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Private and Public Sector Partnerships in Environmental Management: The Case of the Leather Industry in India and the Philippines

Anil Markandya and Abdul Shibli

Harvard Institute for International Development

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Industry Profile

India

The leather industry in India is the fourth largest foreign exchange earner in that country, employing 1.4 million people, of which a high proportion are rural workers, including women. Between 1972 and 1992, the value of total production increased from $1.2 billion to $2.3 billion, and exports rose from $700 million to $1.2 billion.

The leather industry is one of the oldest and fastest growing industries in the country. More than 2,000 tanneries process 500,000 tonnes of hides and skins annually, mostly from domestic sources. Most of the industries are located in rural areas and are owned by private and unorganized small-scale producers. At independence, the government reserved the leather industry for small-scale sector activities. They process raw hides and skins into semi-finished leather. However, in recent years the organized sector is involved in processing semi-finished leather to finished leather, as well as finished goods. As a result, the small and informal sector based in rural areas is facing tough competition from the organized sector both in procuring raw materials and in maintaining the quality of finished products.

Initially, the perception was that this was a rural, traditional, artisan-oriented industry where the introduction of machinery into this sector would displace labor. Though such restrictions have been relaxed from time to time, they do exist in one form or another resulting in technological stagnation for the industry and resistance to adoption of modern technology. However, some relaxations were made in the seventies and the eighties to enable the industries to compete in the world market and take advantage of the finished goods market. Between 1984 and 1991, import of capital goods, raw, semi-processed, and finished leather, and other intermediate

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goods, was allowed duty-free under open general license. During the same period, the export of semi-processed leather was banned and an export tax was imposed on finished goods. These changes have spawned the growth of a new export-oriented modern sector, and dualism in the leather industry — the traditional production sector and the export production sector today stand apart as two distinct systems with not much interaction among them, each using different techniques of management and productions and catering to different clientele.

The Philippines

Out of the approximately 130 leather tanneries in the Philippines, about 96% are located in the town of Meycauayun, in Bulacan. The majority of these tanneries are small- to cottage-sized industries, producing less than 2,000 sq ft of hides per day, with family members usually as employees, and located primarily in residential backyards. Most of the tannery plants are located in one compound, with two or three plants operating under different owners. Roughly 50 tanneries are medium-sized, processing from 2,000 to 10,000 sq ft of hides per day, while 6 to 7 are large, processing more than 10,000 sq ft of hides per day. Some of the plants accept servicing works, leaving the dyeing and finishing to the smaller plants. Tanning jobs are seasonal and contractual, and only the big plants maintain a regular work force. Raw hides and skins, which are the principal raw materials in the manufacture of leather, are mostly imported in The Philippines.[1]

In the Philippines, the government actively promotes both leather tanning and leather goods manufacturing as lucrative business opportunities, especially for foreign investors. A survey by the National Economic and Development Authority (NEDA) shows that operating labor is about 75% of total employment in this sector, indicating that the industry is labor intensive in nature. The respondents also stated that operations are by job order and that, unlike India, their products are only marketed locally. The respondents also indicated that the market is seasonal in nature, implying that all operations, including the waste management aspect, should be flexible. Most respondents stated that their process equipment is underutilized by as much as 40%. This leads one to believe that currently the domestic market is rather limited and possibly that product quality is insufficient to meet the exports standards.

Pollution and the Tanning Industry

Tanning operations generate liquid and solid waste as well as wastewater and volatile organic compound in its production process. Tanneries contribute to the pollution of inland waters,

especially through effluent high in organic and inorganic dissolved and suspended solids content, accompanied by propensities for high oxygen demand and containing potentially toxic metal salt residues. To understand the source and avenues of pollution, it is necessary to understand the tanning process and its various unit operations generating the different types of pollutants. This would be helpful to assess the pollution abatement measures to be taken in the industry.

