8. Case Study Of A Corporate Paper–Sugar Complex

8.1 Beginnings of the Company

SESHASAYEE PAPER AND BOARDS LIMITED (SPB), a private enterprise, set up a paper manufacturing unit on the banks of the river Cauvery. The Cauvery originates in Karnataka and flows through a major part of Tamil Nadu. The river is rain-fed and is subject to the vagaries of the monsoon. The strain on the water resources of the river is high due to increased irrigation, industrialization and a growing population along the river.

The integrated pulp and paper mill commenced production in 1962 with an installed capacity of 20,000 tonnes of paper per annum (TPA). The capacity was later increased to 55,000 TPA. (Since the preparation of this study report, the capacity has been further enhanced to 115,000 TPA.) The company produces a range of high quality writing and printing paper as well as paper used in packaging.

8.2 The Raw Material Problem

The paper industry in India has always faced a problem with availability of raw material. Wood availability is very limited and the paper manufacturers have always been looking for alternative raw material. One such alternative raw material is bagasse. Bagasse is the fibrous mass remaining after the extraction of juice from sugarcane in the process of manufacturing cane sugar. Hence bagasse is a "waste" from the sugar industry.


Bagasse stock yard

Technology has been developed over the last few decades to utilize bagasse for the manufacture of good quality paper. (*See* Annex 8.1 for process information.)

The government has been doing its best to encourage the paper industry to use bagasse as a raw material. This was part of the plan to minimize deforestation. Tax (excise duty) concessions have been made available to paper manufacturers using bagasse.

Traditionally bagasse has been used as a fuel in the sugar industry and it has practically met the total requirement of fuel in the sugar mill. Hence, effectively, there was no cost of heat energy in a sugar mill. If the sugar industry were to sell this bagasse to the paper industry, the revenues had to be necessarily higher than the cost to be paid for an alternative fuel—coal or furnace oil. This price parity (the price obtained by sale of bagasse to the price to be paid for coal/oil) determined the availability of bagasse for the paper industry. If the price of furnace oil went up and hence the sugar industry had to pay more for other sources of fuel than what it obtained from the sale of bagasse to the paper mill, it would refuse to sell the bagasse and use it in their boilers. In this context, many paper mills entered into agreements with the sugar mills by which, the paper mill would supply equivalent heat value of furnace oil to the sugar mill and take away the bagasse for papermaking.

In the early 1980s, the steep increase in the price of furnace oil made this transaction very uneconomical and the company (SPB) was unable to make satisfactory arrangements for regular supplies of bagasse. The decrease in the availability and the high prices of forest-based raw materials added to the problems.

8.3 The Response of the Company

The company chose an unconventional approach to a solution. It decided to get involved in sugar production, so that the raw material problem for its paper mill could be solved. The matter of managing the production and sale of sugar and the attendant issues seemed trivial in comparison with the fact that the raw material problem of the paper mill would be solved.

This was not an easy decision, as there was very little cultivation of cane in the immediate neighborhood. Thus, since the company wanted to get into sugar production, it had first to ensure reliable supply of raw material, i.e. sugarcane.

In spite of the apparent hurdles, the company set up, in 1983, a subsidiary company, Ponni Sugars Limited, to manufacture cane sugar and located the sugar mill next door to the paper mill.

8.3.1 Issues Connected with Sugar Production

Sugarcane is a major cash crop in India and is cultivated over many parts of the country, although the extent varies. In addition to refined sugar, the cane forms the raw material for the manufacture of jaggery (a sweet brown unrefined mass, used as a sweetener), which is manufactured in the cottage sector. In the production of sugar, the cane is crushed and the juice obtained is evaporated and crystallized (see Annex 8.2 for process information). The liquor left after the crystallization is completed is called molasses. Most of the ethyl alcohol in India is distilled from molasses, a waste from the refined sugar industry. The bagasse, as mentioned earlier, is used as a fuel source in the sugar mill itself or as a raw material for manufacture of paper.

The Government in India closely monitors sugarcane and its products as they have a substantial effect on the lives of the people. The industry is governed by a variety of regulations imposed by the central and the state Governments. Some of the rules could be:

- The government specifies the land area from which a sugar mill can draw cane.
- The government decides the price to be paid for sugarcane.
- The movement of the cane is restricted.
- A part of the sugar is to be sold to the Government at a low price for sale through the Public Distribution System.
- The molasses cannot be sold except under the allocation plan of the Government.

Note: The rules could vary from state to state and the situation relates to the period of the case study. Some of these systems have changed over the years.

