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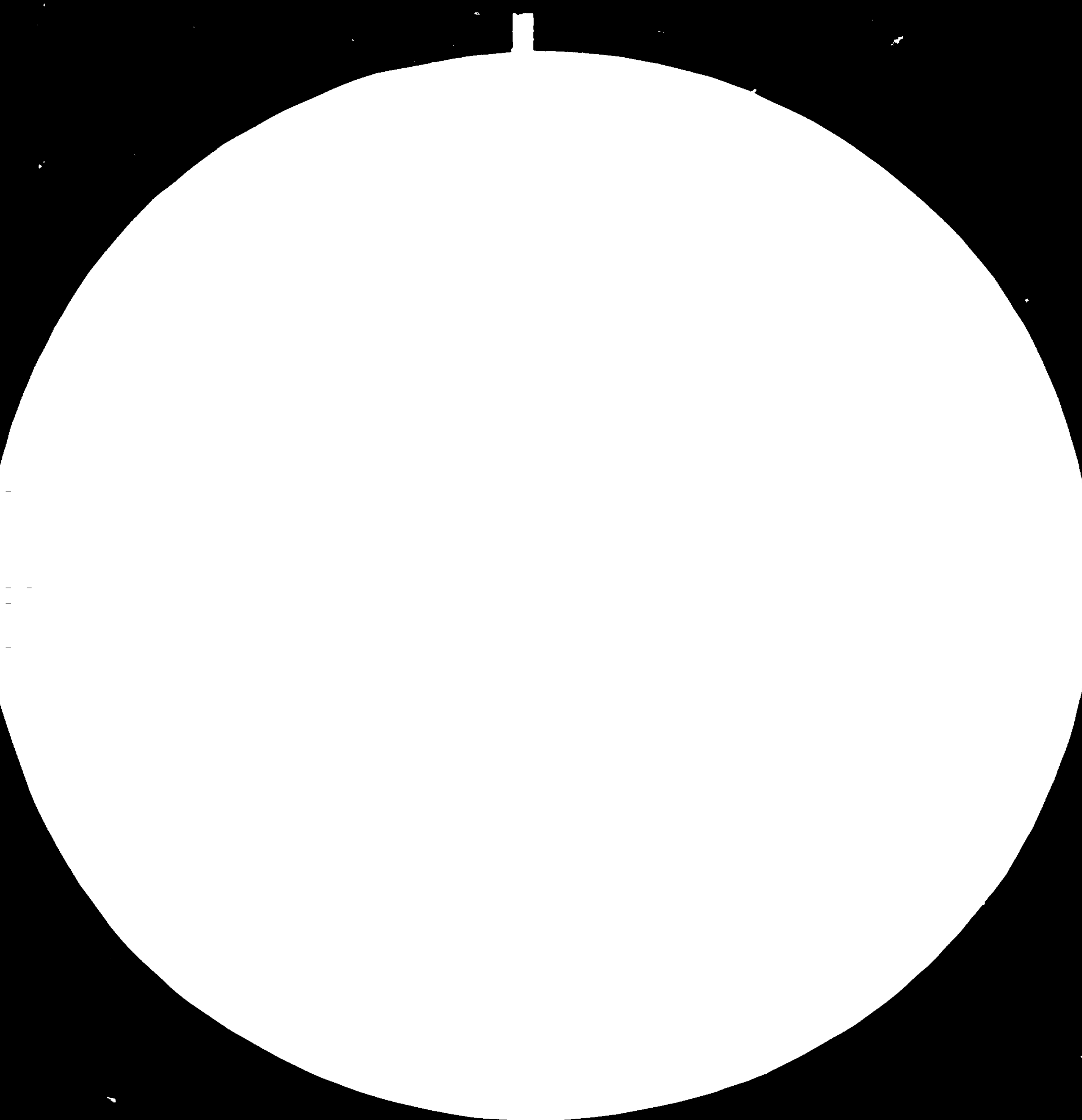

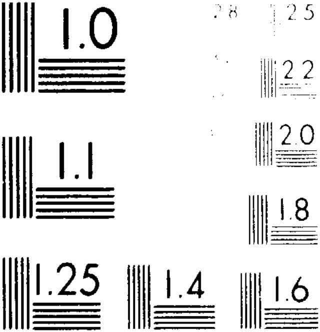
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ASSISTANCE TO THE GENERAL ESTABLISHMENT OF SUGAR

SI/SYR/79/801

SYRIAN ARAB REPUBLIC

Technical report: Assessment of the sugar industry

Prepared for the Government of the Syrian Arab Republic
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of D.D. Spanovic,
expert in sugar technology

United Nations Industrial Development Organization
Vienna

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Explanatory notes

A full stop (.) is used to indicate decimals.

A comma (,) is used to distinguish thousands and millions.

References to "tons" are to metric tons throughout.

The following technical terms and abbreviations are used in this report:

cossette	a strip or slice of sugar beet
massecuite	a dense mass of sugar crystals mixed with mother liquor obtained by evaporation
pH	measure of acidity/alkalinity
Bx	Brix, percentage by weight of sugar in the solution

ABSTRACT

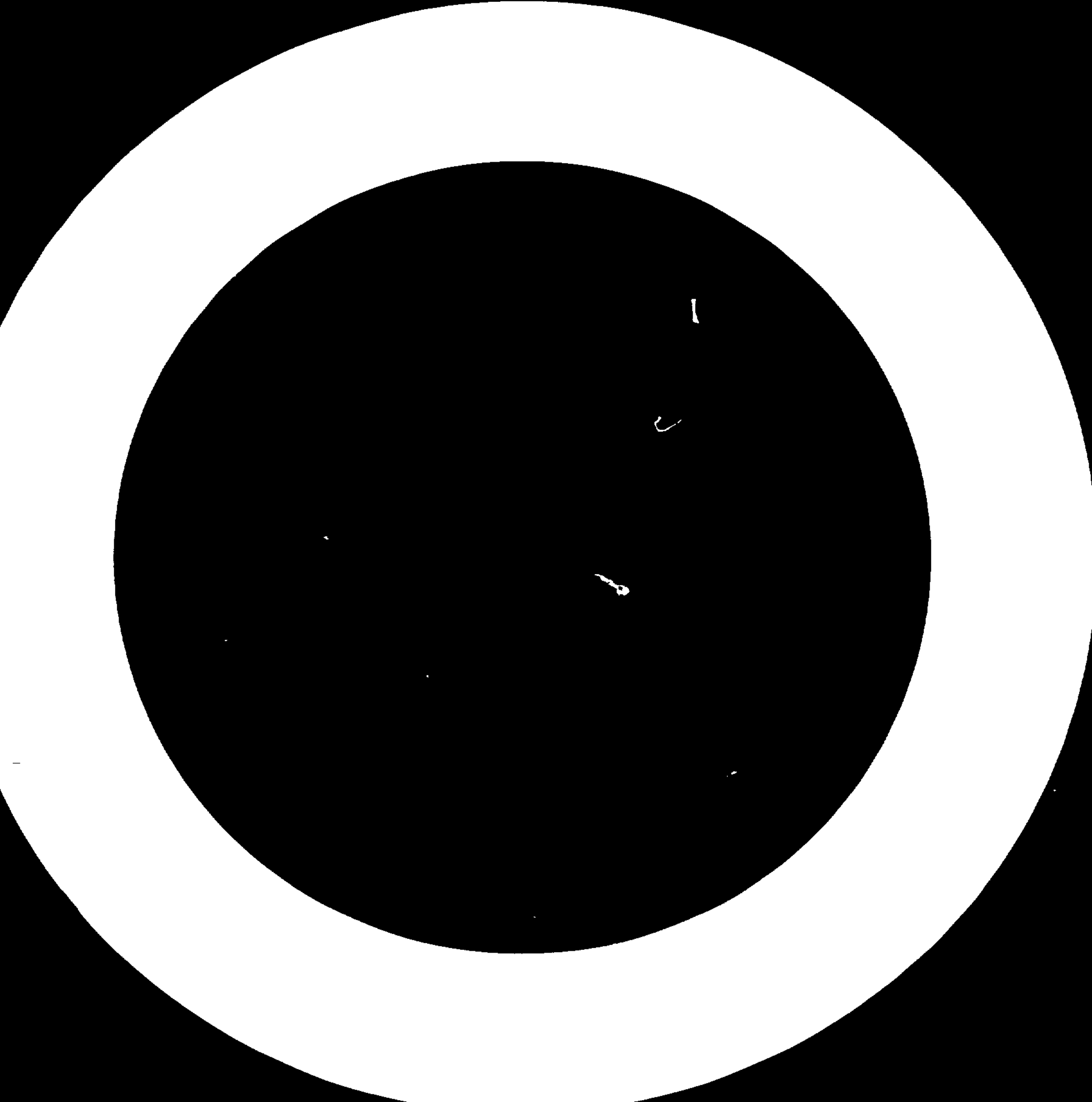
This project, "Assistance to the General Establishment of Sugar" (SI/SYR/79/801), was carried out for the Government of the Syrian Arab Republic by an expert of the United Nations Industrial Development Organization (UNIDO), acting as executing agency for the United Nations Development Programme (UNDP).