Process Background

Tanning is the act of converting animal skins into leather. The manufacture of leather consists of a series of chemical and mechanical treatment of animal hides and skins — from cattle, carabao, goats, pigs, etc. The processes involved in treating the hides can be summarized as follows:

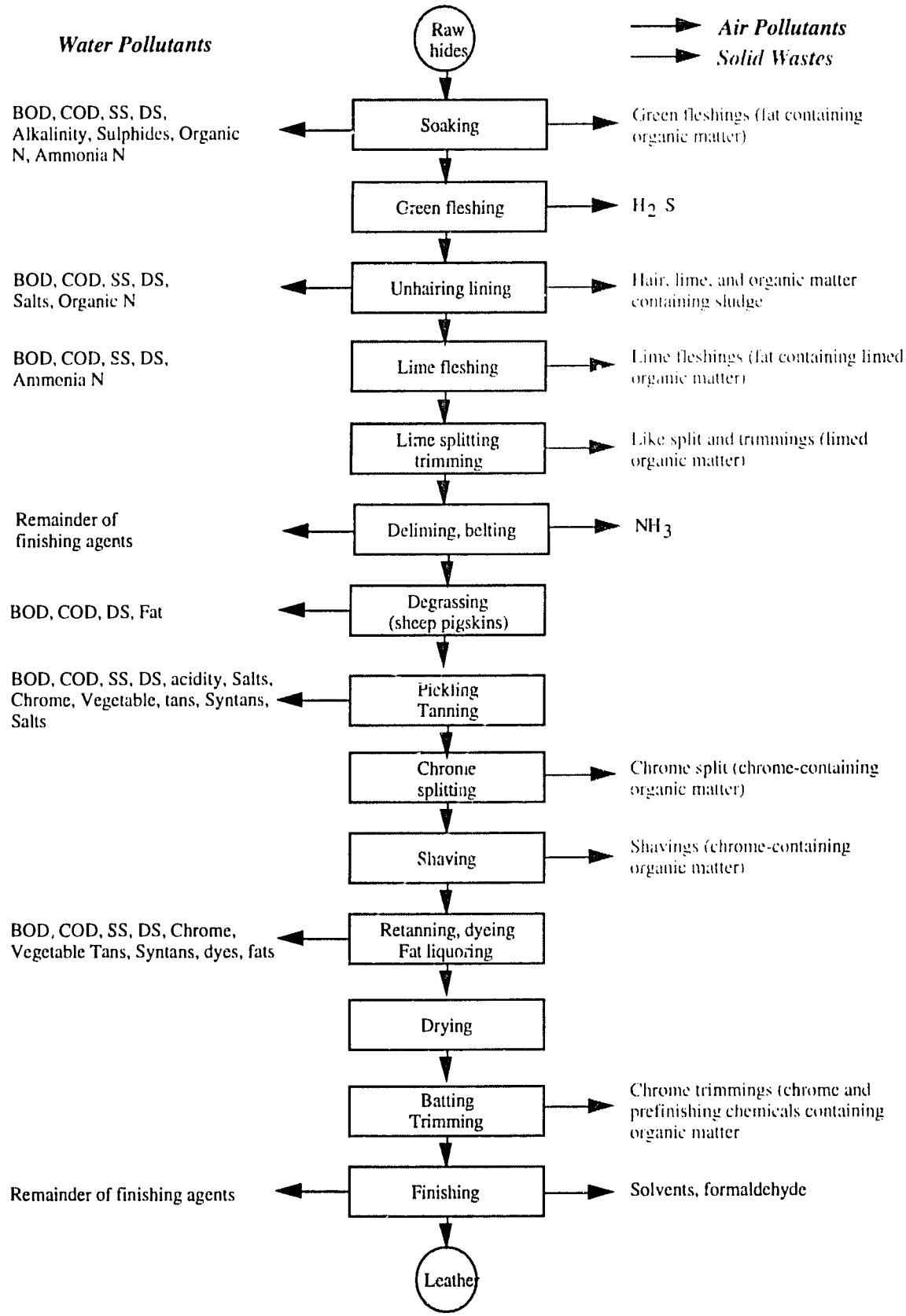
1. Soaking/beaming
2. Liming
3. Unhairing/fleshing/splitting/scudding
4. Deliming and bating
5. Pickling
6. Tanning process
7. Shaving
8. Neutralization
9. Retannage
10. Dyeing and fat liquoring
11. Drying
12. Finishing

The first four processes occur in the beamhouse, while the next five processes take place in the tanyard. The last steps involve finishing operations. The complete flow diagram of the tanning process is given in Figure 1.

Environmental Impact

The production of leather results in solid, liquid and gaseous waste materials in most of the processes shown in Figure 1. The potential environmental impacts of the leather industry are widely acknowledged. However, different sectors of the economy have varying perspectives on environmental issues and place different priorities on these vis-a-vis other social and economic goals. In addition to the traditional problems of air and water pollution, there are other concerns such as chemical safety, contamination of land and

Figure 1. Schematic of Tanning Process



groundwater, inadequate provision for solid waste and sludge disposal, spills and accidents involving chemical substances, and the general nuisance of odor and noise.

