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CHEMONICS INTERNATIONAL INC.

THE ASSESSMENT OF FERTILIZER SUPPLY AND POTENTIAL FOR LIBERALIZATION AND PRIVATIZATION OF FERTILIZER PRODUCTION

Indefinite Quantity Contract PCE-0001-I00-2051-00
Delivery Order No. 26

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CHEMONICS INTERNATIONAL INC.

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Dr. Rollo L. Ehrich
U.S. Agency for International Development
Cairo, Egypt

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Fertilizer Study

Subject: The Assessment of Fertilizer Supply and Potential for Liberalization and Privatization of Fertilizer Production

Dear Dr. Ehrich:

Chemonics International is pleased to submit the final report on our assessment of the fertilizer supply and potential for liberalization and privatization of fertilizer production.

We would like to thank you for your technical insights and your continuing encouragement and support throughout this effort. It was a pleasure working with USAID/Cairo, Egyptian Government officials, our Egyptian counterparts, and the fertilizer industry representatives whose cooperation and advice contributed greatly to the preparation of this report.

Sincerely yours,

Kimball Kennedy III
Project Supervisor

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INTRODUCTION

A Chemonics team, funded by USAID under PRE/IQC delivery order # PCE-0001-I00-2051-00, conducted this study of the Egyptian fertilizer industry from September to December 1995. During the three-year period prior to the study, the industry had undergone dramatic change. The change had begun with the privatization of the fertilizer distribution system and was followed by unprecedented growth in exports brought about by high world market prices for fertilizer. The downside to the change occurred as the 1994-1995 crop year experienced domestic fertilizer shortages which resulted in an estimated loss of LE 2 billion in agricultural production. As the domestic shortages developed, the Government of Egypt (GOE) and USAID were eager to ensure that the industry would be stabilized through a program of liberalization and privatization. Agreement was reached between GOE and USAID officials that one fertilizer company would become private by September 1996. This study, focused on the potential for privatization of the industry, was designed to provide information for needed government policy changes.

The scope of the study was designed to achieve the following goals:

- Assess the structure of the Egyptian nitrogen fertilizer industry
- Identify barriers to entry of private firms into the fertilizer industry
- Estimate the impact of the liberalization of fertilizer production
- Analyze the impact of the fertilizer tariff
- Develop a plan for fertilizer privatization
- Project the outlook for the nitrogen fertilizer industry
- Assess supply and demand for NPK fertilizers in Egypt
- Assess supply and demand conditions for specialty fertilizers; assess supply and demand conditions for potassium fertilizers
- Develop a time-phased liberalization and privatization strategy for traditional fertilizer production, as well as for more specialized products such as NPK
- Assess supply and demand conditions for NPK fertilizers in Egypt

The scope of the study was ambitious. For more information, see the scope of work in Annex A in a separate volume of annexes accompanying this report. However, the study proceeded slowly due to difficulty in obtaining reliable and detailed economic, technical, and financial data. In spite of the difficulty in gathering data, the study team was finally able to conduct a technical and financial assessment of the fertilizer producing companies as well as develop a privatization plan. The team also succeeded in assessing the demand for nitrogen fertilizer.

Following three months of study, the team had gathered enough information to make recommendations that should result in more efficient fertilizer production. The most important recommendation concerned the possibility of building a privately owned fertilizer tolling production facility that could manufacture ammonia for the three fertilizer plants that have outdated ammonia production capabilities.

The results of the study extended beyond the fertilizer production facilities. After studying a variety of data sources, interviewing farmers and professionals in the field of agriculture, the team concluded that domestic demand for nitrogen fertilizer will be flat for the foreseeable future. By implication, increased production would be sold on the world market, as there would be more than enough fertilizer for the domestic market.

Fertilizer plant visits, farmer interviews, numerous meetings with USAID and GOE officials, and review of the literature including several previous studies were all important to the study. At the study team's final report session, held on December 17, 1995, H.E. Minister of Public Enterprise Atef Obeid presented a list of 15 questions relative to the fertilizer industry that he would like to have answered for more effective fertilizer policy. His questions and a draft response are included as Annex B in the annex volume.

This report contains an executive summary, an overview of the fertilizer industry and discussion of the objectives of the study, a technical assessment of the fertilizer producing companies, a report on the demand for nitrogen fertilizer, a financial analysis of the fertilizer producing companies, and a proposed strategy for fertilizer privatization. A number of technical annexes, including an environmental analysis and a study of fertilizer use in Egypt, appear in a second volume.

The fertilizer industry is positioned for changes that can be stimulated both by increased fertilizer production and government policy. Additional studies should be carried out, as outlined in this report. The quality of the future studies and their focus can have a marked effect on the future of the fertilizer industry and the agricultural economy of Egypt.

ACRONYMS

BOOT	Build, own, operate, and toll
C&F	Cost and freight
CPI	Consumer price index
EFDC	Egyptian Fertilizer Development Center
EFIC	Egyptian Financial and Industrial Company
ESA	Employee share association
ESOP	Employee stock option plan
F.O.B.	Free on board
Fed	Feddan
GOE	Government of Egypt
ha	Hectare
IFDC	International Fertilizer Development Center
KG	Kilogram
KIMA	Egyptian Chemical Industries
KWH	Kilowatt-hour
LE	Egyptian pound (currency)
MOA	Ministry of Agriculture and Agrarian Reform
MT	Metric ton
MMBTU/MT	One million British thermal units per metric ton
MPE	Ministry of Public Enterprise
MTPD	Metric ton per day
MTPY	Metric ton per year
MUG	Synthesis makeup gas
N	Nitrogen
PBDAC	Principal Bank for Development and Agricultural Credit
PEO	Public Enterprise Office
PT	Piastre (currency-one hundredth of an Egyptian pound)
PSIG	Unit of pressure
SEMADCO	El Nasr Fertilizer and Chemical Company
SSP	Single superphosphate
TSP	Triple superphosphate
USAID	United States Agency for International Development

EXECUTIVE SUMMARY

A. Introduction

The potential for privatization of the Egyptian fertilizer industry is the focus of the PRE/IQC Chemonics Fertilizer Study. This document, the study's executive summary, synthesizes information related to:

- Existing capacity, status, and financial analyses in the nitrogen and phosphate sub-sectors
- Industry challenges related to current economic conditions, price controls, lack of accurate usage data, and conflicting usage predictions
- Privatization strategies including public stock offerings, private stock placements, and employee stock ownership plan options

The fertilizer industry includes the nitrogen sub-sector consisting of four fertilizer companies with a total of five production sites. The evaluation of the phosphate sub-sectors was limited to just two phosphate fertilizer-producing companies. During this study, the Chemonics team, along with its Egyptian associates, inspected all five of the nitrogen fertilizer production sites and two of the three phosphate fertilizer production sites. The exception was the EFIC site at Assiut, which was inspected only by Chemonics' Egyptian technical associate due to restrictions in that area on expatriate travel.

B. Information for Evaluation

The methodology to implement this diagnostic technical evaluation was based on primary and secondary data. Primary and secondary data was collected from production site inspections and from numerous meetings with governmental agencies and officials associated with the fertilizer industry, including the following: USAID, Ministry of Public Enterprise, the holding companies' chairmen and staff, the fertilizer companies' chairmen and staff, Egyptian Fertilizer Development Center technical director and staff, and Egyptian technical consultants.

Primary data also consisted of an environmental screening report on five of the eight fertilizer production sites. This report, prepared by El Mohamady Eid, is included in the report as Annex E. A study by El-Fouly and Fawzi concerning plant nutritional requirements is also included as Annex G in the annex volume that accompanies this report.

C. Requirements for Privatization

With the exception of Abu Qir Fertilizers and Chemical Industries, holding companies own all assets of the fertilizer companies. Evolving toward privatization will require the holding companies to relinquish majority ownership of stock to private investors. To promote privatization, holding companies may be required to carry out improvements to the fertilizer companies.

D. The Fertilizer Companies

In Egypt, there are four nitrogen fertilizer companies with a total of five production sites and four phosphate fertilizer companies, including two that produce fertilizer, with a total of three production sites.

The nitrogen fertilizer companies and related sites are as follows:

- Abu Qir Fertilizer and Chemical Industries—one production site at Alexandria.
- Egyptian Chemical Industries (KIMA)—one production site at Aswan.
- El Nasr Company of Coke and Chemicals—one production site at Helwan.
- El Nasr fertilizer and Chemical (SEMADCO)—two production sites, Suez and Talkha.

The phosphate fertilizer companies are:

- Abu Zaabal Fertilizer—one production site at Abu Zaabal and one phosphate rock mining site at West Sebeia.
- Egyptian Financial and Industrial Company (EFIC)—two production sites, Assiut and Kafr El Zayat.
- El Nasr Phosphate—one phosphate rock mining site at Sebeia.
- Red Sea Phosphate—one phosphate rock mining site at Hamrawin.

Egypt's presence in the world nitrogen fertilizer market began in 1979-80 with the commissioning of the then state-of-the-art and world-class size ammonia and urea units at Abu Qir (Alexandria) and SEMADCO (Talkha). These operations have design capacities of 1,000 MTPD ammonia/1,550 MTPD prilled urea and 1,200 MTPD ammonia/1,750 MTPD prilled urea, respectively. In 1991, Abu Qir commissioned the second 1,000 MTPD ammonia unit with updated efficiency and a 2,400 MTPD ammonium nitrate unit employing technology of "fluidized bed" granulation. In 1993, SEMADCO (Suez) commissioned a new 400 MTPD ammonia unit and two 500 MTPD ammonium nitrate "pug-mill" granulation trains. Abu Qir has announced the third expansion for 1998-1999: a 1,200 MTPD ammonia/2,000 MTPD urea based on "fluidized bed" granulation.

The ammonium nitrate capacities at SEMADCO's plants at Talkha and Suez and the calcium nitrate and ammonium sulfate capacities at Suez are limited by two old and inefficient ammonia units, one at each location. The ammonium nitrate capacities at KIMA (Aswan) and El Nasr Coke (Helwan) are also limited by old and inefficient ammonia units. With the exception of Abu Qir, which is considered to be a highly efficient operation, all other nitrogen producers will require substantial investments for retrofit and/or new facilities and pollution abatement upgrades. The primary goal for these investments must be to establish a high performance factor of 90-95 percent of design capacity. Efficient operation cannot be achieved without first establishing a high degree of on-stream reliability.

Contrary to the situation with regard to nitrogen fertilizer, Egypt's presence in the world phosphate fertilizer market is very limited. This presence will remain limited until the Abu Tartur project becomes commercially viable. Due to the withdrawal of price subsidies, domestic phosphate fertilizer demand declined by 40 percent from 1991-1995. This reduction required producers to improve quality via granulation for SSP (Abu Zaabal and EFIC) and TSP (Abu Zaabal) in order to develop export markets for their product. EFIC is currently planning a SSP granulation unit at Kafr El Zayat and SSP granulation expansion at Assiut. Abu Zaabal is

planning a TSP granulation unit and retrofit of the phosphoric acid unit. When these projects are completed, both producers should approach full design capacity, subject to domestic and export demand.

The economic viability of both phosphate producers may require restructuring and modernizing in order to remain competitive, especially if and when Abu Tartur becomes a reality. Abu Zaabal is the only vertically integrated operation with both mining and production capabilities. However, it is heavily debt ridden and requires plant improvements, especially in the area of phosphoric acid. EFIC, although not vertically integrated, is well managed and in a sound financial position. EFIC requires plant improvements, as described below. If El Nasr Phosphate and Red Sea Phosphate cease phosphate mining, a consolidation of Abu Zaabal and EFIC could be beneficial to both companies.

E. Operations Overview

Abu Qir Fertilizer and Chemical Industries Company. Abu Qir is a modern, efficient and well-managed operation. The location is uniquely situated for domestic and export markets. Development has been in two phases: 1,000 MTPD ammonia/1550 MTPD urea (1979) and 1,000 MTPD ammonia/2400 MTPD ammonium nitrate (1991). The third phase, consisting of 1,200 MTPD ammonia/2,000 MTPD urea, is scheduled for commissioning in 1998/99. Operations appear to be in environmental compliance with the possible exception of the urea prill tower air emissions.

Egyptian Chemical Industries (KIMA). KIMA's ammonia process is relatively reliable but inefficient due to electrical energy consumption and high maintenance costs. Alternative ammonia supplies have not proven viable. The nitric acid process relies on air enrichment by oxygen from an electrolysis process which, if eliminated, would decrease design capacity by 20 percent to about the 1994-95 level. In general, the plant, which was built in 1960, is old and in need of rehabilitation, especially for pollution abatement. Major environmental concerns are discharge of contaminated wastewater, ammonium nitrate area emissions from neutralizer, evaporation and prilling towers and nitric acid absorber NOX_x

El Nasr Company of Coke and Chemicals. (Note: This information is only in regard to the fertilizer operation, not the company's primary business of coke production.) The ammonia process based on by-product coke oven gas is an old, unreliable, and inefficient operation that should be discontinued. The nitric acid unit requires rehabilitation. The ammonium nitrate solution, evaporation and 33.5 percent prilling should probably be replaced. Major environmental concerns are contaminated wastewater discharges, ammonium nitrate area emissions from neutralizer and prilling tower and nitric acid absorber NO_x. Operation at this site should be continued due to its important central location for fertilizer distribution, existing infrastructure and production of other chemicals. If an economical and reliable source of ammonia were available, production of ammonium nitrate could be doubled over previous production history. Also, coke oven gas could be more efficiently utilized as fuel for steam or electrical generation.

El Nasr Fertilizer and Chemical Company (SEMADCO). (Note: This company consists of two separate operations: Suez and Talkha.)

SEMADCO-Suez. This operation is ideally located for export to the Far East and Europe. A new private sector ammonia unit would allow this operation to achieve design capacity and, possibly, allow for future urea production. A primary problem is lack of the ammonia supply due

to old, unreliable and inefficient ammonia unit I and design defects of ammonia unit II. Ammonia II defects should be resolved with modifications recently completed. Ammonia I should be replaced with an economical and reliable ammonia supply. Calcium nitrate (crystal) production should be converted to calcium ammonium nitrate solution (17 percent N), thereby eliminating costly evaporation and crystallization operations. Refurbishment of other facilities to achieve design capacity and pollution abatement will be required. Major environmental problems are contaminated wastewater discharges, nitric acid absorber NO_x, and ammonium nitrate neutralizer/evaporation emissions.

SEMADCO-Talkha. Production has been limited primarily due to the inefficient and unreliable ammonia I and the steam balance problems of ammonia II. Retrofit plans for both units should allow other units, after refurbishment, to achieve design capacity. Ammonium nitrate prilling may require replacement by granulation. Major environmental concerns are contaminated wastewater discharges and emissions from ammonium nitrate and urea prilling towers.

Abu Zaabal Fertilizer Company. Production capacity has been limited by demand and poor performance of other units. Plans to retrofit the phosphoric acid unit and erect a new SSP and TSP granulation unit, if implemented, should result in the ability to achieve design capacity and the product quality necessary for export. In general, the plant is old and in need of refurbishment and pollution abatement. Major environmental concerns are contaminated waste-water discharges, sulfuric acid SO_x emissions, and dust control.

Egyptian Financial and Industrial Company. (Note: This company consists of two separate operations: Assiut and Kafr El Zayat.)

EFIC-Assiut. Operations appear to be well-managed. The plant requires some refurbishment. Plans to expand granulation of SSP, if implemented, should allow for design capacity, based on market demand. Major environmental concerns include contaminated waste water discharges, sulfuric acid SO_X emissions and dust control.

EFIC-Kafr El Zayat. Operations appear to be well-managed with good unit performances. Limitation to SSP production is sulfuric acid availability. Some refurbishment would be required in addition to plans for a total SSP granulation unit and expanded and new curing storage. If plans are implemented, design production capacity should be achieved. Major environmental concerns are the same as at Assiut: contaminated wastewater discharges, sulfuric acid SO_x emissions, and dust control.

F. Fertilizer Supply/Demand (1993-94 and 1994-95)

Ammonium nitrate statistics for 1994/95 as compared to 1993-94 are as follows:

- Production—1,494,895 MT, up 11.3 percent
- Domestic consumption—1,188,535 MT, down 3.6 percent
- Exports—306,360 MT, up 264 percent
- Unutilized capacity—348,105 MT or 23.3 percent of total production

Urea statistics for 1994-95 as compared to 1993-94 are as follows:

- Production—916,695 MT, down 1.5 percent
- Domestic consumption—731,114 MT, down 7.1 percent

- Exports—185,581 MT, up 19.4 percent
- Unutilized capacity—175,305 MT or 19.1 percent of total production

Ammonium sulphate statistics for 1994-95 as compared to 1993-94 are as follows:

- Production—67,349 MT, down 3.3 percent
- Domestic consumption—81,849 MT, down 58 percent
- Imports—-22,000 MT, down 307 percent
- Unutilized capacity—49,092 MT or 72.9 percent of total production

Total nitrogen fertilizer statistics, expressed as nitrogen, for 1994-95 as compared to 1993-94 are as follows:

- Production—940,250 MT, up 3.4 percent
- Domestic consumption—755,239 MT, down 8.0 percent
- Exports—189,543 MT, up 71.7 percent
- Unutilized capacity—207,368 MT or 22.1 percent of total production

Special attention should be given to "unutilized capacity" statistics. Abu Qir excluded, these statistics represent lost production by failure to achieve, primarily, high performance factors for ammonia production units. Lost production of ammonium nitrate and urea can be equated to new plant capacities of 1,050 MTPD and 550 MTPD, respectively. These statistics demonstrate the necessity to retrofit the ammonia units of SEMADCO Talkha II and, possibly Talkha I and to replace the production of SEMADCO Suez I, El Nasr Coke and KIMA with an economical and reliable ammonia source.

Abu Qir dominates the market share with 57 percent of ammonium nitrate and urea and 54 percent of total nitrate fertilizers. However, SEMADCO (Talkha and Suez) could share almost equal market parity if design capacity of their production units could be achieved.

Single superphosphate (SSP) statistics for 1994-95 as compared to 1993-94 are as follows:

- Production—904,368 MT, up 19.1 percent
- Domestic consumption—740,490 MT, up 5.0 percent
- Exports—185,536 MT, up 76.1 percent
- Unutilized capacity—283,632 MT or 31.4 percent of total production

Triple superphosphate (TSP) statistics for 1994-95 as compared to 1993-94 are as follows:

- Production—39,643 MT, up 276 percent
- Domestic consumption—(essentially nil)
- Exports—52,345 MT, up 9.9 percent
- Unutilized capacity—80,337 MT or 202 percent of total production

Total phosphate fertilizer statistics, expressed as P_2O_5, for 1994-95 as compared to 1993-94 are as follows:

- Production—150,323 MT, up 26.1 percent
- Domestic consumption—110,799 MT, up 4.5 percent
- Exports—47,171 MT, up 41.1 percent

- Unutilized capacity—70,277 MT or 46.7 percent of total production

EFIC dominates the SSP market with 67 percent of total production for 1994/95, up 5 percent from 1993/94. It should be noted that domestic consumption and exports exceeded production capacity due to withdrawals from inventories.

The statistics indicate that the Egyptian phosphate fertilizer industry is dependent on the export market in order to approach design production capacity. To do so will require implementation of the projects previously mentioned for granulation and phosphoric acid retrofit at Abu Zaabal, for granulation expansion at Assiut, and for granulation at Kafr El Zayat.

In summary, the statistics support the following statements:

- Existing nitrogen and phosphate fertilizer producers have sufficient capacity, irrespective of unutilized capacity, to meet domestic requirements based on 1994-95 consumption rates.

- Retrofit of existing facilities in conjunction with new ammonia production to replace inefficient units should essentially recover total unutilized capacity, thereby increasing 1994-95 nitrogen and phosphate fertilizer production by 22.1 percent and 46.7 percent, respectively.

- Egypt's fertilizer industry is dependent on the export market in order to maximize production of existing facilities and ensure profitable operations.

G. Privatization Concepts

G1. Nitrogen Fertilizer Sub-sector

From a technical evaluation only—ignoring the financial aspects of assets and debt—the necessary requirement for privatization is that the candidate company be profitable or demonstrate the potential for profitable operation.

For nitrogen fertilizer products, ammonia is the primary feedstock and the dominant cost of production. When this supply is uneconomical, inefficient or unreliable (low performance factor) the final nitrogen product capacity will be reduced and the product cost will be increased. This low performance factor will result in decreased earnings and in possible operating losses.

In Egypt, there are eight ammonia units with the starting date and design capacity as follows:

AMMONIA UNIT	STARTUP	CAPACITY MTPD
Abu Qir I	1979	1,000
Abu Qir II	1989	1,000
SEMADCO (Talkha II)	1980	1,200
SEMADCO (Suez II)	1993	400
SEMADCO (Talkha I)	1964-1975	360
SEMADCO (Suez I)	1951	250

El Nasr Coke	1964	170
KIMA	1960	413

The first three listed units are considered as world-class, standard design, current state-of-the-art for process technology and capacity. SEMADCO (Suez II) unit, although commissioned in 1993, utilizes reciprocating compressor due to capacity design and, therefore, is less efficient than single train, state-of-the-art, centrifugal ammonia units. The continued operation of these four units are critical to the success of Egypt's nitrogen fertilizer industry. Of the remaining four units, only SEMADCO (Talkha I) is a serious candidate for retrofit while an alternative source of ammonia should be considered for the other three units.

All nitrogen fertilizer companies have either announced or otherwise expressed plans to retrofit or to expand ammonia production and related products. A summary of these plans or needs are as follows:

Abu Qir—new 1,200 MTPD ammonia/2,000 MTPD granular urea (1998-1999);
SEMADCO (Talkha)—retrofit of ammonia I to 450 MTPD and energy efficiency improvement of Ammonia II;
SEMADCO (Suez)—retrofit of ammonia I and new ammonia/urea capacity;
El Nasr Coke—replacement of existing ammonia, nitric acid and ammonium nitrate units with new 1,000 MTPD ammonia and 2,300 MTPD ammonium nitrate facilities; and
KIMA—due to non-availability of an economical ammonia supply, it continues to operate inefficiently.

The goal of privatization of the Egyptian fertilizer industry can be accomplished or advanced by introduction of a new, centrally located, ammonia production facility. This new production would, at the minimum, replace existing inefficient and high-cost ammonia production. Additionally, a reliable, sufficient ammonia supply would allow intermediate and final product units the potential to operate at design capacity, thereby substantially increasing the nitrogen fertilizer production. The capacity of new ammonia production would be determined by the number of fertilizer companies or plants willing to participate.

G2. Tolling Concept

The tolling concept involves constructing one new ammonia unit to supply possibly three existing fertilizer production operations which, in turn, would cease production in old, inefficient ammonia units. This new ammonia supply would be transported to each of the participating companies via rail, truck, and possibly barge. The new production facility would be a private corporation that would build, own, operate and "toll" (BOOT) natural gas into ammonia. Natural gas supply would be guaranteed by the Government of Egypt (GOE) and the price would be passed on to the ammonia consumer, that is, the fertilizer company. The cost of "tolling" would be based on utility type financing, not ammonia market pricing, and would return only the financial and operating costs plus a reasonable profit. The BOOT company would guarantee production capacity, efficiency, and price over the contract life of a 10, 15 or 20-year period. Capital investment for ammonia transport vehicles and transportation activities management could be provided by the BOOT company, a new private transportation company, or the participating fertilizer companies. It is critical to structure the BOOT company as a supplier of an intermediate product (ammonia) and not as a competitor in the production of fertilizer products (urea, ammonia nitrate, etc.) The proposed scenario is to construct a 1,000 MTPD ammonia unit with the distribution of product as follows:

COMPANY	LOCATION	AMMONIA DISTRIBUTION (MTPD)
SEMADCO	Suez	300
El Nasr Coke	Helwan	170
KIMA	Aswan	400
Other Sales		130
		1,000

The location of this unit would be at Suez to facilitate export of ammonium nitrate and ammonia. The design would provide for ease of retrofit to increase capacity up to 1,500 + MTPD for a future urea production unit. This proposal, if implemented, would have the following major advantages:

- New private sector investment of $200-250 million
- A more economical and reliable ammonia supply, enabling the participating companies to increase fertilizer production and improve profitability
- More efficient use of natural gas as compared to the SEMADCO-Suez ammonia operation
- Allows for more efficient use of coke oven gas at El Nasr Coke as fuel to produce steam or electricity
- Reduces electrical power consumption by about 220 MW, primarily from KIMA

The substantial economic impact of this reduction in power consumption is two fold: 1) avoidance of capital investment necessary to build new, equivalent electrical generation capacity; and, 2) an increase in electrical sales revenue over current operations of about LE 130 million per year, based on 11.3 PT/KWH.

The scenario proposed, if implemented, would advance the concept of privatization for the participating nitrogen fertilizer companies. The concept is viable but will require a definitive study with respect to construction, operating and transportation costs.

G3. Phosphate Fertilizer Sub-Sector

The technical concept for privatization of phosphate fertilizer companies is the same as for nitrogen: the candidate company must be profitable or demonstrate the potential for profitable operation. The primary raw material for phosphate fertilizer is phosphate rock or ore concentrate. Usually, profitable phosphate companies are vertically integrated, having both phosphate mining and production of high analysis monoammonium/diammonium phosphate fertilizers. Egypt, however, is somewhat unique in that the domestic market is based on SSP, a low-analysis, non-ammoniated fertilizer. Furthermore, the more profitable of the two phosphate producers, EFIC, is not vertically integrated. Abu Zaabal reported a 1994-95 gross profit of LE 11 million while demonstrating fair performance factors for SSP (74 percent) and poor performance factors for phosphoric acid which, in turn, limited TSP production to only 33 percent of design capacity. Two projects, currently in progress, should make substantial improvement in profitability. These projects, retrofit of the phosphoric acid to achieve 77,000 MTPY and TSP (45 percent P_2O_5) granulation unit for 180,000-200,000 MTPY, are scheduled for completion in 1996-1997. In addition to the implementation of these projects, Abu Zaabal must also restructure its heavy debt burden to be a candidate for privatization.

Contrary to Abu Zaabal, EFIC has little debt and is profitable. However, it is not an integrated phosphate company. The sound financial status of EFIC reflects good management during a difficult phosphate fertilizer period. EFIC (Assiut and Kafr El Zayat) reported a 1994-1995 gross profit of LE 45 million while demonstrating a fair overall performance factor of about 78 percent for SSP.

Improved profitability should result from two projects: at Assiut, granulation expansion scheduled to be completed early 1996-97 and at Kafr El Zayat, a new granulation unit for total SSP production scheduled to be completed within two years. EFIC, with minimum debt and currently profitable, is a candidate for privatization. One point of concern, however, is that EFIC is not vertically integrated. Currently, ore concentrate is purchased from both El Nasr Phosphate and Red Sea Phosphate. Should these companies cease mining operations, EFIC's phosphate supply would be narrowed to only Abu Tartur which, as projected in the phosphate study, would be more expensive.

Recognizing the duplicity of products (SSP) and marketing efforts, both domestic and export, as well as the need for a low-cost supply of ore concentrate, a case can be made for consolidation of Abu Zaabal and EFIC. This case would be strengthened should El Nasr Phosphate and Red Sea Phosphate cease mining operations. Abu Zaabal has the potential, with some investment, to supply ore concentrate to all three production facilities.

This consolidation could result in the total phosphate fertilizer industry being privatized at one time as opposed to a stepwise procedure which may have private entities competing with the public sector.

H. Recommended Studies

In summary, the following recommendations are presented regarding future studies on fertilizer:

H1. Nitrogen Fertilizer Sub-Sector

The following studies should be undertaken in the nitrogen sub-sector:

- **New Ammonia Production**

A two-part study should be undertaken to prove the economics and viability of a new 1,000 MTPD ammonia production facility to replace the old and inefficient ammonia units at SEMADCO-Suez I, El Nasr Coke and KIMA. This facility would be privately financed under the build, own, operate, and toll (BOOT) concept.

The technical portion of this study could be conducted by a company such as Foster Wheeler International USA Corporation (FW/USA), which promotes such BOOT facilities and has expressed interest to develop this project. FW/USA's scope of supply would be to determine cost of supply, construction and operation in order to establish a long-term, fixed FOB price per MT for ammonia-less natural gas. The economics part of this study could be conducted by a consulting firm. The scope of supply would include, but not be limited to, the following:

- The economic impact of overall project and on each participating fertilizer company

- The development of an ammonia distribution network, including private sector investment and operation

This study is an important requirement for the potential privatization of the three operations identified above.

- **Rehabilitation/Pollution Abatement**

A study should be conducted regarding major rehabilitation and pollution abatement at each nitrogen fertilizer operation, except Abu Qir. Scope of supply would be to identify sources, design abatement, and determine project costs and methods of funding. This study is necessary for privatization.

- **SEMADCO (Talkha) Retrofit Program**

A study should be authorized to evaluate and redesign the SEMADCO (Talkha) Debottlenecking project for more efficient operation and reduced investment. Proposed redesign would incorporate a complete, currently erected, 525 MTPD ammonia synthesis loop (170 bar) including centrifugal syn gas and refrigeration compressors with spare rotating elements.

