Inbound Supply Chain Methodology of Indian Sugar Industry

R.S.Deshmukh[a] N.N.Bhostekar[b] U.V.Aswalekar[c] V.B.Sawant[d]

[a] (Department of Mechanical Engineering, Rizvi College of Engineering, Bandra (w),Mumbai-50,India rsdeshmukh@ndatmes.com)
[c] (Department of Mechanical Engineering,Vidyavardhini's College of Engineering and Tech.Vasai Road-401202 asolekaruday@rediff.com)
[b d](Department of Mechancal Engineering, Rajiv Gandhi Institute of Technology Andheri, Mumbai-53, India *sawantvb@gmail.com)*

ABSTRACT

In today's global market, managing the entire supply chain becomes a key factor for the successful business. Consistent supply of quality raw materials (sugarcane) for agro processing industries is lacking in many countries of the Region, with inefficient handling and transportation systems. In this paper, the author has discussed the various problems and challenges of Indian sugar industry have been faced over years. This paper discusses the inbound supply chain issues of Indian sugar industry and developed the framework for supply chain modeling.

Key words- Supply Chain, Logistics Models, Sugar Value Chain, Sugar Industry

1. INTRODUCTION:

India is the second largest sugar producer in the world (after Brazil), accounting for around 10-12% of world's sugar production. The Indian Sugar industry started growing in an organized way during the 1930 after introduction of the sugar industry protection act in 1932.

Sugar is India's second largest agro-processing industry. India's sugarcane cultivation area of 4-4.5 million hectares (ha) accounts for 2.7% of India's cropped area. Sugar industry accounted for around 1% of GDP of the country during FY2005. Further, sugar industry contributes an estimated Rs. 17 billion annually to national exchequer and treasuries of various state Governments by way of excise duty and purchase tax on Sugarcane. Sugarcane farmers and their families number over 45 million, constituting about 7.5% of the rural population. The sugar industry employs 0.5 million workers and also provides substantial indirect employment through various ancillary activities. The sugar industry's contribution to the Indian economy is, therefore, enormous. [7]

1.1Global Sugar Scenario:

Sugar is produced in around 122 countries across the world. It is extracted from two different raw materials, sugarcane and sugar beet. Sugarcane is cultivated under tropical climates, while sugar beet is grown in high temperate regions. Around 78 per cent of the sugar produced in the world is created from sugarcane, with beet sugar accounting for the rest. The choice of sugarcane or sugar beet for sugar production is influenced by weather conditions, crop diseases, soil quality, international trade agreements and domestic price support programmes. The cost of producing sugar from cane is less than the cost of producing from beet. Of the 122 sugar producing countries, 67 produce sugar from cane and 55 from beet. [Krc research]

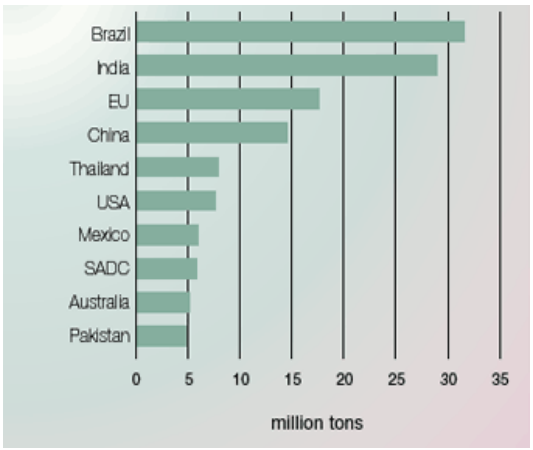


Figure 1: Sugar Production [19]

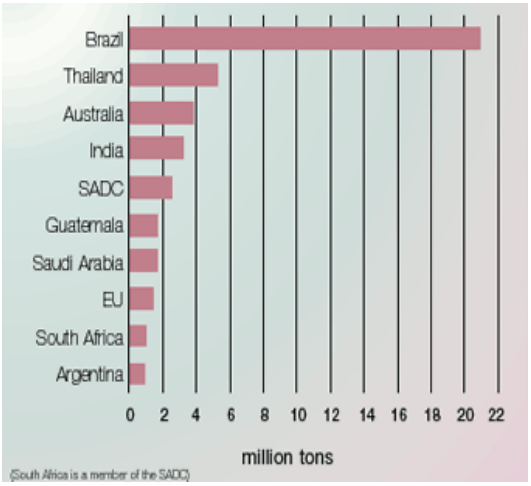


Figure 2: Sugar Exports [19]