Current Practices

In studies conducted in these countries, the solid and liquid wastes have been quantified, but the gas wastes in the form of acid fumes and vapors have not been measured. Most of the tannery operations are done in open pits, creating acidic vapors discharged in the ambient air, thereby creating discomfort and nuisance to the work force and the adjoining neighborhood. Soaking, liming, unhairing, fleshing, splitting, scudding and deliming produce solid wastes in the form of hairs and tissues which must be properly disposed of.

The tannery process consumes a sizable amount of water. Although some plants maintain the rinse bath for a number of production batches, the entire operation makes use of large volumes of water, particularly in their cleaning and beaming work. The wastewater, which contains organic and inorganic salts and is distinctively colored, is often discharged without any processing. The actual tanning operation discharges water with low levels of BOD, although their total solids are high from the salts used.

India

An all India survey revealed that out of 436 tanneries under the Small Scale Industry (SSI) sector, only 22% were found to treat their effluent before discharge (CLRI, 1990). Of industries with capital investment of more than $130 million in India (which are covered under Directorate General of Technological Development (DGTD) and are not small scale sector firms), 59% reported that they are treating their effluents. In most cases, tanneries in India use adjoining lands in addition to their own land for impounding the effluents which partly get evaporated. The balance finds its way into nearby *nallahs*, or rivers, without any treatment.

A study in Tamil Nadu, South India, showed that every 100 kg of skin tanned uses about 3,200 liters of water, or a total of 50 million liters a day from all 680 tanneries in the state, all discharged as wastewater. The water effluents contain common salt, sulfur and chromium compounds and other chemicals. So far, almost all the wastewater is discharged on open land without treatment.

The Philippines

In the Philippines, systematic waste management and control measures have yet to be implemented by the leather producers. A

survey of tanneries in the Meycauayan area indicates that the majority simply impound their effluent, which eventually find their way into inland waters and rice paddies, resulting in the destruction of aquatic and plant life. The solid wastes produced come from hides before and after processing. Some tanneries sell these wastes as poultry food. A portion of these are dumped, burned, or hauled by the municipal waste disposal service. Unprocessed hides, or the fleshings and trimmings of scrap hides, produce undesirable odor especially when dumped indiscriminately. Hides may also be a breeding ground for pathogens during decomposition.

In the same study, respondents reported that wastewater is disposed of or treated through screening/filtering, sedimentation/flocculation, aerated pond system, activated sludge, facultative pond system, stabilization lagoons, impounding, or simply discharging to inland waters. Closer inspection, however, showed that most wastewater treatment facilities are not optimally operated. Thus, tanneries in the Philippines do not conform with effluent standards laid down by National Pollution Control Commission (NPCC) (see also below the discussion under Environmental Standards and Enforcement).

In another survey of waste management practices in Meycauayan, Buacan, three of the seven respondents indicated that untreated wastewaters were simply impounded or discharged directly to inland waters; the remaining four had wastewater treatment facilities, but an ocular inspection by the survey team revealed that most of these facilities are not operated properly, resulting in non-conformance with effluent quality standards (Santiago, et al., 1990). It appears that no effort is made by the plants to segregate the wastewater from any of the operations: unhairing, soaking, deliming, and bating of hides. Wastewaters are discharged in the drains leading to creeks that ultimately find their way to the Meycauayan River. In some cases, the wastewaters are discharged into nearby adjoining vegetation (*kangkongan*) ponds.

Socioeconomic Impacts of the Pollution

Pollution from tanneries, as from any major industry, has a negative long-term impact on environment despite the immediate economic benefits of production. Polluted water, air, or soil affects people's health, and damages the ecological processes that sustain the production of food. The discharge of residues is a waste of scarce resources, whether chemicals, energy, or raw materials. The eventual cleanup of polluted environments requires expenditure of funds that could be used to promote cleaner production. The major problems associated with wastes from leather are given below.

Land Resources

Inadvertent discharge of untreated or poorly treated effluents on land may degrade soils and limit their use in terms of agriculture or habitats. Metal contents of effluents can increase aluminum, chromium, and zirconium, which have detrimental effects on plant growth. Salt dust, wet lime sludge, hairs and green fleshings, vegetable and chrome tanned shavings, spent vegetable tan barks and myrobalan nut (largest fraction), and sludge produced during tanning and waste treatment are the common solid wastes from leather processing. These spoil the aesthetic sense and also create odor and insect nuisance near dumping sites.

