	0.23	11.8	
Overhead 1	182,000	0.31	15.7	Fixed (only machinery, no buildings)
Overhead 2	32,160	0.05	2.8	Variable – power and water
Overhead 3	115,200	0.19	10.0	Variable – effluent
Total	**1,155,840**	**1.93**	**100.0**	

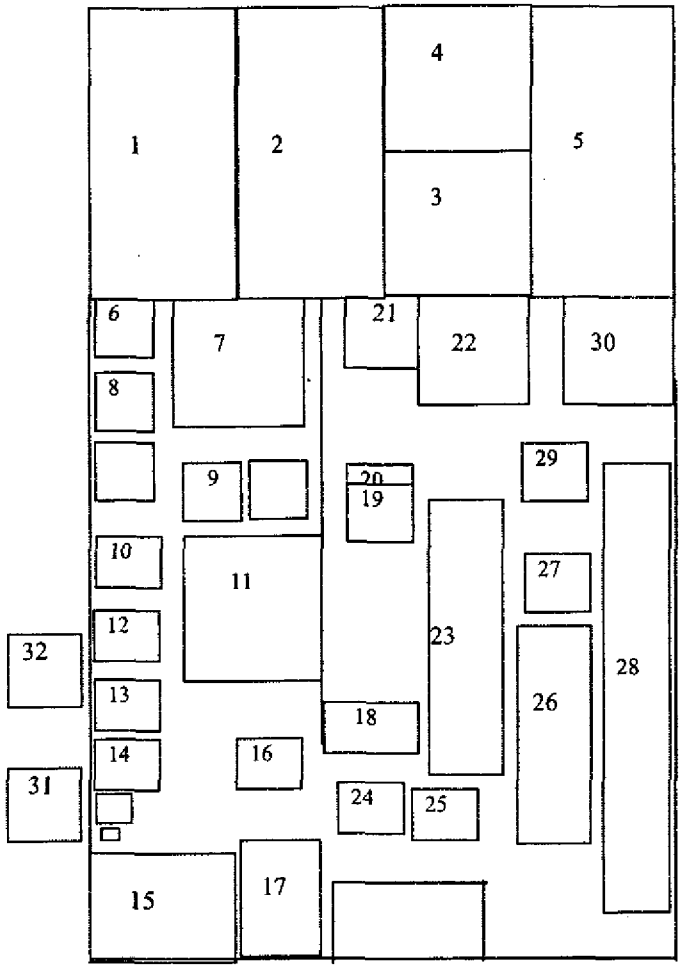
Working Capital is needed for
Raw skin store for 2 weeks.
Skins in work for 18 days.

Chemicals store for 3 months (including order, delivery etc.)	US$ 172,500
Conversion costs of Work in Progress, excluding raw material, for 18 days	US$ 69,500
Total	**US$ 242,000**

Suggested layout for finished leather tannery from raw skins

Production area of 1600 m^2 (40 m $\times$ 40 m) with the wet end section, up to the vacuum drier, being separated from the crust and finishing areas by a 29 m long wall.

Approximate scale 1:500



Key to plan

	Operation		Operation
1	Raw hide store	17	Vacuum drier 4×2.6 m 1 table
2	Chemical stores	18	Dried leather
3	Services – boiler 3 t steam/h	19	Conditioning 1800 mm st. thro'
4	Personnel	20	Staking 1600 mm through feed
5	Offices	21	Crust sort
6	Soak paddle 7.5 m^3	22	Finishing office, colour mix
7	Lime painting and unhairing	23	Toggling 1800 mm conveyor
8	2 lime paddles 7.5 m^3	24	Milling drum 2.5×1.7 m
9	2 fleshing machines 1600 mm	25	Polishing 1800 mm
10	1 tanning drum 2.5×2.5 m	26	Roller coater 1800 mm
11	Horsed overnight	27	Rotary press 1800 mm
12	Sammying 1800 mm	28	Spraying 1800 mm, 2 cabins
13	Shaving 1300 mm	29	Measuring 1800 mm
14	Dye and retan drums: 1 of 2.5×1.8 m, 2×1.5 m and 1.2×0.8 m	30	Sort and despatch
15	Dye house office and laboratory	31	Chrome recovery 4 m^3
16	Setting out 1600 mm	32	Effluent pre-treatment 150 m^3

5. Production of finished and suede leathers from limed splits

This type of specialised leather manufacture will use the flesh splits resulting, as a by-product, from other tannery productions. The raw material may be in limed, pickled or wet-blue condition and allows the tanner a lot of flexibility to produce a wide range of profitable leathers at competitive prices. It can perform very efficiently as an independent unit if there is a sufficient supply of raw material.

The tannery design is at a medium production level and allows for a production of finished and suede splits. Dyed suede is a more demanding production, with regard to expertise and raw material, but it can provide an increased profit margin.

The *Input* consists of the processing equipment, personnel and chemicals, which are required to convert the flesh splits into finished leather for individual customers. The buildings need to have specific construction for supporting the process drums and for the drainage channels, as planned for effluent pre-treatment.

The *Final Products* can include chrome tanned and vegetable tanned splits. The chrome leathers may be either finished or suede for shoe uppers or linings, or as suede for garments or industrial gloves. Suede splits can have a good market for training shoes and the vegetable tanned leathers have another outlet in leather goods, soles and insoles. The present plans do not allow for any pure vegetable tanned split leathers.

Production quantity is based on processing 1,000 whole hide splits per day, about 5.0 t limed weight, or equivalent, producing about 10,000 sq.ft/day. This would be 300,000 pieces/year. It is assumed that the pelt weight of a 10 sq.ft hide flesh split is 5.0 kg, with a wet-blue shaved weight of 2.5 kg (yields of 2.0 and 4.0 respectively). Dry crust weight is 1.5 kg.

Capital required is US$ 1.2 million for equipment without any allowances for bank costs, buildings and any type local duty or tax. Full production needs a working capital of US$ 520,000 plus the costs of the splits in the raw material store and for 14 days work in progress. A conversion cost of US$ 7 per whole butt split is estimated, which excludes the raw material.

Area required is 2400 m^2: 1600 m^2 production and 800 m^2 for non-production.

Personnel required are 57, of whom 12 are indirect. These have to include at least 2 leather technicians (wet work, finishing and suede production) and an engineer (machinery maintenance and effluent plant).
Their costs are calculated at two different rates, US$ 4/day (EGP 13/day) and US$ 9/day (EGP 30/day), with 30 days/month. These rates represent the range of pay for calculations and it should be understood that it does not assume that all indirect workers are paid at the higher rate.

Production schedule showing the Work in Progress is as follows:

Workday	*Process*	*Comments*
1	Delime, pickle, tan	Overnight in drum
2-3 (veg.)	Vegetable tan piled	Well covered
2	Chrome piled	
3	Sammy, sort, shave	
4	Retannage	As required
4	Horsed	Overnight
5	Set out well, dry	Vacuum, then hang dry? or only hang?
6	Dry and pile	
7	Stake, buff, dedust	Now as crust for suede, see below
8-10	Finishing as required	Can be all by hand except press work
8	Sorting suede crust	Prepare dye loads
9	Suede dyeing	
10	Set out suede and dry	Vacuum, then hang dry? or only hang?
11	Stake dyed suede, mill, toggle	
11	Sort + measure finished	
12	Top buff suede, dedust	
12	Pack finished	
13	Sort + measure suede	
14	Pack suede	

Estimates in work days – Crust 7, Finished 3, Suede 5, Pack 2, **total of 12-14 workdays**
Basic pattern for finishing: Coater (or hand padding) – 2 coats, smooth plate, coat/pad, haircell print, spray 2×.
Suede is dyed from special retanned crust as above.

