SCIENTIFIC PROBLEMS OF THE SUGAR INDUSTRY

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The sugarcane industry has many baffling problems to be solved and unless and until active steps are taken to overcome these problems and to solve them by actual scientific research and development, it will not be possible to place this industry on a sound economic footing. The Governments' policy of Selective Control has no doubt been able to tide over the present acute shortage of sugar so much so that our country to-day has become an exporter of this commodity. This policy as a short-term measure has brought this remarkable change and now what is required is not only to increase production but equally to produce better quality of sugar at cheaper rates, so as to increase the internal consumption and to compete in the foreign market. Since the price of sugarcane in India constitutes more than 60% of the price of sugar, the urgent problem before the sugar industry is to reduce the cost of production of sugarcane. This is only possible when the yield of sugar and sugarcane per acre is increased and there is profitable industrial utilisation of its by-products.

It is therefore essential that the existing research organisation be strengthened and for this Government should sanction more funds. At present very little amount is being spent on industrial, technological and agricultural research and development work. A huge research organisation is necessary to conduct large-scale experiments to evolve early and late varieties of cane so as to extend the crushing period which is at present very short as compared with other sugar-producing countries of the world and to discover disease-resisting varieties less susceptible to pests and diseases and varieties which give better yield of sugar and sugarcane per acre.

In short the main scientific problems before the sugar industry may be epitomised as under:—

1. Development of cane (a) to improve the yield of sugar and sugarcane per acre, (b) to evolve early and late ripening varieties, and (c) to control pests and diseases.

2. Evolving more economical and less technical methods for the manufacture of sugar.
3. Improving the technical efficiency of working or minimising manufacturing losses.

4. Industrial utilisation of its by-products.

I shall now deal with some of the points in greater details.

I. Cane Development Work

One of the chief handicaps for the present state of sugar industry in India has been the low yield of sugarcane per acre, which is for all India about 15 tons per acre as compared with 50-60 tons per acre in Hawaii, Java and other progressive sugar-producing countries of the world. The sugar yield per acre for the whole of India is also very low, about 1·5 to 2·0 tons per acre as compared with 8·0 tons in Hawaii and Java; 5·07 tons in Brazil; 3·65 tons in Japan and Formosa; and 3·06 tons in Australia. The higher cost of production of sugar is mainly due to higher cost of the raw material, which is poor both in yield and quality. Unless the yield of sugarcane increases to 30 tons per acre and sugar recovery to 12% on cane, this industry cannot compete in foreign market under any circumstances, so much so that it cannot even survive without protection.

At present the quality of sugarcane is not much of a problem as due to the comprehensive research work done in this direction at the Sugarcane Breeding Station, Coimbatore, and its sub-stations, several standard varieties of sugarcane have been discovered which give greater yield and more sugar. The improved CO varieties now occupy about 90% of the cane area in this country as against that of 11·6% in the year 1928-29 and 75% in the year 1935-36. The achievement of Dr. C. A. Barber, Sir T. S. Venkátraman and Dr. N. L. Dutt and others of this Station in the evolution of improved varieties of cane will long be remembered in the history of sugarcane breeding and development in India and abroad. The varieties evolved there have not only significantly improved the agricultural economy of India, but some of them have been lately introduced and planted in foreign countries like Australia, South Africa, South America and others.

It is regrettable to note that with all the improved “CC” varieties of cane there has been no significant improvement in the yield of sugarcane per acre, mainly due to lack of adequate scientific approach to cane agriculture. It should be clearly understood that the fall in yield not only affects the cane supply to sugar factories, but also affects fortunes of more than ten millions of people who depend on cane agriculture. If the work of cane agriculture and development is carried out carefully on scientific lines, the target figure of 900 maunds of cane per acre in U.P., Bengal and
the Punjab; 700 maunds in Bihar and 1,200 maunds in Bombay and Madras on the average will easily be achieved in the next few years. This sorry state of affairs may be due to the fact that the improved varieties of cane as released by the Research Breeding Stations very often do not give the same results as expected of them under varying climatic conditions and nature of soil. It is therefore essential that the study of the special character of the soil for each factory should be made as the same cane may give quite different yields of cane per acre on different soils and also on the same soil in different seasons. Since the work of this nature has not been done so far at the door of the cultivators, no satisfactory improvement in cane agriculture has been achieved. In the interest of cane agriculture it is suggested that a farm of at least 1,000 acres should be attached with each factory for use as centre of agricultural improvements and as seed nurseries. Soil scientists and sugarcane plant physiologists of the Government as well as the factory technical personnel should work in close association in these farms and study whether the improved varieties of cane as released by Sugarcane Breeding Research Stations can with advantage be grown in the factory zone as well. A work of this nature in the factory zone will give far improved results in a much shorter time.