A study in Tamil Nadu found that the state of adjoining soil is such that nothing grows on the soil, and local farmers are compelled to sell their agriculture lands to tannery owners. Excessive salt contents of waste do not allow seedlings to germinate, and also deteriorate standing trees and plants. Similar findings were reported also in the Philippines.

Water Resources

Physical, chemical and biological quality of both surface and ground water resources may be affected severely by the tanneries' wastewater. Decomposition of organic wastes may deplete dissolved oxygen and threaten survival of aquatic life. Inorganic salts may impart salinity to water, and some of them like chromium, sulphide, and ammonia may also create toxic conditions. Heavy nutrient doses of wastewater contribute to eutrophication, turbidity, color etc., and may hinder photosynthesis, harming aquatic plants. Seepage of chemicals in wastewater from dumping sites contaminate groundwater resources also. These may be the only source of water supply for the nearby locality and may result in several diseases. Self purification capacity of these resources is much less than surface waters as they are not in direct contact with the atmosphere. Therefore, percolation of wastewater creates a long-term deleterious impact on ground water.

Atmospheric Resources

Basic air pollution problems from tanneries include unpleasant odor caused by sulphide emissions from dehairing, as well as ammonia emissions from unhairing and fleshings. Other problems which deteriorate ambient air quality include flue gas from boilers using spent tan bark and other vegetable solid wastes as fuel, particulates, and fly-ash.

Effects on Humans

Continuous exposures of tannery workers to various chemicals may cause severe health hazards such as disability, illness, and in extreme cases, death. Ammonia emission during deliming operations causes irritation of respiratory tracts. H_2S, which is highly toxic, may cause death at the 500-800 ppm level. Formaldehyde and leather dust during post tanning operations can cause skin allergies and cancers. In addition, odor nuisance, unsightly conditions, and air emissions may cause discomforts and severe psychological impacts on the workers. A report in Tamil Nadu, South India revealed that local people near tanneries suffer from various types of ailments like stomach ache, headache, dizziness, etc. (Basker, 1990). The cases of leprosy, tuberculosis, and night blindness are also much higher than normal.

Environmental Management in Leather Tanning

Prevention

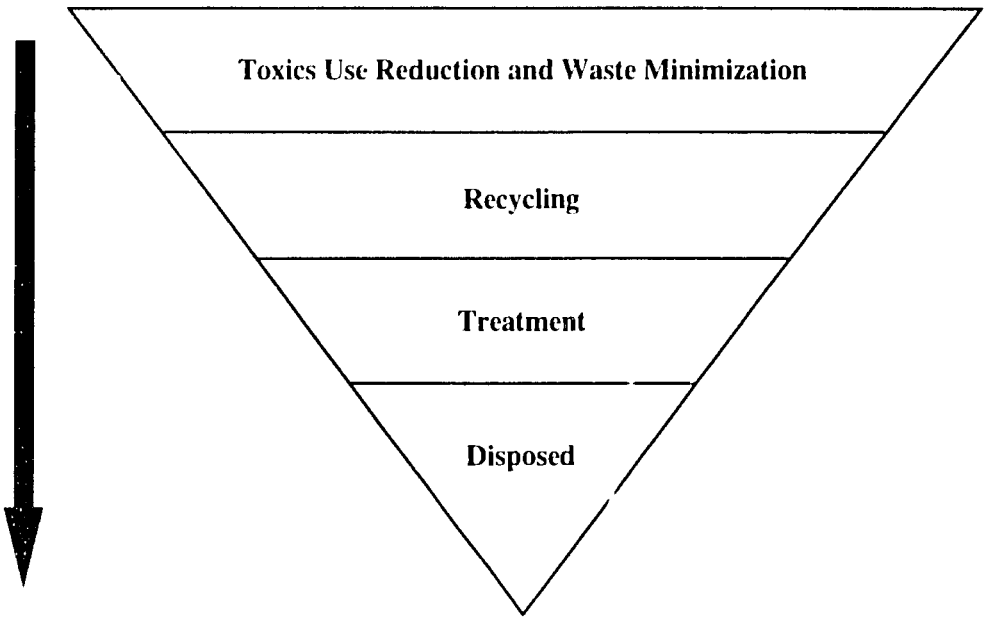
Considerable technical development has occurred in recent years, and less polluting tanning processes are available. These processes are based on lower chemical and water consumption. Treatment plant designs are now available to handle the remaining wastes effectively. However, many obstacles remain to their widespread introduction. The remedies to environmental problems are frequently complex. However, it has been noted in several studies that a systematic and comprehensive approach pollution control is usually cheaper and more effective to pollution control is usually cheaper and more effective, and has longer lasting results, than end-of-pipe treatment and retrospective cleanup (Parikh, et. al., 1993; UNIDO, 1991; WEC, 1992).

