



# Benchmarking in the Tanning Industry

Jakov BULJAN, Ivan KRÁL  
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## List of Abbreviations

AISHTMA	ALL INDIA SKIN & HIDE TANNERS & MERCHANTS ASSOCIATION (India)
appr	approximately
BLC	LEATHER TECHNOLOGY CENTRE (United Kingdom)
BOD <sub>5</sub>	biochemical oxygen demand, 5 days
BREF	“Reference Document on Best Available Techniques for the Tanning of Hides and Skins”
cca	approximately
CETP	common effluent treatment plant
CFC	chlorofluorocarbon
CLE	COUNCIL FOR LEATHER EXPORT (India)
COD	chemical oxygen demand
CSR	corporate social responsibility
DS	dry substance
EMAS	eco-management and audit scheme
ETP	effluent treatment plant
EU	European Union
GMP	good manufacturing practice
HACCP	hazard analysis and critical control point
HDPE	high density polyethylene
HVLP	high volume, low pressure
ICT	INTERNATIONAL COUNCIL OF TANNERS
IPPC	integrated pollution prevention and control
ISO	INTERNATIONAL ORGANIZATION FOR STANDARDIZATION
IT	information technology
IUE	INTERNATIONAL UNION OF ENVIRONMENT
IULTCS	INTERNATIONAL UNION OF LEATHER TECHNOLOGISTS AND CHEMISTS SOCIETY
LGR	LEHR-, PRÜF- UND FORSCHUNGSINSTITUT FÜR DIE LEDERINDUSTRIE (Germany)
MEK	methyl ethyl ketone
NPE	nonylphenol ethoxylates
OEE	overall equipment efficiency
OSH	occupational safety and health
PE	polyelectrolyte
PPE	personal protective equipment
PCP	pentachlorophenol
RO	reverse osmosis
R&D	research and development
SME	small and medium enterprises
SS	suspended solids
STEL	short-time exposure level
SWOT	strengths, weakness, opportunity, threats
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TLV	threshold limit values
TOC	total organic carbon
TWA	time-weighted average
UF	ultrafiltration
UNIDO	UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION



UV	ultraviolet
VOC	volatile organic compound
vs	versus
WG	working group
WWW	wastewater works
XML	extensible markup language

### Units of measurements:

cal	calorie
d	day (= 24 h)
dm <sup>2</sup>	square decimeter
g	gram
GBP	English Pound
GJ	giga Joule (= $10^9$ J = 1,000,000,000 J)
GW	giga watt (= $10^9$ W = 1,000,000,000 W)
h	hour (= 60 min = 3,600 s)
ha	hectare (= 10,000 m <sup>2</sup> )
J	Joule (= 0.239 cal)
kg	kilogram (= 1,000 g)
kW	kilowatt (= 1,000 W)
kWh	kilowatt hour
l	liter (= 1 dm <sup>3</sup> )
m <sup>2</sup>	square meter
m <sup>3</sup>	cubic meter (= 1,000 l)
min	minute (= 60 s)
ml	milliliter (= 0.001 l)
s	second
sqft	square foot (= 0.0929 m <sup>2</sup> )
t	metric ton (= 1,000 kg)
US\$	United States dollar
y	year (= 365 d)
w	watt

***Mention of trademarks and brands does not imply the endorsement of UNIDO.***

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## EXECUTIVE SUMMARY

There are many definitions of benchmarking, the essence of all of them simply being **a comparison with the best in the sector**.

Since comparisons with competitors have always been an imperative, one cannot help wondering what is new here. Is this just another fashionable gimmick invented by smart consulting companies to sell generalities and common sense, or a handy public relations gimmick for factories better at marketing than modern technology, quality and efficiency? Why bother with another buzzword that comes and goes like so many others? Furthermore, are not all those standards such as ISO series, SWOT analysis and EMAS management tools more than sufficient for any tannery struggling to survive the problems posed by raw material, environmental agencies and finished leather prices?

The usual reaction by a tanner to the idea of benchmarking is that it is simply not feasible because one is not comparing apples to apples, each tannery being unique. To accentuate the point many tanners maintain that there is little if anything to be learned in comparing performances (including yields) of a giant automotive leather producer to a manufacturer of high quality shoe uppers.

The overall business environment also considerably influences a tannery's performance. Quite understandably, its management develops strategies with the view of optimizing the balance of factors such as tax regulations, cost of labour (including contribution towards health and pension benefits), power, chemicals, a sometimes rather complex system of export and/or import incentives, duties, and purely financial aspects (foreign exchange regulations, currency rates) etc.

“Environmental performance”, i.e. the ability to meet increasingly stringent environmental legislation, is nowadays for many tanneries a question of their very survival, the three main concerns being sludge disposal, residual COD and TDS (colloquially the salinity). Similarly, reutilization and disposal of solid wastes generated in the process (fleshings, shavings, trimmings) are crucial to the profitability of many tanneries. How is it possible then to benchmark the environmental performance of tanneries operating under very different conditions of location, ultimate recipient of effluents, options for handling wastes, and climate? Is it even possible, and does it make sense, to benchmark activities like marketing, public relations and CSR which are so important for the general perception and image of the company? Should benchmarking be focused only on financial indicators, or should it include “technical”, production parameters as well? There are also those who maintain that **price and profitability** are the best and, as some put it, the only relevant comparison parameters.

### The arguments in favour prevail

Leather tanning is a capital and material inputs (raw hides, chemicals) intensive industry, but is not particularly labour intensive. The typical production cost structure, however, of 50-70% raw hides, chemicals about 10%, labour 7-15%, energy 3%, environmental protection 2-5%, does not justify neglect of the scope for savings from optimization of chemicals or energy and, in particular, from undue pollution treatment costs. Unnecessary costs arising from poorly performed mechanical operations, such as splitting, sammying and shaving, downgrade the quality, decrease the yield and ultimately the profitability. The cost of rework -- reprocessing of batches not meeting internal standards or customers' requirements -- adds to the avoidable losses. The ability to maximize the utilization of the raw material, e.g. by applying good finishing techniques and producing a fashionable item from lower grades, often makes the crucial difference for the success and

profitability of tanneries operating under similar conditions. Other points of comparison are investment in OSH at work, maintenance, continuous training and social welfare, all of which have been shown to have a positive affect on cost control and profitability.

Benchmarking, the process of continuously comparing and measuring one's own operations against other organizations *worldwide* to gain information on their practices, processes and methodologies is an important tool to help an operation identify concrete practices which can be implemented *to improve its performance*.

### How is this accomplished?

Tanneries, for competitive reasons, tend to keep confidential most of their vital performance parameters. Thus, benchmarking carried out to date in the tanning industry has been reduced to either a *generic type* (the company compares itself with itself, i.e. with either its own performance during certain earlier period or with certain, predominantly financial targets), or to *questionnaire and self-assessment based* benchmarking (the company compares its performance with questionnaire-based parameters obtained from a number of producers of rather different profiles and operating under rather different conditions).

A more comprehensive approach would be to have a generic benchmarking system offered by companies which specialize in this field incorporating specific parameters for tanning operations and tailored to specific tannery requirements. This would not be anything really revolutionary, but **such a benchmarking exercise could be a very comprehensive and practical tool for management striving to ensure continuous improvement of company's performance.**

In order to implement such a system it would behove any tannery aspiring to compete successfully in the international market to:

- Conduct regularly not only a financial but also a thorough technical audit, including a detailed material balance of all inputs and outputs. Preferably the audit should be carried out by an external, competent, fully independent party.
- If possible, compare operating parameters with those of a successful (competing) tannery operating which operates under very similar conditions, i.e. converting the same raw material into same product categories.
- Alternatively, *compare certain stages* (e.g. beamhouse, tanning), *processes* and *operations* (e.g. drying, liquid and solid waste management), and *work environment* and *management of human resources* (safety at work, training) with internationally recognized best performers.
- Identify the scope for improvement and set ambitious and yet achievable targets with clearly defined performance indicators (figures) to be implemented within a realistic timeframe.
- Regularly monitor all key parameters; adjust and fine tune targets and implementation deadlines as required.
- At regular intervals (i.e. even in absence of any crisis), revisit, update and refresh the whole issue in light of local and/or global technical, marketing or legal developments and changes to the company's strategy.
- Ideally, develop a tailor made system supplementing the usual generic system with your own, specific performance indicators, including steady critical evaluation and improvement methodology.

What is readily available at this stage?





It was far beyond the scope of this *desk study* to provide proper benchmark parameters for all the various categories which should be monitored. Although it would be highly desirable to provide the tanning industry with a comprehensive paper containing most of the main benchmarking parameters, That would require a multidisciplinary team (leather technologist, specialists for equipment, environment, marketing, finances and human resources) engaged in expanding the questionnaire, obtaining field information and, following a critical review and necessary adjustments, merging the information into a practical manual for individual tanneries to use in preparing their own benchmarking systems.

In order to encourage and facilitate efforts in that direction the paper offers an outline of ten “cock-pit check lists” containing nearly 300 hundred points under the following main headings:

Check list No.	Area – Component
1	Tannery location, infrastructure
2	Production parameters
3	Cleaner technologies
4	Energy management and consumption
5	Quality assurance, reprocessing, delivery time, failures
6	Product development, strategies
7	Occupational safety and health at work, maintenance
8	Effluent treatment, solid waste, air emissions
9	Financial indicators
10	Human resources and staff welfare, CSR

Obviously, this list and the specific points contained therein can be deepened, expanded and (fine) tuned to suit the specific character and operating conditions of an individual tannery.

At this stage, with resources made available, it has been possible to work out and include in the annexes to the study some specific figures in certain areas:

### Effluent treatment plants and landfills

Break-down of investment and operation costs, area required, chemicals consumption, power, specific efficiency, attainable purification levels for key pollutants after primary and secondary treatment as well as typical water consumption, pollution loads and purification levels are given for nearly all sizes of plants in the tanning industry, i.e. treating from 100, 500, 1000, 5000 to 20,000 m<sup>3</sup>/day, including detailed investment and operating cost estimates (for developing countries) for a landfill required to accommodate the sludge produced for each size category.

### Leather processing parameters

A chart with an example of the overall mass balance: input, yields, consumption of chemicals, emissions, production of sludge etc. is included in the detailed study.

Finally, a very rough, tentative outline and some key parameters for a hypothetical “**model tannery**” are given below.

In view of the number and complexity of the factors influencing tannery performance, it is very difficult to accurately define success criteria as proofs to the contrary can always be easily found. While it is obvious that the existence of tanneries situated in arid regions or in



the heart of prime residential areas is jeopardized, and that in the long run small scale units (except specific niche producers) are unlikely to survive, it would be difficult to get agreement on what constitutes the minimum or optimum tannery size. There would be simply too many qualifications, limitations, and *caveats*.

The overview below attempts to provide a very general outline of a modern tannery with some vital parameters, fully recognizing the limitations and arguments that can be raised.

Some criteria and parameters for a tannery processing raw bovine hides into shoe upper leather	
LOCATION	Outside residential area, preferably within industrial zone, <i>proximity of urban sanitary sewage network and wastewater works (WWW) or at the seaside</i> . Sufficient supply of water of appropriate quality, stable and reliable power grid. Solid waste utilization and disposal facilities. Easy access for employees and cargo (public transport, roads, railway, airport, harbour). Reliable and efficient transport, forwarding and customs clearance services. Proximity of finished leather markets.
RAW MATERIAL	Fresh (chilled) hides from abattoir, machine-flayed.
WEIGHT CATEGORY	25-30 kg/hide, area about 4 m <sup>2</sup> (cca. 43 sqft), thickness 6-8 mm.
INPUT/SOAKING	About 300-350 pieces, i.e. 7.5-10 t of raw hides/day.
OUTPUT/PRODUCTION	About 1, 300 m <sup>2</sup> (cca. 14, 000 sqft)/day of grain leather + about 590 m <sup>2</sup> (cca. 6,300 sqft) of split leather, total: 1,890 m <sup>2</sup> (20,300 sqft)/day.
TECHNOLOGY (see <b>Check list 3</b> )	Hair-save liming, carbon dioxide deliming, ex-lime splitting, high exhaustion chrome tanning with full chrome management system, vegetable and environment friendly synthans retanning, optimum exhaustion of dyes and fat liquors, segregation of beamhouse, all chrome bearing and general streams, use of biodegradable surfactants and acceptable biocides, optimized mechanical dewatering and drying, (predominantly) water based finishing. The total amount of chemicals consumed about 4.5 t/day. The work cycle not exceeding three weeks.
EQUIPMENT	High accuracy splitting and shaving, drums suitable for short floats, recycling, good distribution of chemicals, optimized coating, scrubbers for air emissions. High level of automation and process control – automated water, chemicals dosing and mixing systems but also staking and transport.
YIELD	1300 m <sup>2</sup> /10 t = 13.0 dm <sup>2</sup> (1.4 sqft) of grain leather/kg green weight + 590/10 t = 5.9 dm <sup>2</sup> (0.63 sqft) of splits /kg green weight. Total 1,890 m <sup>2</sup> (20,300 sqft)/10 t = 18.9 dm <sup>2</sup> (2.0 sq ft) of leather/kg of green weight. Tailor made software monitoring.
REWORK, CLAIMS	Internal up to 5%, external below 2%. Tailor made software monitoring.
WORKFORCE	85-90 (75 production), without ETP

Some criteria and parameters for a tannery processing raw bovine hides into shoe upper leather	
PRODUCTIVITY	1,890 m <sup>2</sup> (20,300sqft)/75 = 25 m <sup>2</sup> (270 sqft)/day/production worker or 21 m <sup>2</sup> (226 sqft)/day/employee. Tailor made software monitoring.
POWER INSTALLED	Appr. 700-750 KW, production and auxiliary equipment but without ETP.
WATER CONSUMPTION	Not exceeding 25 m <sup>3</sup> /t raw hide, total appr. 250 m <sup>3</sup> /day, including sanitary water. Strict water housekeeping, water meters for each department.
FACTORY COMPOUND	The ratio of built vs. total factory area – “footprint” less than 0.6.
Works area	All at ground level (except workshop mezzanines and supervisor & control panel booths), appr. 3,000 m <sup>2</sup> .
Stores and workshops, offices, sanitary areas	Raw hides, chemicals, hazardous chemicals, maintenance and spare parts, wardrobes, toilettes etc. 1,500 m <sup>2</sup> .
Total	4,500 m <sup>2</sup> of covered area + 600 m <sup>2</sup> for the physical-chemical effluent treatment, the total compound ideally about 10,000 m <sup>2</sup> (1 ha). If the biological treatment also required, than additional 1,000 m <sup>2</sup> , i.e. total 11,000 m <sup>2</sup> needed.
OCCUPATIONAL SAFETY AND HEALTH	All OSH measures, as per examples given in <b>Check list 7</b> strictly and consistently applied with emphasis on personal protection and measures against toxic (hydrogen sulphide) and inflammable materials (solvents) risks.
HUMAN RESOURCES, CSR	Sanitary facilities in conformity with highest standards. Quality and output linked, competitive remuneration, incentives for innovations. Systematic and continuous training, exposure to global trends and developments. Staff welfare facilities (canteen, crèche, ambulance, recreational area) available within the factory compound or at short distance. Continuous, open dialogue with public.
FINANCIAL PERFORMANCE	Favourable ratio of administrative and (individual articles differentiated) production costs. Low stocks/working capital: up to one month for raw hides, about three weeks for hides in work, up to two weeks for specialty chemicals, less than a week for finished leather). Optimum pricing. The return on sales/assets meets/exceeds the cost of own and borrowed capital and anticipated dividends.
PRODUCT DEVELOPMENT AND STRATEGIES	A system for continuous monitoring of the relevant (global) research, access to and dissemination of information in place. Close cooperation of marketing and technology. Alternatives – fall back strategies for various negative scenarios.
SOLID WASTES	Total about 5 t/day (at different levels of water content), albeit without tannery sludge. Strict segregation, HACCP procedure followed. Native trimmings, hair, fleshings, shavings and unusable splits reutilized, only finished leather trimmings disposed off.

Some criteria and parameters for a tannery processing raw bovine hides into shoe upper leather	
EFFLUENT TREATMENT PLANT, ETP	Discharge into the municipality sewage or the common treatment plant for the industrial zone/cluster; thus only the primary (physical-chemical) treatment carried out by the tannery itself, whereas the secondary (biological) treatment carried out together with sanitary WWW. In any case, treatment efficiency in line with IULTCS/IUE figures (see <i>Annex 11</i> and <i>Annex 12</i> ), the reduced pollution load conforms to legislative norms.
Treatment capacity, effluent quality	250 m <sup>3</sup> /day corresponding to water consumption of 25 m <sup>3</sup> /t, working on tannery work-days, 20 h/day. Highest treatment efficiency, the effluent quality conforms to norms for indirect discharge.
Area required	About 600 m <sup>2</sup> (physical-chemical treatment only).
Power	Power installed about 75 KW; energy consumption about 45 kWh/h (appr. 60% of power installed).
Chemicals needed	Catalyst (manganese sulphate) inorganic coagulant (alum sulphate or polychloride, polyelectrolyte for flocculation, hydrated lime for pH correction and/or sludge conditioning.
Sludge handling	Primary sludge dewatered to about 40% dry matter content (nearly 2.5 t/day) forwarded to controlled landfill, land application – composting or thermal treatment.
Treatment costs	Up to USD 1.0/m <sup>3</sup> . After adding the cost of joint treatment at the WWW, the total treatment cost likely to be in the region of US\$ 1.5-1.6/m <sup>3</sup> .

In the highly undesirable case of *direct* discharge into a water recipient (river, lake), i.e. when a tannery has to have the secondary (biological) treatment, the total area required for the ETP is about  $70 * 25 = 1,750 \text{ m}^2$ , power installed 120 kW and power consumption about 70 kWh/h.

Total investment costs for such a plant in a developing country would be on the order of US\$ 230,000 (civil works), equipment US\$ 470,000, total about US\$ 700,000. The running cost, including depreciation, might be of the order of nearly US\$ 2 m<sup>3</sup>, albeit without sludge disposal costs. The costs of land, ETP design, supervision and commissioning as well as any taxes are not included.

As pointed out earlier, an individual fully-fledged tannery ETP following the conventional technology can successfully reduce all pollutants (suspended solids, BOD, COD, nitrogen, sulphide etc), to the acceptable level; however, without reverse osmosis – desalination (or, better, mixing with municipal effluents) it has no effect on TDS, colloquially – salinity.

# 1. INTRODUCTION

The word *benchmarking* is in. Nowadays a factory manager cannot move around without bumping into it around the very first or possibly the second corner. Reputable institutes and a host of consulting companies offer their specialist services in benchmarking to companies keen to keep abreast of the latest management trends. There is already *The Benchmarking Exchange*. Benchmarking has already penetrated bilateral and multilateral assistance to developing countries, including the leather industry on the African continent and UNIDO now offers benchmarking software to interested parties<sup>1</sup>. Participants of the 15<sup>th</sup> Session of UNIDO Leather and Leather Products Industry Panel in León, Mexico in 2005 had the opportunity to learn something about benchmarking in the shoe-manufacturing sector. It would seem therefore, that the time is ripe to open a discussion and exchange views on benchmarking in the tanning sector, and to bring those in the industry up to speed who have no familiarity with the concept.

The dictionary defines the word “benchmarking” as follows (THE FREE DICTIONARY, by Farflex):

**bench·mark** *n.*

1. A standard by which something can be measured or judged: "*Inflation . . . is a great distorter of seemingly fixed economic ideas and benchmarks*" Benjamin M. Friedman. See Synonyms at [standard](#).

2. often **bench mark** A surveyor's mark made on a stationary object of previously determined position and elevation and used as a reference point in tidal observations and surveys.

tr.v. **bench·marked**, **bench·mark·ing**, **bench·marks**

To measure (a rival's product) according to specified standards in order to compare it with and improve one's own product.

From a number of definitions available from various sources (see *Annex 1*) let us quote one<sup>2</sup>: **Benchmarking is a process by which a business systematically measures itself against a better performing business, and then adopts and adapts any functions or procedures shown to be more effective.**

This paper attempts to discuss the main, predominantly technical, issues<sup>3</sup> with regard to benchmarking and is intended to assist those who are willing to admit to the fact that despite all explanations and definitions available, they are not quite sure what it is all about and whether and how it could be applied in the tanning industry.