8.3.2 Availability of Sugarcane for the Sugar Mill

If the sugar mill had to have a regular supply of cane, it was essential that the cultivation of cane be as close to the mill as possible. Transporting the cane over the country roads is a very expensive proposition. Since cane was not grown in the neighborhood, the company had to take action to encourage the cultivation of cane.

The most important problem with the cultivation of sugarcane in the region was the fact that the water availability in the area was poor. Although the River Cauvery runs through the region (the paper mill is situated on the banks of the river), the area is dry as the land is elevated and there was no facility to pump the water from the river whose level is more than twenty feet lower.

The second problem with the cultivation of sugarcane was that the land holding, as in most parts of India, is fragmented. Hundreds of farmers had to be "sold" the idea of cultivating cane.

8.4 The Initiative from the Company

When the company set up a sophisticated system for treatment of its effluent from the paper mill, some of the farmers came forward and wanted the effluent to be diverted to their fields. After elaborate testing to check for possible harmful effects, if any, the effluent water was used for irrigation. This was a success and more farmers came forward to use this wastewater.

The company looked at the opportunity of pumping the wastewater to the farmers, to ensure a supply of sugarcane, which in turn could feed the paper plant with the much needed raw material, bagasse.

The company played a crucial and catalytic role in organizing the farmers into cooperative societies. The societies were intended to set up and manage the pumping of water through the fields of the farmers. This was possible as the industry could afford to make the necessary initial investments in promoting the pumping systems. In addition, the industry was able to get the necessary permissions from the different departments of the government for the collective body of farmers.

The cooperative societies invested in the pumping equipment and the company staff oversees the management of the pumping stations. Ponni Sugars Limited also shares part of the overall pumping cost.

The company has an agreement with the farmers that at least 75% of the land should be utilized for sugarcane cultivation and the cane has to be necessarily sold to the company.

Over time, the effluent from the paper mill was adequate to irrigate 600 hectares of land of which 450 acres would be used for cultivating sugarcane. This helped hundreds of farmers of the region to live a life of relative prosperity. Previously, they had little hope of any returns from their holdings of dry and (as they had imagined) useless land.

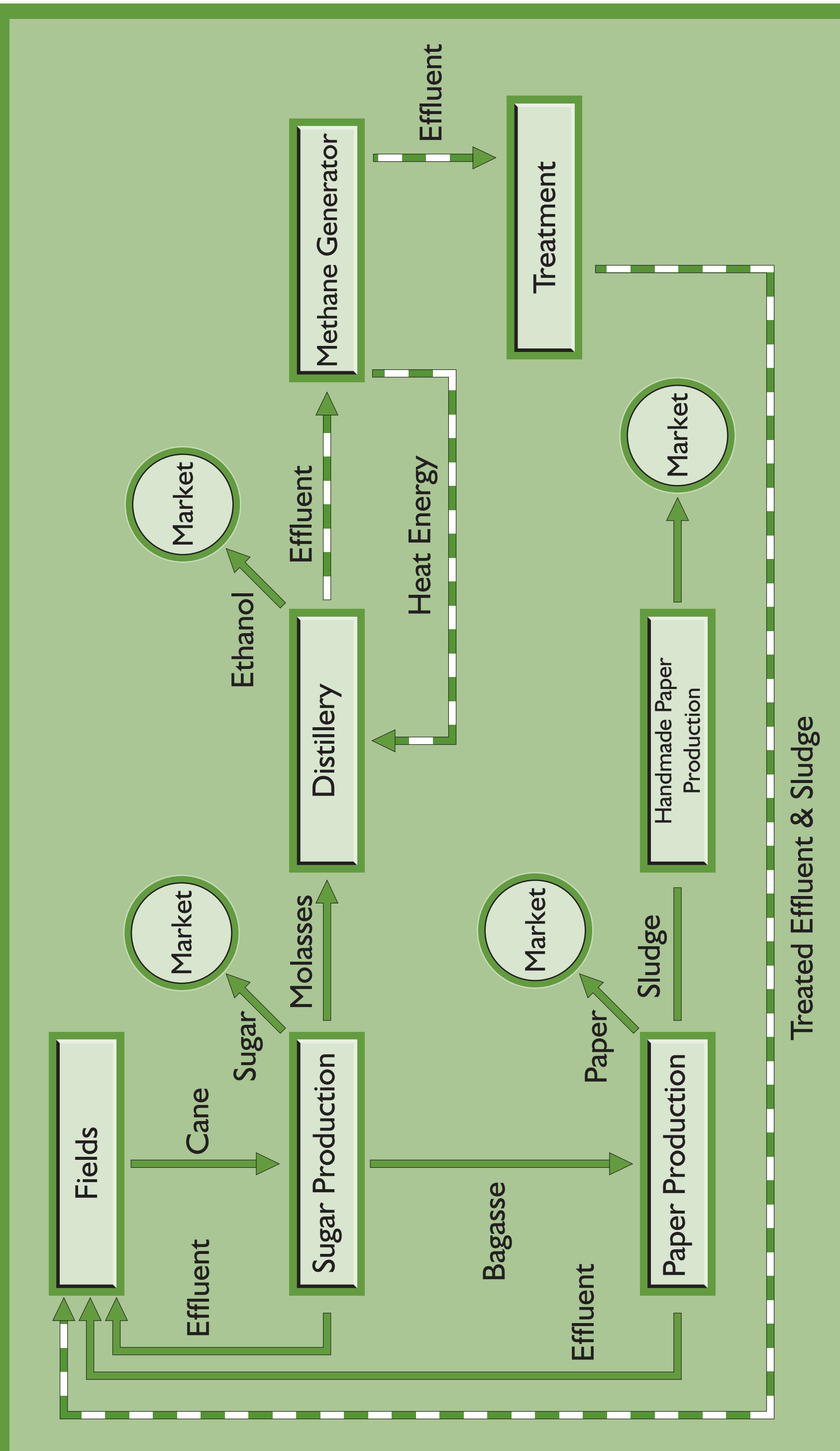
8.4.1 The Production Organization and Waste Management