There are four components of environmental protection: toxics use reduction and waste minimization, recycling, treatment, and disposal. The hierarchical relationship among these four are depicted in Figure 2.

Cleaner Production Options

Tanners in developing countries can begin by adopting good housekeeping measures which require little or no capital investment, such as water conservation at all stages of wet processing. Substantial abatement can be achieved by in-house improve-

Figure 2. Environmental Protection Hierarchy



ments such as improvement of the drainage facilities, utilizing closed conduits/ pipes to replace the open canals. Savings in chemicals by introducing reuse-recovery-recycle systems can pay for the simple equipment needed to run them, such as collection pits, pipes, and pumps.

A number of in-house procedures can be used by tanneries to upgrade their wastewater quality, and likewise achieve a substantial recovery of their chemicals. Using methods such as those described above, it is possible to reduce the organic load emanating from the beamhouse and tanyard by 60%.

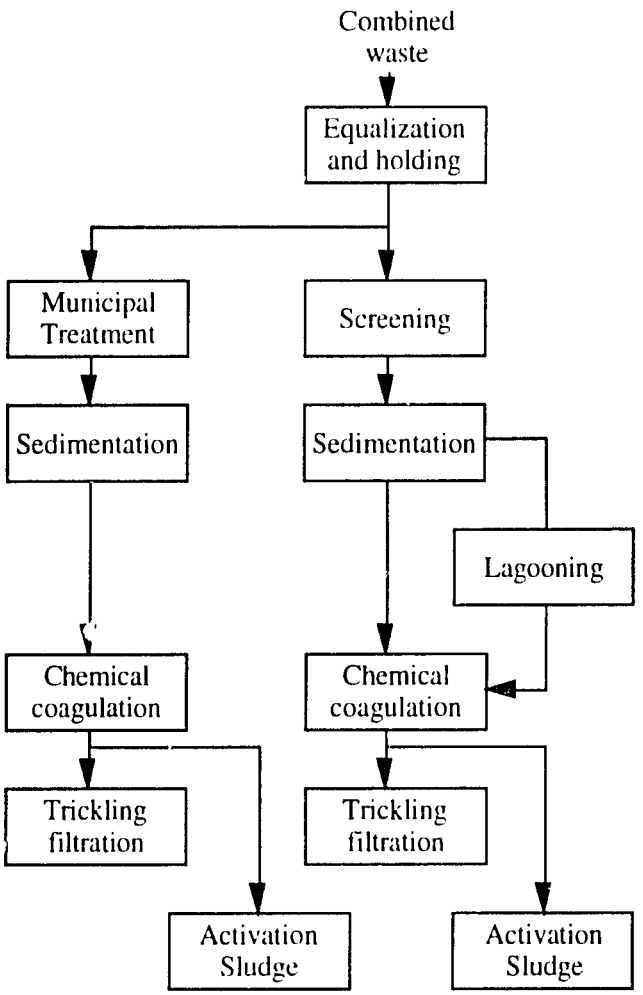
Treatment

Effluent treatment can be done either by physical-chemical (primary) or biological (secondary) treatment processes. Tertiary treatment is not done in developing countries and rarely occurs even in developed countries. Studies in the United States reveal that of 32 plants surveyed, only five employ up to secondary treatment, the rest are using only primary sedimentation.

Primary treatment facilities consist of filters, sedimentation tanks, aerators and clarifiers (Figure 3). Primary treatment requires equalization and sedimentation basins although some chemical coagulation and sludge digestion are also practiced. Equalization is necessary to minimize the wide fluctuations in the composition of the waste caused by intermittent dump discharges of strong liquors, and sedimentation is necessary because of the large volume

of sludge (5-10%) present in the waste. If secondary treatment is necessary, trickling filters and activated-sludge systems can be

Figure 3. Schematic Flow Diagram for Leather Tannery Waste



used (when the pH has been reduced to 9.0 and hardness to 200 ppm) to produce an 85-95% BOD reduction.

