Appendix - A : Note on the Pulp and Paper Sector in India

In the pulp and paper sector, to start with, we take a look at a brief overview of the sector. Next we turn to the historical development of the industry and follow it up with the industry structure that prevails in this sector. Technology and manufacturing process are important while reviewing any sector and we look into that as well. Demand-supply, import-export aspects follow next. Paper prices, raw material use have also been dealt with. International status and key monitorables within the sector completes the review.

Indian paper industry is broadly classified into paper and paper boards and newsprint. The paper and paper board segment constitutes of cultural paper, industrial paper, special paper. Newsprint is a separate type of paper.

Paper industry in India has a long history with the first mill being commissioned in 1832. The number of paper mills have increased from just 17 in 1951 to 325 by 1991.

The Indian paper industry is extremely fragmented. This industry structure is the result of the past Government policies which encouraged the setting up of many small mills with as low capacity as 1 ton per day. These capacities are nonviable in today's competitive world.

The main constituent of paper is cellulose. It is usually produced from wood, waste paper, bamboo, agro-residue like bagasse, jute, straw etc. These materials are not available indigenously in adequate quantities resulting in large scale imports of paper pulp which is then used to manufacture paper.

Paper manufacturing is a highly capital and energy intensive industry. The manufacturing process demands considerable material handling skills as very large quantities of raw materials are used as input. Paper manufacturing is also a highly polluting process and requires substantial investments in pollution control equipment.
Typically, a grass-root paper plant costs about Rs. 50,000 to Rs. 120,000 per ton of capacity.

Domestic paper demand has increased from 2.8 million tpa in 1995-96 to 3.05 million tpa in 1997-98 at a CAGR of 4.4%. The industry is characterised with a closed or dead capacity of 1.1 million. In the last few years, imports have increased substantially from 102,000 ton in 1996-97 to 300,000 ton in 1997-98, leading to increased pressure on domestic production margins.

The domestic demand for paper and paper board is expected to increase from 3.05 million ton in FY98 to 3.6 million ton in FY2001 at a CAGR of 6%. Among the various sub-segments, paper boards is expected to grow above the industry average growth rate, leading to an increase in its share within the paper industry. The industry will continue to have dormant capacity situation leading to capacity utilisation levels of 85 to 90% of operating capacity in the coming years.

Domestic paper prices are linked to international prices. Hence, paper prices in India are very much dependent on the international demand supply situation for paper and therefore the fortunes of the Indian paper industry are largely externally driven.

Raw material consumption constitutes 40 to 60% of total cost of paper production. The major raw materials used for production of paper are: wood, bamboo, waste paper, bagasse, caustic soda, chlorine, power/steam etc.

The persistent shortage of fibrous raw material in the country will lead to continued dependence on imports. In the long term, with proper government policies, the use of semi-arid land for commercial plantations will help in bridging the gap in the supply of fibrous raw material.

We take a look at the different types of paper:
a) Cultural paper

It is mainly used for writing and printing. Demand for this paper arises from educational, printing, corporate and government sectors. This paper accounted for very high percentage of total paper demand in the initial years of economic development. The share has gone down with economic growth. It accounts for nearly 46 per cent of total paper demand. Demand for writing and printing paper has reduced recently mainly due to lower off-take from government, corporate sector (due to poor industrial performance) and poor capital market conditions. Future demand depends on per capita income, literacy rates and growth of the services sector. The growth of information technology was expected to have major adverse effect on the demand for paper especially cultural paper. However, we estimate it to be a long term impact in a phased manner. Further, very low per capita consumption of paper in India, gives little chance for this pessimism.

b) Industrial paper

Industrial paper is used by industrial sector mainly for packaging. Main varieties of this are Kraft paper, Paperboard etc. Industrial paper is used for the production of corrugated boxes, composite containers, multi wall paper sacks, carton, wrappers and bags. Among the other alternatives of packaging like jute, plastic etc. paper has preference in branded consumer goods packaging where attractive, colourful packaging is used as a competitive edge. Industrial paper accounted for 48 per cent of the total paper demand. The major boost in demand is coming from paper board segment which finds major application in consumer goods packaging which is growing very fast. Future demand for kraft paper depends on overall industrial growth whereas that of paper board demand is more linked to the demand for consumer goods.

c) Speciality paper

This includes a wide range of special purpose papers such as security paper, grease proof paper and electrical grades of paper. It accounted for the balance 6 per cent of the total paper demand. It is also one of the fastest growing segments of the paper industry with a growth rate of around 10-12 per cent.
Historical Industry development

Indian paper industry is classified broadly into two categories - paper and paper boards and newsprint. The paper and paper board segment constitutes of cultural paper, industrial paper, special paper.

Paper industry in India has a long history with the first mill being commissioned in 1832. The number of paper mills in the past with average capacity is as given in Table-A.1 below.

Table - A.1 : No. of Paper Mills and their capacity

<table>
<thead>
<tr>
<th>Year</th>
<th>No. of Mills</th>
<th>Inst. cap. (million.)</th>
<th>Average-cap</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-51</td>
<td>17</td>
<td>0.137</td>
<td>8,050</td>
</tr>
<tr>
<td>1970-71</td>
<td>55</td>
<td>0.768</td>
<td>13,500</td>
</tr>
<tr>
<td>1980-81</td>
<td>137</td>
<td>1.816</td>
<td>11,500</td>
</tr>
<tr>
<td>1990-91</td>
<td>325</td>
<td>3.304</td>
<td>10,000</td>
</tr>
</tbody>
</table>

The initial development and growth of paper industry till the early nineteenth century was affected by the shortage of wood (soft wood) in the country. But, in 1914, the development of a process based on bamboo lead to rapid growth of domestic industry.

By the end of the sixties, the capacity for paper production lagged demand and imports increased to approximately 10% of the domestic demand. Most of the domestic production was concentrated in the hands of a few large mills. By the late sixties, bamboo as an input to paper industry came under short supply. Taking this into account, the Government of India started encouraging small units based on agro- residue and waste paper in the seventies. Fiscal incentives were also offered. This lead to a spurt in the number of mills with small capacities. But from the late eighties, industry started facing an over supply situation, lower price realisation and plant closures. The down trend continued till 1992, when demand-supply situation improved. From 1993, in step with the easing of the world-wide recession in the industry, investments started increasing. A booming capital market also helped in raising money for new capacities. The industry was in a jolly mood up to 1996. The increase in supply coupled with a world-wide recession has pushed the Indian paper industry back into down trend. The global cycle was further affected by the Asian crisis which has reduced demand considerably. Since 1990 the paper industry in India, is following global cycle with periods of over capacity.
leading to drop in paper prices, lower capacity utilisation and slow down in investments / capacity addition, followed by closure of mills, decrease in demand-supply gap and then back full circle to an increase in paper prices.

Industry structure

The paper industry structure is largely a result of the government policies of yesteryear. The major government policies and their impact on paper industry is given in the Table-A.2 below.


<table>
<thead>
<tr>
<th>Policy</th>
<th>Purpose/Objective</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper control order (1974)</td>
<td>Ensure availability of paper to priority sectors at reasonable prices. Eg. education sector</td>
<td>Profitability was affected but paper was made available to educational sector at concessional rates.</td>
</tr>
<tr>
<td>National Forest Policy (1988)</td>
<td>To retain adequate forest cover of the country</td>
<td>Shortage of wood</td>
</tr>
<tr>
<td>Low import duties on wood pulp &amp; chips</td>
<td>To provide raw material at lower rates.</td>
<td>Excise Duty changes</td>
</tr>
<tr>
<td>To encourage usage of non-conventional raw materials as input.</td>
<td>Benefit to larger mills, higher import bill.</td>
<td>Industrial structure was influenced with more number of small players.</td>
</tr>
<tr>
<td>Higher import duty on waste paper</td>
<td>To reduce import bill.</td>
<td>with increased raw material cost, small units were put at disadvantage</td>
</tr>
<tr>
<td>Pollution control Norms</td>
<td>To prevent pollution.</td>
<td>Small units which do not have effluent treatment technology are at disadvantage.</td>
</tr>
</tbody>
</table>

Indian paper industry is extremely fragmented. As per some estimates the industry is having approximately 1000 small, unorganised players with a production capacity of 1 ton per day.

Paper mills are classified as large and small mills based on installed capacity. The mills with an installed capacity of more than 33,000 tpa are classified as large mills and
those having a capacity less than 33,000 tpa are classified as small mills. The classification on the cut-off tonnage of 33,000 tpa is based on presently available technology, capacity of paper machines and other supplementary processes like cogeneration plant, chemical recycling facility etc. With the development of new technology and larger paper machines, the cut-off tonnage may change over a period of time.

**Technology and manufacturing process**

The main constituent of paper is cellulose. It is naturally available in wood, cotton, and in agro-residues such as bagasse, jute, mesta, and straw. Cotton though easily available in the country is too expensive to be used for producing paper.

Paper manufacturing process is fairly simple and the technology is easily available in the country. The different equipment/technology suppliers in India are:

1. L&T
2. Eicher
3. Servall Engineering Ltd
4. Jessop & Co
5. Mechano Paper Machines

All the equipment suppliers in the country have a tie-up with foreign technology majors.

Paper manufacturing is highly capital and energy intensive. The manufacturing process demands considerable material handling skills, as very large quantities of raw materials are used as input.

