PERFORMANCE IN THE FACTORY

Factory Recoveries

The ability to produce sugar from cane or beet depends not only upon the quality of the agricultural raw material supplied by the farmer but also upon the efficiency of the factory. Therefore, I have prepared Diagrams 9 to 12, describing the ability of processors to extract sucrose from cane or beet in the mill or diffuser, and then the subsequent boiling house recoveries. These are brought together in Diagrams 13 and 14, which reveal the trends in the overall factory recoveries achieved in each country.

Mill extraction rates are, as one would anticipate, typically higher with diffusers (the two beet industries, as well as South Africa) than with mills. The exception is Australia, where the CCS payment system, which includes the purity of the first expressed juice as an important element in the determination of the price of cane, gives growers an incentive to ensure high cane quality and millers a strong incentive to maximise the power of the first mill and achieve very high mill extraction rates.

Generally speaking, mill extraction rates have increased in the industries with the least impressive performance. Thailand, whose sugar sector was small and inexperienced in the 1960s, has made particularly good progress. In fact, once you allow for the staleness and poor quality of Thai cane, the Thai mills are now achieving one of the world’s highest reduced recovery rates.

The boiling house recoveries, depicted in Diagrams 11 and 12, demonstrate that Australia is again far ahead of most other industries. The diagrams also illustrate the improvements made by the Thai industry since its early days as a substantial producer. For the other countries, the underlying pattern is best described as flat, with few clear signs of consistent gains or setbacks for the other cane and beet producers.

Diagram 9: Mill Extraction Rates — Asia, Oceania and Africa

![Diagram 9: Mill Extraction Rates — Asia, Oceania and Africa](image-url)
Diagram 10: Mill Extraction Rates — The Americas (for Cane) and the EU and US (for Beet)

Diagram 11: Boiling House Recoveries — Asia, Oceania and Africa
Diagrams 13 and 14 combine the mill extraction rates and the boiling house recoveries to yield the overall factory recoveries. The outstanding performance of Australia is very evident, as is the tremendous improvement in the overall recoveries recorded in Thailand. Apart from that, there is little change to observe in the outcome in the other countries in the diagrams. These have mainly remained fairly steady between the high 70s and mid 80s in terms of the percentages recorded as their overall recoveries.

(The two countries with the lowest overall recoveries in the second of the diagrams deserve a special explanation. In the case of Centre/South Brazil, the massive Proalcool fuel alcohol programme has affected the attitude of processors towards the exhaustion of the cane juice in the boiling house. Rather than produce B and C strikes, they nearly all have alcohol circuits alongside their sugar circuits. Therefore, they produce only one strike of sugar, which is of a plantation white standard, known as cristal sugar, and is used for final consumption. The A molasses then goes directly to the distillery for fermentation, together with the sucrose which would be recovered in a more conventionally configured sugar mill.

The US beet industry is the other with a poor overall recovery. This reflects the losses of sucrose during the long periods of storage in mid-winter, before processing. If one records overall recoveries in terms of the sucrose in the beets entering the slicer, rather than the beets entering the factory gate, then the performance is much more creditable, and is in line with the EU outcome.)
Diagrams 15 and 16, in a sense, represent the culmination of the current line of analysis. They depict the recovered yields of sugar per hectare per annum in the sample of major producing countries. (For the beet producers, the values are in terms of white sugar; for the cane industry, they refer to raw sugar.)
Once again, the overall impression of the underlying trends in yields is not one that shows the cane sugar industry in a very favourable light. The beet sugar producers, and the EU beet industry, in particular, have succeeded in raising their yields of recovered sugar per hectare appreciably over the past 25 years.

Most cane industries have shown only modest improvement. Thailand is the best of the cane producers, in this respect, and Mexico has also improved significantly, when recent yields are contrasted with those of the late 1960s.

In terms of the recorded yields of recovered sugar per hectare per annum, the majority of the countries now achieve a performance that lies between 4.5 and 7.0 tons. The outstanding exceptions are Colombia (which produced close to 11 tons of recovered sugar per hectare per annum in the early 1990s) and Australia (with over 9 tons). These are not the only countries to attain such high levels of productivity. Several of the Central/Southern African nations vie with Colombia for the prize of the highest yielding country of all.

Irrigation is one factor behind the highest yields, though Australia’s industry is still mainly rain-fed. Climate and good varieties are also important; but the human element must not be taken for granted, and there can be no doubt that good management and co-ordination of the agricultural and processing ends of the industry contribute appreciably to a successful performance.

Diagram 15: Recovered Sugar Yields per Hectare per Annum — Asia, Oceania and Africa
Yields in both field and factory operations are important in determining the long term viability of a sugar industry, but they are by no means the sole determinant of success. One need only remember what has happened inside the United States sugar industry, for example, to appreciate this. Hawaii has always been outstanding as a place in which to grow and crush sugar cane. It has agricultural yields which are unrivalled elsewhere; and its millers crush cane 12 months of the year, which should guarantee very efficient mill utilisation. Yet, Hawaii’s industry has contracted tremendously in the past decade. Meanwhile, the beet industry in the Upper Midwest, where the ground is frozen for five months a year, and where beet sugar yields per hectare are a tiny fraction of those in Hawaii, has gone from strength to strength.