Included in this facility is a nitrogen wash unit for removal of argon, carbon oxides, methane and excess nitrogen from synthesis makeup gas. This "nitrogen washing" provides an essentially pure hydrogen/nitrogen ratio. This wash unit would also take the synthesis loop purge from Talkha II and eliminate the investment in a hydrogen recovery unit.

The centrifugal synthesis and refrigeration compressors are currently electrically driven. Conversion of these compressors to high pressure (103 bar)/extraction (43 bar) steam turbine drivers would reduce the capacity of, and possibly, eliminate the proposed steam turbine electrical generation and provide for more efficient steam consumption.

This study is critical to the profitability of this company and a key to privatization.

H2. Phosphate Fertilizer Sub-sector

The recommended approach to efficient and profitable phosphate fertilizer production is the same as stated above for the nitrogen fertilizer producers. Phosphate producers also suffer from substantial unutilized capacity. For phosphate producers, however, the problem is a slowly recovering domestic and developing export markets. Announced plans for retrofit and/or expansion are as follows:

Abu Zaabal—retrofit of phosphoric acid and new granulation unit.

EFIC (Assiut)—expansion of granulation capacity.

EFIC (Kafr El Zayat)—expansion of curing storage and new granulation unit.

These announced plans, if implemented, should provide the ability to achieve design capacity and product quality for export. However, these plans do not emphasize efforts to abate pollution.

In summary, the following studies are recommended are presented regarding phosphate fertilizer production:

- **Pollution Abatement**

A study should be undertaken on major pollution abatement at each phosphate fertilizer operation. The study would identify sources, design abatement and determine project cost and methods of funding. This study is an important basis for privatization.

- **Consolidation of Abu Zaabal and EFIC**

A study should be authorized regarding the consolidation of Abu Zaabal and EFIC. The purpose of this study wold be to evaluate the economic viability of a single consolidated company as compared to two individual and competing companies. This study is an important basis for privatization.

I. Financial Analysis

The following is a summary analysis of the financial situation of the fertilizer industry in Egypt.

I1. The Nitrogen Sub-Sector

The market share of the four nitrogen producing companies for the fiscal year ending June 30, 1995, is shown below in Table Exec 1.

Table: Exec 1

Nitrogen Sector Fertilizer Production (%) 2.5 Million Tons	1995
Abu Qir	.54
KIMA	.10
SEMADCO	.33
Coke	.03

The fertilizer production growth rate of the four companies for the past four fiscal years is shown below in Table: Exec 2.

Table: Exec 2

Average Annual Growth Rate (%) Nitrogen Sector Fertilizer Production	1992-1995
Abu Qir	.05
KIMA	-.02
SEMADCO	.004
Coke	.017
Total Supply	.025

The past four fiscal years' operating profit margin for the four companies are shown in the Table: Exec 3.

Table: Exec 3

Operating Profit %	1992	1993	1994	1995
Abu Qir	.39	.41	.39	.43
KIMA	.12	.07	.11	.06
SEMADCO	.12	.02	.07	.11
Coke	-.76	-1.02	-1.12	-1.12

II a. Financial Summary of Nitrogen Fertilizer Producing Companies

Following is a summary statement of the financial condition of the nitrogen fertilizer production companies.

Abu Qir Fertilizers and Chemical Industries Company. As shown above, the Abu Qir Company had an operating profit of 43 percent in fiscal year 1995. Abu Qir has a cost advantage in nitrogen fertilizer production because its plants operate efficiently due to state-of-the-art technology made possible through technical and financial assistance from the German government. The geographic location of Abu Qir is another advantage: located on the coast of the delta, which is Egypt's largest agricultural area, Abu Qir has the ability to sell to Egypt's largest domestic fertilizer market and to export fertilizer from its doorstep. Because of these advantages, and the good management evident in the plant operations and maintenance, the company is the industry leader.

Egyptian Chemical Industries (KIMA). KIMA had a positive operating profit margin in each of the four years under review. Operating profit figures are misleading because KIMA's electrical costs are subsidized. If KIMA paid a fair market rate for electricity, the company would incur an annual loss. KIMA can not produce fertilizer efficiently due to the high cost of the raw material produced through water electrolysis which is an obsolete technology. Presently

KIMA pays a subsidized rate of LE 27 per 1,000 KWH. As a point of comparison, Abu Zaabal Company for Fertilizer and Chemicals pays a market rate of LE 180 per 1,000 KWH.

El Nasr Fertilizer and Chemical Company (SEMADCO). SEMADCO has two plants, one at Suez City and one at Talkha City. The Suez plant has been incurring losses over the past five years on the gross profit level due to the high employment levels and outdated production facilities which were erected in 1948. The plant has 3,000 employees on the payroll, resulting in total salaries amounting to 108 percent of sales revenue in 1995. The 1995 salaries totaled LE 25 million.

Talkha, which has 6,500 employees, made a net profit in each of the years under review. The consolidated income statement of SEMADCO also shows a net profit for each of the five years due to the good performance of the Talkha complex.

The Talkha plant experienced a 9 percent and a 19 percent average annual increase in sales revenue of urea and ammonia nitrate respectively over the past four years. This positive trend resulted from the liberalization of the fertilizer market and the availability of export markets.

SEMADCO's gross profit of 16 percent was affected by the negative gross profits of the Suez plant. The Talkha plant had a 26 percent average gross profit. Similarly, the return on sales for SEMADCO averaged 8 percent while that of the Talkha plant averaged 18 percent.

El Nasr Company for Coke and Chemicals. As a result of the obsolete technology and the high cost of the coke oven gas that the company charges to the fertilizer plant, the plant incurred a large loss each of the four years studied. Coke oven gas is a byproduct of the company's coke production.

Fertilizer sales account for only 4 percent of the company's total sales. The coke oven gas is used to produce ammonia and, in turn, ammonium nitrate fertilizer for agriculture, ammonium nitrate for military explosives, nitric acid and other products.

However, the technology of using coke oven gas to produce ammonia is expensive and obsolete. The fertilizer plant is in need of an efficient source of ammonia for fertilizer production.

I2. Financial Analysis: Phosphate Sector

There are two phosphate fertilizer producing companies in Egypt: Abu Zaabal Company for Chemicals and Fertilizers, and Egyptian Financial and Industrial Company (EFIC), also known as the Société Financière et Industrielle d'Egypte. The market share of the two companies for the fiscal year ending June 30, 1995, is shown below in Table: Exec 4.

Table: Exec 4

Phosphate Sector Fertilizer Production (%)	1995
Single Super Phosphate: 913,000 Tons	
EFIC	.69
Abu Zaabal	.31
Triple Super Phosphate: 42,000 Tons	
Abu Zaabal	1.00

The growth rate of the two companies for the past four fiscal years is shown in Table: Exec 5.

Table: Exec 5

Average Annual Growth Rate (%) Phosphate Sector Fertilizer Production	1992-1995
EFIC	.13
Abu Zaabal	.13

The operating profit margin for two companies for the past four years are shown in Table: Exec 6.

Table: Exec 6

Operating Profit (%)	1992	1993	1994	1995
Abu Zaabal	-.04	-.11	-.10	.02
EFIC	.14	.10	.12	.13

I2a. Financial Summary of the Phosphate Fertilizer Producing Companies

Following is a summary statement of the financial condition of the nitrogen fertilizer production companies.

Abu Zaabal Company for Chemicals and Fertilizers. Abu Zaabal Company for Chemical and Fertilizers owns a phosphate mining operation in addition to the fertilizer plant. Although the Abu Zaabal company had a 2 percent operating profit in 1995, the company incurred large net losses in each of the four years studied because of interest expense. The company recently negotiated with its creditors, the Bank of Alexandria, the National Bank of Egypt, and Bank

Misr, to convert a portion of its overdraft accounts into medium-term loans with reduced interest rates. Agreement was reached to convert LE 65 million of overdrafts into medium-term loans, which will be paid in annual installments with a simple interest rate ranging between 12-13 percent per annum.

Negotiations are in progress with the National Investment Bank to convert a past-due debt from a British loan to buy mining equipment to equity in the company. The loan was later converted to a grant extended to the Egyptian government. As the loan was in British pounds, the amount of the loan increased as the Egyptian pound lost value against the British pound. The company is seeking approval from the Ministry of Finance for the proposed debt-equity swap.

The company's sales increased 26 percent in 1994 and 14 percent in 1995 as a result of increased export sales of triple superphosphate. In 1995, LE 18 million in revenue resulted from the export of 50,000 tons of triple superphosphate. Increased sales in fiscal year 1994 did not result in a gross profit due to the high cost of goods sold. However, the company realized a gross profit of 10 percent in 1995.

Egyptian Financial and Industrial Company (EFIC). The Egyptian Financial and Industrial Company has a factory complex at Kafr El Zayat and another at Assiut. The company does not own a phosphate ore mine.

Balance sheets and income statements for the period studied, fiscal years 1992-1995, were available only as consolidated data for the Kafr El Zayat and Assiut factory complexes rather than individually. The percentage of net income for the four-year period ranged from 6 percent to 10 percent. The 1995 net profit after taxes of LE 10 million was LE 2.7 million. The 1995 net worth of the company was LE 38.6 million, as compared to LE 31.4 million for 1994, and LE 27.2 million at fiscal year-end 1993.

J. Privatization Strategies

USAID and the GOE have expressed an interest in the formulation of a privatization plan for the fertilizer industry, which would guide this sector's departure from state ownership during the next five years. An important purpose of this report is to identify those fertilizer companies that can be privatized in the near term and to provide for the consideration of GOE and USAID. a justification for their imminent divestiture.

The most important underlaying assumption to this privatization plan is that the GOE leadership has made a strong political commitment, in word and in deed, to proceed with a more rapid pace of privatization. A second underlying assumption is that the GOE will take substantial and concrete steps to encourage both domestic and foreign investment in general and investment in the fertilizer section in particular. This commitment also means the enactment of new legislations which has been pending in Parliament for the last 18 months, encouraging private investment, through tax incentives, and the reduction of bureaucratic procedures. In addition, this commitment means that the GOE will provide a series of attractive incentives to investors who create substantial new employment opportunities. The underlying assumption is that the GOE will give reasonable assurances and incentives to the private sector that it will return to its former role as the primary fertilizer distributor in the country.

The major objective of this plan is to initiate a dialogue among both GOE officials in the various ministries and the top management of the holding companies and the fertilizer company

chairmen, and USAID staff in order to determine the types and levels of support that can be provided in the future to implement the plan.

J1. Fertilizer Company Privatization Candidates

Short-term privatization candidates. One company, Talkha Fertilizer Company, we recommend be seriously considered for immediate privatization. We recommend that the parent company, SEMADCO, be separated into two companies, Talkha Fertilizer Company and Suez Fertilizer Company, based on the locations of the two plants. We estimate that establishment of the two companies should not take more than three months. Subsequently, a study of the Talkha Fertilizer Company would identify all the problems and solutions for the increase of production efficiencies and economic and financial viability. We estimate that this study will take three calendar months. After these two, three month periods, Talkha Fertilizer Company will be ready to undergo what we call the pre-privatization phase of activities. These are (1) undertake a full audit; (2) create employee redundancy, training and out placement plans; (3) prepare an equity distribution plan; (4) assemble a portfolio of documents to assist a strategic investor to undertake its due diligence analysis; (5) identify attorneys and investment bankers to represent the company; (6) search, identify, and negotiate with one or more strategic investors; (7) prepare management/labor ESOPs, if any; and (7) prepare and issue an initial public offering.

We estimate that these activities will take six months. Assuming that the GOE agrees to such a plan by March 1, 1996, the Talkha Fertilizer Company would be privatized by early to mid-summer 1997, allowing for several months lag time or unforseen contingencies.

The strategic investor for the purchase of the Talkha Fertilizer Company may come forth from the group of fertilizer distributors who are anxious to secure a reliable and uninterrupted supply of fertilizer for their customers. Given a transparent process, fair pricing of shares and a friendly (versus adversarial) attitude towards the new shareholders, including private investors, workers, and management, we do not foresee any serious problems in the realization of the privatization exercise in 12 to 18 months.

The justification for choosing the Talkha Fertilizer Company as the single candidate most appropriate for immediate privatization is that, despite substantial over employment, it seems well managed, is profitable, and has retrofitting requirements that are not overwhelming. In addition, the efforts and investments required for environmental improvements can be undertaken before or after privatization, subject to specific and concrete agreements with the GOE.

Should the GOE decide to announce the imminent privatization of Talkha as new investment legislation is enacted and an announcement made that PBDAC will terminate its monopoly position in fertilizer distribution, the government will be sending a very strong message underscoring its commitment to a market economy.

In the dialogue to take place between the GOE and USAID, assuming that the privatization of Talkha is acceptable to both parties, USAID and GOE may wish to access the resources available through three separate projects for the implementation of the plan described above, The first is the upcoming Agricultural Policy Reform project, which will be effective in calendar 1996. The second is the Partnership in Development project, effective since mid-1995. The third project is the Energy Conservation and Protection of the Environment project, or EP3. The nature of the resources that could be provided through these three projects for specific activities

could be decided upon over a period of several weeks if there are agreements in principal to proceed with the approach described above.

Medium-term privatization candidates. Three companies fall into this group: Suez Fertilizer Company, Helwan Fertilizer Company, and KIMA Fertilizer Company. All three of these companies are dependent on a secure and reliable ammonia source. Therefore, their privatization should coincide with the commissioning of the new 1000MTPD ammonia tolling plant expected in December 1998. During 1996, all the studies for each plan would be completed. The pre-privatization phase of activities will be undertaken in 1997 and early 1998, and the three companies taken to market by the end of 1998.

The Suez Fertilizer Company will have more serious retrofitting and environmental abatement requirements than some of the other fertilizer producers in the country and will therefore take time to prepare for privatization.

The Helwan Fertilizer Company will need special attention in order to separate it from its traditional coke-producing parent, in addition to addressing its retrofitting and environmental abatement problems.

The KIMA Fertilizer Company is envisioned as a new entity born from the division of the currently existing company into separate companies. The KIMA Heavy Water Company is envisioned as a new Egyptian-Canadian joint venture that will be more than 51 percent privately owned at its creation. The KIMA Fertilizer Company will be privatized shortly after it is converted for use of the ammonia provided by the new tolling operation proposed in Suez.

The companies indicated above would also be able to access the resources of the three USAID-funded projects mentioned earlier, subject to agreements between GOE and USAID.

Long-term privatization candidates. There are three companies that are candidates for privatization over the long term. We expect to create a certain amount of controversy in suggesting that these three companies are long-term rather than medium-term candidates for privatization. The three companies are Abu Qir, EFIC, and Abu Zaabal.

Although Abu Qir has commissioned a privatization study by KPMG/Frankfurt financed by KFW, it is not certain that this study will be divulged outside Abu Qir top management and board of directors in the near future. The main reason why we consider Abu Qir a long term privatization candidate is that the state-owned institution that own 92 percent of its equity will not easily give up or dilute its ownership. Nor will these state-owned shareholders be privatized themselves in the near future. Consequently, Abu Qir, which is a well-managed and highly profitable company at present, without any formal ties to a holding company, will continue to exhibit corporate behavior identical to that of a private company. Depending on the decision of Abu Qir management and shareholders, it would be relatively easy to move Abu Qir Fertilizer Company from a long-term to a short-term privatization candidate. However, given the information available at this time, it is doubtful that 51 percent of the equity could be transferred to private investors in the near or medium term.

Taken by itself, EFIC may be considered a short term privatization candidate. It is profitable and well managed. Retrofitting and environmental abatement problems could be resolved in the short term with the acquisition of a knowledgeable strategic partner. However, taken as one of the two participants of the phosphate fertilizer subsector, in which the other

participant has serious financial, operational, technical, and environmental problems, EFIC's privatization potential is affected. The issue at stake is the combination of these two companies as a single entity that will be privatized. Another important issue is the preparation and implementation of a regulatory framework under which this single company would operate. The market at present has a government owned and operated structure. Combining EFIC and Abu Zaabal does not change this structure. In fact, until Abu Tartur is fully operational, the new single and privately owned entity may be a monopoly itself for a short period of time especially if other phosphate mines close due to exhaustion of reserves. Regardless of whether the market is dominated by one or several players, a regulatory framework will be needed. For the reasons stated above, EFIC and Abu Zaabal are considered long term privatization candidates.

At the time of the writing of this report, EFIC is preparing to divest itself of 30 percent of its shares to its workers and the public. It is possible that the company has already undertaken a full audit and has determined the value of its shares to be floated under its first IPO through recognized financial procedures. It is also a possibility that the company has a detailed and comprehensive privatization plan that identifies how the receipts of the 30 percent divestiture will be utilized. The upcoming divestiture could be the first step of a complete or majority share divestiture that will take place according to a well defined calendar. The company may also have undertaken full disclosure on the risks and expected returns that potential investors will face when investing in company shares, including the expected performance of the company in domestic and international markets over the next five years. In the absence of such information, it is difficult to judge the purpose and significance of the 30 percent divestiture.

In conclusion, there seems to be a real opportunity at this moment in time to open the fertilizer industry to improved technologies, new investments, and increased competition. The final privatization plan that will be implemented in the near or distant future will be drawn up and executed by the Government of Egypt according to its political and economic priorities.

J2. Summary Of Privatization Strategies

Abu Qir Fertilizer and Chemical Industries. The strategy suggested for future study is that 5 percent equity be made available to senior management of 10 to 20 individuals, 10 percent equity for middle management of about 100 individuals and 25 percent equity to workers under an employee stock ownership plan (ESOP). The management and employee ownership would equal a total equity of 40 percent. A 60 percent equity share would be held by the current shareholders. Shares would be purchased by an Employee Shareholder Association (ESA) through a loan from a local or international bank. Earnings would be distributed as dividends in order to liquidate the loan in three to five years, during which time shares could not be traded. USAID could make funds available to the Ministry of International Cooperation (MIC) to guarantee such a loan. Ideally, for true privatization to take place (i.e., more than 51 percent in private hands), the current shareholders would either have to sell their equity or allow the dilution of their equity. However, it is unrealistic to expect either type of privatization to happen in the near or medium term.

El Nasr Fertilizer and Chemical Company (SEMADCO). During the first phase of privatization, after an asset valuation and a complete study of its operations, management, and labor utilization, SEMADCO would be divided into two separate companies. Shares would be held by SEMADCO Holding Company, whose shares in turn would be held by the Holding Company for Chemical Industries. The shares of the two new companies, called, for simplicity's sake, Suez Fertilizer Company and Talkha Fertilizer Company, would be sold to a strategic

investor. The plan would include a public stock offering and an ESA under the following formula.

Suez Fertilizer Company

Holding Co., for Chemical Industries (To be totally divested through stock market or by selling to current share holders in five years.)	10 percent
Suez Fertilizer Co., top and middle management	10 percent
Suez Fertilizer Co., work force	20 percent
Strategic investor and/or public	51 percent
Initial public offering	9 percent

Talkha Fertilizer Company. The strategy suggested for Talkha, subject to additional study, is the transfer of majority control of the new company to an individual or group of strategic investors who would control at least 51 percent of the shares and the board of directors. The remaining 49 percent would be owned by a combination of management/labor ESOP and a public offering. The design of the ESOP would be undertaken in a parallel time frame as the needed valuation studies and investor search activities are undertaken. Under a well-conceived and implemented ESOP, an employee share association would borrow the money to buy the shares using the shares as collateral. The risk to the lender and the cost of the loan to the borrower could be reduced by an MIC issued guarantee. The loan would be liquidated over 5 to 10 years from dividends paid out on each share.

The holding company would own class A shares negotiable at any time; the ESA would own class B shares released to owners as they are paid for and negotiable by owners a year after shares are received from the ESA. The strategic investor or the public would own a type of C share or preferred stock for majority ownership of the company. Past debt would either be forgiven or converted into long-term bonds possibly guaranteed by MIC if a financial analysis proves the soundness of the transaction. The reason a debt-equity swap is not suggested is that this would further dilute ownership. Since the debt is to state-owned banks, majority ownership would not be passing into private hands through a debt-equity swap but to a state-owned bank.

El Nasr Company for Coke and Chemicals. Given a thorough rehabilitation and the establishment of a new tolled ammonium plant in Suez providing the needed supply to Helwan, a privatization strategy could be developed along the following lines:

Phase I:	New ammonia plant: tolling operation 1996-1999
Phase Ia:	Parallel to phase I: financial restructuring 1996-1999
Phase II:	New nitric acid and new ammonium nitrate plant privately owned and operated by a private strategic investor: 2000-2005
Phase IIa:	Parallel to phase II: establish an ESOP with an ESA
Phase I:	Equity distribution: 1996-1999

Holding company	25 percent
Helwan management	10 percent

	Helwan workers	25 percent
	Strategic investor	40 percent

Phase III: Holding company divests its 25 percent share by selling to a strategic private investor and through an offering on the stock exchange.

Egyptian Chemical Industries (KIMA). The company needs a continuous and reliable source of ammonia. Once the ammonia is available, a privatization strategy could proceed as follows:

Phase I: New ammonia supplied by the central tolling operation 1998-1999

Phase II: Formulate ESOP/create ESA 1997-1999

Privatization starts with following distribution:

Strategic investor	40 percent
Holding company	25 percent.
KIMA management	10 percent
KIMA workers	25 percent

Phase III: The holding company divests its 25 percent share by 2000 by selling to a strategic private investor and through an offering on the stock exchange.

Abu Zaabal Fertilizer. Abu Zaabal will require massive financial restructuring prior to privatization. The first step is the financial restructuring which would include the proposed debt-equity swap. The second step is to study the possibility of a merger with the Egyptian Financial and Industrial Company. Following financial restructuring, privatization would require a strategic investor and a minority management-labor ESOP. Bechtel has undertaken a thorough diagnostic study of the phosphate industry; further expertise could build on this study to determine the optimal approach and implement it.

Egyptian Financial and Industrial Company (EFIC). As this report was being written in mid-December of 1995, the study team was informed that the Ministry of Public Enterprise had approved a divestiture plan for this company, under which 1.6 million shares would be offered for sale at LE 90/share. A total of 20 percent of the shares would soon be disposed of in a public offering and 10 percent sold to the workers under concessional terms. The holding company would hold 70 percent of the equity. This plan is not a rational route to privatization since the holding company will continue to hold 70 percent equity without a definite plan and calendar to divest the remaining shares.

A possible privatization strategy would be to sell the company to a strategic investor who would own a minimum of 51 percent with the rest of the 49 percent divided between an expanded ESOP and a public offering. However, under the second option of a merger with Abu Zaabal, this strategy would require substantial further study to determine an optimal and equitable privatization for the two companies.

In summary, privatization strategies suggested for the six companies revolve around an equity distribution among strategic investors, public offerings, and management-labor ESOPs. However, it must be noted that, despite the pros and cons involved in each approach for each company, if the GOE considers this sector as one that should remain under government control for the foreseeable future, it will remain so until the government determines when and how these producers will be privatized.

K. Demand for Nitrogen in Egypt

The challenge of the fertilizer demand aspect of the study was to predict future fertilizer consumption under very different circumstances than have prevailed in the past. The ability to accurately predict fertilizer consumption is complicated by conflicting data concerning current fertilizer usage. A correct assessment of nitrogen fertilizer use is essential for any serious analysis of the fertilizer industry.

By one calculation, new fertilizer production factories are required to meet domestic consumption. By another calculation, surplus fertilizer produced by existing factories will be exported.

Under a liberalized agricultural policy beginning in the mid-1980s, Egyptian farmers have reduced fertilizer use after years of centrally planned agricultural production. The question to be answered is the following: does the flattening off of fertilizer use imply a future of stagnant fertilizer sales, as in other high-use countries, or does this time period represent a temporary period of adjustment to the new forces at work in the agricultural sector?

To understand fertilizer demand in Egypt, it is necessary to start with two premises:

- Under conditions of universal credit and subsidized prices, the quantity of fertilizer used by Egyptian farmers grew dramatically between 1970 and 1991. Nitrogen application rates rose to be among the highest in the world.

- The Egyptian economy is currently following a liberalization program that has meant reduced state control of agricultural inputs and outputs. As a result of liberalization, domestic fertilizer prices rose to approximately world levels. A policy reversal in 1995 resulted in reduced liberalization in the fertilizer sector as policy makers searched for measures to ensure an economical domestic supply.

K1. A Priori Considerations

Some aspects of fertilizer demand can be explained by basic economic theory. When the price of a good goes up, less is used. As subsidies were removed from fertilizer and credit was no longer automatic, Egyptian farmers acted as theory predicts: they used less.

In a market economy, fertilizer use is mainly determined by economic factors. When deciding how much fertilizer to apply, farmers have many options. Those options include changing agricultural practices to substitute labor for excess fertilizer. Under the stimulus of higher prices, farmers increase their fertilizer efficiency, using more labor and less fertilizer. In the same way, low fertilizer prices will induce a replacement of labor by fertilizer, perhaps even above recommended levels.

When fertilizer prices increase, farmers react three ways—by using less on existing crops, using what they do buy more efficiently, and by selecting crops that have a better response to purchased fertilizer.

The use of fertilizer cannot correctly be seen as a question of fixed technical coefficients but must include consideration of farmers' management decisions. The factors of prime importance are the relative price of inputs, fertilizer, land, and labor as well as farmer awareness of improved

practices and the price of outputs. Demand projections made in the absence of such information are likely to be valid only as long as the environment within which the farmer operates remains unchanged. Another trend, seen in the behavior of European farmers who are heavy fertilizer users, is a long-term reduction in nitrogen use. This is due to many factors: increased international trade, greater competition, and reduced subsidies all depress fertilizer demand. When environmental controls are put in place, the result is a relative increase in the cost of using fertilizer.

K2. Data Debates

During the time when the Principal Bank for Development and Agricultural Credit (PBDAC) distributed fertilizer for the 30 years or so prior to 1991, fertilizer use data was available. If too much fertilizer was distributed to some farmers, farmers resold it. At low prices, all fertilizer was used by the farmer who received it. The situation since liberalization has resulted in a lack of data on actual use. Because of a lack of data following the exit of PBDAC as the principal distributor, the team had to spend a great deal of effort simply trying to estimate the pattern of use in recent years.

Limited data was available from PBDAC, the fertilizer production companies, and the Egyptian Fertilizer Development Center (EFDC). Based on available data, the team members predicted a stabilization of nitrogen consumption at 750,000 to 850,000 tons of nitrogen per year (N/year). There is another set of data from CAPMAS which produces much lower estimates, in the range of 650,000 tons N/year.

The Ministry of Agriculture calculations of fertilizer consumption are higher than any other estimates. The ministry predicts that nitrogen needs in 1995-96 will be 952,000 tons. Using a time series, which includes ministry data, this study concluded that nitrogen needs in 1995-96 would be 800,000 tons.

To further confuse the issue, survey data resulted in predictions that were lower than any of the official sources. To add to the confusion, the study team was given the methodology used by the Ministry of Agriculture to estimate nitrogen needs. Using this methodology, the study team predicted a need of 642,000 tons, which is much less than the ministry's own assessment.

The study team was presented with an unofficial summary of a report from the Marketing Research and Study Unit of the Ministry of Public Works, which puts forth a policy proposal for a new distribution system based on 5 percent growth in nitrogen use. Conversations with various fertilizer company officials have elicited growth numbers identical to those used by the Ministry of Public Works.

The study by El-Fouly and Fawzi, which appears as Annex G in the annex volume, describes a scenario of nitrogen requirements based on considerations of plant nutritional requirements and farmer practices. The most compelling evidence for inefficiency in fertilizer use comes from their research. One finding presented below implies that 45 percent of nitrogen applied to maize is wasted. Their assessment is in line with the CAPMAS recommendation and the study team's interpretation of the ministry's methodology.

K3. Predictions

The widely different assumptions about nitrogen use and growth placed the team in a difficult position. However, it is our assessment that demand growth will depend on the government's

decisions with regard to distribution and pricing. As long as low, government-set prices dominate the market, fertilizer consumption will increase.

We believe that government-determined low fertilizer prices would be a waste of resources. Farmers can be induced to much higher levels of efficiency. From both a technical and allocative perspective, the best way to ensure fertilizer efficiency is through an appropriate pricing policy.

For all of the reasons discussed above, domestic demand growth is likely to be flat for the foreseeable future, unless the policy of liberalization is abandoned. Eventually, new land cultivation and increased horticultural production will generate increased demand for fertilizer. Given the wide range of current use figures, the team is unable to estimate the time when that event will occur.

Taking all of the above into consideration—higher fertilizer prices, farmer management options, the direction of agricultural research and environmental concerns—we would expect fertilizer use to stabilize or even continue to decline in Egypt until the end of the century.

L. Conclusion

A series of studies for improvement of fertilizer production facilities are recommended in this report. The studies are considered essential for privatization. The most dramatic recommendation concerns the possibility of significantly improving the nitrogen fertilizer sub-sector through a new privately owned production unit that could supply ammonia to El Nasr Coke, KIMA, and SEMADCO-Suez. Another important finding is that fertilizer use will stabilize or even continue to decline in Egypt until the end of the century.

SECTION I

INTRODUCTION AND OBJECTIVES

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A. Introduction and Background

The Chemonics PRE/ICQ Fertilizer Study was contracted by USAID to include a technical review of the Egyptian fertilizer industry with regards to its potential for privatization. The focal point of the study was the nitrogen sub-sector, consisting of four fertilizer companies, comprising five production sites or locations. The evaluation of the phosphate sub-sectors was limited to the two fertilizer companies, comprising three production sites. Specifically excluded from this study was evaluation of phosphate mining operations, including the Abu Tartur phosphate project.