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<sup>1</sup> See *Annex 16*.

<sup>2</sup> Taken from the paper “Assessing Competitiveness in Shoe Manufacturing, Practical Benchmarking of Shoe Production” by F. Schmél, A. Clothier.

<sup>3</sup> It was felt that marketing and more detailed financial aspects were beyond the scope of this (initial?) paper.

## 2. A TANNER AND BENCHMARKING

Is benchmarking just another fashionable gimmick invented by smart consulting companies to sell generalities and common sense to innocent tanners? Is it merely a new public relations gimmick for factories better at marketing than modern technology, quality and efficiency? Are not all those ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION) series and EMAS (eco-management and audit scheme) management tools more than sufficient for any tannery struggling to survive the hazards of raw material, environmental agencies and finished leather prices? Why bother with another buzzword that comes and goes like so many others?

As said earlier, there are many definitions of benchmarking in many languages, the essence of all of them simply being *a comparison with the best in the sector*. In the case of tanneries, the troubles start right at the very beginning: with whom to compare? How do you compare the incomparable: a tannery processing heavy, +50 kg bull hides with a plant using 15-20 kg cow hides?; a giant upholstery or automotive leather producer with manufacturer of high quality shoe uppers?; full grain vs heavily corrected and coated leather? Is there any sense in comparing the yield in terms of dm<sup>2</sup>/kg of raw material (dm<sup>2</sup>/kg) for hides of 50 and 15 kg/piece?

The overall business environment also considerably influences a tannery's performance. Quite understandably, its management will develop strategies with the view of optimizing the balance of factors such as tax regulations, cost of labour (including contribution towards health and pension benefits), power, chemicals, the sometimes rather complex system of export and/or import incentives, duties, and strictly financial aspects (foreign exchange regulations, currency rates) etc.

Not long ago it was argued in various international forums and leather magazines that a combination of excessive incentives, almost closed local raw material and leather and leather products markets, together with the absence of environmental protection in developing countries, had resulted in a rapid shrinking of the tanning industry in the North and West.

Conventional economic thinking dictates that, if the local labour costs are low (possibly combined with employment incentives), manual or low output machine operations will prevail over high automation. Expensive imported (specialty) chemicals, machines and spare parts and/or expensive energy may discourage production of fully finished leathers. Non-availability of cheap carbon dioxide *a priori* reduces the scope for introducing cleaner, environmentally friendly deliming.

Indeed, a lack of or poor enforcement of environmental protection measures can be crucial in overall profitability of tanning operations: the high cost of energy needed for biological treatment or disposal of hazardous wastes and sludges can make all the difference. In any case, meeting generally accepted environmental and occupational safety and health (OSH) at work norms is a *condition sine qua non* for any tannery to be seen as a reputable and honest competitor; a few years ago UNIDO even proposed that no green label could be awarded to a product manufactured from leather produced under environmentally unacceptable conditions.

There are also claims that **price and profitability** are the best and, as some put it, the only relevant comparison parameters. Such people take the example of a tanner, who - working hand in hand with good designer and shoemaker – bought low-grade African hides and produced leather with a special finishing effect for highly fashionable, expensive shoes!

Is it at all possible, and does it even make sense, to benchmark activities like marketing, public relations and corporate social responsibility (CSR) which are certainly important for the general perception and image of the company, but difficult to quantify? Should benchmarking be focused only on financial indicators, or should it include “technical”, production parameters too?

“Environmental performance”, i.e. the ability to meet increasingly stringent environmental legislation, is nowadays for many tanneries a question of their very survival. Within that context possibly the three main constraints faced by many tannery effluent treatment plants, be they individual (ETP) or common (CETP) servicing tannery clusters, are sludge disposal, residual chemical oxygen demand (COD) and total dissolved solids (TDS). Similarly, reutilization and disposal of solid wastes generated in the process (fleshings, shavings, trimmings) is crucial for the profitability of many tanneries. Yet how can the environmental performance of tanneries operating under very different conditions (location, ultimate recipient of effluents, options for handling wastes, climate) be benchmarked?

Since the tanners are well familiar with the traditional *profitability parameters* such as yield (rendement), effects of grading, labour costs etc., this paper deals with other components of leather manufacture important for tannery performance such as OSH at work and waste treatment in more detail.

Incidentally, to many it is somewhat surprising that one important common denominator for tanneries is effluent discharge norms: all over the world the pollutant limits are nearly the same, the main differences being in monitoring and enforcement.

This paper does not aspire to provide a readily usable benchmarking tool. The aim is rather to highlight the main issues, benefits and limitations of this widely promoted activity, and possibly aid tannery management in discussing and negotiating such services with specialized companies or institutions which usually offer either *generic type* or *questionnaire based* benchmarking services. Alternatively, it is hoped that this report will give the initial impulse to those contemplating the development or upgrade of their own, internal auditing and benchmarking activities.



### 3. TANNERY LOCATION, INFRASTRUCTURE

An existing tannery is limited in the improvements it can make to infrastructure and facilities due to the pre-existing conditions with which it is confronted, but the planning of new tanneries provides the opportunity to carefully consider all aspects critical for successful operations. Of particular importance is the problem of TDS (salinity dealt with later in the paper), and no new tannery should be planned without the ability to discharge its (pre-treated) effluents into municipal sewage.

**Check list 1: Tannery location, infrastructure**

1.	Description, component	Yes	No
1.1	Outside residential area, preferably within industrial zone		
1.2	Sufficient supply of water of appropriate quality		
1.3	Stable and reliable power supply		
1.4	Proximity of urban sanitary sewage network and wastewater works (WWW) and solid waste utilization and disposal facilities		
1.5	Easy access for employees and cargo (public transport, roads, railway, airport, harbour)		
1.6	Reliable and efficient transport, forwarding and customs clearance services <sup>4</sup>		
1.7	The ratio of built vs. total factory area – “footprint”(e.g. less than 0.6)		
1.8	The ratio of production area vs. offices/store rooms/other auxiliary services		
1.9	Availability of staff welfare facilities (canteen, crèche, ambulance)		
1.10	Proximity of finished leather markets		
<b>Recommendations:</b>			

Agreeable work conditions improve staff well being and, thus, ultimately, overall factory performance. Furthermore, in order to ensure optimal land utilization, i.e. both the desirable density of infrastructure (e.g. in an industrial zone) and sufficient “green” space, staff recreation, authorities often define the specific maximum ratio (percentage) of the area built/covered vs. total area of the factory compound, its “footprint”. The recommendation is that for new facilities the *ground occupation ratio* should be limited to 50-60%. Similarly, the permitted height of the building/number of floors is also sometimes limited to a certain ratio, computed as the coefficient of the total built work area vs. the total area of the factory compound.

Ideally, the entire tannery production process would takes place on one level, the ground floor; but the (predominantly) natural drying along with the administrative offices are frequently housed in an upper floor.

<sup>4</sup> In some, especially landlocked countries, they are a serious hindrance to successful tannery operations.



## 4. PRODUCTION PARAMETERS

Production and productivity parameters are the daily bread of any tanner and do not require particular elaboration. Here are some examples of parameters monitored. Computations are made with reference to weight, area or both. The list is certainly far from exhaustive.<sup>5</sup>

### Check list 2: Production parameters

2.	Parameter/Component	Unit	Value
	<b>Input/Output</b>		
2.1	Raw material input, origin-/category-/batch-wise, total	t/day or t/week or t/month or t/year	
2.2	Green hides vs. grain pelt weight	t/t, %	
2.3	Green hides vs. limed split weight	t/t, %	
2.4	Beamhouse output – per day/week/month/year	t/worker or t/work-hour	
2.5	The rate of capacity utilization in terms of actual work-hours of individual machines vs. work-hours theoretically possible and/or target set	work- hours/work- hours %	
2.6	The rate of capacity utilization in terms of actual input/output vs. theoretically possible and/or target set	t/t or m <sup>2</sup> /t or t/m <sup>2</sup> or %	
	<b>Wet blue</b>		
2.7	Shaved weight, grain	t or kg	
2.8	Shaved weight, usable splits	t or kg	
2.9	Shaved weight (grain) vs. green and vs. pelt weight	t/t, %	
2.10	Shaved weight (usable splits) vs. green and vs. pelt weight	t/t, %	
2.11	Grain leather area yield	m <sup>2</sup> /kg	
2.12	Splits area yield	m <sup>2</sup> /kg	
2.13	Splits area vs. grain leather area yield	m <sup>2</sup> /m <sup>2</sup> , %	
2.14	Detailed breakdown of grading vs. origin, category, batch	% of I, II, III grade	
2.15	Tanyard output – per day/week/month/year	t/worker or m <sup>2</sup> /worker or work-hour	
	<b>Crust</b>		
2.16	Grain leather area yield	m <sup>2</sup> /kg	
2.17	Splits area yield	m <sup>2</sup> /kg	
2.18	Splits area vs. grain leather area yield	m <sup>2</sup> /m <sup>2</sup> , %	
2.19	Weight, grain	t or kg	
2.20	Weight, usable splits	t or kg	
2.21	Detailed breakdown of grading vs. origin, category, batch	% of I, II, III grade	
2.22	Crust leather output – per day/week/month/year	m <sup>2</sup> /worker or work-hour	

<sup>5</sup> For some useful information, please see *Annex 3* and *Annex 4*.

2.	<i>Parameter/Component</i>	<i>Unit</i>	<i>Value</i>
	<b>Finished leather</b>		
2.23	Grain leather area yield	m <sup>2</sup> /kg	
2.24	Splits area yield	m <sup>2</sup> /kg	
2.25	Splits area vs. grain leather area yield	m <sup>2</sup> /m <sup>2</sup> , %	
2.26	Weight, grain	t or kg	
2.27	Weight, splits	t or kg	
2.28	Detailed breakdown of grading vs. origin, category, batch	% of I, II, III grade	
2.29	Finished leather output – per day/week/month/year	m <sup>2</sup> /worker or work-hour	
<b>Recommendations:</b>			

For proper evaluation and tracking, all records are maintained with reference to origin, category, and batch. As a rule, unless wet blue leather is the final product, its area is not measured. Nevertheless, it is recommended to monitor the area based on representative samples. The same applies for crust and finished leathers – sold on the basis of area, the weight checked only for transport purposes.

## 5. CLEANER TANNING TECHNOLOGIES

A comprehensive computation of mass balance and the efficiency of leather manufacturing indicates that, for a number of reasons, in a conventional process only some 50% of corium collagen and less than 20% of the chemicals used are actually retained in the finished leather (see *Annex 5*). The primary task of all cleaner technologies is to reduce the amount and possibly change the nature of pollution emissions and thereby reduce the pressure and the cost of end-of-pipe treatment.

### *Check list 3: Cleaner technologies*

3.	<i>Production stage – method – process</i>	Yes	No
	<b>Raw material</b>		
3.1	Green fleshed, preferably in the abattoir		
3.2	Short-term preserved by appropriate chilling, i.e. green – salt-free		
3.3	If applied, then only environmentally acceptable biocides used		
3.4	Dried (primarily skins) under well controlled conditions		
	<b>General</b>		
3.6	Strict water management system (including batch rinsing instead of by continuous flow)		
3.7	Float recycling both to reduce water consumption and/or improve the uptake of chemicals		
3.8	Segregation of all chrome-bearing streams		
3.9	Avoidance and monitoring of banned and/or potentially harmful substances such as pentachlorophenol (PCP), hexavalent chromium (Cr <sup>6+</sup> ), free formaldehyde and forbidden aromatic amines		
3.10	Substitution of all chemicals with strong negative environmental impact, including low biodegradability (e.g. some complexing agents, halogenated organic compounds, organic solvents etc.) with friendlier alternatives		
3.11	Use of least potentially environmentally harmful biocides at all stages (curing, soaking, pickling, tanning, post-tanning)		
3.12	Avoidance of potentially environmentally harmful surfactants such as nonylphenol ethoxylates, NPE <sup>6</sup> , at all stages (soaking, liming, tanning, post-tanning)		
3.13	Preference for chemicals with low neutral salts content		
3.14	Highest possible exhaustion level of chemicals used		
3.15	Monitoring and control of “hidden” presence and/or emissions such as organic solvents contained in finishing chemicals, volatile organic compound (VOC) releases from leather during storage		
3.16	Specific targets – ceilings set for pollution loads (biological oxygen demand – BOD, chemical oxygen demand – COD, suspended solids – SS, total Kjeldahl nitrogen – TKN, TDS etc.) discharged from the main processing steps (liming, deliming, tanning, retanning etc.) <sup>7</sup>		
3.17	Specific targets – ceilings set for the pollution load (BOD, COD, SS, TKN, TDS etc.) contained in the combined effluent		

<sup>6</sup> Endocrine glands disrupter.

<sup>7</sup> Due to the lower water consumption – higher pollution load concentration effect, it is important to monitor not only the concentration (mg/l COD) but also the pollution load (kg of COD).

3.	<i>Production stage – method – process</i>	Yes	No
3.18	Specific targets – ceilings set for all hazardous and/or unpleasant air emissions (VOCs)		
	<b>Specific processing stages</b>		
3.19	Desalting of wet salted hides and skins <sup>8</sup>		
3.20	Hair-save unhairing with hair separation and, ultimately, utilization		
3.21	Splitting of limed pelts (ex-lime splitting)		
3.22	Highest technically possible accuracy of splitting be it in lime or after (pre)tanning		
3.33	Low- or ammonium salts-free (carbon dioxide) deliming		
3.34	Short pickling floats preferably with recycling		
3.35	Full scale chrome management of chrome emanating from the main tannage (high chrome exhaustion, direct recycling of tanning floats, chrome recovery/reuse after precipitation) but also from all other chrome emissions (retanning, sammying, any “bleeding”)		
3.36	Vegetable tanning exhaustion rate not less than 95% (counter-current pit and drum tanning with recycling)		
3.37	Use of syntans and resins with low-phenol, -formaldehyde and low acrylic acid monomer content		
3.38	Optimized mechanical dewatering and forced drying		
3.39	Environmentally friendly finishing: predominantly water based; avoidance of isocyanates and aziridines; preference for roller/curtain coating; in case of spraying use of high volume, low pressure (HVLP) and airless methods		
3.40	Strict use of abatement techniques (wet scrubbing, absorption, bio-filters) to reduce VOC content in as well as malodour of air emissions.		
<b>Recommendations:</b>			

The main expected favorable impacts of cleaner technologies are lower overall pollution and hydraulic load, with correspondingly lower effluent treatment investment and operating costs. More specifically cleaner technologies result in:

- Lower water consumption – better preservation of rapidly diminishing water resources
- Lower TDS content/salinity – lower risk of affecting the usability of the receiving river water for irrigation and livestock watering
- Proportionally higher volume of solid wastes suitable for processing into saleable by-products
- Lower BOD, COD and Nitrogen content within acceptable range – protection of aquatic life, avoidance of eutrophication
- Low level of chromium in CETP sludge – makes possible land application and/or composting
- Lower hazardous and/or unpleasant air emissions (see *Annex 7*)

<sup>8</sup> See also *Annex 6*.

Unfortunately, little is known about the long-term environmental impact of some chemicals such as biocides and surfactants, their possible chronic toxicity or their role as endocrine disruptors. Typical toxicity tests observe acute toxicity only and are limited to a few species.

In general it can be said that the currently available cleaner tanning technology methods can drastically reduce the pollution load, but the need for end-of-pipe treatment remains.

## 6. ENERGY

Despite its relatively low share in the total production cost (typically about 3%), considerable energy savings can be made by careful selection of methods and equipment as well as close control of thermal efficiency. Wherever possible, the principle “no production, no consumption” should be strictly followed.

### *Check list 4.1: Energy management*

4.1	Description	Yes	No
	<b>Energy management</b>		
4.1.1	All warm water and steam pipes well insulated, no leakages		
4.1.2	Hot-cold water mixing system well calibrated, short adjustment cycles		
4.1.3	Optimised mechanical dewatering (sammying)		
4.1.4	If viable natural drying used (especially for high quality soft leather, skins)		
4.1.5	Optimal drying regime in drying chambers and tunnels (e.g. higher air velocity, lower temperature) <sup>9</sup>		
4.1.6	Infrared heating used for drying in finishing		
4.1.7	Solar energy supported drying		
4.1.8	Use of heat pumps		
4.1.9	Electromotors' capacity optimized (usually 75% of maximum performance)		
4.1.10	Hot water/steam boiler and auxiliary components design and performance allows only lowest technically possible losses		
4.1.11	Wherever viable, waste heat (e.g. from vacuum driers, compressors) recovered		
4.1.12	Steam condensate recovered		
4.1.13	The scale of operations permitting, part of energy needs obtained from anaerobic digestion of fleshings and sludge		
4.1.14	The scale of operations permitting, part of energy needs obtained from incineration from chrome-free solid wastes (fleshings, fat)		
4.1.15	Automatic and/or manual controls of heating/cooling/ventilation/lighting systems in place		
<b>Recommendations:</b>			

<sup>9</sup> See also Annex 8.

**Check list 4.2: Energy consumption**

4.2	Description	Unit	Value
	<b>Energy consumption and utilization efficiency</b>		
4.2.1	Energy consumption vs. input (t of raw hide)	GJ/t	
4.2.2	Energy consumption vs. output (wet blue/crust/finished leather)	MJ/m <sup>2</sup>	
4.2.3	Energy used for heating/cooling of store rooms and offices	GJ/year	
4.2.4	Total energy consumption over a certain time span (working/non-working day, month, year)	GJ/working day	
4.2.5	Share of own energy produced (digestion, incineration) vs. total energy consumption	%	
4.2.6	Energy consumption for effluent/waste treatment vs. raw hide input and/or effluent volume (see also <i>Chapter 10</i> )	GJ/t or m <sup>3</sup>	
<b>Recommendations:</b>			



## 7. QUALITY ASSURANCE

Possibly the most complex challenge for every leather manufacturer is to maintain the capability to supply the end-user with a consistent product despite the fact that the properties of the main input, the raw hide, vary considerably even within the same weight, breed and sex category. Consistently adhering to delivery schedules is of equal importance with providing the demanded quality of product. Therefore, the continuous and very careful monitoring of all process parameters is a *conditio sine qua non* for achieving and maintaining the desirable quality level and consistency.

**Good monitoring and control are also the indispensable components of cleaner technologies;** strictly applied and followed they reveal that in most tanneries actual consumption of chemicals exceeds the theoretical, recipe-based computation, at times by as much as 10-15%. There are many possible sources for this difference: the most typical being material handling waste, overdosing (including over-spray in finishing), low exhaustion and, probably most crucial, the reprocessing/refinishing of batches not meeting specifications.

Additional labour, energy and time losses, possibly compounded by the diminished trust by the customer for failing to deliver the goods on time, are further undesirable consequences of reprocessing. To quote an experienced leather industry specialist: **“The costs of chemicals, labour, rejects, re-works, energy, pollution control/treatment are amplified by waste.”**

What is more, the unavoidable wastes due to lower reactivity of some processes/chemicals (e.g. vegetable tanning, retanning with synthans, fat liquoring and dyeing), as well as some general chemicals (e.g. acids) not absorbed in the process, adds to the amount of chemicals which end up in the drain instead of the leather, thereby increasing the pollution load (see also *Annex 9* and *Annex 10*).

Modern controls in leather manufacturing, **preferably partially or fully automated**, monitor and correct parameters such as weights, volumes, pH, temperatures, run-times, preparation and dosing of chemicals, rinsing as well as leather properties, compares and corrects them to coincide with standard/reference values in order to reduce deviations and ensure that the final product complies with the given specification.

Listing all quality parameters that need to be controlled and monitored exceeds the purpose and concept of this paper, but a summary is provided in the chart below. The quality/performance aspects of requisitioning and marketing activities are not included here.