The capital costs for paper industry vary significantly across units based on product mix of the company, choice of plant and machinery, availability of infrastructure, type of raw material used, make or buy decision for paper pulp, technology tie-up, differences in equipment configurations, etc. The capital cost for setting up a green field
project varies between Rs. 50,000 to Rs. 120,000 per ton of production capacity. But the capital cost for the expansion or modernisation of existing production facilities is much lower - about Rs. 30,000 per ton. (end 1998 prices). The process is not directly scale intensive, but large capacity units derive advantage by setting up co-generation plant, chemical recovery plant and through operational efficiency and flexibility of product mix.

The conversion of wood or agro-residues into paper involves three stages:

- conversion of wood into wood pulp
- wood is sized through steps such as removing bark and chipping the wood into small bits,
- cellulose fibres are separated from the matrix of lignin (the glue holding the fibres of wood together)

Preparation of the furnish for paper: The pulp is cut and beaten by making use of Jordan engine, so as to provide strength, opacity and surface finish.

Converting into paper: At this stage actual arranging of fibres in to sheets of paper is carried out and is dried. The most commonly used processes for paper making are - cylinder machines and four-drinier.

Location of paper units is primarily influenced by proximity to sources of raw material and water. eg: Mysore Paper Mills and Seshasayee Paper are located near river beds; many bagasse based mills are concentrated near sugar mills to make use of bagasse produced as a by product in the manufacture of sugar.

Paper manufacturing is a water intensive process with an average requirement of 225 to 250 cubic meters of water per ton of paper produced. It is mainly used during the washing stage of the pulping process.

The quality of paper is dependent upon the extent to which cellulose is freed from lignin during the pulping stage. Lower the lignin better is the quality of paper. The de-
lignification is carried out by one of three methods viz. mechanical pulping, chemical pulping and semi-chemical pulping. Mechanical pulping is the cheapest and commonly used process, but yields the poorest quality of paper. Chemical pulping, in spite of being expensive is used to produce high quality paper. Semi-chemical pulping stands in between the two processes, in terms of both quality and cost.

Paper manufacturing is highly polluting. Discharge of process water contains toxic pollutants like bark, fibres, wood debris, lignin and other suspended solids. Air pollution also takes place at the pulping stage with the release of toxic gases containing oxides of sulphur and nitrogen and the release of nitrogen & carbon oxides by burning of coal to produce steam. The setting up of water treatment plants and chemical recovery systems is economically feasible only for large plants. Therefore, with the stricter enforcement of pollution control norms by the Government of India, many small firms are finding it difficult to continue operations.

The cost of production for small paper mills is higher than that for large mills. The latter get the benefit of lower energy cost by using co-generation facility, chemical recycling, etc. The benefit of lower fixed cost (capital cost) per ton of installed capacity for small paper mills is more than made up by higher variable operating cost. Further small units are also more polluting.

**Demand-supply, Import-export**

Demand for paper is strongly correlated with trends in GDP growth and increase in per capita income (PCI). According to studies conducted by the UN, the demand for paper increases by around 1.5-2.5% for every 1% increase in PCI. This holds good even for India in the higher range in spite of year on year variations in demand growth. Demand for paper is also influenced by other factors like literacy rate, growth of service sector, advancement of printing technology in the country, development of paper-less transaction, development of packaging industry, acceptability of substitutes, etc.
Different types of paper along with their usage, constitution of total demand and expected growth rate is as given in Table-A.3 below.

<table>
<thead>
<tr>
<th>Type of paper (% of total consumption) Main varieties</th>
<th>Applications</th>
<th>Expected growth rate 1999 - 2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultural paper (46%) cream woven, maplitho, bond paper, Chromo paper</td>
<td>textbooks, notebooks, office stationery</td>
<td>5-7%</td>
</tr>
<tr>
<td>Industrial paper (48%) kraft paper</td>
<td>wrappers, corrugated boxes, liners, sacks and textile tubes</td>
<td>6-8%</td>
</tr>
<tr>
<td>paper board-single layer board, multi-layer board, duplex board, chromo-board (one side coating), art board (two side coating)</td>
<td>packaging of pharmaceuticals, cigarettes, match sticks, hosiery, food liquor, fruits juices, edible oils, engineering products,</td>
<td>10-11%</td>
</tr>
<tr>
<td>Specialty paper (6%) security paper, grease proof paper, electrical grades of paper</td>
<td>currency, wrappers, labels</td>
<td>10-12%</td>
</tr>
<tr>
<td>Newsprint glazed, non-glazed</td>
<td>Printing of newspapers and magazines</td>
<td>6-7%</td>
</tr>
</tbody>
</table>

The domestic paper demand in the past has increased from 2.8 million tpa in 1995-96 to 3.05 million tpa in 1997-98 at a CAGR of 4.4%.

The future demand for paper can be estimated by two methods:

1. Estimating demand growth for each sub segment in the paper industry to arrive at total demand for each segment. The demand estimates for individual segments are then added together to arrive at demand for the total paper industry. This is a very tedious process and the demand estimation based on this method may go wrong if the assumption about growth for particular type of paper differs from actual growth. Also this error is cumulated over the years for which demand estimation is carried out. The correlation between growth in GDP and paper demand is used to arrive at demand for paper industry. This is a much easier method to arrive at over all demand for the paper industry. But it cannot be used to estimate demand for different types of paper. Estimations using such mathematical techniques on macro economic data have often been found to be inaccurate.
2. Using the second method, the demand for paper is expected to grow at a CAGR of 6% for the next three years (1998-2001) with the assumption that the GDP will be growing at a rate of 5 to 6% for the corresponding period. Therefore the domestic demand is estimated to increase from 3.05 million ton in FY98 to 3.6 million ton in FY2001.

Certain user industries like FMCG, pharmaceuticals, etc. are expected to grow at a relatively higher rate. The increasing usage of packaged and branded consumer goods is expected to add momentum to the use of paper board packaging. The demand for paper board is therefore expected to grow at between 10 to 11% i.e. much higher than the overall industry growth rate.

The higher than industry average growth rate for paper boards will lead to a reduction in the share of cultural paper in the total industry demand. Per capita consumption of paper & paper board in India at 3.2 Kg is very low compared to other developing countries like China (17.2 Kg), Brazil (28 Kg) for the year 1993. Therefore despite the threat of ‘paperless’ transaction; scope for paper demand appears to be bright.

Supply

The major producers of paper in the country along with their installed capacities as on March 31, 1998 is given in the following Table-A.4

<table>
<thead>
<tr>
<th>Major players</th>
<th>Cap. in tpa (FY98)</th>
<th>Product mix</th>
</tr>
</thead>
<tbody>
<tr>
<td>AP Paper Mills</td>
<td>98,500</td>
<td>creamwove, maplitho, kraft</td>
</tr>
<tr>
<td>Ballarpur Industries</td>
<td>198,368</td>
<td>maplitho, creamwove, bond, others</td>
</tr>
<tr>
<td>Hindustan Paper Corpn</td>
<td>200,000</td>
<td>creamwove</td>
</tr>
<tr>
<td>ITC Bhadrachalam</td>
<td>1,82,500</td>
<td>duplex board, maplitho, kraft</td>
</tr>
<tr>
<td>JK Corporation</td>
<td>75,500</td>
<td>maplitho, bond, art board, security paper, MG poster</td>
</tr>
<tr>
<td>Orient Paper &amp; Industries</td>
<td>161,000</td>
<td>creamwove, kraft, maplitho, duplex board</td>
</tr>
<tr>
<td>Sinar Mas</td>
<td>110,000</td>
<td>coated writing &amp; printing paper.</td>
</tr>
<tr>
<td>West Coast Paper Mills</td>
<td>119,750</td>
<td>creamwove, maplitho, kraft, MG poster</td>
</tr>
</tbody>
</table>
Though the installed capacity of the industry is high, the actual production in the paper mills is dependent upon factors like down time required while varying the product mix, operational efficiency, etc. The variation in grammage (weight) of paper produced also has a prominent role in determining the capacity utilisation levels of the plant as production of lower grammage paper can lead to higher production from the same machine and hence higher capacity utilisation.

The capacity utilisation levels for paper industry have been range bound between 50 to 60% except for early 1970s and 1995. The low capacity utilisation was due to large proportion of closed capacity (1.1 million tpa) in the industry because of non-availability of raw material. Adjusting for closed capacities the capacity utilisation levels for paper industry have been much higher at 85% and above.