During this study, the Chemonics team along with its Egyptian associates inspected all five of the nitrogen fertilizer production sites and two of the three phosphate fertilizer production sites. The exception was the EFIC site at Assiut, which was inspected only by a Chemonics' Egyptian technical associate due to restrictions on expatriate travel within that area.

The Egyptian economy. During the 1950s and 1960s, Egypt pursued centrally planned, strongly nationalistic economic and foreign policies. By the mid-1960s, Egypt had become a public sector-led economy with parastatal monopolies and excessive controls on economic behavior. Social welfare objectives were prioritized, generating large fiscal and current account deficits that were financed largely by foreign debt accumulation.

In the 1970s, Egypt's political and economic policies shifted towards a more liberal, market-oriented course. The economy experienced rapid growth in the late 1970s and early 1980s. Starting in 1986, Egypt's economy began to suffer from a series of setbacks: a high rate of inflation, significant depreciation of the real value of the Egyptian pound, and chronic deficits in both the government budget and the balance of payments. These factors have resulted in sluggish economic growth for Egypt in recent years.

The government of Egypt recognized the need for prompt action to remove economic constraints. With the support of USAID, IMF and World Bank, the government adopted a comprehensive program of stabilization and structural reform to correct distortions in the economy. The objective of any reform policy is to establish a country's economic growth through macro economic stabilization and structural reform to bring about market liberalization, better resource allocation, public spending efficiency, and, above all, an improved climate for the private sector. While price controls of inputs and outputs were not evenly lifted in Egypt, the exchange system was nevertheless liberalized and interest rates freed. The government took serious steps towards liberalization of foreign trade. Today, privatization, parastatal reform, and free market development are under way.

As a result of comprehensive economic reform, Egypt was rewarded with apparent foreign exchange stabilization, a decline in the inflation rate, reductions in government budget deficits, and improvement in the balance of payments. Nevertheless, some Egyptians have experienced increased hardship as the government sought to implement economic reform. Furthermore, the private sector is affected by restrictive financial policies as the government carries out the IMF-recommended program.

The agricultural sector. Agriculture has long played a significant role in creating employment and new businesses in Egypt. Despite the agricultural sector's recent declines in the Egyptian economy, it is still important, generating 18 percent of GDP, and absorbing more than 35 percent of total labor force. However, the agricultural sector in Egypt has always been heavily affected by government's policy. From 1952-1972, agricultural policy relied more on centralized decision making than market mechanisms. The government used four tools to control the agricultural sector: a land reform program, a controlled pricing system, a comprehensive input distribution system, and government-planned investment.

The post-1973 oil boom, coupled with implementation of Sadat's liberalization policies, strongly influenced the rural labor market and agricultural trade. Employment opportunities in the Gulf States and rapid urban growth led to labor migration from rural areas, resulting in significant increases in agricultural wages. However, agricultural production lagged behind the increase in domestic demand for wheat and rice. Until the mid-eighties, there was no fundamental change in an agricultural policy that emphasized controls and agricultural sector taxation.

In the mid-1980s, the government began to remove existing controls over the agricultural sector. In collaboration with USAID, certain reform policies were implemented in the agricultural sector in 1986-1987. Phase I of the USAID policy reform program was from 1986 to 1989; phase II was from 1990 to 1996; the third phase starts in 1996. The objective of these policies has been the liberalization of output prices and removal of input subsidies and crop area controls. By the beginning of the 1990s, crop area allotments and output prices had been released for all major crops except sugar cane and cotton. Subsidies on fertilizers and pesticides were gradually reduced. The private sector was allowed to distribute agricultural inputs and market agricultural outputs. Finally, foreign trade of agricultural inputs was liberalized. In 1994, the government allowed cotton to be traded on the free market. The early 1990s have witnessed significant changes in Egypt's agricultural policies, and agricultural production has responded with a steady 3 percent annual growth rate. The Government of Egypt is currently embarking on an ambitious program that aims to:

- Remove all controls on prices of agricultural inputs and outputs
- Privatize agricultural inputs distribution and agricultural outputs marketing
- Reassess land tax levels and removing rent control on land
- Eliminate institutional constraints to allow policy changes to take place for the privatization of agroindustries

The fertilizer subsector. Increasing agricultural production by use of chemical fertilizers is a practice that is supported by both Egyptian farmers and government policy. Consumption of chemical fertilizers began increasing around 1945, and fertilizers are today one of the major inputs in Egyptian agriculture. During 1960s and 1970s, fertilizer use increased rapidly, reaching some 920,000 metric tons by 1983-1984 with an annual growth rate of 9 percent. Since the mid-eighties, however, fertilizer consumption growth has moderated to 2 percent a year. Nevertheless, Egypt has among the highest developing country rates of chemical fertilizer use, which can be directly attributed to government policy.

During the period of 1960-1987, the distribution of chemical fertilizers in Egypt was a government monopoly centralized in one public agency, the Principal Bank for Development and Agricultural Credit (PBDAC), which had the exclusive franchise for procuring and distributing chemical fertilizers at the national, governorate, and village levels. Such a centralized system allowed the government to control the three critical market parameters of supply, demand, and

price. Fertilizer-producing companies sold their entire local production through PBDAC, which also bought all imported fertilizers from overseas suppliers and local importers. The fertilizer supply was thus controlled by one public agency from the national all the way down to the village level. Fertilizer prices were uniformly subsidized and rigidly controlled throughout the country.

The dominance of government intervention in fertilizer markets during the 1960-1987 period also included farmers' consumption. There was almost no voluntary demand for fertilizers, as farmers' consumption was determined by the Ministry of Agriculture according to state-imposed cropping patterns and prescribed fertilizer dosages. The farmer was not allowed to buy less than his quota, putting a bottom limit on the country's fertilizer consumption. Farmers were allowed to buy amounts over their quotas at unsubsidized, cash prices higher than the subsidized price but less than the border price.

Thus, fertilizer policy adopted in the 1960s and 1980s was characterized by a highly centralized, state-controlled national supply, a functional integration of credit with fertilizer distribution, an almost complete absence of market forces, and high fertilizer subsidies. These features of the fertilizer distribution "pyramid" undoubtedly contributed to the dramatic rise in fertilizer use during this period. However, this system could not totally eliminate private markets for chemical fertilizers and the official system was supplemented by an unofficial and illegal black market. The black market was supplied by farmers who resold part of their quota and perhaps by other diversions of the official system as well. This market, a natural response to the fixed-quota system, had two primary functions. First of all, it enabled farmers to transform part of the fertilizer subsidy into cash. Secondly, it reduced the inherent inflexibility of the quota system by allowing farmers some latitude in deciding how much chemical fertilizers they wished to apply. As a result, chemical fertilizers during this period were traded on two separate markets at significantly different prices: the official market, where prices were highly subsidized (i.e., one-third of the world price) and the unofficial private market, where prices were close to world farm-gate prices.

Evidently, fertilizer policy before 1992 succeeded in promoting fertilizer use, but failed to adjust prices to rationalize farmers' behavior. This policy had also become increasingly expensive. The cost of the subsidies, which reached LE 165 million in 1988, had became a barrier to placing the domestic fertilizer industry on a sound economic basis.

Recognizing the adverse effects of earlier fertilizer policy and the necessity of adjusting fertilizer prices to support sustainable agricultural growth, the Government of Egypt adopted a new policy in 1992 to liberalize the agricultural sector and privatize the industries involved in manufacturing agricultural inputs. A new fertilizer policy was therefore introduced, which moved significantly toward free fertilizer private markets. This policy provided liberalized fertilizer distribution, and privatized fertilizer production and removal of subsidies to allow the fertilizer market to operate on the basis of supply and demand. By 1991, the government had halted all fertilizer subsidies. The PBDAC distribution monopoly was eliminated, and, in June 1992, cooperatives and private sector dealers were allowed direct access to fertilizer supplies at factories. However, while the government has liberalized the fertilizer distribution system, fertilizer production is still in the hands of the public sector: fertilizer plants are owned by holding companies and other state-owned enterprises.

It is worth noting the new policies liberalizing fertilizer distribution worked efficiently in the early years of 1992-1994. While the government was removing subsidies, allowing domestic prices to increase, world fertilizer prices dropped, bringing domestic and world prices closer for

a time. Starting in mid-1994, nitrogen fertilizer prices increased rapidly and substantially, due to shortages on the world market.

While domestic production of nitrogen fertilizer decreased, local producers increased exports to take advantage of high export prices. The government put ceiling prices on fertilizers that were much lower than world prices. This action resulted in market distortions, creating a gap between supply and demand for fertilizers in general and for nitrogen fertilizers in particular.

The government's response to the short supply of fertilizer for the domestic market was to impose a series of controls which led to the reinstatement of the PBDAC distribution monopoly. The export of fertilizer was limited by production quotas. Fertilizer imports were subject to a 30 percent tariff. The ultimate control was applied in late 1995, when the government announced that all fertilizers in Egypt would be purchased by PBDAC.

It was in the context of this reversal of fertilizer liberalization that this study was conducted. The challenge of the team was to develop recommendations for change that would liberalize the fertilizer industry and prevent a reoccurrence of the 1994-1995 domestic fertilizer shortage.

B. Goals and Objectives

The economic system of the Arab Republic of Egypt since its inception can be described as one in which most major investments were undertaken by a central government. Under Presidents Nasser, Sadat, and Mubarak, the country has carried out an industrialization policy that taxed agriculture and held down the price of foodstuffs to benefit the urban population.

Recent worldwide changes in the economic and political systems of centrally planned economies and progress made by those developing countries choosing market approaches started to influence Egyptian decision makers in the mid-eighties. The opening of the Egyptian economy can be dated to 1986, when the government began to implement a serious reform program in the agricultural sector.

As this study was undertaken in the final months of 1995, the GOE, through the words of political leaders and senior bureaucrats, reiterated the importance of agricultural sector liberalization. However, certain official actions had the effect of increasing government control of the sector. Nevertheless, we take as a basic premise that the GOE is truly interested in increasing farm population income and will eventually achieve this goal despite political, social, and economic constraints, which may delay the liberalization of this sector in the near term.

B1. Primary Objectives of this Study

The overall goal of this study is to support liberalization of the agricultural sector and increase farm income. In addition, this study has six primary objectives. The conclusions and recommendations reached by this study are expected to assist the GOE and USAID to undertake and coordinate certain actions to reach these objectives to the fullest extent possible.

Accelerate transition to market economy. The GOE has announced its intent to open up the Egyptian economy by placing over 300 state enterprises under the umbrella of 17 holding companies established to supervise their privatization under the Ministry of Public Enterprise. The six fertilizer companies reviewed in this report are under the purview of four holding

companies and the Ministry of Public Enterprise and therefore are scheduled for future privatization.

The analysis and conclusions of this report should assist the GOE in accelerating the agricultural sector's transition to a market economy, particularly the fertilizer sub-sector, by proposing options to improve efficiencies in production and distribution of fertilizers that involve the private sector to an increasing extent. This report is also meant to support the reduction of government intervention in ways consistent with GOE policies of a smooth, albeit slow, transition to a market economy.

Barriers and constraints on fertilizer market. In early 1992, a new fertilizer policy was adopted, aiming at liberalizing distribution of fertilizers and removing subsidies. The fertilizer market was allowed to operate on the basis of a free market mechanism. Between 1992-1995, the system worked efficiently, as domestic and border fertilizer prices converged. While the government allowed domestic prices to increase (i.e., removing subsidies), world prices of all types of chemical fertilizer were decreasing.

In mid-1995, world prices showed significant increases, but domestic prices were held at low levels as the result of barriers and constraints. As a result, the system became highly distorted and a two-tiered price system was established.

Apparently, the fertilizer market in Egypt was not yet mature and flexible enough to react to market forces. This can be attributed to the existence of restrictions, including legal, administrative, and economic barriers. These barriers and constraints can be classified according to the three market parameters that would affect the availability of fertilizer: imports, production, and distribution.

- **Imports:** Fertilizer industry in Egypt was protected by a 30 percent import tariff until October 1995. This tariff was not a problem until mid-1995, because world prices were decreasing and domestic production was large enough to meet local requirements. With the increase in world prices in May 1995, the tariff on fertilizer imports became a significant barrier, reinforcing the gap between prices of imported and domestic fertilizer. In October 1995, tariffs on fertilizer imports were completely removed to encourage importation of fertilizer. It is evident that some distributors took the initiative and imported substantial quantities of fertilizer (ammonia/nitrate and ammonia/ sulphate). The quantity imported in three months was around 150,000 tons.

- **Production:** Production of fertilizer is still completely controlled by state-owned companies and government agencies. Although the Abu Qir complex is considered a joint stock company, it is dominated by government agents and public companies. While there are no legal restrictions to prohibit private sector firms from entering the fertilizer market, substantial administrative and economic barriers restrict private sector entry. Establishment of a new fertilizer company would require large investment coupled with the risk associated with world price fluctuations and stagnant local demand for fertilizer. By 1998-1999, domestic production is expected to expand to exceed local demand for fertilizer by more than one million tons, creating additional economic barriers to new entry. Administrative barriers include the authority approvals that must be issued to establish a new company. These approvals will not be issued if there is surplus production. Investment in the fertilizer industry should be made in projects that are integrated with existing plants, such as the ammonia plant proposed in this report.

- **Distribution:** The role of the private sector in distribution has increased significantly during the period 1992-1995. The market share of private sector fertilizer distribution was estimated to be 70 percent in 1994-1995, while the share of PBDAC did not exceed 9 percent. Despite the liberalization of fertilizer distribution, the system is based on an imperfect competitive market, where a small number of distributors (11) control around 56 percent of fertilizer distribution. Such an oligopoly market results in price distortion and fertilizer market instability. However, by introducing price controls and restricting entry, the government's policy reinforces rather than reduces price distortions. Controlling the registered number of distributors would form a barrier or restriction on new entry, while showing preference to distributors purchasing large quantities would discriminate against small distributors, increasing imperfections in the market. In general, government intervention cannot be expected to enhance market performance and reduce price distortion. Expanding the market and removing barriers would increase competition and improve performance.

Develop strategies for liberalization. The GOE has invested substantial resources in the nitrogen and phosphate production and distribution industries over the last 50 years. Senior officials are aware of the technical, managerial, and financial challenges entailed by liberalization, but understand the need to identify and pursue strategies to liberalize production, distribution, and trade of fertilizers.

This study attempts to identify and formulate such strategies in a fashion consistent with other important GOE policies, such as maintaining food security, raising incomes for the rural population, increasing exports and providing foodstuffs to urban residents at reasonable cost.

Recommend appropriate policy changes. A key purpose of this study is to recommend such policy changes that will dramatically change the ownership and management of this industry without endangering the supply security for end users or the government's goal of national food security.

Improve performance in fertilizer production. The production technologies utilized by fertilizer producers in Egypt observed by the team range from the latest, state-of-the art methods in Abu Qir to the somewhat outdated electrolysis-based production in Suez. Although technologies vary widely, the study team was impressed by the breadth of knowledge and experience displayed by senior staff in each of the plants visited.

The study team's recommendations for improved fertilizer production performance are given in Section II. It must be noted that the improvements recommended are not based on the assumption that these plants will be made more productive and efficient in order to enable them to stay in the public domain for the foreseeable future. The recommendations are made within a context of liberalization and are based on the assumption that market forces will be allowed to determine fertilizer production and distribution within the next five years.

Improve performance in distribution. Fertilizer distribution was the exclusive domain of PBDAC until June 1992, when the entity relinquished its monopoly position. Private sector firms, cooperatives, and an occasional state-owned enterprise took over distribution functions until June 1995, when the government decided to reestablish the PBDAC's monopoly for the sale and distribution of nitrogen fertilizer.

The GOE blamed private sector fertilizer distributors for hoarding urea and ammonium nitrate. The private sector, meanwhile, accused state-owned producers for increasing exports at the expense of adequate supplies for the domestic market. Producers increased exports as the international price for nitrogen rose in 1994. As the gap between world and domestic prices widened, producers looked to export markets to maximize profits.

The GOE had also overlooked the effect of liberalizing crop production and prices on fertilizer demand. The GOE continued to issue guidelines on the amounts of land to be cultivated for crops such as rice and cotton. Land planted in cotton continued to decrease due to government controls, while land under rice cultivation rose 70 percent over government guidelines, increasing demand for nitrogen in 1994-1995 far beyond the government's projected demand.

Despite the outcry of the private sector—which had grown to an estimated 2000 licensed and 4000 non-licensed distributors, wholesalers, and retailers by June 1995—the government renewed its monthly decrees between June and December 1995 continuing PBDAC's nitrogen distribution monopoly. Field interviews with PBDAC staff and farmers indicated that PBDAC-rationed nitrogen distribution caused both fertilizer use distortion and the re-creation of a secondary or black market similar to the one existing before 1992. While, prior to 1992, it was the farmers themselves who bought and sold nitrogen and phosphate fertilizers on the black market for meager profits, in 1995 the sellers were dealers and profit margins had increased.

The unusual fertilizer supply situation in Egypt in 1995 revealed a lack of confidence in the private sector's ability to deal with a temporary shortage in the marketplace. Instead of assuming a regulatory role vis-à-vis the private sector, the government chose to return to a public monopoly.

B2. Secondary Objectives of This Study

Economic parameters. The fertilizer sector has experienced a series of wrenching changes in the four year period between 1992-95; the government is now searching for appropriate policies to implement. Policy formulation, however, requires reliable and sufficient data for analysis. The study team experienced serious difficulties in acquiring the necessary quality and quantity of data within the time frame allowed for the study. Nevertheless, the team was able to achieve its objective of identifying the key economic parameters of supply and demand, as well as recent, current, and future gaps, prices, and rough estimates of elasticities.

Foreign trade. Fertilizer exports have been a welcome source of revenue for fertilizer producers as well as providing a stream of foreign exchange beneficial to producers and the economy. Producers in Egypt are gearing for a higher rate of participation in international markets in the future and are therefore interested in knowing more about export prospects. An annex to this report analyzes export possibilities, taking into consideration such developments as the closure of all ammonia plants in Italy and the international movement of plants that cease operations in one country and are retrofitted, rehabilitated, and reconstructed at new sites in other countries.

Alternatives of additional capacity. Industrial plants with long operational records may experience a growing gap between design capacities and current production levels due to such problems as maintenance, raw material supply, and storage capacity of inputs, intermediate products, and outputs. Therefore, additional capacity is important not only to replace current

high-cost, inefficient production at multiple sites, but to ensure future domestic needs and take advantage of export opportunities. Additional capacity alternatives are of paramount importance to GOE for supply continuity and efficiency and revenue maximization for the six companies under review.

Technical and management rehabilitation. Early in its deliberations, the study team, together with USAID project staff and MPE/PEO advisors, realized that this effort could be the first of a three phase approach to liberalize and privatize the fertilizer sector. A review of an initial work plan of this study undertaken by H.E. Minister of Public Enterprise, Dr. Atef Obeid, and his advisors, Dr. Fouad Abdul Wahab, Dr. Sabry Aglan, and Dr. Mounir Hamdy, reinforced the necessity of looking more carefully into such a three phase approach.

In this context, the current study can be considered as the first phase report, that is a reconnaissance document that identifies the current conditions and future prospects in fertilizer production, distribution, and trade. It maps out certain alternative solutions for the production and marketing of nitrogen and phosphate fertilizers, based on data made available to the team from October to December 10, 1995, with a draft report submitted on December 21, 1995. As mentioned above, there were serious limitations on the quality, quantity and timeliness of the data, which hindered the team's work. As H.E. Dr. Obeid indicated, the entire industry may require an in-depth, longer term analysis in preparation for further liberalization and privatization.

A second phase may be needed which would focus on identifying and carrying out technical and management improvements in each of the six fertilizer plants in preparation for eventual privatization.

A phased privatization plan for the six companies would precede the design, financing, and implementation of the technical and management improvements. The privatization plan would be prepared by the Ministry of Public Enterprise with the collaboration of the Ministry of Agriculture.

A third phase might consist of the actual privatization of the fertilizer companies. Options and possible strategies for privatization are examined in Section V of this report.

Future technical assistance. The GOE has indicated that it is cognizant of additional technical assistance needs for the rehabilitation, liberalization, and privatization of the fertilizer sector. Subject to the preparation and approval of a privatization plan, USAID might consider financing additional technical assistance within the context of phase two engineering and management rehabilitation mentioned above, or other assistance. A brief assessment of possible technical assistance is given in Section II.

B3. Fertilizer Distribution Systems

The distribution of fertilizers in Egypt has experienced dramatic changes in the five-year period of 1990-1995. PBDAC switched from a public monopoly in 1990-1991 to a relatively minor player in 1993-1994, and switched back to a public monopoly in August 1995. The GOE extended its mandate on a monthly basis until early December 95, at which time it announced that the single nitrogen supplier mandate would continue until June 1996.

An objective of this study was to look into four separate but interconnected policy assumptions concerning fertilizer distribution in Egypt, expressed by the following statements:

1. Fertilizer distribution should revert to the private sector without further delay to avoid even more serious distortions than have already occurred in fertilizer markets.

2. PBDAC's role, while reduced, would remain critical, as the entity would manage buffer stocks sold through private distributors.

3. There is a need for a regulatory framework for the production, distribution, and trading of all fertilizers, a framework that would foster competition, yet ensure the continuous availability of supply at reasonable prices.

While the study team endeavored to fully examine all the above policy assumptions, the lack of timely data impeded the team's progress. More study will be required to fully evaluate the implications of liberalization and privatization.

B4. Production of Complex Fertilizers

Although much emphasis has been placed on the production and distribution of basic nitrogen and phosphate fertilizers, there is no doubt that the demand for complex and foliar fertilizers will increase as farmers change previously mandated cropping patterns. These changes have been evident in recent years and the movement will continue towards farmers choosing crops with higher revenues and profits.

Current production of complex fertilizers in Egypt is extremely limited. The private sector has been somewhat more active in blending operations. However, even those activities have ceased at times in the last four months due to uncertainties created by PBDAC's re-emergence as a monopolistic market supplier.

B5. Environmental Consideration of Fertilizer Producers

The government has generally focused on increased production and use of fertilizer for higher yields without paying sufficient attention to adverse environmental consequences. One objective of this study was to look at the adverse environmental conditions created by the production and use of nitrogen and phosphate fertilizers and explore a number of options to develop a strategy for alleviating negative environmental effects. These issues are explored in Annex E, contained in a separate volume of annexes relating to this report.

B6. Technical, Socioeconomic, and Political Dimensions

Agricultural policy in Egypt, particularly in regards to the fertilizer sub-sector, involves a complex web of technical, socioeconomic, and political considerations. The political consequences of policy-related actions or responses to crises, such as the fertilizer shortage of July 1995, are often more important at the time than technical and economic considerations.

In many ways, the GOE has been a reluctant suitor of liberalization and privatization. The government continues to exhibit paternalistic tendencies in its decision making, which is often overlaid with political concerns focusing on maintaining a stable status quo. The government's decision to bring PBDAC back as a monopolistic nitrogen distributor stemmed from a concern

that fertilizer shortages might cause unrest in rural areas. This study, in a limited way, attempts to desegregate the political from technical and economic issues in order to facilitate the adoption of recommended measures.

B7. Liberalization and Privatization of the Fertilizer Sector

As the title of this study indicates, the liberalization and privatization of the fertilizer sector is of major concern to GOE and USAID. As the study's client is the Ministry of Public Enterprise, the results of this study are expected to contribute to this ministry's efforts to privatize one or more of the six fertilizer producers in the near future.

Given that Abu Qir is well advanced in its privatization plans, which are being drawn by KPMG and financed by KFW, we have chosen not to recommend a detailed privatization strategy for this company since we are not privy to their findings. Furthermore, a comprehensive privatization study was undertaken recently for the two phosphate companies. We have integrated the conclusions from this study into our recommendations.

This study focuses on the privatization of the remaining three nitrogen producers, as well as on increasing the private sector's role in production and distribution.

C. Methodology

Upon arrival in country, the team assembled and prepared a number of work plan drafts, which were submitted to USAID and MPE. The work plan was approved on October 21, 1995 by all parties concerned. Parallel to the work plan preparation, the team prepared a three page questionnaire which was sent to all the six fertilizer companies. The expectation was to receive the information needed for the team's analysis during visits to the plants.

Initial attempts to visit fertilizer production companies, and PBDAC's chairman were thwarted due to the individuals' heavy schedules. The team was finally able to start its field trips in late October, completing them in late November. Data search started the first week in October and continued until the middle of December. Most of the production information requested was never received from the companies or intermediaries who had offered to help.

The primary information sources have been direct observation of the plants, review of relevant literature published to date, and commissioning of mini-studies specifically for this effort. The tools used in the methodology for this study are listed below:

Ministry of Agriculture survey. The Chemonics team commissioned a survey of 300 farmer located in 5 governorates and 20 districts. The survey covered:

	1994 season	1995 season
Feddans of rice	153	160
Feddans of wheat	429	646
Feddans of corn	440	494
Feddans of vegetables	224	207
Feddans of cotton	100	54
Feddans berseem	452	373
Feddans of other crops	91	150

The survey was initially undertaken in early November. Since the results were not satisfactory, it was repeated in late November. The results of this second effort were found to be satisfactory, and the data was tabulated, analyzed, and integrated into this study.

Cairo University, Faculty of Agriculture. Two surveys were undertaken in 1994 and 1995 by students and faculty of the Faculty of Agriculture of Cairo University and personally supervised by Prof. Dr. Emad El Hawary and his colleagues.

The first survey undertaken by the Faculty of Agriculture (FOA) covered 5274 farmers in 3 districts of 3 governorates. It surveyed the 1993 crop season and was published in 1994. The coverage was as follows:

Feddans of cotton	2793
Feddans of rice	3085
Feddans of corn	500
Feddans of wheat	980
Feddans of berseem	5422
Feddans of fava beans	300

The second survey covered 180 farmers during the 1994 crop season and was published in 1995. The coverage was as follows:

Feddans of cotton	250
Feddans of rice	117
Feddans of corn	117
Feddans of wheat	307
Feddans of berseem	214
Feddans of fava beans	58

Fertilizer use/production function survey. Prof. O. Gad was commissioned to carry out a complete search of reports, articles, thesis, and books containing production functions.

Environmental review. Dr. Mohamed Eid was commissioned to conduct a study identifying the pertinent Egyptian legislation involving fertilizer production and use. This report is given in Annex E.

PBDAC data search. With the permission of Dr. Hassan Khedr, Mr. Darwish from PBDAC was asked in late October to provide data on PBDAC operations with special emphasis on transactions during the period of 1990 to October 1995. This information was provided on December 14, but could not be utilized due to its length and the lack of time for translation.

Fertilizers distributor survey. The team carried out about a dozen informal interviews with traders in Cairo and in other governorates during the visits to the fertilizer plants.

Natural gas distribution network study. Through the offices of MPE, numerous requests for data were made of the Ministry of Petroleum and the Egyptian Agency of Petroleum and Minerals. Information was requested on the physical location of the natural gas distribution network in Egypt, as well as on production costs and sales prices to fertilizer producers and other users. This information was never received.

Ministry of Agriculture crop data. Dr. Ismail Gamal was asked to provide detailed crop data, which he provided and was utilized in this study. This data was also used in the NCR study and sent to IFPRI for a study to be undertaken, which was aborted due to lack of funds.

National research center study. Under the supervision of Drs. Mohamed El Fouly and Ahmad Fawzy, a study was commissioned using the data that they have kept on 5000 farmers over the past 10 years. The 5000 farmers provided data on their practices covering:

Crop	Served area (feddan)*
1. Field crops	
* Wheat	8508
* Maize	2618
* Rice	2380
* Cotton	6093
* Clover	5998
2. Vegetable crops	
* Tomato	1261
* Potato	4142
3. Orchards	
* Citrus	47600
* Grape	12000
* Others	5000
Total	93600

Egyptian Fertilizer Development Center. Dr. Mohamed Fathy provided data and analysis on fertilizer production, which was utilized and integrated into this study.

Private manufacturers and blenders survey. A small group of private fertilizer manufacturers and blenders were to be informally interviewed to determine the extent of their operations. However, due to shortage of time, this activity could not be implemented.

Visual observations of fertilizer plants. The team visited 11 plants in 7 production sites owned by 6 producers. The 12th plant in the 8th production site was only visited by Mr. Rushdy Selim Hassan. This plant, located in Assuit, was under a travel advisory status.

IFPRI study. The International Food Policy and Research Institute in Washington, D.C. developed an econometric model for the agricultural sector in Egypt. Providing IFPRI with new data and guidelines on modifying the model for this effort study's purpose would have provided another useful means of analysis. Unfortunately, this had to be abandoned due to lack of funds.

SECTION II

TECHNICAL AND PRODUCTION EVALUATION

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TECHNICAL AND PRODUCTION EVALUATION

A. Current State of the Egyptian Fertilizer Industry

A1. Introduction

The methodology for implementing this diagnostic technical evaluation was based on primary and secondary data and information. Primary data was collected from production site inspections and from numerous meetings with governmental agencies and officials associated with the fertilizer industry, including the following:

- USAID
- Ministry of Public Enterprise
- Holding company chairmen and staff
- Fertilizer company chairmen and staff
- Egyptian Fertilizer Development Center technical director and staff
- Egyptian technical consultants

Primary data and information also consisted of an environmental screening report on five of the eight fertilizer production sites. This report, prepared by Dr. El Mohamady Eid, is included as Annex E in the annex volume of this report.

