Agribusiness Handbooks

vol. 4

Sugar Beets / White Sugar

This publication was prepared by the FAO Investment Centre under the FAO/EBRD cooperation agreement to provide quick technical and economical reference material to EBRD's agribusiness team in sub-sectors where they often work. Focus was given to the Bank's countries of operation in Eastern Europe and the Commonwealth of Independent States, with indicators of technical and economical performance in other regions of the world noted for comparison.

The series of handbooks contained in this publication cover specific agribusiness sub-sectors, with information on production and processing techniques, costs and margins, world production, prices and trade trends. Data were collected from a number of official and unofficial sources as indicative information that should be interpreted with caution, and do not imply the expression of any opinion by FAO concerning the economic situation of countries mentioned.

(October 1999)

1- SUGAR BEET CULTIVATION

It is thought that sugar (cane sugar) was first used by man in Polynesia. Sugar was only discovered by western Europeans as a result of the Crusades in the 11th Century. Sugar beet was first identified as a source of sugar around 1750. By 1880 sugar beet had replaced sugar cane as the main source of sugar on continental Europe.

About 30% of the world's supply of sugar is nowadays derived from sugar beet, the vast majority of which is produced in industrialised countries, while the 70% remaining are derived from sugarcane, mainly produced in developing countries, under tropical climates.

Annual consumption is now running at about 120 million tons and is expending at a rate of about 2 million tons per annum. The European Union, Brazil and India are the top three producers and together accounts for some 40% of the annual production.

1.1. Key production parameters

- Sugar beet is a **temperate climate** biennial root crop. It produces sugar during the first year of growth in order to see it over the winter and then flowers and seeds in the second year.
- It is therefore sown in spring and harvested in the first autumn/early winter (relatively long **growing season)**
- Sugar beet is a profitable crop which is always incorporated into a **rotation scheme**.
- A sugar beet factory can only be operated efficiently if the quality of the beet received is suitable for processing. Cultivation techniques and material inputs must therefore be adapted to the climate and soil types of the region.

As the season progresses in the average climatic conditions of Western Europe, changes occur in the crop before lifting, approximately as follows:

	harvest in Sept.	harvest in Oct.	harvest in Nov.	harvest in Dec.
Yield (ton of washed beet/ha)	up 3.75	up 1.9	down 1.25	down 1.25
Sugar content (%)	up 1%	up 0.25%	down 0.25%	down 0.75%
Yield of sugar (kg/ha)	up 1000	up 375	up 190	down 60

source: Farm Management Pocketbook - John Nix - September 1998

- The average global **yield** is 50 tons/ha. However, depending on climatic and cultivation conditions, specific yields can vary as much as between 30 and 70 tons/ha. Maximum yields can only be obtained when the spacing between rows and seeds within the rows has also been optimised.

Illustrative Yields During the Period 1994-1998 (tons/ha)

	Romania	*Poland*	*Ukraine*	*Russian Fed*	*Italy*	*UK*	*USA*	*France*
1996	21	39,4	18,3	15,2	44,9	52,3	45,2	67,8
1998	20,7	37,7	16	13,4	43,5	51,8	50,4	76

sources: FAO STAT

- Average composition of sugar beet:

	sugar (sucrose)	molasses (48% sucrose)	fibre (pulp)	water
(root without aerial leaves)	14,0%	3,7%	5,5 %	76,8%

1.2. Total world production & main producers

Area Cultivated and Production of Sugar Beets in the Main Producing Countries and Regions

