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# ENVIRONMENTAL IMPACT ASSESSMENT OF BEAT SUGAR PRODUCTION PLANT IN EGYPT

تقييم الأثر البيئي لمصنع لإنتاج سكر البنجر بمصر

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## الخلاصة

تهدف هذه الدراسة إلى تقييم الأثر البيئي لمصنع لإنتاج سكر البنجر بمصر والمملوك لشركة (إسما) لصناعة السكر. وتعتمد صناعة السكر على استخراج السكر من جذور البنجر أو القصب وتعتبر من أهم الصناعات الإستراتيجية المتصلة بالتنمية والتقدم الاقتصادي، لذا فإن إقامة مشاريع جديدة لإنتاج السكر بمصر ضروري. وتستند هذه الدراسة إلى تحقيق العناصر التي قد تؤثر على البيئة والصحة العامة نتيجة لإنشاء وتشغيل مشروع "إسما" بمصر، وتوفير الحلول المثالية لتجنب أي آثار سلبية من خلال خطة لإدارة بيئية تهدف إلى الحد من أي آثار سلبية قد تنتج عن هذه الأنواع من المشاريع والإمتثال للوائح القانون المصري للبيئة رقم ١٩٩٤/٤ بشأن مشاريع إنتاج السكر واتباع الحدود المسموح بها لمعدلات الانبعاثات في جميع القطاعات المصنع. ونتيجة لهذه الدراسة تم اقتراح مختلف تدابير التخفيف من الآثار البيئية، التي قدمت في خطة الإدارة البيئية. ولرصد هذه الآثار قد اقترحت مختلف السمات البيئية في الوقت وبعد الانتهاء من خطط الإدارة. وسوف يتم استخدام برنامج رصد بيئي محدد تحديداً جيداً مع الموظفين المدربين والمؤهلين بالإدارة البيئية للمشروع المقترح، لرصد السمات البيئية للمنطقة فيما يتعلق بخطة الإدارة البيئية بفعالية، فضلاً عن إتباع المبادئ التوجيهية لجهاز شئون البيئة المصري فيما يتعلق بمشاريع إنتاج السكر باتباع الحدود المسموح بها لمعدلات الانبعاثات في جميع القطاعات في المصنع.

## ABSTRACT

This study aims to assess the environmental impact of sugar beat production plant in Egypt owned to ESMA company for sugar production. Sugar industry depends on extracting sugar from the roots of beets or from canes, and is considered as one of the most important strategic industries which is related to development and economic progress, so establishing new projects to produce sugar in Egypt is necessary. This study is based on investigation of the elements that may affect the environment and the public health due to the establishment and operation of the ESMA project in Egypt, and providing the ideal solutions to avoid any negative effects through an environmental management plan that aims to limit the negative effects resulted from these kinds of projects and to comply with the regulations in the Egyptian Law of Environment number 4/1994 concerning the Sugar production projects by following the allowed limits of the rates of the emission in all factory sectors.

As a result this study various mitigation measures have been proposed, which have been presented in Environmental Management Plan (EMP). For monitoring these impacts, various environmental attributes have been proposed at the time and after completing the management plans. A well defined environmental monitoring program would be employed with trained and qualified staff of Environmental Management of the proposed project, to monitor the environmental attributes of the area with respect to EMP with efficacy as well as following the guidelines of EEAA.

**Key Words:** Environmental impact assessment, sugar industry.

## 1. INTRODUCTION

Sugar is considered as one of the most important nourishment commodities in Egypt. The annual consumption of sugar still higher than the annual production capacities of the existing factories which leads to import considerable amounts of sugar; the average annual consumption rate of sugar per capita in Egypt is 31 Kg while its 10 Kg. all over the world. Therefore establishing new sugar factories and increasing the crops of beets – which is used as raw material in sugar industry in Egypt- is necessary to meet with this need.