With the setting up of the sugar mill, a complex industrial system had developed in the region, which is represented by Figure 8.1. This included a captive power plant, which was designed to use a variety of agricultural wastes, as an energy source.

The major wastes from the sugar production are molasses and bagasse. The molasses are sold to a distillery and the paper mill uses the bagasse. The wastewater from the sugar mill after treatment is pumped into the sugarcane fields. A new larger power plant is being planned to cater to the sugar and paper mills, which would also supply waste heat for the production processes. The perspective shown in Figure 8.1 shows the industrial system as if the company had set up a distillery. (The system represented in not a zero waste complex. There are releases to the environment from different parts of the system, which are not shown in the diagram, such as heat, stack emissions and solid waste.)

FIGURE 8.1

Paper–Sugar Complex



Note: The dotted lines represent parts of the system that are not yet in operation.

The company has no immediate plans to set up its own distillery. If a distillery were to be set up, methane would be generated from the wastewater of the distillery, which would meet its energy needs. After methane generation, subject to testing, the high BOD wastewater could be pumped back into the sugar fields.

The company had taken many other steps to improve its utilization of wastes. In the paper mill, in addition to having an excellent chemical recovery process where a bulk of the spent chemicals are recovered, the company has initiated a number of internal measures to save water which is an important and scarce resource.

The following are some of the steps initiated.

- Effluents from the paper machine section are segregated and re-used after treatment.
- Spillage recovery pumping units are installed in the pulp mill section and the soda recovery section.
- Water drained after boiling in the evaporator tubes is recycled.
- Pulp mill effluent is re-circulated.
- The treated effluent is pumped into the sugarcane fields.

The paper mill is going in for an expansion of its capacity and elaborate plans have been drawn up to enable the paper and sugar mill to share waste heat, steam and power from a common power station. In the last few years, the company has been very innovative and uses a variety of unconventional fuels such as bagasse pith (the waste after the bagasse is used for papermaking), coconut shells (an agricultural waste) and raw lignite.