Primary treatment necessitates investment in equalization and primary sedimentation basins. Thickening is a physical process that separates the wastewater into solids and liquids. It is usually accomplished by either gravity or flotation methods. Gravity thickening allows the solids to settle to the bottom of the tank whereas flotation thickening uses air bubbles to float the solids to the top, where they are skimmed off. Of the two methods, gravity thickening is more common.

Secondary treatment uses either an aerated lagoon or the activated sludge system to reduce the effluents biological oxygen demand (BOD). Ideally, an activated sludge system can render tannery wastes entirely suitable for discharge into stream. An effluent that is practically clear, free from objectionable odor, and perfectly stable, can be produced. Anaerobic lagoons have reported 88% of BOD reduction at organic loadings of 1,000 lbs of BOD acre/day. Although lagooning cannot achieve effective removal, effluent is expected to be clean and odorless. Most of the reduction occurs in the anaerobic section, which includes the sludge digester. An aerobic lagoon is utilized primarily for odor control.

Often such treatment can be carried out using joint effluent treatment plants. These are often the best solution for tannery clusters (usually consisting of small- and medium-scale units), typical in the regions discussed. This approach offers technical advantages with an economy of scale, *provided that proper chromium removal is achieved prior to joint treatment*. This approach has been tried in Kanpur, India. The Upflow Anaerobic Sludge Blanket (UASB) bioreactor project, with a capacity to treat 36,000 m^3/day, is reported to be one of its kind and the biggest in the world. In this project, composite wastes from tanneries are mixed with domestic sewage (in the ratio of 1:3) and treated by the UASB technique which reduces the BOD load up to 100 mg/l (60% reduction).

In the Philippines, the town of Meyacauayan has no provisions for sanitary sewers. If a joint treatment is undertaken, a sewerage mix will be necessary for nutrient supply.

Advanced treatment systems can be tailored to specific circumstances and the quality of effluent required. These systems are expensive and require expert control. It is advisable to alter processes and chemicals utilized and thereby avoid the costly sophistication of such methods as high performance aeration, reverse osmosis, etc. As noted earlier, such methods are not used in developing countries, and are rarely used in developed countries.

Management of Treatment Facilities

The conservation and treatment measures described above could be adopted at the plant level. However, most of the treatment and recycling measures may be too expensive for all but the large and modern tanneries in these countries. While the developed countries are using sophisticated pollution control technologies, appropriate technologies are rarely used in India, the Philippines and other developing countries either due to lack of information or lack of financial resources.

Affordable methods for the disposal of tanning effluents is the primary concern of small and medium tanners. A study in the Philippines reports that compliance with effluent standards under the Government Pollution Control Guideline would require large capital and operating expenditures to install, operate, and maintain. This is a financial burden that the small and medium tanners would find hard to absorb. Non-compliance with the strict effluent standards, on the other hand, could result in the imposition of penalties against the tanneries in the form of fines or closure orders.

In such situations, treatment can be organized by one of the following initiatives:

- Private waste collector/recycler
- Local authorities
- Producers cooperatives

Private Waste Collector/Recycler

The private enterprise collects the chemicals, solid waste, and sludge from the tanneries for a fee. The recycler treats the waste at a dedicated treatment plant, or more likely works in collaboration with a municipal waste treatment plant. The tanneries pay for these services based upon the waste hauled away. This market-based approach has worked in some countries and for some industries (for example, solvent recycling in Thailand). In instances where the private initiative leads to a monopoly, it may need to be regulated.

Local Government

Local authorities, in cooperation with the tanneries, might operate a treatment plant. The services are particularly important for tanneries which do not and/or cannot minimize or treat their own wastewater. The waste is collected by pipes and processed for a user fee. Because the amount of investment required to put up a treatment plant is beyond the reach of the tanneries, or because private investors are reluctant to raise capital for this purpose, government institutions and development funding schemes may be organized.

An example of this type of collaboration between the government agencies and industry can be seen in Tamil Nadu, India. The Tamil Nadu Leather Development Corporation Limited (TALCO), the Tamil Nadu Pollution Control Board (TNPCB), UNIDO, and other organizations are setting up a number of Common Effluent Treatment (CET) plants throughout the state.

Under this scheme, all tanneries will be brought under one umbrella, and tannery owners will have to contribute 15% of the project cost. In one instance, the central and state governments will each contribute 25% and the remaining 35% will be raised as loans from financial institutions.