Secondary data and information consisted of review of numerous documents and reports relating to the Egyptian and International Fertilizer Industry. A list of these documents appears in the bibliography in Annex H in the annex volume.

Prior to meetings with the holding and fertilizer company chairmen and staff and the initial production site inspections, a formal written request was issued for detailed information regarding production capacity and cost data for intermediate and final products. The purpose of this data was intended for development of a comparative product efficiency evaluation by product and by production site. Whereas the data requested on production capacity was readily provided, only general and limited cost data was available. Therefore, the product cost comparison is not included in this study and if necessary, must be subject to future study activities.

Production and supply data as presented within this section may vary from that presented in other sections of the Chemonics PRE/IQC Study. Such variance may be attributed to data source, inventory, or data translation from Arabic into English.

A2. Structure: Holding Companies and Fertilizer Companies

The evolution of the industrial sector toward reform and privatization was initiated by new laws passed in 1991 and 1992. The law to restructure public enterprises (law 203 of 1991) removed the 314 industrial (law 97) companies from control of the technical ministries to the management of 17 holding companies, which, in turn report directly to the newly created Ministry of Public Enterprise (MPE). A Public Enterprise Office (PEO) was established within the MPE to facilitate privatization. The primary directives of the holding companies are to maximize profits and to operate commercially in response to market activities.

Currently in Egypt there are eight industrial (law 97) companies evolved in the fertilizer industry: four companies in nitrogen fertilizer production and four companies in phosphate fertilizer production and mining. These eight companies are under the management of four holding companies, each with a board of directors. Table II-1 details the organizational structure of the holding and fertilizer companies.

With the exception of Abu Qir Fertilizers and Chemical Industries, the holding companies own all assets of the related fertilizer companies. The evolution to privatization will require the holding companies to relinquish, via sale of stock, ownership to private and/or public sector investors. To promote privatization, holding companies may be required to make concessions that support fertilizer company investment or improvement. For those holding companies that manage multiple fertilizer operations, the tendency may be to assist the financially stronger companies to the detriment of weaker companies. Should this become a reality, restructuring of the holding company or the fertilizer companies may be beneficial. One possible restructuring could be to place El Nasr Coke, KIMA and possibly SEMADCO-Suez under the same holding company to promote a new ammonia production unit to supply all three fertilizer companies.

A3. Raw Materials

General. Egypt has an abundance of natural gas, limestone and phosphate rock, three of the primary raw materials necessary for production of nitrogen and phosphate fertilizer. The other primary raw material, sulphur, is imported, except for small amounts recovered from refining and coke operations. All raw materials for fertilizer are in the public sector, whether indigenous or imported.

Natural gas. Ammonia is the primary feedstock for urea (ammonia and carbon dioxide), nitric acid (ammonia and air/oxygen), ammonium nitrate (ammonia and nitric acid) and ammonium sulphate (ammonia and sulfuric acid). Natural gas is the primary and most efficient raw material or feedstock used in the production of ammonia, the source of nitrogen in nitrogen fertilizers. Known natural gas recoverable reserves are sufficient for about 53 years, based on 1994 consumption rates. Fertilizer operations accounted for 16.1 percent of the 1994 consumption.

Six ammonia units, two each at Abu Qir, SEMADCO-Talkha and SEMADCO-Suez, use gas for feedstock and fuel. Of the remaining two ammonia units, the El Nasr Coke unit at Helwan is based on oven gas for feedstock and fuel and the KIMA unit at Aswan is based on electrolysis of water with fuel oil for fuel. Any new ammonia production in Egypt should be based on natural gas as feedstock.

Phosphate rock. Phosphate rock is the primary feedstock for phosphate fertilizers. Acidulation of phosphate rock with sulfuric acid produces single superphosphate (SSP) and/or phosphoric acid. Acidulation of phosphate rock by phosphoric acid produces triple superphosphate (TSP).

Egypt has an abundant supply of phosphate rock, even without the Abu Tartur project. Three mining operations, Abu Zaabal (West Sebeia), El Nasr Phosphate (Sebeia), and Red Sea Phosphate (Hamrawin) have a total capacity of about 1,814,000 MTPY of ore concentrates. Domestic consumption of ore concentrate for 1994-1995 was about 700,000 MT; 278,000 MT

Table II-1
Structure: Holding and Fertilizer Companies

HOLDING COMPANY: FERTILIZER COMPANY	PLANT LOCATION	PRIMARY FERTILIZER PRODUCTS (INTERMEDIATE AND FINAL)
CHEMICAL INDUSTRIES: Abu Qir Fertilizer & Chemical Industries	Alexandria	Ammonia, Nitric Acid, Ammonium Nitrate, Urea
METALURGICAL INDUSTRIES: El Nasr Company for Coke & Chemicals	Helwan	Ammonia, Nitric Acid, Ammonium Nitrate
CHEMICAL INDUSTRIES: El Nasr Fertilizer & Chemicals (SEMADCO)	Suez	Ammonia, Nitric Acid, Ammonium Nitrate, Calcium Nitrate, Sulphuric Acid, Ammonium Sulphate
	Talkha	Ammonia, Nitric Acid, Ammonium Nitrate
Egyptian Chemical Industries (KIMA)	Aswan	Ammonia, Nitric Acid, Ammonium Nitrate
MINING AND REFRACTORIES: Abu Zaabal Fertilizer	Abu Zaabal	Phosphoric Acid, Single Super Phosphate, Triple Super Phosphate, Sulphuric Acid, Agri. Gypsum
	West Sebeia	Phosphate Mining & Ore Concentrates
Egyptian Financial & Industrial (EFIC)	Assiut	Single Super Phosphate, Sulphuric Acid
	Kafr El Zayat	Single Super Phosphate, Sulphuric Acid
El Nasr Phosphate	Sebeia	Phosphate Mining & Ore Concentrates
Red Sea Phosphate	Hamrawin	Phosphate Mining & Ore Concentrates

and 422,000 MT consumed by Abu Zaabal and EFIC, respectively. Domestic supply was provided by Abu Zaabal (40 percent), El Nasr Phosphate (36 percent) and Red Sea Phosphate (24 percent).

Sulphur. Sulphur is the primary feedstock in the production of sulfuric acid (sulphur and air/oxygen). Since the closing of the sulphate mining in the 1960s at Ras Gemsa on the Red Sea coast, all sulphur has been imported except for small quantities recovered from refining and coke operations. In 1994-1995, about 250,000 MT were imported.

Limestone. Limestone is a primary feedstock in the production of calcium nitrate (limestone and nitric acid) and a secondary feedstock, as a diluent, in the production of 33.5 percent ammonium nitrate. Egypt has an abundant supply of limestone which is added to ammonium nitrate to provide calcium. In doing so, the nitrogen content of the final product is lowered. Beginning in 1951, the acceptable product was calcium nitrate 15.5 percent N. Over the years, the nitrogen content was increased to 21 percent N, 26 percent N, 31 percent N. Today, the typical product is 33.5 percent N. Based on the 1994-1995 ammonium nitrate (33.5 percent N) production of 1,494,895 MT, the consumption of limestone was about 64,000 MT.

A4. Process Discussion

General. The purpose of this section is to briefly discuss the current state-of-the-art process technology for ammonia urea, nitric acid, and ammonium nitrate and how this technology compares to existing Egyptian production units.

Ammonia. State-of-the art technology for ammonia has not changed radically over the last 10 to 20 years beyond energy saving and pollution abatement improvements. The degree of energy efficiency is related primarily to the price of natural gas and, to a lesser extent, the price of electricity. To be efficient, an ammonia unit must maintain a high degree (92-95 percent) of on-stream reliability. For this reason, the plant design must provide for independence from unreliable electrical and steam supply, which can be the cause of frequent shutdowns. The design incorporates single train, centrifugal compression (process air, synthesis gas, and refrigeration), high pressure (450-550 PSIG) steam/methane reforming, and synthesis pressure at 1,500-2,000 PSIG. Production capacity is in the range of 1,000-1,800 MTSPD.

The steam system design is based on high pressure (1500 PSIG) generation, with let-down through the synthesis gas compressor turbine to mid-pressure (600 PSIG) level for supply to other turbine drivers. An energy-efficient option is a gas turbine driver for the process air compressor, with exhaust into the primary reformer for supply of pre-heated combustion air.

A significant recent advance in technology is the catalytic partial oxidation (APO/CPO) process, as offered by Foster Wheeler International Corporation in the United States. Other companies, such as M.W. Kellogg and Uhde, offer similar versions. This process eliminates the tubular primary reformer by reforming all steam/methane in the packed bed secondary reformer. Oxygen for reforming can be supplied by excess process air or by oxygen enrichment of process air. Excess nitrogen is removed from the synthesis makeup gas (MUG) prior to compression by a simplified "nitrogen wash" unit. This "washing" also removes argon, carbon oxides, water, and methane and provides an essentially pure hydrogen/nitrogen ratio of MUG to synthesis. The dry, pure MUG reduces synthesis loop pressure drop, recycle and refrigeration loads and, since purge gas is minimized, eliminates purge gas ammonia scrubbing and hydrogen recovery units.

Current state-of-the-art technology offers two options of natural gas efficiency: standard and low energy. These efficiencies, based on "inside battery limits (ISBL)" charging the ammonia unit for electricity (if not ISBL generated) and crediting for exports of steam and electricity, are as follows:

Standard design: 34.5-35.5 MMBTU/MT
Low energy design: 28.5-29.5 MMBTU/MT

The basic reforming processes for the two design options are essentially identical with the low-energy option having additional efficiency features such as:

- Combustion air preheating
- Pre-reforming
- High efficiency CO_2 removal (physical or chemical absorption)
- Makeup gas drying
- Radial flow ammonia converter
- Hydrogen recovery (not required with cryogenic nitrogen unit)
- Process condensate recovery as BFW

The design for either option incorporates "zero flow liquid effluent," except for cooling water and boiler blow-down, vent stack mufflers for noise abatement, and ammonia scrubbing of atmospheric vents. Nitrogen oxide abatement of combustion stack gases can be an added feature.

These units can be retrofitted to increase capacity by 10-25 percent. Standard design units can also be retrofitted for increased natural gas efficiency approaching that of the low energy design units.

Egypt has eight ammonia units with a total design capacity of 4,800 MTPD. Three of these units, with a total capacity of 3,200 MTPD, are rated as world class, state-of-the-art, standard design. These units, Abu Qir I and II and SEMADCO-Talkha II, have undergone moderate modifications for efficiency improvements.

A fourth unit, SEMADCO-Suez II, which was commissioned in 1993, is a 400 MTPD, reciprocating compressor design and less efficient than the world class design units. The remaining four units, with a total capacity of 1,200 MTPD, are inefficient and, as discussed herein, the subject of possible retrofit or replacement.

Urea. Current state-of-the-art technology for urea solution units require total recycle and stripping process designs and include standard and low energy efficiency options. Capacity range would be 800-2,000 MTPD. Standard and low energy designs include "deep hydrolysis," or process condensate recovery as high pressure boiler feedwater. These units can be retrofitted for increased capacity of 10-20 percent. Standard units can be retrofitted for increase efficiency approaching that of the low energy design. Urea solid can be produced in prill or granular form. The world quality standard is granular.

Egypt has two urea units, 1,550 MTPD at Abu Qir and 1,725 MTPD at SEMADCO-Talkha. Both units are related as world class, state-of-the-art, standard design. Neither unit is believed to have "deep hydrolysis" design and have not undergone retrofit for increased capacity or energy improvement. Both units are prilling process without prill tower scrubbing of air

emissions. The Abu Qir design appears to meet environmental standards. However, the SEMADCO-Talkha prill tower emissions require pollution abatement modifications.

Nitric acid. Nitric acid processing has distinct unit operations: the conversion of ammonia/air to nitrogen oxide (NO_X) gases and the absorption of these gases in water to produce nitric acid. The first operation is favored by low pressure (atmospheric); the second by higher pressure (10 atmospheres).

The older units were designed for different levels of "dual pressure." Current state-of-the-art technology utilizes single pressure, either 10 or 6 atmospheres, with the latter being more efficient and the preferred design. The older dual pressure design requires more equipment, maintenance, and manpower to operate.

In Egypt, there are 15 nitric acid units with a total design capacity of about 4,550 MTPD. With the exception of the Abu Qir 1,800 MTPD (1991), the SEMADCO-Suez 450 MTPD (1986) and, possibly, the SEMADCO-Talkha (4) - 225 MTPD (1975) units, all other units will require investment for refurbishment and NO_x abatement.

Ammonia nitrate. Ammonia nitrate solution neutralizers employ unsophisticated process design but have the potential to be a major source of air pollution. The steam vapor vented to the atmosphere may contain substantial quantities of ammonia, ammonium nitrate, and nitrous oxides. The abatement methods are the design of the neutralizer to allow proper reaction prior to venting to the atmosphere or to condense the vapors and recycle the condensate to the nitric acid absorber for recovery. Both methods eliminate liquid effluent from the neutralizer/nitric acid areas. Only the units at Abu Qir and SEMADCO-Talkha employ abatement designs. All other units require retrofit.

Other sources of pollution, both air and liquid, are the ammonium nitrate evaporation sector and the ammonium nitrate prilling or granulation units. Each of the Egyptian plants, with the possible exception of Abu Qir, require detailed engineering studies as to the methods of abatement.

A5. Fertilizer Companies

General. In Egypt there are four nitrogen fertilizer companies with five production sites and four phosphate fertilizer companies with three production sites and three phosphate rock mining operations. Figure II-1 shows the location of these sites.

Figures II-2 and II-3 illustrates the integrated material flow and processing sequences of Egyptian nitrogen and phosphate fertilizer production, respectively.

The nitrogen fertilizer companies are as follows:

- Abu Qir Fertilizer and Chemical Industries—one production site at Alexandria
- Egyptian Chemical Industries (KIMA)—one production site at Aswan
- El Nasr Company of Coke and Chemicals—one production site at Helwan
- El Nasr Fertilizer and Chemical (SEMADCO)—two production sites at Suez and Talkha

Table II-2 is a summary of technical data regarding the production units of the four Egyptian nitrogen fertilizer companies. Table II-3 details the production capacities and performances for 1993-1994 and 1994-1995 of the four Egyptian nitrogen fertilizer companies.

The phosphate fertilizer companies are as follows:

- Abu Zaabal Fertilizer—one production site at Abu Zaabal and one phosphate rock mining site at West Sebeia
- Egyptian Financial and Industrial (EFIC)—two production sites: Assiut and Kafr El Zayat
- El Nasr Phosphate—one phosphate rock mining site at Sebeia
- Red Sea Phosphate—one phosphate rock mining site at Hamrawin

Table II-4 details the production capacities and performances for 1993-1994 and 1994-1995 of the two Egyptian phosphate fertilizer companies.

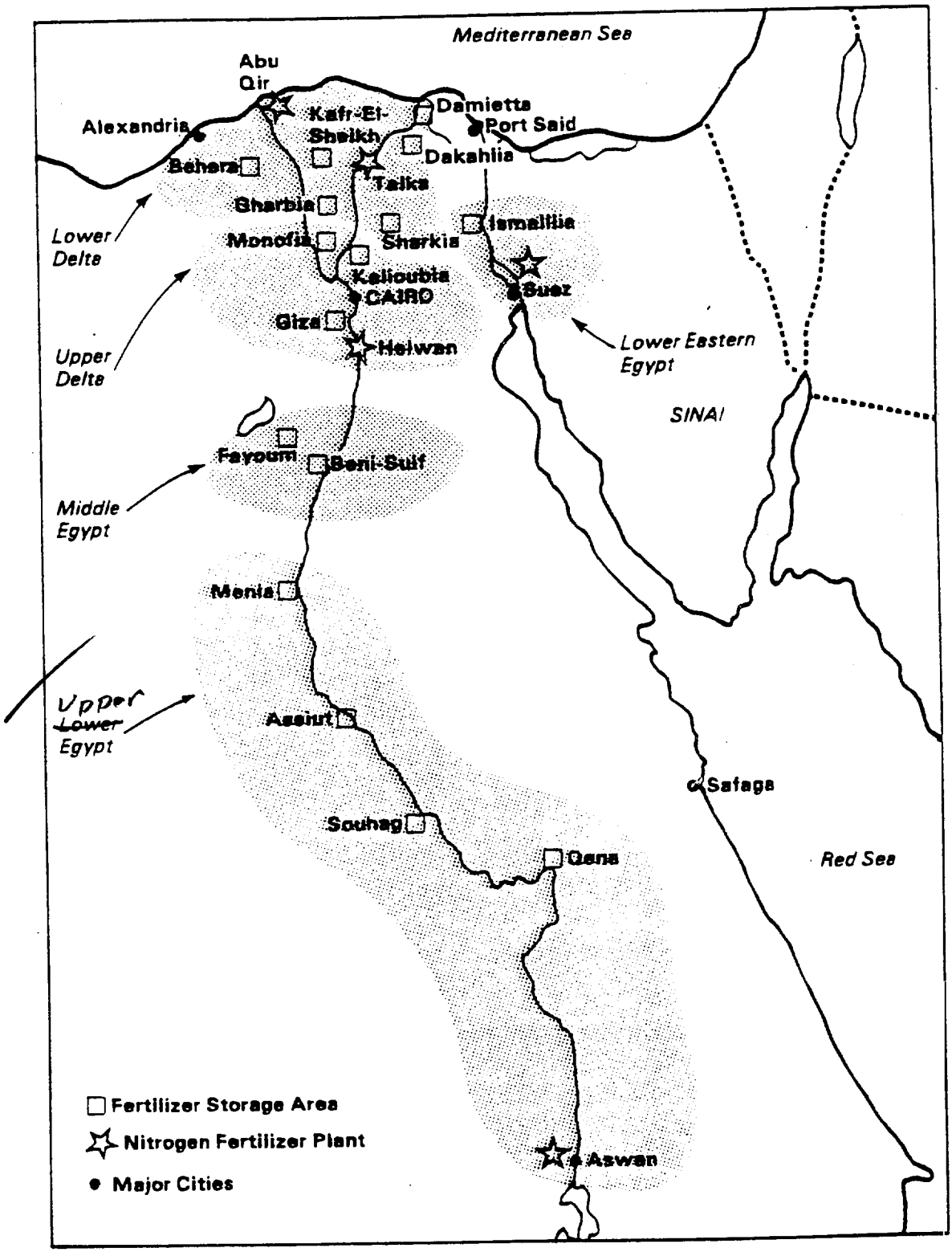
Discussion of the phosphate mining operations is specifically excluded from this technical evaluation. For details on this subject, reference is directed to the report presented by Overseas Bechtel, Inc. (OBL) entitled The Egyptian Phosphate Industry—A 1995 Diagnostic Study, dated April 3, 1995.

Egypt's presence in the world nitrogen fertilizer market began in 1979-1980 with the commissioning of the (current period) state-of-the-art technology, world-class size, ammonia and urea units at Abu Qir (Alexandria) and SEMADCO (Talkha). These operations have design capacities of 1,000 MTPD ammonia/1,550 MTPD prilled urea and 1,200 MTPD ammonia/1,725 MTPD prilled urea, respectively. In 1991, Abu Qir (Alexandria) commissioned the second 1,000 MTPD ammonia unit (with updated efficiency) and a 2,400 MTPD ammonium nitrate unit employing the present state-of-the-art technology of "fluidized bed" granulation. In 1993, SEMADCO (Suez) commissioned a new 400 MTPD ammonia unit and two 500 MTPD ammonium nitrate "pug-mill" granulation trains. Abu Qir has announced the third expansion for commissioning in 1998-1999: a 1,200 MTPD ammonia/2,000 MTPD urea based on "fluidized bed" granulation. The ammonium nitrate capacities at SEMADCO's plants at Talkha and Suez and the calcium nitrate and ammonium sulfate capacities at Suez are limited by two old andinefficient ammonia units, one at each location. The ammonium nitrate capacities at KIMA (Aswan) and El Nasr Coke (Helwan) are also limited by old and inefficient ammonia units.

With the exception of Abu Qir, which is considered to be a highly efficient operation, all other nitrogen producers will require substantial investments for retrofit and/or new facilities and in pollution abatement. The primary goal must be to establish a high performance factor (90-95 percent) for design capacity. Efficient operation cannot be achieved without first establishing a high degree of on-stream reliability.

Contrary to nitrogen fertilizer, Egypt's presence in the world phosphate fertilizer market will be very limited until the Abu Tartur project becomes commercially viable. The domestic phosphate fertilizer demand, due to the withdrawal of price supports, was reduced by 40 percent between 1990-1995. This reduction has spurred producers to improve quality, via granulation, for SSP (Abu Zaabal and EFIC) and TSP (Abu Zaabal) in order to develop export markets. Presently, EFIC is planning a SSP granulation unit at Kafr El Zayat and SSP granulation

Figure II-1
Location of Nitrogen Fertilizer Plants and Fertilizer Storage Areas



SOURCE: Stone & Webster Report (March, 1986)

FIGURE 4.1

EGYPTIAN NITROGEN FERTILIZER SUB - SECTOR : MATERIAL FLOW DIAGRAM

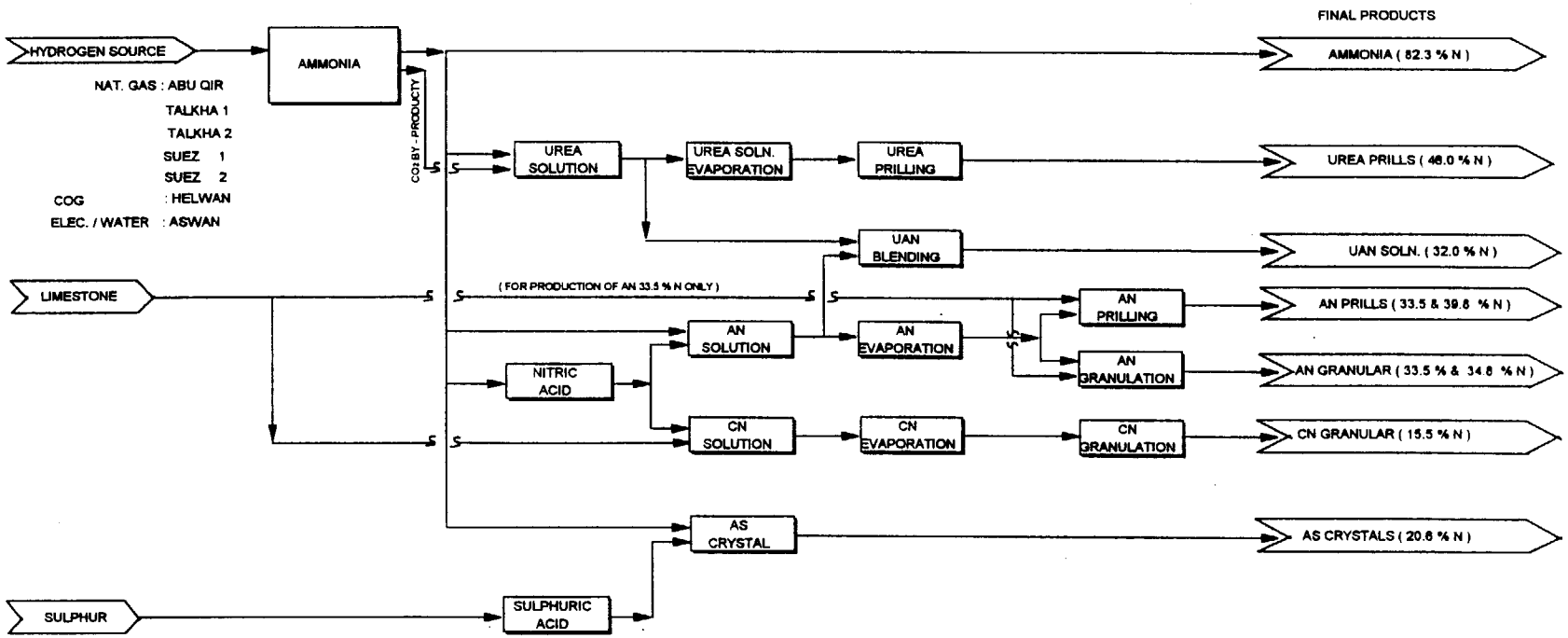


Figure II-3
Egyptian Phosphate Fertilizer Subsector: Material Flow Diagram

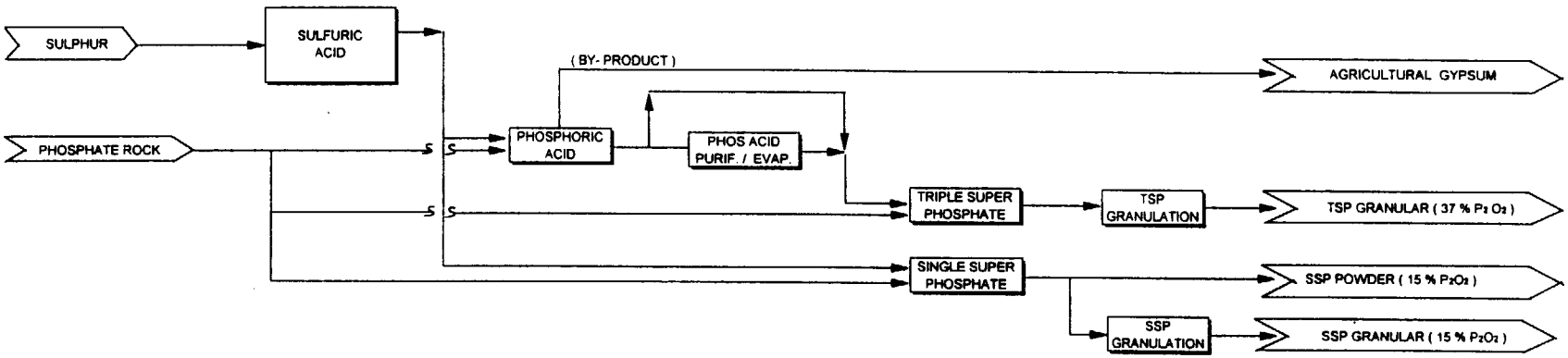


Table II-2
Technical Data: Egyptian Nitrogen Fertilizer Facilities

COMPANY/ LOCATION	PRODUCT	STARTUP YEAR	DESIGN CAPACITY MTPD	PROCESS/ CONTRACTOR	COMMENTS
ABU QIR — Alexandria	Ammonia I	1979	1,000	Uhde/Uhde	Nat. gas feedstock;single train;centrif.compression;steam/methane reform.(33 bar);one syn converter (270 bar).
	Ammonia II	1991	1,000	Uhde/Uhde	Essentially duplicate of Ammonia I.
	Urea	1979	1,550	Stamicarbon/Uhde	Single train;total recycle;CO_2 stripping;single prill tower.
	Nitric Acid	1991	1,800	Uhde/Uhde	Single train;dual press (4/9 bar);extended absorption (single absorber).
	Ammonium Nitrate Solution	1991	2,400	Uhde/Uhde	
	Ammonium Nitrate Granulation	1991	2,400	NSM/Uhde	Two trains;fluidized bed granulation.
SEMADCO — Talkha	Ammonia I	1964/1975	360	BASF/Uhde	Relocated from Suez;nat.gas feedstock;two complete trains;recip.compression; partial oxid.reform (atm);two syn converters (440 bar).
	Ammonia II	1981	1200	ICI/Foster Wheeler	Nat.gas feedstock;single train;centif.compression;steam/methane reform.(40 bar);two syn converters (240 bar).
	Nitric Acid	1975	900		
	Ammonium Nitrate Solution	1989	1200	MCC	Four trains, dual press (atm./4 bar);four absorbers/train.
	Ammonium Nitrate Prilling	1975	900		Two MCC neutralizers (replacement);vacuum evap.
	Urea	1981	1725	Stamicarbon/FW	Single prill tower;two dryers/coolers.
	Methanol	1993	72	Stamicarbon	Two complete trains;total recycle;CO_2 stripping;two prill towers.
	PE BAG MFG.	1981		Dolci	Once through process integrated into Ammonia I for CO removal. 90,000 Bags/Day.
SEMADCO — Suez	Ammonia I	1951	250	Chemico/Chemico	Nat.gas feedstock;recip.compression;four steam/methane reform.(3 bar);three syn converters (340 bar).
	Ammonia II	1993			Nat.gas feedstock;recip.compression;steam/methane reform.(40 bar);single syn converter (190 bar).
	Nitric Acid I	1951	150	Chemico/Chemico	Three trains;dual press.(atm/4 bar).
	Nitric Acid II	1958	150	Uhde/Uhde	Three burners;dual press.(atm/3bar);six absorbers.
	Nitric Acid III	1986	450	GP/Creusot Loire	Single train;dual press.(3/9 bar);extended absorption (single absorber).
	Ammonium Nitrate Solution	1993	1,000		
	Ammonium Nitrate Granulation	1993	1,000		
	Calcium Nitrate Solution	1951	800	Chemico	Two trains;pug mill granulation-drying-cooling.
	Calcium Nitrate Crystalization	1951	800	Chemico	Three dissolving towers;two stage evaporation.
	Sulphuric Acid	1983	300	Davey MsKee	Ten crystallizer drums.
	Ammonium Sulphate	1963/1969	300	Chemico	
— El Sadat	Limestone (Mining)	1950	800		Two crystallizers;single dryer;two pan filters.