Country or region	1996			1998		
	Area ('000 ha)	Production ('000 tons)	%	Area ('000 ha)	Production ('000 tons)	%
EEC (total)	*2 108*	*113 976*	*43*	*2 037*	*114 400*	*44*
France	460	31 211	12	413	31 407	12
Germany	515	26 064	10	503	26 940	10.5
Italy	273	12 250	5	287	12 521	5
UK	199	10 420	4	189	9 802	4
Spain	157	8 236	3	153	8 918	3.5
Other European (total)	*963*	*35 267*	*14*	*809*	*30 220*	*12*
Poland	452	17 845	7	401	15 100	6
Czech republic	104	4 315	1.5	85	3 722	1.5
Hungary	118	4 677	1.5	79	3 200	1.5
USA	535	24 204	10	587	29 628	11.5
Ukraine	1 260	23 008	9	1 000	16 000	6
China	656	16 726	7	510	14 000	5.5
Russian Federation	1 060	16 166	7	806	10 800	4
Turkey	422	14 543	5	500	20 000	8
Iran	149	3 686	2	191	4 754	2
Others	**498**	**7491**	**3**	**514**	**19 060**	**7**
World Total	**7 651**	**265 924**	**100**	**6 954**	**258 860**	**100**

sources: FAO STAT

Brazil, India, China and Australia are dominant in sugar cane production while Europe is dominant in sugar beet production with yearly 45-50% of total world production.

1.3. Key production costs

For an average yield of 50 ton/ha obtained in in good cropping condition with availability of all necessary good quality inputs, the variable costs per ha are roughly as follows:

Seeds	Fertilisers	Sprays	Machinery (contract)	Transport	Salaries	Others	**TOTAL**
US$ 190	US$ 200	US$ 245	US$ 230	US$ 300	US$ 130	US$ 50	**US$ 1 345**

source: Farm Management Pocketbook - John Nix - September 1998

On the top of those cost must be added operative cost and maintenance for machinery as well as its depreciation (average US$ 240 / ha).

The relatively high prices the farmers receive justify the important level of resources required to obtain good yields up to 50-60 tons/ha.

1.4. Sugar beets sale's prices

Sugar Beet Average Sale's Prices (US$ per clean tonne)

EU - Quota A			World Prices		
1995-96	**1996-97**	**1997-98**	**1995-96**	**1996-97**	**1997-98**
60.1	55.8	57.2	22.3	13.5	10.6

source: Economics of the UK Sugar Beet Industry - University of Cambridge, 1998

Prices which European farmers receive for their beets are largely **subsidised**. Processors pay only a part of the market value, the remaining amount being paid partly by the profession and partly by the consumers themselves. A short calculation illustrates quite well what happens:

To produce one ton beet sugar, one needs about 7.7 tons sugar beets (ref. page 6), which represents an amount of 7.7 x 55 = US$ 423, to which must be added all other production costs, whereas world market price for white sugar varied only from US$ 400 down to US$ 250 during the four past years (ref. page 7).

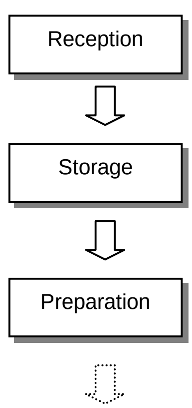
1.5. Average margins for producers

Assuming that the average sale's price of clean ton of sugar beet at standard 16% sugar content is US$ 55 per ton and average yield around 50 tons / ha, the general output is 55 x 50, i.e. US$ 2 750.

Gross margin for production of sugar beets is 2 750 - (1 345 + 240) = **US$ 1 165 / ha**