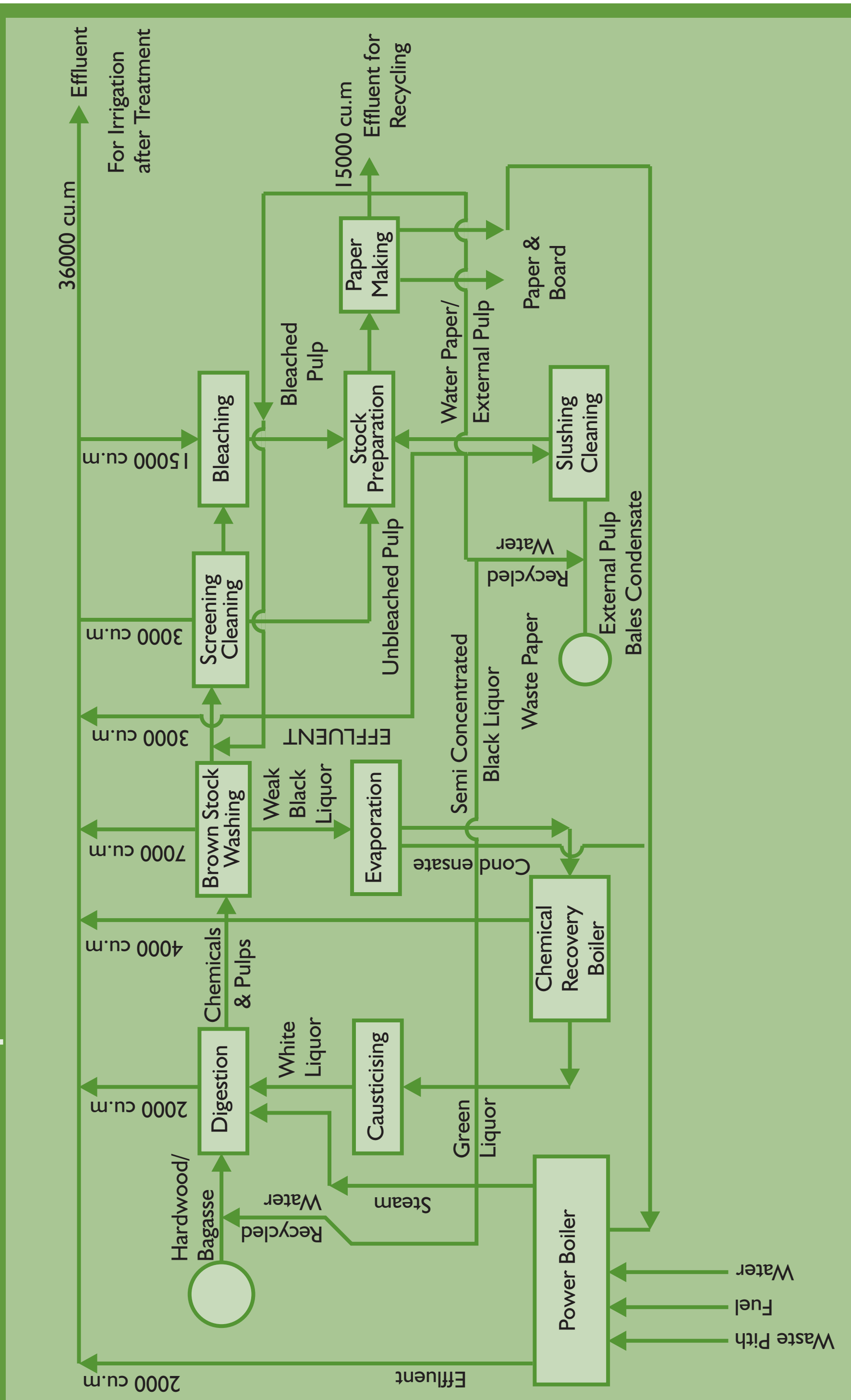
In the recent years, the company is reported to have cut down the water requirement by as much as 50%, which is commendable.

The manufacturing process for paper is shown in Figure 8.2 for reference (see also Annex 8.1).

Note: *SPB is not the only paper plant co-located with a sugar mill.*

FIGURE 8.2

Process Chart — Paper



8.5 A New Growth Model for Companies

The important concept from the study is the highlight of a corporate planning model, which is compatible with the concepts of Industrial Ecology. This case study points to a possible path for corporate growth, which generates little or no waste from its overall manufacturing system. Usually, a company plans its development within a product-market matrix and all environmental issues are seen as secondary to the main goals of the company. This new growth model shows a way by which a company may include profitable waste management in its main goals.

For a business organization to set up such an integrated complex will require a new thought process and there are likely to be complicated organizational issues involved. The focus of this case study is to bring some of the issues to the fore.

For the governments in developing countries, this model might provide an option for strategic development of a region as the scheme could also ensure that the farmers get better organized and get a better return from their crops. In countries where farmers have very small land holdings, an industry-agriculture partnership such as this could give the farmers all the advantages of a cooperative effort along with the professionalism of organized business.

Obviously, similar agro-industrial schemes could be envisaged for different crops such as cotton, coconut, coffee, etc. In fact, there is a high potential for innovative integrated complexes, combining agricultural and industrial activities in rural contexts. The case of SPB also shows that application of the principles of Industrial Ecology in rural areas can be directly beneficial to farmers and local communities, through efficient use of resources.