The reasons for this paradox are economic. In some cases, such as certain Caribbean islands or Hawaii, economic development and tourism have pushed wages up to a point where sugar production ceases to be profitable. In other cases, high sugar yields are often an indication that the land in question is excellent for growing other crops, too. The migration of sugar mills from the Central Region in Thailand to the North and North East has reflected the growing value of land for horticulture, as well as urbanisation.

Factory operations are a further respect in which sugar producers have only partial control over their economic competitiveness. One way in which they can exert some control over their profitability is by exploiting economies of scale. Therefore, I have prepared Diagrams 17 and 18, describing the average factory sizes in the countries selected for comparison.

Thailand proves to have the largest factories of all, followed by Australia, averaging between 10,000 and 12,000 tcd. Brazil, US Cane and South Africa are all close to 7,000 tcd in size. The two beet industries, as well as Colombia and Mexico, lie between 4,500 and 6,500 tons per day. India, with barely 2,500 tcd, and China, with only half of that figure, bring up the rear.
Diagram 17: Average Factory Size, Early 1990s — Asia, Oceania and Africa

Diagram 18: Average Factory Size, Early 1990s — The Americas (for Cane) and the EU and US (for Beet)
Another important determinant of the economics of processing is the length of the crushing season; and this is depicted in Diagrams 19 and 20. This is a measure in which cane mills are typically better placed than beet factories. Colombia is the ideal, with its year-round crushing. South Africa and Centre/South Brazil also do well, with over 200 days of processing each year. In the case of South Africa, the climate is the main determining factor. For Brazil, however, the Proalcool fuel alcohol programme makes it possible to extend the milling season, so as to crush cane at the two ends of the harvest period, when the low sucrose content is complemented with an acceptably high level of other fermentable sugars, and this enables millers to use most of the cane juice obtained at that time for alcohol fermentation.

India, China, US Cane, Mexico and Australia, are all cane producers with a season that extends for close to five months. Thailand is the only cane producing country in the group whose millers typically crush all of their cane within approximately four months. This cannot really be blamed upon the climate. In the North East of the country, the season can be stretched as long as 200 days, if adequate cane supplies exist. The problem is more one of excess milling capacity than of climatic reasons for the low utilisation of the investment in factories.

The US beet industry, like its European counterpart, has to harvest most of its beets within a period of a month or, occasionally, two. Cold weather at that time of year allows growers and factories to stockpile beets, without too much deterioration, sometimes until Spring arrives. In the really cold parts of the Mid-West, the beet slicing campaign can extend to 200-250 days, using frozen beets for much of the time. In the EU, the temperatures in Winter tend to bounce between freezes and thaws, forcing many processors to squeeze their campaigns into periods as short as 60-70 days, and restricting the EU average to below 90 days.

Diagrams 21 and 22 translate these data on campaign lengths into the productivity of average factories, measured by the annual tonnages of sugar which they manage to produce from each ton of daily crushing or slicing capacity.

One of the conclusions to be drawn from comparing these two diagrams will probably surprise many people. This is the high productivity of the US beet industry, which manages to produce 20 tons of sugar in a year from each ton of daily beet slicing capacity. Not only does it have a fairly long campaign; it also enjoys high sucrose beets and has less down-time than most cane mills (because the beets are processed direct from stockpiles for much of the campaign, there are few stoppages caused by a lack of beets).

It is no surprise to find that Colombia has, by far, the best productivity of its milling investments, producing 26 tons of sugar per tcd of installed capacity. The US beet industry follows Colombia, and South Africa, with its fairly long season, comes a little further behind, with an average of 18 tons of sugar per tcd of capacity, during the early 1990s (when, admittedly, South African output was hit hard by drought).

Australia manages to produce 16 tons of sugar per tcd of capacity, while most of the others lie between 10 and 15 tons of sugar per tcd. As we have already noted with US beet, thanks to the high rendements that it obtains, and the very limited amount of down-time, the EU beet industry does better than one might expect. It actually squeezes ahead of Mexico, India and the US cane industries, even though its campaign length is so short.

The least satisfactory performances, from the perspective of factory productivity, are those from the Chinese cane industry and from Thailand, both of which produce only 9 tons of sugar in a year from each ton of crushing capacity. In other words, an investment in a given size of mill, say, 5,000 tcd, will yield approximately three times as much sugar in a year in Colombia as it will in Thailand.
Diagram 19: Average Campaign Length, Early 1990s — Asia, Oceania and Africa

Diagram 20: Average Campaign Length, Early 1990s — The Americas (for Cane) and the EU and US (for Beet)
Diagram 21: Annual Output of Sugar per Ton of Daily Crushing Capacity - Asia, Oceania and Africa

Diagram 22: Annual Output of Sugar per Ton of Daily Crushing Capacity — The Americas (for Cane) and the EU and US (for Beet)
A final point of comparison that I would like to mention is in the main respect in which cane mills are customarily assumed to fare better than beet factories, namely in their energy requirements. With bagasse available more or less as a free good, cane mills have, at least until very recently, tended to take their energy needs for granted.