Sugar beet is the best raw material used in producing sugar as it has many advantages over cane sugar; its plantation requires low water rates and has the ability to adapt among the difference climatic conditions. Fortunately the Egyptian scientists specialized in the agricultural and genetics engineering field have developed programs for increasing the production of beet crops by using better kinds of seeds and developed technologies, and as a result planting beet sugar has succeeded in many Egyptian governorates [1]. Recently, the planted area in Egypt with beet sugar is about 200000 acres and a horizontal

expansion to plant beet sugar in Egypt is expected. Therefore, the gap between the sugar production and consumption can be reduced if this type of industry is supported. Sugar beet is an important crop within many arable rotations and is commonly grown in conjunction with wheat, barley or potatoes. It is a valuable break crop, preventing the build up of disease and reducing the need for pesticides in the following crops; this is a fundamental strategy of integrated crop management. However, the general public seem to believe that sugar beet production is environmentally damaging. Without a detailed study designed to identify and quantify environmental impacts, farmers and the beet sugar industry have no ammunition to dispel such claims [2].

Environmental Impact Assessment (EIA) is a process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made. These studies integrate the environmental concerns of developmental activities in to the process of decision-making [3]. EIA has emerged as one of the successful policy innovations of the 20th Century to

ensure sustained development. Today, EIA is formalized as a regulatory tool in more than 100 countries for effectively integration of environmental concerns in the economic development process [4].

The process of the environmental impact assessment of the projects is also known as the logical way of examining and testing the impacts of the projects on the environment. The environmental impact assessment aims to defining and classifying the impacts of the projects on the natural environment and the human health. It also aims to analyzing and explication this information and delivering them successfully and clearly in a text of a final environmental report that is used by decision makers for evaluating the projects [5]. The completeness of the environmental impact assessment with the circle of the periods of the project is important for all activities that are connected to the planning of the project. It represents the importance of inserting the environmental impacts in the process of project planning with the appearance of its effective impact on the stages of designing and preparing and on the cost of the project [6]. Prediction of the potential adverse environmental and social impacts arising from development

interventions is at the technical heart of EIA process. An equally essential element of this process is to develop measures to eliminate, or reduce the impacts to acceptable levels during implementation and operation of the projects. The integration of such measures into project implementation and operation is supported by clearly defining the environmental requirements within an Environmental Management Plan (EMP). Normally, potential impacts are identified early during the initiation of project, and measures to avoid or minimize impacts are incorporated into the alternatives being considered. In this respect, some of the most important measures to protect the environment and local communities become integral to the project design, and may not be reflected in a formal EMP [7].

Agriculture has a complex relationship with the environment because of its dependence on natural resources and natural processes. Farm practices have an impact on the environment within the farm itself, but these impacts, both positive and negative, can be felt well beyond the farm gate. The potential impacts are very diverse (e.g. pollution and loss of biodiversity) and result from

farm inputs (fertilizers and pesticides, non-renewable resources such as fossil fuels) and land management practices which result in the loss of wildlife habitats [2]. The sugar industry may be responsible for more biodiversity loss than any other crop, due to its destruction of habitat to make way for plantations, its intensive use of water for irrigation, its heavy use of agricultural chemicals, and the polluted wastewater that is routinely discharged in the sugar production process. Environmental impact assessments are often used to aid decision-making on complex planning issues and the use of such techniques within agriculture is about to come of age. Sophisticated risk assessment methods are now available for planning pesticide strategies and mathematical models have been developed which simulate the nitrogen dynamics within arable land to generate field specific fertilizer recommendations [2]. The British Beet Research Organization has a key research target to improve the environmental impact of the sugar beet crop and the sugar industry. Consequently, they have funded a research project to use state-of-the-art tools to compare the potential environmental impact of a range of conventional beet production systems in

the UK and to present the findings alongside an economic assessment [2].

However this study is prepared to assess the positive and negative impacts on the surrounding environment of the proposed ESMA sugar production plant.

## 2. DESCRIPTION OF THE PROJECT SITE

The project site is located in Elkantra, Ismailia governorate, Egypt west to kilo 23 Port Said - Ismailia road. The total area available for establishment this project is 150 acre (630,000 m<sup>2</sup>). The site has been selected depending on the availability of raw material of sugar beet in Ismailia and neighbor governorates where the soil for beet agriculture is suitable. Also the site has proximity signed Suez port, availability of labors specialized in beet agriculture near to the project area. The project intended to establishment required definitive areas according to operation requirement and general planning of the project which estimated by 50000 m<sup>2</sup>. The main component of the project is as follow: (i) raw material storage area, (ii) sugar production area, (iii) utilities and auxiliaries area, and (v) water treatment plant.