Annex 8.1

Fact File—Paper Production

Fibers constitute the basic raw material for paper production. These are composed mainly of cellulose, and may be derived from either wood or non-wood sources. The fibers represent some 50% of the dry weight of the fiber sources, the other major components consisting of hemi-cellulose and lignin. The last two substances serve to cement the fibers together. Fibers are separated from the raw material (wood or any other) by means of the pulping operations, using mechanical pulping, chemical pulping or a combination of both.

Non-wood materials used for paper production includes agricultural residues (bagasse, cereals), natural plants (such as bamboo) and cultivated fiber crops (such as jute, flax and sisal). In India, the most widely used of these are wheat straw, rice straw, bamboo and bagasse. The process used for the paper production using non-wood raw materials is generally similar to that using wood based materials. The overall process consists of pulp preparation, pulp bleaching, stock preparation and paper production.

Pulp Preparation

Mechanical or chemical processes are used for pulp preparation. The principal *mechanical* processes include stone ground-wood, refiner ground-wood, thermo-mechanical, cold soda and chemical ground-wood. The process selected is based on the raw material supplied, type of fiber desired, and strength of the paper needed for specific uses. In *chemical* pulping, the raw material is cooked in batch or continuous digesters (large pressure vessels) with solutions of various chemicals. Digestion (or cooking) proceeds to the point at which non-cellulose constituents are dissolved and the fibers can be liberated by blowing (ejecting the chips) from the digester.

Pulp Bleaching

The most common bleaching agents are hydrosulfites and peroxides, used either individually or in sequence. Zinc hydrosulfite, sodium and potassium borohydride, hydrogen peroxide are specific chemicals particularly used. For chemical pulps, the most commonly employed bleaching chemicals are chlorine, calcium or sodium hypochlorite and chlorine dioxide. Alkalis such as caustic soda and calcium hydroxide are used to extract chlorinated reaction products. Oxygen bleaching of chemical pulps is a new process developed in recent years.

A variety of waste papers are de-inked to produce different grades of pulps. Before waste paper can be used for this purpose, it must be carefully classified into different groups, only some of which can be de-inked.

Stock Preparation

The stock is mechanically treated in the refiners to brush or cut the individual fibers. This step produces the properties needed to give the desired strength to the paper. In cases where good formation is needed, such as for fine papers, the stock is also pumped through a jordan, which further cuts the fiber to the necessary length with a minimum of brushing. The amount of brushing varies with the type of pulp used and the requirements of the end paper product.

Chemical additives could be used for various purposes. For example, resin is used for sizing, which prevents blotting of ink, clay, calcium carbonate, and titanium dioxide are some of the substances as fillers where opacity and brightness of the paper are important.

Paper Production

The final paper or board product is formed on a Fourdrinier, a cylindrical machine or a twin-wire machine. The Fourdrinier has a sheet-forming surface while the cylindrical machine uses a cylindrical shaped mould. The Fourdrinier is most widely used at the present time.

In the *Fourdrinier* operation, the dilute pulp flows onto a wire screen, on which the water drains off and the sheet is formed. A suction pick-up roll transfers the sheet from the wire to presses, which enhances the density and smoothness and removes additional water. It then passes through a series of hollow metal cylinders for final drying. In the *cylinder* operation, revolving wire mesh cylinders rotate in one or more vats of dilute pulp, picking up fibers and depositing them on a moving belt. The pressing and drying procedures are the same as for the Fourdrinier operation. The cylinder machine has the capability of producing heavier multi-layered sheets, and therefore its principal use is in the manufacture of paperboard. In the *twin-wire* operation, the paper stock passes between two wire webs. Water drains simultaneously from each side of the stock, resulting in formation of the sheet.

Flow of Resources for Paper Production

The flow of resources in paper production at SPB is shown in Figure 8.3. As can be seen, by far the most important raw material in paper production is water. Hence a separate water balance is provided in Figure 8.4 for better understanding. The nature of solid waste generated in the paper plant is shown in Table 8.1.