The top ten sugar producers account for 77% of global production which was 169 million tons in 2007/08.The figure No.3 is self-explanatory and offers ample scope for reducing the cost of sugar production in India as compared to South African countries and Brazil. [19]

1.1.1 Supply and Demand

In 2007/08, global sugar consumption totalled 157.6 million tonnes, compared with global production of 167.2 million tones, thus creating a surplus of 9.6 million tones. Global consumption is forecast to reach 160.6 million tonnes surpassing production of 153.3 million tones (a year on year decline of 8%), generating a deficit of 7.3 million tonnes. Furthermore, this deficit is expected to continue into the 2009/10 season with a likely shortfall of 3.3 million tonnes. The world consumption is projected to grow to 160.7 MMT in 2010 and 176.1 MMT by 2015.[Source: Czarnikow Research]

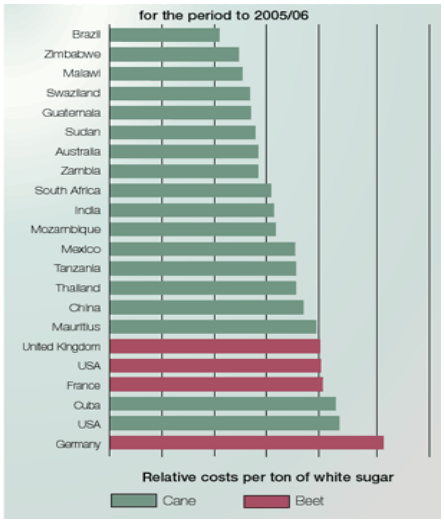


Figure 3: Low Cost Sugar Producers

Consistent supply of quality raw materials (sugarcane) for agro processing industries is lacking in many countries of the Region, with inefficient handling and transportation systems. This situation can improve when a mutually beneficial and stable relationship between the producer and process Industry develops and matures, whichever way as a contractual arrangement or any other suitable form of arrangement.

1.2 Indian Sugar Scenario:

India has 566 sugar mills in the country, of which 56 per cent are in the co-operative sector, 34 per cent in the private sector and the remaining 10 per cent are in the public sector. These processing units are located in 80 major districts and a large number of these units are in Maharashtra (142 in the co-operative sector and 12 in the private sector during 2008-09) and Uttar Pradesh (28 in co-operative sector, 64 in private sector and 22 in public sector as at end 2005-06). The increased number of sugar factories has affected the availability of sugarcane for processing and in turn the viability.

For the entire sugar industry sectors (private, Cooperative and government ownership), the average of 13 years Net Recovery (NR) is estimated to be 9.14% which much lower than average Net Recovery 10.2%. For instance, during the period (1991-2004), Sugar industry in Maharashtra has obtained 11.20% average recovery [Indian Sugar, May 2005, p153]. India's competitiveness has been hampered by the low sugar recovery of 10.2%, as compared with 12-13% in some other major producing countries, and around 14.6% in Brazil. [7]

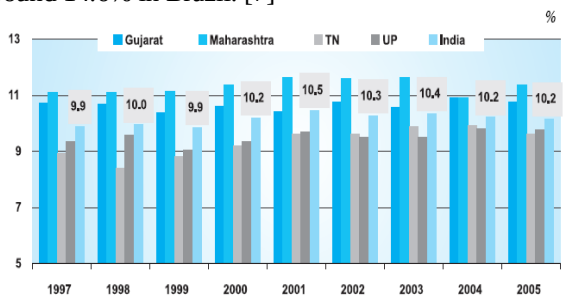


Figure 4: Sugarcane Recovery Rate for Sugar Production (Source: ICRA)

1.2.1Financial Performance:

The Government of India fixes Statutory Minimum Price (SMP) for sugarcane. Moreover, certain State Governments like Uttar Pradesh, Maharashtra insist for an even higher payment in the form of State Advised Price (SAP). The introduction of the Statutory Minimum Price (SMP) for cane is related to recovery percentage, their repeated upward revision and the introduction of the State advised prices (SAP) fixed by the State Governments has

contributed significantly to the expansion in area and production of sugarcane. The relatively favourable prices obtained by cane growers were reflected in the shift in areas, especially in the 1980s, away from Wheat and other competing crops. However, since these price systems provide little incentive to improve quality (in terms of sucrose content); the sugar recovery content of cane has remained stagnant at around10% for the last two decades. [6]