The purpose of this project was to give assistance to the General Establishment of Sugar in improving the technical operation, productivity and profitability of the existing plants in this sector, including the by-products of the sugar industry, such as baker's yeast and alcohol.

This report covers the work of the expert in beet-sugar technology. The report of the expert in yeast and alcohol technology is issued separately under the same number.

The expert's mission lasted from 7 May to 30 July 1980. During this period, the expert studied the operations, not only of the sugar plants in Homs and Raqqa as originally planned, but also those of all other sugar plants in the Syrian Arab Republic.

In this report, the expert assesses the natural resources available for sugar-beet production and the market demand for sugar. He reviews the operations of existing sugar plants and makes specific recommendations for their improvement, and he analyses the application of new technology to the Syrian sugar industry in general.



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INTRODUCTION

This project, "Assistance to the General Establishment of Sugar" (SI/SYR/79/801), was carried out for the Government of the Syrian Arab Republic by an expert of the United Nations Industrial Development Organization (UNIDO), acting as executing agency for the United Nations Development Programme (UNDP).

The aim of this project was to give assistance to the General Establishment of Sugar by suggesting ways of improving their existing beet-sugar, yeast and alcohol manufacturing plants. It was originally intended to send three experts, one each for the fields of beet sugar, yeast and alcohol. However, only two experts were needed as one of these was able to cover the fields of both yeast and alcohol technology. The present report covers the work of the expert in beet-sugar technology. (The report of the expert in yeast and alcohol technology is issued separately under the same project number.)

The expert's mission lasted from 7 May to 30 July 1980. It was originally intended that the expert would study the operations of the sugar plants in Homs and Raqqa. During the mission, his activities were extended to cover all the sugar plants in the Syrian Arab Republic. The expert worked in close co-operation with the personnel of the counterpart agency, the General Establishment of Sugar, and with the managements of the sugar plants. Details of the assistance given to the sugar factories by the expert are given in annex V at the end of the report.

Project background

The Syrian Arab Republic produces some 30,000-35,000 tons of beet sugar annually. This represents only a small proportion of the country's white sugar requirements. About 30 per cent of the country's white sugar has to be imported, and a further 50-60 per cent is imported as raw sugar and subsequently refined. The long-term aim is to produce enough white sugar from local sugar beet to satisfy the country's requirements and to eliminate all imports of white and raw sugar.

The country's climatic conditions are very favourable for growing sugar beet and the Government is promoting the expansion of this sector of the economy. The western agricultural region already grows a lot of sugar beet, although the small size of the agricultural holdings makes the introduction of modern, mechanized methods difficult. The eastern agricultural region, round the Euphrates, has all the natural prerequisites for growing sugar beet, including an irrigation system. This region, properly developed, could supply enough sugar beet to make the import of sugar unnecessary.

The existing sugar-processing plants are faced with various technical and technological problems which make full utilization of installed capacities impossible. Production costs are, therefore, much higher than they should be. The expert was required to assess all stages of production and all equipment in these plants and to advise on ways of improving production from the technical, technological and economic points of view.

Under the present five-year plan, the Government is erecting four new sugar factories. Those at Maskaneh and Raqqa are nearing completion and those at Tel Selhab and Deir ez Zor are expected to be put into operation for the 1981 sugar-beet season. Suggestions are also made for these new plants.

Conclusions and recommendations are given throughout the report in each section, as well as summarized on the following pages.

RECOMMENDATIONS

Sugar-beet production

1. In view of the steadily increasing demand for white sugar and the already inadequate supply of sugar beet, the first essential is to increase sugar-beet production so that each sugar plant has an adequate supply from its surrounding area.

2. Sufficient suitable agricultural land is available, but inefficient forms of sugar-beet production should be replaced by mechanized agriculture organized around state-owned farms which would be centres for improving the technical and technological level of sugar-beet production.

3. A larger proportion of the sugar-beet crop should be transported to the new sugar factory at Maskaneh for processing until such time as the older sugar plants are modernized.

The Adra sugar factory

1. The Adra sugar factory should be converted into a modern sugar refinery capable of producing a large assortment of sugar crystals and liquid sugar for industrial purposes.

2. This must be officially decided and a proper programme drawn up as soon as possible. All further investment in this plant is only to be made in accordance with the plant's conversion programme, except for the laboratories where new equipment is needed immediately.

The Homs sugar factory

1. The sugar factory in Homs should be reconstructed so as to have a nominal capacity of 2,500 tons of sugar beet per day and an imported raw-sugar refining capacity of 400 tons of white sugar per day. All production lines based on batch processing are to be replaced by modern continuous-process technology.

2. Certain kinds of machinery should be eliminated because they are now unreliable, even dangerous, and because they have an uneconomically high consumption of energy and labour and often only produce lower-quality end-products.

3. Existing equipment with good mechanical properties can be included in modern technological processes to decrease investment costs.

4. As a first step, a detailed technological proposal must be drawn up showing the extent of the work to be done and the total amount of investment which would be needed.

5. If, for any reason, the total reconstruction of the plant is not feasible or is postponed, the present state of costs and efficiency would still make a change of technology and work processes necessary. These can only be realized by an engineering-team approach to any improvements. In any event, the introduction of continuous juice purification would contribute to raise capacity in the sugar-beet processing season to a level of 1,000 tons of sugar-beet slicing per day.

6. In this case, it will also be necessary to change the raw-sugar refining process by improving the lime kiln.

7. The introduction of continuous juice purification also involves the improvement of energy and cold and hot water circuits. If the whole factory is not reconstructed, then a separate technological study should be made of these aspects.

8. Impartial advice on technological matters and on tenders should be sought from UNDP experts before any decisions are made.

The Jisr esh Shughur sugar plant

1. Elimination of purification in batches is the first main task on the way to increasing the plant's capacity.

2. A project for this factory's improvement has to be drawn up on the engineering level, combining both foreign technological experience and the local staff's familiarity with the equipment. Analysis of improvement possibilities in water, energy and technology should be parallel tasks in considering the plant's improvement as a whole.

3. A careful choice of additional equipment for the diffusion, filtration and de-calcification stations is advisable in order to improve the efficiency of the existing equipment and to cope with future increased capacity. The existing equipment will give much better results if it is incorporated into a modern, continuous-purification system.

The new sugar plants

1. Detailed staff programmes should be drawn up for the new sugar factories by an experienced specialist, and should be put into effect before the next sugar-beet season. Experienced staff for maintenance work as well as for production are especially needed.

2. Plans should be made for finishing the installation of equipment and checking it thoroughly before it is put into operation. Separate plans should be made for Raqqa and for Tel Selhab in view of their difference of equipment.