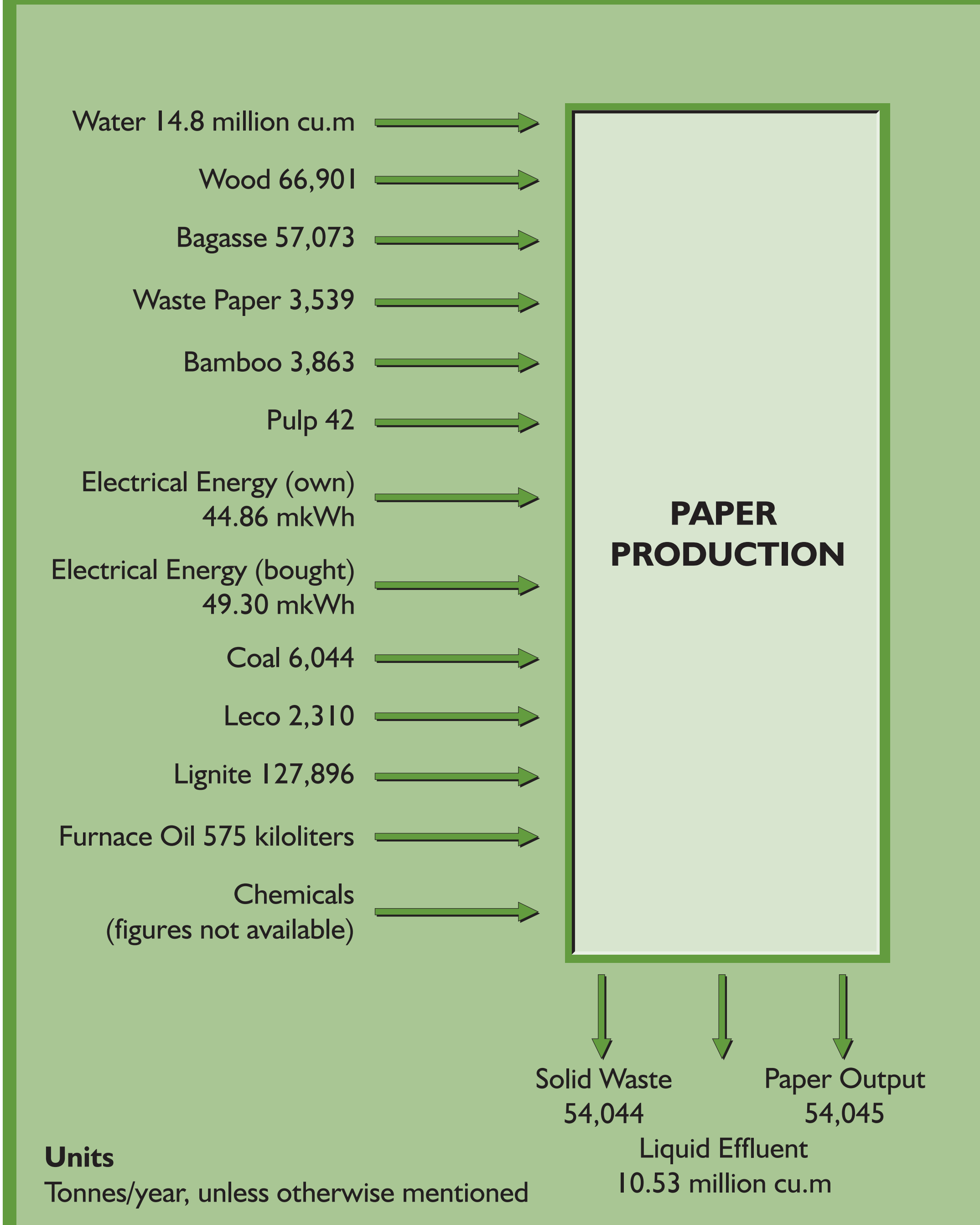
Table 8.1: Solid Waste Generation in the Paper Plant in 1994–95

Type of Waste	Quantity tonnes/year	Nature	Utilization Possibilities
Ash from Boiler	27,022	Minerals Admixture, Inert material, Good pozzolanic properties	Manufacture of bricks, filler for low lying areas
Sludge from Hypo Plant	10,809	Mostly calcium carbonate. High silica content	Manufacture of cement and mortar
Sludge from Effluent Treatment	16,213	Mostly fine pulp fiber and combustible	Manufacture of hand-made paper products, Secondary Fuel

Source: Rapid EIA Report, SPB Ltd, 1994.