The major players in different types of papers is as given below. Some of the players have created a very strong brand name within a particular segment and are able to command a premium price for their product as compared to the competitors. e.g. in bond papers, BILT commands a premium for its brand "executive bond" which has become a generic name as seen in Table-A.5 below

<table>
<thead>
<tr>
<th>Type</th>
<th>Major Co.s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creamwove</td>
<td>HPC, Orient, BILT, AP-Paper, TNPL, small regional players</td>
</tr>
<tr>
<td>Kraft paper</td>
<td>ITC Bhadra, Orient, Nath Pulp, Rama Pulp&amp;Paper</td>
</tr>
<tr>
<td>Mapitho</td>
<td>BILT, JK Corpn., AP Paper, West Coast,</td>
</tr>
<tr>
<td>Speciality paper</td>
<td>BILT, Pudmujee Pulp, Shree Vindhya</td>
</tr>
<tr>
<td>Coated duplex board</td>
<td>Balakrishna, NR Agarwal, Rollatainers</td>
</tr>
<tr>
<td>LWC duplex board</td>
<td>NR Agarwal, Jayant Paper, Rohit Pulp</td>
</tr>
<tr>
<td>Uncoated duplex board</td>
<td>ITC Bhadra, Orient, Seshasayee, small regional players</td>
</tr>
</tbody>
</table>
**Paper prices**

Paper prices vary based on type of paper, grammage of paper, brand, quality etc. Usually, prices of paper of comparable qualities don’t differ across most producers. But prices of cheaper varieties of paper fluctuate widely as they are supplied by small players who adjust production based on realisation levels.

The sharp increases in prices by paper manufacturers in past shows that users shift to other substitute product or lower quality or grammage. For example the note book manufacturers shift to lower quality paper when the prices of writing paper is increased. Therefore the paper producers have to be very cautious in deciding about the increase in prices of paper.

After liberalisation, paper prices are more driven by international prices as imports are allowed freely at much lower customs duty. Domestic producers were forced to keep prices down in 1993 and again in 1998 in line with low international paper prices.

<table>
<thead>
<tr>
<th>Type of paper</th>
<th>Price Rs'000/ ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kraft</td>
<td>22-25</td>
</tr>
<tr>
<td>Duplex Board</td>
<td>25-28</td>
</tr>
<tr>
<td>Maplitho</td>
<td>28-32</td>
</tr>
<tr>
<td>Creamwove</td>
<td>27-29</td>
</tr>
<tr>
<td>Chrome Paper</td>
<td>33-35</td>
</tr>
<tr>
<td>Bond</td>
<td>38-40</td>
</tr>
</tbody>
</table>

**Raw materials**

Raw materials account for nearly 40 to 50% of the total cost of production for paper. The cellulose fibre sourced from softwoods, bamboo, agro-residues or from recycled waste paper, is the major input for paper. The product mix of a company is a major factor in determination of choice and mix of raw materials. eg. newsprint and industrial paper can be produced from waste paper and agro- residues but maplitho production requires virgin wood pulp.

The restriction in availability of forest based raw materials along with favourable government policy towards alternative sources of raw material has forced industry to shift towards bagasse and waste paper as sources of fibre.
The shortage of raw material has already become a driver for take over activity in the industry, with acquirers looking to control units having captive raw material supply. Take over activity is further fuelled by the fact that capital cost per ton for expansion of existing facility is almost half the cost needed to set up a green field project.

The industry is likely to face a serious shortage of domestic forest based wood material by year 2001, if it does not shift to other sources for cellulose fibre inputs. As per NCAER study, the demand for wood from paper industry is expected to increase from 3.2 million tpa in 1991 to 7.6 million tpa in 2000, with supply remaining stagnant at present levels.

Fibre

The quality of paper produced is very much dependent upon the quality and proportion of raw material used (e.g. the higher the recycled paper content used as input, lower the strength of paper). The range of input ratio for per ton of pulp produced is as given in Table-A.7 below. The input-output ratio for pulp to paper is between 0.9 - 1.1 units of pulp to produce 1 unit of paper. The actual input-output ratio varies in a range, based on equipment used, origin of fibre and paper quality. Wastepaper is used during the de-inking process in the ratio of 1-1.3 ton of wastepaper for every ton of paper produced.

<table>
<thead>
<tr>
<th>Type of input</th>
<th>Ton of input for ton of pulp production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>1.5-3.0</td>
</tr>
<tr>
<td>Bamboo</td>
<td>2.6-2.7</td>
</tr>
<tr>
<td>Bagasse</td>
<td>5.0-6.0</td>
</tr>
<tr>
<td>Straw</td>
<td>2.5-3.5</td>
</tr>
</tbody>
</table>

Some times, paper manufacturers are forced to deviate from their pre planned raw material mix due to constraints of availability, quality and price of raw material. This has an impact on the quality of the output.

With the restricted availability of soft wood pulp in the country, the dependence of the paper industry (especially large mills) on imported pulp has been increasing at accelerated rates. This trend is expected to continue in the future with most new capacities based almost entirely on assumptions of imported pulp.
The royalty rates for wood and bamboo play a crucial role in the cost structure of paper mills. The royalty rates for wood have increased substantially in the eighties as state governments revised them with the intention to cover re-plantation costs. The royalty rates charged in early eighties were as low as Rs. 20-40 per ton against the re-plantation cost of Rs. 75. They have now increased to around Rs. 90 by end 1998.

The shortage of soft wood in the country along with the intention to make better use of the fibre available in other products lead to the usage of other fibrous materials like agro-residue (bagasse, jute, cereal straws, grasses, waste paper etc.). Agro-residues are renewable resources, but have several limitations like seasonal availability leading to higher working capital needs, problems in transportation of large volumes, additional investment in pollution control equipments etc.

The two important sources of agro-residue are bagasse and straw. Bagasse is the residue left after sugar cane is crushed for preparing sugar. Straw is obtained from both rice and wheat.

Large quantities of straw/bagasse will be available in the country even if a small percentage of waste of wheat, rice and cane is used for the same. The paper industry consumes just about 1.5-1.8 million tpa approx. The paper units based on straw are forced to have higher working capital as the duration of the wheat/rice harvesting season is just 45-50 days and the straw has to be stored for the rest of time. The availability of straw in the vicinity of the plant is a crucial factor in using it as an input as large quantities of straw is required to produce one ton of paper. eg. Tamil Nadu Newsprint (TNPL) uses straw available in the nearby area for a period of one to two months every year and shifts to other inputs for the remaining period of the year. This is possible due to availability of multi pulping facility at its plant. Even companies like TNPL are finding it difficult to increase the usage of straw and are opting for imported pulp for their future expansion plans.

Straw prices vary substantially across units in the range of Rs. 500 to 1000 depending on the type of straw and its availability.

India being the world's second largest producer of sugar cane, large quantities of bagasse is easily available in the country. But the transportation of bagasse is a major
problem as one ton of paper production requires 5 ton of bagasse with a mix of 80:20 ratio for mixing bagasse and soft pulp. The problem is compounded by the high volume-weight ratio of bagasse.

A few paper mills in the country have an exchange arrangement with sugar mills. Sugar mills supply bagasse for exchange of power/coal from paper mills. The difference in value is settled in monetary terms. eg. TNPL has entered into a tie-up with five sugar mills for a regular supply of bagasse. Sugar mills normally use most of the bagasse produced by them internally as fuel for generating process steam. Under the agreement the company has installed at its own cost coal/lignite fired boilers at the premises of sugar mills. The company operates the off site boilers by supplying coal/lignite and by employing its own operating personnel. The sugar mills release bagasse to the Company at an agreed ratio based on the steam supplied by company's off site boilers. Generally bagasse prices in the open market fluctuate heavily depending on sugarcane production in a particular year. In the event of lower sugarcane production the bagasse prices shoot up and vice versa. But the company gets hedging against price movement of bagasse due to the above arrangement.

In the past few years, small mills are facing difficulty in procuring agro based raw material as they have to compete with larger mills for bagasse. The situation is expected to worsen in the future as new capacity addition by large mills is based on higher ratio of waste paper and agro- residue along with imported paper pulp in the raw material mix.

Waste paper

Waste paper is used along with other inputs for producing certain types of papers like duplex boards, second grade writing paper and board, newsprint etc. Different grades of waste paper are used for different applications.

Waste paper as a raw material to produce paper results in lower usage of water, electricity and lesser pollution. The main sources of waste paper in the country are: Industrial waste (packaging, carton), house hold waste (newspapers, magazines, packages etc.), government papers (files, memos) etc.

The average recycling of waste paper in the country is estimated to be 17% compared to an average of 40% in advanced countries. This is due to diversion of waste
paper for packing and other uses and difficulty in collection from all parts of the country. Small paper mills, the major users of waste paper, find difficulty in obtaining this crucial raw material. The collection of waste paper from different parts of the country requires an extensive dealer network, which is very difficult to set up by small paper mills. Therefore the ‘sourcing’ is carried out with the help of regional waste paper merchants.

Since waste paper is not a manufactured item, prices vary in a wide range based purely on the demand supply situation. The landed prices of imported waste paper are higher than domestic prices but these are of better quality. A few large paper manufacturers import waste paper for mixing it with other inputs eg. ITC Bhadrachalam, BILT, etc.

Caustic soda and chlorine

Caustic soda is used in paper manufacture at the pulp making stage and chlorine is used for bleaching of pulp and paper. In FY98, paper industry consumed 0.32 million ton of caustic soda and 0.3 million ton of chlorine. It accounted for 27% of total caustic soda demand and 22% of the total chlorine demand for FY98.

The consumption of caustic soda depends upon factors like size of plant, presence of chemical recovery unit, raw materials used etc. Normally the consumption varies from 65 to 120 Kg of caustic soda and 50Kg of chlorine per ton of paper production.

Many paper mills have in house caustic soda production facility so as to have control on input costs and to avoid uncertainty in supply. eg. BILT, Century, Orient.