### 3. RAW MATERIALS USED IN THE PROJECT

Sugar Beet is the raw material used in this project and estimated to be 150000 ton /year. Beet is used to produce sugar instead of canes which was used for long time especially in the south of Egypt where water is available. World wide, the planting of sugar canes spreads from 21° north to 21° south of equator.

Sugar beet is considered as a new crop in Egypt as it was first planted in 1981 with founding the Delta factory in Kafr El Sheikh which is the first factory to produce sugar from beet in Egypt. Sugar beet has the following advantages as compared with sugar canes: (i) planting beat needs six months less than cane, (ii) irrigation of beat needs 1/6 water quantity of canes needs, and (iii) beat is planted in low quality and salty soils but canes is planted in a muddy soil.

Beet roots are used to produce sucrose which represents (14 – 20 %) by weight. This is divided into three sections according to content of sucrose as follows: summit which represents 23 % of the roots weight, trunk represents 70 %, and the tail represent 7 % [1]. The main factors affect roots contents are kind of soil, climatic condition such as (temperature, water, and agriculture

factors such as fertilization). In general every 100 kg of the beet's roots gives 93 kg juice and 7 kg rubbish. There are many factors affects storage of beet roots such as temperature, humidity rates, physiological condition of roots, and the storage time.

The chemicals used in the project are: lime stone, coke coal, phosphoric acid, concentrated hydraulic acid, concentrated sulphuric acid, ethyl alcohol, yorya, and liquid sodium.

### 4. THE PROJECT PRODUCTS

White sugar is the main product of the project; its quality is in accordance with European STD. E.C.2 and Egyptian STD. No. 358/1990. In addition to sugar, two by products are obtained; these are Molasses and Pellets. Molasses is a viscous-brown liquid with density of about 1.4 gm/cm<sup>3</sup> and is the minor product of the final crystallization period in the industrial process in sugar factories where no more sugar can be recovered economically [6]. There are several industrial uses of this product. For this project, initially it will be exported for use in ethanol production and some will be sold as local livestock feed. In the long term, the company

intends to use the molasses for ethanol production through fermentation process. The financial feasibility of producing ethanol biofuel from sugar beets in central North Dakota has been examined [8]. Under the Energy Independence and Security Act (EISA) of 2007, biofuel from sugar beets uniquely qualifies as an "advanced biofuel". EISA mandates production of 15 billion gallons of advanced biofuels annually by 2022 [8]. The sugar industry can therefore be a major contributor of biomass energy as sugar feedstock are easy to convert and efficient for biofuel production [8,-12].

## 5. DESCRIPTION OF THE INDUSTRIAL ROCESSSES

Stages of industrial processes to produce sugar from beat are explained in details in [1]. These stages are: (i) Beats collection and preparation, (ii) juice extraction, (ii) juice treatment, (iv) evaporation process, (v) crystallization process, and (vi) white sugar production. These stages are briefly explained as follows.

Initially the beats are collected in the fields and carried in vehicles to the reception area in the factory where samples are tested to determine the rates of sugar and dusts in beat. Then the beets are washed inside the washing

drum to get rid off mud and sand. The beats are cut in the cutters in V shaped slices to achieve the greatest surface area for extraction; Juice extraction process occurs in the spreading device which consists of interior drill of 5 m diameter and 26 m length; the slices move inside the spreading device while water at 4.5 at and 72 °C is skipped on it. Pulp (slices which the sugar is extracted from it) is taken off the spreading device to the pulp station to produce the beet's residues which represent the minor product in the sugar production process.