General

1. The General Establishment of Sugar in Homs should:

(a) Establish a mixed Syrian-foreign engineering team for the modernization of the old sugar plants;

(b) Organize staff education programmes and training abroad for technical personnel;

(c) Establish a department for sugar industry development, application of fermentative and related technologies for the full utilization of sugar-beet resources, and for environmental protection;

(d) Organize an information distribution centre for technical literature and consultations;

(e) Organize a commercial centre for co-ordinating investment, supply of spare parts, materials and so on.

2. All the above-mentioned activities should be supported and supervised by experienced technical experts made available by UNIDO.

I. PRESENT STATE OF THE SUGAR INDUSTRY

A. Sugar-beet production

Natural resources, soils and water

The total area of the Syrian Arab Republic is 18,517,971 hectares of which about 8 million hectares is cultivated land. The land can be divided into the following main soil groups:

(a) Red Mediterranean soil: this has about 600 mm of annual rainfall, dominant colour red, clay loam and loam montmorillonite, pH 7-8, some clay movement. Population density is generally very high;

(b) Orumusol: this has 300-600 mm of annual rainfall, dominant colours dark red, brown, dark brown, and black, clay, montmorillonite, pH 8-8.5. This is the wheat belt of Syria and, under irrigation, these soils are ideal for sugar-beet production;

(c) Cinnamamonic: this has 150-300 mm of annual rainfall, dominant colour reddish-yellow, brown, montmorillonite - attapulgite loam and clay loam, highly calcareous, pH 8-8.5. This area is mainly for barley planting;

(d) Alluvial: this is sandy loam to clay, pH 8, found mainly in the low valleys of the Euphrates river and its tributaries. This type of land is suitable for sugar-beet plantation but also for various types of crops;

(e) Gypsiferrous: this land is naturally suitable for grazing having pH 7. It is yellowish - orange brown powdery land, easily subject to wind erosion. Permanent agriculture is possible under irrigation only.

Other types of soil are not of agricultural importance.

It can be seen that many of the soil types in the Syrian Arab Republic are suitable for sugar-beet growing.

Water resources are distributed among the following basins: Jezireh, Aleppo, Horan, Damascus, Orontes, coastal and desert. Local rainfall and snowfall constitute the main sources for these basins, except for the Jezireh and Orontes basins which are fed externally. Except for the steppes and desert area, all other parts of the Syrian Arab Republic have an annual rainfall of over 200 millimetres, and in areas which have an annual rainfall of over 250 millimetres, it is possible to get two crop seasons a year. All other climatic conditions are favourable for agricultural production, especially in the irrigated areas.

There are 29 surface dams of which 8 have a lower storage capacity than 1 million cubic metres.

In the Euphrates region, the current development of the irrigation system reaches an area of over 62,500 hectares and its expansion continues. The final result of this large investment should be 600,000 to 800,000 hectares of arable land under irrigation.

The main Syrian rivers, the Euphrates and Orontes, have an average water flow of 971 and 60 cubic metres per second respectively which it is planned to harness for agricultural as well as industrial use.

In general, the water resources in the Syrian Arab Republic are more than adequate for an extension of agricultural production.

Agricultural potential for sugar beet

The agricultural potential of the main areas in which sugar beet is grown are shown below.

Table 1. Agricultural potential of sugar-beet areas
(Thousand hectares)

Type of soil	Areas: Homs	Hama	Aleppo	Deir ez Zor	Raqqa
Red Mediterranean	38	54	200	-	-
Orumusol	157	268	434	-	4
Cinnamamonic	936	381	646	90	685
Gypsiferrous	672	-	188	2 596	1 293
Alluvial	-	51	52	248	202
Groundwater	24	28	88	-	-
Total (including other types of soil)	4 222	886	1 608	3 306	2 204
Potential cultivable land	2 748	118	25	1 941	1 089
Land permanently cultivated now	237	358	803	129	347

It will be seen that there is a great development potential here for crops, including sugar beet. In spite of this, the area under cultivation with sugar beet in 1978 was only 14,000 hectares and the total quantity produced was 210,000 tons.

These figures refer mainly to sugar-beet production in the western region. The new areas in the east, where new sugar plants have been built, have only just started sugar-beet cultivation and cannot therefore be taken into account.

Sugar-beet production in the western region depends mainly on a large number of small land-owners. A certain amount of sugar beet is grown in agricultural co-operatives. In 1978, there were 6,000 hectares of sugar beet under co-operative production, producing 21.4 tons per hectare, compared to a national average of 15.0 tons of sugar beet per hectare. The relatively poor national average yield is understandable in view of the large numbers of land-owners with very small average holdings, which makes the introduction of mechanization and modern scientific agricultural methods very difficult. This, together with transport difficulties, creates a real barrier to the desired increase in sugar-beet production around the old sugar factories and no great improvement can be expected in the future unless there is an increase in co-operative production. Although they are planned, there are as yet no large state-owned farms whose facilities and mechanization would also be available to the surrounding small sugar-beet growers.

Sugar-beet production in the Euphrates region has started to show a very good potential with yields of up to 30 tons per hectare of sugar beet containing about 16 per cent sugar. Development of the irrigation system in this region will ensure about 800,000 hecatres of new agricultural land so that the provision of about 10,000 hectares yearly for every new sugar factory should not be a problem. Special efforts are to be made in the case of the new sugar plants expected to start in 1981, to supply each of them with 250,000 to 300,000 tons of sugar beet even in that first sugar-beet season. For such results, it is indispensable to introduce modern mechanization and sugar-beet production in correct crop rotation with other crops such as wheat, barley, cotton and sunflower. The only way to do this is to set up state-owned agricultural production centres which will be the basis for the food industry's development in each area of the Euphrates region. In this way, the problems existing in sugar-beet production in the western region will be avoided and each sugar plant will be ensured of its own supply of sugar beet.

Sugar beet has to compete for land use with other crops and its relative profitability to the farmer will be a determining factor. Comparing the production in 1978 of sugar beet with that of eleven other major crops (wheat, barley, lentils, cotton, peanuts, tomatoes, onions, potatoes, olives, apples and other fruit), only one of these (onions) had a higher yield per hectare than sugar beet. There is no doubt that, in Syrian agricultural conditions, sugar beet is a really competitive crop.

In assessing the value of sugar beet as a crop, it must also be remembered that, in modern farming, one hectare of sugar beet also yields enough animal foodstuff for one cow for a year. The leaves, discarded parts of beet and the cossettes after extraction of sugar can all be used for animal feed. Indeed, in modern sugar-beet production, the financial value of the by-products, molasses, animal feed and, lately, energy produced from the waste water, is equal to that of the sugar produced.

B. Market demand for sugar beet and sugar

The essential pre-condition for any product and its development is commercial viability. For white-sugar and sugar-beet production there should not be any hesitation, bearing in mind that a lot of sugar is imported and that only quite a small quantity of the white sugar available on the Syrian market is produced from local sugar beet. Much of the country's sugar is refined from imported raw sugar. In 1978, a total of 104.8 thousand tons of raw sugar, and 206 thousand tons of white sugar, were imported into the Syrian Arab Republic. This represents a great outflow of convertible currency.

The country's demand for white sugar increases constantly. The actual trend of white-sugar demand growth in the coming years can be assessed on the basis of predicted population growth as shown below.

Table 2. Predicted population growth and sugar consumption

Year	Population growth (millions)	Sugar consumption (thousand tons)
1980	8.9	194.1
1990	12.8	357.7
2000	17.1	597.9

The figures for sugar consumption are actually likely to be higher than above because of the effects of a progressively increasing standard of living on average consumption.

If we assume that the yield of white sugar from sugar beet will reach 12 per cent in 1985 due to improved technology, and that the yield will improve by 0.5 per cent every five years, the estimated demand for white sugar could be met by the levels of sugar-beet production shown below.