The caustic soda industry has been witnessing over supply situation since 1995. The capacity utilisation levels have dropped to 70% in 1997-98 as compared to 78% in 1995-96. The domestic prices of caustic soda have also been under pressure because of depressed international prices. The international caustic soda prices have almost halved since their peak level in June 1995. This has also adversely affected margins of integrated producers who were selling excess caustic soda production in market. This has forced the largest paper producer, BILT, to hive off its chemical division into a separate subsidiary as part of its re-structuring.
Energy

Paper industry is energy intensive due to running of large machines and movement of large quantity of fibrous raw material. The major sources of energy for paper production are steam (thermal energy) accounting for 75 to 80 % of total energy requirements with the rest coming from electric power.

Steam requirement is sourced from coal fired boilers and chemical recycling facilities. Nearly 80% of paper industry's power requirement is met from power grid with the rest coming from DG sets, co-generation facility and other captive sources.

One ton of paper production requires 7.5 to 13 million Kilo Calorie of energy. The process usually makes use of around 10-15 ton of steam and 1250-1550 KWh of power for producing one ton of paper.

The exact mix of the two sources of energy for a particular manufacturer depends on factors like type of pulping process (mechanical or chemical process), type of paper produced, type of cellulose raw material used, pulping facility, layout, size of plant etc.

The approximate break up of energy usage at different stages of paper production is given in the Table-A.8 below. The energy consumption pattern differs for small and large paper mills.

<table>
<thead>
<tr>
<th>Process stage</th>
<th>% of total energy consumption (range)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chipping</td>
<td>4-6</td>
</tr>
<tr>
<td>Pulping</td>
<td>21-30</td>
</tr>
<tr>
<td>Stock making</td>
<td>20-25</td>
</tr>
<tr>
<td>Recycling Chemicals</td>
<td>0-12</td>
</tr>
<tr>
<td>Paper making</td>
<td>40-42</td>
</tr>
</tbody>
</table>

The energy usage of small paper mills usually differs (on a higher side) from large mills because of factors like non usage of chemical recycling facility and lack of wood pulping facility.

The efficiency of Indian paper mills is very low compared to international average. The wastage of energy in Indian paper mills is at a high level of 40% of total energy requirement in comparison to international average of around 20% due to reasons...
like poor quality of available coal, lack of recycling facility at small mills, obsolete plant & machinery, etc. Therefore, for each ton of paper produced Indian manufacturers use more total energy compared to international average.

As paper plant location is primarily decided based on proximity to fibrous raw material (e.g., wood availability), compromise is made on power cost. The power cost varies from unit to unit as power tariffs differ from state to state.

**International status**

The world consumption of paper and paper boards of 250 million tpa in 1998 is expected to increase by 3 to 4% per annum in the next five years.

United States of America is the world's largest market for paper and paper boards accounting for nearly 40% of the total world demand. USA consumed approximately 98 million ton of paper and paper board for the year 1995 aggregating to $73 billion. The demand for paper and paper boards in the US is expected to increase by 2.5% to 111 million ton aggregating $73 billions by year 2000.

In developed countries the demand for recycled paper is increasing at a much higher rate than average paper demand. This trend is expected to continue in the future as recycling of waste is gaining further momentum in these countries e.g., the share of recycled paper as a proportion of total paper and paper board demand in the US is expected to increase from 30% in 1995 to 35% in year 2000. In 1998, the Asian crisis led to a drop in the demand for paper and the excess supply has all been diverted to the export market. In combination with stagnation in demand in the US and Europe, this led to a further fall in international paper prices. Since the second quarter of 1998, paper mills have been undertaking shut downs, slowing down production etc. in order to reduce supply.

The economic situation in Southeast Asian countries has improved in the past few months and it is expected to improve further. This may reduce the extent of oversupply. But the take-over of Korean paper manufacturers by world paper majors and the revival of dormant production facilities may lead to continuation of excess capacity in the world.
Key monitorables

International paper prices

The global over supply situation in the paper industry has resulted in a sharp cyclical drop in paper prices in the last three years. Average prices are down 25% from the peak levels of 1995-96. As the Indian paper industry faces threat from imports, the improvement in international demand-supply situation resulting in increase in paper prices will help domestic players by improving sales realisation.

Growth in industrial production / usage industries

The demand for paper boards is dependent upon growth in usage industries like FMCG, pharmaceuticals, cigarettes etc. Therefore the demand for the fastest growing segment, paper boards can be traced by tracking the growth in these industries.

Changes in import duty of paper

With the opening of the economy in 1991, the basic import duty paper and paper boards has come down from a peak of 140% in 1991 to 30% in 1999. This has exposed Indian paper mills to the threat of imports. Any increase in import duty on paper will help the industry in countering the threat from imports along with increases in price realisations and capacity utilisation.

Power tariff

Paper manufacturing is an energy intensive process. 10 million kilo calorie of energy are required to produce one ton of paper. The power tariffs, which differ from state to state, have a major impact on the cost of production of paper. Also, the power supply situation in a particular state may become a cause of concern as it will have bearing on production activity of a company, unless the mill has sufficient captive power generation facility.

Changes in import duty on wood pulp and waste paper

The increase in import duty on wood pulp and waste paper has increased the input cost for many large players as they depend on imports. This has a negative impact on the profitability of the Indian companies as their raw material cost goes up. Any changes in import duty on raw material inputs in the future are bound to have a pronounced impact on operating margins of Indian paper manufacturers.
Forest policy

The request by industry to allow use of degraded land for commercial plantation is long pending before the government. Similar schemes in countries like Indonesia, Malaysia, Brazil have been carried out successively and have helped the paper industry to grow to global levels. Therefore, proper policy on this front by GoI will help in boosting the growth of paper industry in the country.

The demand for paper and paper products is directly related to a nation's state of development and progress on the literacy front. Pulp and paper industry depends primarily on raw materials like wood, and agro-residues which are treated with chemicals to produce the final product. The manufacturing process requires a lot of water and it also discharges volumes of effluent water onto the same water bodies. This is a source of water pollution and causes enormous damage to living organisms which depend upon such water bodies for existence. A major water polluting industry such as this can be disciplined by designing a suitable environmental policy. Pulp and paper is thus a very good example to test the viability of a liability structure in controlling industrial pollution.
Appendix - B : Note on the Fertiliser Sector in India

While reviewing the fertiliser sector, firstly we provide a sector overview. We look at the pertinent issues and characteristics of this sector. However a brief mention of the types of fertilisers in use in India is also made. The retention pricing scheme and the urea decontrol are looked into. The structure of the industry is looked at and is followed by industry characteristics. Key issues of the sector are followed by its earning sensitivity factors in conclusion.

Agriculture accounts for a third of India’s national income. It provides employment to over 70% of the population. Fertilisers play a key role in improving the crop yield and hence, is integral to modern farming.

A fertiliser is artificial manure made from chemicals. It is used to supplement key soil nutrients i.e. nitrogen (N), phosphorus (P) and potassium (K). The preferred usage ratio of NPK is 4:2:1. Urea, di-ammonium phosphate (DAP) and single super phosphate (SSP) are the widely used fertilisers in India.

India is not globally competitive in manufacture of fertilisers, due to shortage/ non availability of key raw materials and high energy costs. India does not have rock phosphate to produce DAP and imports phosphoric acid. Globally, the major suppliers of phosphoric acid are DAP exporters.

The Indian fertiliser industry has developed under government control. To reduce import dependence, the Government encouraged domestic capacity creation under the retention-pricing scheme. This ensured all producers to earn a 12% post-tax return on investment. The Government kept the fertiliser prices artificially low by giving subsidies. The subsidy burden on fertilisers is now Rs.120 billion.

The process of decontrol began in 1992 with decontrol of DAP and SSP, whereas urea (70% of total fertiliser consumption in volumes) was kept under control. The
relatively low prices of urea resulted in a skewed consumption pattern of fertilisers in India, which will have long term deleterious effect on soil properties. Unfortunately, the Government is unable to raise prices for fear of political repercussions. The recommendations of the Hanumantha Rao committee, which was constituted to charter the course of future reforms is still being deliberated upon.

**Types of fertiliser**

There are various types of fertiliser that are used in Indian agriculture. The main nutrients that deplete with successive cropping are nitrogen (N), phosphorus (P) and potassium (K). Fertilisers supplement the natural deficiency as well as depletion of nutrients. Organic manure (such as cow dung) fulfils a small part of total nutrient requirement.

For optimum yield, a combination of fertilisers depending on the state of soil, seed, crop, climatic conditions, etc. is used. Excessive and/or imbalanced use of fertilisers can adversely affect soil. Indian farmers, who are generally uneducated, are not able to take scientific decision on the fertiliser mix from a long-term point of view. They use the cheapest mix. This has resulted in damage of soil quality due to excessive use of urea, which is cheaper than P or K fertilisers. The key fertilisers used in India are;

Urea supplies around 83% of the total nitrogen requirements. It is manufactured from ammonia in an energy intensive process. Natural gas is the preferred feed stock as it results in low variable cost compared to naphtha. At present, only 50% of the total domestic capacity is gas based, about 30% is based on naphtha and rest on fuel oil and coal.