**Check list 5: Quality assurance, reprocessing**

5.	Parameter/Component	Yes	No
5.1	Raw hide/skin: origin, preservation, sex, weight, grade, thickness, trimming, health inspection if applicable		
5.2	General and specialty chemicals <sup>10</sup> : material safety data sheets, active substance content, shelf life, properties specific for a particular chemical		
5.3	Processes: weights and volumes, run times, temperatures, pH, including specific controls (e.g. deliming, bating, neutralization level)		
5.4	Mechanical operations: performance specific for a certain machine and operation such as pressure and dewatering effect for sammying, thickness and accuracy for splitting, uniform coating and minimal losses in spraying etc.		
5.5	Final product – wet blue, crust, finished leather: laboratory tests as per the INTERNATIONAL UNION OF LEATHER TECHNOLOGISTS AND CHEMISTS SOCIETY (IULTCS) physical (IUP), chemical (IUC) and fastness (IUF) norms and procedures and customer specifications		
5.6	Additional analyses for presence of banned and/or potentially hazardous chemicals (e.g. banned amino dyes)		
5.7	Infrastructure, auxiliary equipment: power, steam, compressed air sources and supply lines, stores, vessels under pressures, vehicles etc. in conformity with official standards		
5.8	All staff welfare related matters such as catering, hygiene, resting and recreational facilities, transport etc. complying with highest standards		
5.9	All tannery operations and activities duly reflected and recorded in easily accessible and retrievable documents		
	<b>Laboratory control (a few examples)<sup>11</sup></b>		
5.10	Chrome content in the fresh main tanning float		
5.11	Chrome content in the main tanning spent float		
5.12	Chrome content in the retanning float		
5.13	Chrome content in the spent retanning float		
5.14	Chrome content in the waters from sammying		
5.15	Chrome content in the combined chrome bearing streams		
5.16	Chrome content in the combined tannery effluent		
5.17	Chrome content in wet blue/crust/finished leather		
	<b>Rework/reprocessing/delivery time</b>		
5.18	A (software) programme regularly compares the amount of chemicals purchased/actually used vs. theoretical, recipe based quantities		
5.19	A (software) programme regularly compares the excess chemicals used against the (maximum) limit set		
5.20	Actual exhaustion rates (e.g. for retanning agents, fat liquors, dyes) regularly compared with the targets set		
5.21	Number of batches reprocessed regularly compared against the ceiling set		
5.22	Number of customers' claims regularly compared against the (maximum) limit set		

<sup>10</sup> In EU countries the suppliers are also expected to comply with the REACH regulative introduced since the beginning of 2007.

<sup>11</sup> Laboratory monitoring and control of effluent treatment parameters (BOD, COD, TKN, sulphide, TDS, DO etc.) is another, rather complex area.

5.	<i>Parameter/Component</i>	Yes	No
	<b>Failures</b>		
5.23	Records about all technical and delivery failures together with critical assessment of their causes orderly maintained		
5.24	Records kept about the nature and effect of corrective actions taken (e.g. technical modifications, training, new recipes etc.)		
5.25	Critical evaluation of failures conducted periodically (e.g. weekly, monthly)		
5.26	Assessment of the impact of preventive actions carried out regularly		
<b>Recommendations:</b>			

## 8. PRODUCT DEVELOPMENT, LONG-TERM STRATEGIES

The complexities of product development and long-term strategies exceed the scope of this paper; the points below are intended only as reminders of some essential considerations.

### *Check list 6: Product development, strategies*

6.	Component	Yes	No
6.1	A system for continuous monitoring of the relevant (global) research, access to and dissemination of information in place; periodically updated to reflect the progress in communication technologies		
6.2	Marketing and product development teams work hand-in-hand to anticipate/identify/verify the trends and timely develop products meeting customers' requirements		
6.3	The technologists make sure that new products are a step forward also in terms of environmental criteria in production and ultimate use.		
6.4	Alternatives – fall back strategies exist for gradual and/or sudden drying up of current raw material/chemicals/sourcing		
6.5	Alternatives – fall back strategies exist for gradual and/or sudden deterioration in demand/sales of currently prevailing products		
6.6	The existing production capacity is too low/too large, optimal		
<b>Recommendations:</b>			

Today there is a very clear trend of a steady increase in tanning capacity. Currently tanneries with a daily input of some 100 t of hides replacing many smaller operations are not uncommon. Similarly, it is rather doubtful whether fully independent sheep or goat skin tanneries processing less than 2,000-3,000 pieces/day can survive unless producing for a specific niche. Despite some negative consequences of this trend, and despite governmental support provided to small and medium scale producers, the future viability of these smaller operations remains uncertain. The challenge for tanneries in this category is to take a hard look at their own position and compare – benchmark themselves against the successful ones.

## 9. OCCUPATIONAL SAFETY AND HEALTH (OSH)<sup>12</sup>, MAINTENANCE

The main factors affecting health hazards and safety at work are machines and equipment, chemicals, working environment and conditions, and people. As a rule, OSH standards in a tannery are among the best visual indicators of its overall performance.

### *Check list 7: Occupational safety and health at work, maintenance*

7.	Component	OK	Not OK
	<b>Chemicals, general</b>		
7.1	Material safety data sheets of all chemicals readily available		
7.2	Staff familiar with the basic content of data sheets		
7.3	All chemicals stored in orderly manner		
7.4	All containers correctly labelled		
7.5	Staff familiar with the meaning of signs and symbols, risks and first aid, especially concerning hydrogen sulphide (H <sub>2</sub> S)		
7.6	Transfer and dosing of chemicals ideally in fully closed systems		
7.7	Concentration of (hazardous) chemicals levels below TLV in terms of both TWA and STEL		
7.8	Hazardous/inflammable chemicals stored in proper, prescribed manner		
7.9	Limited access to areas with hazardous chemicals		
7.10	Residues disposed in prescribed manner		
7.11	Small empty containers returned or disposed in prescribed manner		
7.12	Use of PPE: gloves, goggles, aprons, boots etc.		
	<b>Machines, general</b>		
7.13	Machine's position allows smooth work flow and maintenance		
7.14	Preventive/regular maintenance and spare management in place		
7.15	Active safety devices (pneumatic, ultrasonic, optical or electrical) installed and functioning		
7.16	Electrical installation in accordance with high safety standards in all respects (corrosion, earthing, water, gases, sparking etc.)		
7.17	Passive safety devices (guards, fences) on moving parts (gears, belts etc.) installed, firmly anchored		
7.18	Noise, vibration, radiant heat, dust, gas/vapours levels in accordance with high legal standards		
7.19	Operation instructions, understandable to the operator, fixed at suitable place		
7.20	Operation controls buttons/switches labelled in the language of operators		
7.21	Emergency OFF button/switch within easy reach of operator and helper		
7.22	Strict adherence to preventive checks and maintenance schedules		
7.23	Use of PPE		
	<b>Workplace environment and conditions</b>		

<sup>12</sup> For a full overview, including a very detailed list of items to be monitored, refer to the study "Occupational Safety and Health Aspects of Leather Manufacture" by J. Buljan, A. Sahasranaman and J. Hannak, jointly published by UNIDO and COUNCIL FOR LEATHER EXPORTS (CLE), India, 1999.

7.	Component	OK	Not OK
7.24	Even floors with slip-proof surface, covered floor openings		
7.25	Drains covered with corrosion resistant grates		
7.26	Safe and clearly marked transport and passageways		
7.27	Adequate lay-out/spacing, room lighting, ventilation, humidity		
7.28	Fixed and portable hydrogen sulphide (H <sub>2</sub> S) and ammonia (NH <sub>3</sub> ) meters used in hazardous areas (beamhouse, waste treatment)		
7.29	Personal breathing apparatuses readily available in higher risk areas		
7.30	Safety and health protection signs and instructions visibly displayed		
7.31	Staff trained and uses personal protective equipment: gloves, aprons, boots, goggles, hearing protection, harnesses for entering pits etc.		
7.32	First medical aid kits readily available, staff trained in how to use them		
7.33	Appropriate fire fighting equipment ready at marked locations		
7.34	Well established emergency procedures, regular drills		
7.35	Well established accident prevention and monitoring system and records <sup>13</sup>		
	<b>Machines, example of specific cases</b>		
	<i>Drums</i>		
7.36	One-meter space provided in the rear and sides of the drum		
7.37	Fixed barrier guards installed in the rear and side areas to prevent access to drum and drive while the drum is rotating		
7.38	Removable, interlocked safeguard installed at the front, which automatically stops rotation of the drum if not in place or opened		
7.39	All operating control switches marked in local/operator's language and/or colour (e.g. OFF – red, ON – green)		
7.40	The control switches installed close to the drum but away from any moving part		
7.41	The electrical starter of the motor will not restart on its own when the supply is restored after the power failure		
7.42	Electrical cables armoured and routed in corrosion-proof conduits		
7.43	Electrical enclosures and motors have IP55 degree protection		
7.44	Motor terminal boxes covered and closed		
7.45	Cable entry holes have gland fittings		
7.46	All openings in the electrical enclosure boxes closed with tight fitting plugs to prevent the ingress of dust and water		
7.47	Electric motor body and base frame earthed		
7.48	All electrical enclosures of switchgear connected with corrosion protected earth wires; if insulated then marked as per international colour code (yellow and green)		
7.49	Metal parts/bands on wooden drums corrosion protected; if corroded replaced		
7.50	Power supply to the drum motor disabled or locked out (by removing fuses/locking isolator switch) before any maintenance work		
7.51	A mechanical stop-device (brake) used to prevent accidental drum rotation during loading/unloading and repair and maintenance work		
7.52	A sign board "Under repair" or "Men at work" visibly posted during repair and maintenance work		

<sup>13</sup> Includes not only records but also critical assessment of causes as well as corrective and preventive actions taken (e.g. training) to avoid the same accidents happening again.

7.	Component	OK	Not OK
7.53	Appropriate devices (ducts, hoses) ensure controlled draining of floats – no flooding		
7.54	Sufficient time allowed for harmful gases, fumes, vapours to exit before checking or attempting removal of entangled hides/skins inside the drum		
7.55	Another person keeps watch outside in (exceptional) case of operator entering the drum		
7.56	Drum operators and helpers wear personal protective equipment (gloves, waterproof, non-slip footwear) especially during loading/unloading, when checking leather; all chemicals handled in prescribed, safe manner		
	<i>Automatic spraying machine</i>		
7.57	The machine, including the drying tunnel, positioned in a way allowing sufficient space for operation, maintenance and repair		
7.58	Fixed guard and covers installed and in place to prevent the possibility of accident/injury by contact with moving parts: pulley, drive, belts		
7.59	(Glass) panels of the spraying compartment in place and good order, tightly sealing the compartment		
7.60	Spray vapours and mist efficiently ducted out from the spraying boot and drying tunnel and subsequently efficiently removed/neutralized.		
7.61	Spraying area regularly checked for concentration of harmful evaporations		
7.62	Fire fighting equipment suitable for inflammable solvents (class B fire) regularly checked and readily available		
7.63	All operating control switches marked in local/operator's language and/or colour (e.g. OFF – red, ON – green, EMERGENCY STOP –yellow/red)		
7.64	All electric motors and enclosures in the spraying area enclosed and explosion-proof (EX rated)		
7.65	Electric motors bodies, base-frames and electrical enclosures earthed with corrosion-protected wires; if insulated then marked as per international colour code (yellow and green)		
7.66	The electrical starter of the motor will not restart on its own when the supply is restored after the power failure		
7.67	Electrical cables armoured and routed in corrosion-proof conduits		
7.68	Electrical enclosures and motors have IP55 degree protection		
7.69	Operators clean the machine before lubrication		
7.70	Grease nipples, breathers and filler caps in place to prevent ingress of dust		
7.71	Compressed air regulators and pressure gauges in good, working condition.		
7.72	The collection well for excess spray liquid clean, regularly emptied		
7.73	All light fittings and bodies periodically cleaned		
7.74	Power supply to the motor disabled or locked out (by removing fuses/locking isolator switch) before any maintenance work		
7.75	A sign board “Under repair” or “Men at work” visibly posted during repair and maintenance work		
7.76	The operator ensures that the glass panels of the spraying compartment are closed before starting the machine.		
7.77	Before checking inside the spraying compartment, the operator allows for sufficient time for removal of the spraying mist		



7.	Component	OK	Not OK
7.78	Exhaust fans of the spraying compartment and drying tunnel programmed to run for at least 20 minutes after ending the spraying operation to ensure removal of all pigment residues and spray mist		
7.79	Operators and helpers checking the spraying compartment wear solvent-resistant gloves, aprons, boots and respirator suitable for organic vapours; all chemicals handled in prescribed, safe manner		
<b>Recommendations:</b>			

## 10. ENVIRONMENTAL ASPECTS – TREATMENT OF WASTES

### 10.1. Effluents

Not unlike the case of leather processing itself, any comparison of effluent treatment performance is also very difficult due to significant differences in a great number of factors relevant for design and treatment operations: initial pollution load, legislation – discharge limits, space available, climate, cost of energy, chemicals, labour etc.<sup>14</sup>

Furthermore, some tanneries, mainly in industrialized countries, have the advantage of discharging their effluents into municipal sewage for final treatment. In developing countries individual tanneries must employ the more complex and costly biological (secondary) treatment in their own ETPs before discharge into open water recipients such as rivers and lakes. CETPs servicing tannery clusters (nowadays the prevailing situation in developing countries and Italy) enable lower unit treatment costs but, regrettably, without dilution with sanitary effluents are confronted with the problem of salinity.

Obviously, the paramount criterion for the performance of the treatment plant is its ability to cope with the pollution load (including possible shock loads) and to produce effluent which conforms to the local regulations, i.e. discharge norms.<sup>15</sup> There are quite a number of parameters which give an indication of the real efficiency of the (C)ETP. Here are only a few of them.

**Check list 8.1: Effluent treatment**

8.1	Description/Component	Yes	No
8.1.1	The rates (percentages) of removal of the key pollution parameters (BOD <sub>5</sub> , COD, SS, TKN, sulphide, chrome) in the course of the primary (physical-chemical) treatment coincide with the best ones known		
8.1.2	The rates (percentages) of removal of the key pollution parameters (BOD <sub>5</sub> , COD, SS, TKN, sulphide, chrome) in the course of secondary (biological) treatment coincide with the best ones known		
8.1.3	The efficiency of the primary and secondary treatments makes tertiary treatment unnecessary <sup>16</sup>		
8.1.4	The amount of energy used for treatment (usually expressed in kWh/kg of COD) equal or lower than in other, similar plants		
8.1.5	The amount of sludge generated (in relation to BOD/COD/SS of the raw influent) equal or lower than in other, similar plants <sup>17</sup>		
8.1.6	The amount of chemicals used at different stages (catalytic oxidation, coagulation, flocculation, sludge conditioning etc.) compares well with similar plants		

<sup>14</sup> For supplementary information see *Annex 11, Annex 12* and *Annex 13*.

<sup>15</sup> Contrary to common perception, there are no significant differences in discharge limits for main pollutants (e.g. BOD, COD, SS, sulphide, chrome and nitrogen) but rather in monitoring and enforcement.

<sup>16</sup> More recently, primarily in EU countries, there are growing concerns about the lack of hard evidence about the fate and negative impact of biocides and surfactants in terms of chronic toxicity, carcinogenic, mutagenic or teratogenic and endocrine disrupter effects.

<sup>17</sup> It is desirable to produce as little sludge as possible.

8.1	Description/Component	Yes	No
8.1.7	Malodours and/or aerosols below the level causing irritation to staff and neighbours		
8.1.8	Spare capacities and stand-by equipment and arrangements ready to cope with emergency situations (shock loads, power failures)		
8.1.9	On- and off-line monitoring system ensures stable operations and prompt reaction to/rectification of any departure from desirable/defined parameters/values		
8.1.10	The cost of overall treatment in terms of US\$/kg of COD removed compares well with those in similar plants		
8.1.11	Part of fully treated effluent recycled and reused for some processes		
<b>Recommendations:</b>			

## 10.2. Solid waste and sludge generated by the ETP

The sources of solid waste at the ETP are:

- Grids and screens – coarse and small particles
- Sand and grit pits – sand (unless washed and reused)
- Sedimentators – scum and primary and secondary (biological) sludge; as a rule the primary and secondary sludge are mixed and disposed of together.

Environmental regulations usually limit the content of trivalent chrome ( $\text{Cr}^{3+}$ ) in solid waste and sludge to be disposed of in ordinary landfills. For some time the European Union (EU) has also set the limit on the total organic carbon (TOC) content in sludge at 18%. The presence of lipophilic substances (emulgators) is also beginning to be limited.

Table 1

### Typical amount of sludge at 40% of DS generated by tannery using 25 m<sup>3</sup> of water/t of raw hide processed

Treatment/unit	DS kg/t raw hide processed	DS kg/m <sup>3</sup> of effluent	Sludge (40% DS) kg/t raw hide	Sludge (40% DS) kg/m <sup>3</sup> effluent
Primary treatment only	100	4	250	10
Full treatment with nitrification/denitrification, up to BOD <sub>5</sub> < 20 mg/l	125	5	312.5	12.5

A tannery using state-of-art technology and the cleanest processing methods, including strict chrome management, for disposal of ETP solid waste and sludge should take into consideration the following options<sup>18</sup>:

- substantial reduction of the amount of sludge by anaerobic digestion (before dewatering) producing biogas,
- land application (agriculture),
- composting/agriculture,
- solidification (usually with lime) for disposal in a landfill,
- thermal treatment,
- supplementary fuel (e.g. in brick and cement production),
- burning/gasification/ pyrolysis.

### 10.3. Solid waste from leather processing

It has been well established that only about 50% of corium collagen and 15-20% of the chemicals used in processing are retained in the finished leather. The challenge for any tannery striving to work profitably in an environmentally friendly manner and to compare favourably in waste disposal benchmarking, is to practice (in order of preference): *i*) avoidance, *ii*) recycling, *iii*) recovery and reuse, i.e. conversion into saleable by-products, of the following waste products:

#### **Untanned waste**

Raw hide trimmings  
Green fleshings  
Hair  
Lime fleshings  
Lime split waste

#### **Tanned waste**

Wet-blue split waste  
Wet-blue shavings  
Buffing dust  
Dry trimmings  
Screenings

The less waste produced and the larger the share of it profitably converted into secondary products yields a better ranking in a benchmarking exercise.

The key issue is usually the commercial viability of converting impure waste into valuable, but in terms of purity very demanding, food and cosmetics raw material. When a tannery is considering operating its own conversion plant, an additional constraint is the problem of economy of scale, i.e. will the plant be large enough to be economically feasible.

At this point in time supplying converted waste products to the food industry is not possible without a hazard analysis and critical control point (HACCP) system in place. Some of the key factors monitored are veterinary certificates, raw material inspection, bacterial control (specifically for *Salmonella* and *Staphylococcus aureus*), temperature control during storage, pelt baskets disinfection, etc<sup>19</sup>.

The leather literature abounds with suggestions on options for conversing solid waste into *by-products*: bovine hair for fertilizer, goat hair for felt manufacture, raw trimmings for glue, fleshings for glue and tallow, poultry feed supplements, biogas, composting, pelt splits for cosmetics, dog chews, wet-blue shavings and trimmings for leather board and hydrolysis, vegetable and Cr leather shavings for leather board, sludge for composting, gasification and bricketing etc. Controlled

<sup>18</sup> In some countries tannery sludge is also being disposed in abandoned salt mines.

<sup>19</sup> It is reported that a wet blue tannery in Central Europe with the HACCP system in place is able to sell its limed bellies and shoulders for about US\$ 0.5/kg; however, it has to pay for fleshings to be taken away for conversion into fat and glue.

incineration and pyrolysis of combined wastes has been tested and there are a few industrial scale plants in operation (see also *Annex 15*). In reality, however, there are few economically viable alternatives. Typically, tanners in industrialized countries pay to have the waste removed; in developing countries the waste products can often be sold as is.

The challenge is to find the optimum balance between commercial and environmental requirements. Following are some starting points for drawing up an internal checklist for dealing with solid waste handling:

**Check list 8.2: Solid waste**

8.2	Description/Component	Yes	No
8.2.1	Strict collection, segregation and appropriate storage of all categories of solid waste		
8.2.2	Continuous monitoring of material balance, quantities produced		
8.2.3	Continuous laboratory control of key properties		
8.2.4	HACCP system in place		
8.2.5	Specific targets for reducing the amount of each waste category set and updated		
8.2.6	Specific targets for increasing the range and the amount of waste reutilized set and updated		
8.2.7	The amount of waste (volume, weight) in each category for delivery and/or for final disposal orderly recorded		
8.2.8	Detailed breakdown of <i>costs</i> and <i>income</i> generated by disposal of each category of solid waste		
<b>Recommendations:</b>			

#### 10.4. Landfill

Once the preferred options such as prevention, recycling and utilisation have been exhausted or are not viable, the only remaining practical solution for disposal is a landfill. While in industrialized countries tannery solid waste and dewatered sludge are usually disposed of together with municipal and other industrial wastes, tanneries (be they stand alone or in clusters) in developing countries very often have to establish their own landfills.