Table 3. Required sugar-beet production over next 20 years

Year	Sugar yield (percentage of beet)	Sugar-beet production (million tons)
1985	12.0	2.2
1990	12.5	2.9
1995	13.0	3.6
2000	13.5	4.4

When we compare the figure for the amount of sugar beet which will be required in 1985 with the figures for current sugar-beet production, it is clear how very great a task lies ahead.

Table 4. Sugar-beet production in 1980

Production area	Planned cultivation (hectares)	Actual cultivation (hectares)	Expected yield (tons per hectare)	Total quantity expected (tons)
Adra	1 700	700	30	21 000
Homs	3 700	3 300	30	99 000
Jisr esh Shughur	6 700	3 400	30	102 000
Maskaneh	10 000	2 300	10	23 000
Raqqa	7 500	1 300	10	13 000
Tel Selhab	5 000	2 200	30	66 000
Deir ez Zor	10 000	4 000	10	40,000
Total	44 600	17 200	21.16	364 000

From the total expected sugar-beet crop in the current year, it is expected to produce about 43,680 tons of white sugar which is only about 10 per cent of the estimated demand for white sugar in 1981. The actual production could be less for many reasons, so that the expenditure on sugar imports threatens to be bigger than expected. In any event, much capital is going to be spent on importing raw or white sugar which would be much better invested in the development of state-owned farms and increasing local sugar-beet production.

Bearing in mind that, fundamentally, sugar is produced in the field, i.e. in the sugar beet, all efforts must be directed to sugar-beet production, especially as there is not enough sugar beet for the new sugar factories now being put into operation nor for other new sugar plants expected to start running in 1981. Unless this great effort to increase sugar-beet production is made, the investment already made in erecting new sugar factories will be largely wasted. The first priority must be to see that enough sugar beet is grown to supply all the sugar factories.

C. Present industrial capacity

Table 5. Nominal and predicted actual capacity of sugar plants (tons of sugar beet per day)

Sugar plant	Nominal capacity	Expected capacity	Remarks
Adra	800	450	Experienced staff
Homs	1 200	650	Experienced staff
Jisr esh Shughur	2 000	1 200	Experienced staff

Table 5 (continued)

Maskaneh	4 000	3 500	Lack of experienced staff and management
Raqqa	4 000	3 500	Lack of experienced staff and management
Deir ez Zor	4 000	3 500	Lack of experienced staff and management
Tel Selhab	4 000	3 000	Lack of experienced staff and management
Total	20 000	15 800	

Three of the plants listed above (Deir ez Zor, Raqqa and Tel Selhab) will not come into production in the current year (1980). This leaves the remaining plants, the new sugar factory at Maskaneh and the three old sugar factories, with the following production loads.

Table 6. Production loads of working sugar plants in 1980

Sugar plant	Intake of sugar beet (tons)	Capacity (tons per day)	Production season (days)	Expected quantity of sugar (tons)
Adra	21 000	450	47	1 890
Homs	99 000	650	152	10 890
Jisr esh Shugur	102 000	1 200	85	11 220
Maskaneh	142 000	3 500	41	17 750
Total	364 000	5 800		41 750

It is clear that the Homs and Jisr esh Shughur plants have the most difficult tasks and the new sugar plant in Maskaneh should be enabled to reduce the load in these two plants by supplying it with sugar beet from the El Gaab and Homs regions, using every available means of transport. Sugar beet from the Deir ez Zor and Raqqa regions should also be collected and treated in the Maskaneh sugar factory as soon as possible. It would be advisable to transport and treat in Maskaneh about 29,000 tons of sugar beet from the Homs region and about 22,000 tons of sugar beet from the El Gaab region. The result of such an operation, if carried out, are shown below.

Table 7. Effect of redistribution of production loads

Sugar plant	Intake of sugar beet (tons)	Production season (days)	Expected sugar yield (% of beet)	Additional increase in sugar yield from re-distribution (% of beet)	Expected quantity of sugar (tons)
Adra	21 000	47	9	0.00	1 890
Homs	70 000	108	12.4	+1.4	8 680
Jisr esh Shughur	80 000	67	12.0	+1.0	9 600
Maskaneh	193 000	55	12.63	+0.13	24 376
Total	364 000				44 546

The effect of such a redistribution of sugar beet from the older plants to the new sugar factory at Maskaneh would be to increase total white sugar production by at least 2,796 tons. It is true that there would be transport and organization costs involved in redistribution, but these could be more than offset by the value of the extra white sugar produced (about $US 1 million at current world prices) and by the fact that loss of sugar in the beet during storage at the old plants between harvesting and slicing would be reduced. It is estimated that storage losses of 1.5 per cent of sugar on a quantity of 364,000 tons of sugar beet represents a loss of around 5,460 tons of white sugar.

These calculations underline the advantage of sugar production in modern, large-capacity plants, and consequently the need to reconstruct and modernize the older sugar factories.

Recommendations

1. In view of the steadily increasing demand for white sugar and the already inadequate supply of sugar beet, the first essential is to increase sugar-beet production so that each sugar plant has an adequate supply from its surrounding area.

2. Sufficient suitable agricultural land is available but inefficient forms of sugar-beet production should be replaced by mechanized agriculture organized round state-owned farms which would be centres for improving the technical and technological level of sugar beet production. They should supply their farm staff with living conditions at a level not lower than that of the cities. Roads, electricity, drinking water, public health, schools and opportunities for permanent, well-paid jobs should be available on the state-owned farms and accessible to all members of neighbouring co-operatives.

3. A larger proportion of the sugar-beet crop should be transported to the new sugar factory at Maskaneh for processing until such time as the older sugar plants are modernized.

II. ASSESSMENT OF EXISTING SUGAR PLANTS

Detailed studies of each sugar factory and region would show very interesting, as yet un-exploited, reserves. This is beyond the scope of this report, but should be the subject of a development feasibility study for each sugar factory and its sugar-beet producing region. Here only the technological level of the sugar plants is dealt with.

The old sugar factories are technically and technologically obsolete, with very low efficiency and unacceptably high production costs as they treat imported raw sugar as well as local sugar beet.

Insufficient attention has been paid to the improvement of maintenance and technical and technological levels in the old sugar factories. Only simple maintenance between the sugar-beet treatment period and the imported-sugar refining period has been carried out. The noticeable shortage of spare parts has contributed to the decreasing level of efficiency in the old sugar factories. Old-fashioned technology and obsolete equipment, combined with difficulties in energy supply, have all led to a decrease of efficiency.

A very low level of analytical control is practised, starting with soil and other analyses in the sugar-beet fields. Absence of reproduction-material control is also evident and the production line gives no possibility of determining or decreasing the evident and substantial losses. In the old sugar factories, the necessary attention has not been paid either to regular maintenance of existing analytical equipment or to the technological training of the staff.

Some steps have already been taken to improve raw-sugar refining by installing new equipment, although without properly analysing the complexity of the technological lines involved. This underlines the necessity of having a unified engineering approach in reconstructing any line or the stations as a whole. These activities are not routine maintenance and therefore the local staff had to rely on the technical assistance of the equipment's supplier to gain experience of the machinery. Also, some worn out equipment has been replaced with equipment of the same type and capacity rather than with newer and better models. There is an urgent need for a well-planned and co-ordinated approach to investment in plant modernization and the management needs continuing technical assistance from outside to plan, prepare and supervise every future technical improvement.

A. The Adra sugar factory

The Adra sugar factory is equipped at the technical and technological level available in Czechoslovakia before the second world war. From a modern technological point of view, this factory is obsolete. Although it was improved after 1965 by a new DDS extractor (diffusion), and in 1980 by new FC-1000 continuous centrifuges, this did not produce any evident improvement in technological results, either in the sugar-beet treatment period or in the imported raw-sugar refining season. Lack of water and energy supplies have always been given as the main reasons for difficulties and obstacles to improved efficiency in both production periods. In reality, the situation is as follows.