Table II-2 (continued)
Technical Data: Egyptian Nitrogen Fertilizer Facilities

COMPANY/ LOCATION	PRODUCT	STARTUP YEAR	DESIGN CAPACITY MTPD	PROCESS/ CONTRACTOR	COMMENTS
KIMA — Aswan	Ammonia	1960	413	Uhde	Electolysis of water for H_2 feedstock;200 MW;N_2 from Air Sep;recip.compression; four syn converters (340 bar).
	Nitric Acid	1960	800	Stamicarbon/Uhde	Four trains;air enrich.;three burners/train;dual press.(atm/3 bar);four absorbers/train;two larger absorbers added for any train.
	Ammonium Nitrate Solution	1960	1,000	Stamicarbon/Uhde	Four neutralizers (atm.vent);four 1st stg. - six 2nd stg.evap;one falling film (replacement, 1981).
	Ammonium Nitrate Prilling	1960	1,000	Stamicarbon/Uhde	Three towers;33.5% and 34.8%N.
EL NASR COKE — Helwan	Ammonia	1964	170		Coke oven gas feedstock;recip.compression;partial oxidation.
	Nitric Acid	1970	250	Uhde/Uhde	Four burners;dual press.(atm/3 bar);four absorbers
	Ammonium Nitrate Solution	1969		DSM/Uhde	Two neutralizers
	Ammonium Nitrate Prilling	1970	250		One tower (33.5%N)
	Ammonium Nitrate Prilling		100		One tower (34.8%N)
	Ammonia Sulphate		60		Two crystallizers;by product from coke oper.plus purchased acid.
	Nitric Acid Concentration	1984	50	Tech.Unitos	
	Ammonium Bicarbonate	1994		Staff	$MgNO_3$ process
	Carbon Dioxide Liquid	1983	50		

Egyptian Nitrogen Fertilizer Sub-sector: Production Capacities and Performances (1993/94-1994/95)

COMPANY/LOCATION	PRODUCT	Startup YEAR	Design Capacity, MT DAILY	Design Capacity, MT (a) ANNUAL	Actual Capacity, MT 1993/94	Actual Capacity, MT 1994/95	Performance Factor 1993/94	Performance Factor 1994/95	Unutilized Capacity, MT 1994/95
ABU QIR — Alexandria	Ammonia	1979	1,000	330,000					
	Ammonia	1991	1,000	330,000					
	Urea	1979	1,550	511,500	537,302	522,000	105%	102%	—
	Nitric Acid	1991	1,800	594,000					
	Ammonium Nitrate	1991	2,275	750,000	770,386	823,000	103%	110%	—
SEMADCO — Talkha	Ammonia	1964/1975	360	118,800	71,957	74,378	61%	63%	44,422
	Ammonia	1981	1,200	396,000	302,747	298,893	77%	76%	97,107
	Nitric Acid	1975	900	297,000	204,469	197,591			99,409
	Ammonium Nitrate	1975	850	280,000	257,792	248,808	92%	89%	(b) 31,192
	Urea	1981	1,725	570,000	393,345	394,695	69%	69%	175,305
SEMADCO — Suez	Ammonia	1951	250	82,500	22,477	23,522	27%	29%	58,978
	Ammonia	1993	400	132,000	28,318	60,702	22%	46%	71,298
	Nitric Acid	1951	150	49,500					
	Nitric Acid	1958	150	49,000	75,400	104,300	31%	42%	143,200
	Nitric Acid	1986	450	148,500					
	Calcium Nitrate	1951	(c) 800	(c) 270,000	107,485	25,205	40%	9%	(c)
	Ammonium Nitrate	1991	(d) 1,000	(d) 330,000	-0-	105,182	—	32%	(d) 224,818
	Sulfuric Acid	1983	300	99,000	44,800	42,100	45%	43%	56,900
	Ammonium Sulfate	1963/1969	300	100,000	54,127	50,908	54%	51%	49,092
EL NASR COKE — Helwan	Ammonia	1964	170	56,100	24,500	29,000	44%	52%	27,100
	Nitric Acid	1971	250	82,500	60,800	58,700	74%	71%	23,800
	Ammonium Nitrate	1969	270	90,000	45,973	48,148	51%	54%	41,852
	Ammonium Sulphate	—		12,000	15,515	16,441	129%	137%	—
KIMA — Aswan	Ammonia	1960	413	136,000	123,088	124,002	91%	91%	11,998
	Nitric Acid	1960	800	264,000	215,478	214,285	82%	81%	49,715
	Ammonium Nitrate	1960	36	320,000	269,393	269,757	84%	84%	50,243

NOTATIONS:

a. Based on 330 Days Per Year Operation.
b. Existing Evaporation/Prilling Facilities Will Consume Only 75% of Nitric Acid Capacity.
c. Dependent on Nitric Acid Availability.
d. Limited by Nitric Acid Capacity.

Table II-4
Egyptian Phosphate Fertilizer Sub-sector: Production Capacities and Performances (1993/94-1994/95)

COMPANY/ LOCATION	PRODUCT	Startup Design Capacity, MT YEAR	DAILY	(a) ANNUAL	Actual Capacity, MT 1993/94	1994/95	Performance Factor 1993/94	1994/95	Unutilized Capacity 1994/95
ABU ZAABAL — Abu Zaabal	Sulphuric Acid		200						
	Sulphuric Acid		250	363,000	194,409	221,482	54%	61%	141,518
	Sulphuric Acid		650						
	Phosphoric Acid		200	65,000					
	Single Superphos.		1200	396,000	283,061	291,201	72%	74%	104,799
	(Powder)		365	120,000	14,381	39,643	12%	33%	80,357
	Triple Superphos.		450	144,000	32,426	52,292	23%	36%	91,708
	(Powder)			10,000					
	Granulation (SSP/TSP)								
	Dicalcium Phosphate								
	Gypsum								
EFIC — Assiut	Sulphuric Acid	1970	250						
	Sulphuric Acid	1982	300	181,500	72,409	133,726	40%	74%	47,774
	Single Superphos.	1970	600						
	(Powder)	1982	600	396,000	179,230	294,358	45%	74%	101,642
	Single Superphos.	1987	600						
	(Powder)	1992	250	165,000	135,171	163,472	82%	99%	1,528
	Single Superphos.	1994	250						
	(Powder)								
	Granulation (SSP)								
	Granulation (SSP)								
— Kafr El Zayat	Sulphuric Acid	1953	50						
	Sulphuric Acid	1962	150	165,000	147,705	173,599	90%	105%	—
	Sulphuric Acid	1982	300						
	Single Superphos.	1964	(b)						
	(Powder)	1975	600	396,000	297,114	318,809	75%	81%	77,191
	Single Superphos.	1987	(b)						
	(Powder)		600						
	Single Superphos.		(b)280						
	(Powder)								

NOTATIONS: a. Based on 330 Days Per Year Operation.
b. Based on 20 Hour Per Day Operation.

expansion at Assiut. Abu Zaabal is planning a TSP granulation unit and retrofit of the phosphoric acid unit. When these projects are completed, both producers should approach full design capacity, subject to domestic and export demand.

The economic viability of both phosphate producers may require restructuring and modernizing in order to remain competitive entities, especially when and if Abu Tartur becomes a reality. Abu Zaabal is the only vertically integrated operation with both mining and production capabilities. However, it is heavily debt ridden and requires plant improvements, especially in the area of phosphoric acid. EFIC, although not vertically integrated, is well managed and in a sound financial position. EFIC also requires plant improvements. If El Nasr Phosphate and Red Sea Phosphate cease phosphate mining, a consolidation of Abu Zaabal and EFIC could be beneficial to both companies.

A5a. Abu Qir Fertilizer and Chemical Industries Company

- Holding Company: Engineering Industries

- Location: Abu Qir Bay, 20 kilometers east of the port city of Alexandria in Lower Delta. Natural gas supply for ammonia feedstock and fuel from nearby Abu Qir gas field. Product shipments by rail, truck and ship (ammonia). Export of ammonium nitrate and urea via truck through Port of Alexandria.

- Products:
  - * Ammonia
    Urea Solution (83 percent concentration)
  - * Urea (prilled)
    Nitric acid (60 percent concentration)
    Ammonium nitrate solution (83 percent concentration)
  - * Ammonium Nitrate 34.8 percent N (granular)

Tables II-2 and II-3 contain technical details, production capacities, and performances of individual production units.

*Products for domestic and/or export sales

- Employment: Approximately 3,000

- Operations Overview: Abu Qir is a modern, efficient, and well managed operation. The location is uniquely situated for domestic and export markets. Development has been in two phases: 1,000 MTPD ammonia/1550 MTPD urea (1979) and 1,000 MTPD ammonia/2400 MTPD ammonium nitrate (1991). The third phase, consisting of 1,200 MTPD ammonia/2,000 MTPD urea, is scheduled for 1998-1999.

  Operations appear to be in environmental compliance with the possible exception of the urea prill tower, and air emissions.

- Financial Overview: Abu Qir has demonstrated strong, profitable operations based on its ability to achieve and exceed design production capacity in combination with high price and strong export demand. With long range export demand projected to remain strong,

the proposed expansion is well timed. Assuming reasonable natural gas pricing, Abu Qir should maintain a competitive position in the world market.

A5b. Egyptian Chemical Industries (KIMA)

- Holding Company: Chemical Industries

- Location: About four kilometers southeast of the city of Aswan in Upper Egypt. Electricity (200 MW) for electrolysis of water to supply hydrogen to ammonia synthesis and oxygen to nitric acid units comes from the nearby Aswan High Dam. Product shipments are made by barge, rail and truck. There is no economic potential for major export.

- Products:
  Hydrogen (gas)
  Oxygen (gas)
  Nitrogen (gas)
  Ammonia
  Nitric acid (55 percent concentration)
  Ammonium nitrate solution (80 percent concentration)
  * Ammonium nitrate 33.5 percent (prilled)
  * Ammonium nitrate 34.8 percent N (prilled)

Table II-2 contains information on production capacities and performances of individual production units.

*Products for domestic sales

- Employment: Approximately 2,000 full, and 600 part-time.

- Operations Overview: KIMA's ammonia process is relatively reliable but inefficient due to electrical energy consumption and high maintenance costs. Alternative ammonia supplies have not proven viable. Nitric acid process relies on air enrichment by oxygen from electrolysis process which, if eliminated, would decrease design capacity by 20 percent to about 1994-1995 level. In general, the plant is old (1960) and in need of rehabilitation, especially for pollution abatement.

  The major environmental concerns are discharge of contaminated wastewater, ammonium nitrate area emissions from neutralizer, evaporation, and prilling towers, and nitric acid absorber NO_X.

- Financial Overview: Although debt-free, the marginal profitability results from highly subsidized electrical energy. Long-range profitability requires an economical and reliable source of ammonia, independent of the electrolysis process, along with rehabilitation of the existing facilities. Additional profitability may result from proposed projects of heavy water and hydrogen peroxide. This will require partial operation (25 percent) of the water electrolysis units and would also provide oxygen for increasing nitric acid production. However, the economic justification for this phase should be independent of the nitrogen fertilizer operation.

A5c. El Nasr Company for Coke and Chemicals

El Nasr Coke for Coke and Chemicals Company (Note: profile herein regards only the fertilizer operation, not the primary business of coke production).

- Holding Company: Mining and Minerals

- Location: City of Helwan, 45 kilometers south of Cairo in Upper Delta. The feedstock for ammonia is coke oven gas, a by-product of coke production from the adjacent coke operation. Product shipment is made by rail and truck with potential of barge. Export potential of ammonium nitrate would be via truck or rail through ports of Alexandria or Damietta.

- Products:
  - Ammonia
  - Nitric acid (55 percent concentration)
  - * Nitric acid (98 percent concentration)
  - Ammonium nitrate solution (80 percent concentration)
  - * Ammonium nitrate 33.5 percent N (prilled)
  - * Ammonium nitrate 34.8 percent N (prilled)
  - * Ammonium sulphate
  - * Oxygen (liquid/gas)
  - * Nitrogen (liquid/gas)
  - * Carbon dioxide (liquid/dry ice)
  - * Ammonium bicarbonate

Tables II-2 and II-3 contain technical details, production capacities and performances of individual units.

*Products for domestic sales

- Employment: Approximately 1,200

- Operations Overview: The ammonia process based on by-product coke oven gas is an old, unreliable, and inefficient operation which should be discontinued. The nitric acid unit requires rehabilitation. The ammonium nitrate solution, evaporation and 33.5 percent prilling should probably be replaced.

  Major environmental concerns are contaminated wastewater discharges, ammonium nitrate area emissions from neutralizer and prilling tower, and nitric acid absorber NO_X.

  Operation at this site should be continued due to importance of distribution/ transportation centroid, existing infrastructure, and production of other chemicals. If an economical and reliable source of ammonia is available, production of ammonium nitrate could be doubled over previous production history. Also, coke oven gas could be more efficiently utilized as fuel for steam/electrical generation. Liquid carbon dioxide would be lost but the facilities could be relocated.

- Financial Overview: The existing operation is unprofitable and will remain so as long as ammonia production from coke oven gas is continued. Profitable operation should result from an economical supply of ammonia sufficient to operate existing facilities at design capacity, after reasonable investment for refurbishment and pollution abatement.

A5d. El Nasr Fertilizer and Chemical Company (SEMADCO)

(Note: This company consists of two separate operations; Suez and Talkha. For profile purposes, each operation is discussed separately).

SEMADCO-Suez

- Location: Lower eastern Egypt, 15 kilometers south of city of Suez. Natural gas feedstock for ammonia production comes from El Faiyum and Ras Skukleir gas fields. Product shipments made by rail and truck. Export of ammonium nitrate via truck to ports of Suez (Far East) and Damietta (Europe).

- Products:
  - Ammonia
  - Nitric acid
  - Ammonium nitrate solution (80 percent concentration)
  - * Ammonium nitrate 33.5 percent
  - Calcium nitrate solution
  - * Calcium nitrate 15.5 percent N (flakes)
  - * Sulfuric Acid
  - * Ammonium sulphate (crystal)

Tables II-2 and II-3 contain technical details, production capacities, and performances of individual production units.

*Products for domestic sales

- Employment: Approximately 3,000

- Operations Overview: Primary problem is lack of ammonia supply due to old, unreliable and inefficient ammonia unit I and design defects of ammonia unit II. Ammonia II defects should be resolved with modifications recently completed. Ammonia I should be replaced with an economical and reliable ammonia supply. Calcium nitrate (flakes) production should be converted to calcium ammonium nitrate solution (17 percent N) thereby eliminating costly evaporation and crystallization operations. Refurbishment of other facilities to achieve design capacity and pollution abatement will be required.

  Major environmental problems are contaminated wastewater discharges, nitric acid absorber NO_X, and ammonium nitrate neutralizer/evaporation emissions.

  This operation is ideally located for export to the Far East and Europe. A new private sector ammonia unit would allow this operation to achieve design capacity and, possibly, allow for future urea production.

- Financial Overview: The currently unprofitable status of this operation is due primarily to problem of ammonia supply and secondly to excess labor costs. Profitable operation should result from an economical and reliable ammonia supply in conjunction with ammonia unit II achieving design capacity. However, investment for rehabilitation and pollution abatement will be required.

SEMADCO-Talkha

- Location: City of Talkha in the Lower Delta. Natural gas for ammonia feedstock from Abu Madi gas field. Product shipments by truck and rail. Export of ammonium nitrate and urea is made via truck through the port of Damietta.

- Products:
  * Ammonia
    Nitric acid (55 percent concentration)
    Ammonium nitrate solution (75 percent concentration)
  * Ammonium nitrate 33.5 percent N (prilled)
    Urea solution (75 percent concentration)
  * Urea (prilled)
  * Urea-ammonium nitrate solution

Tables II-2 and II-3 contain technical details, production capacities, and performances of individual production units.

*Products for domestic sales

- Employment: Approximately 6,500

- Operations Overview: Production has been limited primarily due to inefficient and unreliable ammonia I and steam balance problems of ammonia II. Retrofit plans for both units should allow other units, after refurbishment, to achieve design capacity. Ammonium nitrate prilling may require replacement by granulation.

  Major environmental concerns are contaminated wastewater discharges and emissions from ammonium nitrate and urea prilling towers.

- Financial Overview: SEMADCO-Talkha is presently a profitable operation. Implementation of the retrofit of ammonia unit I and II, after refurbishment of other facilities, should achieve design capacity and substantially improve profitability.

A5e. Abu Zaabal Fertilizer Company

- Holding Company: Mining and Refractories

- Location: Phosphate fertilizer production is located at city of Abu Zaabal in Upper Delta. Ore concentrate is received from Abu Zaabal mining operation in West Sebeia via barge or rail. Product shipments are made by barge, rail, and truck. Products are exported via truck through the ports of Alexandria and Damietta.

- Products:
  * Sulfuric acid (98 percent) concentration)
  * Phosphoric acid
  * Single superphosphate (powder and granular)
  * Triple superphosphate (powder and granular)
  * Dicalcium phosphate

Table II-4 contains information on production capacities and performances of individual production units.

*Products for domestic and export sales

- Employment: Unreported.

- Production Overview: Production capacities has been limited by demand and poor performance of other units. Plans to retrofit the phosphoric acid unit and erect a new SSP and TSP granulation unit, if implemented, should result in ability to achieve design capacity and the product quality necessary for export. In general, plant is old and in need of refurbishment and pollution abatement modifications. Major environment concerns are contaminated wastewater discharges, sulfuric acid SO_X emissions and dust control.

- Financial Overview: Present marginal profitability is based on lack of repayment of excessive debt. Whereas retrofit and refurbishment would increase production capability, long-range profitability will require debt restructuring and further expansion of domestic and export markets. Economics of mining operation would be improved by supplying EFIC. Consolidation of Abu Zaabal and EFIC could result in more efficient and profitable operations.

A5f. Egyptian Financial and Industrial Company (EFIC)

(Note: This company consists of two separate operations: Assiut and Kafr El Zayat. For profile purposes, each operation is discussed separately).

EFIC-Assiut

- Location: City of Assiut in Upper Egypt, 500 kilometers south of Cairo. Ore concentrate is received by barge, rail or truck. Product shipments made by rail and truck. SSP is exported via truck through port of Safaga.

- Products:
  * Sulfuric acid
  * Single superphosphate
  * Ferrous sulphate solution

Table II-4 contains information on production capacities and performances of individual production units.

*Products for domestic and export sales

- Employment: Approximately 1,285

- Operations Overview: Operations appear to be well managed but will require some refurbishment. Plans to expand granulation of SSP, if implemented, should allow for design capacity, based on market demand. Major environmental concerns include contaminated wastewater discharges, sulfuric acid SO_X emissions and dust control.

- Financial Overview: Refer to consolidated EFIC comments below.

EFIC-Kafr El Zayat

- Location: City of Kafr El Zayat in Lower Delta, 100 kilometers from Cairo. Ore concentrate is received by rail. Product shipments made by rail and truck. Export shipment reflected by truck through Port of Alexandria.

- Products:
  * Sulfuric acid (98 percent concentration)
  * Single superphosphate
  * Ferrous sulphate solution
  * Micro elements solution

Table II-4 contains information on production capacities and performances of individual production units.

*Products for domestic and export sales

- Employment: Approximately 1,800

- Operations Overview: Operations appear to be well managed with good unit performances. The limitation to SSP production is sulfuric acid availability. Some refurbishment is required in addition to plans for a total SSP granulation unit and expanded and new curing storage. If the plans are implemented, design production capacity should be achieved. Major environmental concerns are the same as at Assiut: contaminated wastewater discharges, sulfuric acid SO_X emissions, and dust control.

- Financial Overview: Present consolidated profitability of EFIC should be substantially improved if refurbishment and expansion plans are implemented. One concern is that EFIC is not a vertically integrated (no mining) operation. Consolidation with Abu Zaabal may be beneficial for both companies and strengthen their position regarding potential competition from Abu Tartur.

B. Environmental Discussion

The authority to establish, monitor, and enforce compliance of environment laws is the responsibility of the Egyptian Environmental Affairs Agency (EEAA). This agency was reorganized by Law Number 4 (1994) and established within the prime minister's cabinet. The chairman of the agency is appointed by presidential decree upon nomination of the minister of Environmental Affairs and the recommendation of the prime minister. A brief summary of the major environmental legislations covering air emissions and discharge water quality follows.

- Ministerial Decree No. 470 of 1971-Air Pollution Control: Establishes general requirements for control of ambient and work space air quality and limits release of air contaminants in residential and industrial areas.

- Article 34-Public Law 4 (1994): Establishes procedure for approval of new projects including site selections, air emission standards, and noise level.

- Article 42-Public Law 4 (1994): Establishes procedure for compliance of production activities with regards to noise level.

- Law 48 (1982)-Protection of the Nile River and waterways by establishing licensing requirement and standards for discharge of solid, liquid or gaseous water from industrial and other operations. Definition of standards and discharge are applied to each case separately.

Based on the directive of Law 4 (1994), establishments existing at the time of the promulgation of this law in February 1994 shall have three years to reach compliance. However "...The cabinet may extend this grace period of no more than two years if deemed necessary and it appears to the cabinet that serious efforts have been taken towards complying with the provisions of the following law."

The environmental evaluation conducted by the Chemonics study team was limited to observations and discussions during the brief plant inspections. No sampling or testing of air or water emissions was conducted. As a follow up to this limited activity, an environmental screening report was commissioned to evaluate five of the eight fertilizer operations. This report is included in Annex E in the annex volume. The five operations evaluated were:

- SEMADCO-Suez
- SEMADCO-Talkha
- El Nasr Coke-Helwan
- Abu Zaabal
- EFIC-Kafr El Zayat

Due to time constraints, three operations were not evaluated. Other reasons for exclusion were as follows:

- Abu Qir—modern facilities, state-of-the-art process technology and excellent management/operations
- EFIC (Assiut)—similarity to Kafr El Zayat operations
- KIMA—remote location

With the exception of Abu Qir, all fertilizer operations are in non-compliance with regards to air and water emissions. Major areas of non-compliance for each fertilizer operation is summarized as follows:

- SEMADCO-Talkha
  - Ammonium nitrate and urea prilling tower particulate (solids) emissions
  - Nitric acid NO_X emissions
  - Fugitive ammonia venting from multiple sources

- Wastewater discharges from multiple sources containing ammonia, ammonium nitrate and urea
- Noise levels

- SEMADCO-Suez, El Nasr Coke and KIMA
  - Ammonium nitrate granulation particulate (solids) emissions
  - Ammonium nitrate neutralize emissions
  - Nitric acid NO_X emissions
  - Fugitive ammonia venting from multiple sources
  - Wastewater discharges from multiple sources of ammonia and ammonium nitrate
  - Noise levels

- Abu Zaabal and EFIC (Assiut and Kafr El Zayat)
  - Sulphuric acid SO_X emissions
  - Fluoride emissions from multiple sources
  - Particulate emissions from multiple sources
  - Wastewater discharges from multiple sources of solids and other contaminants

Pollution problems of the nitrogen fertilizer producers, although similar, may require different methods of abatement. The same statement can be made for phosphate fertilizer producers. For example, at one plant it may be more economical to install prilling tower scrubbing equipment, whereas, at another plant replacement of the prilling system by granulation may be required. The same analysis may apply to the problems of the ammonium nitrate neutralizers, either retrofit or replace. The proposal to replace the three old and inefficient ammonia units at SEMADCO-Suez, El Nasr Coke-Helwan and KIMA-Aswan would eliminate substantial pollution problems.

A review of projects submitted by all fertilizer producers, except Abu Qir, indicates that these projects seem to emphasize energy efficiency and production capacity expansion rather than pollution abatement. For that reason, it is recommended that a definitive study be undertaken for each fertilizer operation to define pollution abatement alternatives and the associated capital investment required. This potential liability is a major concern with regards to potential privatization.

C. Fertilizer Supply/Demand (1993-1994 and 1994-1995)

Table II-5 details production, domestic consumption, exports, and imports for nitrogen and phosphate fertilizers for 1993-1994 and 1994-1995.

Ammonium nitrate statistics for 1994-1995 as compared to 1993-1994 are as follows:

- Production—1,494,895 MT, up 11.3 percent
- Domestic consumption—1,188,535 MT, down 3.6 percent
- Exports—306,360 MT, up 264 percent
- Unutilized capacity—348,105 MT or 23.3 percent of total production

Urea statistics for 1994-1995 as compared to 1993-1994 are as follows:

- Production—916,695 MT, down 1.5 percent

- Domestic consumption—731,114 MT, down 7.1 percent
- Exports—185,581 MT, up 19.4 percent
- Unutilized capacity—175,305 MT or 19.1 percent of total production

Ammonium sulphate statistics for 1994-1995 as compared to 1993-1994 are as follows:

- Production—67,349 MT, down 3.3 percent
- Domestic consumption—81,849 MT, down 58 percent
- Imports—22,000 MT, down 307 percent
- Unutilized capacity—49,092 MT or 72.9 percent of total production

Total nitrogen fertilizer statistics, expressed as nitrogen, for 1994-1995 as compared to 1993-1994 are as follows:

- Production—940,250 MT, up 3.4 percent
- Domestic consumption—755,239 MT, down 8.0 percent
- Exports—189,543 MT, up 71.7 percent
- Unutilized Capacity—207,368 MT or 22.1 percent of total production

The nitrogen fertilizer statistics shown above and in Table II-5 should be self explanatory. However, special attention should be given to "unutilized capacity" statistics. These statistics represent lost production by failure to achieve, primarily, high performance factors for ammonia production units, Abu Qir excluded. Lost production of ammonium nitrate and urea can be equated to new plant capacities of 1,050 MTPD and 550 MTPD, respectively. These statistics are evidence of the necessity to retrofit the ammonia units, SEMADCO Talkha II and, possibly Talkha I and to replace the production of SEMADCO Suez I, El Nasr Coke, and KIMA with an economical and reliable ammonia source.

Figures II-4, II-5 and II-6 illustrate the market share by company for ammonium nitrate, urea and total nitrate fertilizers, respectively. Abu Qir dominates the market share with 57 percent of ammonium nitrate and urea and 54 percent of total nitrate fertilizers. However, SEMADCO (Talkha and Suez) could share almost equal market parity if design capacity of their production units could be achieved.

Single superphosphate (SSP) statistics for 1994-1995 as compared to 1993-1994 are as follows:

- Production—904,368 MT, up 19.1 percent
- Domestic consumption—740,490 MT, up 5.0 percent
- Exports—185,536 MT, up 76.1 percent
- Unutilized capacity—283,632 MT or 31.4 percent of total production

Triple superphosphate (TSP) statistics for 1994-1995 as compared to 1993-1994 are as follows:

- Production—39,643 MT, up 276 percent
- Domestic consumption—(essentially nil)
- Exports—52,345 MT, up 9.9 percent
- Unutilized capacity—80,337 MT or 202 percent of total production

Table II-3

Egyptian Fertilizer Sub-sector: Supply-demand Statistics (1993-1994-1994-1995) 1994/95

	1993/94 METRIC TONS				1994/95 METRIC TONS				1994/95 METRIC TONS
PRODUCT	Production	Domestic Consumption	Exports	Imports	Production	Domestic Consumption	Exports	Imports	Unutilized Capacity
Ammonium Nitrate (33.5%N)	1,343,544	1,233,501	116,043	6,000	1,494,895	1,188,535	306,360	-0-	348,105
Urea (46.0%N)	930,647	787,415	155,416	12,184	916,695	731,114	185,581	-0-	175,305
Calcium Nitrate (15.5%N)	107,485	107,485	20	-0-	25,205	25,205	-0-	-0-	—
Ammonium Sulphate (20.6%N)	69,642	141,213	40	71,611	67,349	81,849	7,500	22,000	49,092
TOTAL AS NITROGEN	909,190	821,181	110,376		940,250	755,239	189,543		207,368
Single Super Phosphate (15%P_2O_5)	759,405	(a) 705,438	(a) 105,384	—	904,368	(a) 740,490	(a) 185,536	—	(b) 283,632
Triple Super Phosphate (37%P_2O_5)	14,381	(a) 482	(a) 47,614	—	39,643	(a) 173	(a) 52,345	—	(c) 80,357
TOTAL AS P_2O_5	119,232	105,994	33,425	—	150,323	110,799	47,174	—	70,277

NOTATIONS:
a. Domestic Sales Plus Exports Exceeds Production Due to Withdrawal From Inventory.
b. May be Limited by Sulphuric Acid Availability.
c. May be Limited by Sulphuric Acid and Phosphoric Acid Availability.