2- SUGAR BEETS PROCESSING INTO WHITE SUGAR

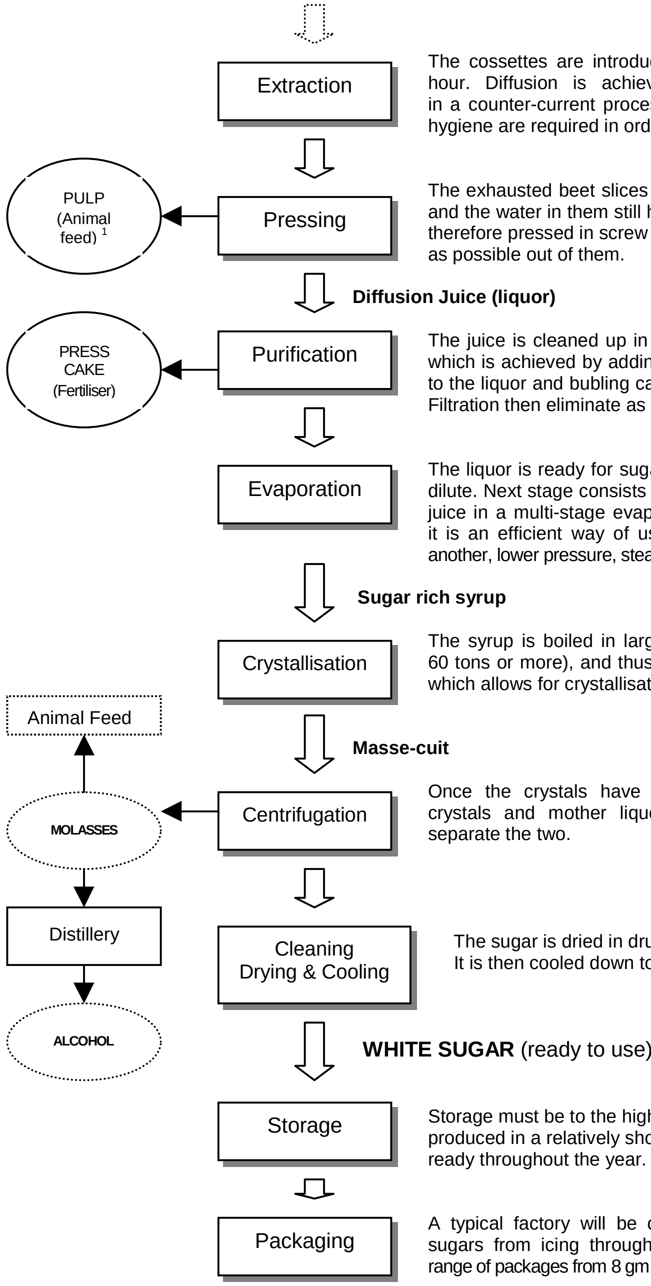
2.1. Process description



Sophisticated sampling and analysis systems have been developed to determine the sugar and impurities content (beet leaves, stones and other trash material) in each load so that accurate payment methods are applied.

Necessity for storage at the factory will depend mainly on climatic conditions but can require several weeks' supply where harvesting disruption occur.

Beets are thoroughly washed and separated from any remaining impurities.
They are then cut into chevron shaped slices (cossettes) with the view of increasing the surface area of the beets.



The cossettes are introduced into a diffuser for about one hour. Diffusion is achieved with water at about 70°C in a counter-current process. Strict temperature control and hygiene are required in order to achieve maximum extraction.

The exhausted beet slices from the diffuser are still very wet and the water in them still holds some useful sugar. They are therefore pressed in screw presses to squeeze as much juice as possible out of them.

The juice is cleaned up in a process known as carbonation, which is achieved by adding milk of lime (calcium hydroxide) to the liquor and bubling carbon dioxyde through the mixture. Filtration then eliminate as many impurities as possible.

The liquor is ready for sugar production except that it is very dilute. Next stage consists therefore in a concentration of the juice in a multi-stage evaporator. This technique is used as it is an efficient way of using steam and it also generates another, lower pressure, steam, which can be used for next step.

The syrup is boiled in large vacuum pans (typically holding 60 tons or more), and thus concentrated to obtain saturation which allows for crystallisation.

Once the crystals have grown, the resulting mixture of crystals and mother liquor is spun in in centrifuges to separate the two.

The sugar is dried in drum dryers with hot air current.
It is then cooled down to temperature around it.

Storage must be to the highest quality if the products, usually produced in a relatively short campaign, are to remain market ready throughout the year.

A typical factory will be capable of producing a range of sugars from icing through cubes to liquid products and a range of packages from 8 gm sachets to bulk road / rail tanker.

[1] Molasses is often added to the pressed pulp before drying in order to provide a higher sugar content animal feed. Typically, two tons of pressed pulp and 0.4 tons of molasses are dried to make one ton of dried pulp at 10% moisture content. The dried pulp in then extruded into pellets to increase the density of the product and make it easier to store and handle.