In many sugar producing countries, where cane price is based on the sucrose content and the sugarcane price in India is paid on the basis of weight of cane. This system does not provide an incentive to cane growers to plant high sucrose varieties and adopt practices which increases the sucrose content of the cane at the time of its supply to the mills including harvesting of cane at maturity and minimizing the time involved from harvesting of cane and its supply to the mills. [7]

Sugarcane is the main raw material for sugar industry and accounts for 70-75% of the cost of production of sugar. The harvested cane needs to be crushed within a few hours to avoid loss of sucrose content, necessitating close coordination of harvesting and cane supply with cane crushing operations. The determination of SMP for sugarcane, average recovery rate, and sugar price realisations, affect the financial performance of the sugar industry.

%

FY	2001	2002	2003	2004	2005
Raw Material Cost	76.1	74.1	71.1	73.1	71.7
Power & Fuel	2.6	2.6	2.5	3.6	3.5
Employee Costs	7.7	7.2	6.4	7.5	5.8
Other Operating Costs	13.5	16.1	20.0	15.8	19.0

[Source:ICRA]

Table 1: Break-up of Operating Costs

The main determinants of factory efficiency are cane quality, represented by the pol percent which is the sucrose content in the juice; factory recovery rate, in turn the product of rates of mill house and boiler house extraction. As detailed below, the cost of production of sugar has increased in successive years primarily because of an increase in sugarcane prices, and lower cane recovery rates.

Table 2,shows that the cost of sugar production in Maharashtra is higher than Utter Pradesh, thus there is scope for reducing the sugar production cost

Table2: State wise Cost of Sugar Production

Rs. per kg for S-30 Grade

FY	2002	2003	2004
AP	12.82	12.90	14.13
Gujarat (Saurashtra)		13.16	14.65
Gujarat (South)	11.08	11.95	12.22
Karnataka (North-West)	12.61	13.13	14.86
Karnataka (Rest)	11.96	11.69	13.96
Maharashtra (South)	12.66	13.71	14.98
Maharashtra (North)	12.45	12.91	14.39
Maharashtra (Central)	12.21	12.69	15.22
TN	11.88	12.54	14.38
UP (Central)	11.78	12.62	13.50
UP (East)	12.30	12.80	14.48
UP (West)	11.68	12.39	13.01

2. LITERATURE REVIEW:

There is a literature base of sugar industry related issues like sugar cane quality, Simulation and optimization of

sugar cane, logistics supply system, harvest planning and scheduling, production optimization etc. is carried out in Cuba, Brazil, Australia, France, South Africa.

The literatures of sugar industry of these countries are available.

This range of tools and techniques has several constraints with respect to decision support on organizational issues within poorly integrated sugarcane supply chains. Logistic modeling is hard to apply to complex interactions between independent growers and millers. Firstly, they need a detailed dataset, including field data. Because of the diverse range of growers of various cultures and economic situations, the lack of detailed field data, the need to provide an understandable model to stakeholders and to enhance discussion and negotiation capacities, simulation was preferred over optimization.

In brief, the most important aspect of cane harvesting is being able to determine the optimal combination of transportation means; this result in a minimization of transportation cost and the fulfilment of daily sugar mill supply needs with an acceptable level of quality, avoiding at the same time losses caused by not harvesting. Thus ensuring vertical growth of the sugar industry.