Equipment costs are in US$ thousands, 'id' refers to indirect worker. The power and working time required are shown in kW and hours per day.

Operation	*Workers*	*Equipment*	*Cost*	*KW*	*H d*	*Detail*
Store	2	Handcarts				Check and sort
Relime option		Pits in store	?			For limed splits only
Delime/tan	3 + 1 id	2: 2.5×2.5 m OD	93	25	20	2500 kg/drum
Sammy	2	1: 1800 through	61	25	8	
Sort	1 id	Table and lights				
Shave	2	1: 1800 mm	58	55	8	
Retan	4 + 1 id	1: 2.5×1.8 m OD	24	15	16	900 kg shaved 2x/day
Retan		1: 2×1.5 m OD	15	10	8	500 kg shaved
Set out	2	1: 2400 mm	80	45	8	
Vacuum dry	4	1: 1 table 4×3 m	50	40	8	With chiller. Suede: 8+ h
Hang dry	2	100 m with drive	35	2	8	Could be all sticks.
Stake	2	1: 1600 mm thro'	53	17	4	
Buff/dedust	4	1:1800 mm	56	40	12	830 splits 3x. Suede:12+
Buff –suede	1	1: 800 mm	22	10	8	Extra needed
Sort crust	1 id	Table and lights				
Coater/drier	4	1: 1800 mm	54	15	12	3× or + 10 workers?

Operation	Workers	Equipment	Cost	KW	H d	Detail
Press	4	1: 880×1000 mm	97	40	16	
Spray	2 + 1 id	1: 1800 mm	61	25	8	1 cabin + tunnel
Measure	2	1: 1800 mm	25	4	4	Electronic
Sort	1 id	Table and lights				
Pack	1	Table				
Dye –suede	2 + 1 id	1: 2.5×1.8 m. OD	24	15	16	500 kg dry 2×/day
Dye – suede		1: 2×1.5 m OD	15	10	16	250 kg dry 1-2×/day
Trial – suede		1: 1.2×0.8 m OD	12	10		Trial dyeing
Mill-suede	2	1: 2.5×1.7 m OD	30	8	16	
Toggle-suede	As team	1: machine 3618	48	27	8	Compact type
Control lab	1 id	Basic	10		8	Control
Scales		1: 300 kg	2			
Scales		2: 30 kg	1			
Compressor		1: 5 m^3/min	23	15	16	7 bar
Boiler	1 id	1: 3 t steam/h	40	15	16	2 or 15 bar
Cr recovery		2.5 m^3/day	25	10	8	If tanning, small scale
Effluent	1 id	30 m^3/day	50	35	6	According to scale
Office	2 id					
SUBTOTAL	*45/12 id*		*1,064*	*513*		*Extras: suede production*
Add 15%		7% spares + 8% shipment	160			+ installation
TOTAL			**1,224**			

Technology covers a wide range of tanning and retanning methods to cover the different raw materials and wide variety of final leathers. The daily input is divided between 2 tanning drums to allow flexibility in production.

If the splits arrive in the limed state, ideally they will go into production without delay. However, it is also practical to store them for a short time in weak lime liquor. Productions from the lime have the advantage of a known and uniform tannage.

In contrast, wet-blue leathers may be stored for longer periods. As they are usually from a number of different sources, a re-chroming process is normal to reduce the variations.

Other possibilities could include the slower vegetable tannage or the special retanned crust for better quality suede dyeing. The majority is expected to be chrome tanned with a suitable retannage to assist finishing. Here also there is a lot of flexibility from basic hand padding to special foam finishes from the roller coater. The high performance finishes have increased the added value of splits. Suede is prepared from a special crust with extra buffing. This dry crust is then wet back, dyed and dried before a final buffing. The special dyestuffs are a significant extra cost, but there are no finishing chemical costs.

The effluent requires less pre-treatment than a full tannery operation but still needs attention, depending on actual production mix and scale. A small chrome recovery plant is included. Solids in the main effluent will be reduced by precipitation and centrifuge.

Costings

CHEMICALS are estimated at US$ 0.56/sq.ft, using the proportion of 80% finished/20% suede for the basic costs of US$ 0.60/sq/ft for finished and US$ 0.40/sq.ft for suede splits (see *Annex 2*).

LABOUR COSTING

From above	45 direct workers at US$ 120/month	=	US$ 64,800
	12 indirect workers at US$ 270/month	=	US$ 38,880
	Total		**US$ 103,680**

FIXED OVERHEAD COSTING

Depreciation of machinery (estimated cost of US$ 1.21 mio.) over 10 years	US$ 122,400
Maintenance, budgeted at 3% of cost is	US$ 36,700
Total	**US$ 159,100**

VARIABLE OVERHEAD

1. The cost of power input at 460 kWh/t of daily input is calculated at EGP 0.18/kWh and taken for 300 days/year. This is a total of US$ 36,500/year (EGP 124,200/year).
2. Water usage is 30 m^3/t of input. The cost of 1 m^3 is EGP 0.60. The 300 days annual charge is calculated from 150 m^3/day (5 $\times$ 30 m). This is US$ 7,900 (EGP 27,000).
3. Effluent charges for complete tannery operation are at 4% of the operating costs in Italy, equivalent to 10% excluding the raw material. As the split processing is after the liming and unhairing, the costs are estimated at half the full cost (5% of costs excluding the raw material).

Overall Costs for the total annual production of 300,000 pieces. All figures are in US$.

Item	*Cost p.a.*	*per split*	*% costs*	*Comment*
Chemicals	1,680,000	5.60	80.7	Average from above as 80/20
Labour	103,680	0.34	4.9	
Overhead 1	159,100	0.50	7.2	Fixed: machinery. No buildings
Overhead 2	44,400	0.15	2.2	Variable – power and water
Overhead 3	104,590	0.35	5.0	Variable – effluent
Total	**2,091,770**	**6.94**	**100.0**	

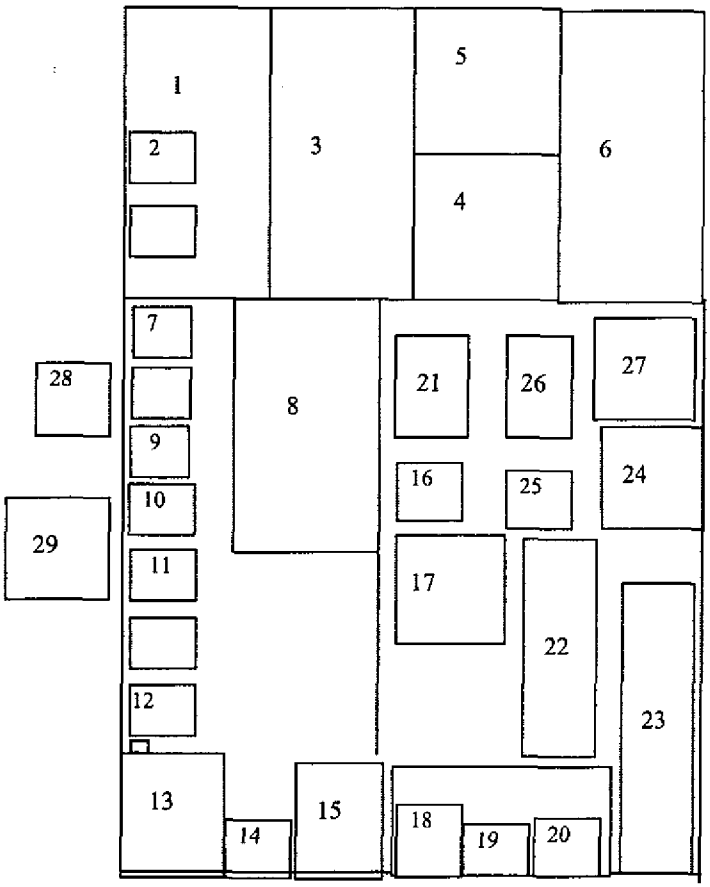
Working Capital is needed for
Limed/ wet-blue split store for 2 weeks.
Splits in work for 14 days.