The new DDS extractor is a very sophisticated and impressive piece of apparatus, but its full capabilities cannot be utilized because behind the extractor there is a purification station using the discontinuous batch method and an obsolete, worn out and inefficient filtration station. The extractor is working at 40 per cent of its nominal capacity at best, which involves great microbial activity, great sugar losses and low purity in the extracted juice. All of this leads to difficulties during purification and filtration, and to a lower quality of white sugar and molasses.

Purification of the extracted juice in the sugar-beet season is done in batches, without reliable control of pH, calcium salts, filtrability or decantability, so that sugar losses in this stage are also remarkable. However, the laboratory data necessary to demonstrate this is not available.

The filtration station is composed of filter presses only. These are mechanically obsolete, worn, do not have the necessary installation for extracting sugar from filter cake, and contribute generally to the unsatisfactory production results of the factory.

The evaporation station's area is quite satisfactorily designed and some heat exchangers have been added. Later, direct steam was made available at every, even unnecessary, points of the process, so that full use of the evaporators and heat exchangers and their maintenance has been neglected. In this way, consumption of heat energy was increased and production costs also.

The vacuum pans are old-fashioned. Unreliable and porous tubes are used which occasionally leak sugar in the condensation of the boilers. Heating surfaces are covered with deposits and there are no exact and reliable measurements of pressure or temperature.

The centrifuges for the first massecuite are really museum pieces, without the ability to separate syrups according to purity, and their electrical equipment is unfit to achieve the desired centrifugal field, involving increased water consumption in the centrifuge, lower Bx in the syrups (which means increased recirculation of sugar in the refinery), greater sugar losses during crystallization (caused by microbiological and heat destruction of sucrose), higher heat consumption, and lower quality of white sugar and molasses produced. The centrifuge for the middle and final massecuites are new, but difficulties evident in the current season indicate that the equipment has not been properly replaced. Produced sugar is below second class and is only distributed in 50 kilogramme packages.

The water supply of about 80 cubic metres an hour could be seen as one of the possible limitations. However, all circuits are open, there is no recirculation or cooling, and existing equipment for that purpose is not maintained or used. The present water supply would be adequate if these faults were corrected.

The energy supply from outside is not reliable and one of the factory's steam-turbine generators is out of order because of lack of spare parts.

Laboratory control is on a very low level. The number and quality of analyses is small and the analytical equipment is worn and really obsolete. Microbiological control of the production line and final products is unknown.

The refining of raw sugar is based on a purification method using lime milk and phosphates only, with the addition of active carbon and Dika-Litte by filtration. Crystallization is usually done in five steps which involves an inefficient use of the centrifuge and noticeable destruction of sucrose during refining due to heat and microbial activity.

Uneven distribution of qualified personnel between shifts, and frequent mechanical breakdowns also decrease capacity and efficiency in both refining and sugar-beet seasons. It would be advisable to find a means of improving the level of the staff's interest in production results since both the work force and the management, although short of modern technological knowledge, have a great deal of practical experience.

The future of the Adra sugar factory must be considered not only in the light of the poor state of its present equipment and technology, but also of the following factors:

(a) Sugar-beet production in the Damascus region has no chance of being increased in the near future;

(b) White-sugar demand in the Damascus region in the next decade will be at least double that of today;

(c) The distance between Damascus and other white-sugar suppliers is:

	Ragqa	Deir ez Zor	Aleppo	Homs	Idleb
		(kilometres)			
Damascus	547	691	355	162	335

The lack of an adequate supply of local sugar beet to meet the ever-increasing demand, and the distances over which sugar must be transported to meet the shortfall, all indicate that the Adra factory should concentrate on refining in order to meet the demand for white sugar in the Damascus region in the coming decades.

Recommendations

1. The sugar factory at Adra should be converted into a modern sugar refinery capable of producing a large assortment of sugar crystals and liquid sugar for industrial purposes.

2. This must be officially decided and a proper programme drawn up as soon as possible. All further investment in this plant is only to be made in accordance with the plant's conversion programme, except for the laboratories where new equipment is needed immediately.

B. The Homs sugar factory

The Homs sugar factory was the first sugar plant to be built in the Syrian Arab Republic. It also was equipped at the technical and technological level of Czechoslovakia before the second world war and generally speaking it is using an obsolete technology.

Sugar-beet transport from storage to the factory is by hydraulic machinery with insufficient quantity and pressure of water, involving additional manpower assistance and stoppages and irregularity in the beet supply to the factory. The line of washing and lifting to the slicers should be improved in order to separate mechanical admixtures from the sugar beet. Final washing with pure water is advisable in order to diminish microbial content in the cossettes. Weighing of sugar beet before slicing, and weighing of cossettes after slicing are very far from being reliable and correct, so that the dosage of water for extraction is very approximate, causing difficulties and irregularities in rinsing sugar from the cossettes.

<u>Slicing</u> is hindered by the very inadequate quality of the preparation of knives. There is no equipment for dressing, testing or sharpening knives, nor for correct adjustment. All of this involves a higher water dosage in the extractor and greater sugar losses and energy consumption in the stage of evaporation.

<u>Extraction</u> is carried out by a very old-fashioned piece of apparatus, mechanically unreliable and difficult to maintain. Control of quantities entering diffusion is quite approximate, and the temperatures required for accurate extraction are never attained because only fresh water is used for extraction, instead of using press water recycled after terminal treatment. Press water is discarded without re-circulation. The existing heat exchangers and the extractor's built-in heating jackets are designed for heating the diffusor with low-energy steam. However, high-energy steam is directly blown in, destroying the cossettes and giving an undesirable amount of dilution. The water used for extraction is of an unacceptable quality and is the direct source of much microbiological pollution in the extracted juice and great losses of sucrose, not only in the extraction stage, but in all further stages until the molasses and white sugar are stored. Use of measurement instruments is very rare, and microbiological control and use of disinfectants are totally absent.

<u>Purification of extracted juice</u> is in batches, without the necessary measuring instruments. Heating is insufficient and the whole treatment is technologically obsolete. Where sugar beet of a lower quality is used, the present processes and equipment are not capable of coping with non-sugars in the extracted juice and this results in a decreased white-sugar yield and an increase in losses and production costs. Proper purification of the extracted juice is a crucial part of the white-sugar production line and must be continuous and carefully and correctly controlled. The process should be based on efficient technological handling, should be highly automated and not subject to manual errors. Purification treatment in the Homs sugar factory is far from acceptable. The filtration equipment, an integral part of purification, is partly obsolete but, included in a better purification process, would be capable of performing its function. Vacuum filters, decanter, press filters and other installations, if included in an improved continuous purification system, could be satisfactorily efficient, even for full-capacity production, with a minimum of investment for the improvement needed.

The evaporation station and heat exchangers should be adequate, but the cleaning, maintenance, renewal of tubes and secondary-steam consumption is very unsatisfactory. The mechanical tool for cleaning tubes is broken, and for chemical cleaning there is neither the knowledge nor the necessary equipment. The installation for condensed water should be improved to give a better hot-water supply system and a better supply for the steam boilers. The scheme for secondary-steam consumption was dropped a long time ago and this is really, together with pu: fication, the worst point in the Homs sugar factory. Instead, high-energy steam is used directly in the evaporation station and this is wasteful, especially as the condensate of this steam is not completely recovered. Steam and water consumption are not recorded or controlled and an exact, reliable manometer or thermometer is a real rarity.

The decalcification station for thin juice could be adequate even for nominal capacity, but it is operated by seasonal workers without the necessary background knowledge for the job they are doing and without reliable means and methods of control.

The vacuum pans, although old-fashioned, could cope with their job, especially as some of them have new tubes. The others should be chemically treated against deposits and rust. Steam traps, separators and the condensed-water installation should be improved too.