Single super phosphate supplies 19% of the total phosphatic nutrients. It is manufactured by treating rock phosphate with sulphuric acid and calcium. Both rock phosphate and sulphur are imported.
Di-ammonium phosphate meets 50% of phosphatic and 8% of nitrogenous nutrients. Rock phosphate is the main feedstock. Phosphoric acid is manufactured by treating rock phosphate with sulphuric acid. It is then reacted with ammonia to manufacture DAP. The integrated manufacturers have their own ammonia, phosphoric acid and sulphuric acid plants, while sulphur and rock phosphate are imported.

Potassium fertilisers are not manufactured in India due to non-availability of the basic feedstock. Muriate of Potash (MOP) is imported from countries like Canada, Jordan and Germany.

The domestic fertiliser demand was met largely by imports till mid-seventies. To reduce import dependence, the Government implemented a Retention Pricing Scheme (RPS) in 1977 to encourage domestic capacity creation. Earlier all fertilisers were under state control, however in 1992-3, potassium and phosphatic fertilisers were deregulated.

Characteristics

Capital intensive

The industry is capital intensive, both capital and working capital. The investment for a minimum economic size urea plant (2,250 tpd) is Rs15bn. The investments for a minimum economic size capacity in DAP (1,500 tpd) and SSP (100 tpd) plant is lower at Rs5bn and Rs0.4bn, respectively. The working capital requirements of the industry are high because of commitments towards imports (if using imported raw materials, generally the case in phosphatic fertilisers) and delays in release of subsidies. This implies that about 30-45% of sales is locked in working capital. This acts as an effective barrier restricting easy entry of new players.

Feed-stock requirement

Feed stock is the major cost component, which can vary from 50-80% of total cost depending on its age and technology. For nitrogenous fertilisers, feed-stock are natural gas and naphtha. Given shortages of natural gas, most modern plants have dual feed units,
so that switch over to naphtha is possible. Generally DAP/ SSP plants use imported phosphoric acid or rock phosphate and sulphur.

Many fertiliser units have been set up along the Hazira-Bijapur-Jagdishpur (HBJ) pipeline of GAIL because of the government's incentives to promote use of natural gas as a feed-stock DAP/ SSP units are coast based because of their imports of raw materials.

**Competition**

In spite of differences in nutrients supplied, there is a tendency amongst farmers to switch to urea from DAP/SSP. This is due to the price differential between the two. As the sector is liberalised and price controls get dismantled, competition will get fierce. The cost disadvantages of the naphtha as a feedstock will become visible.

The cost of producing urea using different feedstock varies from Rs. 5,200 to Rs. 12,200 per ton depending on age and feedstock, while for DAP it will range between Rs. 9,250 to Rs. 12,250 per ton. Landed cost of urea and DAP is about Rs. 4,200 and Rs. 9,500 per ton. Given China's absence in trade, urea and DAP prices have remained subdued for the last 12 months, and are likely to remain so in the near future. So all domestic producers face an import threat.

Given the commodity nature, differentiation is difficult. Hence, most producers spend efforts in educating the farmer on seed selection, fertiliser usage, and modern farming techniques to generate brand loyalty.

Entry of new players is difficult given capital intensity. Given the threat of imports and uncertainty regarding government policies, a greenfield venture is potentially nonviable. This restricts entry of new players.

**Demand determinants**

The key determinants of fertiliser demand are

1. Fertiliser and food-grain prices, which are crucial to willingness and ability of a farmer to purchase fertilisers. The overall consumption went down in FY93 because of phosphatic fertiliser decontrol and the resultant steep rise in their selling prices.

2. Monsoon/ irrigation facilities give farmer confidence to invest in fertilisers.
3. The fertiliser consumption goes down in bad monsoon years.

4. Government policy directly influences pricing, production and distribution of fertilisers. This is evident as demand for phosphatic fertilisers went down when prices of phosphatic fertilisers went up after decontrol.

5. Availability of credit to farmers, which enables them to purchase fertilisers, determines demand. Given that most Indian farmers are marginal with meagre resources, credit availability is critical.

6. Cropping pattern determines the need and timing of fertiliser purchases especially cash crops.

Retention pricing scheme

Urea, the most widely used fertiliser is under state control. Production cost for each unit is calculated separately, at a normative capacity level of 90% (80% in year 1). Adding cost of production and a fixed return on investment, one can arrive at the retention price. The Government reimburses the difference between retention price and selling price, which is also fixed by the Government. Operating at higher than 90% utilisation levels enables a producer to generate more than 12% returns as all costs are covered at 90% utilisation.

The retention price for most units is higher than the selling price. The difference is compensated to the producer and reflected in the fertiliser subsidy. The revised estimate for urea subsidy is Rs. 80 billion. The concessions available to P and K will add another Rs. 40 billion.

Implications of controls

Under the regime of assured returns, capacities were set up at high capital costs. These coexisted with older units with lower retention prices. There was no incentive to upgrade and invest in modern technology. Although the profitability of the sector was assured, modernisation efforts were limited because of limited operational freedom and incentives.
Under political compulsions, successive Governments have not been able to raise the fertiliser prices in spite of cost increases. With other sectors witnessing liberalisation, especially the hydrocarbon sector, prices of petroleum feedstock (gas, fuel oil and naphtha) have increased. Lower than estimated international prices of urea led to higher imports. In line with the economic reforms, the Government decontrolled DAP, SSP and other fertilisers in August 1992, while urea was kept under state control. DAP and SSP prices doubled. This has led to undesirable changes in fertiliser mix used by the farmers. This resulted in NPK ratio changing to 10:3:1. In an attempt to mitigate this, DAP and other complex fertilisers were given price sops.

Table-B.1: Price SOPS to various types of fertiliser.

<table>
<thead>
<tr>
<th>Year</th>
<th>Urea (Rs./mt.)</th>
<th>DAP (Rs./mt.)</th>
<th>MOP (Rs./mt.)</th>
<th>DAP/ Urea</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>2350</td>
<td>3600</td>
<td>1300</td>
<td>1.53</td>
</tr>
<tr>
<td>1992</td>
<td>3060</td>
<td>4680</td>
<td>1700</td>
<td>1.53</td>
</tr>
<tr>
<td>1993 K</td>
<td>3060</td>
<td>4680</td>
<td>1700</td>
<td>1.53</td>
</tr>
<tr>
<td>1993 R</td>
<td>2760</td>
<td>6650</td>
<td>4500</td>
<td>2.41</td>
</tr>
<tr>
<td>1994 K</td>
<td>2760</td>
<td>6600</td>
<td>3800</td>
<td>2.39</td>
</tr>
<tr>
<td>1995 K</td>
<td>3320</td>
<td>7500</td>
<td>3800</td>
<td>2.26</td>
</tr>
<tr>
<td>1996 K</td>
<td>3320</td>
<td>9800</td>
<td>4450</td>
<td>2.95</td>
</tr>
<tr>
<td>1996 R</td>
<td>3320</td>
<td>10000</td>
<td>4600</td>
<td>3.01</td>
</tr>
<tr>
<td>1997 K</td>
<td>3320</td>
<td>11000</td>
<td>4800</td>
<td>3.31</td>
</tr>
<tr>
<td>1997 R</td>
<td>3320</td>
<td>9000</td>
<td>4300</td>
<td>2.71</td>
</tr>
<tr>
<td>1998</td>
<td>3320</td>
<td>8300</td>
<td>3700</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Source: GoI Publication

Table-B.2: NPK Ratio

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>P</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960-61</td>
<td>7.2</td>
<td>1.8</td>
<td>1</td>
</tr>
<tr>
<td>1970-71</td>
<td>6.5</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>1980-81</td>
<td>5.9</td>
<td>1.9</td>
<td>1</td>
</tr>
<tr>
<td>1990-91</td>
<td>6</td>
<td>2.4</td>
<td>1</td>
</tr>
<tr>
<td>1995-96</td>
<td>8.5</td>
<td>2.5</td>
<td>1</td>
</tr>
<tr>
<td>1996-97</td>
<td>10</td>
<td>2.9</td>
<td>1</td>
</tr>
<tr>
<td>1997-98</td>
<td>8</td>
<td>2.9</td>
<td>1</td>
</tr>
</tbody>
</table>

Source: GoI Publication
Table-B.3 : Concession rates in Rs./mt

<table>
<thead>
<tr>
<th>Upto</th>
<th>Indigenous DAP</th>
<th>Imported DAP</th>
<th>MO P</th>
<th>SSP (16%)</th>
<th>Indigenous complexes</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/7/96</td>
<td>1000</td>
<td>1500</td>
<td>1000</td>
<td>340</td>
<td>435-999</td>
</tr>
<tr>
<td>31/3/97</td>
<td>3000</td>
<td>2250</td>
<td>1500</td>
<td>500</td>
<td>1304-2633</td>
</tr>
<tr>
<td>30/9/97</td>
<td>3750</td>
<td>2000</td>
<td>2000</td>
<td>600</td>
<td>1630-3320</td>
</tr>
<tr>
<td>31/3/98</td>
<td>3500</td>
<td>N.A.</td>
<td>2000</td>
<td>600</td>
<td>1522-3130</td>
</tr>
</tbody>
</table>

Source: Go!

As is evident, in light of the worsening NPK ratio, Go had no option but to dole out increased subsidies in Potassium and Phosphatic fertilisers. This had a negative impact on the subsidy bill, which has risen to Rs. 75 billion.