2.2. Conversion factors from raw material

- Sugar beets contain in average **16 % sugar**, 80 % of which can be recovered by the extraction process. One tonne sugar beets gives therefore a maximum of 130 kg white sugar. remaining sugar (non-crystallised) are left with the molasses, which contain 50% sugar
- With yields ranging from 55 to 65 tons/ha, the expected sugar production would reach **7.8 tons per hectare of sugar beets** in ideal conditions.

2.3. Key processing costs

Sugar manufacture is a heavy industry which requires substantial investment in a product for which the international market price is rather low. It is of utmost importance to have a competitive raw material (high and regular output and low transportation costs) as well as sufficient technical means to ensure continuous functioning of a large unit which immobilisation is rather costly.
The following economic considerations are for illustrative purpose only (European standard plant).

Illustrative Operating Cost for Sugar Extraction
(US$/ton sugar produced)
(Assumptions: 2 100 h per year operation - daily processing capacity of 11 000 tons sugar beets)

Item	Cost (1997)
sugar beets	427
fuel energy	19
lime kiln operation	15
capital cost	108
maintenance	21
miscellaneous, other costs	22
labour	55
Total direct operating costs	**667**

source: Beet and Cane Sugar Manufacture, P.W. Van der Poel, ed.Bartens - 1998

One of the big differences between a beet sugar factory and its cane sugar counterpart is with respect to energy. Both factories need steam and electricity to operate and both have co-generation stations where high pressure steam is used to drive turbines which produce the electrical power and create the low pressure steam needed by the process. However the beet factory does not have a suitable by-product to use as fuel for the boilers, it has to burn a fossil fuel such as coal, oil or gas, while in the case of sugar cane factories, the fibre resulting from crushing the cane are burnt.

Given the relatively short period during which sugar beets are harvested and available for processing, a beet sugar factory operates in average only 90 days a year (2 100 hours). A cane sugar factory operates longer since after raw sugar is produced during approximately 5 months, refining process can take place in the same plant for some months.

The production costs of beet sugar are significantly affected by the revenue from the sales of the by-products: molasses, pulp, beet particulate matter and carbonation lime.

2.4. Refined sugar sale's prices

White Sugar Quarterly Average Prices / London D.P. N°5- F.O.B. Europe in bulk (US$ per ton)

	Jan/Mar	Apr/Jun	Jul/Sep	Oct/Dec	Jan/Dec
1995	399	385	417	386	**396**
1996	392	395	363	314	**366**
1997	308	321	332	321	**316**
1998	283	260	244	233	**255**

source: F.O. Licht

- Sugar world market price is one of the most volatile of all commodity prices because of the residual nature of the world market, made up of two closely related but differing products: raw and refined sugar. Prices may fluctuate significantly from one region of the world to another. For example, the wholesale price of white sugar from sugar beets in Russia, traded by processing plants, was about 440 dollars per ton in May 1998, while the world prices of sugar were much less. Therefore, Russia represented an attractive market for white sugar traders.
- Sugar prices collapsed in January 1998 due to the Brazilian currency devaluation, the large Brazilian sugar crop, and the increasing surplus of world sugar stocks. Since then prices do not cease declining.
- Forecasts predict that sugar world prices will reach their bottom level in year 2000, at around 170 US$/ton, and that a slow increase will be initiated from 2001.

2.5. Average margins for processors

- Factory profitability often relies on the efficient utilisation of the molasses and animal feed by-products. The importance of the feed products to the factory is such that uniform, high quality products must be produced at all times. Efficiency also depends substantially on the use of multiple effect evaporation. It is of utmost importance for the beet factories because there is no surplus fibre available to provide fuel for the power generation.

