THE INDIAN SUGAR INDUSTRY: A COMPLEX, YET INCREASINGLY PROMINENT FORCE IN THE WORLD SUGAR SCENE

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Overview

Numerous papers have been written on the Indian sugar scenario, but few have tried to forecast the future, especially with the imminent policy changes. This is probably due to the fact that the industry is incredibly complex, with an almost infinite number of variables and possible outcomes. It is the most regulated sugar industry in the world but, at the same time, probably has the greatest potential for making a substantial impact on the world sugar situation. This impact is not confined to large imports or exports but has major repercussions on financial flows and investments, technology and capital equipment requirements, availability of skilled manpower, potential for research and development, and commercialisation of new products and processes in the agricultural, factory and co-product areas. Sugar is the second largest industry in India and is of vital importance to the Indian economy. Some statistics in this respect are given in Annexure A. The industry has the potential to transform the rural sector into a massive revenue generator for the nation, and can usher in modern concepts that will raise the standard of living and quality of life for the rural population.

There are few countries in the world which have a drop in sugar production of 3,5 million tons tel quel in one year, have the potential to generate 3 000 MW of power, or buy sugarcane from 35 million farmers! Before attempting to make any forecasts, one needs to understand the existing sugar situation in India. Here, I have attempted to highlight only the more important facts and trends. Naturally, for a deeper analysis of the subject, many other aspects need to be considered.

Sugar production in India started in the early 1930s, and Annexure B shows the increase in area under sugarcane, yield and cane and sugar production to date. In India, sugarcane is grown in three basic areas, and the country can be divided into the three sugar zones shown in Annexure C. Cane was first cultivated in the Northern zone, and today is mainly concentrated in the state of Uttar Pradesh, with lower production in the states of Bihar, Haryana and Punjab. In the Western zone, production is concentrated in the states of Maharashtra and Gujarat, and here the co-operative movement predominates. In the Southern zone, sugarcane is grown in the states of Tamil Nadu, Karnataka and Andhra Pradesh. Cane production in states other than those mentioned above constitutes less than 5% of total production.

Annexure D gives cane yield, area under cane, and total sugar and cane production in the different states. We see that yields in the Southern tropical zone are at international standards, and are much higher than those in the Northern sub-tropical zone. Consequently, a tremendous potential exists for increasing productivity in the Northern states, especially in Uttar Pradesh (UP) and Bihar. Area under cane and cane production is the largest in UP and, in 1995-96, production here was 113 million tons – which is the highest in the world after India and Brazil!

Maharashtra follows with a cane production of 44,3 million tons. In the Southern zone, factories have a much longer grinding season, and sugar recovery (the word recovery is used for sugar rendiment, i.e. the amount of sugar as a percentage of cane) in the Western zone is much better than in the other two zones, owing to farmers planting an 18 month crop, versus 9 to 12 months elsewhere.

There are large variations in the usage of sugarcane for production of sugar between the three zones. The majority of cane in the north is used for the production of alternate sweeteners, known as 'jaggery' and 'khandsari', whereas in the Western zone, almost all of the sugarcane is consumed by sugar factories. There is very little second ratoon cane and no third ratoon, and about 55% of cane on an all-India basis, goes for the production of white sugar. Jaggery accounts for roughly 30% and khandsari for about 5% of the total cane grown. Annexure E gives an idea of these disparities, and from it we see that in 1995-96 a much larger proportion of the cane was crushed by the sugar factories. This resulted in factories having to extend the grinding season into the summer months when recoveries were very low. The normal all-India recovery is 10%, and in 1995-96 this was 9,42%. (Statewise recovery figures are also given in Annexure E.)

It is not the agronomic factors but the diversion percentage (that is, the cane diverted away from sugar factories) that is primarily responsible for the fluctuations in sugar production from year to year. Hypothetically, if there was an average recovery of 10% in 1995-96, and if 85% of the cane produced was consumed by the sugar factories, production could have been 21,8 million tons of white sugar against the 16,5 million tons actually produced, i.e. 5,3 million tons more, which is more than the sugar production of all the countries of the world except India

and Brazil. It must be noted that the percentage changes in sugar production are appreciably more than the corresponding changes in sugarcane production. Fundamental to understanding the Indian sugar economy is to appreciate why this phenomenon occurs.

Sugar cycles

The violent swings in sugar production are due entirely to the excessive controls and regulations imposed by the Central and State Governments. Sugar units are not free to deal with the farmers nor the consumers on the basis of market forces, and this has severely affected their ability to generate resources for modernisation and capacity expansion. The industry operates with a dual pricing system for its sugar output. Forty per cent of sugar is procured by the Government for the Public Distribution System (PDS) at a subsidised price, which varies from region to region. In arriving at these prices, the Central Government declares a minimum cane price, and a cost of conversion, which is estimated by its Bureau of Industrial Costs and Prices. Sixty per cent of production can be sold in the open market, but only up to a fixed quantity decided on by Government for each factory each month. When prices rise on the open market, Government releases additional sugar, and when there is a shortfall in domestic production, imports take place almost automatically.

In reality, however, no factory can procure cane at the Central Government minimum price. Factories are forced to pay more for cane, and recover these costs through the sale of 60% of their production on the open market. They must share 50% of this extra realisation with the farmers but, in fact, they are forced to share much more, and at times incur large losses owing to the high actual cane prices. Under the federal structure, state Governments have large powers, and with sugarcane being a politically sensitive subject, these state Governments announce very high State Advised Cane Prices. Over 60% of sugar production in India is controlled by the Co-operative and State Government sugar factories. Operation of these factories is subsidised by the state exchequer, and they are encouraged to pay these high cane prices, setting a precedent which the private mill owners have to follow.