FIGURE 8.3

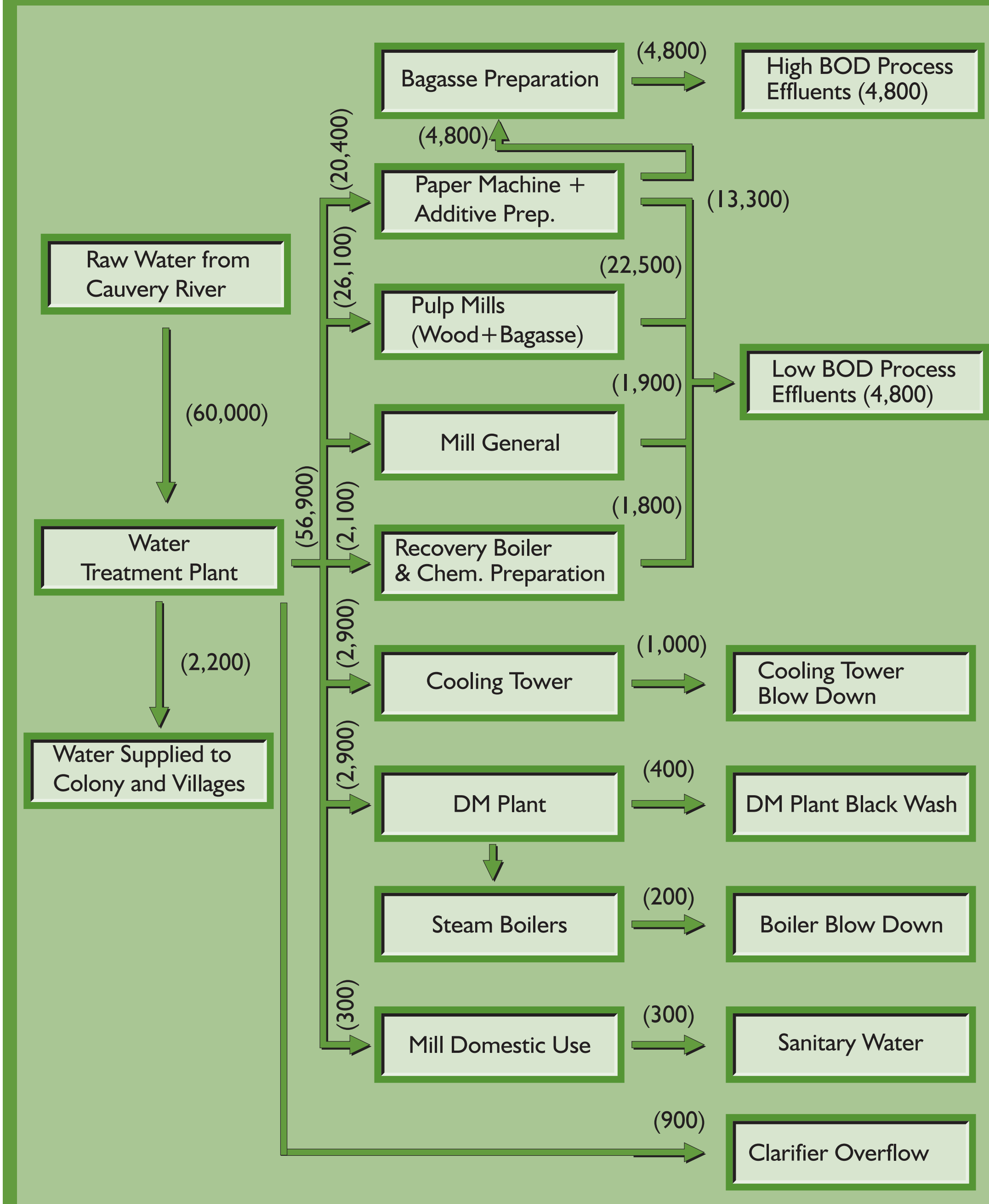
Resource Flows: Paper Production



Source: Annual report of SPB, 1994–95.

FIGURE 8.4

Water Balance at Site



Note: 1. Figures given in parenthesis are flow rates in cu.m/day 2. The balance between inflow and outflow is either carried with the product or lost into the atmosphere.

Annex 8.2

Fact File—Sugar Production

Sugarcane is a giant perennial grass, containing varying amounts of juice in the mature plant. The exact amount of sucrose depends upon the variety of cane, agricultural practices and other factors. The harvested cane will typically contain 15% fiber and 85% juice by weight. In turn the juice will yield 80% water, 12% sucrose and 8% invert sugars and impurities.

The manufacturing process consists of cane washing and cleaning, milling or extraction of the juice from the stalk, clarification, filtration, evaporation and crystallization. Washing is generally employed when mechanical harvesting and loading are used. After cleaning, the cane is cut into chips, shredded and fed into a series of mills for crushing and extraction of 40 to 50% of the juice. The cane fiber from the final mill is known as bagasse.