The juice treatment process is done in steps as follows: liming, carbonation, sulphation, and rationalization. Liming is used to remove dust and collect the un-sugar materials by adding lime solution to the juice in two steps (primary liming and final liming). Carbonation is done by adding CO<sub>2</sub> to the solution to produce CaCO<sub>3</sub> and to collect all un- sugar material. Sulphation occurs then by the addition of SO<sub>2</sub> which equalize any increase in the added lime which reduce the viscosity of the juice. Finally the juice is rationalized to get rid of all dusts. The juice passes through the ion exchanging station to remove the increased solved calcium as a result of the existence of lime solution in the juice

to avoid any effects to the evaporation process. It may be noted that by juice treatment process we will be get rid of the un-organic salts, organic acids, colored materials, Nitric materials, poisons.

The evaporation process occurs on the treated juice to increase the concentration of the melted-solid materials from 17% to 70 % by evaporation devices which use the steam at 2.8 bars and 135 °C, and is operated by thermal exchanging system between the steam and the juice. During the crystallization process, the juice is concentrated in the super saturation period and is turned into crystallized sugar. Finally white sugar is produced by centrifugal process which separates clear crystals and collects yellow sugar and yellow liquid to treat them chemically and produce sugar.

## **6. THE ENVIRONMENTAL EFFECTS OF THE PROJECT**

The environmental effects are known as any environmental change for certain period inside particular area as a result of special action comparing with the situation without this action. All projects have effects on the environment; some of these effects are positive and

others are negative. Generally the environmental effects can be classified as: (i) temporary and direct effects, (ii) temporary and secondary effects, (iii) continuous and direct effects, and (v) continuous and secondary effects [5]. The effect of industrial projects may extend to whole levels of the environment's features including: air, water, soil, noise, human and natural recourses. All these effects are called the primary effects or direct effects and some of it may increase indirectly by using the sources of the project. However to evaluate the environmental effects (impacts) of the project we proceed as follows: (i) identifying the environmental elements related to the project, (ii) identifying the possible effects on the environmental elements during the project life, (ii) assessment of the Environmental Impacts, and (v) mitigating the negative effects by suggesting methods to reduce negative effects.

### **6.1 The Environmental Elements Related to the Project.**

The environmental elements related to the project are identified as follows: area available for the factory and area which will be affected by the project operation - energy resources needed for

the project and its rates - amount of fuel and the size of tanks and handling operations - under ground water - methods of solid waste disposal - nearest monitoring station to the project - natural aspects of the project site.

## 6.2 The Possible Effects on the Environmental Elements

The environmental effects of the project result due to the establishment of the project and its operation as outlined in the following.

- ❖ **Air Pollution:** Dust and small particles are released during the construction period from the vehicles and the cars movement. There are also pollutant gases such as Nitrogen oxides ( $\text{NO}_x$ ), Sulphur oxides ( $\text{SO}_x$ ), carbon monoxide ( $\text{CO}$ ), and carbon dioxide ( $\text{CO}_2$ ) released from engines.
- ❖ **Noise Pollution:** Transport vehicles, equipment, and other maintenance process represent the main source for the noise which affects the living beings in the area of the project.
- ❖ **Liquid waste:** Liquid waste is expected in waste water discharges as well as discharges resulted from the manufacturing processes. Activities are related to the site

preparations as well as storing of fuel, oils and materials used to produce sugar and its derivatives. Also discharges resulting from sudden accidents as a result of liquids leakage, and discharging of fuel, liquid and chemical waste.

- ❖ **Solid waste:** Solid waste due to producing sugar and its derivatives results from the manufacturing processes and as a result of the raw material handling and storing. There is also a source of rubbish such as work shops and garages.
- ❖ **The infrastructure:** The increased consumption of water, electricity, and transportation results from establishment and operation of the project represents extra pressure on the existing infrastructure facilities, but good project planning leads to elimination of any undesired effects.

## 6.3 The Environmental Impact Assessment of the Project

This process aims to examine and evaluate effects of the project activities on the environment. There are four methods used for this evaluation: (1) matrix method, (2) check list method, (3) network method, and (4) overlay method. The matrix method is the

most used method in the assessment of the environmental effects of the projects in general, and for large scale projects in particular. In this method the activities of the project are related to the effects in a matrix. The matrix is used in the assessment process by entering numbers for the environmental effects as follows: (0) refers to no effects, (1) refers to the positive effects, and (-1) refers to the negative effects.