Sugar factories are not allowed to have their own plantations, and they have to deal with a large number of farmers. State laws restrict the land that can be owned by a single individual, with the result that some farmers do not even have an acre of land under cane. Factories in North India deal with as many as 60 000 farmers and, in India, there are over 35 million cane farmers (including their families), and they represent a very important political force. Owing to the fact that private sugar factories in most cases are close to the Co-operative or state Government factories, they are unable to withstand the political pressure of the farmers, and inevitably have to pay the same price as that advised by the state Government.

High cane prices encourage farmers to grow more cane, and the subsequent increase in sugar production brings with it a crash in open market sugar prices. This lowers the price of alternate sweeteners, and these manufacturers then find it difficult to compete with the sugar factories for cane and pay the high state advised sugarcane prices. We therefore see more than the normal quantities of cane coming to sugar factories and a record sugar production is achieved. However, the cycle is soon reversed, as the high cane and low sugar prices affect the viability of the industry, and factories are unable to pay the farmers for their produce for many months. This deters the farmers from planting cane, and there is a drop in cane and sugar production, and an increase in the open market sugar prices. The prices for alternate sweeteners also go up, and the manufacturers are able to pay more for cane, thereby successfully diverting cane away from the factories.

After two years of record sugar production, we will see a sharp drop in the current year. In 1994-95, India produced 14,7 million tons of sugar and in 1995-96, 16,5 million tons. In the current year ending September 1997, production is estimated at 13,0 million tons, and in the coming year it will probably drop below 11,5 million tons. In 1993-94 it was 9,8 million tons. Annexure F shows a graphic representation of the sugar and sugarcane production cycle.

Alternate sweeteners

Jaggery, or 'gur' as it is known in India, is produced in the rural areas, where there is some hard core demand. However, khandsari, the other alternate sweetener, which uses the open pan process of boiling, is extremely inefficient (recoveries some 3-4% lower), and exists only on political incentives and subsidies. Per capita consumption of all sweeteners in 1995-96 in India was 23,3 kg and compares favourably with the world average per capita consumption of sugar of 20 kg. There is a preference for sugar which is increasing over time and, in the past 20 years, the per capita consumption of white sugar has increased from 6 to 14,3 kg (raw sugar equivalent 15 kg) with a corresponding reduction in per capita consumption of alternate sweeteners from 14 to 9 kg. Soft drink, confectionery and biscuit manufacturers and other bulk consumers are adding to the increased demand for sugar. There is very little production of artificial sweeteners such as high fructose corn syrup.

Gur and khandsari producers, and especially the latter, are able to compete with sugar factories for cane, as they do not have to sell any of their gur, khandsari or molasses to the Government at a fixed subsidised price. They are also not subject to any taxes on the purchase of cane or on their final product. In many instances, this more than makes up for the inefficiencies in their production processes, and allows them to pay a higher price for cane than the factoryis able to pay, thereby diverting cane away from the factory.

Sugarcane management

In an Indian sugar plant there are generally two departments. The cane marketing section deals with cane pricing, payments, harvesting, transport, communication and competition from alternate sweeteners. The cane development section deals with

liaison with research institutes, introduction of new varieties, tissue culture, soil testing, management of demonstration plots, training and holding of seminars, plant protection and extension services to farmers. The scope and exact nature of activities of these departments dif fer in the various zones of the country. I shall describe what happens in the state of Uttar Pradesh in the Northern sub-tropical zone.

In UP, the state Government every year reserves a cane area for each factory. Normally a factory gets the same area as the previous year but, when a factory has expanded or a new factory is erected, this area is changed. There is a lot of competition between factories for cane areas, and every year this is the subject of much lobbying and litigation. Although the UP Cane Act lays down certain principles, a good deal of discretion remains in the hands of the Government.

Cane is purchased through cane co-operative societies which have a certain area attached to them. These societies are meant to be democratically elected and to represent the interests of the farmers, but this does not happen in reality. This is the only state in the country where there is no direct link between the factory and the farmer, and it is a major reason why yields and recoveries are lower than in the Western and Southern zones. The potential for a rapid increase in cane yields is the largest in the state of UP. The societies survey the farmers' fields before the grinding season and establish the yield, area and cane availability of both ratoon and plant cane. A calendar (roster) is then drawn up on a fortnightly basis so as to allow for equality in purchases among all farmers belonging to the society. No account is taken of when the cane was planted or its maturity. There are separate calendars for ratoon and plant cane and, for a limited period, preference is given to early maturing, high sucrose varieties of cane. The societies charge a commission on each ton of cane supplied to the factory.

The immediate area around a factory is known as the 'gate' area and is normally meant to cover a radius of 5 kms. In this area all cane is brought to the factory using the farmer's own transport. Normally this is a cart pulled by bullocks and able to carry about 1,5 tons of cane. The more affluent farmers now have tractor drawn trolleys which carry 3-7 tons. Heavy duty trolleys able to carry up to 15 tons have recently come into operation. The farmer is responsible for harvesting the cane, binding it into small lots and arranging transport. The tops are used as fodder, which at times can be in great demand. The area outside the gate area is known as the 'out centre' area. Here, the factory sets up purchasing centres to which the farmer brings his cane. Similar to the gate area, this cane is weighed by factory staff, but the transportation to the mill is arranged and paid for by the factory, usually using contractors' trucks. The farmer receives a lower price when supplying to the out centre than that paid at the gate area.