Chemicals store for 3 months (including order, delivery etc.)	US$ 420,000
Conversion costs of Work in Progress for 14 days, with a value of	US$ 98,000
Total	**US$ 518,000**

Suggested layout for finished and suede split leather tannery

Production area of 1600 m^2 (40 m × 40 m) with the wet end section, up to the vacuum drier, being separated from the crust and finishing areas by a 29 m long wall.

Approximate scale 1:500



Key to plan

	Operation		Operation
1	Split store:limed/ wet-blue/ pickle	16	Staking machine 1600 mm
2	2 limed splits storage pits	17	Split crust sort
3	Chemical stores	18	Buffing and dedusting 1800 mm
4	Services – boiler 3 t steam/ h	19	Buffing 800 mm
5	Personnel	20	Milling drum 2.5 x 1.7 m
6	Offices	21	Toggling 3618 compact
7	2 tanning drums 2.5 x 2.5 m	22	Roller coater 1800 mm
8	Tanned splits piled	23	Spraying 1800 mm
9	Sammying machine 1800 mm	24	Finishing office, colour mix
10	Shaving 1800 mm	25	Hydraulic press 1370x1000 mm
11	2 retanning drums:2.5x1.8, 2x1.5	26	Measuring 1800 mm
12	2 suede dye drums:2.5x1.8,2x1.5 and trial drum 1.2x 0.8	27	Sorting and despatch
13	Dye house office and laboratory	28	Chrome recovery for 2.5 m3
14	Setting out 2400 mm	29	Effluent pre-treatment 30 m3
15	vacuum drier 1 table 4x3 m		

6. Heavy vegetable tanned leather production from raw hides

This design is for a mechanised tannery working with a mixture of pits and drums to produce a well tanned sole leather from Culattas (whole hides without the shoulders). Shoulders are cropped (cut) after fleshing for a separate, and faster, drum tannage for insoles, or similar. A lighter vegetable tannage of the shoulders and bellies could make such leather for bags, small leather goods, or sandals. The extra investment required is not viable at the present production level.

The *Input* consists of the processing equipment, personnel and chemicals, which are required to convert the raw cattle hides into finished leather for individual customers. The buildings need to have specific construction for supporting the process drums and for the drainage channels, as planned for effluent pre-treatment.

The *Final Products* are in a range of thick and firmer materials, for example, the heavy vegetable tanned leather for soles (3-7 mm), insoles (3-4 mm), and belts (2 mm). These may be sold as Culattas (the whole hide minus the shoulder), whole Butts, Bends (half butts), Shoulders and Bellies.

Production quantity is based on processing 4.5 t/day (200 hides of 22 kg, or 150 hides of 30 kg). This is estimated to produce 3.0 t/day of finished heavy leather, or 900 t/year.

Capital required is US$ 1.0 mio. for equipment, without allowances for bank costs, buildings and any local duty or tax. It is difficult to obtain new equipment prices for some specialised operations and the reconditioned machinery market can be more rewarding. Full production needs a working capital of US$ 348,000 plus the costs of the hides in store and for 26 days Work in Progress. A conversion cost to heavy leather (Culatta and shoulder) of US$ 21.60/whole hide – or US$ 0.96/kg. of input – is estimated, excluding the raw material.

Area required is 2750 m^2: 2000 m^2 are for production and 750 m^2 are for non-production. Extra area is needed for the pits and the longer process time.

Personnel required are 36, of whom 6 are indirect. These have to include at least 1 leather technician (tanner) and an engineer (machinery maintenance and effluent plant).
The costs are calculated at two different rates, US$4/day (EGP 13/day) and US$ 9/day (EGP 30/day), with 30 days/month. These rates represent the range of pay for calculations and it should be understood that it does not assume that all indirect workers are paid at the higher rate.

Production schedule, showing the Work in Progress is as follows:

Workday	*Process – Hide/Culatta*	*Process –Shoulder*	*Comments*
1	Soak drum. 2-3 rpm		Over night.
2	Lime drum – first stage		Hair-save system
3	Lime drum – second stage		White lime
4	Fleshing and cut into Culatta and Shoulder	Split shoulder only	Now separate process; could include bellies
4 -5	Delime and pretan	Delime, pickle, pretan	2-3 rpm
5 -13	Pit tanning – 3 stages		
5 – 6		Drum tannage 2-3 rpm	
6 – 8		Horsed/ well covered	

Workday	*Process – Hide/Culatta*	*Process –Shoulder*	*Comments*
9		Sammy, shave	Finish as Culattas?
10		Bleach and oil, retan?	
12		Set, hang, slow dry	
14-16	Drum tannage 2-3 rpm	Slow dry and set out	
17		Dry and heavy roll	
16- 18	Culatta: piled/well covered		
18		Weigh and sort	
19	Sammy, shave	Pack	
20	Bleach and oil. 10-12 rpm		
21	Set out, hang for slow dry		
21-24	Slow dry and setting out		Adjust dry for locality
25-26	Drying and heavy rolling		
27	Weigh and sort		
28	Pack		

Estimated *production time* for the sole leather is 28 workdays, others as 19 workdays; average of 26.

Equipment costs are in US$ thousands, 'id' refers to indirect worker. The power and working time required are shown in kW and hours per day.

Operation	*Workers*	*Equipment*	*Cost*	*kW*	*H/d*	*Detail*
Store	4 + 1 id	Handcarts				Check and sort
Soak/lime		3: 3.5×3.5 m drums, for hair-save and recycle	180	90	24	2 -3 rpm
Flesh	2	1: 2700 mm	109	75	2	+ cleaning
Cutting	Team	Manual				
Splitting	4	1: 1800 mm	106	18	2	Limed shoulders
Delime etc.	2 + 1 id	1: 3×3 m drum 4-5 rpm	35	30	20	3.4 t of Culattas
Delime tan		2: 2×2 m drum 5 rpm	42	20	24	1.0 t of Shoulders
Tanning	6	18 pits: 2.5x2.5x2 m	10?	25?	24	Pumps and rockers?
Tanning	2 + 1 id	2: 3×3m drum 2-3 rpm	70	60	24	3.4 t of Culattas
Sammying	2	1: 1800 mm thro'	61	25	3	
Shaving	1	1: 1800 mm	76	55	5	
Bleach/oil	2	1: 3.0×2.0 m drum	27	16	16	10-12 rpm
Drum set	1	1: heavy drum setting	30	10	8+	4×
Rolling	1	1: heavy leather	60	18	8	2×
Hang dry	2 + team	Sticks and fans	5?	15	24	Separate
Sort, pack	1 + 1 id	Table and lights				
Scales		1: 2 t	8			
Scales		1: 300 kg	2			
Scales		1: 30 kg	1			
Effluent	1 id	180 m^3/day	100	100	24	Pre-treatment
Office	1 id					
SUBTOTAL	*30 + 6 id*		*922*	*557*		
Add 15%		7% spares + 8% shipping	138			+ installation
TOTAL			**1,060**			

Workers are spread through different operations as a team.