Satisfactory handling and disposal of non-utilisable wastes and sludge are essential to achieve high ranking in any benchmarking exercise. The information and estimates in *Annex 14* are intended to assist tanneries in developing countries to accomplish that.<sup>20</sup>

<sup>20</sup> See also *Annex 13*.

## 10.5. Air emissions from tanneries and tannery effluent treatment plants

Whereas earlier air pollutants were not a focal point of pollution control legislation in many countries, these pollutants are increasingly coming under the scrutiny of legislators. A reputable tannery must not only adhere to local regulations, but should also compare itself to the best in the industry.

Air pollution involves not only releases into the atmosphere, but also the quality of the air in the workplace. The main air pollutants are hydrogen sulphide ( $\text{H}_2\text{S}$ ), sulphur dioxide ( $\text{SO}_2$ ), ammonia ( $\text{NH}_3$ ), VOC emanating from organic solvents used in finishing, and malodours, but there are also acid fumes, phenols, formaldehyde<sup>21</sup> and fine dust.

As a rule, environmental protection agencies regulate not only air polluting emissions, but also the absorption capacity of the receiving environment.

Table 2

**Some typical air emission limits**

Pollutant	Emission $\text{mg/m}^3$	Imission $\text{mg/m}^3$ .
Hydrogen sulphide, $\text{H}_2\text{S}$	2-5 at 50 g/h mass flow rate	0.005-0.010
Sulphur dioxide, $\text{SO}_2$	500 at 5,000 g/h mass flow rate	0.050-0.25
Ammonia	10-30 at 300 g/h mass flow rate	0.03-0.07
Volatile organic carbons, VOC Category I	20 at 100 g/h mass flow rate	
Volatile organic carbons, VOC Category II	150 at 2,000-3,000 g/h mass flow rate	
Volatile organic carbons, VOC Category III	300 at 3,000-6,000 g/h mass flow rate	

The use of volatile chlorofluorocarbons (CFCs) and other halogenated hydrocarbons is banned in most countries, but halogenated biocides are still used.

EU legislation is taking a very strong position on air emissions and the regulations are frequently revised. For example, the following are the current VOC emission limits related to organic solvent consumption in finishing<sup>22</sup>:

10-25 t/year:	85 $\text{g/m}^2$ of finished leather produced
More than 25 t/year:	75 $\text{g/m}^2$ of finished leather produced.

Even more complex and strict are regulations for emissions in the workplace. The presence and the concentration of the hazardous air pollutants described earlier is here regulated in terms of Threshold Limit Values (TLV), defined as Time Weighted Average (TWA, i.e. eight hours of continuous exposure), as well as Short Term Exposure Limit (STEL).

<sup>21</sup> While earlier the attention was primarily focused on formaldehyde perceived as carcinogenic, more recently there are strong concerns about possible mutagenic effects of glutardialdehyde.

<sup>22</sup> There are specific regulations for emissions from degreasing.

Table 3

**Some TWA and STEL values for the main air pollutants**

Pollutant	TWA ppm	TWA mg/m <sup>3</sup>	STEL ppm	STEL mg/m <sup>3</sup>
Hydrogen sulphide, H <sub>2</sub> S	10.0	14.0	15.0	21.0
Sulphur dioxide, SO <sub>2</sub>	2.0	5.0	5.0	13.0
Ammonia	25.0	18.0	35.0	27.0
Formaldehyde	2.0	2.5	2.0	2.5

Similarly, specific limits have also been established for each individual organic solvent – VOCs.

The main air pollutants generated by effluent treatment plants are:

- Hydrogen sulphide – the sources being the sewage pipes, pumping station, and pre-treatment and the homogenization tank. This is a more pronounced problem when the effluent pH falls below 8.5–9.0, or the catalytic oxidation of sulphide in beamhouse liquors has not been carried out correctly.
- Ammonia – usual source is the sludge handling line.

**Check list 8.3: Source of air emissions – prevention and abatement<sup>23</sup>**

8.3	Description/Component (some examples)	Yes	No
	<b>Leather processing</b>		
8.3.1	Liming – measures to prevent development of H <sub>2</sub> S (lowering of pH) its detection and neutralization in place (absorption alkaline solution, oxidation)		
8.3.2	Liming and deliming - measures to prevent development of ammonia, its detection and neutralization in place (absorption in acidic solution)		
8.3.3	Finishing – VOC removed by adsorption in activated carbon or absorption in scrubbers/packed towers		
8.3.4	Good ventilation of all spaces with emissions of air pollutants		
8.3.5	Elimination of malodours (scrubbers, biofilters)		
	<b>Wastewater treatment</b>		
8.3.6	All buildings accommodating waste handling (e.g. sludge dewatering) well ventilated		
8.3.7	If the ETP close to residential areas, sources of air emissions and malodours such as tanks covered and the air purified before discharge		
8.3.8	Advanced equipment and methods (e.g. use of pure oxygen) applied in the homogenization tank eliminating the possibility of H <sub>2</sub> S generation		
8.3.9	Elimination of any residual malodours in scrubbers and biofilters		
<b>Recommendations:</b>			

<sup>23</sup> See also the chapter on OSH measures.



## 11. FINANCIAL INDICATORS

There are many well-established indicators of financial performance and there is no need to repeat all of them here. Below are just a few indicators which could be used in a benchmarking exercise:

**Check list 9.1: Some financial indicators**

9.1	Parameter/Component	Unit	Value
9.1.1	Total production cost for wet blue leather	US\$/ m <sup>2</sup>	
9.1.2	Total production cost for crust leather	US\$/ m <sup>2</sup>	
9.1.3	Total production cost for finished leather	US\$/ m <sup>2</sup>	
9.1.4.	Overhead (administrative) vs. direct production costs	Ratio, %	
9.1.5	Comparison of the profitability of individual articles from the product range	Ratio, %	
9.1.6	Environmental protection costs (effluents, solid waste, sludge)	US\$/ m <sup>2</sup>	
9.1.7	Cost of staff training	Ratio, %	
9.1.8	Costs of CSR activities	Ratio, %	
<b>Recommendations:</b>			

In this context there are also some other vital indicators to be considered:

**Check list 9.2: Some further financial indicators**

9.2	Description/Component	Yes	No
9.2.1	The number of working days (working capital) for raw material, chemicals and finished leather on stock, production cycle lower/higher than in similar companies and/or compared with target		
9.2.2	The capital turn (annual turnover divided by total assets) is lower/higher than in similar companies and/or compared with target		
9.2.3	The return on assets (capital turn * profit on sales percentage) is lower/higher than in similar companies and/or compared with target		
9.2.4	The return on sales/assets meets/exceeds the cost of own and borrowed capital and anticipated dividends		

## 12. HUMAN RESOURCES, STAFF WELFARE, CSR

Not only the educational background and skills of employees, but also their motivation and commitment are key ingredients of any successful operation. A dedicated and loyal workforce is the result of not only appropriate remuneration, but also fair treatment, recognition, encouragement of initiative and innovation.

While this sounds obvious, in real life that is not always the case. In some developing countries in particular, too often the importance of attracting, retaining and remunerating the technical staff (skilled operatives, supervisors, technicians, engineers) is not fully appreciated.

### **Check list 10: Human resources, staff welfare, CSR**

10.	Description/Component	Yes	No
10.1	The company is able to attract and retain the best skills		
10.2	Competitive remuneration linked to both output and quality		
10.3	The company offers attractive social package (insurance, health and pension benefits)		
10.4	The company offers equal opportunities for all staff/both genders (pay, promotion, training)		
10.5	A stable system for continuous systematic training of staff of all profiles and levels in place (courses, workshops, team building etc.)		
10.6	The level of absenteeism lower/higher than in similar companies or against the target set (e.g. 5-6%)		
10.7	Exposure of key personnel to global and prevailing trends and developments in the (sub)sector: fairs, exhibitions, machinery innovations, study tours, visit		
10.8	A transparent and motivating system of rewarding new ideas, savings and innovations in place		
10.9	Participation in national and international sector associations (e.g. IULTCS, ICT), meetings; subscription to technical periodicals		
10.10	Appropriate and sufficient toilets, showers; canteen, crèche, ambulance, postal services; recreational area		
10.11	Where relevant, proximity of place(s) for religious service		
10.12	Share of training, welfare, CSR costs in the overall production costs stable or increasing		
10.13	Maintaining a high CSR profile; continuous dialogue with the local community, supporting its activities <sup>24</sup>		
<b>Recommendations:</b>			

<sup>24</sup> Not to be confused with regular promotion and marketing activities.

A company maintaining a continuous dialogue with the local community will be in a better position to resist unfounded pressures of local politics that, regrettably, often (mis)use environmental issues for their own purposes.

### 13. SUMMARY OF RECOMMENDATIONS

No	Area - component	Recommendation / Action to be taken	Deadline	Responsible	Remarks
1	Tannery location, infrastructure				
2	Production parameters				
3	Cleaner technologies				
4	Energy management and consumption				
5	Quality assurance				
6	Product development				
7	Occupational safety and health				
8	Effluent treatment, solid waste, air emissions				
9	Financial indicators				
10	Human resources				
	Summary				

## 14. AN OUTLINE OF A “MODEL TANNERY”

In view of the number and complexity of the factors influencing tannery performance, it is very difficult to accurately define general success criteria applicable to all tanneries, because exceptions arising out of local conditions could invalidate the general rule. While it is obvious that existence of tanneries situated in arid regions or in the heart of prime residential areas is jeopardized, and that in the long run small scale units (except specific niche producers) are unlikely to survive, it might be hard to agree about the minimum or optimum tannery size; there would be (too) many qualifications, limitations, and *caveats*.

The overview below attempts to provide a very general outline of a modern tannery with some vital parameters, fully recognizing the limitations and the counter arguments which could be raised.

Table 4

Some criteria and parameters for a tannery processing raw bovine hides into shoe upper leather	
LOCATION	Outside residential area, preferably within industrial zone, <i>proximity to urban sanitary sewage network and wastewater works (WWW) or at the seaside</i> . Sufficient supply of water of appropriate quality, stable and reliable power grid. Solid waste utilization and disposal facilities. Easy access for employees and cargo (public transport, roads, railway, airport, harbour). Reliable and efficient transport, forwarding and customs clearance services. Proximity to finished leather markets.
RAW MATERIAL	Fresh (chilled) hides from abattoir, machine-flayed.
WEIGHT CATEGORY	25-30 kg/hide, area about 4 m <sup>2</sup> (cca. 43 sqft), thickness 6-8 mm.
INPUT/SOAKING	About 300-350 pieces, i.e. 7.5-10 t of raw hides/day.
OUTPUT/PRODUCTION	About 1,300 m <sup>2</sup> (cca. 14,000 sqft)/day of grain leather + about 590 m <sup>2</sup> (cca. 6,300 sqft) of split leather, total: 1,890 m <sup>2</sup> (20,300 sqft)/day.
TECHNOLOGY (see <b>Check list 3</b> )	Hair-save liming, carbon dioxide deliming, ex-lime splitting, high exhaustion chrome tanning with full chrome management system, vegetable and environment friendly synthans retanning, optimum exhaustion of dyes and fat liquours, segregation of beamhouse, all chrome bearing and general streams, use of biodegradable surfactants and acceptable biocides, optimized mechanical dewatering and drying, (predominantly) water based finishing. The total amount of chemicals consumed about 4.5 t/day. The work cycle not exceeding three weeks.
EQUIPMENT	High accuracy splitting and shaving, drums suitable for short floats, recycling, good distribution of chemicals, optimized coating, scrubbers for air emissions. High level of automation and process control – automated water, chemicals dosing and mixing systems but also staking and transport.
YIELD	1300 m <sup>2</sup> /10 t = 13.0 dm <sup>2</sup> (1.4 sqft) of grain leather/kg green weight + 590/10 t = 5.9 dm <sup>2</sup> (0.63 sqft) of splits /kg green weight. Total 1,890 m <sup>2</sup> (20,300 sqft)/10 t = 18.9 dm <sup>2</sup> (2.0 sq ft) of leather/kg of green weight. Tailor made software monitoring.
REWORK, CLAIMS	Internal up to 5%, external below 2%. Tailor made software monitoring.

Some criteria and parameters for a tannery processing raw bovine hides into shoe upper leather	
WORKFORCE	85-90 (75 production), without ETP
PRODUCTIVITY	1,890 m <sup>2</sup> (20,300sqft)/75 = 25 m <sup>2</sup> (270 sqft)/day/production worker or 21 m <sup>2</sup> (226 sqft)/day/employee. Tailor made software monitoring.
POWER INSTALLED	Appr. 700-750 KW, production and auxiliary equipment but without ETP.
WATER CONSUMPTION	Not exceeding 25 m <sup>3</sup> /t raw hide, total appr. 250 m <sup>3</sup> /day, including sanitary water. Strict water housekeeping, water meters for each department.
FACTORY COMPOUND	The ratio of built vs. total factory area – “footprint” less than 0.6.
Works area	All at ground level (except workshop mezzanines and supervisor & control panel booths), appr. 3,000 m <sup>2</sup> .
Stores and workshops, offices, sanitary areas	Raw hides, chemicals, hazardous chemicals, maintenance and spare parts, wardrobes, toilettes etc. 1,500 m <sup>2</sup> .
Total	4,500 m <sup>2</sup> of covered area + 600 m <sup>2</sup> for the physical-chemical effluent treatment, the total compound ideally about 10,000 m <sup>2</sup> (1 ha). If biological treatment also required, then an additional 1,000 m <sup>2</sup> , i.e. total 11,000 m <sup>2</sup> needed.
OCCUPATIONAL SAFETY AND HEALTH	All OSH measures, as per examples given in <b>Check list 7</b> , strictly and consistently applied with emphasis on personal protection and measures against toxic (hydrogen sulphide) and inflammable materials (solvents) risks.
HUMAN RESOURCES, CSR	Sanitary facilities in conformity with highest standards. Quality and output linked, competitive remuneration, incentives for innovations. Systematic and continuous training, exposure to global trends and developments. Staff welfare facilities (canteen, crèche, ambulance, recreational area) available within the factory compound or at short distance. Continuous, open dialogue with public.
FINANCIAL PERFORMANCE	Favourable ratio of administrative and (individual articles differentiated) production costs. Low stocks/working capital: up to one month for raw hides, about three weeks for hides in work, up to two weeks for specialty chemicals, less than a week for finished leather). Optimum pricing. The return on sales/assets meets/exceeds the cost of own and borrowed capital and anticipated dividends.
PRODUCT DEVELOPMENT AND STRATEGIES	A system for continuous monitoring of the relevant (global) research, access to and dissemination of information in place. Close cooperation of marketing and technology. Alternatives – fall back strategies for various negative scenarios.
SOLID WASTES	Total about 5 t/day (at different levels of water content), albeit without tannery sludge. Strict segregation, HACCP procedure followed. Native trimmings, hair, fleshings, shavings and unusable splits reutilized, only finished leather trimmings disposed off.
EFFLUENT TREATMENT PLANT, ETP	Discharge into the municipality sewage or the common treatment plant for the industrial zone/cluster; thus only the primary (physical-chemical) treatment carried out by the tannery itself, whereas the secondary (biological) treatment carried out together with sanitary WWW. In any case, treatment efficiency in line with IULTCS/IUE figures (see <b>Annex 11</b> and <b>Annex 12</b> ), the reduced pollution load conforms to legislative norms.

Some criteria and parameters for a tannery processing raw bovine hides into shoe upper leather	
Treatment capacity, effluent quality	250 m <sup>3</sup> /day corresponding to water consumption of 25 m <sup>3</sup> /t, working on tannery work-days, 20 h/day. Highest treatment efficiency, the effluent quality conforms to norms for indirect discharge.
Area required	About 600 m <sup>2</sup> (physical-chemical treatment only).
Power	Power installed about 75 KW; energy consumption about 45 kWh/h (appr. 60% of power installed).
Chemicals needed	Catalyst (manganese sulphate) inorganic coagulant (alum sulphate or polychloride), polyelectrolyte for flocculation, hydrated lime for pH correction and/or sludge conditioning.
Sludge handling	Primary sludge dewatered to about 40% dry matter content (nearly 2.5 t/day) forwarded to controlled landfill, land application – composting or thermal treatment.
Treatment costs	Up to USD 1.0/m <sup>3</sup> . After adding the cost of joint treatment at the WWF, the total treatment cost likely to be in the region of US\$ 1.5-1.6/m <sup>3</sup> .

In the highly undesirable case of *direct* discharge into a water recipient (river, lake), i.e. when a tannery has to have secondary (biological) treatment, the total area required for the ETP is about 70 \* 25 = 1,750 m<sup>2</sup>, power installed 120 kW and power consumption about 70 kWh/h.

Total investment costs for such a plant in a developing country would be on the order of US\$ 230,000 (civil works), equipment US\$ 470,000, total about US\$ 700,000. The running cost, including depreciation, might be of the order of nearly US\$ 2 m<sup>3</sup>, albeit without sludge disposal costs. The costs of land, ETP design, supervision and commissioning as well as any taxes are not included.

As pointed out earlier, an individual fully-fledged tannery ETP utilizing conventional technology can successfully reduce all pollutants (suspended solids, BOD, COD, nitrogen, sulphide etc), to an acceptable level; however, without reverse osmosis – desalination (or, better, mixing with municipal effluents) conventional technology has no effect on TDS, i.e. salinity.

Principles of effluent treatment, investment and operating costs for ETPs and landfills are dealt with in detail in **Annex 13** and **Annex 14**.



## 15. CONCLUSIONS

Leather tanning is a capital and material inputs (raw hides, chemicals) intensive industry, but is not particularly labour intensive. The typical production cost structure of 50-70% raw hides, chemicals about 10%, labour 7-15%, energy 3%, and environmental protection 2-5%, does not, however, justify neglecting the savings available from optimization of chemical usage and energy, and, in particular, from minimization of pollution treatment costs. The importance of chemical and pollution treatment is underscored by the fact that on average processing one tonne of raw hides requires nearly half a tonne of chemicals and if the amount of salt used in traditional preservation is included, the weight ratio hides to chemicals is almost 1:1.

Poorly performed mechanical operations such as splitting, sammying, and shaving downgrade quality, decrease yield and ultimately negatively impact profitability. The usually somewhat “hidden” costs of rework, i.e. the reprocessing of batches not meeting internal standards or customer requirements, are another factor causing avoidable losses.

The ability to maximize the utilization of the raw material (e.g. by applying good finishing techniques and producing a fashionable item from lower grades) is often the key factor making some tanneries more profitable than others operating under similar conditions. Investment in OSH at work, maintenance, continuous training, and social welfare has also been shown to contribute to higher profitability.

In order to assess its competitiveness, a tannery needs to be able to compare its performance to other similar operations, identify the best performers in the industry, and identify its strengths and weaknesses as compared to the best, so that its performance can be continuously improved. Benchmarking is the tool used to gather this information and when regularly employed provides information as to whether a tannery is competitive, or whether it is falling behind its competitors, or is perhaps performing better than the competition. Benchmarking can be defined as:

- *The process of continuously comparing and measuring your processes against other organizations worldwide to gain information on their practices, processes or methodologies which will help your organization take action to improve its performance.*
- Benchmarking is the practice of being *humble enough* to admit that someone else is better at something, and being *wise enough* to learn to be as good as/or even better than them.

Unfortunately, since companies keep most of their vital performance parameters confidential, benchmarking in real life is often reduced to:

- i) generic types of benchmarking  
The company compares itself with itself i.e. with either its own performance during certain earlier period or with certain (predominantly financial) targets.
- ii) questionnaire and self-assessment based benchmarking  
The company compares its performance with questionnaire-based parameters obtained from a number of producers of rather different profiles and operating under rather different conditions.