2.6. World production & main processors

World Production and Trade of Refined Sugar ('000 tons) [(a)]

Country or region	PRODUCTION ('000 tons)			EXPORTS ('000 tons)		IMPORTS ('000 tons)	
	1996/97	**1997/98**	**%**	**1996/97**	**1997/98**	**1996/97**	**1997/98**
EU	18 756	19 275	15	5 064	5 450	1 902	1 825
Brazil	15 269	18 134	14	5 995	8 483	-	-
India	14 030	13 900	11	-	-	-	-
China	7 323	8 747	7	-	-	-	-
USA	6 537	7 274	6	-	-	2 620	2 106
Australia	5 793	5 480	4.5	4 415	4 222	-	-
Mexico	4 822	5 675	4.5	742	775	-	-
Thailand	6 099	4 325	3.5	4 129	2 570	-	-
Pakistan	2 460	3 800	3	-	500	-	-
Cuba	4 316	3 200	2.5	3 597	2 500	-	-
Russian Fed.	3 219	3 755	3	-	-	3 060	4 850
Ukraine	3 497	2 102	1.5	-	-	-	-
Japan	2 232	2 372	2	-	-	1 726	1 605
Colombia	1 454	1 479	1	808	945	-	-
South Africa	1 531	1 977	1.5	939	1 078	-	-
Korea Rep.	1 165	1 190	1	-	-	1 446	1 380
Malaysia	1 255	1 176	1	-	-	1 122	1 010
Canada	1 130	1 150	1	-	-	1 064	1 068
Others	22 944	22 474	17	9 892	8 394	22 641	21 073
World Total	**123,832**	**127,485**	**100**	**35,581**	**34,917**	**35,581**	**34,917**

source: International Sugar Organisation & FAO Stat

(a) data relative to both cane (raw sugar) and beet (white sugar) mixed together
the world sugar year runs from September to August

- When collecting data for the production of sugar from sugar beets only, one could draft the following table (figure for 1997/98):

Country	EU	USA	Turkey	Poland	Ukraine	Russia	China	Czech Rep
'000 tons	19 130	3 901	2 556	2 261	2 207	1 453	1 461	558

source: Centre d'Etudes et de Documentation du Sucre - France

- Most of the sugar produced is consumed within the country of production and only approximately 25% is traded internationally. Moreover, the free world market accounts for only 18% of world exports while 7% is traded on the basis of bilateral trade agreements.
- The CEE and NIS represent together 10% of the world sugar production (13,7% of world consumption in 1993).

- Over the world, there are a very large number of sugar extraction and refining companies. Among the largest are:

Europe	Yearly production ('000 tons)	% sugar in total sales
- Sudzuker (D)	2 400	74
- Eridania Béghin-Say (I)	1 950	26
- British Sugar (UK)	1 150	85
- Danisco (DK)	900	46
- Sucre et Denrées (F)		
USA		
- Domino/Western	2 400	19
- Savannah	1 500	90
- BC Sugar	950	100

2.7. Other relevant information

- Although beet is physically different from its tropical counter-part, sugar cane, the factory processes are surprisingly similar. Two major differences are the lower juice colour levels with beet - which allows direct production of white sugar - and a cane factory's self sufficiency in fuel.
- Over the world, 115 countries are producing sugar, 9 grow cane and sugar beets, 39 grow only sugar beets while 67 grow only cane. It represents as a whole some 2 520 industrial sugar factories, 820 processing sugar beets and 1 700 for cane transformation.
- One can notice a recent shift in consumption from direct to indirect sugar intake with the industrial sector now accounting for 70% of sugar use.
- The major sugar users among food processors are soft drink and chocolate/confectionery manufacturers. In France, direct sales to consumers represented 22.5% of the total amount of sugar used in 1998.
- Most of the world's sugar production is consumed in the countries of origin and levels of consumption vary a lot depending on the countries/regions.

Sugar consumption (kg/head/year)

Brazil	EU	Australia	Cuba	South Africa	Thailand	USA
51	35	45	44	19	27	30

- List of relevant web sites visited:

  http://www.fao.org

  http://www.illovosugar.com

  http://www.sucrose.com

  http://www.fas.usda.gov/htp/sugar