Technology of vegetable tanning here is for a system of pits and drums, which is faster than the traditional "all pit" system and produces better quality leather than the rapid 'all drum' system. It has a daily input of raw hides, and shoulders are cropped (cut) after fleshing for a separate drum tannage.

This can produce insole leather, but also provides for some flexibility of production.

The use of drums allows a more uniform, and therefore better, quality of production compared with pits. It is also faster.

Soaking and liming is in drums. The unhairing and liming system (hair-save) in the drum is designed for clean technology and to reduce the cost of treating the effluent by 30-40%. After fleshing, the shoulders are cropped of to follow the different process. It is estimated that 1.0 t of shoulders will be removed (23% of the hide), leaving about 3.4 t of Culattas for the pit/drum tannage. It is also an option to cut the bellies at this time, if they are more profitable in another tannage. The shoulders are split as required. Each type is given a complete deliming and a particular pre-tannage, before the shoulders have a rapid drum tannage of 2 days.

The main vegetable tannage is for the Culattas and given as a pit tannage of 9 days, followed by 2 days in a drum to achieve a solid, good quality product. Tan strength increases through 3 stages of pits to the drum and the liquors are recycled between them, adjusting Beaume from 4, 7-9, 12 and 27 respectively. 2 Culattas are hung on each stick, with the butt end down, and it is estimated that

there are 50 sticks in 2.5 m length. 6 pits correspond to each stage. There has to be a daily movement here, which is either a rocker system or manually hauled out and in. A counter current circulation system ensures an efficient use of tanning materials.
The finishing is conventional with bleaching and oiling in a drum and slow drying with setting out. Lighter weight leathers would involve much more finishing equipment.
The design for the liming drums includes the recycling and filters to allow for the hair saving method, and reduces the solids in the effluent.
The drying and shedding procedure will always have to be modified for the local conditions of humidity and temperature. It is assumed that the ambient temperature is high enough for the drying and that no extra heating is needed. A slow dry is needed to prevent migration of loose tannin to the surface.
The estimated total tannery effluent volume of 180 m^3 (4.5 t $\times$ 40 m^3) is pre-treated to remove sulphide by aeration and to reduce solids by precipitation and centrifuge. Although there is no chromium problem in the effluent from pure vegetable tanning, the Biological Oxygen Demand (BOD) is much higher than a chrome tannery effluent. A suitable secondary treatment system (biological) is needed in the receiving domestic scheme.

Costings

CHEMICAL COSTS are estimated at US$ 0.70/kg raw hide, or US$ 1.05/kg finished leather (yield of 67%) – see *Annex 2*.

LABOUR COSTING

From above	30 direct workers at US$ 120/month	= US$ 43,200/year
	6 indirect workers at US$ 270/month	= US$ 19,440/year
	Total	**US$ 62,640/year**

FIXED OVERHEAD COSTING

Depreciation of machinery (estimated at US$ 1.06 mio.) over 10 years	US$ 106,000/year
Maintenance, budgeted at 3% of cost is	US$ 31,800/year
Total	**US$ 137,800/year**

VARIABLE OVERHEAD

1. Cost of power input is estimated at 460 kWh/t of daily input is calculated at EGP 0.18/kWh and taken for 300 days/year. This is a total of US$ 10,960 (EGP 37,300).
2. Water usage is 40 m^3/t of raw input. The cost for 1 m^3 is EGP 0.60. The 300-day charge is calculated from 180 m^3/day. This is US$ 9,530 (EGP 32,400).
3. Effluent charges in Italy are 4% of operating costs, equivalent to 10% of costs excluding raw material. The estimates here are made on that 10% basis.

Overall Costs for the total annual production of 1,350 t of hide input (about 900 t of heavy leather output) is related to 200 hides at 22.5 kg average. All figures in US$.

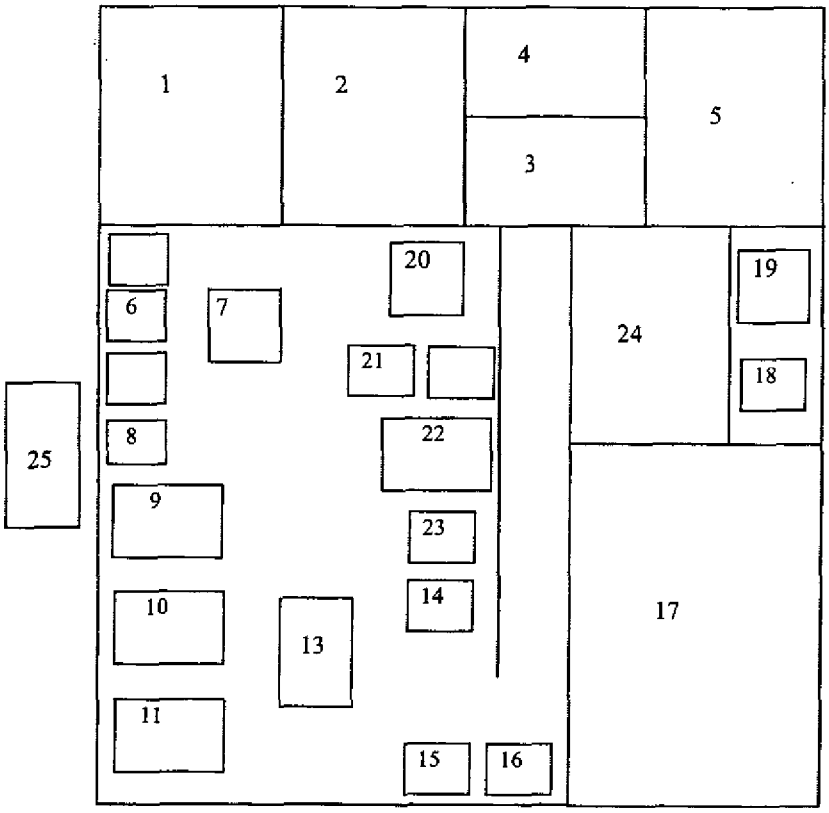
Item	*Cost p.a.*	*Per hide*	*% costs*	*Comment*
Chemicals	945,000	15.75	73.0	
Labour	62,640	1.04	4.8	
Overhead 1	137,800	2.30	10.6	Fixed – only machinery. No buildings
Overhead 2	20,490	0.34	1.6	Variable – power and water
Overhead 3	129,500	2.16	10.0	Variable – effluent
Total	**1,295,430**	**21.59**	**100.0**	

Working Capital is needed for

1. Raw hide store for 2 weeks.
2. Hides in work for 26 days.
3. Chemicals store for 3 months (including order, delivery etc.) US$ 236,250
4. Conversion costs of Work in Progress for 26 days. US$ 112,270

Total **US$ 348,520**

Suggested layout for heavy leather tannery from raw hides
Production area of 2000 m^2 (50 m $\times$ 40 m) with the wet end section, up to drum setting, being separated from the drying and finishing areas by a 31 m long wall.
Approximate scale 1:500