Table-B.4 : Subsidies on Fertiliser

<table>
<thead>
<tr>
<th>Rs. billion</th>
<th>Domestic</th>
<th>Imports</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-81</td>
<td>1.7</td>
<td>3.35</td>
<td>5.05</td>
</tr>
<tr>
<td>1990-91</td>
<td>37.3</td>
<td>6.59</td>
<td>43.89</td>
</tr>
<tr>
<td>1995-96</td>
<td>43</td>
<td>19.35</td>
<td>62.35</td>
</tr>
<tr>
<td>1996-97</td>
<td>47.43</td>
<td>13.5</td>
<td>60.93</td>
</tr>
<tr>
<td>1997-98</td>
<td>66</td>
<td>8.26</td>
<td>74.26</td>
</tr>
</tbody>
</table>

Source: Go!

The Indian fertiliser industry has developed under the government’s control. India does not have any advantages for globally competitive manufacture of fertilisers, as it lacks key raw materials. In the past to reduce dependence on imports, the entire industry was given sops by the government. After economic liberalisation in the 90s, things took a turn with decontrol of phosphatic and potassic fertilisers.

The fertiliser sector is one of the most important one in India. It is a sector which has environmental impacts both at the manufacturing end as well as at the consumption end. A liability structure can not be used to reduce pollution at the consumption end. However, at the manufacturing end, a liability rule can be used to enforce environmental discipline. The discharges of chemicals during the production processes in the manufacture of fertilisers has deleterious effects on the environment. Thus policy measures needs to be so designed as to curb such effects. Moreover, the use of fertilisers is imperative in agriculture and hence its demand will never fall. In fact in order to feed
the burgeoning populace of the country, its use and production as well will rise in the future. Thus, this seems to be a good sector to study in the present context for designing a liability rule to implement environmental discipline.
Table: A - I

**Name of firms of the fertiliser industry.**

<table>
<thead>
<tr>
<th>F1</th>
<th>Adarsh Chemicals &amp; Fertilisers Ltd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>F2</td>
<td>Agro Chemicals Punjab Ltd.</td>
</tr>
<tr>
<td>F3</td>
<td>Anil Chemicals &amp; Industries. Ltd.</td>
</tr>
<tr>
<td>F4</td>
<td>Asian Fertilisers Ltd.</td>
</tr>
<tr>
<td>F5</td>
<td>Basant Agro Tech (India) Ltd.</td>
</tr>
<tr>
<td>F6</td>
<td>Belsund Sugar &amp; Industries. Ltd.</td>
</tr>
<tr>
<td>F7</td>
<td>Bharat Fertiliser Industries. Ltd.</td>
</tr>
<tr>
<td>F8</td>
<td>Chambal Fertilisers &amp; Chemicals Ltd.</td>
</tr>
<tr>
<td>F9</td>
<td>Coromandel Fertilisers Ltd.</td>
</tr>
<tr>
<td>F10</td>
<td>Deccan Sales Corporation. Ltd.</td>
</tr>
<tr>
<td>F11</td>
<td>Duncans Industries Ltd.</td>
</tr>
<tr>
<td>F12</td>
<td>Fertilisers &amp; Chemicals, Travancore Ltd.</td>
</tr>
<tr>
<td>F13</td>
<td>Fertiliser Corporation. Of India Ltd.</td>
</tr>
<tr>
<td>F14</td>
<td>Ganges Fertiliser &amp; Chemicals Ltd.</td>
</tr>
<tr>
<td>F15</td>
<td>Godavari Fertilisers &amp; Chemicals Ltd.</td>
</tr>
<tr>
<td>F16</td>
<td>Good Value Marketing Co. Ltd.</td>
</tr>
<tr>
<td>F17</td>
<td>Gujarat Narmada Valley Fertilisers Co. Ltd.</td>
</tr>
<tr>
<td>F18</td>
<td>Gujarat Nitrates Ltd.</td>
</tr>
<tr>
<td>F19</td>
<td>Gujarat State Fertilisers &amp; Chemicals Ltd.</td>
</tr>
<tr>
<td>F20</td>
<td>Harshvardhan Chemicals &amp; Minerals Ltd.</td>
</tr>
<tr>
<td>F21</td>
<td>Hind Lever Chemicals Ltd.</td>
</tr>
<tr>
<td>F22</td>
<td>Hindustan Agro Chemicals Ltd.</td>
</tr>
<tr>
<td>F23</td>
<td>Hindustan Fertiliser Corporation Ltd.</td>
</tr>
<tr>
<td>F24</td>
<td>Indian Farmers Fertiliser Co-operative Ltd.</td>
</tr>
<tr>
<td>F25</td>
<td>Indo-Gulf Corporation Ltd.</td>
</tr>
<tr>
<td>F26</td>
<td>Khaitan Chemicals &amp; Fertilisers Ltd.</td>
</tr>
<tr>
<td>Code</td>
<td>Company Name</td>
</tr>
<tr>
<td>------</td>
<td>------------------------------------------------------------</td>
</tr>
<tr>
<td>F27</td>
<td>Krishak Bharati Co-operative Ltd.</td>
</tr>
<tr>
<td>F28</td>
<td>Krishna Industrial Corporation. Ltd.</td>
</tr>
<tr>
<td>F29</td>
<td>Liberty Phosphate Ltd.</td>
</tr>
<tr>
<td>F30</td>
<td>M P Agro Industries. Ltd.</td>
</tr>
<tr>
<td>F31</td>
<td>Madras Fertilisers Ltd.</td>
</tr>
<tr>
<td>F32</td>
<td>Mangalore Chemicals &amp; Fertilisers Ltd.</td>
</tr>
<tr>
<td>F33</td>
<td>Mittal Fertilisers Ltd.</td>
</tr>
<tr>
<td>F34</td>
<td>Munak Chemicals Ltd.</td>
</tr>
<tr>
<td>F35</td>
<td>Nagarjuna Fertilisers &amp; Chemicals Ltd.</td>
</tr>
<tr>
<td>F36</td>
<td>National Fertilisers Ltd.</td>
</tr>
<tr>
<td>F37</td>
<td>Oswal Chemicals &amp; Fertilisers Ltd.</td>
</tr>
<tr>
<td>F38</td>
<td>Paradeep Phosphates Ltd.</td>
</tr>
<tr>
<td>F39</td>
<td>Peirce Leslie India Ltd.</td>
</tr>
<tr>
<td>F40</td>
<td>Phosphate Co. Ltd.</td>
</tr>
<tr>
<td>F41</td>
<td>Punjab National Fertilisers &amp; Chemicals Ltd.</td>
</tr>
<tr>
<td>F42</td>
<td>Raashi Fertilisers Ltd.</td>
</tr>
<tr>
<td>F43</td>
<td>Rashtriya Chemicals &amp; Fertilisers Ltd.</td>
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<tr>
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<td>S F L Industries Ltd.</td>
</tr>
<tr>
<td>F45</td>
<td>Shiva Fertilisers Ltd.</td>
</tr>
<tr>
<td>F46</td>
<td>Shree Acids &amp; Chemicals Ltd.</td>
</tr>
<tr>
<td>F47</td>
<td>Shriniwas Fertilisers Ltd.</td>
</tr>
<tr>
<td>F48</td>
<td>Southern Petrochemical Industries. Corporation Ltd.</td>
</tr>
<tr>
<td>F49</td>
<td>Sri Durga Bansal Fertiliser Ltd.</td>
</tr>
<tr>
<td>F50</td>
<td>T. Stanes &amp; Co. Ltd.</td>
</tr>
<tr>
<td>F51</td>
<td>Teesta Agro Industries Ltd.</td>
</tr>
<tr>
<td>F52</td>
<td>Trimurtee Fertilisers Ltd.</td>
</tr>
<tr>
<td>F53</td>
<td>Tungabhadra Fertilisers &amp; Chemicals Co. Ltd.</td>
</tr>
<tr>
<td>F54</td>
<td>Udaipur Phosphates &amp; Fertilisers Ltd.</td>
</tr>
<tr>
<td>F55</td>
<td>Unialkem Fertilisers Ltd.</td>
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<td>F56</td>
<td>Zuari Industries Ltd.</td>
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Table: A - II