## 16. Recommendations

Every tannery aspiring to compete successfully in the international market needs to:

- Conduct regularly not only a financial but also a thorough technical audit, including a detailed material balance of all inputs and outputs. Preferably, the audit is to be carried out by an external, competent but fully independent party.
- If possible, compare your own parameters with those of a successful (competing) tannery operating under very similar conditions i.e. converting the same raw material into same product range.
- Alternatively, **compare certain stages** (e.g. beamhouse, tanning), **processes** and **operations** (e.g. drying, liquid and solid waste management) and **work environment** and **management of human resources** (safety at work, training) with the internationally recognized best performers.
- Identify the scope for improvement and set ambitious and yet achievable targets with clearly defined performance indicators (figures) which can be achieved within realistic timeframe.
- Regularly monitor all key parameters; adjust and fine tune targets and implementation deadlines as required.
- After some time-lapse (i.e. even in absence of any crisis), revisit, update and refresh the whole issue in light of local and/or global technical, marketing or legal developments and changes to the company's strategies.
- **Ideally, develop a tailor made system supplementing the usual generic system with your own, specific performance indicators – parameters, including ongoing critical evaluation and improvement methodology.**

It is hoped that this paper will serve as a useful reference for tanneries in drawing up their own checklist(s) of parameters to be monitored and, from time to time, refined, in order to compete not only with itself (continuous improvement), but also, possibly, with a direct, successful competitor operating under very similar conditions. A more comprehensive approach would be to have a generic benchmarking system offered by a company specializing in this field, which has been tailored to the specific tannery. Benchmarking is not anything exotic or revolutionary, but it is a **very comprehensive and practical tool for management striving to ensure continuous improvement of company's performance.**

It was far beyond the scope of this *desk study* to provide even indicative benchmark parameters for various categories. It would of course be highly desirable to provide the tanning industry with a comprehensive paper containing most of the main benchmarking parameters. To make this possible it would be necessary to have a multidisciplinary team (leather technologist, specialists for equipment, environment, marketing, finances and human resources) engaged in preparing the questionnaire, obtaining field information and, following a critical review and necessary adjustments, merging all the information into a practical manual for individual tanneries to use in preparing their own benchmarking systems.

In lieu of such a comprehensive study however, there is useful and specific information available in certain areas:

- **Effluent treatment (plants):** Rather detailed investment and operating costs, area required, chemicals consumption, power, specific efficiency, attainable purification levels for key

pollutants after primary and secondary treatment are given in *Annex 13*. Typical water consumption, pollution loads and purification levels are available from the relevant IULTCS/IUE tables (*Annex 11* and *Annex 12*).

- **Landfills:** Similarly, very detailed information and cost estimates (for developing countries) are provided with the aim of helping developing countries in dealing with one of the most difficult problems of environmental protection in the tanning industry – safe disposal of unusable solid wastes and sludges (*Annex 14*).
- **Leather processing parameters:** An example of mass balance (inputs, yields, consumption of chemicals, production of sludge etc) can be found in the charts in *Annex 9* and *Annex 10*. Very informative are also figures given in *Annex 3* (wet blue tannery) and *Annex 4* (ELMO CALF).

Furthermore, useful figures are available in UNIDO papers:

- **Typical tannery designs**, by *Michael L. Woodley*, Vienna, 2003  
Layout, equipment specification, labour, chemicals, costing etc.
- **Chrome balance in leather processing**, by *J. Ludvik*, Vienna 2000  
Detailed breakdowns of chrome distribution: offer, its content in leather, solid waste and all effluent streams (spent chrome float, sammying/draining waters, spent retanning float, leacheable chrome) for different variations of conventional and high exhaustion tanning.

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<sup>25</sup> Often referred to as BREF.

## Acknowledgments

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I have also greatly benefited from exchanging ideas with, and drawing on, the practical experience of my long-time friend who is possibly the leading specialist in technical auditing of tanneries and avoidance and reduction of wastes, *J. C. Crowther* – SWYSTEM LOGIC GMBH, [www.swystemlogic.com/swystem/index.htm](http://www.swystemlogic.com/swystem/index.htm).

Finally, I am pleased to acknowledge specific information on performance of a wet blue tannery provided by *I. Kral*, UNIDO.

## Annex 1: Some definitions of benchmarking

### 1.1. English

- The process of setting “benchmarks,” which means identifying accurate historical data against with a data set can be compared now and in the future. In some cases the term has come to mean goals, which confuses participants in dialogue about indicators. – [indicators.top10by2010.org/glossary.cfm](http://indicators.top10by2010.org/glossary.cfm)
- Continuous measurement of a process, product, or service compared to those of the toughest competitor, to those considered industry leaders, or to similar activities in the organization in order to find and implement ways to improve it. This is one of the foundations of both total quality management and continuous quality improvement. Internal benchmarking occurs when similar processes within the same organization are compared. – [www.jcaho.org/accredited+organizations/sentinel+event/glossary.htm](http://www.jcaho.org/accredited+organizations/sentinel+event/glossary.htm)
- Measuring progress toward a goal at intervals prior to the anticipated attainment of the goal. FOR EXAMPLE, measuring and tracking grade-level performance of students in a remedial program at intervals prior to completion of the program. – [www.ojp.usdoj.gov/BJA/evaluation/glossary/glossary\\_b.htm](http://www.ojp.usdoj.gov/BJA/evaluation/glossary/glossary_b.htm)
- A continuous process of measurement of products, services and work processes, against those recognised as leaders. – [thequalityportal.com/glossary/b.htm](http://thequalityportal.com/glossary/b.htm)
- Performance comparison of organization business processes against an internal or external standard of recognized leaders. Most often the comparison is made against a similar process in another organization considered to be "world class." – [emissary.acq.osd.mil/inst/share.nsf/Glossary](http://emissary.acq.osd.mil/inst/share.nsf/Glossary)
- A process of studying successful competitors (or organizations in general) and selecting the best of their actions or standards. In the new product program it means finding the best development process methods and the best process times to market and setting out to achieve them. – [www.shapetomorrow.com/resources/glossaryofterms.html](http://www.shapetomorrow.com/resources/glossaryofterms.html)
- The process of comparing performance against the practices of other leading companies for the purpose of improving performance. Companies also benchmark internally by tracking and comparing current performance with past performance. – [www.blinco.com/solutions/glossary/logisticsae.htm](http://www.blinco.com/solutions/glossary/logisticsae.htm)
- The process of re-estimating statistics as more complete information becomes available. Estimates are usually calculated using only a sample of the universe (total count). Therefore, benchmarking allows for correction of estimating errors. New benchmarking levels are introduced on an annual basis. – [www.vec.virginia.gov/vecportal/lbrmkt/glossary.cfm](http://www.vec.virginia.gov/vecportal/lbrmkt/glossary.cfm)
- Comparing information of one entity to like information of another entity or composite group for the purpose of determining areas for potential improvement and to identify the best practices. – [www.harperrisk.com/ArtGlossary/ArtGlossab.htm](http://www.harperrisk.com/ArtGlossary/ArtGlossab.htm)
- The comparison of similar processes across organizations and industries to identify best practices, set improvement targets and measure progress. Benchmarking results may serve as potential targets for Balanced Scorecard measures. – [www.balancedscorecard.biz/Glossary.html](http://www.balancedscorecard.biz/Glossary.html)
- Rating your company's products, services and practices against those of the front-runners in the industry. – [www.powerhomebiz.com/Glossary/glossary-B.htm](http://www.powerhomebiz.com/Glossary/glossary-B.htm)
- The process for identifying standards to use in comparison of practices, activities, institutions or equipment; standards may be used to identify minimal levels or for determining relative performances for comparison of subjects. – [www.teach-nology.com/glossary/terms/b/](http://www.teach-nology.com/glossary/terms/b/)
- Identifying processes and results that represent best practices and performance for similar activities, inside or outside the organisation. This term is often confused with ‘Competitive Comparisons’ – [www.unisa.edu.au/pas/qap/planning/glossary.asp](http://www.unisa.edu.au/pas/qap/planning/glossary.asp)
- In the context of Tasmania Together, benchmarking is an active process that sets standards for a particular activity or goal, identifies targets or interim steps required to meet the standards, and selects specific indicators or measures of progress along the way. Benchmarks are the term used to collectively identify the standards, targets and indicators. A standard is a measurable statement that supports a goal. Example: to reduce the crime rate in Tasmania. – [www.tasmaniatogether.tas.gov.au/tastog\\_original/tt\\_glossary.html](http://www.tasmaniatogether.tas.gov.au/tastog_original/tt_glossary.html)
- The practice of studying the methods of an acknowledged leader in an industry as a way of setting standards for one's own operation. – [www.hometravelagency.com/dictionary/ltrb.html](http://www.hometravelagency.com/dictionary/ltrb.html)
- Is a process of comparing organisational performance and practices with others (preferably leaders) in the same or different industries. – [wps.prenhall.com/wps/media/objects/213/218150/glossary.html](http://wps.prenhall.com/wps/media/objects/213/218150/glossary.html)
- Tests functions, particularly efficiency and price of outputs, against a standardised function or set of achievements, to place it in the context of its peers. – [www.finance.gov.au/pubs/AnnualReport99-00/gloss.htm](http://www.finance.gov.au/pubs/AnnualReport99-00/gloss.htm)



- The act of comparing measurement to a benchmark. External benchmarking seeks to compare internal measurement to measurement from an external source. Internal benchmarking seeks to compare internal measurements to historic internal measurements. – [accuracybook.com/glossary.htm](http://accuracybook.com/glossary.htm)
- Searching for the best practices or competitive practices that will help define superior performance of a product, service, or support process. Competitive benchmarking allows a company to know precisely where their operation is in relation to a direct competitor, to determine its competitive position, and to identify major performance gaps. – [strategis.ic.gc.ca/epic/internet/instco-levc.nsf/en/h\\_qw00037e.html](http://strategis.ic.gc.ca/epic/internet/instco-levc.nsf/en/h_qw00037e.html)
- Occurs when the retailer sets its own standards and measures performance based on the achievements of its sector of retailing, specific competitors, high-performance firms, and/or the prior actions of the company itself. – [www.prenhall.com/rm\\_student/html/glossary/b\\_gloss.html](http://www.prenhall.com/rm_student/html/glossary/b_gloss.html)
- Benchmarking is the process of continuously measuring and comparing one's business processes against comparable processes in leading organizations and industry best practices to obtain information that will help the organization identify and implement improvements. – [www.promitheas.com/glossary.php](http://www.promitheas.com/glossary.php)
- Comparison of one organization's performance with a group of other organizations, on some particular group of measures. The best performing organization is considered to have best practice, and other organizations may adopt its methods. – [www.audiencedialogue.org/gloss-eval.html](http://www.audiencedialogue.org/gloss-eval.html)
- The analysis of effective processes in other organizations to determine standards of performance and the processes used to achieve them. This involves an ongoing process of collecting data and comparing results. – [www.fiu.edu/~pie/sec8appglossary.htm](http://www.fiu.edu/~pie/sec8appglossary.htm)
- A process of searching out and studying the best practices that produce superior performance. Benchmarks may be established within the same organization (internal benchmarking), outside of the organization with another organization that produces the same service or product (external benchmarking), or with reference to a similar function or process in another industry (functional benchmarking). – [www.qaproject.org/methods/resglossary.html](http://www.qaproject.org/methods/resglossary.html)
- Comparison of a company's products, services or financial figures with the best in its particular sector. – [www.schulergroup.com/en/20investorrelations/50boersenglossar/](http://www.schulergroup.com/en/20investorrelations/50boersenglossar/)
- Benchmarking (also "best practice benchmarking" or "process benchmarking") is a process used in management and particularly strategic management, in which companies evaluate various aspects of their business processes in relation to best practice, usually within their own industry. This then allows companies to develop plans on how to adopt such best practice.

## 1.2. Spanish

- Es un proceso proactivo para cambiar las operaciones de manera natural y lograr un desempeño superior. Se define como el proceso continuo de mejora de productos, servicios y métodos con respecto al competidor más fuerte o aquellas compañías consideradas líderes. – [es.wikipedia.org/wiki/Benchmarking](http://es.wikipedia.org/wiki/Benchmarking)
- Evaluación comparativa. – [www.red.es/glosario/glosariob.html](http://www.red.es/glosario/glosariob.html)
- Es una evaluación comparativa que establece un punto de referencia a partir del cual se comparan de manera sistemática, los productos, servicios y métodos de una empresa con sus competidores. – [www.arearh.com/glosario/AB.htm](http://www.arearh.com/glosario/AB.htm)
- Herramienta de gestión que basa su metodología en la identificación de las mejores prácticas para utilizarlas como referencia. Consiste en un proceso sistemático cuyo objetivo es evaluar, comprender y comparar procesos operativos, productos y/o servicios propios, con aquellos relativos a prácticas reconocidas como más eficientes y líderes. Fundamentalmente se aplica para la mejora de procesos ayudando a la toma de decisiones que apoyen acciones encaminadas hacia su mejora. – [www.construir.com/Econsult/Construr/Nro61/document/gestion2.htm](http://www.construir.com/Econsult/Construr/Nro61/document/gestion2.htm)
- Procedimiento por el cual las empresas analizan comparativamente su situación y/o actuaciones en relación con otras empresas consideradas como las más exitosas o eficientes en su segmento de actividades, mercados, tamaños, etc. La comparación se puede llevar a cabo a través de análisis cualitativos o cuantitativos, monetarios o no monetarios, entre empresas distintas o entre áreas o divisiones de una misma empresa o grupo empresarial, etc. – [www.observatorioiberoamericano.org/Revista%20Iberoamericana%20de%20Contab%20Gesti%C3%B3n/N%C2%BA%201/Glosario.htm](http://www.observatorioiberoamericano.org/Revista%20Iberoamericana%20de%20Contab%20Gesti%C3%B3n/N%C2%BA%201/Glosario.htm)
- Filosofía japonesa en la que se analiza a la competencia para aprender de ellos y mejorarlos. – [www.buzoneo.info/diccionario\\_marketing/diccionario\\_marketing\\_b.php](http://www.buzoneo.info/diccionario_marketing/diccionario_marketing_b.php)
- Se refiere a la acción de comparar nuestra empresa con la competencia en términos de calidad, procesos, actividad, etc. – [www.esmas.com/emprendedores/glosario/400189.html](http://www.esmas.com/emprendedores/glosario/400189.html)





- Se entiende por Benchmarking el análisis exhaustivo de las primeras marcas o empresas competidoras, estudiando en detalle, su política de precios, sus productos y servicios complementarios, su tipo de atención al cliente y la financiación de las ventas, con el fin de sacar conclusiones aplicables a nuestro entorno. – [www.ofertaformativa.com/conceptos-generales-sobre-los-metodos-empresariales-para-la-gestion-3.htm](http://www.ofertaformativa.com/conceptos-generales-sobre-los-metodos-empresariales-para-la-gestion-3.htm)

### 1.3. French

- Le Benchmarking est une technique de marketing qui consiste à étudier et analyser les techniques de gestion, les modes d'organisation des autres entreprises afin de s'en inspirer et d'en retirer le meilleur. – [fr.wikipedia.org/wiki/Benchmarking](http://fr.wikipedia.org/wiki/Benchmarking)
- [Economie] Etude des techniques de gestion (au sens large) employées par les autres entreprises, dans le but de s'inspirer des méthodes les plus performantes. Observer et apprendre ce que d'autres, dans certains domaines sont capables de faire au travers d'une grille d'analyse composée d'un ensemble d'indicateurs et critères. – [www.afnet.fr/afnet/glossaire/thesaurus/get\\_glossaire\\_I](http://www.afnet.fr/afnet/glossaire/thesaurus/get_glossaire_I)
- Méthode d'évaluation de la performance de l'entreprise par comparaison avec les standards de la profession selon un référentiel préétabli. Remarque : S'il est important de se situer sur l'échiquier, le benchmarking ne peut être une fin en soi. La course à l'idéal stéréotypé n'est pas vraiment une recette susceptible d'apporter l'avantage concurrentiel tant espéré. – [www.piloter.org/references/glossaire-B](http://www.piloter.org/references/glossaire-B)
- banc d'essai – [fr.wikibooks.org/wiki/Dictionnaire\\_Fructueux:\\_B](http://fr.wikibooks.org/wiki/Dictionnaire_Fructueux:_B)
- Méthode élaborée par Rank-Xerox, consistant à prendre pour référence (benchmark) une entreprise particulièrement performante dans un domaine particulier. – [www.ecogexport.com/gestion/dicogestion.htm](http://www.ecogexport.com/gestion/dicogestion.htm)
- Adoption d'un critère, d'une norme ou d'une référence permettant de fixer des objectifs et d'évaluer les progrès obtenus. – [lacityennete.com/magazine/mots/glossaireegaliteHF.php](http://lacityennete.com/magazine/mots/glossaireegaliteHF.php)

## Annex 2. Some examples of benchmarking in the tanning industry

### 2.1. Benchmarking by the LEATHER TECHNOLOGY CENTRE (BLC)

While offering their benchmarking services the BLC claims the following benefits:

- Creation of a framework for continuous improvement.
- Allows measurement and comparison with other tanners.
- Enables realistic targets to be set and focuses valuable resources.
- Identifies strengths, weaknesses, opportunities and threats for strategic planning.
- Gives an independent and external perspective of the business.

The BLC also claims to have conducted benchmarking in about a hundred tanneries all over the world.

Based on scarce information made available it seems that the following are the main features of the BLC benchmarking methodology:

- 2.1.1. It is *questionnaire and self-assessment based*; the participating tanneries respond by filling in forms with questions and awarding marks in the 1-5 range.
- 2.1.2. The questions cover areas such as: strategy and vision, customer and market focus, product development, suppliers and sourcing, productivity and response, product and process quality, advanced technologies, training, finances, health and safety, technical management and environmental performance.
- 2.1.3. To overcome the problem of diversity, tanneries are grouped according to region, size and type of process (e.g. wet blue, chrome, vegetable tanning); also, for the same reason, as a rule, benchmarking is conducted simultaneously among several tanneries.
- 2.1.4. The quantitative and qualitative scores are analyzed by a simple but efficient system and results presented in the form of a series of customized graphs indicating the relevant values (e.g. range, average, company's position) accompanied by critical evaluation pointing to strengths, weaknesses etc.
- 2.1.5. The cost to a tannery is in the range of GBP 1,500–2,000.

Contact: <http://www.bcleathertech.com>

### 2.2. Report: “Performance Benchmarking in Tanneries” by the NATIONAL PRODUCTIVITY COUNCIL, Regional Professional Management Group, Chennai conducted for the ALL INDIA SKIN & HIDE TANNERS & MERCHANTS ASSOCIATION (AISHTMA), Chennai in 2005

- 2.2.1. The exercise is based on questionnaires filled in by visiting consultants in cooperation with the factory staff.
- 2.2.2. The report covers bovine and skin wet blue and finished leather tanneries as well as those converting vegetably pretanned and wet blue into finished leather, all under codified numbers. Although the attempt has been made to group them accordingly, delimitations for the purpose of comparison are not too clear.
- 2.2.3. There are only four indicator categories: *i*) financial, *ii*) resources (energy only!?), *iii*) quality, cost and time and stakeholders (customers and employees).
- 2.2.4. The report is largely focused on productivity<sup>26</sup>, operatives and working practices with a specific local angle<sup>27</sup>.

<sup>26</sup> There is a detailed listing – comparison of output for each machine operation.

- 2.2.5. There is a table listing performance indicators together with very useful definitions and utility (purpose) and interpretation columns.<sup>28</sup>
- 2.2.6. A kind of summary table overview of twenty key indicators (from capacity utilization, yield, energy consumption, value per square foot produced, export/domestic ratio to absenteeism rate and average age of employees) provides the average and best values/figures.
- 2.2.7. The charts present performance by aggregating the units in three groups: best, average and the rest.

Despite some very useful and well conceived features, on the whole, this report clearly points to complexities and traps of benchmarking and in particular, to the need *to compare apples to apples*.

**2.3. “Benchmarking the African Leather Sector”** – a report prepared for UNIDO by *S. M. Kiruthu*, August 2002, backstopping officer *A. Calabro-Bellamoli*.

The report attempts to highlight the strengths and weaknesses of the leather sector in Africa with the aim of providing the industry with information enabling it to design suitable development strategies. Benchmarking factors listed include: raw material related, processing/manufacturing related, market related, human resource, investment and financial related and macroeconomic policy environment together with specific issues, as well as specific recommendations to the private sector, governments and donor organizations pertaining to each category (factor).