The centrifuges should be urgently replaced by totally new centrifuges with the appropriate electrical installation. The old ones have a low efficiency in syrup separation, which involves a higher water consumption and five-stage crystallization with all the negative consequences in sugar inversion and higher steam consumption. However, this investment should only be made after serious investigation of the technological and economic suitability of available equipment.

The white-sugar drying, screening and packaging installation should also mostly be replaced by new equipment as the existing one is very obsolete.

The extracted-pulp treatment line begins with hydraulic transportation from the diffusor to the pulp-pressing station which is the worst possible means of transportation, involving a low efficiency in pulp pressing and high energy and fuel consumption. A higher level of maintenance and a better spare parts supply would enable this line to stop being a bottle-neck in the development of full-capacity production. The press-water from pulp extraction should be re-used for sugar extraction and not just discarded as waste to pollute the environment.

Energy supply is not a problem in that plenty of steam is available. However the electricity supply and its distribution are not adequate for the production process as a whole and should be improved. Steam-energy consumption is careless and wasteful. Its use should be optimized simultaneously with the development of the purification and refining sections. In any case, a separate feasibility study should be carried out.

The water supply is based on open circuits except for the greater part of the condensed water. It is far from being acceptable and should be the object of a technological feasibility study connected with the improvement of purification of the extracted juice. The improvement of the water circuits is urgent.

The future of the Homs sugar factory must take into consideration both the agricultural potential of the surrounding region and the fact that the present industrial capacity of the factory is quite inadequate for producing white sugar either from imported raw sugar or from local sugar beet. All the prerequisites for successful sugar production exist in this region but have not been developed because the industrial capacity is obsolescent and unreliable.

Agricultural production possibilities are many times greater than the industrial plant's capacity and further development of sugar-beet production in the Homs region will be possible only if the capacity in the industrial plant is increased and modernized.

If the recommendation for the sugar factory in Adra is adopted, all usable equipment for sugar-beet treatment in Adra should be carefully disconnected from the installation there, transported to Homs and integrated with the new production equipment in the Homs sugar factory.

Recommendations

1. The sugar factory in Homs should be reconstructed so as to have a nominal capacity of 2,500 tons of sugar beet per day and an imported raw-sugar refining capacity of 400 tons of white sugar per day. All production lines based on batch processing are to be replaced by modern continuous-process technology.

2. Certain kinds of machinery should be eliminated because they are now unreliable, even dangerous, and because they have an uneconomically high consumption of energy and labour and often only produce lower-quality end-products.

3. Existing equipment with good mechanical properties can be included in modern technological processes to decrease investment costs.

4. As a first step, a detailed technological proposal must be drawn up showing the extent of the work to be done and the total amount of investment which would be needed.

5. If, for any reason, the total reconstruction of the plant is not feasible or is postponed, the present state of costs and efficiency would still make a change of technology and work processes necessary. These can only be realized by an engineering-team approach to any improvements. In any event, the introduction of continuous juice purification would contribute to raise capacity in the sugar-beet processing season to a level of 1,000 tons of sugar-beet slicing per day.

6. In this case, it would also be necessary to change the raw-sugar refining process by improving the lime kiln.

7. The introduction of continuous juice purification also involves the improvement of energy and cold and hot water circuits. If the whole factory is not reconstructed, then a separate technological study should be made of these aspects.

8. Impartial advice on technological matters and on tenders should be sought from UNDP experts before any decisions are made.

C. The Jisr esh Shughur sugar factory

The sugar factory in Jisr esh Shughur is the newest one, but unfortunately has the same type of Czechoslovakian technology as Homs. The nominal capacity of 2,000 tons of sugar beet daily has never been reached, mainly because the production process and all the present equipment is designed for operation in batches.

Sugar-beet reception is modern, efficient and reliable.

Unloading, transport and storage equipment is very satisfactorily installed and efficiently used. Even ventilation is provided for, but in Jisr esh Shughur's climate, such ventilation is very rarely needed. In the process of sugar-beet transport from the storage to the factory, it would be advisable to add two leaf and two stone catchers. The present equipment for removing sugar beet tails and particles could be improved mechanically and technologically without much expense.

The sugar-beet slicers are the first weak point. The type of knives should be changed and a complete line for knife preparation, such as exists in new sugar factories, should be installed.

Diffusion - extraction should be better equipped with control, recording and measuring instruments for temperature and flow-rate. Press-water should be heated and returned for the final extraction from cossettes. Continuous microbiological control of diffusion and recording the pH of extracted juice and press-water would be advisable.

Purification of extracted juice is the main weak point of the factory but it could easily be improved with a moderate investment because other equipment belonging to the present filtration process and the two decanters can easily and successfully be included in a new, modern continuous purification treatment.

All other stations are satisfactorily designed and are not an obstacle to the achievement of the nominal capacity of 2,000 tons daily. In these stations, better maintenance would contribute to greater efficiency. Here also, the noticeable lack of spare parts is the main limitation in getting the desired results.

The development of the Jisr esh Shughur sugar factory can be based on existing agricultural advantages in the surrounding region, the technical level of the plant and the workers' experience, which, with a moderate investment, could lead to a remarkable increase of capacity and production efficiency. With the elimination of purification in batches, the main bottle-neck would disappear and the nominal capacity would be attainable. There is no reason to delay taking steps towards the desired improvement of the sugar factory in Jisr esh Shughur.

Recommendations

1. Elimination of purification in batches is the first and main task on the way to increasing the plant's capacity.

2. A project for this factory's improvement has to be drawn up on the engineering level, combining both foreign technological experience and the local staff's familiarity with the equipment. Analysis of improvement possibilities in water, energy, and technology should be parallel tasks in considering the plant's improvement as a whole.

3. A careful choice of additional equipment for the diffusion, filtration and decalcification stations is advisable in order to improve the efficiency of existing equipment and to cope with future increased capacity. The existing equipment will give much better results if it is incorporated into a modern, continuous-purification system.

D. The new sugar plants

The new sugar plants at Maskaneh, Raqqa and Tel Selhab are not finished yet. They are scheduled to operate in the next sugar-beet season (1981). In the meantime, the whole equipment should undergo very detailed examination because it was delivered more than two years ago and has not yet been put into operation. It is advisable also to test all equipment because there are clear signs that some equipment has mechanical faults or is not suitable for the process. Some basic mistakes were also made and some mechanical damage caused during installation. If the new sugar plants are tested during a trial run, they have a chance of being improved at little expense and would then be capable of maintaining their nominal capacity for a longer period. Some improvements towards this end have already been suggested separately to the General Establishment of Sugar in Homs.

In the new sugar factories, lack of highly-educated technological personnel has led to the employment of other staff who do not have the necessary technological background or knowledge and do not recognize the importance of regular analytical and microbiological control. The total absence of microbiological control in the Syrian sugar industry should be urgently remedied whatever the necessary investment in time and money.

Recommendations

1. Detailed staff programmes should be drawn up for the new sugar factories by an experienced specialist, and should be put into effect before the next sugar-beet season. Experienced staff for maintenance work as well as for production are especially needed.

2. Plans should be made for finishing the installation of equipment and checking it thoroughly before it is put into operation. Separate plans should be made for Raqqa and for Tel Selhab in view of their difference in equipment.

E. General considerations on the sugar industry

The whole work-force in the sugar industry at present is not adequate to ensure the desired production target. In the old sugar factories, the number and experience of workers is sufficient for some of the construction and mechanical work which will be necessary during modernization. In the new sugar factories, the number, qualifications, experience and technological background of workers are far from being adequate to cope with their tasks. In sugar-beet production for the new sugar plants, the shortage of labour should be partly solved by the introduction of mechanization, but technological training abroad in similar sugar-beet areas should also be provided.

Before starting the reconstruction of the old sugar factories, their technical staff should be trained abroad to be acquainted in detail with the equipment which will be used.

Academic research institutes in the Syrian Arab Republic are in a position to help solve the great problem of the low level of analytical control from soil through to final products. Application of modern control methods and training abroad to familiarize laboratory staff with these methods is an undispensible investment.