The factory advises the society of its cane requirement two days in advance, as these requisition slips have to reach the farmers in time. In arriving at this requirement, the factory must have an accurate idea of the balances at all out centres and estimate its crush for the next two days. At the more sophisticated factories cane weighing is computerised, as is the calculation of cane requirements and drawing up of the calendar. These factories also have a databank on the particulars of each farmer. A factory handling 10 000 tons of cane per day can be dealing with 60 000 farmers, eight societies, have 180 out centres and use a fleet of 250 trucks every day.

Although the cane is mechanically harvested, it starts deteriorating after 16-20 hours, especially in hot weather. It is therefore essential to have a system of checks and counter checks to ensure good lifting at the out centres, and to ensure that the farmer does not cut his cane before he is given an indent for the same. Payment is made purely on a weight basis and not on the sucrose content in cane. Mechanical loaders are just starting to be used at the out centres, but harvesting will remain manual for some time.

In the Western zone, the factory is responsible for harvesting all cane and transporting it to the factory. Cane is procured on an ex-field basis and a deduction is made by the factory from the farmers' prices for transporting the cane to the factory. It is therefore possible in the West and South to harvest a farmer's cane according to a maturity survey, and also to control deterioration after harvesting. Harvesting here is done manually by the factories through contract labour. The payment system in the North and South is comprised of a one time payment which becomes due two weeks after supply. In the West payment is made in three instalments, and the final payment can be as long as a year after supply. Sugar factories in the West, and some in the South, provide a variety of inputs such as seed, fertiliser and insecticide to the farmers on loan and recover the cost of the same from them when they supply their cane.

The cane development staff of the factories need to continually survey the cane fields and initiate programmes for insect and/or disease control, and not leave this to the society or the farmers. In many cases, the factories provide fertilisers and other inputs and also advise the farmers on its use relative to different soil conditions. The selection and propagation of new varieties of seed for early, mid and late season has to be done by the factory. Limited help is forthcoming from Government research centres, and many factories have, or are setting up, their own tissue culture laboratories. The treatment of seed and its testing in demonstration plots is an essential ongoing activity. Factories also use newsletters and seminars for disseminating information on good extension practices and factory operations.

Consumption

The per capita consumption of all sweeteners in India is double the Asian per capita average consumption of 12 kg. With its large population, India is by far the largest consumer of sugar in absolute terms in the world. In practice, China is among the lowest consumers with a per capita consumption of 6,5 kg. In the past 30 years, consumption of sugar world-wide increased by 3% per annum. During the same period, consumption in Asia increased by 10% per annum, and in India was 13% per annum.

Certain states in India such as Punjab and Haryana have a much higher per capita GDP than others. These states also have a higher per capita consumption of sugar. Annexure G shows the per capita consumption of sugar and alternate sweeteners in two high income states (Punjab and Haryana) and two low income states (Uttar Pradesh and Andhra Pradesh). The per capita consumption in Punjab of all sweeteners is 44,7 kg which is more than that of the USA (32,5 kg), Canada (40,5 kg) and the EEC (37,6 kg).

There is also a wide disparity in per capita sugar consumption in the rural and urban areas of the country. Seventy per cent of India's population is in the rural areas where the consumption of sugar is low and, in some backward states, the consumption of alternate sweeteners equals or even exceeds that of sugar. Annexure G also gives a breakdown of per capita consumption of sugar in rural and urban areas in the above mentioned four states. From this, we see that the per capita consumption of sugar in the urban areas of Punjab and Haryana is as high as 71,5 and 66,5 kg respectively. This is quite remarkable and shows the future trend of sugar consumption in India.

As income in rural areas increases and as the low income states raise their per capita GDP, the per capita consumption in India can easily reach the consumption levels in developed nations by the year 2010 or shortly thereafter.

Trade

Annexure H gives the position of production and stocks of sugar for the past 11 years and shows the large fluctuations in imports and exports.

The obligation of factories to produce 40% of their sugar for the PDS is a disincentive towards producing good quality sugar. However, in recent years, many factories have improved their standards and are now producing substantial quantities of sugar for export, with some factories producing plantation white sugar of a quality equivalent to EEC grade II, or under the ICUMSA 30 level. If sugar policies are liberalised and there is decontrol of sugar prices and distribution, India could with ease become a regular exporter of over two million tons of white sugar every year. This would be fairly significant in terms of the total world trade in white sugar. If we leave out 5 million tons towards tolling operations, and 3 million tons towards the bilateral and preferential quotas, the world's sugar trade will be around 22 million tons. India could thus account for 10% of this trade, with the proportion of white sugar trade being very much more.

Internally, sugar is sold mainly through agents who then sell to wholesalers and finally to the retailer. By law sugar is to be packaged in 100 kg jute bags which are very bad for preserving quality. A few days before the end of every month, the central Government publishes a list stating how many tons of sugar each factory can sell in the open market during the following month. To prevent speculation, 40% of this monthly quota must be sold by each factory each fortnight. The Government also controls hoarding by the trade by stipulating how much stock they can carry. A small quantity of consumer packs are appearing in the market, but these have to be repacked from the 100 kg jute bags. For export, sugar is packed in 50 kg double-lined polyethylene bags. Unlike other sugar producing nations, the domestic price of sugar in India is very low. Annexure I gives these prices. Among all the nations mentioned, including South Africa, the average domestic price of sugar is the lowest in India.