Table 1 shows the matrix of the effects of the project activities on the environmental elements.

## 6.4 The Mitigation Procedures of Environmental Effects of the Project

This section provides the mitigation measures to attenuate or eliminate negative environmental impacts, which are likely to be caused by the proposed project. In general, it's possible to identify the procedures to limit the pollution of air, water and soil by providing ideal conditions to the operation and controlling processes and developing it by using modern techniques and cleaner raw materials. For this project, an Environmental Management Plan (EMP) has been developed to mitigate the potential adverse impacts and to strengthen the

beneficial environmental impacts during the construction and operation phases. In addition, during the operation phase this project will have responsibility to comply with the statutory requirements as per the EEAA guidelines. However, the EMP to control the pollution and reduce its effect on the surrounding environment and inside the factory is presented in the following.

### (A) Air Pollution Control Measures

- All safety measures in code for building and construction will be followed and regular monitoring of construction activity will be done.
- Personal protective equipment (PPE) will be provided to all the workers.
- Sprinkling of water in open area of factory premises will be done.
- Special care will be taken for the handling & transportation of the raw material within the premises.
- Material handling in the plant will be done in closed conveyors.
- All the trucks being used for transportation of raw material and final product shall be checked for "Pollution Under Control" certificate prior to their entry to the plant premises.

**(B) Water Environment (Water Sources and Waste water Minimization)**

Ample precautions will be taken to reduce water consumptions; water consumption will be observed using automatically controlled valves.

- All the industrial effluent will be recycled back in the process itself and there will not be any disposal of industrial effluent.
- Effluent generation of domestic effluent will be sent to water treatment plant in the project. No impact on ground or surface water is envisaged due to the project.

**(C) Noise Environment**

- The statutory national standards for noise levels at the plant boundary and at residential areas near the plant will be met. The selection of any new plant equipment is to be made with specification of low noise levels.
- Noise suppression measures such as acoustic enclosures /cabins, buffers and /or protective measures will be provided (wherever noise level is around +80 dB and exposure limits to workers is more than 8 hours a day) to limit noise levels within occupational exposure limits.
- Areas with high noise levels are to

be identified and segregated where possible and will include prominently displayed caution boards. However, in areas where noise levels are high and exposure time is less, employees will be provided with ear protection measures like earplugs or earmuffs. Earplug should be provided to all workers where exposure level is > 85 dB.

- The exposure of employees working in the noisy area should be monitored regularly to ensure compliance with the regulatory requirements.
- The existing practice of regularly monitoring of noise levels is essential to assess the efficacy of maintenance schedules undertaken to reduce noise levels and noise protection measures.
- The green belt around the plant will attenuate the noise level but instead of block plantation there should be variability in tree height and shape, as this would disperse the sound waves more efficiently. Plant that attenuate should be planted at the noise zone.

**(D) Solid Waste and Land Environment**

The proposed project will generate limited quantity of solid waste, disposal of waste shall be ensured as per the EEAA guidelines. Discarded containers will be kept at a designated place with paved surface. These containers will be decontaminated (washed/ cleaned) and after that will be stored in the scrap yard. Later on, these will be sold to the registered recyclers. The record of discarded containers stored in scrap yard and inventory of their selling to the recyclers shall be maintained. These solid waste and rubbishes should be collected and removed daily according to the environmental measures.

## **7. ENVIRONMENTAL MONITORING OF THE PROJECT**

This section provides the proposed environmental monitoring program for the proposed project to access the environmental attributes after the commissioning of the project. The environmental monitoring is related to the measurements of the processes inputs and the levels of emission and pollution. The environment monitoring is necessary to the industrial projects to improve its economical performance via defining the sources of losses in the raw material, the water, and the energy; which represent the main source of

pollution. This enables the factory institution to implement methods of decreasing the pollution which in turn reduces the production cost and leads to the economic and the environmental improvement. The environmental monitoring occurs according to the following.

- Observing the affected emission on the environment; this includes air conditions, waste water discharge, solid and hazards waste, and work condition.
- Observing the control measures in the processes; which are related directly to the operating temperatures and pressures.
- Observing the working conditions which are related to emission such as process shut down, the process of the protective, the periodic, and the sudden maintenance.