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<th>Name Of Firms In The Pulp and Paper Industry</th>
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<td>P2</td>
<td>Afsons Industrial Corporation</td>
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<tr>
<td>P3</td>
<td>Ajanta Paper &amp; General Products Ltd.</td>
</tr>
<tr>
<td>P4</td>
<td>Andhra Pradesh Paper Mills Ltd.</td>
</tr>
<tr>
<td>P5</td>
<td>Arrow Coated Products Ltd.</td>
</tr>
<tr>
<td>P6</td>
<td>Associated Pulp &amp; Paper Mills Ltd.</td>
</tr>
<tr>
<td>P7</td>
<td>Aurangabad Paper Mills Ltd.</td>
</tr>
<tr>
<td>P8</td>
<td>B K Duplex Board Ltd.</td>
</tr>
<tr>
<td>P9</td>
<td>Balkrishna Industries Ltd.</td>
</tr>
<tr>
<td>P10</td>
<td>Ballarpur Industries Ltd.</td>
</tr>
<tr>
<td>P11</td>
<td>Bazargaon Paper &amp; Pulp Mills Pvt. Ltd.</td>
</tr>
<tr>
<td>P12</td>
<td>Cauvery Papers Ltd.</td>
</tr>
<tr>
<td>P13</td>
<td>Central Pulp Mills Ltd.</td>
</tr>
<tr>
<td>P14</td>
<td>Chadha Papers Ltd.</td>
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<tr>
<td>P15</td>
<td>Chemopulp Tissues Ltd.</td>
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<tr>
<td>P16</td>
<td>Circar Paper Mills Ltd.</td>
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<tr>
<td>P17</td>
<td>Coastal Chemicals Ltd.</td>
</tr>
<tr>
<td>P18</td>
<td>Coastal Papers Ltd.</td>
</tr>
<tr>
<td>P19</td>
<td>Continental Papers Ltd.</td>
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<td>P20</td>
<td>Coral Newsprints Ltd.</td>
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<tr>
<td>P21</td>
<td>Core Emballage Ltd.</td>
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<tr>
<td>P22</td>
<td>Cosboard Industries Ltd.</td>
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<tr>
<td>P23</td>
<td>Crest Paper Mills Ltd.</td>
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<tr>
<td>P24</td>
<td>Danalakshmi Paper Mills Ltd.</td>
</tr>
<tr>
<td>P25</td>
<td>Delta Paper Mills Ltd.</td>
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<tr>
<td>P26</td>
<td>Eggro Paper Moulds Ltd.</td>
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</table>
P27  Ellora Paper Mills Ltd.
P28  Emami Paper Mills Ltd.
P29  G V G Paper Mills Ltd.
P30  Gayatri Tissue & Papers Ltd.
P31  Global Boards Ltd.
P32  Gold Star Straw Products Ltd.
P33  Gulmohar Paper Ltd.
P34  Hanuman Agro Industries. Ltd.
P35  Haryana Coated Papers Ltd.
P36  Hindustan Newsprint Ltd.
P37  Hindustan Paper Corporation. Ltd.
P38  I T C Bhadrachalam Paperboards Ltd.
P39  J C L Ltd.
P40  Jackard Products Ltd.
P41  Jayakwadi Pulp & Paper Mills Ltd.
P42  Jayant Paper Mills Ltd.
P43  Jayanth Paper Mills Ltd.
P44  Kalptaru Papers Ltd.
P45  Kanoi Paper & Industries. Ltd.
P46  Kasat Paper & Pulp Ltd.
P47  Kay Pulp & Paper Mills Ltd.
P48  Kores (India) Ltd.
P49  Laxmi Board & Paper Mills Ltd.
P50  Madhya Bharat Papers Ltd.
P51  Madhya Desh Papers Ltd.
P52  Mandya National Paper Mills Ltd.
P53  Mansarover Paper & Industries. Ltd.
P54  Mohan Fibre Products Ltd.
P55  Mohit Paper Mills Ltd.
P56  Mukerian Papers Ltd.
P57 Mysore Paper Mills Ltd.
P58 N E P C Paper & Board Ltd.
P59 N R Agarwal Industries. Ltd.
P60 Nagaland Pulp & Paper Co. Ltd.
P61 Napa Papers Ltd.
P62 Nath Pulp & Paper Mills Ltd.
P63 Nepa Ltd.
P64 Nice Papers Ltd.
P65 Nishant Paper Mills Ltd.
P66 Orient Paper & Industries. Ltd.
P67 P C I Papers Ltd.
P68 Pamwi Tissues Ltd.
P69 Parijat Paper Mills Ltd.
P70 Partap Paper Mills Ltd.
P71 Pitambar Coated Paper Ltd.
P72 Pondichery Papers Ltd.
P73 Ponmudi Paper Mills (P) Ltd.
P74 Pudumjee Agro Industries. Ltd.
P75 Pudumjee Pulp & Paper Mills Ltd.
P76 Purity Flex Pack Ltd.
P77 R N Paper & Boards Ltd.
P78 Raigarh Paper & Board Mills Ltd.
P79 Rainbow Papers Ltd.
P80 Rajalakshmi Paper Mills Ltd.
P81 Rama Newsprint & Papers Ltd.
P82 Rama Paper Mills Ltd.
P83 Rama Pulp & Papers Ltd.
P84 Rana Mohendra Papers Ltd.
P85 Ravindra Steel Ltd.
P86 Reacto Papers India Ltd.
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</tr>
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<td>P88</td>
<td>Rohit Tissue Ltd.</td>
</tr>
<tr>
<td>P89</td>
<td>Ruchira Papers Ltd.</td>
</tr>
<tr>
<td>P90</td>
<td>Sangal Papers Ltd.</td>
</tr>
<tr>
<td>P91</td>
<td>Sarda Papers Ltd.</td>
</tr>
<tr>
<td>P92</td>
<td>Satia Paper Mills Ltd.</td>
</tr>
<tr>
<td>P93</td>
<td>Saurashtra Paper &amp; Board Mills Ltd.</td>
</tr>
<tr>
<td>P94</td>
<td>Seshasayee Paper &amp; Boards Ltd.</td>
</tr>
<tr>
<td>P95</td>
<td>Shefali Papers Ltd.</td>
</tr>
<tr>
<td>P96</td>
<td>Shirke Paper Mills Ltd.</td>
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<td>Shiva Paper Mills Ltd.</td>
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<td>P98</td>
<td>Shree Ajit Pulp &amp; Paper Ltd.</td>
</tr>
<tr>
<td>P99</td>
<td>Shree Ambeshwar Paper Mills Ltd.</td>
</tr>
<tr>
<td>P100</td>
<td>Shree Bhawani Paper Mills Ltd.</td>
</tr>
<tr>
<td>P101</td>
<td>Shree Industries Ltd.</td>
</tr>
<tr>
<td>P102</td>
<td>Shree Jagdambe Paper Mills Ltd.</td>
</tr>
<tr>
<td>P103</td>
<td>Shree Karthik Papers Ltd.</td>
</tr>
<tr>
<td>P104</td>
<td>Shree Krishna Paper Mills &amp; Industries. Ltd.</td>
</tr>
<tr>
<td>P105</td>
<td>Shree Rajeshwaranand Paper Mills Ltd.</td>
</tr>
<tr>
<td>P106</td>
<td>Shree Swami Harigiri Paper Mills Ltd.</td>
</tr>
<tr>
<td>P107</td>
<td>Shree Vindhya Paper Mills Ltd.</td>
</tr>
<tr>
<td>P108</td>
<td>Shreyans Industries Ltd.</td>
</tr>
<tr>
<td>P109</td>
<td>Sirpur Paper Mills Ltd.</td>
</tr>
<tr>
<td>P110</td>
<td>Soma Papers &amp; Industries. Ltd.</td>
</tr>
<tr>
<td>P111</td>
<td>South India Paper Mills Ltd.</td>
</tr>
<tr>
<td>P112</td>
<td>Speciality Papers Ltd.</td>
</tr>
<tr>
<td>P113</td>
<td>Star Paper Mills Ltd.</td>
</tr>
<tr>
<td>P114</td>
<td>Sukhna Paper Mills Ltd.</td>
</tr>
<tr>
<td>P115</td>
<td>Sun Paper Mill Ltd.</td>
</tr>
<tr>
<td>P116</td>
<td>Superb Papers Ltd.</td>
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</tbody>
</table>
P117  Suryo Papers Ltd.
P118  Sushila Pulp & Papers Ltd.
P119  Tamil Nadu Newsprint & Papers Ltd.
P120  Tungbhadra Pulp & Board Mills Ltd.
P121  Universal Paper Mills Ltd.
P122  Vamshadhara Paper Mills Ltd.
P123  Varinder Agro Chemicals Ltd.
P124  Vecron Industries Ltd.
P125  Victory Paper & Boards (India) Ltd.
P126  Vidarbha Paper Mills Ltd.
P127  Vidhi Industries Ltd.
P128  Vrindavan Paper Mills Ltd.
P129  Well Pack Papers & Containers Ltd.
P130  West Coast Paper Mills Ltd.
P131  Yash Papers Ltd.
Table: A - III

Name of firms of the fertiliser industry included in assessing credit worthiness of firms.