There is also a table with descriptive comparisons between Kenya, Ethiopia and Italy regarding the availability and quality of raw hides and skins, access to financial resources, sustained capital investment, degree of vertical integration, technology, process skills, R&D, product development, tradition, products perception by the global market.

The report provides a rather accurate picture of the general status and performance of the leather sector in Africa and thus conforms to the task indicated in the title. Although to some extent has the flavour of the traditional SWOT (strength, weakness, opportunity, threats) analysis to be read by decision makers and potential donors, the report can serve as a relevant example of benchmarking at the sectoral level.

Yet, somehow, it is a pity that the report refrains from critical analysis and/or suggesting any views about the *reasons* for Africa’s disappointingly slow progress, especially in comparison with other developing regions/countries (e.g. South East Asia, Brazil). What is the real impact of the many projects of technical assistance in hides and skins improvement? Why it claims that there is shortage of skills when there are several R&D and training establishments all over the continent?

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<sup>27</sup>For example, non-existence of trade union is seen as a sign of harmonious relations as well as the practice that upon completing their allotted work/achieving the norm, operators can go home.

<sup>28</sup> E.g., **Value added per employee** is defined as Net Sales – (Raw materials + Stores + Spares + Purchased Services + Power Fuel + Administrative, marketing and other expenses) over Number of employees. Its utility: Value added is a measure of wealth creation. The ratio indicates wealth creation per employee. It depends on productivity of labour and capital and resource optimization.

### Annex 3. Some production parameters of a European wet blue tannery

**Input:** 60 t (1,000-1,200 pieces)/day of mostly fresh hides

**Technology:** Soaking – liming (pulping) within 24 hours, ex-lime splitting. Tanning is with 6% of basic chrome sulphate, 25% Cr<sub>2</sub>O<sub>3</sub>, basicity 33%.

#### Bulls 40 kg + for automotive leather

Table 3.1

Raw hides	Pelt weight	Split	Fleshings	Thickness (WB)
kg	kg	kg	kg	mm
1,000	400	500	150	1.6-2.0
1,000	550	400	150	2.0-2.4
1,000	600	300	150	2.8-3.2
1,000	1,100	–	150	Full thickness

*Typically:*

1,000 kg raw hides gives 400 kg pelt weight (thickness 2.0-2.2 mm), which after tanning and sammying gives about 270 kg of wet blue leather with area of nearly 120 m<sup>2</sup>, i.e. 12 dm<sup>2</sup>/kg.

Immediately after splitting pelts are trimmed and only croupions (butts) are tanned, bellies and shoulders are sold to the food industry whereas trimmings (together with fleshings) are used for production of fat and glue.

#### Cows 40 kg+

Table 3.2

Splitting	1,000 kg raw hides	WB (m <sup>2</sup> )	WB (mm)
2.2-2.4 mm	1,000 kg	116	1.6-2.0
2.8-3.0 mm	1,000 kg	108	2.0-2.4

*Note:* Chrome uptake – chrome content in 2.0-2.4 WB is less by 0.1-0.2% compared to 1.6-2.0 mm WB

#### Water consumption

Table 3.3

Operation	Consumption (m <sup>3</sup> /t)
Soaking/liming	5-7
Fleshing	1-3
Splitting	0.5
Tanning (leather)	2.5-3.5
Tanning (split)	1.5-2.5
Sammying	0.5
Cleaning etc.	1
<b>Total</b>	<b>12-18</b>

**Energy consumption – raw to wet blue, GJ/t***Table 3.4*

Steam	1.42 GJ/t	Including heating cca. 25%
Electricity	104 kWh or 0.374 GJ	Including effluent pre-treatment
Total	1.794 GJ/t of raw hide	Moderate climate, long winters

**Labour**

Production, stores, grading, maintenance, effluent pre-treatment:	60
Administration, management:	<u>10</u>
<i>Total</i>	<i>70</i>
Working hours:	production in two shifts
Working days:	5 days/week; 10 days/year holidays, cca. 20 days general overhaul, summer leave time, effectively about 230 working days/year
Individual leaves:	20-25 days/year
Average sick leave	
Absence:	18 days/year
Work accidents:	17/year (cca. 20 accidents/100 employees) 1-2 more serious requiring several days of sick leave
Productivity:	151 t/employee/year

*Source:* Informal, private communication



**Annex 4. Input/output overview for ELMO CALF AB**  
*(per t raw hide treated – year 1999)*

Table 4.1

<b>Annual production</b>	11,700 t raw hide 2.4 million m <sup>2</sup> finished products (automotive and furniture use)	
	Discharge/t raw hide	
<b>Water (discharge to the municipal sewage treatment plant)</b>	20 m <sup>3</sup>	
	COD	270 kg
	BOD <sub>7</sub>	120 kg
	Chrome	0.4 kg
	Sulphide	0.02 kg
	Total nitrogen	12.3 kg
<b>Chemicals</b>	470 kg	
<b>Energy</b>	11.3 GJ	
	Electric energy	3.0 GJ
	Thermal energy	8.3 GJ
<b>Air</b>	VOC	3.6 kg
	NH <sub>3</sub>	0.7-1.0 kg
	H <sub>2</sub> S	0.05 kg
<b>Waste</b>	Hair	0.2. kg
	Untanned	360 kg
	Tanned	140 kg
	Sludge from treatment plant	185 kg dry matter (42.6% dry matter content)
<b>Outlet from treated water</b> (municipal sewage treatment plant with more than 90% of load coming from ELMO CALF AB)	COD	27 kg
	BOD <sub>7</sub>	3 kg
	Chrome	0.007 kg
	Chrome reduction in average	98.5%
	Total nitrogen	9.4 kg

*Source:* Integrated Pollution Prevention and Control (IPPC), Reference Document on Best Available Techniques for the Tanning of Hides and Skins (BREF), February 2003.



## Annex 5. Collagen balance in leather processing

When evaluating the efficiency of leather manufacture, one of the main criteria is the actual utilisation of collagen, the genuine leather building substance. An example of the “fate” of the collagen, calculated on the basis of 1,000 kg wet salted hides input is given in the table below:

Table 5.1

### Collagen distribution wet salted hide, finished leather and solid waste

(Starting material: 1,000 kg wet salted raw hides, splitting in chrome)

Component	Amount of collagen		
	kg	% of corium collagen	% of total collagen
<b>Input</b>			
Corium collagen (leather building collagen)	280	100	92
Subcutis collagen	24	—	8
<b>Total collagen input</b>	<b>304</b>	<b>—</b>	<b>100</b>
<b>Output</b>			
Grain leather	113	40.0	37.2
Split leather	36	13.0	11.8
<b>TOTAL COLLAGEN IN FINISHED LEATHER</b>	<b>149</b>	<b>53.0</b>	<b>49.0</b>
<b>Fleshings</b>	24	from subcutis	8.0
<b>Trimming</b>	18	6.5	6.0
Unusable chrome split	49	17.5	16.1
Shavings	45	16.0	15.0
Wet blue trimmings	9	3.0	2.8
Crust leather waste	5	1.8	1.6
Buffing dust	1	0.4	0.3
Finished leather off-cuts	4	1.6	1.3
<b>TOTAL COLLAGEN IN SOLID WASTE</b>	<b>155</b>	<b>47.0</b>	<b>51.0</b>
<b>Total collagen output</b>	<b>304</b>	<b>100</b>	<b>100</b>

Evidently, only 53% of the corium collagen and about 50% of the total collagen content of the raw hide end up in the finished leather.

**Annex 6. Material balance of common salt applied on one tonne of raw hides**

*Table 6.1*

<i>Description</i>	<i>Average</i>
<b>Applied in curing</b>	400 kg
Discharged as leachate resulting from dehydration of raw hides	60 kg
Fallen during handling and transport of raw stock	40 kg
Fallen during trimming, cutting into sides, handling, etc in the raw material store (this is generally collected for safe disposal or reuse)	15 kg
Removed during mechanical desalting – 12.5% (of applied salt)*	50 kg
Removed during manual desalting using DODECA frame – 20% (of applied salt) <sup>#</sup>	80 kg
Washed out in 1 <sup>st</sup> soak – 300% float	120-145 kg
Washed out in 2 <sup>nd</sup> soak liquor – 300% float	45-60 kg
Carried over by hides to further operations (estimate)	30-40 kg

Remarks: \* Salt removal is 5% on the weight of raw stock taken for desalting.

<sup>#</sup> Salt removal is 8% on the weight of raw stock taken for desalting.

Annex 7. **Some organic solvents used in finishing**

Table 7.1

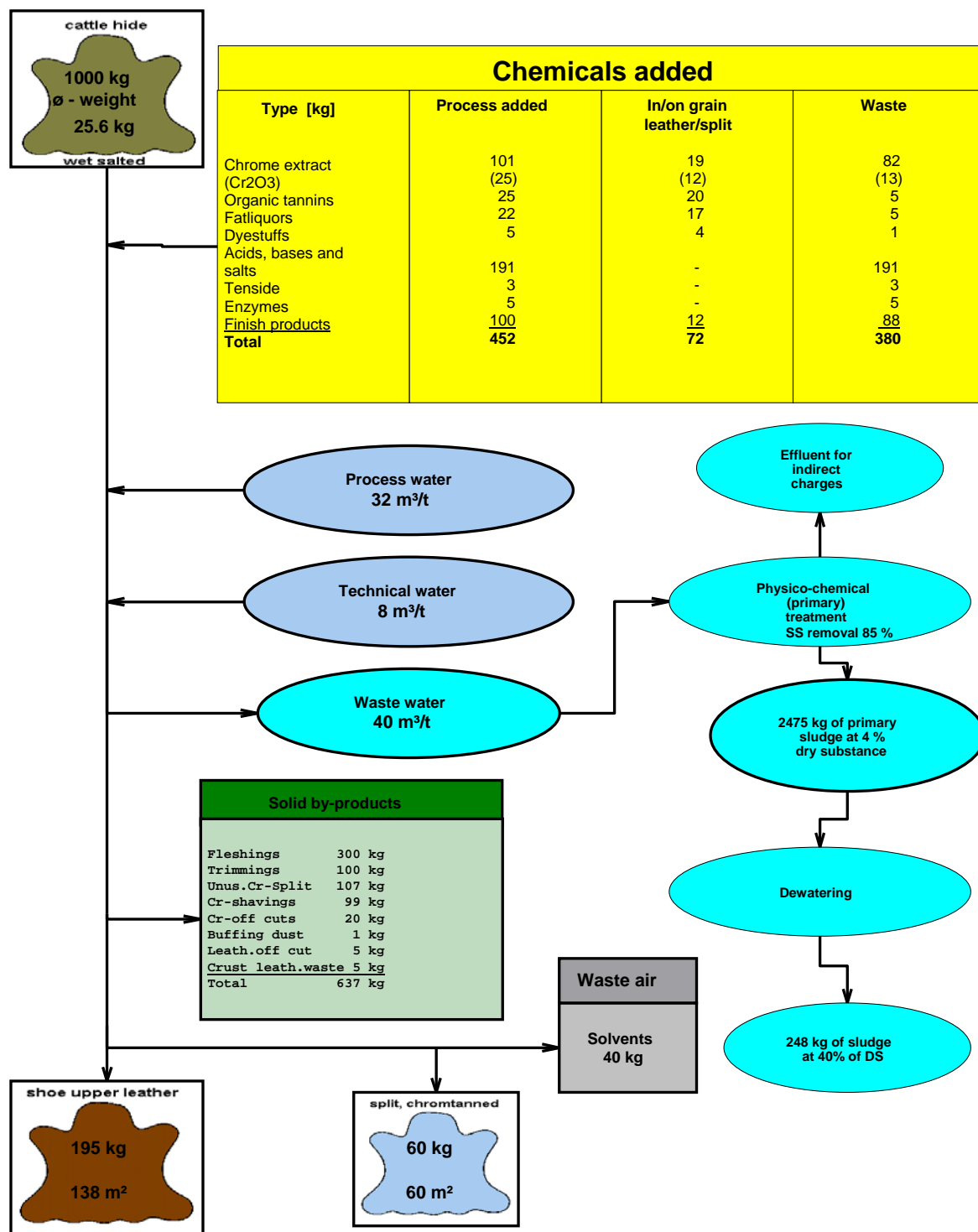
<i>Alcohols</i>	<i>Ketones</i>	<i>Esters</i>	<i>Glycol ethers</i>	<i>Hydrocarbons</i>
Methyl alcohol	Acetone	Isopropyl acetate	2-Ethoxyethanol	Xylene (II)
Ethyl alcohol	Methyl ethyl ketone (MEK) III	n-Butyl acetate (III)	2-Butoxyethanol	Toluene (II)
n-Propyl alcohol	<b>Methyl isobutyl ketone</b>	Ethyl acetate	2-Ethoxyethyl acetate	
Isopropyl alcohol (III)	Cyclohexanone (II)	n-Propyl acetate	2-Butoxyethyl acetate	
n-butyl alcohol	Di-isobutyl ketone	n-Amyl acetate	1-Methoxy-2-Propanol	
Di-acetone alcohol			1-Methoxy-2-Propyl acetate	

## Annex 8. Energy consumption of various drying methods

Table 8.1

Various drying methods	MJ/kg of water evaporated	
	Without heat pump	With heat pump
Theoretical minimum	2.48	
Toggling	8.17	
Pasting	6.37	
Chamber drying	5.83	1.62
Vacuum drying	7.20	1.37
Through-feed drying	5.22	1.12
High frequency drying	6.84	

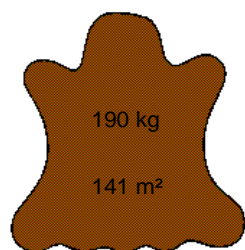
## Annex 9. An example of overall material balance in conventional tanning



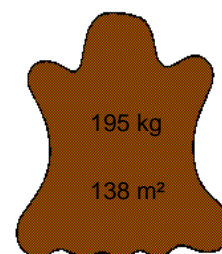
**Annex 10. An example of overall material balance in conventional finishing**

*Table 10.1*

<i>Chemicals: binder(s), pigments, solvents, water, auxiliaries</i>		
<b>INPUT</b>		
Dry substances	11 kg	
Solvents	28 kg	
Water	35 kg	
<i>Wet finish (total)</i>	<i>74 kg</i>	
<b>EMISSIONS</b>		
Dry substances	1 kg	
Solvents	28 kg	
Water	35 kg	
<b>Total emissions</b>	<b>64 kg</b>	
<b>Actual dry substance added</b>	<b>10 kg</b>	
Buffing dust	1 kg	
Trimming	4 kg	
<b>Net weight increase</b>	<b>5 kg</b>	



190 kg – 141 m<sup>2</sup>



195 kg – 138 m<sup>2</sup>





## Annex 11. IUE Table – Typical pollution values in conventional tannery processes

Table 11.1

	Water	COD	BOD <sub>5</sub>	SS	Cr <sup>3+</sup>	S <sup>2-</sup>	TKN	Cl <sup>-</sup>	SO <sub>4</sub> <sup>2-</sup>	Grease	TDS
Values per t of rawhide	m <sup>3</sup> /t	kg/t	kg/t	kg/t	kg/t	kg/t	kg/t	kg/t	kg/t	kg/t	kg/t
<b>BOVINE SALTED RAW HIDE PROCESS</b>											
Beamhouse (soaking to bating)	7/25	120/160	40/60	70/120		2/9	9/14	120/150	5/20	5/8	200/300
Tanning operations	1/3	10/20	3/7	5/10	2/5		0/1	20/60	30/50	1/2	60/120
Post tanning	4/8	15/40	5/15	10/20	1/2		1/2	5/10	10/40	3/8	40/100
Finishing	0/1	0/10	0/4	0/5							
<b>TOTAL</b>	<b>12/37</b>	<b>145/230</b>	<b>48/86</b>	<b>85/155</b>	<b>3/7</b>	<b>2/9</b>	<b>10/17</b>	<b>145/220</b>	<b>45/110</b>	<b>9/18</b>	<b>300/520</b>
<b>PIG SKINS</b>											
Beamhouse	23/49	120/272	46/98	62/110		3/7	11/17	57/197	4/15	30/67	120/300
Tanning operations	2/5	10/18	3/6	4/8	2/4		0/1	20/37	26/45	1	40/120
Dyeing operations	5/10	10/25	3/9	8/15	1/2		1/2	3/6	10/40	3	20/80
Finishing	2/5	0/5	0/2	0/2							
<b>TOTAL</b>	<b>32/69</b>	<b>140/320</b>	<b>52/115</b>	<b>70/135</b>	<b>3/6</b>	<b>3/7</b>	<b>12/20</b>	<b>80/240</b>	<b>40/100</b>	<b>34/71</b>	<b>180/500</b>
Values in litres or grams per skin	l/skin	g/skin	g/skin	g/skin	g/skin	g/skin	g/skin	g/skin	g/skin	g/skin	g/skin
<b>SHEEPSKINS (wet-salted)</b>											
Beamhouse	65/150	250/600	100/260	150/300		6/20	15/30	150/400	5/40		
Degreasing - Tanning	30/70	50/300	20/100	15/30	8/12		4/10	40/200	30/50	40/150	
Post tanning	15/35	30/100	15/35	10/20	1/3		2/4	20/40	10/20		
Finishing	0/10	0/5	0/2	0/2							
<b>TOTAL</b>	<b>110/265</b>	<b>330/1,005</b>	<b>135/397</b>	<b>175/352</b>	<b>9/15</b>	<b>6/20</b>	<b>21/44</b>	<b>210/640</b>	<b>45/110</b>	<b>40/150</b>	
<b>WOOL-ON SHEEPSKINS</b>											
Beamhouse	220	550	150	100	–	–	16	400			600
Tanning operations	40	150	45	15	15	–	2	460		40/150	650
Dyeing operations	100	80	25	80	5	–	3	50			270
Finishing	–	–	–	–	–	–	–	–			
<b>TOTAL</b>	<b>360</b>	<b>780</b>	<b>220</b>	<b>195</b>	<b>20</b>	<b>–</b>	<b>21</b>	<b>910</b>		<b>40/150</b>	<b>1,520</b>
bovine hides = goat skins											
It is important to note that all values relate to processing under conditions of good practice, and the ranges reflect variations in raw materials and processes.											
Taking into account the increasing importance of water conservation, it must be pointed out that this practice leads to higher pollution level in terms of concentration.											

## Annex 12. IUE Table – Typical performance for tannery waste treatment

Table 12.1

Parameters	COD (chemical oxygen demand)		BOD <sub>5</sub> (biological oxygen demand)		Suspended Solids		Chromium		Sulphide		N (Kjeldahl)		Colour	Sludge Production
	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	%	mg/l	% Pt-Co unit	kg DS/t rawhide
<b>PRE-TREATMENT</b>														
Grease removal (dissolved air flotation)	20-40													
Sulphide oxidation (liming and rinsing liquors)	10								10					
Chromium precipitation							2-10							
<b>PRIMARY TREATMENT</b>														
Mixing + Sedimentation	25-35		25-35		50-70		20-30				25-35			80
Mixing + Chemical treatment + Sedimentation	50-65		50-65		80-90		2-5		2-10		40-50			150-200
Mixing + Chemical treatment + Flotation	55-75		55-75		80-95		2-5		2-5		40-50			150-200
<b>BIOLOGICAL TREATMENT</b>														
Primary or chemical + Extended aeration	85-95	200-400	90-97	20-60	90-98	20-50	<1		<1		50	150		70-150 <sup>(1)</sup>
Primary or chemical + Extended aeration with nitrification and denitrification	85-95	200-400	90-97	20-60	90-98	20-50	<1		<1		80-90	30-60		130-150 <sup>(1)</sup>
Primary or chemical + Aerated facultative lagoons	80-90	300-500	85-95	60-100	85-90	80-120	<1		<1		50	80		100-140
Anaerobic treatment (lagoon or UASB) (2)	65-75	500-700	60-70	150-200	50-80	100-200	<2	0			20-30			60-100
Constructed wetlands (after primary treat.)	70-80	300-400	85-95	60-100									85-90	
<sup>(1)</sup> Without chemical treatment														
<sup>(2)</sup> Mixed with 75% domestic sewage, UASB = upflow anaerobic sludge blanket														
The above data represent typical values for tannery waste water treatment efficiency for conventional process liquors for production of finished leather from raw material. Salinity is not removed through primary and biological treatment. TDS can be increased by chemical treatment.														