The environmental monitoring aims to observe effect of the emissions on the environment as well as measures of the processes control which is related to the environmental effect of the institution. Thus the emission monitoring is necessary to reduce the emission of the source through the procedures of decreasing the pollution. The environmental monitoring of processes

results in many benefits such as: (i) reduction in the production losses, (ii) reduction in production cost, (iii) energy and water conservation, (iv) using the planned and repairing maintenance instead of sudden troubleshooting, and (v) improving the working process.

**Table 2** shows the suggested environmental monitoring procedures and its rates for the proposed project.

## **8. ENVIRONMENTAL MANAGEMENT PLAN OF THE PROJECT**

The EMP is a documented procedure that promotes sound environmental stewardship, and ensures compliance with regulatory and corporate environmental commitments. The document should provide a framework for tracking environmental performance over the life of the project. It should be appreciated that this EMP has been adopted to cover both construction and operational phases, and thus includes parties responsible for the construction and operations of the facility. As the project develops, modifications to the EMP will be required. A detailed environmental management plan is usually finalized following approval of the development application and addresses all the technical requirements and conditions of the license and other

regulatory requirements. At this stage, this EMP outlines management control and mitigating measures for the impacts identified by this EIA. However, the EMP of sugar plant usually considers the following aspects: Description of mitigation measures, Description of monitoring program, Institutional arrangements, Implementation schedule and reporting procedures. Institutional framework includes the responsibilities for environmental management as well as responsibilities for implementing environmental measures.

## **9. CONCLUSIONS AND RECOMMENDATIONS**

Based on this study, it is expected that there will be no significant environmental negative impact of the proposed project. However, possible adverse cumulative impacts should be considered; this could be achieved through the monitoring program of air, noise, and groundwater. In order to ensure that the proposed project complies with required environmental and social standards, an Environmental Management Plan is also presented, including mitigation and monitoring recommendations. The proposed mitigation measures should reduce residual environmental and social impacts to acceptable levels in

compliance with the relevant EEAA standards.

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**Table 1 Matrix of Environmental Impact Assessment of the Project**

Environmental element / Activities	soil	Air quality	Surface water quality	Ground water quality	Infrastructures	Traffic	noise	Communication	Worker hand	Social activities
Site Preparation	-1	-1	0	0	0	-1	-1	0	+1	0
Digging Works	-1	-1	0	0	0	0	-1	0	+1	0
Materials supply for civil	-1	-1	0	0	0	-1	-1	0	+1	0
Concrete Works	-1	-1	-1	-1	0	0	-1	0	+1	0
Construction Works	-1	-1	-1	0	-1	1-	-1	0	+1	0
Pluming Works	-1	0	0	0	0	0	-1	0	+1	0
Electrical Works	0	0	0	0	0	0	-1	0	+1	0
Buildings Completion	0	0	0	0	0	0	-1	0	+1	0
Machines Supply to the site	0	-1	0	0	1-	1-	-1	0	+1	0
Production lines Assembly	0	0	0	0	0	0	0	0	+1	0
Testing and commissioning	0	-1	0	-1	0	-1	-1	0	+1	0
Raw materials supply	0	0	-1	-1	-1	-1	-1		+1	0
Steady Operation	0	-1	-1	0	0	-1	-1	0	+1	+1
Sugar Production	0	-1	-1	0	0	-1	-1	-1	+1	+1
Ethanol production	0	-1	-1	0	0	-1	0	0	+1	+1
Stored and packing	1	0	-1	-1	0	0	-1	0	+1	+1

**Table 2 Matrix of Environmental Monitoring Plan of the Project**

No.	Measured parameters	Location	Rates
1	Emission rates of SO <sub>2</sub> , NO <sub>x</sub> , and CO.	Within Plant Premises & Boundary	Weekly
2	Noise levels and thermal stresses inside the work environment.	Within Plant Premises	Monthly
3	Dust pollution rates inside and outside the work's environment.	All stacks	Weekly
4	The concentration of SO <sub>2</sub> and the noise levels outside the factory.	Plant Premises & Boundary	Monthly