Table 4: List of the Logistical models of sugar value Chain

Model	Sugar Industry	Title of the Paper	Approach
Lopez Milan et al. (2006)	Cuba	Sugar cane transportation in Cuba, a case study	mixed integer linear programming
Iannoni and Morabito (2006)	Brazil	A discrete simulation analysis of a logistics supply system	Simulation
Jiao et al., (2005)		An integrated statistical and optimisation approach to increasing sugar production within a mill region	linear programming
Yosnual and Supsomboon (2004)	Indonesia	An integer programming for sugarcane factory supply allocation	mathematical optimisation
Higgins et al. (2004)	Australia	A framework for integrating and optimising a complex harvesting and transport system for sugar production	mathematical optimisation
Perry and Wynne (2004)	South Africa	The sugar logistic improvement programme (SLIP): an initiative to improve supply chain efficiencies	mathematical optimisation
Le Gal et al. (2004)	South Africa	Value and feasibility of alternative cane supply scheduling	mathematical optimisation
Higgins and Muchow, (2003)	Australia	Assessing the potential benefits of alternative cane supply arrangements	simulation modelling
Milan et al. (2003)	United States	The transportation problem of sugarcane	mathematical optimisation
Ronnqvist, (2003)		Optimisation in forestry. Math. Program.	mixed integer programming
Gigler et al., (2002)		On optimization of agri chains by dynamic programming	Dynamic programming
Loubser, (2002)		Model for estimating effects of harvesting practices on factory output.	linear programming
Diaz and Perez (2000)	Cuba	Simulation and optimisation of sugarcane transportation in harvest season	Simulation
Hahn and Ribeiro (1999)	Brazil	Heuristic guided simulator for the operational planning of the transport of sugarcane	Simulation
Hansen et al. (1998)	South Africa	Using computer simulation to evaluate sugarcane harvest-to-mill delivery systems	Simulation
Grimley and Horton (1997)	Australia	Cost and service improvements in harvest/transport through optimisation modelling	mathematical optimisation

3. PROBLEMS AND CHALLENGES IN INDIAN SUGAR INDUSTRY:

3.1 Introduction

India ranks first in sugar consumption and second in sugar production in world but its share in global sugar trade is below 3%. Indian sugar industry has been facing raw material, and resource as well as infrastructural problems. Globalization has brought a number of opportunities but at the same time posed certain challenges before sugar industry.

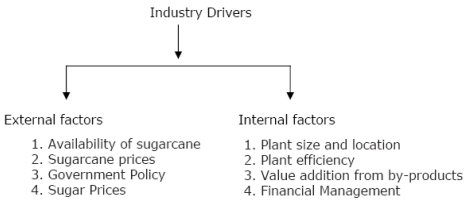


Figure 6: Sugar Industry Drivers

Over the years, the sugar industry has been facing both internal and external challenges. Even after a decade of economic reforms, the industry continues to be under stiff government control right from the procurement of sugarcane to the marketing of sugar and its bi-products.[18]

- Labour cost
- Duration of crushing seasons
- Net sugar recovery percentage (NR) of cane
- Other factors that determine NR are
  - Duration of crushing season,
  - Quality of inputs,
  - Technical efficiencies etc.
- Lack of efficient resource management
- The cyclical pattern of sugar production

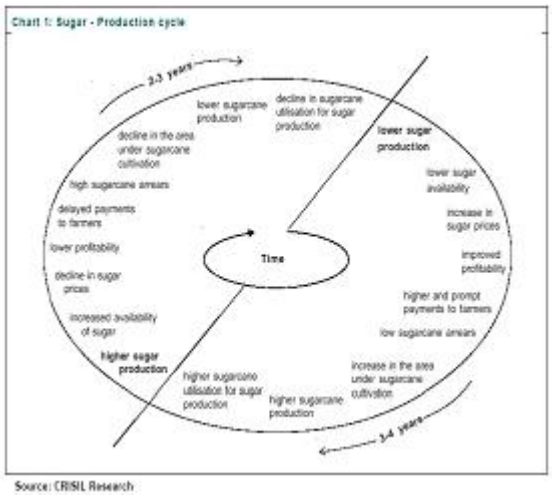


Figure 7: Cyclic Pattern of Sugar Production

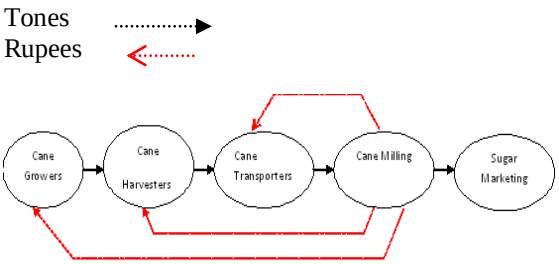


Figure 8: Indian Sugar Supply Chain

3.2 Importance of Crushing

The main concern of sugar industry in India is fluctuations in sugarcane Production due to inadequate irrigation facilities, lower sugarcane yield, and frequent droughts in tropical and sub-tropical areas where sugarcane is grown one large scale. In addition, sugarcane yield has been lower (59 Mts per hectare).
Sugar recovery is also lower in comparison with other sugar manufacturing countries. This leads to escalation of production costs and weakness competitive edge of the industry.
There are several factors related to sugar industry performance such as:

• Sugar production [million tons]
• Average duration of factory [days]
• Average crushing capacity [tons/day]
• Molasses production [million tons]

Sugarcane has to be crushed soon after it has been harvested. The time delay between harvest and

inventory in the yard (for sugarcane to be crushed) cannot be more than 8-12 hours. Anything beyond that can lead to stock-out, and will lead to spoilage of sugar production as well as molasses production. Further, the complexity increases since cane is harvested continuously from a few hundred centers across various remote locations.