Consequently, beet factories, which have to buy all of their energy, are now much more efficient in their use of energy, as Diagram 23 illustrates. Many beet factories are now at the point where the by-product credits from the sale of beet fibre, in the form of beet pulp, actually exceed the costs of energy, which puts them in a better economic position than a large number of cane mills.

Beet factories have also made considerable progress in boosting their energy efficiency over time, whereas co-generation projects among sugar millers are still something of a rarity. Diagram 24 depicts the trend in the energy use per ton of beets inside French beet factories. If one superimposed the world crude oil price on top of this curve, it would soon be apparent that energy savings are strongest two or three years after a period of high oil prices. Efforts to save energy are given a lower priority when oil prices are low.

The trend in the energy use per ton of beet sugar is more impressive than that per ton of beets, as the final diagram reveals. The continual progress in reducing the TBTS ratio means that fewer beets are needed over time to produce one ton of sugar, and this generates the downward curve contained in Diagram 25.

The cane sugar industry cannot afford to be complacent. If the beet processors can make such dramatic progress in their energy savings, while the cane sector marks time, the beet industry should be able to pose a greater competitive threat in the long run.

Diagram 23: Productivity of Energy Use in Factories
CONCLUSIONS

This quick tour of the world of cane — and of beet, too — has focused upon the technical aspects of the competitiveness of leading producers. There can be no doubt that technical competitiveness is important for the long run success of an industry, but it is valuable to repeat a warning made during the course of this paper, which is that economic competitiveness is not synonymous with technical competitiveness. The contrast in virtually every measure of technical efficiency between the Hawaiian cane industry, at one end of the spectrum in terms of efficiency, and the Upper Mid-West US beet industry, which is down towards the other end, illustrates this very well. Hawaii may win hands down from a technical point of view, but while the Minnesota and North Dakota sugar beet sector continues to go from strength to strength, Hawaii’s industry is now only a pale shadow of its former self.

This same warning should be borne in mind when reviewing some of the comparisons prepared for this paper. Thailand frequently appears as one of the lowest productivity producers in the diagrams, and yet it is now consistently one of the world’s top three cane sugar exporters, without any substantial government financial support.

Despite these qualifications, it is generally true that economically successful industries are also at the vanguard of technical improvements. Australia, in particular, performs well in the field and the factory, given the constraints of a largely rain-fed agriculture and a milling season which is restricted by the timing of the rainy season.

Those industries with natural advantages, such as access to irrigation, very long crushing seasons, a climate which favours high sucrose contents, etc., tend to fare well in our comparisons. One country which benefits substantially from these factors is Colombia. India has had a boost from access to irrigation. South Africa has the advantage of a longer milling season than most other countries.

In terms of self-made benefits, there are a few valuable pointers from the paper. Thailand is to the fore in only one respect: the size of its mills, which gives it economies of scale, and thus reduces its milling costs. Presumably, these advantages are sufficiently substantial to have enabled the industry to expand rapidly, despite a relatively poor technical performance in other respects. Another self-made benefit is evident for Brazil, where the Proalcool programme for the production of fuel alcohol has enabled sugar millers, with annexed distilleries, to extend their processing season, and thereby reduce their unit costs.

Beet sugar has been included in the comparisons as an indication of the ways in which a quite different type of sugar industry has gone about raising its productivity. One self-made benefit which we have identified is the yield increases which have been made possible as a result of the development of new varieties by the private sector, commercially orientated beet seed industry. Another lesson which the cane sector could learn from its beet counterparts is the scope for greater energy efficiency.

The list could be made much longer, and undoubtedly will be added to during the course of the current Congress. That is why ISSCT Congresses are such a vital element of the sugar world, to economists, such as me, as well as to the cane technologists for which the Congress is designed.

Thank you very much for giving me this opportunity to put on paper some of my thoughts about international productivity comparisons.
International Productivity Comparisons — An Abstract

The paper presents comparisons of technical efficiency in both field and factory operations over the past 25 years in a cross-section of leading sugar producing nations worldwide.

In the field, the greatest progress in improving yields occurred in India and the EU beet industry. In South Africa, Thailand and the US cane industry yields declined; yet this did not prevent Thailand from expanding rapidly as a sugar producer.

The beet sector has outstripped cane in increasing sucrose content. Consequently, the beet industry has increased the sucrose obtained per hectare, while most cane industries’ sucrose yields are close to the levels of the late 1960s.

In the factory, Australia has been outstanding in its overall recoveries. Most countries’ recovery percentages have been steady between the high 70s and mid 80s.

Beet has done better than cane in raising overall sugar output per hectare per annum, but Colombia (11 tons/ha/yr) and Australia (over 9 tons) were outstanding.

In the factory, Thailand is to the fore in mill size. The length of campaign favours Colombia, while the EU has the shortest season. Overall output of sugar/ton of daily crushing capacity is highest for Colombia and US beet.

In energy efficiency, beet factories are far ahead of cane mills.

key words
Yields; Cane quality; Mill productivity; Energy saving