## Annex 13: Principles of effluent treatment and cost estimates for developing countries

Physical-chemical (primary) treatment is the first and unavoidable vital stage for the treatment of tannery effluents for both direct and indirect dischargers everywhere in the world.

For the biological (secondary) treatment an activated sludge system still the most appropriate, but an oxidation ditch is possibly the optimum method. Anaerobic treatment is not widely used despite obvious advantages such as lower energy input and lower production of sludge due to the dilution needed, however, the toxic, corrosive, and malodorous  $H_2S$  developed in the process is a major problem mandating against its employment. Due to limitations imposed by the space requirements, use of other interesting options such as reed beds and lagooning is limited to smaller plants only.

All parameters and cost estimates for wastewater treatment have been derived on the basis of the following (C)ETP configuration:

### Physical-chemical (primary) treatment

- manually cleaned grid/screen for coarse material
- grease and grit removal
- lifting station
- fine, mechanically cleaned screen
- effluent homogenization/equalization and mixing with surface aerators<sup>29</sup>, including catalytic sulphide oxidation and pumping
- chemical treatment: coagulation, flocculation and pH adjustment with hydrated lime
- sedimentation in the primary clarifier with sludge pumping station.<sup>30</sup>

### Biological (secondary) treatment, sludge handling and auxiliaries

- biological treatment in tanks by activated sludge with bottom membrane air diffusers, blowers and adding of nutrients
- nitrification and denitrification, including pumping station effluent recirculation
- secondary clarifier with pumping station for sludge recirculation and disposal
- station for chemicals preparation
- primary and secondary sludge thickening and dewatering by filter presses to 40% DS<sup>31</sup>
- measuring and monitoring equipment
- electrical equipment, including emergency, stand-by Diesel generator
- internal infrastructure: process and drinking water, sewage system, roads, fence, landscaping
- laboratory

**Remark:** Advanced technologies such as use of pure (liquid or gas) oxygen instead of air to avoid stripping, tertiary treatment, covering of tanks to prevent spreading of malodour, bio-filters etc. are not taken into account.

Ideally, effluent treatment should be completed in two steps only; however, sometimes they are insufficient to attain the desired quality and a third step, **tertiary treatment** is required.

<sup>29</sup> Due to difficulties with aerosols, especially in proximity of residential areas, increasingly replaced by bottom air diffusers.

<sup>30</sup> For segregation of fine solids (diffused air) flotation also well established.

<sup>31</sup> For sludge dewatering centrifuges also widely used.

In addition to the problem of salinity described earlier, hard to degrade residual COD, disagreeable colour and/or specific organic pollutants make tertiary treatment necessary.

The most frequently used methods are:

- Chemical treatment supplemented by coagulation and flocculation
- Biological treatment (BOD and COD reduction) with biomass or in polishing lagoons
- Reed beds
- Activated carbon (colour, COD)
- Membrane technologies: ultrafiltration (UF), reverse osmosis (RO); the latter in order to reduce TDS and enable reuse of the treated effluent<sup>32</sup>
- Ozonization (COD, colour, disinfection)
- Treatment with ultraviolet (UV) radiation (disinfection)

The cost of tertiary treatment is not included in cost estimates.

In addition to differences resulting from effluent characteristics and discharge limits, there are also considerable differences in investment and unit operating costs as well as in performance parameters depending on the size of the effluent treatment plants. For the purpose of comparison tanneries in the chart below have been grouped based on the daily raw material input and assumed water consumption of 25 m<sup>3</sup>/t of raw hide (this water consumption/discharge level is used in all further computations).

Table 13.1

**Tanning capacities and volume of effluents discharged**

Raw hide input <i>t/day</i>		Volume of effluent discharged <i>m<sup>3</sup>/day</i>
Small scale tannery	4	100
Medium scale	20	500
Large tannery	40	1,000
CETP, tannery cluster	200	5,000
CETP, large tannery cluster	400	10,000
CETP, very large tannery cluster	800	20,000

<sup>32</sup> The main disadvantages of this method being the cost and the problem of disposal of residual, highly concentrated effluent.

Table 13.2

### Typical effluent characteristics and treatment effects<sup>33</sup>

#### Primary treatment

Parameter	Pollution load in the raw effluent	Pollution load after primary treatment	Raw, composite effluent	Composite effluent after primary treatment	Treatment efficiency
	kg/t of raw hide		mg/l		%
COD	150.0	60.0	6,000	2,400	60.0
BOD <sub>5</sub>	62.5	25.0	2,500	1,000	60.0
SS	100.0	15.0	4,000	600	85.0
Cr <sup>3+</sup>	4.0	0.1	160	4	97.5
S <sup>2-</sup>	5.0	0.125	200	5	97.5
TKN	12.5	7.5	500	300	40.0
Cl <sup>-</sup>	150.0	150.0	6,000	No change	No change
SO <sub>4</sub> <sup>2-</sup>	62.5	62.5	2,500	No change	No change
TDS	375.0	375.0	15,000	No change	No change
Sludge – DS		100.0			

#### Biological treatment, final bod<sub>5</sub> < 20 mg/l

Parameter	Pollution load after primary treatment	Pollution load after biological treatment	Composite effluent after primary treatment	Treated effluent	Total treatment efficiency
	kg/t of raw hide		mg/l		%
<b>COD</b>	60.0	6.00	2,400	240	96.00
BOD <sub>5</sub>	25.0	0.50	1,000	20	99.20
SS	15.0	0.75	600	30	99.25
Cr <sup>3+</sup>	0.1	0.025	4	1	99.30
S <sup>2-</sup>	0.125	0.025	5	1	99.50
TKN	7.5	1.25	300	50	70.00
Cl <sup>-</sup>	150.0	150.00	6,000	No change	No change
SO <sub>4</sub> <sup>2-</sup>	62.5	62.50	2,500	No change	No change
TDS	375.0	150.00	15,000	No change	No change
Sludge– DS	100.0	125.00			

Table 13.3

### Consumption of chemicals

Chemicals	Unit	Amount	Amount g/t raw hide
Catalyst, MnSO <sub>4</sub> ·4H <sub>2</sub> O	g/m <sup>3</sup>	30	750
Coagulant, Al <sub>2</sub> (SO <sub>4</sub> ) <sub>3</sub> ·18H <sub>2</sub> O	g/m <sup>3</sup>	300	7,500
Hydrated lime for pH adjustment, Ca(OH) <sub>2</sub>	g/m <sup>3</sup>	300	7,500
Polyelectrolyte (PE)	g/m <sup>3</sup>	1	25
Nutrients, P and N salts	g/m <sup>3</sup>	30	750
Coagulant/flocculant for sludge handling (Fe-salts)	g/kg of DS	85	2,150
Hydrated lime for sludge conditioning (Ca(OH) <sub>2</sub> )	g/kg of DS	130	3,250

<sup>33</sup> As said earlier, all based on consumption/discharge of 25 m<sup>3</sup>/t of raw hide.

Regrettably, the conventional (affordable) treatment systems in purpose-built, “independent” tannery ETPs do not reduce the content of TDS – mainly chlorides and sulphates. Consequently, treated effluents emanating from tanneries processing raw material preserved by salting remain potentially hazardous to the environment and, in particular, to scarce water resources in arid regions.

Various in-plant (prevention) and end-of-pipe mitigation methods can help reducing the content and/or negative impact of saline effluent. On the whole, however, methods attempted to date either give results that fall short of legal requirements or are applicable only under specific local conditions. Separate treatment of segregated saline streams by reverse osmosis (desalination) is possibly feasible, but is a rather expensive and cumbersome method.

The most feasible approach appears to be the processing of salt-free cured hides<sup>34</sup> complemented by the discharge of tannery wastes into the local sewage system. Where this option is feasible, the tannery performs the primary (physical-chemical) treatment in its own treatment plant, and the final, biological treatment takes place together with urban wastewaters in the municipal plant.

Table 13.4

### Some indicative effluent treatment plant parameters<sup>35</sup>

Parameter	Unit	Tannery/cluster capacity, <i>t</i> of wet-salted hides/day					
		4	20	40	200	400	800
		Treatment capacity, <i>m</i> <sup>3</sup> of effluents/day					
		100	500	1,000	5,000	10,000	20,000
<b>Primary (physical – chemical) treatment</b>							
<b>Area required</b>	<i>m</i> <sup>2</sup>	920	1,600	2,400	7,200	13,000	24,000
Area required vs. input	<i>m</i> <sup>2</sup> /t raw hide	230	80	60	36	32	30
Installed power required	<i>kW</i>	33	81	147	538	991	1,850
Installed power required vs. input	<i>kW</i> /t raw hide	8.3	4.1	3.8	2.7	2.5	2.3
Power consumption	<i>KWh/day</i>	480	1,200	2,100	7,800	14,300	26,600
Power consumption vs. input	<i>kWh/t raw hide</i>	120	60	50	40	36	33
<b>Biological treatment up to <i>bod</i><sub>5</sub> &lt; 20 mg/l (including nitrification and denitrification)</b>							
<b>Total area required</b>	<i>m</i> <sup>2</sup>	2,100	4,600	7,600	28,000	5,200	100,000
Area required vs. input	<i>m</i> <sup>2</sup> /t raw hide	530	230	190	140	130	130
Installed power required	<i>kW</i>	73	210	340	1,300	2,300	3,800
Installed power required vs. input	<i>kW</i> /t raw hide	18.3	10.5	8.4	6.4	5.7	4.7
<b>Power consumption</b>	<i>kWh/day</i>	1,060	3,000	4,850	18,400	32,500	54,000
Power consumption vs input	<i>kWh/t raw hide</i>	265	150	120	90	80	70

<sup>34</sup> The experience shows that emission loads from processing salted and salt-free hides are 65 kg of chlorides/t and 5 kg of chlorides/t respectively.

<sup>35</sup> Some discrepancies due to rounding up figures computed by the programme.

Table 13.5

**Some indicative effluent treatment construction costs<sup>36</sup>**

Parameter	Unit	Tannery/cluster capacity, <i>t</i> of wet-salted hides/day					
		4	20	40	200	400	800
		Treatment capacity, <i>m</i> <sup>3</sup> of effluents /day					
		100	500	1,000	5,000	10,000	20,000
<b>Primary (physical – chemical) treatment</b>							
Investment	US\$	380,000	711,000	1,193,000	4,332,000	7,980,000	15,000,000
Investment vs. effluent volume	US\$/ <i>m</i> <sup>3</sup> /day	3,800	1,400	1,200	900	800	750
Investment vs. raw hide input	US\$/ <i>t</i> /day	95,000	36,000	30,000	22,000	20,000	19,000
<b>Biological treatment up to <i>bod</i><sub>5</sub> &lt; 20 mg/l (including nitrification and denitrification)</b>							
Investment	US\$	800,000	1,658,000	2,858,000	10,371,000	18,940,000	35,000,000
Investment vs. effluent volume	US\$/ <i>m</i> <sup>3</sup> /day	8,000	3,300	2,900	2,100	1,900	1,700
Investment vs. raw hide input	US\$/ <i>t</i> /day	200,000	83,000	72,000	52,000	47,000	44,000

Any computation of (C)ETP operating costs should include the cost of depreciation (replacement); depreciation rates of 2% for civil works and 5% for equipment, calculated on the investment cost, are considered realistic and are used here for comparison purposes.

Table 13.6

**Some indicative ETP running costs<sup>37</sup>**

Parameter	Unit	Tannery/cluster capacity, <i>t</i> of wet-salted hides/day					
		4	20	40	200	400	800
		Treatment capacity, <i>m</i> <sup>3</sup> of effluents /day					
		100	500	1,000	5,000	10,000	20,000
<b>Primary (physical – chemical) treatment</b>							
Operation cost	US\$/year	204,400	326,700	587,700	2,390,800	4,270,500	8,103,000
Operation costs vs. volume	US\$/ <i>m</i> <sup>3</sup> /day	5.6	1.8	1.6	1.3	1.2	1.1
Operation cost vs. hide input	US\$/ <i>t</i> /day	140	45	40	33	30	28
<b>Biological treatment up to <i>bod</i><sub>5</sub> &lt; 20 mg/l (including nitrification and denitrification)</b>							
Operation cost	US\$/year	280,700	525,600	824,900	3,321,500	5,840,000	10,220,000
Operation cost vs. volume	US\$/ <i>m</i> <sup>3</sup> /day	8.0	3.0	2.3	1.8	1.6	1.4
Operation cost vs. hide input	US\$/ <i>t</i> /day	190	72	57	46	40	35

<sup>36</sup> Some discrepancies due to rounding up of figures computed by the programme.

<sup>37</sup> Some discrepancies due to rounding of figures computed by the programme.

Estimates of construction costs are based on indicative prices in the year 2007, albeit without the cost of financing, and are primarily applicable for plants in developing countries. To simplify the calculations as well as due to the fact that the biological treatment has to work without interruption, it is assumed that the plant operates 24 hours/day, 365 days/year resulting in a slightly lower unit cost.

Depreciation is included in the estimates of operating costs at the rate of 2% for civil works and 5% for equipment, calculated based on the original construction cost.

Table 13.7

**Some indicative costs of effluent treatment in terms of pollutants removed**

Parameter	Unit	Tannery/cluster capacity, <i>t</i> of wet-salted hides/day					
		4	20	40	200	400	800
		Treatment capacity, <i>m</i> <sup>3</sup> of effluents /day					
		100	500	1,000	5,000	10,000	20,000
<b>Primary (physical – chemical) treatment</b>							
COD <sub>initial</sub>	<i>g O<sub>2</sub>/m<sup>3</sup></i>	6,000					
COD <sub>exit</sub>	<i>g O<sub>2</sub>/m<sup>3</sup></i>	2,400					
COD <sub>removed</sub>	<i>g O<sub>2</sub>/m<sup>3</sup></i>	3,600					
Cost per kg of COD <sub>removed</sub>	<i>US\$/kg COD<sub>removed</sub></i>	0.9	0.4	0.3	0.2	0.2	0.2
<b>Biological treatment up to <i>bod</i><sub>5</sub> &lt; 20 mg/l (including nitrification and denitrification)</b>							
COD <sub>initial</sub>	<i>g O<sub>2</sub>/m<sup>3</sup></i>	6,000					
COD <sub>exit</sub>	<i>g O<sub>2</sub>/m<sup>3</sup></i>	240					
COD <sub>removed</sub>	<i>g O<sub>2</sub>/m<sup>3</sup></i>	5,760					
Cost per kg of COD <sub>removed</sub>	<i>US\$/kg COD<sub>removed</sub></i>	0.8	0.3	0.3	0.2	0.2	0.2

A possibly more accurate computation of the cost of treatment in terms of pollutants removed is given in the following table.



Table 13.8

Some indicative costs of effluent treatment in terms of pollutants removed<sup>38</sup>

Parameter	Unit	Tannery/cluster capacity, <i>t</i> of wet-salted hides/day					
		4	20	40	200	400	800
		Treatment capacity, <i>m</i> <sup>3</sup> of effluents /day					
		100	500	1,000	5,000	10,000	20,000
<b>Primary (physical – chemical) treatment</b>							
COD <sub>initial</sub>	<i>g O<sub>2</sub>/m<sup>3</sup></i>	6,000					
COD <sub>exit</sub>	<i>g O<sub>2</sub>/m<sup>3</sup></i>	2,400					
COD <sub>removed</sub>	<i>g O<sub>2</sub>/m<sup>3</sup></i>	3,600					
SS <sub>initial</sub>	<i>g/m<sup>3</sup></i>	4,000					
SS <sub>exit</sub>	<i>g/m<sup>3</sup></i>	600					
SS <sub>removed</sub>	<i>g/m<sup>3</sup></i>	3,400					
Operation cost/ <i>m</i> <sup>3</sup> effluent	<i>US\$/m<sup>3</sup></i>	5.6	1.8	1.6	1.3	1.2	1.1
60% of COD cost as COD <sub>removed</sub> / <i>m</i> <sup>3</sup>	<i>US\$/m<sup>3</sup></i>	3.4	1.1	1.0	0.8	0.7	0.7
60% of COD cost as COD <sub>removed</sub>	<i>US\$/kg of COD<sub>removed</sub></i>	0.9	0.3	0.3	0.2	0.2	0.2
40% of SS costs as SS <sub>removed</sub> / <i>m</i> <sup>3</sup>	<i>US\$/m<sup>3</sup></i>	2.2	0.8	0.6	0.5	0.5	0.4
40% of SS costs as SS <sub>removed</sub>	<i>US\$/kg of SS<sub>removed</sub></i>	0.7	0.2	0.2	0.2	0.1	0.1
<b>Biological treatment up to bod<sub>5</sub> &lt; 20 mg/l (including nitrification and denitrification)</b>							
COD <sub>initial</sub>	<i>g O<sub>2</sub>/m<sup>3</sup></i>	6,000					
COD <sub>exit</sub>	<i>g O<sub>2</sub>/m<sup>3</sup></i>	240					
COD <sub>removed</sub>	<i>g O<sub>2</sub>/m<sup>3</sup></i>	5,760					
SS <sub>initial</sub>	<i>g/m<sup>3</sup></i>	4,000					
SS <sub>exit</sub>	<i>g/m<sup>3</sup></i>	30					
SS <sub>removed</sub>	<i>g/m<sup>3</sup></i>	3,970					
Operation cost/ <i>m</i> <sup>3</sup>	<i>US\$/m<sup>3</sup></i>	7.7	2.9	2.3	1.8	1.6	1.4
60% of COD cost as COD <sub>removed</sub> / <i>m</i> <sup>3</sup>	<i>US\$/m<sup>3</sup></i>	4.6	1.7	1.4	1.1	1.0	0.8
60% of COD cost as COD <sub>removed</sub>	<i>US\$/kg of COD<sub>removed</sub></i>	0.8	0.3	0.2	0.2	0.2	0.2
40% of SS costs as SS <sub>removed</sub> / <i>m</i> <sup>3</sup>	<i>US\$/m<sup>3</sup></i>	3.1	1.2	1.0	0.8	0.6	0.6
40% of SS costs as SS <sub>removed</sub>	<i>US\$/kg of SS<sub>removed</sub></i>	0.8	0.3	0.2	0.2	0.2	0.1

<sup>38</sup> All figures in the table rounded up.

**Annex 14. Basic parameters and costing estimates for a landfill in a developing country**

Table 14.1

**Estimated amounts of solid waste generated by a (C)ETP**

Parameter	Unit	Tannery/cluster capacity, <i>t of wet-salted hides/day</i>					
		4	20	40	200	400	800
		Treatment capacity, <i>m<sup>3</sup> of effluents /day</i>					
		100	500	1,000	5,000	10,000	20,000
<b>Primary (physical – chemical) and biological treatment up to <i>bod<sub>5</sub></i> &lt; 20 mg/l (including nitrification and denitrification)</b>							
Solid waste at 40% DS	<i>kg/t of raw hide</i>	312.5					
Solid waste at 40% DS	<i>kg/m<sup>3</sup> of effluent</i>	12.5					
Solid waste at 40% DS	<i>kg/day</i>	1,250	6,250	12,500	62,500	125,000	250,000
Solid waste at 40% DS	<i>t/year</i>	500	2,300	4,600	23,000	45,000	90,000
Solid waste at 40% DS	<i>t (m<sup>3</sup>)/10 year</i>	5,000	23,000	46,000	230,000	450,000	900,000

Table 14.2

**Key parameters of landfill(s) for disposal of sludge generated by effluent treatment<sup>39</sup>**

Parameter	Unit	Tannery/cluster capacity, <i>t of wet-salted hides/day</i>					
		4	20	40	200	400	800
		Treatment capacity, <i>m<sup>3</sup> of effluents /day</i>					
		100	500	1,000	5,000	10,000	20,000
<b>Primary (physical – chemical) and biological treatment up to <i>bod<sub>5</sub></i> &lt; 20 mg/l (including nitrification and denitrification)</b>							
Solid waste At 40% DS	<i>t (m<sup>3</sup>)/10 years</i>	5,000	23,000	46,000	230,000	450,000	900,000
Useful height	<i>m</i>	5					
Total height	<i>m</i>	5.5					
Square side length, bottom	<i>m</i>	23	60	88	206	295	420
Square side length, top	<i>m</i>	40	77	105	223	312	440
Dam top width	<i>m</i>	1					
Dam height above ground	<i>m</i>	2.6	3.7	4.0	4.7	4.9	5.1
Excavation depth	<i>m</i>	2.9	1.8	1.5	0.8	0.6	0.4
Excavated material	<i>m<sup>3</sup></i>	2,100	7,400	12,000	34,000	52,000	74,000
Surface, protected	<i>m<sup>2</sup></i>	1,800	6,300	11,600	51,000	96,700	194,000
Square side's length	<i>m</i>	50	90	120	240	330	460
Total surface	<i>m<sup>2</sup></i>	2,500	8,000	14,500	58,000	110,000	210,000
Area needed for 10 years	<i>m<sup>2</sup>/t raw hide/day</i>	625	400	350	290	270	260
Top sealing membrane	<i>m<sup>2</sup></i>	1,560	5,900	10,900	49,500	97,100	191,500
Soil for the top covering	<i>m<sup>3</sup></i>	1,560	5,900	10,900	49,500	97,100	191,500

<sup>39</sup> Some figures rounded up.