<table>
<thead>
<tr>
<th>F1</th>
<th>Adarsh Chemicals &amp; Fertilisers Ltd.</th>
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<tbody>
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<td>F2</td>
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<tr>
<td>F5</td>
<td>Basant Agro Tech (India) Ltd.</td>
</tr>
<tr>
<td>F8</td>
<td>Chambal Fertilisers &amp; Chemicals Ltd.</td>
</tr>
<tr>
<td>F9</td>
<td>Coromandel Fertilisers Ltd.</td>
</tr>
<tr>
<td>F11</td>
<td>Duncans Industries Ltd.</td>
</tr>
<tr>
<td>F15</td>
<td>Godavari Fertilisers &amp; Chemicals Ltd.</td>
</tr>
<tr>
<td>F16</td>
<td>Good Value Marketing Co. Ltd.</td>
</tr>
<tr>
<td>F17</td>
<td>Gujarat Narmada Valley Fertilisers Co. Ltd.</td>
</tr>
<tr>
<td>F19</td>
<td>Gujarat State Fertilisers &amp; Chemicals Ltd.</td>
</tr>
<tr>
<td>F20</td>
<td>Harshvardhan Chemicals &amp; Minerals Ltd.</td>
</tr>
<tr>
<td>F21</td>
<td>Hind Lever Chemicals Ltd.</td>
</tr>
<tr>
<td>F22</td>
<td>Hindustan Agro Chemicals Ltd.</td>
</tr>
<tr>
<td>F25</td>
<td>Indo-Gulf Corporation Ltd.</td>
</tr>
<tr>
<td>F26</td>
<td>Khaitan Chemicals &amp; Fertilisers Ltd.</td>
</tr>
<tr>
<td>F29</td>
<td>Liberty Phosphate Ltd.</td>
</tr>
<tr>
<td>F30</td>
<td>M P Agro Industries. Ltd.</td>
</tr>
<tr>
<td>F31</td>
<td>Madras Fertilisers Ltd.</td>
</tr>
<tr>
<td>F32</td>
<td>Mangalore Chemicals &amp; Fertilisers Ltd.</td>
</tr>
<tr>
<td>F34</td>
<td>Munak Chemicals Ltd.</td>
</tr>
<tr>
<td>F35</td>
<td>Nagarjuna Fertilisers &amp; Chemicals Ltd.</td>
</tr>
<tr>
<td>F36</td>
<td>National Fertilisers Ltd.</td>
</tr>
<tr>
<td>F37</td>
<td>Oswal Chemicals &amp; Fertilisers Ltd.</td>
</tr>
<tr>
<td>F41</td>
<td>Punjab National Fertilisers &amp; Chemicals Ltd.</td>
</tr>
<tr>
<td>F42</td>
<td>Raashi Fertilisers Ltd.</td>
</tr>
<tr>
<td>F43</td>
<td>Rashtriya Chemicals &amp; Fertilisers Ltd.</td>
</tr>
<tr>
<td>Code</td>
<td>Company Name</td>
</tr>
<tr>
<td>------</td>
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</tr>
<tr>
<td>F44</td>
<td>S F L Industries Ltd.</td>
</tr>
<tr>
<td>F46</td>
<td>Shree Acids &amp; Chemicals Ltd.</td>
</tr>
<tr>
<td>F51</td>
<td>Teesta Agro Industries Ltd.</td>
</tr>
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<td>F54</td>
<td>Udaipur Phosphates &amp; Fertilisers Ltd.</td>
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<tr>
<td>F56</td>
<td>Zuari Industries Ltd.</td>
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Table: A - IV

**Significant Variables In Assessing Credit Worthiness For Fertiliser Industry**

Dependent Variable: Current Growth

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<th>Lags (if any)</th>
<th>Coefficient</th>
<th>t-value</th>
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<td>Net Profit / Total Asset</td>
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<td>Growth in Net Sales</td>
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<td>Inventory / Total Asset</td>
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<td>-17.24409</td>
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<tr>
<td>Retained Profits/ Total Assets</td>
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<td>7.63132</td>
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<td>Current Assets/ Current Liabilities</td>
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<td>0.07247</td>
<td>5.67504</td>
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<tr>
<td>Long-Term Finance</td>
<td>---</td>
<td>0.00041</td>
<td>6.420353</td>
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<tr>
<td>Wages / Sales</td>
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<td>MPI</td>
<td>---</td>
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<tr>
<td>Retained Profits / Net Profits</td>
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<td>4.36864</td>
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<td>Market Share</td>
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<td>-2.41948</td>
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<td>Short Bank Borrowings</td>
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<td>0.00119</td>
<td>15.91876</td>
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<td>Share Prices</td>
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$R^2 = 0.98673$;

Durbin-Watson Statistics = 2.246568
## Table: A - V

Name Of Firms In The Paper Industry Used in Assessing the Credit-Worthiness of Firms.

<p>| P4 | Andhra Pradesh Paper Mills Ltd. |
| P6 | Associated Pulp &amp; Paper Mills Ltd. |
| P8 | B K Duplex Board Ltd. |
| P9 | Balkrishna Industries Ltd. |
| P17 | Coastal Chemicals Ltd. |
| P20 | Coral Newsprints Ltd. |
| P21 | Core Emballage Ltd. |
| P22 | Cosboard Industries Ltd. |
| P26 | Eggro Paper Moulds Ltd. |
| P35 | Haryana Coated Papers Ltd. |
| P38 | I T C Bhadrachalam Paperboards Ltd. |
| P39 | J C L Ltd. |
| P41 | Jayakwadi Pulp &amp; Paper Mills Ltd. |
| P49 | Laxmi Board &amp; Paper Mills Ltd. |
| P50 | Madhya Bharat Papers Ltd. |
| P51 | Madhya Desh Papers Ltd. |
| P53 | Mansarover Paper &amp; Industries. Ltd. |
| P55 | Mohit Paper Mills Ltd. |
| P56 | Mukerian Papers Ltd. |
| P58 | N E P C Paper &amp; Board Ltd. |
| P66 | Orient Paper &amp; Industries. Ltd. |
| P67 | P C I Papers Ltd. |
| P68 | Pamwi Tissues Ltd. |
| P71 | Pitambar Coated Paper Ltd. |
| P75 | Pudumjee Pulp &amp; Paper Mills Ltd. |</p>
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<thead>
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<th>Company Name</th>
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<td>Raigarh Paper &amp; Board Mills Ltd.</td>
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<td>P80</td>
<td>Rajalakshmi Paper Mills Ltd.</td>
</tr>
<tr>
<td>P81</td>
<td>Rama Newsprint &amp; Papers Ltd.</td>
</tr>
<tr>
<td>P83</td>
<td>Rama Pulp &amp; Papers Ltd.</td>
</tr>
<tr>
<td>P84</td>
<td>Rana Mohendra Papers Ltd.</td>
</tr>
<tr>
<td>P86</td>
<td>Reacto Papers India Ltd.</td>
</tr>
<tr>
<td>P88</td>
<td>Rohit Tissue Ltd.</td>
</tr>
<tr>
<td>P89</td>
<td>Ruchira Papers Ltd.</td>
</tr>
<tr>
<td>P90</td>
<td>Sangal Papers Ltd.</td>
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<td>Sarda Papers Ltd.</td>
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<td>Satia Paper Mills Ltd.</td>
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<td>P93</td>
<td>Saurashtra Paper &amp; Board Mills Ltd.</td>
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<tr>
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<td>Shirke Paper Mills Ltd.</td>
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<td>Shiva Paper Mills Ltd.</td>
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<td>Shree Ambeshwar Paper Mills Ltd.</td>
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<td>Shree Bhawani Paper Mills Ltd.</td>
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<td>Shree Jagdambe Paper Mills Ltd.</td>
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<td>P107</td>
<td>Shree Vindhya Paper Mills Ltd.</td>
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<td>P110</td>
<td>Soma Papers &amp; Industries. Ltd.</td>
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<td>P114</td>
<td>Sukhna Paper Mills Ltd.</td>
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<tr>
<td>P118</td>
<td>Sushila Pulp &amp; Papers Ltd.</td>
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Table: A - VI

**Significant Variables In Assessing Credit Worthiness For Pulp and Paper Industry**

Dependent Variable: Current Growth

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<th>Coefficient</th>
<th>t-value</th>
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<td>Net Profit/ Total Asset</td>
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<td>Net Sales/Net Worth + Debentures</td>
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<td>Inventory/ Total Asset</td>
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<td>-5.174573</td>
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<td>Retained Profits/Total Assets</td>
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<td>Current Assets/ Current Liabilities</td>
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<td>Wages / Sales</td>
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<td>Retained Profits / Net Profits</td>
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<td>Net Sales / Total Assets</td>
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<tr>
<td>Market Share</td>
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<tr>
<td>Short Bank Borrowings</td>
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<td>Share Price</td>
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\[ R^2 = 0.94829; \]
\[ \text{Durbin-Watson Statistics} = 2.258551. \]
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<td>Duncans Industries Ltd.</td>
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<td>Fertiliser Corporation. Of India Ltd., Dhanbad</td>
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<td>Indian Farmers Fertiliser Co-operative Ltd., Aonla</td>
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<tr>
<td>Indian Farmers Fertiliser Co-operative Ltd., Kalol</td>
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<tr>
<td>Indian Farmers Fertiliser Co-operative Ltd., Phulpur</td>
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<tr>
<td>Khaitan Chemicals &amp; Fertilisers Ltd.</td>
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<tr>
<td>Krishak Bharati Co-operative Ltd.</td>
</tr>
<tr>
<td>National Fertilisers Ltd., Panipat</td>
</tr>
<tr>
<td>National Fertilisers Ltd., Nangal</td>
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<tr>
<td>Pyrites, Phosphates and Chemicals Ltd.</td>
</tr>
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<td>Projects and Development India Ltd.</td>
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Component-wise rank of Achievement Score Method for Environmental Performance for Fertiliser Industry.

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**Summary Of Results Of Environmental Performance Index For Fertiliser Industry**

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Table: A - XII

**Names Of The Firms in the Pulp and Paper Industry Included In The Construction The Environmental Index**

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Table: A - XIV

Component-wise rank of Achievement Score Method for Environmental Performance for Pulp and Paper Industry.

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Table: A - XV

Result of Principal Component Analysis for Environmental Performance Index for Fertiliser Industry

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**Summary Of Results Of Environmental Performance Index For Pulp & Paper Industry**

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