(a) Irrigation and Manuring.—Substances that act as a growth factor are fertilizers, water and gases like carbon dioxide and oxygen of the air and sunlight. All these factors are indispensible. If there is a shortage of any of them the growth is stunted.

Successful agriculture depends on the joint action of the abovementioned factors, all of them indispensible. Water is more indispensible than the others. Experience has shown that even the best variety of cane does not give the results as expected of it due to lack of timely irrigation facilities in cane areas coupled with the well-balanced organic manures and suitable fertilizers.

Soil scientists and plant physiologists should therefore labour to determine the amount of different fertilizers needed to produce the maximum yield of cane. There should be enough of the three principal elements Nitrogen (N), Phosphoric acid ($P_2O_5$) and Potash ($K_2O$) for a maximum yield. The farmer should know how much of these elements are already present in his soil and how much new fertilizers must be added. The physiologist should actually determine the water requirement of the sugarcane in the factory zone in relation to the fertilizers added to the soil.

A pressing need in sugarcane as well as in all agriculture is for a procedure by which both big and small farmers can easily and inexpensively
make enough field tests to disclose the fertility status of all their cultivated lands. The Mitscherlich's table of one plot test to determine the Law of Diminishing Return will be very much useful.

The sources of organic manure in the world and in this country are limited and this has led to the manufacture of inorganic fertilizers. It is hoped that the Sindri Fertilizer Factory will soon solve this big problem. For organic manures the State should formulate and popularise plans for the utilisation of compost and farmyard manure and other organic village manurial sources. The efforts in this direction require greater publicity. Even now we are not utilising the night soil and other refuse for composting which costs very little but which would give additional revenue. It is hoped that the States would make suitable arrangement for composting this in villages if possible, municipalities and towns and would give technical aid and demonstrations where required.

(b) Control of Pests and Diseases.—One of India's most serious problems in recent years has been the damage done by sugarcane pests and diseases to the extent of many lakhs of rupees annually. In the beginning the diseases were mostly confined to "Desi" or indigenous varieties of cane in Northern India. But at present it is gradually spreading to several "CO" varieties as well. As a result of scientific tests made so far, a few practical methods have been evolved for protection of cane against Red Rot, Smut, and Mosaic diseases and for controlling borers and other insects. But these methods have not been amply demonstrated so far to the cultivators. An intense research in the direction of curative methods is urgently needed.

(c) Small Holdings and Their Disadvantages.—The Indian Agriculture is also backward and cannot progress fast due to small and scattered holdings, which are proving uneconomical to the farmer. He does not know where to go for money to effect improvements or even to meet his ordinary expenses for cultivation. The consolidation of small holdings and co-operative farming will give them the desired salvation and improvement. It should also be remembered that there is a shortage of agricultural labour and the Indian cattle is almost useless and uneconomic in agricultural operation. Hence there is a great necessity for partial mechanisation in cultivation which, though difficult for an individual cultivator to adopt, may become easy by promoting co-operative farming. Our cultivators unfortunately are not co-operative minded and the States will have to make strenuous efforts to educate them.

Cultivators in the East U.P. and North Bihar have very small holdings, while those in the West have comparatively bigger ones. In small holdings
there is no rotation of crop and the cane is grown year after year as it fetches better price and the land consequently becomes cane sick. This also gives low yield and poor quality of cane followed by diseases. Consolidation of holdings will give a fair solution.