The juice from the mill contains large amounts of impurities. Screening removes the coarser shreds, which are returned to the mills. Lime, heat and a small amount of phosphate are used to remove much of the remaining impurities through precipitation, settling and decantation in continuous clarifiers. Following clarification, the juice is divided into the clarified and the precipitated mud portions. Rotary, vacuum or other types of filters are used to thicken the precipitated materials and recover a part of the juice. The liquid from the clarification system is about 85% water and 15% soluble solids. Before crystallization, the solution is reduced by evaporation to obtain a syrup containing about 60% soluble solids.

The concentrated juice from the evaporation is crystallized, gently agitated and discharged to high-speed centrifuges to separate the crystal from the syrup. Crystals remaining in the centrifuge are washed with hot water to remove remaining syrup and the crystalline sugar transferred to storage for subsequent shipping or further processing.

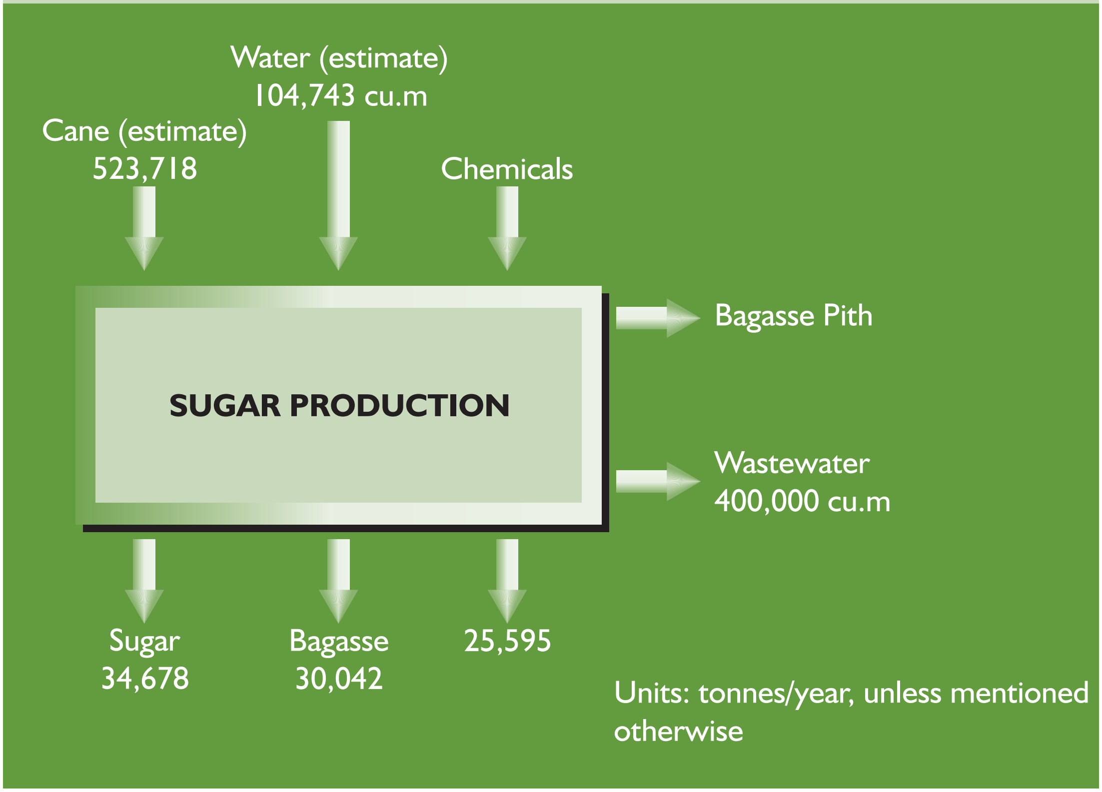
This raw sugar can be refined. The raw sugar contains a film of molasses, as well as various impurities such as bagasse particles, organics, inorganic salts and microorganisms. The refining process involves the removal of most of this film and associated impurities. The steps generally followed include affination and melting, clarification, decolorization, evaporation, crystallization and finishing.

The flow of resources for sugar production is shown in Figure 8.5.

Source (Annexes 8.1 and 8.2): *Environmental Guidelines*, World Bank Environment Department, September 1988.

FIGURE 8.5

Resource Flows: Sugar Production



Source: Annual Report, Ponni Sugars and Chemicals Ltd, 1994–95.