Figure II-4
Market Share by Company - Ammonium Nitrate 33.5%

For year 1994 / 95
in thousands of tons

Abu Qir	823
Semadco	354
Kima	230
Coke	48
Total Supply	1,455

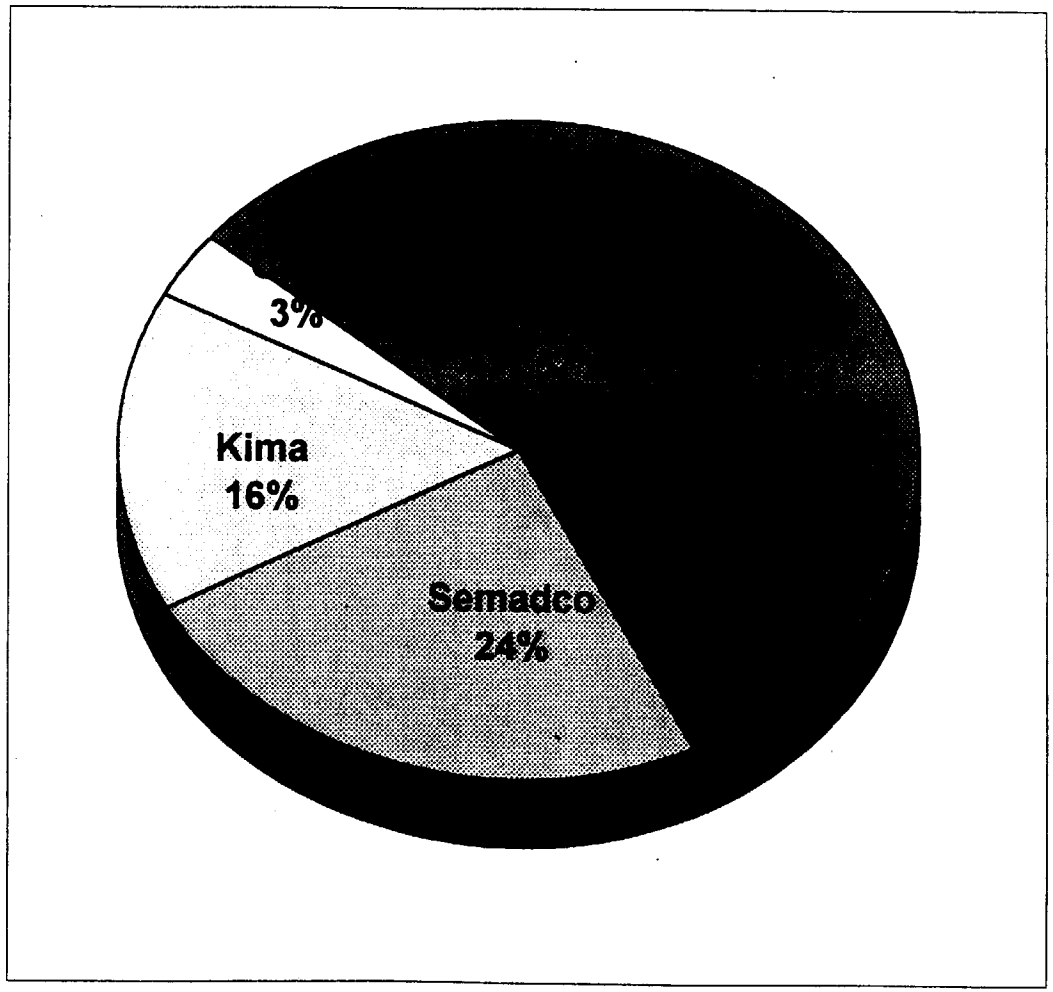


Figure II-5
Market Share by Company - Urea 46%

For year 1994/95
in thousands of tons

Abu Qir	522
Semadco	395
Total Supply	917

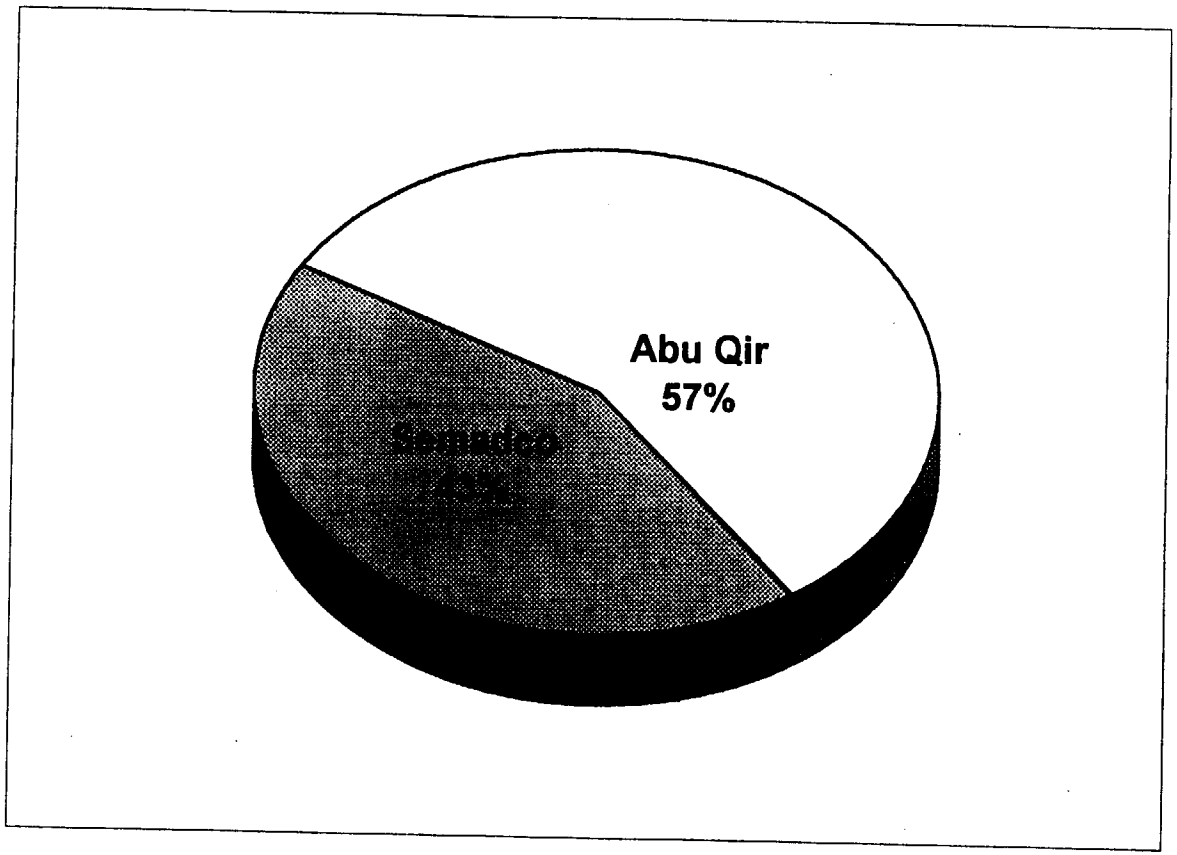


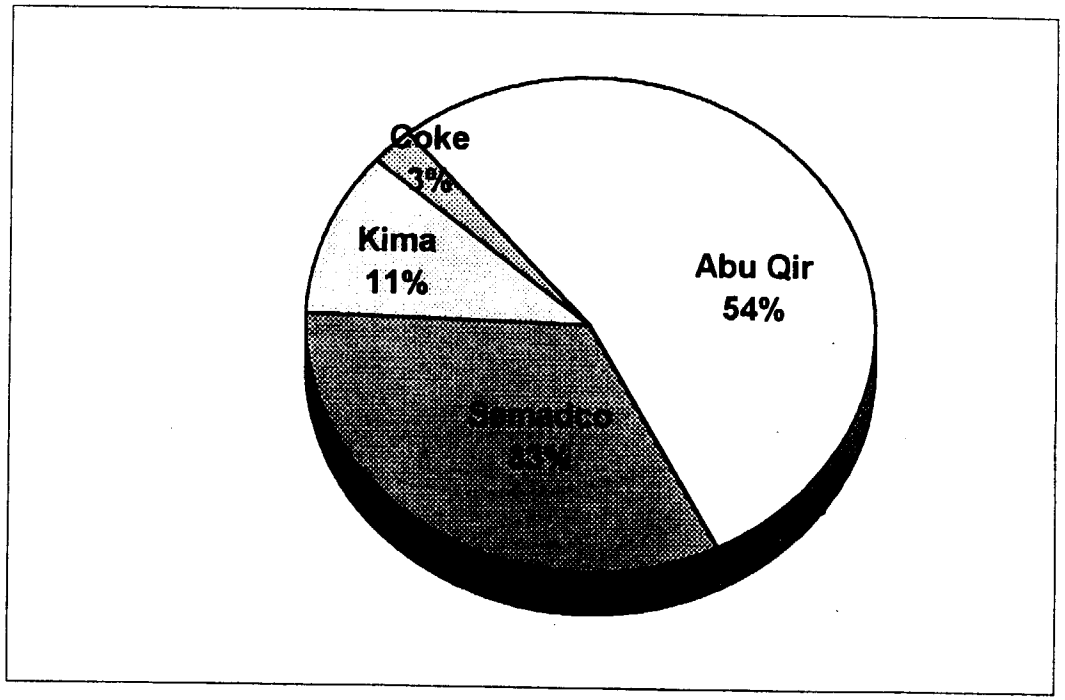
FIGURE 4.8
Share by Company - Nitrate Fertilizers ...
(AN 33.5% N, UREA 46% N, AS 20.6% N, CN 15.5% N)

For year 1994/95
in thousands of tons

Abu Qir	1,345
Semadco	825
Kima	270
Coke	64
Total Supply	2,504

4 year average annual growth

Abu Qir	5.1%
Semadco	0.4%
Kima	-0.2%
Coke	1.7%
Total Supply	2.5%



Total phosphate fertilizer statistics, expressed as P_2O_5, for 1994-1995 as compared to 1993-1994 are as follows:

- Production—150,323 MT, up 26.1 percent
- Domestic consumption—110,799 MT, up 4.5 percent
- Exports—47,171 MT, up 41.1 percent
- Unutilized capacity—70,277 MT or 46.7 percent of total production

It should be noted that domestic consumption and exports exceeded production capacity due to withdrawals from inventories.

Figure II-7 illustrates that EFIC dominates the SSP market, with 67 percent of total production for 1994-1995, up 5 percent from 1993-1994.

The phosphate fertilizer statistics shown above and in Table II-5 should be self explanatory. These statistics show that the Egyptian phosphate fertilizer industry is dependent on the export market in order to approach design production capacity. To reach design production capacity will require implementation of the projects previously mentioned for granulation and phosphoric acid retrofit at Abu Zaabal, granulation expansion at Assiut, and granulation at Kafr El Zayat.

In summary, a review of Tables II-3, II-4, and II-5 provide statistics supporting the following statements:

- Existing nitrogen and phosphate fertilizer producers have sufficient capacity, irrespective of unutilized capacity, to meet domestic requirements based on 1994-1995 consumption rates.

- Retrofit of existing facilities in conjunction with new ammonia production to replace inefficient units should recover total unutilized capacity, thereby increasing 1994-1995 nitrogen and phosphate fertilizer production by 22.1 percent and 46.7 percent, respectively.

- Egypt's fertilizer industry is dependent on the export market in order to maximize production of existing facilities and insure profitable operations.

D. Privatization Concepts

D1. Nitrogen Fertilizer Sub-sector

From a technical point of view, ignoring the financial aspects of assets and debt, the necessary requirement for privatization is that the candidate company be profitable or demonstrate the potential for profitable operation. For nitrogen fertilizer products, ammonia is the primary feedstock and the dominant cost of production. When this supply is uneconomical, inefficient and/or unreliable (low performance factor) the final nitrogen product capacity will be reduced and the product cost will be increased. This will result in decreased earnings and possibly in operating losses.

FIGURE 4.9
Market Share by Company - SSP 15%

For year 1994/95
in thousands of tons

Abu Zaabal	**300**
EFIC	**613**
Total Supply	**913**

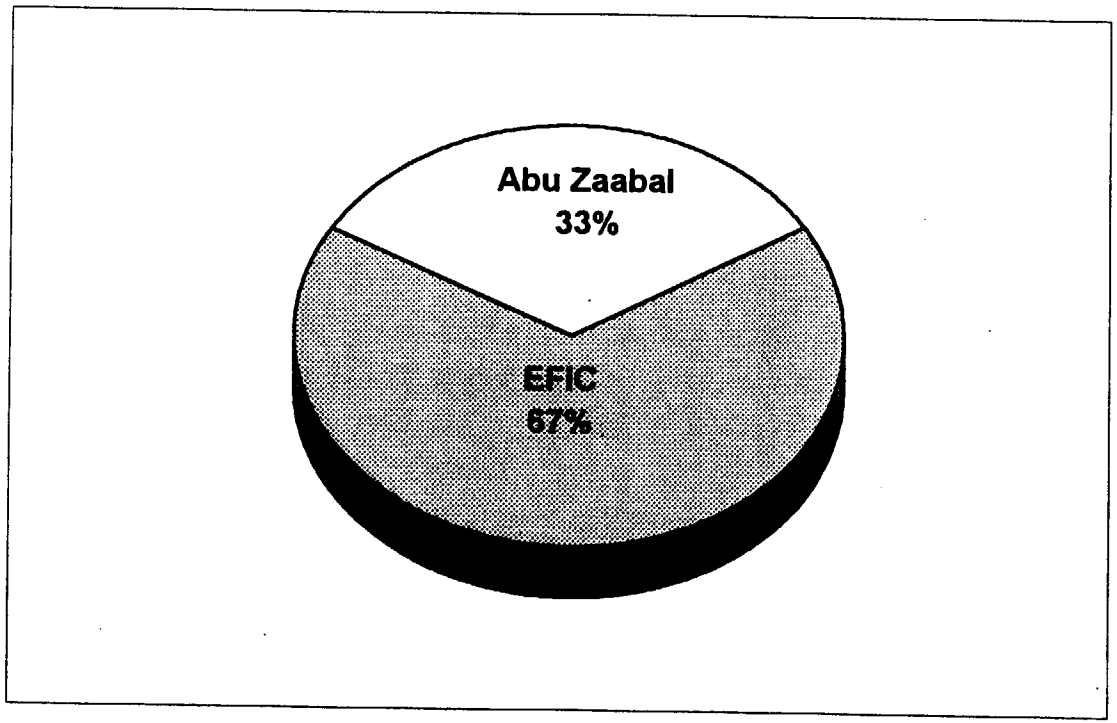


Figure II-8 details 1994-1995 revenue and gross profit for each of the five nitrogen fertilizer operations.

There are eight ammonia units in Egypt. The starting date and design capacity are as follows:

Ammonia Unit	Start Up	Capacity MTPD
• Abu Qir I	1979	1,000
• Abu Qir II	1991	1,000
• Semadco (Talkha II)	1980	1,200
• Semadco (Suez II)	1993	400
• Semadco (Talkha I)	1964/1975	360
• Semadco (Suez I)	1951	250
• El Nasr Coke	1964	170
• KIMA	1960	413

The first three units listed are considered world-class, standard design, current state-of-the-art as to process technology and capacity, as discussed earlier in the section on process technology. SEMADCO (Suez II) unit, although commissioned in 1993, utilizes a reciprocating compressor due to capacity design and is therefore less efficient than single train, state-of-the-art centrifugal ammonia units. The continued operation of these four units is critical to the success of Egypt's nitrogen fertilizer industry. Of the remaining four units, only SEMADCO (Talkha I) is a serious candidate for retrofit while an alternative source of ammonia should be considered for the other three units.

All nitrogen fertilizer companies have expressed plans to retrofit and/or to expand ammonia production and related products. A summary of these plans are as follows:

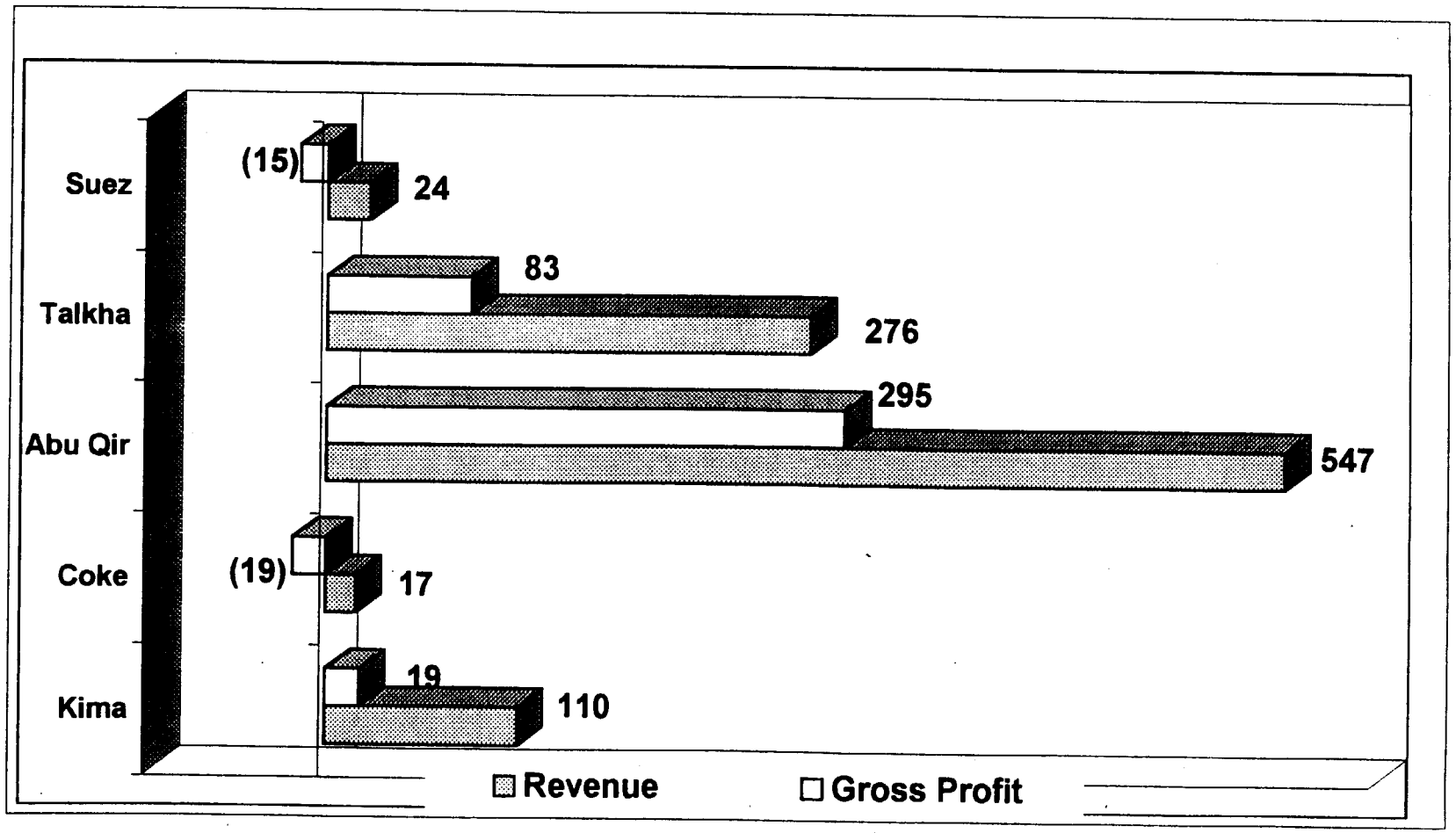
- Abu Qir—new 1,200 MTPD ammonia/2,000 MTPD granular urea (1989-1999)
- SEMADCO (Talkha)—retrofit of Ammonia I to 450 MTPD and energy efficiency improvement of Ammonia II
- SEMADCO (Suez)—retrofit of Ammonia I and new ammonia/urea capacity
- El Nasr Coke—replacement of existing ammonia, nitric acid, and ammonium nitrate units with new 1,000 MTPD ammonia and 2,300 MTPD ammonium nitrate facilities
- KIMA—due to non-availability of an economical ammonia supply, continued operation of inefficient and subsidized ammonia unit

Abu Qir reported a 1994-1995 gross profit of LE 295 million. while exceeding design capacities of ammonia, urea, and ammonium nitrate units. Due to its excellent management, operating performance, and profitability, this company would be a candidate for privatization.

SEMADCO (Talkha) reported a 1994-1995 gross profit of LE 83 million, while demonstrating poor operating performance of both ammonia units. Ammonia I produced 74,378

Nitrogen Fertilizer

Comparison of revenue and gross profit in LE million as of 1994 / 95



MT as compared to the design capacity of 115,500 MT, for a performance factor of about 63 percent. Ammonia II produced 298,893 MT, as compared to design capacity, (330 DPY) of 396,000 MT for a performance factor of about 76 percent. Plans to retrofit Ammonia I and efficiency improvement of Ammonia II, when implemented, will increase fertilizer production and profitability. Although investment for pollution abatement will be required, this plant, standing alone, would be a candidate for privatization.

SEMADCO (Suez) reported a 1994-1995 gross loss of LE 15 million, primarily based on poor operating performance of both ammonia units. Ammonia I produced 23,522 MT as compared to a design capacity of 82,500 MT, for a performance factor of about 29 percent. Ammonia II produced 60,702 MT, as compared to the design capacity of 132,000 MT, for a performance factor of about 46 percent. Ammonia II performance should substantially improve with modifications to correct design defects recently completed. However, this unit cannot supply sufficient ammonia for full production of the existing fertilizer units. Plans for retrofit of Ammonia I should be reconsidered and the required investment redirected to efficiency improvements and pollution abatement projects if an alternative source of ammonia becomes available. Reasonable investment should also provide a 10-15 percent increase in the design capacity of fertilizer products. With these investments and an economical and reliable supply of ammonia, this company standing along, would be a candidate for privatization.

El Nasr Coke reported a 1994-1995 gross loss of LE 19 million for the fertilizer operation, primarily attributed to the quality and cost of ammonia feedstock (coke oven gas) and poor performance of the ammonia unit. Ammonia production was 29,000 MT as compared to a design capacity of 56,100 MT, for a performance factor of 52 percent. Retrofit of this unit is not economically feasible. Continued fertilizer production at this location is important due to the centroid for distribution, the derivative chemicals production, and the existing infrastructure. For continued operation, an alternative supply of ammonia will be required as well as investment in refurbishment or replacement of existing facilities. It should be noted that during the period 1991-1992 through 1994-1995, production of ammonium nitrate was limited to about 50 percent of design capacity due to limited ammonia supply. There are two scenarios for continued operation, both requiring a new source of ammonia. The first would involve the refurbishment of the existing nitric acid units and the installation of a new granular ammonium nitrate unit in conjunction with pollution abatement and cleanup. The second would see the installation of a new and larger nitric acid/ammonia nitrate facility. The first scenario would require moderate investment, the second, substantial investment. With regards to privatization, the first scenario should be more attractive for privatization.

KIMA reported a 1994-1995 gross profit of LE 19 million, while operating at a performance factor of about 85 percent of design. The ammonia process (electrolysis of water), although reasonably reliable, is energy intensive and uneconomical at the electricity prices charged to other nitrogen fertilizer procedures. For example, if the present cost (2.7 PT/KWH) was escalated to industry cost (11.3 PT/KWH), KIMA would have a 1994-1995 gross loss of about LE 115 million. However, with an economical and reliable supply of ammonia, this company would be a candidate for privatization.

The goal of privatization of the Egyptian fertilizer industry could be advanced or accomplished by introduction of new, centrally located ammonia production. This new production would at minimum replace existing inefficient and high-cost ammonia production. Additionally, a reliable, sufficient ammonia supply would allow intermediate and final product units the

capability of operation at design capacity, thereby substantially increasing the production of nitrogen fertilizer. The capacity of new ammonia production would be determined by the number of fertilizer companies or plants willing to participate.

The concept overview is to construct one new ammonia unit for supply to possibly three existing fertilizer production operations which, in turn, would cease production of old, inefficient ammonia units. This new ammonia supply would be centrally located and transported to each of the participating companies via rail, truck and possibly by barge. The new production would be a private corporation that would build, own, operate and toll (BOOT) natural gas into ammonia. Natural gas supply would be guaranteed and the price would be passed on to the ammonia consumer, the fertilizer company. The cost of "tolling" would be based on utility type financing, not ammonia market pricing, and would return only financial and operating costs plus a reasonable profit. The BOOT company would guarantee production capacity and efficiency over the contract life of a 10, 15 or 20 year period.

Ammonia tolling concept. Tolling, as herein defined, is the utilization of equipment, support facilities, utilities, labor, etc., owned and operated by one party, to process new material owned by another party, into finished products. The party providing the raw materials will obtain immediate title or ownership to the finished products and will pay a predetermined fee to the tolling party for performing the processing services. The tolling party, in turn, will guarantee the quantity of raw material required to produce one unit of finished product. The tolling party may dedicate the total processing capacity to a single party or to a group of parties. The facilities may be in existence at the initiation of the tolling agreement or new facilities may be constructed.

This tolling concept is ideally suited for the production of ammonia in order to improve the financial position of certain Egyptian fertilizer companies that presently operate old and inefficient ammonia plants. For this concept, a single, new, state-of-the-art and efficient ammonia facility would be constructed to supply ammonia to certain fertilizer companies, which, in turn, would cease production from old and inefficient ammonia units.

The new ammonia unit would be designed, financed, constructed, owned and operated by a new company, the tolling company, in the private sector. This company would process natural gas, the only raw material, into ammonia and guarantee the production capacity and quantity of natural gas required to produced one metric ton of ammonia. The tolling company would charge a predetermined fee for each ton of ammonia, excluding the price of natural gas. This fee would result from a definitive project study performed by the tolling company in order to determine and guarantee the total cost to build, own, and operate the ammonia facility. The cost of this definitive study would be provided by others, not the tolling company. Should the project proceed to construction/operation, the cost of the study could be included in the capital financing and, therefore, return funds to the provider of the study. The estimated cost of such a definitive study would be in the range of $1.0 to 1.5 million.

The natural gas supply must be guaranteed for the project duration of at least 20 years. The cost of the natural gas, either variable or fixed, will be a pass-through to the participating companies receiving the ammonia. The tolling company will be responsible for intermediate storage and loading of the ammonia into transportation vessels.

The responsibilities and ownership of the transportation vessels could be by the participating fertilizer companies or by a newly formed and private ammonia transportation

company. The cost of the transportation vessels could be financed as part of the new ammonia facility and therefore depreciated and included in the predetermined tolling fee. The cost of transportation of ammonia will be the responsibility of the participating fertilizer companies.

In summary, this ammonia tolling concept, if implemented, could immediately create two new private companies, the tolling company and the ammonia transportation company. Additionally. the potential for privatization of the participating fertilizer companies would be greatly enhanced by the financial improvement resulting from a more efficient and economical ammonia supply.

The capital investment for ammonia transport vehicles and the management of transportation activities could be provided by the BOOT tolling company, a new private transportation company, or by participating fertilizer companies.

In analyzing this concept, it is important to structure the BOOT tolling company as a supplier of an intermediate product (ammonia) and not as a competitor in the production of fertilizer products (urea, ammonia nitrate, etc.)

The proposed scenario is to construct a 1,000 MTPD ammonia unit with supply of product:

Company	Location	Supply MTPD
SEMADCO	Suez	300-350
El Nasr Coke	Helwan	170-200
KIMA	Aswan	400-450
Other sales	---------	130-0
		1,000-1,000

The location would be at Suez to facilitate export of ammonium nitrate and ammonia. The design would provide for ease of retrofit to increase capacity for a future urea production unit.

This proposal, if implemented, would have the following major advantages:

- New private sector investment of approximately $200-250 million
- A more economical and reliable ammonia supply, enabling the participating companies to increase fertilizer production and improve profitability
- More efficient use of natural gas as compared to the SEMADCO-Suez I ammonia operation
- Allow for more efficient use of coke oven gas at El Nasr Coke as fuel to produce steam/electricity
- Reduce electrical power consumption by about 220 MW, primarily from KIMA. The substantial economic impact of this is two fold:
  - Avoidance of capital investment necessary for building new, equivalent electrical generation capacity

- Increased electrical sales revenue over current operations of about LE 130 million per year, based on 11.3 PT/KWH

The scenario proposed herein, if implemented, would advance the concept of privatization for participating nitrogen fertilizer companies. The concept is viable but will require a definitive study with respect to construction, operating, and transportation costs.

D2. Phosphate Fertilizer Sub-sector

The technical concept for privatization of the phosphate fertilizer companies is the same as for nitrogen: the candidate company must be profitable or demonstrate the potential for profitable operation. The primary raw material for phosphate fertilizer is phosphate rock or ore concentrate. Usually, profitable phosphate companies are vertically integrated, with both phosphate mining and production of high analysis monoammonium/diammonium phosphate fertilizers. Egypt, however, is unusual in that the domestic market is based on SSP, a low analysis, non-ammoniated fertilizer. Furthermore, the more profitable of the two phosphate producers, EFIC, is not vertically integrated.

Figure II-9 illustrates the 1994-1995 revenue and gross profit for each of the two phosphate fertilizer companies.

Abu Zaabal reported a 1994-1995 gross profit of LE 11 million, while demonstrating a fair performance factor for SSP (74 percent) and poor performance factors for phosphoric acid which, in turn, limited TSP production to only 33 percent of design capacity. Two projects, currently in progress, should make substantial improvement in profitability. These projects, retrofit of the phosphoric acid to achieve 77,000 MTPY and TSP (45 percent P_2O_5) granulation unit for 180,000-200,000 MTPY, are scheduled for completion in 1996-1997. In addition to the implementation of these projects, Abu Zaabal must also restructure its heavy debt burden to be a candidate for privatization.