The modernized and reconstructed sugar plants will encourage an increase in sugar-beet production in the surrounding regions and will provide, at the same time, a basis for the development of related fermentative industries and of industries for by-products and waste-material utilization. Modernization of the old sugar factories should contribute to the protection of the environment, especially of the river Orontes (Asi), instead of their being one of the main sources of heavy pollution as they are now.

<u>Recommendations</u>

1. The General Establishment of Sugar in Homs should:

(a) Establish a mixed Syrian-foreign engineering team for the modernization of the old sugar plants;

(b) Organize staff education programmes and training abroad for technical personnel;

(c) Establish a department for sugar industry development, application of fermentative and related technologies for the full utilization of sugar-beet resources, and for environmental protection;

(d) Organize an information distribution centre for technical literature and consultations;

(e) Organize a commercial centre for co-ordinating investment, supply of spare parts, materials and so on.

2. All the above-mentioned activities should be supported and supervised by experienced technical experts made available by UNIDO.

III. APPLICATION OF THE NEW TECHNOLOGY

The new technology which it is proposed to introduce in the Jisr esh Shughur and Homs sugar factories should be so designed as to give a process which, above all, ensures a maximum utilization of raw-material quality. The choice of location for any future sugar factory should aim to reduce transportation time to a minimum.

With regard to the complex questions of investment, general application of technological processes, power consumption, use of reproduction materials and labour, it is necessary to co-ordinate and optimize operations within units which are organically connected. All technical solutions should ensure maximum profitability for each of the stages in the sugar factory.

Modern sugar technology and the organization of work processes distinguish the following stages:

(a) Technology of raw material from the field to the factory;
(b) Processing of beet up to the thick-juice and dry-pulp stage;
(c) Sugar crystallization from thick juice;
(d) Sugar storage, packing and distribution to the market.

Neither the fourth stage and the results that can be achieved by good product design, packaging and marketing, nor the work of the refinery in stage three are going to be considered here. The first two stages are discussed below.

A. <u>The technology of raw material from the field to the factory</u>

It is not appropriate here to go too fully into all the factors affecting raw-material quality. The composition and technological value of sugar beet as a raw material requires special study of climate, soil and other factors. It is sufficient to say that these should be such as to ensure a high percentage of sugar in the beet. Beet quality is also determined by the genetic characteristics of the seed chosen and by correct agricultural methods such as the use of a rotational crop cycle.

For the present purpose, it can be said that fundamentally sugar is produced in the field and that, given sugar beet of a good quality, all further processes merely represent an effort to transform what has been produced in the field into the final consumer product with as little loss as possible.

Up to now, efforts to increase sugar production have been concentrated on beet processing in the factory. This is all to the good, but the greatest possible improvement achieved in this way, is considerably less than the improvement than can be achieved if attention is paid to decreasing the loss of sugar from the moment of beet harvesting to the beginning of processing in the factory. The basic aim of the new technology from the field to the factory is to establish a mutually satisfactory business relationship between the producer of beet and the sugar factory, and to ensure a maximum utilization of agricultural potential, both in conditions where arable land is limited and where there is enough of it. If there are specially favourable climatic conditions in combination with this technology, sugar production should be especially profitable.

The best technology of raw material from the field through to processing can, in comparison with effects attainable in the factory, ensure a two or threefold increase in profitability. Other factors such as soil and climatic conditions, and the economic level of the country also have an effect, so that the true value of the technology can only be judged in a concrete case, but, whatever the specific conditions, positive improvements can be achieved in all cases, and the most important of them are as follows.

Effects of harvesting at the right moment

These effects are the consequence of the new conception of beet manipulation and its processing during the peak period when the beet has been allowed to reach its biological and technical optimum. This can be seen in the optimal size of the beet root and the maximum possible quality of sugar in it.

Assuming that we cultivate a special sort of beet which is genetically predisposed to attain a certain size of root and concentration of sugar, it is in the interest of the beet producers and of the factory to pick the beet and process it when the required yield per hectare and the concentration of sugar in the beet are at a maximum.

For various reasons, the period of beet harvesting usually starts considerably earlier and ends considerably later than the period when both the yield of beet per hectare and the percentage of sugar in the beet are at a maximum. The aim of the new technology is to reduce the harvesting period to the time when the sugar beet is at its best, and to process the beet as soon as possible. This can only be done by close co-operation and organization between the beet producers and the factory. The factory must have the technical capacity to store sugar at the thick-juice stage rather than as sugar beet.

The effects of harvesting beet at the right moment are detailed in annex I where the old and new methods are compared. On an area of 6,250 hectares, by harvesting at the right time, one can get an increased beet yield per hectare of 9.18 per cent. The percentage of sugar in the beet will be 0.74 per cent higher, the total amount of sugar in the beet harvested will be 4,438 tons more, and the amount of white sugar finally produced will be increased by 3,645 tons.

Effects of beet processing without storage. This involves processing the beet just after harvesting, which reduces the negative effects of "biological shock" and the initial loss of sugar from the beet, which can be as high as 0.4 per cent per beet even during short-term storage for 3-4 days. In the new method, intake of beet into the factory lasts 14-18 hours, the beet is stored after washing and will be processed before the arrival of fresh beet the following day. The results of this process on a given quantity of 200,625 tons of sugar beet are shown in annex II at the end of this report. The essence of this method of work is to decrease the loss of sugar between the field and the factory by one half, which alone would lead to an increase of 1,347 tons of white sugar from the same quantity of beet, and to an increase of about 287 tons of molasses.

Effects of a decrease in the cost of transportation. This is a very important element in the new technology, but the exact extent of its contribution to economic viability can only be demonstrated in each particular case. The size of the beet area, the capacity of each truck, daily output and the duration of the harvest period are decisive in assessing the total effect, but essentially the method calls for a small number of trucks, their maximum utilization and a reduction of the labour required. The example in annex III, based on a sugar factory processing 200,625 tons of beet annually, shows how an optimum use of transport can reduce the price per kilometre/ton by 40 per cent.

Sum of effects of the application of the new technology. This is given in annex IV at the end of the report. The summary only takes into account improvement in raw material quality and technological process. By taking into consideration present sugar prices, molasses, pulp and reproduction material, the financial effect of the new technology can be easily predicted. It is quite certain that a combination of good sugar-beet varieties and the application of particular elements of the new technology, together with local conditions, will lead to extremely positive effects.

The effects of harvesting at the right time and of processing without storage, taken together, give an increase in sugar production of 5,026 tons and an increase in molasses production of 355 tons.

B. Processing of beet up to thick juice and dry pulp

The sugar beet, having been harvested at the right time and transported to the factory, is then processed as fast as possible up to a stable intermediate product (thick juice or dry pulp) which can be stored without loss. The choice of technical process and the production capacity to be installed will depend on an accurate projection of the regular supply of raw material. The production technology must contribute to a maximum utilization of raw-material quality, that is, the amount of sugar accumulated in raw material in the field.

It must be taken into consideration that, after putting the sugar factory into operation, the utilization of technical capacity should reach 80-100 per cent, depending on the skill and training of personnel. Independence of the sugar-beet treatment process from the capacity of the refinery, should ensure that the utilization of beet-processing capacity is as near as possible to 100 per cent.

Material balance

If measures are taken, as described in section A above, to ensure an optimum quality of raw material, the sugar beet entering the production process should have a sugar content of 16.5 per cent. The choice of technology and equipment for processing the beet should result in the following material balance in which only 0.5 per cent of the original sugar in the beet is lost.