Co-operative movement and plant capacities

To erect or expand a sugar factory, a license from the central Government is necessary. In the 1960s, Government took a decision that expansions should be restricted and new sugar units must come up in the co-operative sector. In this sector, farmers were asked to contribute a small part towards the share capital, and the majority was subscribed by the state Government. Regional banks and the all-India financial institutions provided the loan funds. Politically, it was, and still is, important for every political leader to have a sugar factory in his or her constituency. While in the early 1960s there may have been some logic in increasing the number of units, as these units served as engines of growth in the rural area, the practice of granting these sugar unit licenses soon became highly discretionary and politicised. To make matters worse, Government announced an incentive scheme for new sugar factories which allowed them to avoid supplying sugar to the PDS at subsidised rates. It thus became more viable to put up a new unit rather than expand the existing one, and this distortion provided the incentive for the proliferation of new units of small capacities. Annexure J gives the state-wise distribution of plant capacities in 1995-96.

These policies have been a major cause of slow technological development in the sugar industry in India. Existing factories were not allowed to expand capacities and there was very little incentive to adopt modern technologies. Low cost of equipment rather than efficiency or quality became the predominant criteria. Of the total sugar units in India today, over 30% are not viable and will eventually be closed down. Some 10% have already closed or are being auctioned by the state Governments and the financial institutions. There are currently 448 sugar factories in India, compared with only about 240 units each in Brazil and China. In all, 649 sugar units have been licensed, although some, of course, will not be erected. If their licensed annual capacities were totalled, the answer would be an astounding figure of an all-India sugar production of 30 million tons.

The minimum capacity for new sugar mills has been set by Government at 2 500 tons cane per day (earlier it was 1 250 tonnes cane per day) despite our financial institutions claiming that viability will only be possible with a plant size of 5 000 tons cane/day and above. All these factories adopt the double sulphitation process, and the specifications for plant and machinery are standardised. There are a few factories in the private sector that have in the past few years achieved a size of 10 000 tons cane/day, and a number of others (including several co-operative units) have been modernised and are now adopting

new technologies. The pace is accelerating, but will increase exponentially only when the industry is decontrolled.

Sugar policy changes

It seems inevitable that Government will have to loosen its control on the sugar industry fairly soon. Almost all other industries in India have been liberalised, and this will happen to the sugar industry as well. Integration into the world trading system is bringing about a shift in India's trade policies, and this must encompass the sugar industry. In the future, the pricing and distribution of sugar will be left to market forces, and this will bring about a radical change in the industry. The sugar industry will also have to be delicensed, and the so-called 'incentive' scheme abolished. Capacities, whether in the form of a new factory or an expansion, will then depend purely on economic considerations.

Government will also not be able to continue subsidising the retail price of sugar, nor force the industry to do the same. Realistic prices for factory sugar will increase the viability of the sugar industry and allow it to pay more for cane, thereby lessening the diversion to alternate sweeteners. Plant capacities will rise substantially, and a number of the weaker units will have to close or merge with their neighbours. In the past few years there has been substantial investment in the private sector sugar industry for upgrading plant capacities and sugar quality levels. Today, India is probably making a larger investment in sugar than any other country in the world, and it will continue to do so for many years to come. The potential for investment is not limited to the manufacture of sugar, but to co-products as well, and the concept of world class sugar complexes is gradually taking shape.

On the agricultural side, two major changes will eventually come about and will greatly improve efficiency. The first will be to allow for payment of cane on the basis of sugar content. Although India has a large number of cane growers, many of whom supply in small quantities, it is still possible technically to introduce this method of payment in most of the units. In some parts of the country, an attempt has been made to set a differential price for the different varieties of cane, especially the high sucrose, early maturing varieties.

The second policy change will be to let factories deal with the farmers directly in all aspects, including selection of seed, pest and disease control, timely application of inputs and adoption of correct sugarcane farming practices. This direct linkage, and a properly devised incentive system, could substantially improve yields and recoveries in large areas of the country. It is clear from the disparities that exist between yield and recovery in the different parts of the country, that this is not due to agronomic factors alone and that substantial scope for improvement exists.

Technology

Sugar factories in India extract juice from sugarcane by means of milling and the number of mills in tandem is generally four or five. The most commonly employed cane preparatory devices are two sets of knives followed by a fixed hammer fibrizor on a swing hammer shredder. There are four to six rollers in each mill. Some mills are working with three rollers and one under-feed roller, while others have three rollers, two pressure feeders and one feed roller. A few factories are working with constant ratio self-setting mills. There is also an arrangement for adjustment of feed and discharge openings provided in the rollers. Most of the sugar factories have steam turbines as mill drives, while some have started using variable speed DC electric motors to save on energy.

New sugar factories are installing high pressure boilers with a 67% efficiency and a pressure range of between 32 and 63 kg/cm^2 g. The boilers have spreader stoker/pulsating grate/inclined water cooled grate furnaces. Membrane wall construction bodies have also been introduced. Multi-stage highly ef ficient steam turbine driven alternators are being installed. Generally 440 V three phase AC supply is generated.

The Indian sugar industry has been under modernisation for more than a decade, with a two-pronged approach. Emphasis is being placed on energy conservation and improvement in productivity (capacity utilisation and recovery), and also on improvement in the quality of sugar produced, particularly with respect to colour.