3.3 Sugar Cane Transportation System

In India Almost all sugar mills depend for their supplies of sugar cane on large number (5000 to 25000) of independent farmers. The sugar cane harvest is a complex logistical operation that involves the cutting and loading of cane in the fields, the transportation to the factories and the unloading of the cane in the factory.

Each sugar factory has a number of teams, which cut cane with hand (Manual harvesting) in order to meet a daily quota. Sugarcane cutting is a hard and dirty job, but provides employment to people in nearby areas where jobs are scarce. Sugarcane is cut at about ground level, the top green leaves are chopped off and then the stalk is bundled.

Once a complete bundle has been assembled, it is removed from the field with the help of laborers and transferred to a larger vehicle for transport to the mill. Then, depending on the quota for a particular day, resources such as Bullock Cart, tractors and trucks are assigned. The harvested sugar cane should be crushed within 8-12 hrs. to get a good recovery of sugar.

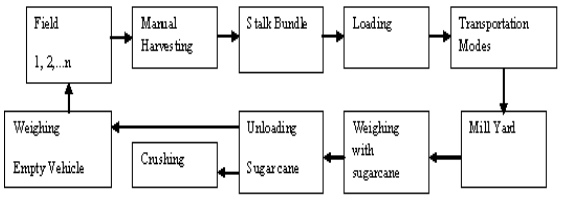


Figure 9: Cane Transportation Process

In view of the changes from year to year in the amount of cane available in the fields and in view of changes in conditions in the factories, a reliable method has to be found to ensure that future requirements could be met efficiently. With a view to cope with the harvest changes from season to season, there has to be a constant and ongoing analysis of the current organization, the available infrastructure and future needs.

4. METHODOLOGY:

To enhance productivity and the competitiveness of Indian sugar industries by modeling and evaluating the inbound supply chain issues for decision support in production planning.

Following objectives have been identified to meet the above goal.