Cooperatives

Producers may form a cooperative or a joint treatment plant. While some financial and technical help may be forthcoming from the government agencies or NGOs, these plants are operated by the tanneries and the bulk of the capital cost and operating cost is borne by the tanneries. It is reported that in India, where small scale sector tanneries are scattered, construction of common treatment plants for their effluents on a cooperative basis seems to be the only cost effective solution.

A survey of plant owners in the Philippines shows that a majority of them believe that the most effective program to control their wastewater is through provision of a joint treatment facility, to be operated by a government agency. They realize that the capital cost of realizing the treatment plant is distributed to the participating plants in an equitable manner. This can likewise assure an acceptable level of treatment, since proper controls and instrumentation will be provided and qualified people will be operating the plant. The tanning industry in the Philippines is seeking government assistance in developing low cost, affordable wastewater treatment measures and facilities. Unlike the other industrial sectors, this particular industry has not been able to develop a potent organization or association which can spearhead the much needed research programs.

Industrial Relocation

In many countries, the government has provided incentives to the tanneries to relocate away from urban centers. In India, such relocations has taken place in the states of West Bengal and the Punjab. These leather complexes are to be equipped with various facilities, including bonded warehouse, testing laboratory, training center, etc. Similar incentives have been successful in Turkey.

Environmental Standards and Enforcement

Current policy in both countries is based on command and control type regulations. In India, effluent standards are: BOD: 30 mg/liter (max); suspended solids: 200 mg/liters (max). For new tanneries, provision for effluent treatment has been made mandatory before issuing licenses.

Environment management of leather industries entered the fast track as a result of the Supreme Court verdict in 1987 (M.C. Mehta v. Union of India) where the polluting tanneries were asked to install adequate treatment units or close down. While the bigger units readily acceded to the demand, it was practically difficult for the smaller units to have individual treatment units as their effluent quantity was small and processing intermittent. Many smaller units had to face stringent actions and even temporarily close down.

In the Philippines, effluent standards have been specified under the Government Pollution Control Guideline. However, there has been minimal effort from the industry to adopt pollution control measures and meet the standards. Some tanneries have installed wastewater treatment facilities. These generally consist of chemical treatment (sedimentation and flocculation), followed by biological treatment, usually in aerated lagoons. The National Pollution Control Commission usually conducted 2-3 inspection trips to the tannery annually, but wastewater samples are not always taken during the trips (see Section 3 above for evidence on lax compliance). Fines are imposed in cases of non-compliance, but since these fines are not based upon production or effluent levels, larger plants find payment of penalties a less expensive option than abatement.

Techno-economic Barriers to Environmental Protection

Problems in India

The problems faced by the Indian tanning industries in the treatment and disposal of effluents are:

- Acquirement of large land area, energy and high capital, operation and maintenance cost.
- Disposal of chrome sludge which accumulates in large quantities in the effluent treatment area.
- Techno-economic constraints in the implementation of treatment plants, mode of cost sharing for the construction, and operation and maintenance of common effluent treatment system.
- Removal of dissolved solids and chlorides from the effluents due to inherent tanning processes and poor quality of ground water which is used for tanning operations.

Social Considerations

Tanning is a traditional industry. In many developing countries it is carried out by a certain sector of society. In India it is almost entirely the preserve of the Muslim population. Simply tanned leathers are produced for local markets. Methods of tanning and fabrication of goods are far removed from modern methods (see above). Such segments of society are difficult of bring within the modern framework of production and emission control. Governments often feel inhibited in dealing with such problems because of the social and even political upheaval that would occur. The problem is further exacerbated in some countries where tanners are traditionally regarded as socially inferior because of the nature of their work. These groups, because of traditional discrimination, have amassed considerable political privileges. Consequently, there are difficulties in altering the structure of artisan industry.

The adoption of low-waste technology often requires a radical alteration of most tannery processes while, at the same time, ensuring that the ultimate product retains its marketable properties. Therefore, if a tanner is producing a consistent quality of leather which satisfies his customers, using a process which may be wasteful in water, energy, and chemical utilization, he may resist altering his operations to comply with environmental demands.

Industrialized tanners in some developing countries, who face the enforcement of emission regulations, are in some instances contracting their wet work processing to artisan tanners who continue to operate without restrictions.