Key to plan

	Operation		Operation
1	Raw hide store	14	Sammying 1800 mm
2	Chemical stores	15	Bleach and oil: 1 drum 3x2 m
3	Services	16	Drum setting out machine
4	Personnel	17	Culattas hung to dry – 5 days
5	Office	18	Heavy rolling machine
6	3 soak/lime drums 3.5x3.5 m	19	Sort and pack
7	Fleshing machine 2700 mm	20	Splitting machine 1800 mm
8	Delime/pretan Culattas: drum 3x3m	21	Delime/tan shoulders: 2 drums 2x2 m
9	6 tanning pits – first stage Culattas	22	Shoulders piled after tannage – 2 days
10	6 tanning pits – second stage Culattas	23	Shaving machine 1800 mm
11	6 tanning pits – third stage Culattas	24	Shoulders hung to dry – 5 days
12	2 tanning drums 3x3 m - Culattas	25	Effluent pre-treatment – 180 m^3
13	Culattas piled after tannage – 2 days		

Annex 1

Equipment

This list is only indicative and there are other suppliers, in addition to those listed below.
All of these prices are also only an INDICATION of the FOB costs because – the local commission will vary, the exchange rate changes, there is no allowance for any type of local duty/tax and there are always special requirements for equipment and extras. They are not related to any specific country. Discounts are certainly possible for large orders etc.

Always allow an extra 15%: 7% for Spares to be ordered with the equipment and 8% for Shipping and Installation.
Comparative costs are US$ thousands. Drum capacity is volume, only 40% is used. Hides are 20-22 kg/pc.

Item	*Description*	*Capacity (/h) kW*	*Cost - a*	*Cost - b*	*Cost – c*
Water batching	Feeds 5 drums	1 m^3/min 15	17 PAJ	17 ITPR	
Water batching	6 to 12 drums	?	22-24 VAL		
Lime drum	2.0x2.0m OD	4.5 m^3: 0.75 t	18*VAL	20 ITPR	21*PAJ
Lime drum	2.5x2.5m OD	10 m^3: 1.6 t	26* PAJ	26* VAL	30 ITPR
Lime drum	3.0x3.0m OD	17 m^3: 2.7 t 30	33* PAJ	38* VAL	40 ITPR
Lime drum	4.0x4.0m OD	43 m^3: 7 t 30	60 ITPR	61*PAJ	64* VAL
Lime paddle	7.5 m^3	2.25 t 10	20 ITPR	26* PAJ	
Lime paddle	8.5 m^3	2.55 t	28 VAL		
Lime paddle	15 m^3	4.5 t	30 ITPR	36 VAL	37 PAJ
Sulphide applicat.	1800 mm	400 skins	38 F-V		
De-wooling	1600 mm	200 skins	53 M-T		
Fleshing	1600 mm	200 skins 18	46 CM	48 AL	53 M-T
Fleshing	2200 mm	100 sides/hides	111 RIZ		
Fleshing	2700 mm	100 hides 75	109 POL	115 RIZ	
Fleshing	3100 mm	120 hides 75	123 M-T	117 RIZ	
Lime splitting	1800 mm	120 sides 18	106 MSC	137 riz	
Lime splitting	2400 mm	120 sides/hides	139 RIZ		
Lime splitting	3000 mm	120 hides 25	119 MSC	139 M-T	143 RIZ
Tanning	2.0x2.0 m OD	4.5 m3: 1.1 t	21 PAJ*	19* VAL	

Item	Description	Capacity (/h) kW	Cost - a	Cost - b	Cost – c
Tanning	2.5×2.5 m OD	10 m^3: 2.5 t 25	26 PAJ*	28* VAL	
Tanning	3.0×3.0 m OD	17 m^3: 4.3 t 30	35 PAJ*	41 VAL*	
Tanning	3.5×3.5 m OD	28 m^3: 7 t 25	45 PAJ*	46 VAL*	50 ITPR
Samm st/thro'	1800 mm	250 skins 15	61 3p	102 M-T	
Samm st/thro'	1800 mm	120 sides 25	61 3p	102 M-T	
Samm st/thro'	2100 mm	120 sides	65 3p	109 RIZ	
Samm st/thro'	2400 mm	120 sides	68 3p	74 BAU	110 RIZ
Samm st/thro'	2700 mm	120 hides	72 3p	92 CM	109 BAU
Samm st/thro'	3000 mm	150 hides 25	75 3p	114 RIZ	122 M-T
Samm st/thro'	3200 mm	150 hides	79 3p		
Reciproc. Sammy	1600 mm	200 skins	52 CM		
Reciproc. Sammy	1850 mm	100 sides	88 CM		
Reciproc. Sammy	2250 mm	100 sides	89 CM		
WB splitting	1800 mm	150 sides	100 MSC	132 RIZ	
WB splitting	2400 mm	150 sides or 120 hides	136 RIZ		
Dry shaving	1500 mm	200 skins	80 M-T		
Shaving	1300 mm	200 skins 40	58 AL		
Shaving	1500 mm	200 skins	66 RIZ		
Shaving	1700 mm	90-120 sides	68 RIZ		
Shaving	1800 mm.	90-120 sides 55	58 AL	76 M-T	85 POL
Shaving	1900 mm	90-120 sides	106 RIZ		
Retan/Dyeing	3.0×2.0 m OD	11m^3: 1.5 t 16	27 PAJ*	30 VAL*	35 ITPR
Retan/Dyeing	2.5×1.8 m OD	7 m^3: 0.9 t 15	24 PAJ*	24 VAL*	25 ITPR
Retan/Dyeing	2.0×1.5 m OD	3.6 m^3: 0.5 t 10	22 PAJ*	22 VAL*	18 ITPR
Sammy/set	1600 mm	200 skins 15	48 AL	52 M-T	52 M-T
Setting out	2750 mm	100 sides	85 CM		
Setting out	2700 mm	100 sides	99 POL	108 CTG	111 BAU
Sammy/set	2400 mm	100 sides 45	80 AL	113 RIZ	
Sammy/set	3000 mm		105 M-T		
Vacuum	2 tables 4×2 m	360skins (6 workers)	40 FIN		
Vacuum	3 tables 4×2 m	540 skins	50 FIN		

Item	Description	Capacity (/h) kW	Cost - a	Cost - b	Cost – c
Vacuum + chiller	1 table 4×2.6 m	30 side or 240 skin 30	54 CTG		
Vacuum + chiller	2 tables 4×2.6 m	60 sides/480 skins	127 CTG		
Vacuum + chiller	3 tables 4×2.6 m	120 sides or 480? skins	157 CTG		
Vacuum + chiller	4 tables 4×2.6 m	180 sides	195 CTG		
Vacuum + chiller	5 tables 4×2.6 m	180? sides	230 CTG		
Vacuum	1 table 4×3 m	45 sides or 360 skin 35	34 FIN	47 CTG	
Chiller for	1 table 4×3 m	10	14 CTG		
Vacuum	2 tables 4×3 m	90 sides or 720 skins	47 FIN	114 CTG	
Chiller for	2 tables 4×3 m		18 CTG		
Vacuum	3 tables 4×3 m	135 sides or 720? skins	63 FIN	140 CTG	
Chiller for	3 tables 4×3 m		22 CTG		
Vacuum	2 tables 5×2 m	480 skins	44 FIN		
Vacuum	3 tables 5×2 m	720 skin? (8workers)	56 FIN		
Rotovac GT	6×1.8 m	100 sides	122 M-T		
Overhead chain	100 m	10 sides or 30 skins/m	15 ITPR	28 F-V	29 POL
Chain drive	Up to 250 m	2	5 ITPR	7 F-V	
Conditioner	1800 mm	200 sides or 800 skin 2	14 POL	15 F-V	
Conditioner	2200 mm	240 sides or 1000 skins	17 F-V		
Conditioner	3000 mm	180 hides or 240 sides	19 F-V		
Rotary staker	1700 mm	200 skins or splits	48 AL		
Stake st./through	1600 mm	240 sides 17	53 CTG		
Stake st/through	2000 mm	240 sides 17	58 CTG		
Toggle conveyor	1800 mm 5×19 m	120 side or 140 skin 25	94 F-V		
Toggle machine	1512: 15 m^2	100 skins only 18	39 F-V		