Extensive vapour bleeding is used on the evaporators to maximise steam economy. Vapour cell followed by quadruple effect evaporator, and double effect pre-evaporators followed by a quadruple effect evaporator are used. Vertical continuous crystallisers and continuous pans have also been installed in the modernisation process. Fully automatic, recycling type high speed batch centrifugal machines are used for high grade massecuites, and continuous centrifugal machines for low grade massecuites.

New technologies such as short retention clarifiers, clarification of syrup and filtrate from vacuum filter and clarification of B and C sugar melt, have great potential. Syrup clarificationand filtrate clarification have been tried in a few sugar mills to improve process efficiency and sugar quality with a reduction in sulphur content. A number of factories have been able to produce plantation white sugar of 60 ICUMSA units.

Apart from the above, the following technological advancements are at the research stage in various research and development institutes:

- Improvement in the pan boiling process with the use of a micro-video project system.
- Application of gas liquid chromatography and automatic absorption spectrophotometry techniques for analysis of sugar.
- High performance liquid chromatography for evaluating sucrose balance.
- Microprocessor based integrated optimum mass flow control system for cane feed to mills.

At those stations where human lapses could affect the working of the factory to a considerable extent, modernisation has focused on instrumentation and automation. Micro-processor controlled automation has been introduced for autocane feed, auto control of imbibition of mills, auto control of boilers to regulate steam flow and air:fuel ratio, auto control of juice sulphitation process, auto control of vacuum pan boiling and automation of batch centrifugals. These systems have been developed locally.

A Sugar Technology Mission has been set up to encourage the adoption of new technologies. Some of the areas currently being looked at include low pressure extraction technology, cane separation system, decanter centrifuge, membrane press, short retention clarifier, electrodialysis and clarification control. By limposing a levy on the production of sugar, the Government established a Sugar Development Fund (SDF) in 1982, which has benefited the industry in a number of areas, particularly the following:

- modernisation of plant and equipment
- cane development
- co-generation
- absorbing interest on a buffer stock of sugar when there is excess production.

Over the past six to seven years, collection and use of SDF funds has increased. To date, over US$700 million has been collected, $350 million has been sanctioned and $300 million disbursed. In a good sugar year, annual disbursements are $30 million.

In India the two main research and training Institutes are the National Sugar Institute at Kanpur in Uttar Pradesh and the Vasant Dada Sugar Institute at Pune in Maharashtra. There are two major agricultural institutes; the Sugar Breeding Institute at Coimbatore in Tamil Nadu and the Indian Institute of Agricultural Research at Lucknow in Uttar Pradesh.

With the imminent change in policies, a substantial scope exists for sugar quality improvement. The double sulphitation process traditionally used in India was adopted for low cost of production, as the Government pays no premium for quality for the 40% sugar it procures. With the expected change in consumer trends and the increasing requirements of the food processing and beverage industries, an improvement in quality consciousness is inevitable. Factories are examining alternate process technologies to replace the existing double sulphitation process. Some factories have tried the use of phosphoflotation for treatment of vacuum filtrates, and are trying a similar process for the treatment of syrup. Although expensive, the adoption of a well designed de-ashing and de-colouring process, with appropriate ion exchange resins, should substantially reduce the ash and colour content in sugar.

The Codex Alimentarion Commission of the FAO has prescribed sugar quality standards which influence international trade. Indian sugar presently conforms to the current Codex standard for plantation white sugar. The Codex standards are being upgraded, and perforce Indian sugar will have to keep pace with this change. Factories will also be looking at the production of refined sugar through the raw sugar route, and also at producing dif ferent varieties of sugar such as Demerara, pharma and golden granulated.

Co-products

The sucess story of Tamil Nadu News Print Ltd (TNPL) has amply proved the viability of using bagasse as a raw material for the manufacture of various grades of paper and newsprint. TNPL is now producing 600 tons of newsprint and writing paper per day, and is by far the largest paper plant in the world that uses bagasse. A number of small paper plants and particle board plants using bagasse also exist in the country. This is very important, as the potential for using timber as a raw material is limited, owing to the forest reserves in India having been depleted to an alarming extent.

Molasses is another important by-product, and is mainly used for the production of liquor and organic chemicals. India has the largest chemical industry in the world that uses sugarcane molasses as a feedstock. An example is a company with an acetic acid production capacity of over 70 000 tons per annum using alcohol from molasses.

There are also substantial capacities of poly vinyl chloride (PVC) and mono ethylene glycol (MEG). Elsewhere in the world, these chemicals are produced via the petrochemical route. There are as many as 108 sugar units with attached distilleries supplementing their requirement of molasses from the neighbouring factories. However, in a liberalised environment, with chemicals being produced from the cheapest feedstock route, it is estimated that by the turn of the century India may have a surplus of 700 million litres of alcohol. There is, therefore, an imperative need to explore the commercial viability of other value-added products using molasses, and to look at mixing alcohol from molasses (and not cane juice) with gasoline. India is a substantial importer of petroleum and petroleum products, and dependence on imports is going to increase quite substantially in the next 10 years.

Co-generation

In the Central Government, there is a separate Ministry for Non-Conventional Energy Sources. With the power generation shortfall estimated at over 85 000 MW in the next 10 years, non-conventional energy sources are being given a tremendous boost by the Government through the use of forward looking policy measures, such as low cost loans, cash incentives and 100% depreciation allowances. This has been extremely successful in the wind energy area, with the largest amount of investment anywhere in the world taking place in India for the past few years. By next year, India will be the second largest producer of wind energy in the world.