2. **Evolving More Economical and Less Technical Methods for the Manufacture of Sugar**

Simultaneously with the efforts in the direction of improvements in cane cultivation, technological researches on improved methods for the manufacture of cheaper and better quality of sugar should be evolved so that the cost of production of sugar may be further reduced. So far very little work has been done in this direction and a more intensive research is needed. Professor J. M. Saha, Director of the Indian Institute of Sugar Technology, has evolved a process "White Sugar Without Sulphur", but his experiment so far is based on laboratory scale only. It is difficult to say at this stage how far his new process is practically workable and economically sound on the industrial scale. But still his efforts in this direction deserve appreciation as it might solve the problem of the shortage of sulphur which is largely imported. Professor D. N. Ghosh of the Science College, Patna, has invented and patented a process for the clarification of cane juice by an electrical process without the aid of chemicals and of heat. The process seems to be theoretically correct and economically sound but it has not been tried on commercial scale to my knowledge, and no definite opinion can be expressed at this stage. In these days of limited profits to sugar industry, sugar factory owners do not easily come forward to undertake the risk of a trial with a new research in their factories. It is therefore suggested that the Experimental Sugar Factory attached to the Sugar Institute, Kanpur, should be enlarged in capacity and equipped so well as to enable the practical technologists and the research scholars to experiment there on the industrial scale. The humble writer has some of his own valuable researches waiting for such trials.

3. **Improving the Technical Efficiency of Working**

Regarding the technical efficiency, the industry has achieved a fairly high efficiency in working as compared with the other leading sugar-producing countries of the world. The over-all efficiency (which denotes the technical efficiency of the factory) has gone up from 83.5% in 1934 to about 86% now, which is better than Natal (82-83%) and is equal to Mauritius, Java and Cuba, but is still less than Hawaii (89%), and Formosa (91%). The recovery of sugar has also much improved in recent years.
There is still scope for improving the efficiency of the factory. The existing plant must be designed to avoid the basic causes of lack of efficiency. The most skilled operator regardless of his ability and devotion to work cannot adjust and balance the operation as effectively as can automatic instruments. The utilisation of steam flow, pressure and vacuum recorders attached to various units not only results in a more uniform operation but also in saving much fuel. It must be clearly understood that the secret of obtaining higher over-all efficiency depends on the regularity in its operational conditions, regularity in the juice and steam flow and maintaining high vacuum without fluctuation. Unless these conditions are improved to the optimum with the help of the automatic instruments and devices, all considerations on the improvements in the construction and design of the plant will prove worthless.

I sincerely feel and regret to note that the importance of technical and scientific control has not been realised fully so far by most of the factory owners.

Persistent demands for increasing labour wages also forces us to replace hand labour with mechanical and automatic operations.

4. INDUSTRIAL UTILISATION OF THE BY-PRODUCTS OF THE INDUSTRY

The cost of production of sugar in a very large measure would also depend on the profitable utilisation of the two chief by-products of the industry—molasses and bagasse.

(a) Bagasse.—It is an important by-product of the industry and not a waste product. It is used as fuel in sugar factories, where power and steam are important cost items in the manufacturing process.

Our country is short of cellulosic materials and bagasse can well be utilised as a source of cellulose in several essential industries, as for example Paper, where foreign currency is involved. Bagasse on dry weight contains about 18% lignin, 15% water-soluble substances, 45% cellulose and the remainder hemi-cellulose. The prospects of its utilisation in any other industry, however, depends upon the economic supply of the alternative fuel. Fortunately our country is in a position to replace bagasse by coal and the bagasse so saved can be used with advantage in other industries.

Our cane varieties in general have a large percentage of fibre, 15% and above. The Java cane has about 11–12% fibre and factories operating there under conditions of improved heat balance do not require extra fuel. Potentially our factories have surplus bagasse. With similar improved heat balance the saving in term of fibre in bagasse should therefore be about
3 to 4% on cane. A further surplus of fibre by about 2% can be achieved by making the plant semi-electric. The total surplus in that case will come to 5 to 6% of fibre on cane. Bagasse produced by our mills is in the neighbourhood of 5 million tons every year, almost the whole of which is used as fuel. From the above calculations about 2 million tons of bagasse can therefore be economically used for other important industries in India. In U.P. and Bihar where more than 75% of sugar is made the surplus bagasse will be about 1·5 million tons, and the remaining 2·5 million tons of bagasse will be used as fuel. If coal replaces one million tons of bagasse, then the total bagasse available for other industries will be to the extent of 2·5 million tons. In U.P. and Bihar sugar mills are practically clustered which offers a definite advantage in the transportation of bagasse from several mills in the neighbourhood to work a central paper mill or a chemical industry.

Cardboard manufacture from bagasse has been undertaken by some enterprising industrialists but paper pulp manufacture entirely from bagasse has yet to be undertaken. Availability of bamboos and Sahai grass for the production of papers is limited, because the former is used for a large variety of purposes and the latter grows in particular areas.