Item	Description	Capacity (/h) kW	Cost - a	Cost - b	Cost – c
Toggle machine	3618: 20 m^2	40 side or 120 skin 27	48 F-V		
Buffing	800 mm	200 skins 10	21 AL		
Buffing	1300 mm	200 skins	36 AL		
Dedusting	1300 mm		24 AL		
Buffing	1500 mm	200 skins	78 M-T		
Dedusting	1500 mm	1400 skins	SET M-T		
Wet buffing	1500 mm	200 skins	54 AL		
Buffing	1800 mm	140 sides 40 for	35 AL	71 FOR	82 FOR
Dedusting	1800 mm	600 sides set	21 AL	SET POL	SET M-T
Milling	2.0×1.5 m OD	3.6 m^3	15 PAJ		
Milling	2.5×1.7 m OD	6.3 m^3 8	30 VAL		
Polishing	600 mm	150 skins?	22 AL		
Polishing	1800 mm	150 sides? 25	39 AL		
Roller coater	1800 mm/3 for firm	180 sides 15	27 GEM		
Tunnel dry	For coater	180 sides	27 GEM	31 POL	
Roller coater	1800 mm/3 softer		65 GEM		
Spray – transverse	1800 mm 1 cabin	160 sides	48 CARL		
Spray – transverse	1800 mm 2 cabin	160 sides	81 CARL		
Spray – transverse	2200 mm 1 cabin	160 sides	50 CARL		
Spray – transverse	2200 mm 2 cabin	160 sides	82 CARL		
Spray – rotary	1800 mm 1 cabin	240 side or 360 skin 25	61 CARL	75 M-T	
Spray –rotary	1800 mm 2 cabin	240 sides 50	101 CARL		
Spray–rotary	2200 mm 1 cabin	240 sides	63 CARL		
Spray–rotary	2200 mm 2 cabin	240 sides	105 CARL		
Spray–rotary	2600 mm 1 cabin	200 hides	72 CARL		
Spray–rotary	2600 mm 2 cabin	200 hides	118 CARL	149 POL	
Rotary press	1800 mm iron	300 sides	89 ROT		
Rotary press	1800 mm 3 rolls	300 sides 28	124 ROT		
Rotary press	3000 mm 3 rolls	300 hides	158 ROT		
Rotary iron	1520 mm	140 skins	50 AL		
Finiflex iron	1600 mm	180 skins	60 M-T		
Glazing machine		60 skins?	13 AL		
Hydraulic press	880x600 mm	80 sides	80 MST		
Hydraulic press	1370×1000 mm	120 sides 40	97 MST		

Item	Description	Capacity (/h) kW	Cost - a	Cost - b	Cost – c
Measuring	Electr. 2200 mm	240 sides 4	24 GER		
Measuring	2200 mm	100 sides			
Control lab.			10 C-P		
Lab. drum	1.5×1.0 m	1.0 m^3	11PAJ	14VAL	22 ITPR
Lab. drum	1.2×0.8 m	0.36 m^3 5	12VAL		
Lab. drum	1.2×0.6 m		15 ITPR		
Lab. drum	1.0×0.5 m		13 ITPR		
Lab. drum	1.0×0.8 m	0.25 m^3	11 PAJ		
Hand spray	Cabin		5?		
Scales	5 t		12 C-P		
Scales	2 t		8 C-P		
Scales	300 kg		2 C-P		
Scales	30 kg		0.5 C-P		
F/ lift – electric	4 t		50 C-P		
F/ lift – electric	2 t		30 C-P		
Elec. pallet truck	2 t		10 C-P		
Hand pallet truck	2 t		0.75 C-P		
Horse		150 sides	0.1		
Pallet		100 hides	0.033		
Charger	For accumulators	For pallet truck	2 C-P		
Air compressor	2.5 m^3/min, 7 bar	8 guns: 1 cabin	15 CARL		
Air compressor	5 m^3/min, 7 bar	16 guns: 2 cabin 15	23 CARL	25 CEC	
Air compressor	75 m^3/min, 7 bar	General	220 CEC		
Boiler	2 or 15 bar	3 t steam/h 15	40 BIA		
Chrome recovery	6-10 t tan load input	9 m^3 batch 15	60 UN	70 ITPR	
Effluent plant	Primary, solids: centrifuge	400 m^3/day 250	300 C-P		
Effluent	Primary		70 ITPR		
Effluent	Biological		60 ITPR		
Effluent	Sludge: press		70 ITPR		

AISI 316 (drums) is OK for formic acid and salt but NOT for sulphuric, oxalic or hydrochloric.
AISI 304 (vacuum) is NOT OK for the formic and salt.
10 HP = 7.5 kW; KVA × 0.8 = kW

- Drums are basic prices but all have extras for recycling and filter – PAJ is US$ 41 for 2 lime drums; VAL US$ 19/drum and less (smaller drum 11). Recycling on VAL tanning is US$ 5 and US$3 for other extras with temperature control US$ 2. VAL retanning drum has cyclone and filters for US$ 10/drum and US$ 4 other extras. All are useful and clean technology. Prices are not included in the above table, except for milling. PAJ only offers lime filters but has dust control in milling and soft starters everywhere. The VAL milling drum has all extras added to give equivalent comparison. Needs detailed check on specification.

- Chrome recovery is based on simple approach to precipitate with Magnesium Oxide, decant supernatant and re-dissolve in concentrated Sulphuric acid. Needs laboratory Control. Can reduce tanning cost by 25% i.e. 0.9 US cents/. for unsplit hides if chrome cost is 3.6 US cents/. Pay back period calculated at 3 years (UNIDO). Cost for 6 t of tannery input.
  *Vacuum driers have net are 0.2 m less. All FINVAC are flexible for sizes (custom made).

- Effluent system has separate sulphide aeration, equalisation (balancing) tank, dosing and separation of solids by centrifuge. No secondary (biological) treatment.

- "Just in time" drying unit from CARTIGLIANO produces 90-100 hides/h (6 table vacuum) for US$ 670,000, 2,000 hides/24 h.