A similar or better situation is envisaged in the field of co-generated bagasse based power. By the end of the following grinding season, there will be almost 250 MW of power on

stream. These efforts began only in the past few years, and if the state electricity boards in the major sugar producing states in India are privatised or if their power purchase agreements are deemed to be bankable, there will undoubtedly be a large increase in investment in this sector. It is estimated that over 2 500 MW of this power can be fed into the grid.

Assistance from the biomass based co-generation division of the Ministry depends on the technology being used. More assistance is provided for projects using boilers with pressures of above 60 bars and 450°C temperature. To encourage technical upgrading, all steam saving devices receive 100% depreciation, which means they can be written off in the year of installation. This includes boilers, turbo generators and heat exchangers. One can forecast for the very near future a wide usage of boilers using even higher pressures. Like Okeelanta, boilers using 80 bar pressure and over 500°C temperature will soon be used in sugar units. A number of energy and steam saving measures will be necessary to increase the saving of bagasse so as to provide for larger capacity power plants. Some of these measures are given below:

- Electric and hydraulic drives for the juice extraction plant.
- High pressure boilers of 63 bars and above.
- Use of thermo compressors.
- Use of falling film evaporators/plate heat evaporators.
- Use of efficient continuous vacuum pans.
- Installation of continuous centrifugal machines for curing of all massecuites.
- Energy audit.

It is felt that energy consumption can be reduced to about 250 units from the present average 350 units per ton of sugar produced, and steam consumption can be reduced to 40% from the average of 48% on cane which is the present norm for an efficient new sugar factory. In South India, where lignite is available, boilers are operated either on bagasse or on lignite, and in the North and West, the alternate fuels are coal or furnace oil. It has been found, however, that at very high pressures it is difficult to fire bagasse and the secondary fuel simultaneously, while preserving efficiency.

Technology in power generation equipment is also improving fiarly rapidly. For turbo generators with capacities as low as 20 MW, a modular concept is being used, with separate high and low pressure rotor sections. In the past this was possible only in turbo generators with much higher capacities. Flexibility for single and double extraction, ease of operation and a substantial reduction in costs, makes this equipment, used earlier only in large utilities, suitable for modern sugar co-generation plants. Their steam consumption is very low and, with 80 bar boilers, future steam consumption as low as 35 kg per ton of cane is certainly possible. This technology would result in an excess energy production of around 90 kWh/ton of cane crush. Some work is being done on advanced gasification/gas turbine technology to dramatically increase excess energy to around 250 kWh/ton of cane, although results are not expected in the near future.

Using current technology, co-generation schemes in India can be installed for US$0,7 million per MW of co-generated power. On an incremental basis, this cost may drop below $0,6 million per MW. Various methods of bagasse drying to reduce the moisture content, and newer technologies such as the Swirl Burner from Australia, which reduces moisture content to as low as 15-20% on cane, will also add to the viability of co-generation projects.

A key factor is grid synchronisation and grid stablity. It must be ensured that coupling the co-generation plant to the grid does not affect sugar plant operations. Various isolation devices have been analysed, and these are operating effectively in the state of Tamil Nadu in South India, where the majority of the co-generation capacity has so far been established. The price paid by the state electricity boards to sugar plants for power is US6,5 cents per unit, but it is hoped that this will rise to 7,5 cents fairly soon. This is a reasonbly good rate, as the sugar plant is under no obligation to provide uninterrupted power supply all year round. In some cases, more profit is being made in the co-generation part of the unit than in the factory itself.

There is a move for sugar factories to establish these co-generation facilities as separate units. A utility would establish the power plant near the sugar factory and supply power to the grid. It would purchase bagasse from the sugar unit and supply the unit with electricity and steam. New boiler and turbo-generator units would be set up and owned by the utility, and the factory could retain its old units as standby, or dispose of the same. This utility concept is especially viable in states which allow for the wheeling and banking of power. In these states utilities are allowed to supply power to the grid at one location and use it at another, even where this location is as far as 1 000 miles away. The user need not be the same corporate entity as the producer, and the electricity board takes only 2% of the power transmitted as its charge for this wheeling facility.

Forecasts for the the Indian sugar industry

It is estimated that the Indian economy could grow at an average rate of over 7% per annum, with a growth rate of 8% also being attainable. The Government of India has formulated projections for its 9th and 10th Five Year Plan up to 2006-2007. As per these plans the drawal of cane by sugar factories would increase to 65% on an all-India basis by the end of the 9th plan, and the average yield per hectare should reach 75 tons. With these assumptions, the Government is forecasting sugarcane production of 300 million tons in 2001-2002, with sugar production of 19,5 million tonnes. This will go up to 381 and 25,3 million tons respectively in 2006-2007.

The area under sugarcane is forecast to increase from 3,9 to 5 million hectares in 10 years. Per capita consumption of sugar is estimated to reach 18 kg in 2001-2002 and 21,8 kg by 2006-2007. This will require 17,3 and 24 million tons of sugar respectively. The present population growth of 1,7% per annum has been used in the projections.

It may be interesting to know that when the 8th Plan was prepared, the 1995-96 sugar production was estimated at 14,1 million tons versus the 16,5 million actually achieved, and the area under cane was actually 3,9 million hectares versus the estimated 4,3 million hectares. It is probable that in the future also, production will be far higher than the levels forecast by the Government. I do not see a substantial drop in the population growth rate in the next few years, although I am hopeful that it will drop to 1,5-1,2% after 2010-2020.