Inadequate Legislation and Lack of Monitoring Facilities

Pollutant discharge standards in most developing countries are by nature rigid and have a disregard for specific site conditions. Instead of a gradual approach as called for which would phase installation of treatment facilities (for example, the physical-chemical first, followed by the biological treatment facilities and appropriate sludge handling), a tanner is under pressure to set up a complete treatment system and meet all discharge limitations at once, which is beyond his financial and technical means.

Market-based versus Command and Control Approaches

As mentioned above, pollution control efforts in India and the Philippines are based on the command and control approach. This strategy relies on engineering controls, pollution ceilings, and bans. Market-based instruments, on the other hand, seek to influence the behavior of the agents, the tanneries in this case, through economic incentives such as taxes, fees, tradable permits, etc. While

these market-based instruments have not been tried to regulate the tannery industry, they may provide a less expensive and more efficient method to achieve the environmental target. The following market-based instruments may be tried:

- Monetary incentives such as taxes, charges, fees, or subsidies.
- Creation of markets through the use of marketable disposal permits or emission reduction credits.
- Deposit/refund systems for chemicals.

Because tanneries vary in size and in the ability to absorb the costs of treatment, it has been suggested that uniform effluents standards may force some of the smaller and traditional tanneries to close down. In such cases, fees and tradable disposal permits might allow greater flexibility in the enforcement of environmental rules.

Questions for Discussion

A. *The paper identifies the following measures to control pollution from tanneries: improved housekeeping, primary treatment, secondary treatment, tertiary treatment, and industrial relocation. How would you determine the relative amounts of effluent reduction under improved housekeeping, primary treatment, secondary treatment and tertiary treatment. What information would you need to arrive at the right orders of magnitude for these reductions?*

B. *What policy incentives would you use to induce better housekeeping? How would you evaluate the success of your programs/policies?*

C. *Where primary treatment is required as part of the solution, it has been established that this has to be carried out at the plant level. Moreover, it is essential that this treatment take place if secondary collective treatment is to be carried out. The following data are provided on the cost of primary treatment:*

	India	Philippines
Unit Cost of primary treatment	0.4 Rs/sq ft	0.3 P/sq ft
Average market price of treated leather	25 Rs/sq ft	21 P/sq ft
Total production (million sq ft/per annum)	500	118

Given an elasticity of supply of 1.0, how much would production fall if these additional costs were to be incurred? Assume that the market price remains unchanged, but that the price received by the producers falls by the costs of primary treatment.

How big an employment effect would this have if each employee produced (on average) 350 sq ft/year in India and 425 sq ft/year in the Philippines?

What measures would you propose (if any) to avoid such a loss of employment? What would your measures cost?

D. *For secondary treatment a number of options were considered. These included:*

- *Private wastewater collection from tanneries and treatment of the waste thereafter.*
- *Operation of the facilities by the local authorities for a user fee.*
- *Cooperative producer facility for treatment.*

How would you evaluate these alternatives and which one would you recommend? Note that it may be possible to switch from one option to another — e.g., a public facility can be handed over to the private sector once it has been established. The questions to be considered are:

How do we fix the price to be charged for the collective facility?

How do we ensure that waste generated is actually sent to the treatment plant?

How do we cover the capital cost of the collective treatment plant?

If waste that is sent to the center has not been given primary treatment, the operations of the collective plant become much less effective. How do we ensure that proper primary treatment has been given?

If these costs are to be borne by the tanneries, some may go out of business, or at least reduce output and employment. The size of the effect will depend on how much of the costs are to be borne by the firms. An increase in the cost of treatment of around 3% of the present price is expected if no subsidies are given. What are the possible employment effects of such an increase? What measures would you propose (if any) to mitigate the output effects of the increased cost of treatment?

E. *In some cases, it may be desirable to close some plants entirely, or at least to require them to relocate. How would you arrive at such a decision? If a relocation is to be considered, what role, if any should the regulatory authority have in this regard?*

F. *It has been pointed out that a single effluent standard for all producers will hit the smaller firms harder, as they are the "marginal" firms and cannot meet the standards. What instruments/measures do you consider useful in addressing this problem?*

G. *How big an impact would you expect the introduction of treatment of waste from tanneries to have on the export market? What measures can be taken to reduce the magnitude of this effect?*

In answering the questions refer to the information in the case study, and distinguish, if necessary, between the solutions for India and the Philippines.

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Endnotes

[1] The Philippines imports raw hides from Germany, Sweden, the USA, Australia, Hong Kong, and Japan.