The other outstanding successful industrial utilisation of bagasse as a raw material has been in the manufacture of wide varieties of insulating and hard board products for the building industries and for providing insulation against heat, cold and sound. Louisiana, Hawaii, Australia, Cuba and England are doing so. The Japanese are said to have manufactured insulating building board from Bagasse in Formosa. According to Dr. C. E. Lathrop, "bagasse, because of its long tough, springy character is a superior raw material for the manufacture of insulating building board products and that it is not possible by known means to produce a fibre of similar properties from wood." Intensive experiments conducted in America have shown that fibres of the rind and bundles are excellent for producing writing and fine papers.

Bagasse is not only a source of useful fibre but also is an excellent source of chemicals. These chemicals are formaldehyde, furfuraldehyde and various ketones.

As bagasse contains a large proportion of pentosans, it is a very suitable raw material for the production of furfural which has a wide range of uses, commencing from the synthetic manufacture of Rubber and Nylon to the separation of vegetable oils into food and paint oil constituents.
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(b) Molasses.—Production of molasses by central sugar factories is of the order of 4 to 5 lakh tons annually and the disposal of the same was a problem of great headache to the industry even a few years back. But use of alcohol in admixture with petrol due to Government policy has now relieved the situation. Price of molasses fixed for this purpose, however, continues to be unremunerative, as price of alcohol is linked up with that of petrol. Molasses contains about 28 to 30% sucrose, 16 to 20% reducing sugars and a substantial quantity of aconitic acid, besides valuable nitrogenous substances, potassium salts and phosphates.

Molasses is now sold to the distilleries of Northern India at a price less than Rs. 6 per ton ex-factory, whereas the actual sugar content of a ton of molasses has a value of Rs. 175 to Rs. 200 at the present cost price of sugar. If the price of sugar is to be reduced it is not sound economics to remain satisfied with this price of molasses which may go down still lower if the petrol becomes cheaper. It has not been possible so far to extract sugar of molasses profitably but with a more intensive scientific research it should be possible to utilise the different constituents of molasses in producing other useful substances. Bio-chemical methods may come to our aid in producing lactic and citric acids. How to improve yields of acetone and butanol requires our concentrated attention.

Molasses contains an appreciable quantity of aconitic acid. If in near future, industries requiring aconitic acid and its derivatives are developed, molasses will be a very good source of the same. Our efforts should be directed to develop a suitable method of recovering this particular acid.

There are still many more possibilities to be explored and the field is still a fertile one in which important developments may confidently be expected in the future.

Conclusion

The sugar industry has many baffling problems to be solved. The great problem before the industry is to produce sugar at cheaper rates, so as to increase the internal consumption and to compete in the foreign market, when Protection is lifted. This object will only be achieved if the cost of production of sugarcane is reduced by scientific methods of cultivation and processes evolved for the profitable utilisation of its by-products. A huge research organisation is necessary to conduct large-scale experiments in the domain of agriculture and technological developments. Early and late varieties of cane should be evolved to extend the period of crushing, especially in U.P. and Bihar. How to produce disease-resisting varieties and the type of cane which gives better yield of sugar and sugarcane per acre, needs urgent
research. Less technical and improved methods for the manufacture of cheaper sugar should be discovered by intensive technological researches. Pests and diseases play a great havoc with sugarcane crop. Although some preventive methods have been evolved which need greater demonstration, curative methods are yet to be investigated. Farmer should know the condition of his soil and what fertiliser is needed. A pressing need in sugarcane agriculture is for a procedure by which both big and petty farmers can easily and inexpensively make enough field tests to disclose the fertility status of the soil. The Mitscherlich table, of one plot test to determine the law of diminishing return will be very useful. Our country is short of cellulose materials and bagasse can well be utilised as a source of cellulose in several essential industries like paper and insulating materials. Availability of bamboos and Sahai grass for the production of paper is limited and therefore bagasse can be used in its place. Coal can be used in place of bagasse to develop subsidiary industries. The use of molasses for the production of power alcohol has now removed the great headache for its disposal, but the price of molasses fixed for this purpose is unremunerative for the industry, and it is suggested that a part of it may be utilised to produce chemicals like aconitic acid, lactic acid and citric acid.

Government should allot more funds for the development of the by-product industries.

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