An enormous potential exists to increase cane yield and recoveries in the sub-tropical zones of India, particularly in the states of Uttar Pradesh and Bihar. The difference between yields in demonstration and commercial plots is over four-fold. Sugar recoveries also have the potential to increase by almost 1% over the levels being achieved today, through the usage of improved cane varieties, better harvesting and transportation techniques, and improved factory equipment and processes. Neither a recovery of 11% nor a sugarcane productivity of 80-85 tons per hectare is beyond reach.

I feel that the targets in the Government's 10-year plans can be exceeded with the inevitable loosening of Government control, and increased participation by the private sector in both the growing and processing of sugarcane. The total sugarcane requirement for 2005 can easily be met without having to commit much additional area to cane cultivation. A conservative estimate would be 4,5 million hectares, and we may even get away with 4,2 million hectares. It is also my belief that sugar consumption, especially in the urban areas, will increase at a faster rate than that forecast by the Government. Keeping these factors in mind, I see the following likely scenario for 2006-2007:

- Area under sugarcane : 4,5 million hectares
- Cane yield : 82 tons per hectare
- Cane production : 370 million tons
- Availability to sugar factories : 247 million tons
- Sugar production : 27 million tons
- No of factories : 400
- Domestic sugar consumption : 24,5 million tons
- Exports : 2,5 million tons.

To raise production from last year's 16,5 to 27 million tons (i.e. an increase of 10 million tons in 10-11 years) is quite a task, but I feel there is a good chance of this happening if the Government liberalises the industry soon. This will require an investment of some US$2 billion and, along with investments in co-generation, ethyl alcohol for motor fuels and bagasse based paper, total investment will be over US$3 billion.

Sugar is an industry where India has a comparative advantage in the world economy and, with the benefit of a large consumption and production base and the expansion mentioned above, there is in India today tremendous scope for virtually every type of technology, process or equipment available.

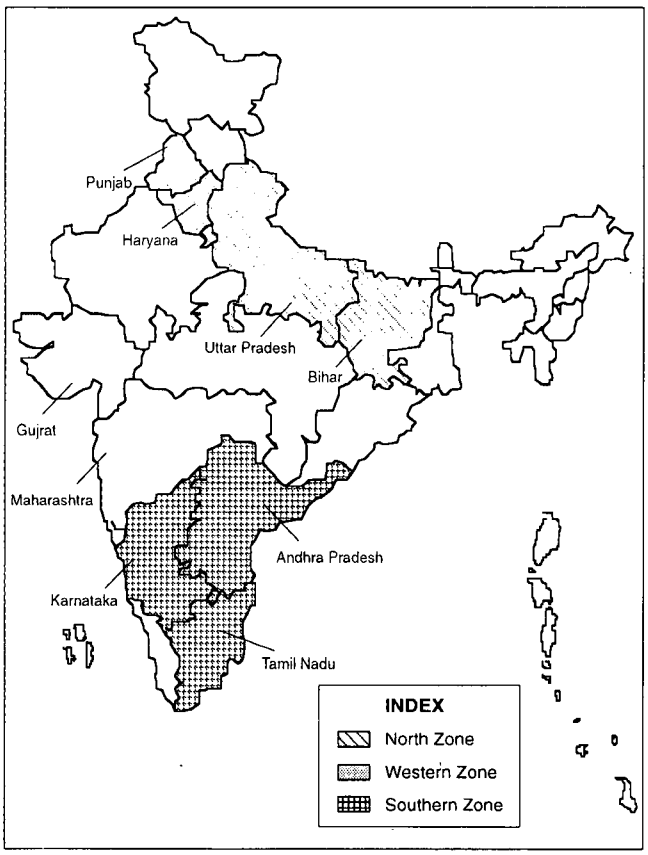
ANNEXURE A
Importance of the sugar industry to the Indian economy.

Number of sugar units installed	448
Number of growers, including dependants (7% of rural population)	35 million
Average number growers supplying cane to each sugar unit	20 000
Annual payments to cane growers	US$3 000m
Annual value of sugar production	US$5 000m
Annual wage bill	US$375m
Annual contribution to central exchequer	US$325m
Annual collections by state Governments	US$175m

ANNEXURE B
Area under cane, cane yield and cane and sugar producton in the Indian sugar industry, 1930-31 to 1995-96.

Year	Cane area (million ha)	Yield (t/ha)	Cane production (million tons)	Sugar production (million tons)
1930-31	1,2	30,9	36,4	0,1
1940-41	1,6	32,1	52,0	1,1
1950-51	1,7	40,5	69,2	1,1
1960-61	2,4	45,0	110,5	3,0
1970-71	2,6	48,3	126,4	3,7
1980-81	2,7	57,8	154,3	5,1
1990-91	3,7	65,4	241,1	12,0
1995-96	3,9	68,0	267,4	16,5

ANNEXURE C
The sugarcane zones of India.