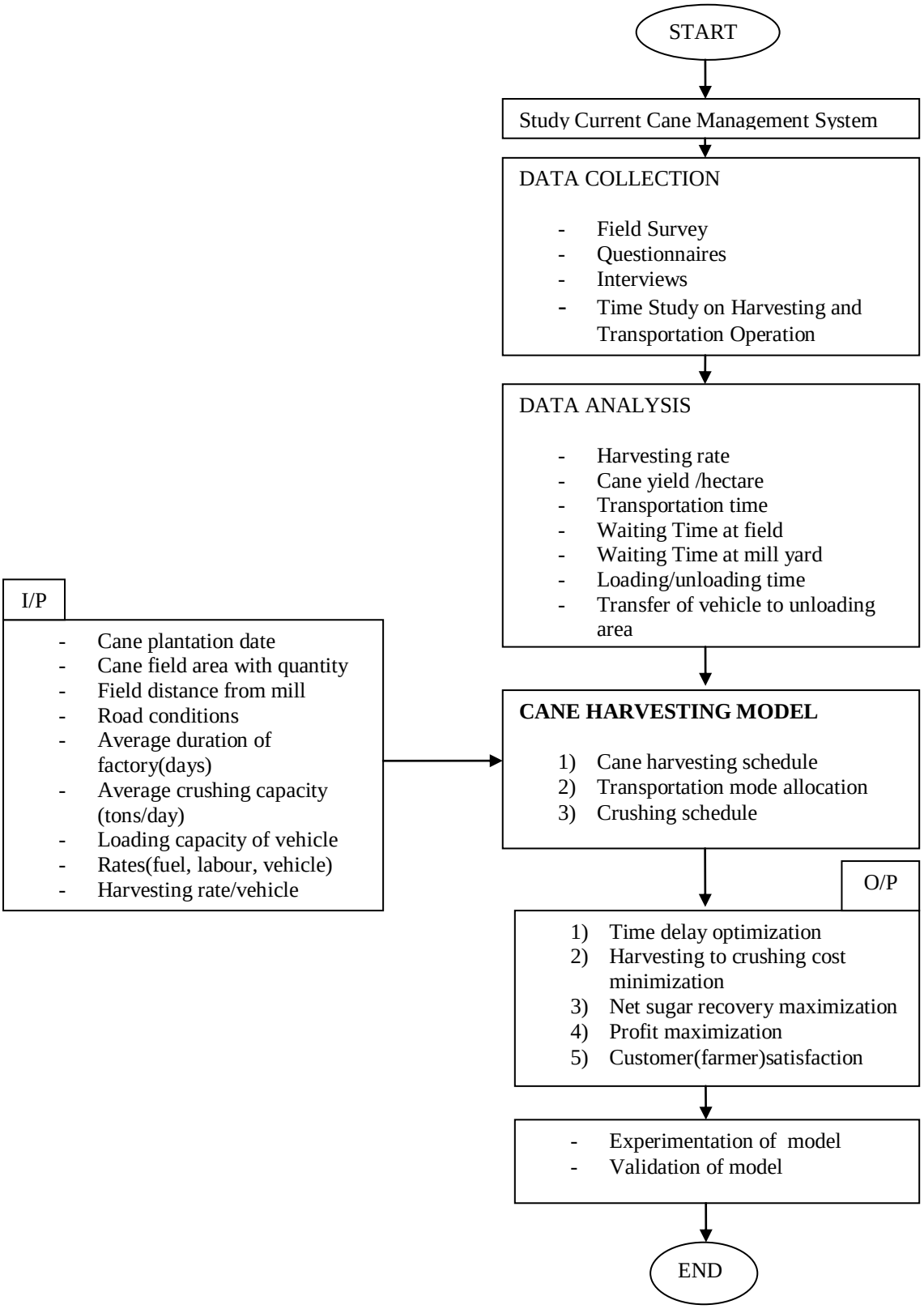
(i) To study the relevant literature with emphasis on current practices followed in Indian context and other countries.

(ii) To understand the working of Indian sugar industry by visits.

(iii) To collect the necessary data for inbound supply chain related issues like harvesting-transportation, crushing time, crushing capacity.etc

(iv) To develop a 'Cane Harvesting Model' for generation of sugar cane transportation schedule subject to constraints such as transportation mode (Bullock Cart, tractors and trucks),crushing delay for better recovery.

To achieve the above goal by considering the various objectives, a new supply chain methodology will be proposed to address the sugarcane supply chain problems.


START
Study Current Cane Management System
DATA COLLECTION
- Field Survey
- Questionnaires
- Interviews
- Time Study on Harvesting and Transportation Operation
DATA ANALYSIS
- Harvesting rate
- Cane yield /hectare
- Transportation time
- Waiting Time at field
- Waiting Time at mill yard
- Loading/unloading time
- Transfer of vehicle to unloading area
I/P
- Cane plantation date
- Cane field area with quantity
- Field distance from mill
- Road conditions
- Average duration of factory(days)
- Average crushing capacity (tons/day)
- Loading capacity of vehicle
- Rates(fuel, labour, vehicle)
- Harvesting rate/vehicle
CANE HARVESTING MODEL
1) Cane harvesting schedule
2) Transportation mode allocation
3) Crushing schedule
O/P
1) Time delay optimization
2) Harvesting to crushing cost minimization
3) Net sugar recovery maximization
4) Profit maximization
5) Customer(farmer)satisfaction
- Experimentation of model
- Validation of model
END

5. IMPLICATIONS:

This study has focused on the relationship between sugarcane growers and millers at a specific management level, the mill supply area. The relationship will be analyzed through the management of cane flows from the growers' fields to the mill as a way to enhance the mill area profitability. The study would be beneficial for growers as well as the millers.

In the proposed Supply Chain Methodology an attempt will be made to minimize harvesting to crushing time to obtain the maximum possible sugar recovery to enhance the profitability of an organization. For this purpose, cane growers and millers are needs to be treated as an inter-dependent enterprise.

This study will make an attempt to develop a systematic approach for analyzing the interfaces between the sugar industry and the farmers (also referred as in-bound logistic analysis) to achieve the above said goal.

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