Italian producers

Code	Name	Address	Fax
AL	ALETTI S.R.L.	via Tiepolo 14 – 2100 Varese	0332-331917
BAU	BAUCE TRI.MA S.R.L.	via del lavoro 27-36070 Trissino (VI)	0445-490068
BIA	BIASI S.P.A.	Via Leopoldo Biasi 1, 37135 Verona	045-8090333
CTG	CARTIGLIANO S.P.A.	Via San Giuseppe 2-36050 Cartigliano (VI)	0424-598035
CARL	CARLESSI	Via Sprirana- 24059 Urgamano (BG)	035-891067
CEC	CECCATO	Alte ceccato di montecchio maggiore (Vicza)	0444-695544
CM	CM S.P.A.	v. Cristof. Colombo 17-56029 S.Croce (PI)	0571-34785
F-M	FORNI VARESE	v. enrico fermi 25 – 21027 ispra	0332-780854
GEM	GEMATA S.P.A.	v.Rampa dell'Agno 6, 36070 Trissino (VI)	0445-490111
GER	GER ELETTRONICA S.R.L	v.dell'Artig. 26-36075 Montecchio Mg. (VI)	0444-499083
ITPR	ITALPROGETTI	Lung. Pacin 59/A-56020 San Romano (Pisa)	0571-450301
MSC	MOSCONI & C S.P.A.	v.del commercio 7-37135 Verona	045-509855
MST	MOSTARDINI S.P.A	v. Piovola 138 – Empoli (Fi)	0571-592995
PAJ	PAJUSCO TECNOLOGIE	v. G.Marconi 1-36050 Zermeghedo (VI)	0444-686166
POL	POLETTO	v. Vicenza 50-1-36071 Arzignano (VI)	0444-451846
RIZ	RIZZI	v. M.Fanti 88 – 41100 Modena	059-315461
ROT	ROTOPRESS EMMEZETA	v. Isola Corso2 –36054 Montebello Vic.(VI)	0444-648900
VAL	VALLERO INTERNATIONAL	v. Bordonnato 4 – 10080 Oglianico (To)	0124-348953

Other producers

Code	Name	Address	Fax
FIN	FINVAC	PO Box 94, FIN-34801 Virrat, Finland	3-34728040
M-T	MERCIER TURNER	BP 128, 07104 Annonay Cedex, France	04-75321022
OLC	OLCINA	Ctra.de caravaca,56 – 30814 Lorca, Spain	068-443155

Project Engineers

C-P	CHEM-PRO ENGINEERING	v.Torino 201-10040 Leini (Torino)	011-9973239

PLANNING DATA

Input of 1 t W/S cattle hides per day needs

500 m^2 of area: 350 m^2 production, 150 m^2 non-production. Production divides into equal thirds for wet-blue, crust and finishing. 1 t of hides for heavy leather (pits/drums) needs 600 m^2 total and 1 t of skins needs 1000 m2 total. Foundation strength of drums and machines is to be reinforced concrete of not less than 250 kg/cm^2 after 28 days. Process platform strength is not less than 200 kg/cm^2 after 28 days.

40-60 m^3 water (reducing to 25-40 at extremes). This is two thirds for wet-blue production. Probably only 70% of intake becomes effluent after evaporation. Water usage as % for raw: 40% soak/lime, 20% delime/bate, 10% pickle/tan, 20% retan/fatliquor, 10% other.

2,000 kg steam.

700 kWh electricity, in three equal parts – wet-blue, crust, finishing.

1-1.5 m^3 compressed air/min (confirm with machines).

14.02.00/mw

Annex 2

Basis for Chemical Costs

All light leather, is processed in the wet stages (tanning, retanning and dyeing) on the basis of weight although the final dry leather is sold by area. The chemical consumption, and cost, differs widely according to the processes.

The chemical costs in this report are estimated at a consumption rate of 25% on the input weight of cattle for light leathers, 30% for skins/splits and 35% for heavy leathers. A special usage of 40% is included for suede production, due to the high cost of dyestuffs. A cost of US$ 2/kg of chemicals is used. These figures tend to overestimate actual costs, so that some cost reduction should be possible.
The estimated yield figure shows the ratio of the dry output area to the input weight and is required to relate the chemical costs of production to the sales price.

Finishing costs are US$ 0.12/sq.ft to US$ 0.30/sq.ft, according to quality of full grain/ corrected grain (FG/CG). Splits have a higher finishing cost estimate at US$ 0.30/sq.ft.

All costs in US$.

Item	*Cattle*	*Skins*	*Finished split*	*Suede split*	*Heavy*
Cost total wet work/kg input	0.50	0.60	0.60	0.80	0.70
Chrome cost/kg	0.07	0.07	0.07	0.07	Nil
Costs to wet blue/kg	0.14	0.14	0.10	0.10	
Yield in . dry output/kg input	1.70	5.00	2.00	2.00	67% kg/kg
Cost total wet work/dry	0.29	0.12	0.30	0.40	1.05/kg
Cost to wet blue/sq.ft	0.08	0.03	0.05	0.05	
Retannage costs/sq.ft	0.21	0.09	0.25	0.35	
Finishing	0.28	0.16	0.30	0.00	Nil
Total	**0.57**	**0.28**	**0.60**	**0.40**	**1.05/ kg**
Notes	*90% CG*	*All FG*			*Sold by weight*

Annex 3

Comparative table of production costs in the tanneries

Type	1	2	3	4	5	6
	Raw hide to wet-blue	*Wet-blue hide to finish*	*Raw hide to finished*	*Raw skin to finish*	*Split suede and finish*	*Raw hide heavy vegetable*
	Whole hides & splits out	**Whole hides in, sides out**	**Whole hides in, sides out**	**Skins**	**Whole butt splits**	**Culattas & shoulders**
Input: *pc/day*	640	320	300	2,000	1,000	150-200
t/day	14.0	3.2	6.6	2.5	5.0	4.5
Output: *pc/year*	192,000	96,000	90,000	600,000	300,000	45-60,000
t/year	4,200	960	2,000	750	1,500	1.350
Equipment, *US$ mio*	1.5	1.4	2.34	1.4	1.2	1.1
Employees	29	59	88	77	57	36
Conversion, *US$/pc*	5.29	22.74	26.80 *split:* 6.70	1.93	6.94	21.59
% chemicals	60.6	81.9	71.9	59.7	80.7	73.0
% labour	5.7	4.9	5.1	11.8	4.9	4.8
% equipment	19.2	8.1	10.1	15.7	7.2	10.6
% power	7.0	2.6	2.9	2.8	2.2	1.6
% effluent	7.5	2.5	10.0	10.0	5.0	10.0
Conversion, *US$/sq.ft*	0.14	0.60	0.70 *split:* 0.67	0.38	0.69	1.44/kg
Time, *days*	7	16	22	18	14	26
Working capital, *US$*	177,000	563,000	856,000	242,000	518,000	348,000

Notes: In the Conversion costs % equipment is Overhead 1 – fixed
% power is Overhead 2 – variable for power and water
% effluent is Overhead 3

Working capital required excluding raw material

Annex 4

Introduction of new equipment

The hide tannery process includes machines for fleshing and for lime splitting, which are not generally used in Fustat. They are needed to improve quality and to increase the added value for each hide; proper machine fleshing allows an improved penetration of process chemicals, and the splitting allows the production of split leathers. These are economic leathers having a good sale in a number of different articles, in either chrome or vegetable tannage. The chrome leathers may be either finished or suede for shoe uppers or linings, or as suede for garments or industrial gloves. Vegetable leathers may be for use in leather goods, soles and insoles.

Toggling machines and conveyors are included to replace the nailing out on boards and improve quality and yield.

In relation to the environment, splitting in the lime means that the trimming and scrap produced does not have the problem of chrome content. It can be sold more easily than chrome-tanned waste, which is becoming more difficult and expensive for disposal.

Annex 5

Comparison of Manual and Machine Work

The traditional Artisan tanners use a minimum of equipment and generally basic chemicals in their processing to produce a low cost production. This limits the quality of the product and the manual work will soon become uneconomic as production costs, and the quality of competition, rise. Manual work may give superior quality, as in the finer grain from hand painting skins, but it will also be more variable in performance compared to a machine, such as fleshing. Tannery 4 design uses manual labour and shows a cost reduction of US$ 8,000/year and a better working timetable.