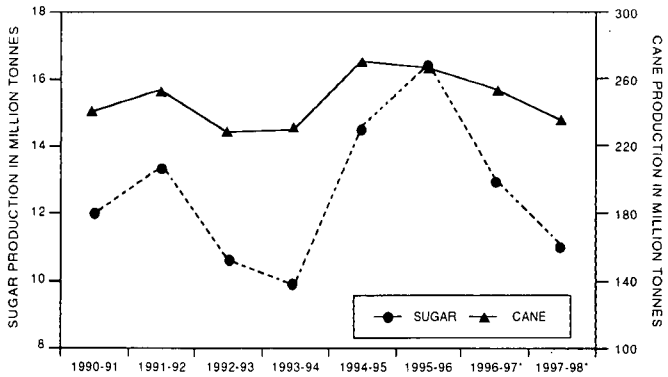
ANNEXURE D
Area under cane, cane yield and cane and sugar production in the different zones/states in India, 1995-96

Zone/State	Cane area (000 ha)	Yield (t/ha)	Cane production (million tons)	Sugar production (million tons)
NORTH				
Uttar Prodesh	1 930	59	112,8	4,4
Bihar	123	46	5,7	0,4
Punjab	131	70	9,2	0,6
Haryana	146	52	7,5	0,5
Total	2 330		135,2	5,9
WEST				
Maharashtra	540	82	44,3	5,4
Gujarat	140	70	9,8	1,1
Total	680		54,1	6,5
SOUTH				
Tamil Nadu	294	97	28,4	1,6
Karnataka	265	104	27,6	1,3
Andhra Pradesh	203	71	14,4	0,9
Total	762		70,3	3,8

ANNEXURE E
Regional recoveries and consumption of cane by Indian sugar factories.

Zone/State	Recovery (%)		Cane consumption by factory (%)	
	1995-96	1994-95	1995-96	1994-95
NORTH				
Uttar Pradesh	8,68	9,40	48	36
Bihar	8,81	9,10	73	72
Punjab	8,88	9,13	77	68
Haryana	8,35	9,10	66	53
WEST				
Maharashtra	10,48	10,92	95	93
Gujarat	10,48	11,65	93	70
SOUTH				
Tamil Nadu	8,33	8,68	74	60
Karnataka	9,80	10,30	70	51
Andhra Pradesh	9,51	9,43	71	58
All-India	9,42	9,92		

ANNEXURE F
Cane and sugar production trends in India. Figures for 1996-97 and 1997-98 are estimates.



ANNEXURE G
Per capita consumption of sugar and alternative sweeteners in selected states in India.

States	Sugar (kg)	Alternate sweeteners (kg)	Total (kg)
Punjab	33,7	11,0	44,7
Haryana	26,9	10,0	36,9
Uttar Pradesh	12,5	15,0	27,5
Andhra Pradesh	10,3	8,6	18,9
All-India	14,3	9,0	23,3

ANNEXURE G (continued)
Comparison of per capita consumption of sugar between urban and rural areas in India.

States	Urban (kg)	Rural (kg)	Total (kg)
Punjab	71,5	22,2	33,7
Haryana	66,5	18,5	26,9
Uttar Pradesh	35,2	10,4	12,5
Andhra Pradesh	19,7	9,9	10,3
All-India	31,5	11,5	14,3

ANNEXURE I
Domestic retail price of sugar in India and various other countries, 1995-96.

Country	Price equivalent (Rs/kg)
Japan	66,00
Switzerland	38,00
France	36,00
United Kingdom	33,00
Hong Kong	32,00
Germany	31,00
Sweden	31,00
South Korea	29,00
USA	28,00
China	22,00
Bangladesh	22,00
Nepal	21,00
Australia	21,00
Indonesia	21,00
South Africa	20,00
Philippines	19,00
Sri Lanka	18,00
Thailand	18,00
Malaysia	16,00
Brazil	15,00
INDIA	12,00
PDS	9,05
Free	14,00
Average	26,00

Rs36 = US$1,00 Rs7,68 = R1,00

ANNEXURE H
Supply and demand position of Indian sugar, 1986-87 to 1995-96.

	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96
Opening stock as at 1 Oct	1,9	2,7	2,4	1,2	2,2	3,3	4,9	3,2	3,1	5,6
Production during season (Oct-Sept)	8,5	9,1	8,7	10,9	12,0	13,4	10,6	9,8	14,6	16,4
Imports	0,9	0,1	–	0,2	–	–	–	2,0	0,2	–
Total availability	11,3	11,9	11,2	12,3	14,2	16,7	15,5	15,0	17,9	22,0
Internal consumption	8,7	9,4	9,9	10,2	10,7	11,2	11,9	11,9	12,3	13,1
Exports	+.+	+.+	+.+	+.+	0,2	0,6	0,4	+.+	0,1	1,0
Off-take	8,7	9,4	9,9	10,2	10,9	11,8	12,3	11,9	12,3	14,1
Closing stock as at 30 Sept	2,6	2,5	1,3	2,1	3,3	4,9	3,2	3,1	5,6	7,9
Stock as % of off-take	29,9	26,6	13,1	20,6	30,3	41,5	26,0	26,0	45,5	55,9

+.+ = negligible, only preferential quota

ANNEXURE J

Capacity of installed sugar units in different states in India, 1995-96.

State	Below 1 250 t cane/day	1 251 to 2 500 t cane/day	2 501 to 5 000 t cane/day	5 001 to 9 000 t cane/day	10 000 t cane/day	Total number of factories
TROPICAL REGION						
Andhra Pradesh	7	27	3	1	–	38
Gujarat	–	13	5	1	1	20
Karnataka	2	23	5	1	–	31
Maharashtra	2	88	22	–	–	112
Tamil Nadu	1	26	8	–	–	34
Total	12	176	43	3	1	235
SUB-TROPICAL REGION						
Bihar	15	13	1	–	–	29
Haryana	–	11	-	–	1	12
Punjab	1	20	1	–	–	22
Uttar Pradesh	22	74	15	5	2	118
Total	38	118	17	5	3	181
Others	13	19	–	–	–	32
All-India	63	313	60	8	4	448