	Percentage
Initial sugar in beet	16.5
loss by diffusion	0.25 (or less)
loss by purification	0.15 (or less)
loss by crystallization	0.1
Total sugar in products	16.0
molasses	2.3
sugar crystals	13.7

Technological operations up to production of thick juice

After slicing the beet and extracting the sugar from the cossettes, production should proceed in the following way. The diffusor produces 110-125 kilogrammes of raw juice per 100 kilogrammes of beet, depending on the type of apparatus. To this is added 2.0-2.5 per cent calcium oxide, in the form of milk of lime, during purification. This reagent is used to bind non-sugars from the sugar beet during extraction of sugar from the cossettes. Together with carbon dioxide, calcium oxide changes into calcium carbonate, which is taken away, together with the non-sugars, by decantation and filtration from the sugar solution (thin juice). After purification, from 100 kilogrammes of sugar beet, about 125-130 kilogrammes of thin juice are obtained. This consists of, for example, 13.64 per cent dry matter and 12.58 per cent sugar. This means the purity percentage of the previous raw juice from the diffusor has been improved from 86.8 per cent to 92.2 per cent. After evaporation, the crystallization of sugar in a three-stage cycle follows and results in sugar crystals on the one side and molasses on the other.

This process of purification of raw juice, by which over 40 per cent of non-sugars can be taken away, is characterized by considerable heat consumption. It is necessary, depending on the choice of purification process and of equipment, to reckon on a heat consumption of approximately 7,100 kilocalories per 100 kilogrammes of beet.

Evaporation from thin juice is carried out in the evaporation station with four or five evaporators. From 128 kilogrammes of thin juice, one can get 25.4 kilogrammes of thick juice by evaporation. The evavorated water, in the form of steam, should be re-used for heating the juices in the process of purification and also for sugar crystallization in the refinery where concentration of thick juice is carried out.

During the crystallization process in the refinery, the 25.4 kilogrammes of thick juice which have been produced from 100 kilogrammes of beet, are partly transformed into white sugar and the remainder is stored as thick juice after concentration to 68-70 per cent of dry matter, cooling and adjustment of alkalinity.

Annex I

THE EFFECTS OF HARVESTING SUGAR BEET AT THE OPTIMUM TIME

(based on a production area of 6,250 hectares)

	Units	According to classic method of work	According to modern concept
Quantity of beet produced in the given area	tons	183,750	200,625
Percentage of sugar in beet in the field	percentage	17.45	18.19
Total quantity of sugar in the beet crop	tons	32,062	36,500
Inevitable loss of sugar from field to factory (@ 2% per beet)	tons	3,675	4,012
Total sugar entering processing	tons	28,387	32,488
Percentage of sugar in cossettes	percentage	15.45	16.19
Quantity of sugar produced	tons	23,426	27,071
Utilization of sugar per beet	percentage	12.75	13.49
Quantity of molasses	tons	3,858	4,213
Dry pulp (3.2% per beet)	tons	5,880	6,240
Pressed pulp (18% per beet)	tons	33,092	36,130
Loss of sugar during processing, including sugar left in molasses	percentage	3.89	3.71

Annex II

THE EFFECTS OF BEET PROCESSING WITHOUT STORAGE

	Units	According to classic method of work	According to modern concept
Quantity of beet produced in the field	tons	200,625	200,625
Percentage of sugar in beet in the field	percentage	18.5	18.5
Total quantity of sugar in the beet crop	tons	37,012	37,012
Inevitable loss of sugar from field to factory	tons	3,627	2,003
Total sugar entering processing	tons	33,385	35,009
Percentage of sugar in beet on slicers	percentage	16.64	17.45
Quantity of sugar produced	tons	27,710	29,057
Utilization of sugar per beet	percentage	13.82	14.49
Quantity of molasses	tons	4,471	4,758
Dry pulp (3.2% per beet)	tons	6,240	6,240
Pressed pulp (18% per beet)	tons	36,130	36,130
Loss of sugar during processing including sugar left in molasses	percentage	3.61	3.44

Annex III

THE EFFECTS OF OPTIMUM UTILIZATION OF TRUCKS

	Units	According to classic method of work	According to modern concept
Life of truck	kilometres	300,000	300,000
Working days per year	days	240	240
Average distance of trip	kilometres	25	25
Average trips per day	number	2.5	10
Average result	tons per kilometre	90,000	350,000
Trucks required	number	190	67

Annex IV

SUMMARY OF THE EFFECTS OF APPLYING NEW TECHNOLOGY

The existing inner reserves which can be developed by using the new technology are shown below.

	Units	According to classic method of work	According to modern concept
Quantity of beet produced in the field	tons	183,750	200,625
Beet yield	tons per hectare	29.4	32.1
Percentage of sugar in beet in the field	percentage	17.45	18.19
Total quantity of sugar in the beet crop	tons	32,062	35,600
Inevitable loss of sugar from field to factory	tons	3,675	2,003
Total sugar entering processing	tons	28,387	34,497
Percentage of sugar in beet on slicers	percentage	15.45	17.19
Quantity of sugar produced	tons	24,054	29,080
Utilization of sugar per beet	percentage	13.09	14.49
Quantity of molasses	tons	3,858	4,213
Dry pulp (3.2% per beet)	tons	5,880	6,240
Pressed pulp (18% per beet)	tons	33,092	36,130
Total loss of sugar during processing	percentage	2.36	2.70

Annex V

DETAILED ASSISTANCE RENDERED TO SUGAR FACTORIES

During his mission to the sugar factories at Adra, Jisr esh Shughur, Homs, Tel Selhab and Maskaneh, the expert tackled the following problems and worked out solutions to them:

1. Methods of protecting sugar beet in storage against microbial activity and destruction of sucrose.

2. Methods of assessing the quality of sugar beet and determinating the start of the processing season.

3. Improvement of stone catcher's hydraulic mechanism by recirculating flume water.

4. Elimination of sugar-beet tails and particles before slicing in order to utilize them as food stuff and to increase extraction efficiency.

5. Applying methods of sharpening and adjusting slicing knives in order to improve quality of cossettes, increase efficiency of extraction and improve the purity of extracted juice.

6. Cleaning sugar-beet slicing knives with liquid disinfectants in order to improve quality of cossettes and to optimize extraction.

7. Mechanical improvement of mixing impeller in the pre-liming reactor.

8. Optimization of heating system for sugar juice before final carbonation.

9. Instructions on starting operating the lime kiln and on limestone and coke preparation.

10. Improvement of the sugar-beet washer's internal stone catcher.

11. Improvement of the operation of the filtration station's vacuum drum through using compressed air instead of steam.

12. Improvement of the raw-sugar refinery's filtration by using filter materials and introducing a system for their preparation and dosage.

13. Modification of the dosage of sugar-beet cossettes in the extractor with the intention of decreasing the quantity of extracted juice and stabilizing the factory's heat consumption.

14. Recirculation of press-water for heating, in order to decrease sugar destruction and to improve the heat economy of the extraction unit.

15. Improvement of transport of extracted pulp, adjusting total heat balance and decreasing waste-water pollution.

16. Decreasing microbial activity during extraction by heat and chemical sterilization.

17. Use of continuous method and equipment for sugar-juice purification, improving the technological level and the entire efficiency of the sugar factory.

18. The addition of natrium hydroxide to sugar juices and syrups to prevent sucrose destruction during evaporation and crystallization.

19. Provision of good quality fresh water for industrial consumption.

20. Use of separated, centrifuged syrups for melting raw sugar, which is the first rule for correct crystallization and successful elimination of non-sugars in raw-sugar refining.

21. Use of mechanical separators in white-sugar centrifuges to improve the syrup's purity and crystallization and to save sucrose and energy.

22. Introduction, in many cases, of closed water circuits to re-use water, thus saving heat and energy and decreasing the quantity of waste water.

23. Elimination of some mechanical and hydraulic errors made in installation of equipment and of bottle-necks in the raw-sugar melting line. Increase of the capacity and efficiency of the continuous centrifuges.

24. Dealing with the presence of leuconostoc mesenteroides in the sugar juices, and their influence on the quality and quantity of final products.

25. Introduction of modern analytical methods in process control.

26. Combatting the influence of microbial activity on the sucrose balance in both the sugar-beet processing and raw-sugar refining seasons.