Contrary to Abu Zaabal, EFIC has little debt, is profitable, and is not an integrated phosphate company. This reflects good management during a difficult phosphate fertilizer period. EFIC (Assiut and Kafr El Zayat) reported a 1994-1995 gross profit of LE 45 million while demonstrating a fair overall performance factor of about 78 percent for SSP. Improved profitability should result from two projects: at Assiut, granulation expansion is scheduled for completion early 1996-1997 and at Kafr El Zayat, a new granulation unit for total SSP production scheduled to be completed within two years. EFIC, with minimum debt and currently profitable, is a candidate for privatization. One point of concern, however, is that EFIC is not vertically integrated. Currently, ore concentrate is purchased from both El Nasr Phosphate and Red Sea Phosphate. Should these companies cease mining operations, EFIC's phosphate supply would be narrowed to only Abu Tartur, which, as projected in the OBI phosphate study, would be more expensive.

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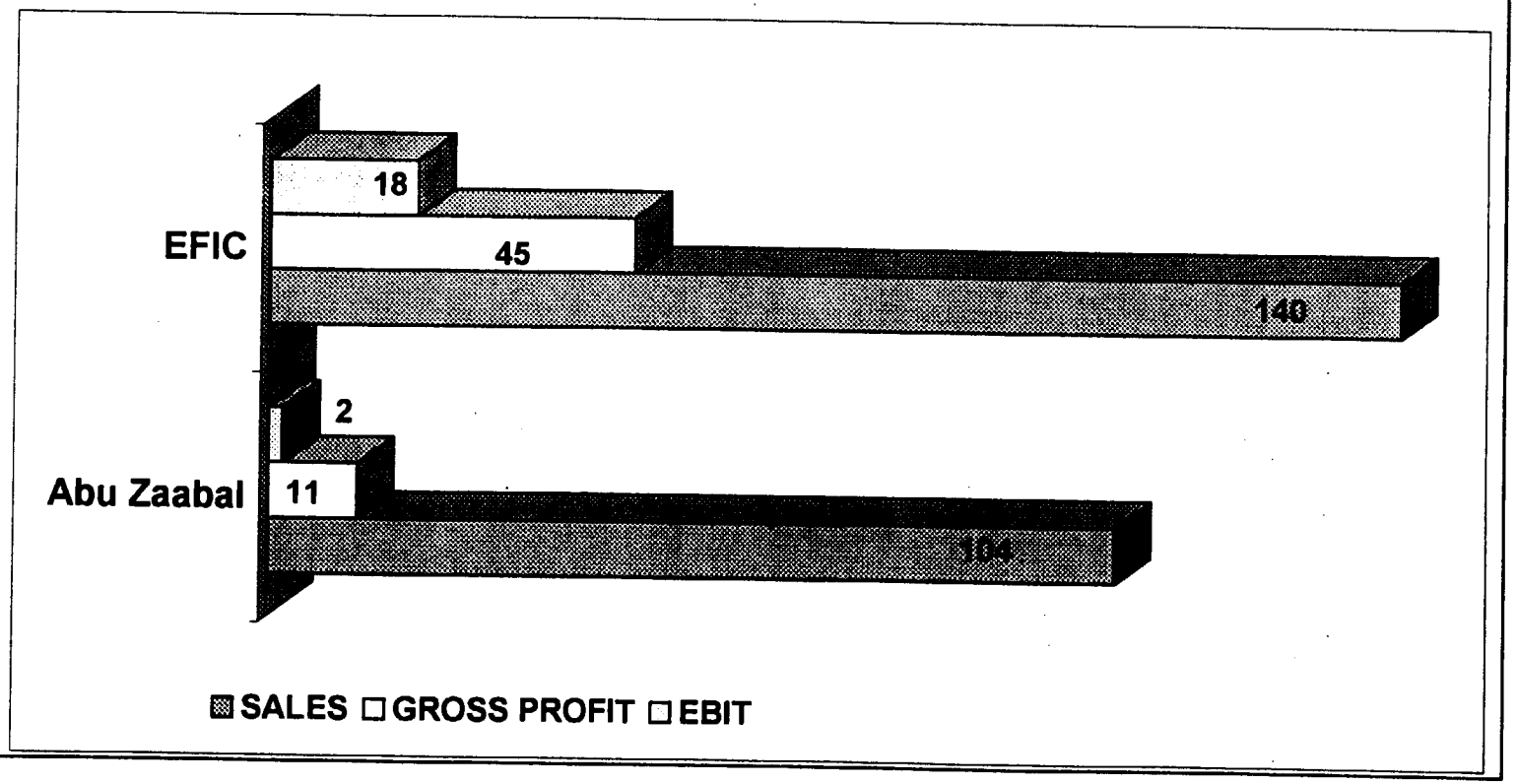
Figure II-9
Phosphate Fertilizer Subsector
Comparison of profitability by Company in LE million as of 1994/95



Recognizing the duplicity of products (SSP) and marketing efforts (domestic and export) and the need for a low cost supply of ore concentrate, a case can be made for consolidation of Abu Zaabal and EFIC. This case would be strengthened should El Nasr Phosphate and Red Sea Phosphate cease mining operations. Abu Zaabal has the potential, with some investment, to supply ore concentrate to all three production facilities. This consolidation could result in the total phosphate fertilizer industry being privatized at one time as opposed to a stepwise procedure, in which the private and public sectors could be competitors.

E. Comments and Recommendations

General. On December 17, 1995, the Chemonics study team conducted a seminar for officials of USAID and GOE. The purpose of this seminar was two-fold: to discuss the data and information of the pending study report and to elicit comments and questions concerning this report.

In addition to the comments and questions presented by other attendees, a list of 15 questions was presented by the Minister of Public Enterprise, Atef Obeid. This verbal list was accompanied by a request that responses be included in the Chemonics report. Only two questions were applicable to technical issues: identification of rehabilitation projects and costs and new plant costs. Answers to these questions will require implementation of the studies described in the recommendations that follow. The list of questions and a response for USAID's consideration in replying to the minister is included as an annex to this report.

Attendee comments regarding the Chemonics presentation were very favorable, including responses to the primary recommendation for a new ammonia facility at Suez to replace three old and inefficient units.

E1. Nitrogen Fertilizer Sub-sector

The recommended approach to efficient and profitable nitrogen fertilizer production is a four step process:

- Existing facilities must achieve a high degree of on stream reliability (320-340 DPY)
- Existing facilities must achieve design production capacity
- Existing facilities must maximize process efficiency
- When the above three goals are achieved, production should be increased by a major retrofit (up to 20-30 percent) or by new facilities.

Benefits of improved process efficiency will be lost by failure to achieve design production capacity or operational reliability.

In planning for debottlenecking or expansion, pollution abatement must be emphasized in order to minimize product losses, prevent environmental damage, and reduce potential liability for future cleanup. The effects of integrated operations must be considered during the design phase. An example is the recovery of ammonia as aqua from ammonia synthesis purge gas, which, in turn, is fed to the ammonium nitrate neutralizer, which dilutes the solution and increases both the evaporator steam load and quantity of contaminated wastewater. A more efficient method would be the steam stripping of aqua and recycling the water and recovery of the ammonia as product.

Table II-3 details the production capacities and performances for each nitrogen fertilizer company. These statistics show that all operations, with the exception of Abu Qir, experienced reduced performance resulting in substantial unutilized production. The primary cause was an insufficient and unreliable ammonia supply.

Announced plans for retrofit and expansions are as follows:

- Abu Qir—new facilities for ammonia and urea
- SEMADCO (Talkha)—retrofit of Ammonia I; energy efficiency for Ammonia II (hydrogen recovery and cogeneration)
- SEMADCO (Suez)—retrofit of Ammonia I; new facilities for ammonia and urea
- El Nasr Coke (Helwan)—new facilities for ammonia, nitric acid and ammonium nitrate
- KIMA (Aswan)—status quo due to lack of viable option for onsite ammonia production

Excluding Abu Qir, the announced plans do not detail or emphasize efforts to achieve design capacity or abate pollution. Also, recommendations regarding new ammonia production, if implemented, would have a substantial effect on these plans and, in some cases, lead to cancellation. Therefore, these plans should be reviewed in conjunction with this report and the recommendations included herein.

In summary, the following recommendations are presented regarding nitrogen fertilizer production:

New ammonia production. A two part study should be conducted to prove the economics and viability of a new 1,000 MTPD ammonia production facility to replace the old, inefficient ammonia units at SEMADCO-Suez I, El Nasr Coke, and KIMA. This facility would be privately financed under the build, own, operate toll (BOOT) concept.

A study should be conducted to determine the costs of supply, construction, and operation in order to establish a long-term, fixed FOB price per MT for ammonia-less natural gas. The scope of the proposed study should include:

- Economic impact of project overall and on each participating fertilizer company
- Development of ammonia distribution network, including private sector investment and operation

This study is required for privatization of the three operations identified above.

Rehabilitation/pollution abatement. A study should be conducted regarding major rehabilitation and pollution abatement at each nitrogen fertilizer operation, except Abu Qir. The scope of work would be to identify sources, design abatement, and determine project costs and methods of funding. This study is required for privatization.

SEMADCO (Talkha) retrofit program. A study should be conducted to evaluate and redesign the SEMADCO (Talkha) Debottlenecking project for more efficient operation and reduced investment. This study is critical to the profitability of this company and key for privatization.

The proposed redesign would incorporate a complete, currently erected, 525 MTPD ammonia synthesis loop (170 bar), including centrifugal syn gas and refrigeration compressors with spare rotating elements. Included in this facility is a nitrogen wash unit for removal of argon, carbon oxides, methane and excess nitrogen from synthesis makeup gas (MUG). This "nitrogen washing" provides an essentially pure hydrogen/nitrogen ratio MUG that minimizes synthesis loop purging and eliminates the necessity of hydrogen recovery. This unit would also take the synthesis loop purge from Talkha II and eliminate the investment in a hydrogen recovery unit.

The centrifugal synthesis and refrigeration compressors are currently electrically driven. Conversion of these compressors to high pressure (103 bar)/extraction (43 bar) steam turbine drivers would reduce and possibly eliminate the proposed steam turbine electrical generation and provide for more efficient steam consumption.

E2. Phosphate Fertilizer Sub-sector

The recommended approach to efficient and profitable phosphate fertilizer production is the same as described above for nitrogen fertilizer producers. Phosphate producers also suffer from substantial unutilized capacity. For phosphate producers, however, the problem is a slowly recovering domestic market, coupled with the challenge of developing export markets. Table II-4 details production capacities and performances for each of the phosphate fertilizer operations.

Announced plans for retrofit or expansion are as follows:

- Abu Zaabal—retrofit of phosphoric acid and new granulation unit
- EFIC (Assiut)—expansion of granulation capacity
- EFIC (Kafr El Zayat)—expansion of curing storage and new granulation unit

These plans, if implemented, should provide the ability to achieve design capacity and product quality necessary for export. However, these plans do not emphasize pollution abatement.

In summary, the following recommendations are presented regarding phosphate fertilizer production:

Pollution abatement. Studies should be parried out regarding pollution abatement at each phosphate fertilizer operation. Scope of the studies would be to identify sources, abatement design, and determine project cost and funding methods. These studies are necessary for privatization.

Consolidation of Abu Zaabal and EFIC. A study should be conducted regarding the consolidation of Abu Zaabal and EFIC. The purpose of this study would be to evaluate the economic viability of a single consolidated company as compared to two individual, competing companies. This study is also necessary for privatization.

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SECTION III

DEMAND FOR NITROGEN IN EGYPT

SECTION III
DEMAND FOR NITROGEN IN EGYPT

A. Introduction and Background

To understand the fertilizer economy of Egypt, it is necessary to begin with two basic observations:

- Under Egypt's former policy of universal credit and subsidized prices, the quantity of fertilizer used by Egyptian farmers grew dramatically between 1970 and 1991. Nitrogen application rates rose to be among the highest in the world.

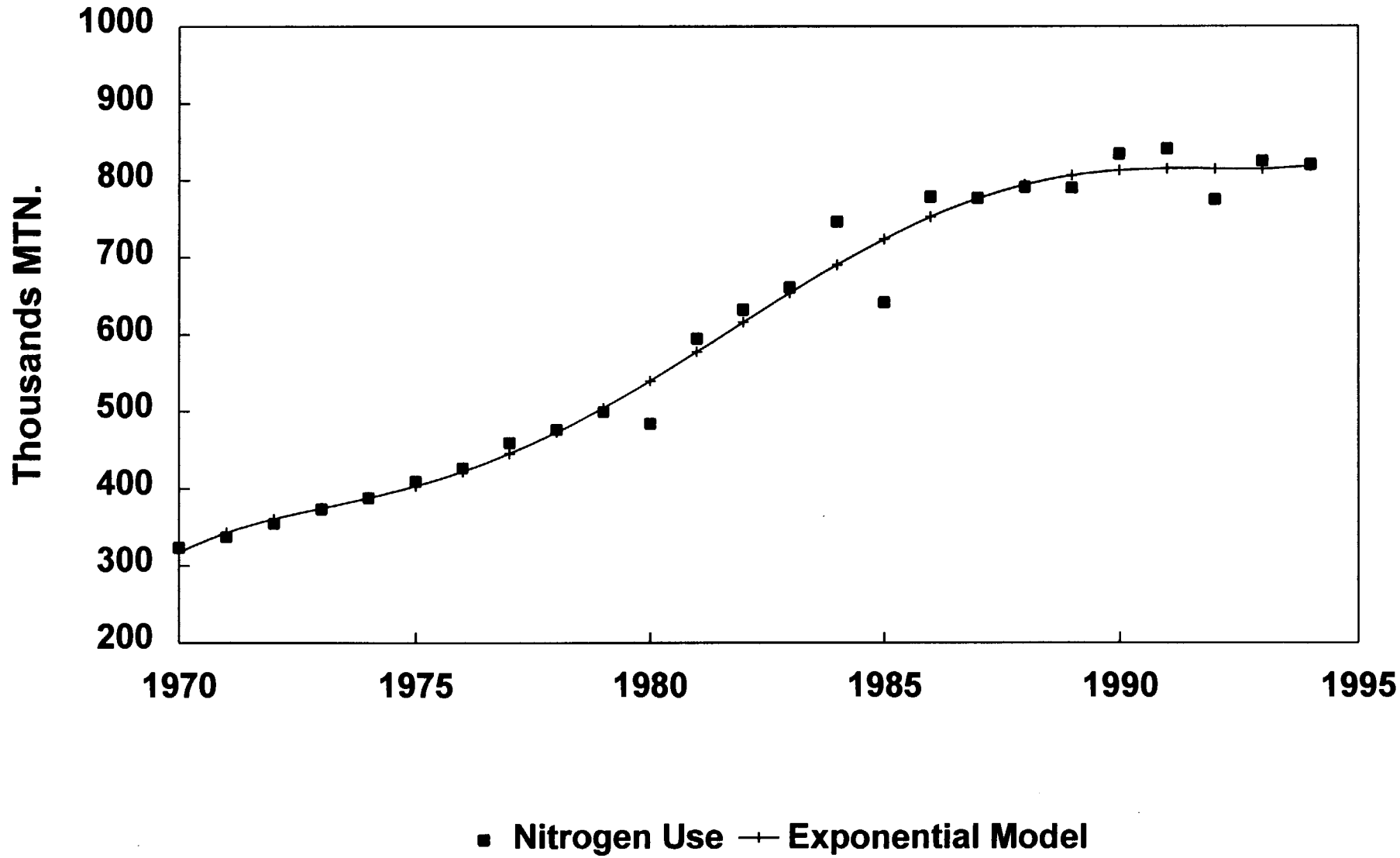
- The current liberalization program in Egypt has meant reduced state control of agricultural inputs and outputs. Until a policy reversal in 1995, fertilizer was for a time sold at world prices. It is now sold on a cash basis to farmers.

It is also necessary to take into account the fact that environmental concerns have forced many high-use countries to reduce fertilizer use. Environmental concerns have generated research to reduce nitrogen needs, representing a departure from the green revolution period which saw an emphasis on increasing nitrogen use. Plant breeders are searching for varieties that use fertilizer more efficiently. Plant nutritionists are researching methods of using nitrogen fixing organisms to reduce the need for nitrogen application. Fertilizer producers are delivering liquid and foliar fertilizers that are less polluting, and micronutrient researchers are finding ways to improve macronutrient uptake. The result of all these efforts is increased production with less fertilizer. We see the fruits of this work in Table III-1. Japan, France, Germany, and the Netherlands have all reduced fertilizer use substantially, in the range of 13 to 40 percent, while increasing yields during the period from 1984 to 1994.

It is also interesting to look to former centrally planned economies for examples of the impact of liberalized agricultural policies on fertilizer use. As Egypt moves to greater reliance on market forces in its economy, lessons may be learned from countries that have followed the same path for evidence on fertilizer use. Planned economies were characterized by the easy availability of fertilizer. Quantities used were set by central authorities, and application carried out by farmers who did not have responsibility for their farms. When these economies liberalized, the results were predictable. Fertilizer use plummeted, with yields following. However, yields dropped less dramatically than fertilizer use because farmers increased their efficiency. As seen in Table III-1, Bulgaria's fertilizer use dropped by 77 percent while yields fell by 32 percent. Hungary's consumption plummeted by 90 percent while yields dropped by a more modest 22 percent.

The challenge of the current study is to predict future fertilizer consumption under very different circumstances than have prevailed in the past. Egypt exhibits two characteristics that often lead to reduced fertilizer use in countries: high application rates and market liberalization after years of centrally planned agricultural production. Figure III-1 clearly demonstrates the current reduction in the growth rate of fertilizer use. The question to be answered is the following: does the flattening off of fertilizer use imply a future of stagnant fertilizer sales, as in many other high use countries, or does this time period represent a temporary period of adjustment to new forces at work in the agricultural sector?

Figure III-1. Exponential Model
For Nitrogen Consumption



Source: IFDC EFDC and PBDAC
Exponential model to the fifth power

Table III-1. Cross Country Comparison of Fertilizer Use

Country	Nitrogen kg/ha		Cereal Yield kg/ha		Total Fert/ha	
	1984	1994	1984	1994	1984	1994
Low Use Countries						
Algeria	6	9.4	623	726	20.3	16.6
Morocco	10	13.	825	1606	24.5	29.2
Chile	15	45.8	2704	4489	32.1	90.4
Colombia	28	48.9	2552	250	58.2	94.3
High Use Countries						
Japan	157	134.4	5353	6449	470.0	407.1*
Israel	108	101.1	1738	1729	193.1	225.2*
Korea N.	291	312.5	4237	3237	395.5	391.5*
Korea S.	195	254.1	5512	5808	382.5	518.9
France	119	111.4	5977	6554	300.0	237.2*
Germany	172	132.2	4710	5721	378.5	220.5*
Netherlands	511	400.4	7156	7983	730.1	559.9*
USA	53	61.0	4378	5572	87.4	108.3
Ex-Planned Economies						
Bulgaria	127	41.7	4159	2814	234.1	54.0
Hungary	125	28.9	5138	4027	307.2	39.6
Egypt (Cultivated area)	99	157.3	3650	5420	161.	184
Crop area	185	291	3650	5420	300	343

* Countries exhibiting an inverse relationship between fertilizer use and cereal yield: rising yields and falling fertilizer use or falling yields and increased fertilizer use.

Source: FAO Production Yearbook 1984-1994
Note: the FAO standard is to report countries' physical crop area plus permanent cultivation. This understates Egypt's land use as it does not take into account multi-season cropping. As a result, per feddan application rates are overstated.

This section concentrates on demand in Egypt for nitrogen fertilizer for two reasons: first, it was the shortage in nitrogen fertilizer that provoked the recent reversal in government policy; secondly, nitrogen fertilizer is the fertilizer that is most used, indeed overused, and hence is the one with the most room for improvement. One measure of nitrogen fertilizer overuse is a run-off of nitrates, a phenomenon with serious health implications.

B. Considerations in Projecting Future Demand

When speaking about production, economists use three concepts: allocative efficiency, technical efficiency, and economic efficiency. Allocative efficiency is simply using the cheapest combination of inputs to produce a given output. Technical efficiency means that producers are

using the best techniques of production given existing input prices. Economic efficiency is the combination of the two and is usually measured by profit.

Some aspects of fertilizer demand can be explained by basic economic theory. When the price of a good goes up, less is used. As subsidies were removed from fertilizer and credit was no longer automatic, Egyptian farmers acted as theory predicts: they used less. While this is no surprise to economists, it may be so to those who see fertilizer demand as a function of nutritional requirements. Fertilizer use, however, should not be seen simply as a physical/ nutritional relationship between input and output. In a market economy, fertilizer use is mainly determined by economic factors. Farmers have various options open to them when deciding how much fertilizer to apply. Those options include adjusting agricultural practices to replace fertilizer with labor. Under the stimulus of higher prices, farmers increase their fertilizer efficiency, using more labor and less fertilizer. Inversely, low fertilizer prices will induce a replacement of labor by fertilizer, sometimes beyond recommended levels.

When the price of fertilizer increases, farmers react in three ways: by using less on existing crops, using what they do buy more efficiently, and selecting crops with a better financial return to purchased fertilizer. Depending on the relative prices of land, labor, and fertilizer, farmers may also substitute land for fertilizer. Agricultural practices change with rising fertilizer prices in a predictable way. The response to higher fertilizer prices is shown in Figures III-2 and III-3, which illustrate the case for labor- and capital-intensive agriculture. In the former case, labor is substituted for fertilizer as fertilizer prices rise relative to labor costs. In the latter case, capital is substituted for fertilizer.

Using labor to replace fertilizer follows a fairly predictable pattern. The exact order of changing practices varies with different agricultural systems and labor costs, but in a labor-intensive system, the following changes are widely observed at the farm level:

Changing Labor Use

- Broadcast seeding is replaced by row seeding
- Broadcast fertilizer gives way to side dressing
- Weed control is improved
- Single fertilizer doses are split into two or three
- Fertilizer is incorporated into the soil, not left on surface
- Farmers adopt composting practices

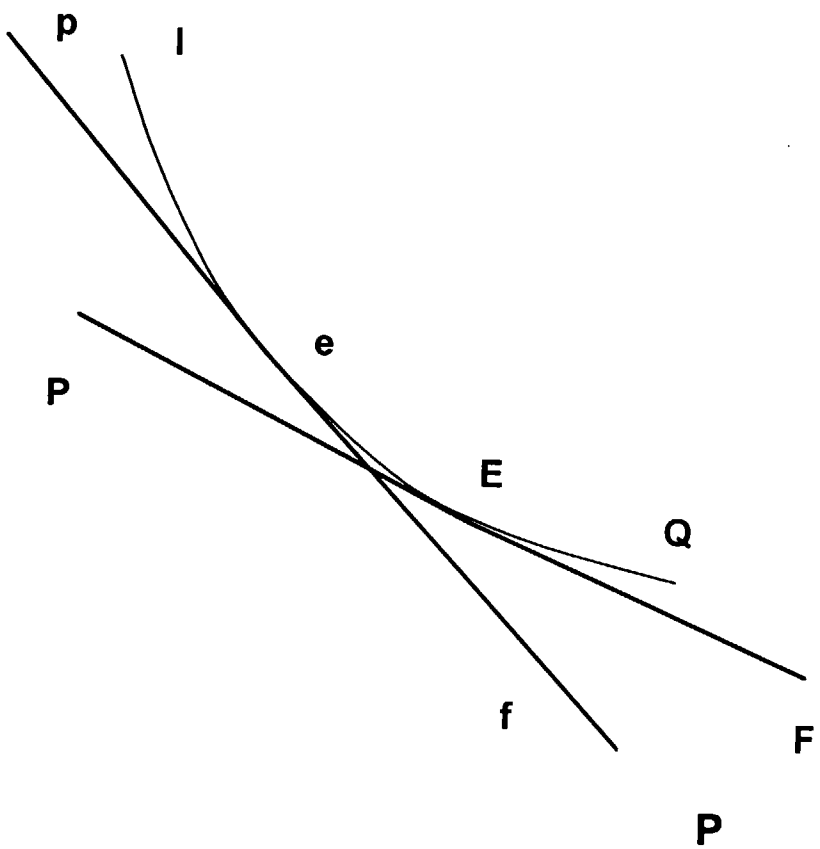
Changing Cropping Pattern or Technology

- Farmers intercrop nitrogen fixing crops or include in rotation
- Crops with deeper root systems tap fertilizer at lower levels
- Inoculation with nitrogen fixing bacteria (mainly for soya beans)
- Micronutrients are utilized

Changing Irrigated Agriculture

- Water is applied directly after fertilizing
- Excessive irrigation is eliminated
- Incorporation of liquid fertilizer into drip irrigation

Figure III-2. Labour/Fertilizer Tradeoff



Price line=PF & pf

Slope=price fertilizer/ price labour

E=equilibrium at price PF

e=equilibrium at price pf

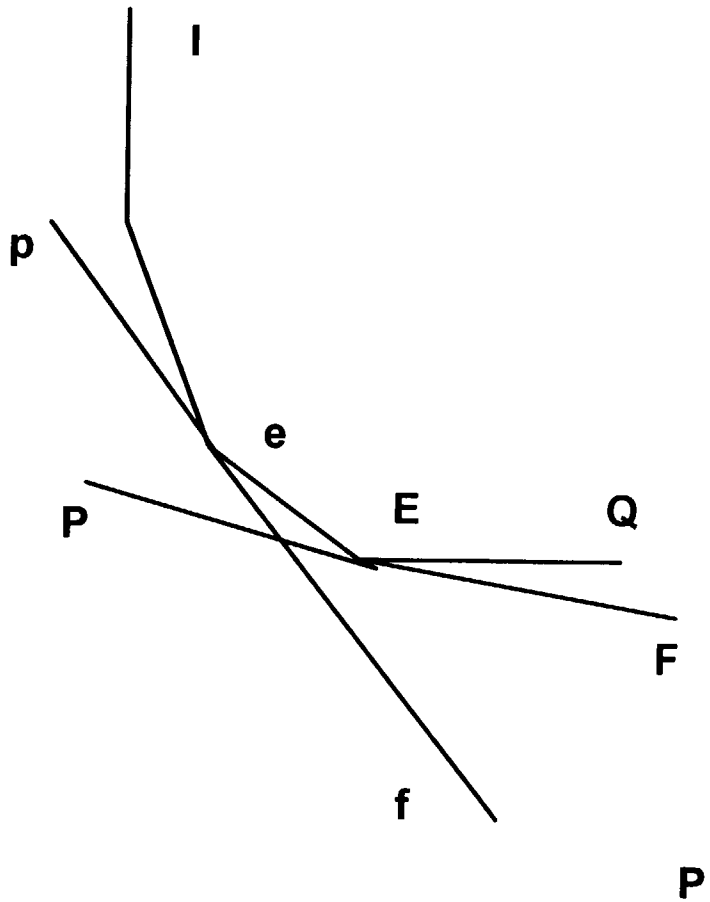
Labour for fertilizer

Slope IQ=substitution of labour for fertilizer

Maize yield 2500 kg/fed

Illustrative data
Fertilizer price rises from PF to pf
Fertilizer use falls from 45 to 30 kg

Figure III-3. Capital/Fertilizer Tradeoff



Price line=PF & pf
Price fertilizer/Price capital

E=equilibrium at price PF
e=equilibrium at price pf

Slope IQ=Rate of Substitution
Capital for fertilizer

Maize yield
2500 kg/fed

Illustrative data
Fertilizer price rises from PF to pf
Fertilizer use falls from 45 to 30 kg

In adopting these techniques, farmers move up the labor/fertilizer curve, maintaining yield by substituting labor for fertilizer. These changes can have dramatic impacts. Incorporation of urea in the soil has shown yield increases of 25 percent in rice.[1] As the research at the Botany Department of the Egyptian National Research Center has shown, there is a massive loss of nitrogen in the application of nitrogen fertilizer to maize and cotton. In the case of maize, the loss is equivalent to 10 percent of all nitrogen applied in Egypt. (See Annex G by Dr. El Fouly et al.) Hamissa reports that splitting nitrogen doses can increase yields from 10 to 17 percent depending on the crop and number of applications.[2] Wheat farmers in the delta are experimenting with a lentil-wheat rotation sown in orchards, which is reducing the need for nitrogen application by 30 percent.

C. Summary of Conclusions

The use of fertilizer cannot be seen as merely a question of fixed technical coefficients but must include consideration of the management decisions of farmers. The factors of prime importance are the relative price of inputs, fertilizer, land, and labor as well as farmer awareness of improved practices. Demand projections made in absence of such information are likely to be valid only as long as the environment within which the farmer operates remains unchanged.

Another trend, seen in the behavior of European farmers who are heavy fertilizer users, is the long-term reduction in nitrogen use. This is due to many factors. Increased international trade, greater competition, and reduced subsidies are all depressing fertilizer demand. Stricter environmental controls also explain part of the fall in European fertilizer use. When environmental controls are put in place, the result is a relative increase in the cost of using fertilizer. Looking at Figure III-3 once again, we see that as the cost of using fertilizer increases, European farmers use more capital and less fertilizer. This may involve such expenditures as liquid fertilizer tanks and injectors or foliar sprayers. A similar choice faces large mechanized Egyptian farmers. This curve is not smooth as there are fewer options for technical substitution.