Basic assumptions:

- capacity to accommodate 10-years production of sludge
- rectangular shape
- useful depth 5 m
- dam height 0.5 m
- dam slope 1:1.5
- sealing with HDPE geomembrane and concrete
- equipment for handling of wastes (purchased or services outsourced)
- collection and handling of storm waters and seepage
- top sealing with HDPE membrane and 1 m soil layer.

*Remark:* The cost of land not included!

*Table 14.3*

**Estimate of landfill construction costs for tanning capacities of 40-200 t raw hides/day in a developing country, unit costs**

Description	Unit	US\$
Excavation and dam building using the same material	$m^3$	5
Delivery and laying of bottom protection membrane	$m^2$	7
Delivery and laying of top protection membrane	$m^2$	7
Supply and laying of soil layer for greening the top cover	$m^3$	5
Horticulture	$m^2$	2
Equipment for handling the waste	<i>piece</i>	25,000
Supply and erection of a system for management of leachate waters (sprinklers)	<i>set</i>	20,000

Table 14.4

## Estimated construction costs for a 10-year landfill in a developing country

Parameter	Unit	Tannery/cluster capacity, <i>t</i> of wet-salted hides/day					
		4	20	40	200	400	800
		Treatment capacity, <i>m</i> <sup>3</sup> of effluents /day					
		100	500	1,000	5,000	10,000	20,000
<b>Primary (physical – chemical) and biological treatment up to bod<sub>5</sub> &lt; 20 mg/l (including nitrification and denitrification)</b>							
Solid waste at 40% DS	<i>t (m<sup>3</sup>)/ 10 years</i>	5,000	23,000	46,000	230,000	450,000	900,000
Excavated material	<i>m<sup>3</sup></i>	2,100	7,400	12,000	34,000	52,000	74,000
Cost	<i>US\$</i>	10,500	37,000	60,000	170,000	260,000	370,000
Surface, protected	<i>m<sup>2</sup></i>	1,800	6,300	11,600	51,000	96,700	194,000
Cost	<i>US\$</i>	12,400	44,200	81,200	357,000	676,900	1,358,000
Top sealing membrane	<i>m<sup>2</sup></i>	1,560	5,850	10,900	49,500	97,100	191,500
Cost	<i>US\$</i>	11,000	41,000	76,000	347,000	680,000	1,341,000
Soil for the top covering	<i>m<sup>3</sup></i>	1,560	5,850	10,900	49,500	97,100	191,500
Cost	<i>US\$</i>	8,000	29,000	54,600	248,000	486,000	958,000
Horticulture	<i>m<sup>2</sup></i>	1,560	5,850	10,920	49,500	97,100	191,500
Cost	<i>US\$</i>	3,100	11,700	21,800	99,000	194,000	383,000
Equipment for waste handling	<i>pieces</i>	–	–	1	1	1	1
Cost	<i>US\$</i>	–	–	25,000	25,000	50,000	50,000
Rain and leachate waters management system	<i>set</i>	–	–	1	1	1	1
Cost	<i>US\$</i>	–	–	10,000	10,000	20,000	20,000
<b>Total cost</b>	<i>US\$</i>	<b>44,700</b>	<b>163,100</b>	<b>329,100</b>	<b>1,255,100</b>	<b>2,366,300</b>	<b>4,479,600</b>
<b>Unit cost</b>	<i>US\$/t(m<sup>3</sup>) waste</i>	<b>10</b>	<b>7</b>	<b>7</b>	<b>6</b>	<b>5</b>	<b>5</b>
<b>Unit cost</b>	<i>US\$/t of raw hide</i>	<b>3.0</b>	<b>2.2</b>	<b>2.3</b>	<b>1.8</b>	<b>1.6</b>	<b>1.5</b>

Table 14.5

**Estimated running costs for a 10-year landfill in a developing country**

Parameter	Unit	Tannery/cluster capacity, <i>t</i> of wet-salted hides/day					
		4	20	40	200	400	800
		Treatment capacity, <i>m</i> <sup>3</sup> of effluents /day					
		100	500	1,000	5,000	10,000	20,000
<b>Primary (physical – chemical) and biological treatment up to bod<sub>5</sub> &lt; 20 mg/l (including nitrification and denitrification)</b>							
Solid waste at 40% DS	<i>t</i> ( <i>m</i> <sup>3</sup> )/10 years	5,000	23,000	46,000	230,000	450,000	900,000
Useful volume	<i>m</i> <sup>3</sup>	3,650	18,250	36,500	182,500	365,000	730,000
Total construction costs	US\$	45,000	163,000	329,000	1,255,100	2,366,000	4,480,000
Equipment (own/outsourced)	US\$/y	500	1,000	2,000	5,000	10,000	20,000
Rain/leachate water system	US\$/y	100	200	500	1,000	2,000	5,000
Depreciation	US\$/y	4,500	16,300	32,900	125,500	236,600	448,000
<b>Total costs</b>	<b>US\$/y</b>	<b>5,000</b>	<b>17,500</b>	<b>35,400</b>	<b>131,500</b>	<b>248,600</b>	<b>473,000</b>
<b>Specific costs</b>	<b>US\$/<i>t</i> (<i>m</i><sup>3</sup>) of waste</b>	<b>11.0</b>	<b>7.7</b>	<b>7.7</b>	<b>5.8</b>	<b>5.5</b>	<b>5.0</b>
<b>Specific costs</b>	<b>US\$/<i>t</i> raw hide</b>	<b>3.5</b>	<b>2.4</b>	<b>2.4</b>	<b>1.8</b>	<b>1.7</b>	<b>1.6</b>

Estimates of running cost are calculated with depreciation for both civil works and equipment at the rate of 10%; the costs of land and solid waste transport are not included.

**Annex 15. Examples of solid waste utilization/disposal in France, Italy and India (2002)**

*Table 15.1*

Solid waste	France	Italy	India
<b>Raw hide trimmings</b>	N.A.	N.A.	Glue manufacture in some organized factories and some cottage industries in Tamil Nadu and Kanpur. One big unit in Haryana and some cottage industries manufacture dog chews.
<b>Hair</b>	Rendering plant (cost paid by the tannery for disposal: US\$ 141/t).	SALA SRL.: Organic fertilizer 20-30 t/day. Cost paid by tanneries is US\$ 30-34/t of hair.	Wool is picked up from tanneries @ US\$ 65 / ton and used to make cheap blankets. Hair from hair-sheep and goats is used in felt making and also exported to Australia.
<b>Fleshings (limed)</b>	<ol style="list-style-type: none"> <li><i>Fat and protein recovery:</i> <ul style="list-style-type: none"> <li>Only to animals other than ruminants.</li> </ul> </li> <li>Possible to <i>recover protein</i> for energy source through incineration.</li> <li><i>Compost making:</i> necessary to maintain temperature of 60-65<sup>0</sup>C inside the piles.</li> <li><i>Glue:</i> technical glue-one factory.</li> <li><i>Bio-methanation:</i> tested in a plant dedicated to domestic refuses.</li> </ol>	<ol style="list-style-type: none"> <li><i>Santa Croce</i> – CONSORZIO SGS SPA: grease and proteins for animal feed and fertilizers</li> <li><i>Arzignano</i> – SICIT SPA: grease and protein recovery, given the BSE problem the recovered protein used solely for agriculture.</li> <li><i>Solofra</i> – no generation, mainly semi-finished to finished leather.</li> </ol>	<ol style="list-style-type: none"> <li><i>Glue production:</i> <ul style="list-style-type: none"> <li>Practised in Tamil Nadu, Kanpur;</li> <li>Glue mainly used as adhesive;</li> <li>Main consumers – abrasive industry, safety matches and textile industry;</li> <li>Competition from synthetic adhesives.</li> </ul> </li> <li><i>Poultry feed:</i> PRAKASH feed mills manufactures protein as partial substitute for fishmeal in poultry feed from dried fleshings.</li> </ol>
<b>Limed split waste</b>	<ol style="list-style-type: none"> <li>Gelatine production – 4 factories <ul style="list-style-type: none"> <li>Only if the animal has been certified before and after slaughtering fit for human consumption</li> </ul> </li> <li>Several prescriptions to be followed by the tanneries</li> </ol>	–	Negligible lime-splitting done.

Solid waste	France	Italy	India
<b>Wet blue split waste and shavings</b>	<p>1. Most difficult problem.</p> <p>2. Leather-board: exported to Germany and Spain for leather-board manufacture.</p> <p>3. Fertilizer: a project for fertilizer production similar to Italy was considered, but dropped owing to high investment and operational costs.</p> <p>4. Incineration and pyrolysis: being evaluated.</p>	<p>1. <i>Santa Croce</i>: Two companies produce fertilizers by hydrolysis and drying</p> <p>2. <i>Arzignano</i>:</p> <ul style="list-style-type: none"> <li>- ILSA SPA: fertilizer production process similar to Santa Croce.</li> <li>- SICIT SPA: grease and fertilizer production, now used only for agriculture owing to BSE.</li> </ul> <p>3. <i>Solofra</i>: a blend for fertilizer sent to other factories for blending or enrichment with other residues and sold as fertilizer.</p>	<p>1. Leather board manufacture: Tamil Nadu, Kanpur. Chrome shavings mixed with vegetable shavings (ratio 1:2) to produce leather-board.</p> <p>2. Fertilizer in Kolkata by a crude process of cooking chrome shavings, reportedly used on tea estates.</p>
<b>Vegetable tanned cuttings, trimmings and shavings</b>	N.A.	Good demand. Several companies manufacture leather-board and fertilizer. Tanneries paid at US\$ 14/t of material.	Sent for leather-board manufacture.

## **Annex 16. Benchmarking in Pharos – Business Navigator** *(A brief overview\*)*

The **Enterprise Benchmarking** is an add-on module for Pharos – Business Navigator. Another add-on module [Advanced Data Export-Import](#) supports effective data transfer between Pharos and other software, which may be used in enterprises.

The benchmarking module facilitates the presentation of major indicators as a time series running from the current date to a specified date in the past, which data are called the “benchmarking analysis period”. Current business results can be compared with those of a selected earlier “reference date”. Any reference date can be selected within the benchmarking analysis period, limited only by availability of data in the enterprise database.

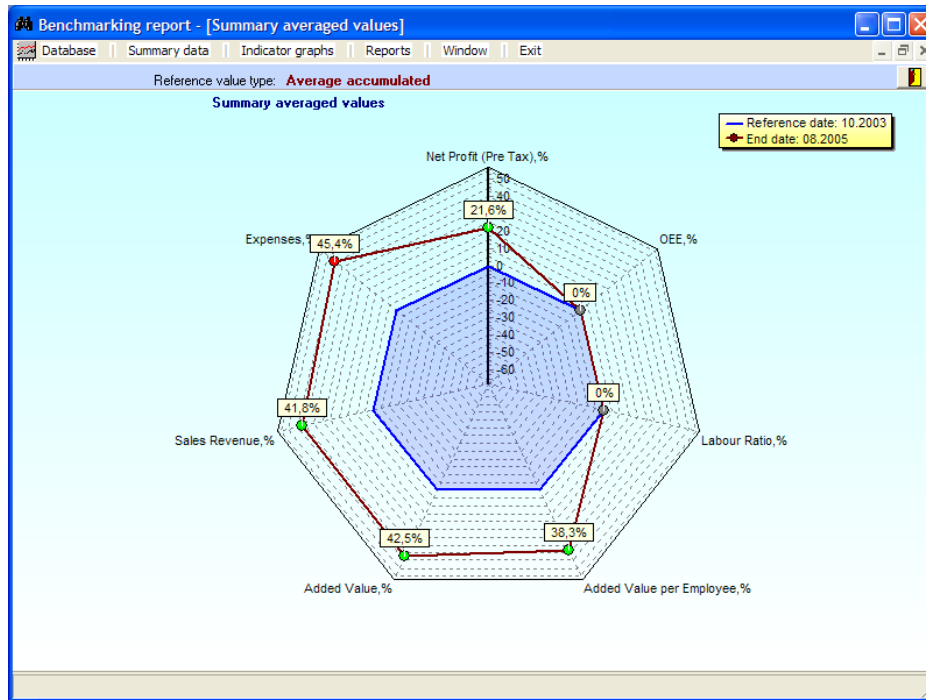
The information is calculated according to particular indicator formulas used in Pharos and Produce Plus, and is presented in graphs, tables and benchmarking reports. The data used for the benchmarking is extracted from the actual enterprise database available in Pharos and Produce Plus. The benchmarking module allows entrepreneurs and consultants to track changes to the following indicators:

- Net Profit (Pre Tax),
- Expenses Overall,
- Sales Revenue,
- Overall Added Value,
- Overall Added Value per Employee
- Labour Ratio
- OEE (Overall Equipment Efficiency).

The indicators are calculated in two formats: actual and averaged. The duration of the period making up the average can be varied by users within the time span of 1 to 12 months in order to identify trends.

The output information is available in tables, graphs and a business report document. The report provides only relative figures to avoid revealing sensitive financial data. The information about relative change is available in a benchmarking report and can be used in presentations for various third parties (bankers, investors, industrial associations, image making events, etc). The absolute monetary data is available in on-line graphs for in-house analysis of results. All indicators are presented in the so called radar graph which provides an overview of changes at a glance as follows:



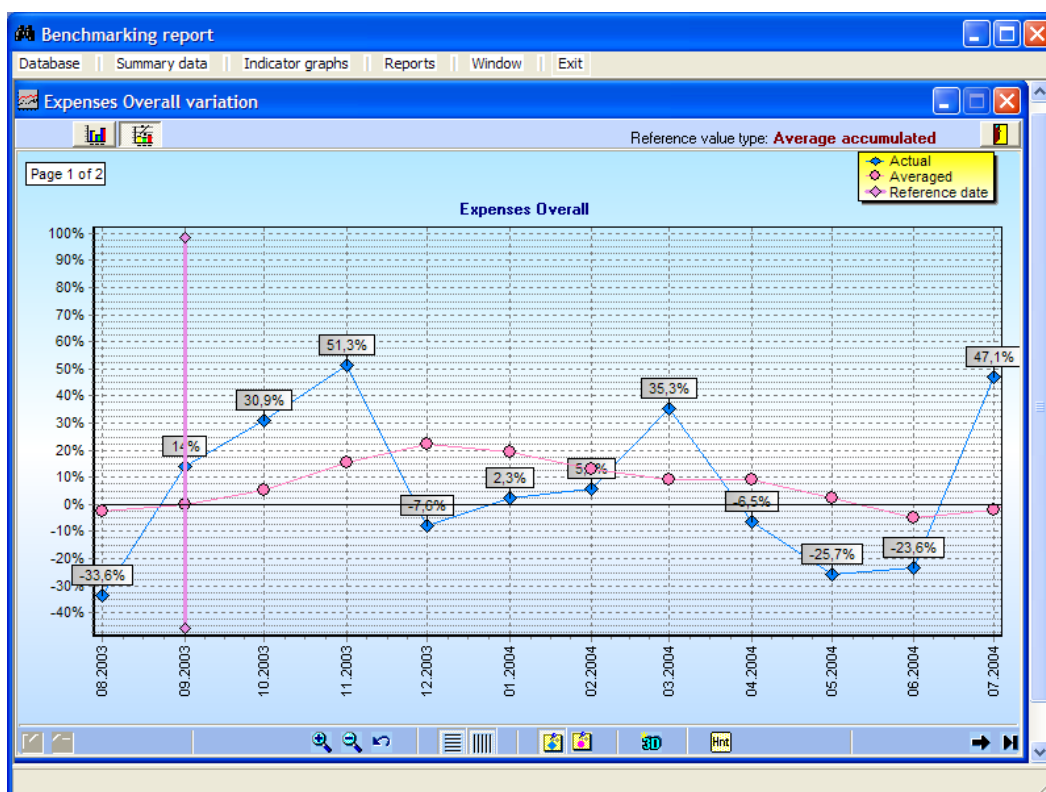


**Pharos benchmarking: Radar Chart of Change**

In the charts below the selected past reference point is designated by the vertical line, the blue line shows the actual data at the measured points in time, and the lavender line is the accumulated average over the time period:



**Pharos benchmarking: Sales revenue against past reference**



**Pharos benchmarking: Overall expenses against past reference**

The module can be run at any time by selecting the "**Benchmarking report**" item in the Reports section of the main menu in the updated version of Pharos – Business Navigator software. It provides for simple and easy monitoring of the results. The copies of the reports are always available in the extensible mark-up language (XML) format under the particular enterprise database subdirectory XML.

### The benchmarking applications

The benchmarking module provides enterprise management as well as business consultants and policy makers with a simple way to evaluate the main business and identify where corrective action is needed. This application differs from the typical benchmarking approach which is based on interviews with senior management and questionnaires, as follows:

1. Entrepreneurs and assisting personnel are provided with the Pharos suite and take part in the introductory training workshop
2. The enterprise database is developed by entering past data for one or more years. Pharos needs only minimal data to calculate key performance indicators and generate benchmarking reports
3. The benchmarking consultant runs a quick audit of the enterprise, verifies the database completeness, runs diagnostics and then prints a benchmarking report
4. The reports from multiple enterprises can be saved in electronic format XML for further comparison and calculation of accumulated statistics.

The use of this software tends to improve *data quality and verification*, because it is based on *actual enterprise results*. In addition, it can facilitate a change to the business culture in many enterprises

by introducing information technology (IT) as a tool for benchmarking, measurement, management oversight and decision making.

The benchmarking reports are available in short or extended format. The extended report provides a time series for each indicator over the entire selected period of analysis.

By maintaining up to date information in the database, the audits necessary for various certification programs are greatly simplified, thereby minimizing costs and the time expenditure for certification.

The Pharos software can further be used for real time performance monitoring for enterprise groups, e.g. in regions or industrial sectors to support policymaking. A simple statistical analysis of data about relative change based on multiple enterprise reports considerably enhances the actual picture of economic developments in small and medium enterprises (SMEs), industries in clusters, regions and countries.

### **Examples of applications:**

1. Provides valuable additional information when applying for a business development loan
2. Can be used by management to present business results to owners, shareholders or potential investors
3. Monitor business results after making strategic changes, for example, introduction of new management, innovation, application of new technology, shift in production pattern, etc.
4. Analysis of credit risks and compliance to BASEL II standard
5. Evaluation of various strategic options for future development
6. Assist business consultants in management upgrade programmes
7. Evaluate results in business games and educational applications
8. Presentation of business development examples in public events such as seminars, conferences, workshops, etc.

The modular design of the software provides for the possibility of further expansion of the benchmarked set of indicators.

*\*Note: The content of **Annex 16** has been extracted from the contribution by S. Golovanov.*

**Serge Golovanov**, PhD, Dipl.Eng., Director

ENTERPRISE PERFORMANCE IMPROVEMENT CENTRE

GOLEM IMS GES.M.B.H., Vienna, Austria

Reg. Nr. FN68378g; EU Tax Nr.: ATU16848106

E-mail: [info@win2biz.com](mailto:info@win2biz.com); [epic.golem@gmail.com](mailto:epic.golem@gmail.com)

Internet: [www.win2biz.com](http://www.win2biz.com)

Phone: +43.699.1947.3508; +44.20.7871.6951 (Skype)

Fax: +43 (1) 2533033-4174

Skype: [golemit](#)

MSN Messenger: [bizsw@hotmail.com](mailto:bizsw@hotmail.com)