The Painting and Unhairing of 2000 skins per day can be done in 3-4 hours by a team of 12 workers manually (from a tannery study in Eritrea) or by machinery in 6-7 hours, and a total of 3 workers.

MANUAL daily unhairing programme is

1. Soaked skins piled (170/pile) to drain for 2 hours.
2. Paint 1.5 hours
3. Stand 4 hours
4. Unhair 1.5 hours
5. Load into lime paddle.

Total time is 7 hours after draining.

As the workers are available for other work with soak/lime paddles, the TOTAL COST for painting and unhairing is US$ 24 (6 man days).

MACHINE daily programme is

1. Soaked skins piled to drain
2. Paint on applicator machine in 7 h (300 skins/h and costs US$ 38,000)
3. (Standing time is 7 hours following these machines)
4. Unhair by machine in 7 h (300 skins/h and costs US$ 53,000)

Total time to complete load is 14 h.

Machine cost is US$ 91,000 with depreciation over 10 years of US$ 9,100/year and a maintenance cost of US$ 2,730 = US$ 11,830 for machine costs p.a. (US$ 39.43–300/days).

Method	*Man-days*	*Cost/day*	*Labour cost*	*Machine costs*	*Total*
Hand	6.00	4.00	24.00	Nil	24.00
Machine	3.00	4.00	12.00	39.43	51.43

The machine option is an extra US$ 27/day at a full capacity; quality is lower and there is a longer time to complete the work.

Annex 6

The Economics of Small Scale Producers
(using new equipment costs)

All manufacturing business begins as small-scale production. Mechanisation is important for leather quality but the equipment costs are prohibitive unless the machine can be used for a full working day. It is possible to develop a working pattern in which leather, owned by the tanner, is processed partly in his own factory and partly on equipment owned jointly with other tanners. This is different to job-work in a Common Facility, where all the equipment is owned by a third party. The costs for the individual tanners are still significant but below US$ 300,000, if the leather production is divided into the three main stages. (Further sub-division is possible.)

The critical factor is to have a sufficient number of similar units willing and able to form a joint company to own the equipment; the alternative is the Common Facility Service Centre under the ownership of a third party.

Each stage can have various calculations and some minimum size has to be used. This could be 150 hides/day for Wet Blue, 100 hides/day (200 sides/day) for Crust and 200 sides/day for Finishing as an attempt to balance the sales value against the difficulty of production for roller coater and spraying machines. Hand padding and spraying would have a minimum of 100 sides (with a final sales value of US$ 3,000-4,000).

For example, the leather production could be divided into 3 stages.

1. Raw to Wet blue, with the drums owned by the tanner and with joint ownership of the fleshing and splitting machines. 120 hides/day will mean a machine usage for 8 h/day.

Individual tanner:

120 hides/ day and owns	4 drums: 2 for soak/lime, 2.7 t	US$ 66,000
	1 to tan grains, 2.5 t	US$ 26,000
	1 to tan split, 1.1 t	US$ 21,000
	Subtotal	US$ 113,000
Add 15% to cover spares, shipment, installation		US$ 16,950
Total machine cost in own company		*US$ 119,950*

Joint company:

Joint machinery	
(in a group of 8 similar tanners means a total output of 960 hides/day):	
Fleshing machine for 120 hides/h, deals with 960 in 8 h/day	US$ 123,000
Splitting machine for 120 hides/h, also deals with 960 in 8 h	US$ 119,000
Subtotal	US$ 242,000
Add 15% to cover spares, shipment, installation	US$ 36,300
Total investment in joint company	*US$ 278,300*

An individual share in joint company is US$ 34,750.

Each small-scale unit has a total investment of about US$ 155,000 (including US$ 35,000 in the joint facility).

There will also be a cost for the effluent treatment if this is not provided by the local authority; in any case, it would have to be paid for over a period of time. A closer estimate could be made for clean technology etc. but an estimated figure of US$ 300,000 to treat the 500 m^3 from 22 t/day, means an extra individual charge of US$ 37,500, to make a new total of US$ 193,000. The charge for effluent pre-treatment is, of course much heavier in this section.

There are all the usual costs for the raw hides and the work in progress.

2. Wet Blue to Crust, with the drums owned by tanner and joint ownership of sammying, shaving, setting out, and probably drying. However, it may be that each tannery would have one of the machines itself and hire them out to their associates. 120 sides/day will mean machine usage for 8 h (except for vacuum at 16 h).

Individual tanner:

120 sides/day and owns 2 drums for retanning and dyeing	US$ 54,000
Add 15% to cover spares, shipment, install.	US$ 8,100
Total machine cost in own company	*US$ 62,100*

Joint company:

Joint machinery (in a group of 5 similar tanners means a total output of 500 hides/day, processed as 1,000 sides):	
Sammying machine for 120 sides/h, deals with 1000/8 h day	US$ 61,000
Shaving machine for 120 sides/h, also deals with 1000/8 h	US$ 58,000
Setting machine for 100 sides/h, works for 10 h	US$ 80,000
Vacuum drier and chiller for 60 sides/h, works for 16 h	US$ 127,000
Boiler	US$ 40,000
Subtotal	US$ 366,000
Add 15% to cover spares, shipment, installation	US$ 54,900
Total investment in joint company	*US$ 410,900*

An individual share in joint company is US$ 82,000.
Each small-scale unit has a total investment of about US$ 144,000 (including US$ 82,000 in the joint facility). However, other combinations of ownership are feasible with an individual tanner owning one more of the other machines and hiring them out for the job work.
There will also be a cost for the effluent treatment if this is not provided by the local authority; in any case, it would have to be paid for over a period of time. A closer estimate could be made for clean technology etc., but an estimated figure of US$ 75,000 to treat the 120 m^3 per day, means an extra individual charge of US$ 9,500, to make a new total of US$ 153,500. The charge for effluent pre-treatment is, of course much lighter in this section.
There are all the usual costs for the work in progress.

3. Crust to Finishing. More machines are needed here for flexibility and it may be that a Common Facility is more likely for some or all of the machines. The total machinery costs are higher and there will need to be a greater number of the smaller producers, who may

finish by hand padding and spray. There is a practical minimum of 200 sides in a single colour for machine colouring.
There could be joint ownership for staking, toggling, pressing, measuring; with a Common Facility for dry drums, buffing, polishing. It may be preferable for each small unit to own at least 1 machine as a commitment, and a source of income.

A joint unit with a daily capacity of 1000 sides, could have the following equipment, which would work for at least 8 h/day:

Machine	*US$*
Conditioning	14,000
Staking	58,000
Toggling	94,000
Buffing and dedust – 2 or 3 times	56,000
Polishing – according to product	39,000
Roller coater and tunnel – used for 2-3 coats for minimum lots of 200 sides	54,000
Spraying and tunnel – used for 2-3 coats for minimum lots of 200 sides	61,000
2 Milling drums	30,000
Hydraulic press	97,000
Rotary press	89,000
Measuring	24,000
Boiler	40,000
Subtotal	*656,000*
Add 15% to cover spares, shipment, installation	98,400
Total investment for joint finishing company	**754,400**

Tanners would have an initial investment of US$ 150,000 each but it would be practically difficult to have the 5 different productions working in the one unit. It is the actual finish applications, with colour mixing, which would need to be done in the individual units.

There are all the usual costs for the raw hides and the work in progress.