As the next figure illustrates, Egypt also must come to terms with environmental concerns. Figure III-4 shows that poisonous nitrates leak into drinking water as fertilizer runs off the fields. When fertilizer run-off causes harm to the community, the social cost should be added to the cost of fertilizer. The price of nitrogen should include all its costs, which include the direct costs of production and distribution as well as the indirect costs of pollution. This problem of environmental damage from heavy fertilizer use can be addressed three ways: through regulation to enforce compliance with safe water standards (in Egypt, Article 38, Public Law 4, 1994); the imposition of a tax that forces producers to limit applications to levels that do not harm fellow citizens; or fines levied on producers in proportion to their run-off. The latter is probably the most efficient economic mechanism, but requires sophisticated monitoring mechanisms. In Egypt, higher prices will most probably be the means by which farmers will be forced to be more efficient in their fertilizer use.

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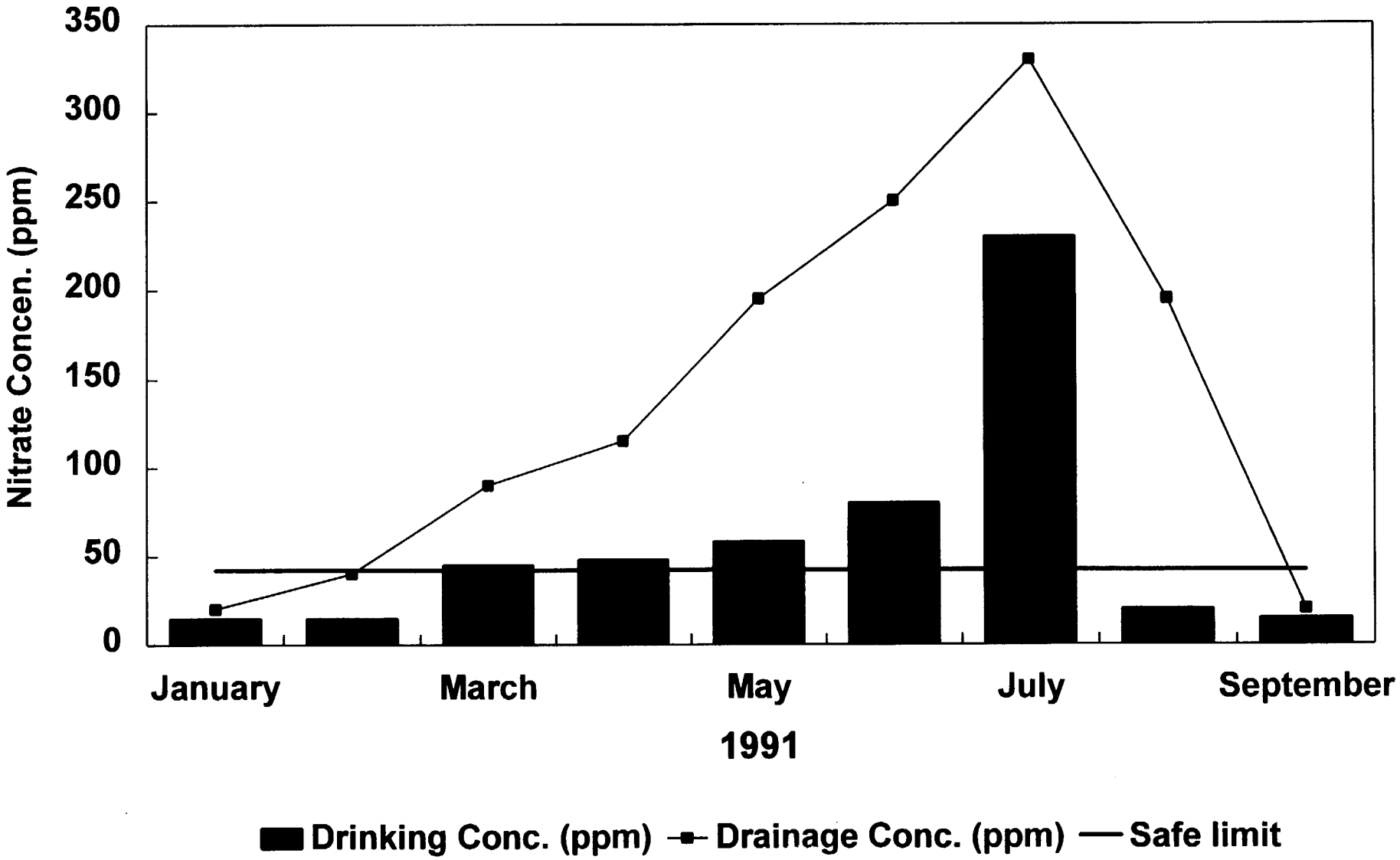
[1] FAO, 1972, Soils Bulletin #6. Rome p.42.

[2] Hamissa M.R. and Serry A. El-Mowelhi, 1991. Fertilizer Policy in Egypt: Soil and Fertilizer Policy II. Ministry of Agriculture, Agriculture Research Center, Soils and Water Institute, pp. 46-53.

Figure III-4. Nitrate Concentration in Sharkia

Agricultural Drainage Water and Ground Drinking Water



Source: El-Fouly & Fawzi (see Annex G)

In conclusion: taking higher fertilizer prices into consideration, farmer management options, the direction of agricultural research and environmental concerns, we expect fertilizer use to stabilize or even continue to decline in Egypt until the end of the century. As is clear, GOE policy will be a major factor.

D. Current Policy, Winter 1995-1996

The current policy of winter 1995-1996 is an attempt to control prices, not only at the factory but also those paid by the farmer. Farmers are rationed by the coops or PBDAC according to an assessment of their needs. Figure III-5 illustrates this situation. The starting point is the demand and supply lines. Prices are fixed at 27 LE/bag for urea. This is below a market clearing price. Farmers are allocated fertilizer, reducing the level of demand by the amount farmers have received (at 27 LE, some farmers would like to use more than is available). The new demand is Demand II. Those farmers with fertilizer who put a lower value on it than 26 LE will sell it to those who place a higher value on the fertilizer. OC-OB represents this quantity of fertilizer. This quantity is then sold on the market and is represented by the quantity OA. The resulting price is difficult to predict as the nature of the demand curve is not precisely known. Also, as the fertilizer has been given out in portions, farmers are not sure how much they will receive. This will initially limit the quantity for resale. We should expect to see high prices in the beginning, which fall as the quota is distributed.

In November, the survey team found that each farmer had received two bags of fertilizer and was about to receive two more. There still existed a private market for fertilizer. For the most part, this market functioned because traders bought fertilizer from a farmer who placed more value on cash than on the fertilizer. The trader then resold to farmers who put a higher premium on fertilizer. It was also possible for distributors to import and sell to their clients. As the survey took place in November, there were only a limited number of observations for the distribution of purchases of urea for wheat in 1994 and 1995. This information is presented below in Table III-2:

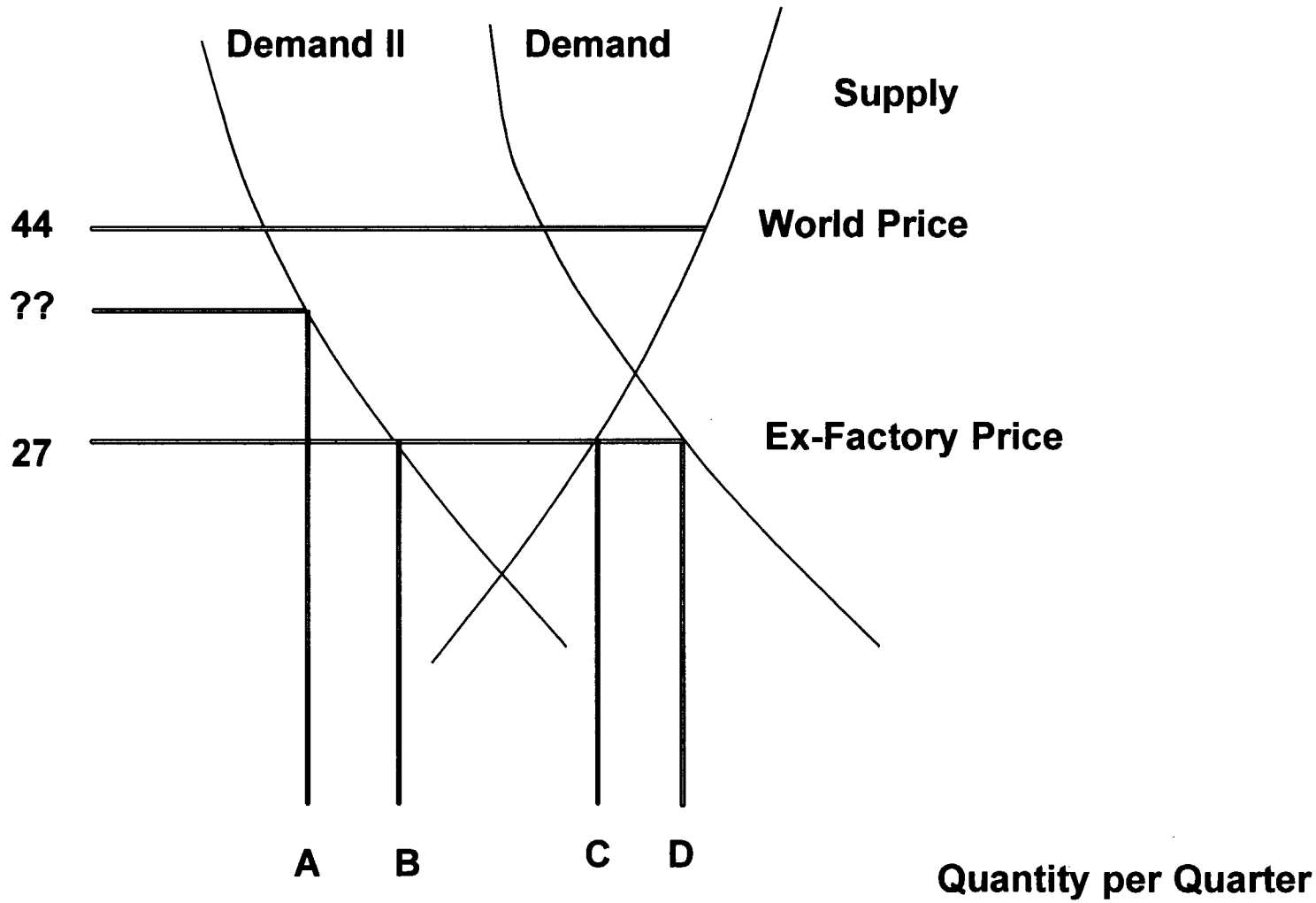
Table III-2. Urea Purchases for Wheat 1994-1995 - 1995-1996

	PBDAC	Private Merchant	Cooperative
Price/bag	(LE/ 50 kg.)		
1994	25.9	27.7	26.6
1995	26.4	48.5	26.5
Quantity Purchased Percent			
1994	28	37	35
1995	85	14	1

Note: in 1994, n=134; in 1995, n=45.

Figure III-5. Supply and Demand for Urea Under Rationing

Price of Urea/LE per 50 kg



As is apparent, the role of the private merchant is much diminished. While merchants' prices remain above the world price, the policy has had the effect of reducing overall fertilizer cost to the farmer compared to the prices paid for urea in the summer of 1995. The merchant acts as a mechanism, transferring fertilizer from farmers who do not need or want their allocation to those who do. It would be interesting to know how much the farmer/seller receives from the merchant, but no information was collected on this point.

Farmers in November 1995 were paying on average LE 32.7/bag for urea (using both sources). Current (Dec 1995) world prices are $230 FOB (LE 38 ex-factory, Egypt). Egyptian officials involved in fertilizer policy decisions with whom the team met expressed concern over the fact that higher prices would enrich wealthy fertilizer producers at the expense of the poor farmer. This is a valid concern, stemming from complex political and economic issues. Policy makers must decide if farmers are better off under a controlled or market economy for fertilizer. Trying to mix the two systems can lead to the problems of 1995, when attempts to protect farmers actually made them worse off.

E. The Role of Prices in Government Intervention

The debate on government intervention centers on the role of prices as indicators of scarce goods. High prices indicate relative scarcity. The following are important factors to bear in mind.

- Farmers in Egypt use too much nitrogen fertilizer and higher prices will force more efficient use.

- Since liberalization, farmers have followed price signals; as a result, efficiency has risen. To the extent that the survey data was analyzed, there are indications that income has risen as well. High prices for nitrogen forces farmers to use this scarce resource with care. A cheaper alternative exists in the form of additional labor and/or different crop rotations and/or micronutrients. In time, the environmental costs of fertilizer run-off will be reduced with more efficient application methods.

- World scarcity allows Egypt to earn high prices for its fertilizer exports. The increased export earnings allow Egypt to import what it cannot efficiently produce, thus improving economic well being.

- Prices below world levels reduce investment incentives in fertilizer production, eventually causing shortages and high-cost production. This leaves farmers worse off.

- Governments worried about transferring income from the poor to the rich should address the situation through taxation of profits rather than by setting prices.

- Prices that reflect peak season demand and off season surplus provide an incentive for storage of fertilizer.

When farmers were asked to list their paramount difficulties of the 1995 crop year, 90 percent named fertilizer availability. Only 10 percent named price as their most serious problem.

E1. Fertilizer Security

The GOE is concerned that a free market would put farmers at risk. The Egyptian fertilizer market exhibits a seasonality that does not exist in the world market. This creates both opportunities and problems. Low sales in September, October, and February through May permit exports, and also the building up of stocks for the summer planting season, June through August. In 1995, a combination of unrealistic production targets and plant shutdowns meant that too much fertilizer was exported. The resulting shortage led to the return to monopoly control of fertilizer by PBDAC. Was this an example of market failure? Are the underlying conditions of Egypt such that a similar situation is likely to occur frequently? Is a government policy necessary to ensure adequate supplies or can the market mechanism be relied upon to provide the needed quantities?

Such questions are related to a larger issue: What is the relationship between consumption and production capacity? If use is low relative to capacity, then little storage is necessary. The factories can supply local needs from current production. This is the case for phosphorous fertilizer, where there is no need for large stocks of phosphorous (this will be even more the case when Abu Tartur comes on full production). It is also the case for potassium, which is all imported and thus poses no conflict between exports and local needs. If annual production and annual use are equal, then all quantities produced in the low season and not immediately consumed must be stored for use in the high season. Table III-3 below illustrates this issue. We are forced to return to a fundamental question: what is the "need" of the farmers for fertilizer?

It is the view of the study team that consumption will normally lie within a range of 700,000 to 800,000 tons per year (under a liberalized price regime), with cyclical factors occasionally pushing demand to 850,000. Production capacity exceeds this by a substantial amount. Actual production reached 900,000 tons in 1990, while planned additional capacity will generate 1.2 million tons N. This implies a production capacity that is 50 percent greater than needs. This is the top line in Figure III-6.

The table below is based on monthly sales by PBDAC in 1990-1991. To the extent that cropping patterns have changed, the figures will need modification. This figure could be presented as nitrogen product by product, but as the product mix is changing (calcium nitrate, for example, has largely been replaced by ammonia nitrate since 1990-1991), total nitrogen needs are used.

Table III-3. Monthly Nitrogen Production Short Falls
Various Scenarios
(Negative Numbers Only)

	Percent Of Annual Use	Prod=Cons At 800,000 Tons N. *	Prod Exceeds Use ** Prod.=900,000 Cons.=800,000	Production After Abu Qir III *** Prod.=1,200,000 Cons.=800,000
July	14	-45.6	-37.3	-12.4
Aug.	7.3	8	16.3	41.2
Sept.	4.95	26.8	35.1	60
Oct.	4.05	34	42.3	67.2
Nov.	8.25	0.4	8.7	33.6
Dec.	10.25	-15.6	- 7.3	17.6
Jan.	7.85	3.6	11.9	36.8
Feb.	8.6	-2.4	5.9	30.8
Mar.	7.75	4.4	12.7	37.6
April	6.1	17.6	25.9	50.8
May	10.1	-14.4	-6.1	18.8
June	10.75	-19.6	-11.3	13.6

Source: IFDC Fertilizer Policy Impact Study. Negative numbers are the months when consumption exceeds production..

* Production and consumption are equal at 800,000 tons N per year

** Assumes production of N at 900,000 per year and consumption at 800,000

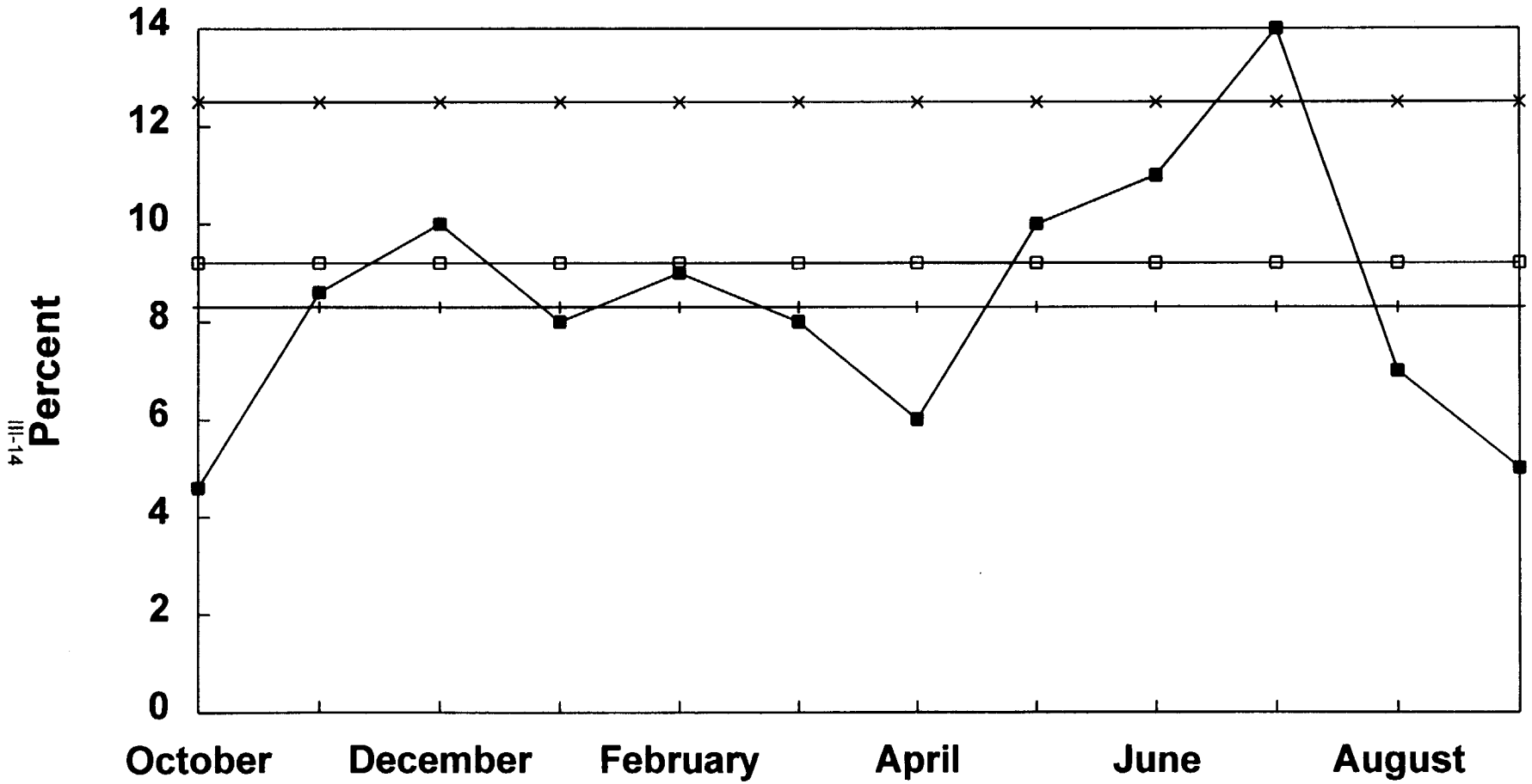
*** Production at 1.2 million and consumption at 800,000

As is apparent from Table III-3, the problem of storage disappears in 1998-1999 when the 2000 MTPD line comes on at Abu Qir. Only 12,000 tons more will be needed than current production in July. Until that time, storage is necessary. Under the scenario where production and consumption are equal at 800,000 tons, all production must be stored. IFDC[3] found that monthly storage costs, including interest at 17 percent per year, was 2.5 percent of the ex-factory price. This will add 15 percent to the cost of peak season fertilizer (six months *0.025). If the second scenario holds true, then storage needs are much less. Peak season fertilizer would bear an 8.75 percent storage costs in this case where production exceeds consumption by 100,000 tons.

A problem might arise if storing fertilizer requires a lower off-season purchase price than the producer could earn if it were sold on the world market. There is, however, another possibility. If distributors are free to seek supply anywhere in the world, if, in other words, domestic and foreign suppliers compete for Egyptian fertilizer orders, it may make economic sense to export during the slack period and import before the peaks. The conditions for this to be economically viable are that the opportunity cost of capital tied up in financing storage exceed the

[3] IFDC, op. cit. p. 58.

Figure III-6. Percent Distribution of Nitrogen by Month



Distribution N. Prod N.=needs Prod N.>Needs by 10% Prod N.>needs by 50%

EFDC data from PBDAC
Based on 1990/91 crop year

transaction and transportation costs of the fertilizer imports. The physical capacity of the port and bagging facilities must be taken into consideration before this policy option is adopted. In the current situation, we take urea and ammonia nitrate as examples.

Table III-4. Import Versus Export Prices

	Export Price FOT LE/Mt	Import Price C&F	Difference	Storage Cost *	Storage Cost **
Urea	745	850	105	112	65
Ammonia Nitrate	454	529	75	68	40

Prices as of 12-95
* Production equals consumption, storage cost= 15 percent* FOT
** Production exceeds consumption by 100,000 tons/year, storage cost=8.7 percent*FOT

If such prices prevailed when ordering for the peak season, a distributor would find it in his interests to store rather than import, except perhaps in the case of urea where storage would be 7 LE greater than importing. This is unlikely to be a large enough difference to cover the foreign exchange risk of importing fertilizer.

Were Egyptian market prices to equal world prices, there would not be a problem of peak season shortages. The room for price negotiation between producer and distributor is such that both will be better off in the domestic market than in the export market. Taking the latter case, where ammonia nitrate production exceeds domestic needs, distributors would be willing to pay up to 489 (529-40) and the producer would be willing to accept anything over 454. Through bargaining and competition, the price should lie between these two levels, making both sides better off.

E2. Export Quotas in the Future

If the government wishes to restrict the quantity exported, it should not interfere in domestic price formation. The quantity of exports should create the conditions of supply such that the domestic price equals the border equivalent price. In the slack months, supply can be reduced through exports so that local demand and supply conditions generate prices that are lower than world level prices by enough to encourage adequate storage for the peak months. In the months when demand exceeds production plus storage, then the rate of imports should keep domestic prices at world levels. This requires detailed information about demand conditions and is not an easy task for planners to accomplish.

As mentioned above, the current method of determining export levels needs examination. Producers now set target production figures and are allowed to export 20 percent. A system that limits monthly exports to a percentage of the last two years production (adjusted conservatively for new capacity) would limit the temptation of factories to overstate their targets. This system has the advantage of reducing the foreign exchange risk associated with increased exports and imports. It does, however, run the risk of creating a two tiered market if the balance between

exports and imports is such that the domestic market price is substantially less than the export price.

Whatever policy is adopted, adequate stocks must be kept on hand for the first five years as the various participants learn the market. These stocks will be turned over semi-annually and should be seen as a seller of last resort. The prices charged for reselling this fertilizer should be replacement cost, at world prices. This stock can also act as a means of preventing monopoly prices. The stock can be managed by PBDAC or a tender might be let by the government where private firms would bid to manage the stocks. The fee would not be much more than storage costs. It simply means the government bears the cost of storage, but does not interfere with the price mechanism.[4]

In a situation in which domestic prices are below international prices, unauthorized exports may occur. In such a case, everyone but the illicit traders lose. The factories do not get the true value of their production, and the farmers pay prices that exceed border equivalent prices (for a portion of their needs). Profits for dealers are squeezed by reduced volume and limited purchasing power. It must, however be stated that the volume of unauthorized exports is not known. Please see Annex F in the annex volume in a fuller discussion of these issues.

F. Other Fertilizers

F1. Phosphorous Fertilizers

The demand for phosphorous fertilizer did not receive a great deal of attention by the study team. A major industry study was completed in early 1995[5] and its marketing findings were tested by the team. That study examined the worldwide decline in phosphorous use and claimed that farmers had learned, despite agronomic advice, to reduce phosphate application both absolutely and relative to nitrogen. The study documented the decline of phosphate use in Egypt from 190,000 tons P_2O_5 in 1990 to 120,000 in 1994. They concluded that the decline had leveled out and recovery in use was expected to resume.

The survey carried out by the study team found a continued decline. Comparing the summer crop of 1994 to the 1995 season, the consumption of single superphosphate (SSP) dropped from an average of 6.9 bags per farm (1.9 bag/fed.) to 5.4 (1.5 bags/fed). This drop of 22 percent in use occurred as prices rose 18 percent, from LE 11.7 per bag to LE 13.7 per bag. This is counter to the sales figures for the country as a whole (see below). Farmers reported no difficulties obtaining SSP nor were there any complaints about the price. The decease could have been due to the price hike as well as to the dramatic increase in nitrogen prices which left farmers with less cash for phosphate fertilizers. Triple superphosphate was used by only one farmer out of 300 who paid LE 20/bag.

There has been a dramatic increase in phosphate exports as domestic consumption has increased 4.5 percent from 1993-1994 to 1994-1995.

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[4] It has been suggested that the "slack" season for local demand that permitted exports is no longer as evident as in the past. The optimum level of stocks needs to be determined.

[5] The Egyptian Phosphate Industry: 1995 Diagnostic Study. Prepared for USAID and the Government of Egypt.

The most recent export contract was concluded at $68/ton FOB for bulk granulated SSP. This translates into a domestic price of LE 14.6 LE per bag. (assuming a 15 percent marketing margin and LE 30/ton bagging cost). This is what farmers are now paying.

Given a vibrant export market, the development of a diammonium phosphate production capacity should be considered, but would require that the additional ammonia capacity discussed elsewhere in this report be established.

F2. Potassium

Potassium use in Egypt is low. Farmers in the survey used only 7.3 kg of potassium sulphate nutrient per farm. This translates into 2 kg per feddan, on average. Real application figures are higher as most apply none at all. Only 1 percent of farmers applied potassium to maize, 1 percent to cotton, 1 percent to berseem and 3 percent to wheat.

All potassium is imported as potassium sulphate, an expensive form of potassium (200-205 FOB Europe spot market bulk granular 10-95). Much cheaper is muriate of potash. Little agronomic evidence supports the view that MOP (Potassium chloride) is unsuitable for Egyptian soils.

F3. Minor Fertilizers

Annex G in this report's second volume examines agronomically sound application rates. These rates are far exceeded in observed practice. This annex also includes a discussion of micronutrients, foliar fertilizers, and compound fertilizers. The use of such fertilizers in Egypt is minimal. None was discovered among the farmers surveyed for this study.

F4. New Products

The production and marketing of liquid fertilizer has become widespread throughout the world. SEMADCO is planning to increase its production of the most common one, UAN solution (urea ammonia nitrate) in the near future. A marketing report prepared by EFDC[6] indicates that sales rose from 68 tons per year in 1990-1991 to 643 tons in 1992-1993. In examining the targeted market, sandy soils under sprinkler or drip irrigation, the study finds a potential market for 43,000 tons. Only 30 percent of the land is now equipped with fertilizer tanks and injectors. If all land was so equipped, then potential demand would rise to 144,000 tons per year.

F5. Fertilizer Balance

Plant nutrition requires a balance of macro and micronutrients. The ratio varies by crop and land type. Balanced nutrient application for wheat in Lower Egypt, for example, has a ratio of one unit of nitrogen to 0.25 units of phosphorous to 0.2 units of potassium.

[6] Marketing Study-UAN, 1994, UNIDO Project No. DP/EGY/85/008 Loren Ahlrichs, IFDC & Mohamed Fathy EFDC.

Table III-5. Nutritional Balance

	Nitrogen	Phosphorous	Potassium
Wheat Lower Egypt	1	0.25	0.2
Rice Lower Egypt	1	0.27	0
Maize Lower Egypt	1	0.3	0.24
Potato Lower Egypt	1	0.75	1
Average 1991 ratio for all crops and regions (PBAC):	1	0.23	.03
Study team's 1995 observations:	1	0.14	.03

The actual use of nutrients deviates from the optimum. While use patterns may reflect farmer resources and management skills, there is cause for concern. Liberalization has upset traditional patterns of fertilizer practice, creating possibilities for improvement as well as the risk of nutritional imbalance during this learning period.

G. Data Debates

The data and analysis that follow attempt to assess nitrogen consumption in Egypt. As will become apparent, figures from various sources can differ substantially. When PBDAC was the sole distributor of fertilizer, relatively firm data was available on use. If too much was distributed to certain farmers, they resold it. At low prices, all fertilizer was simply used. Liberalization has resulted in a lack of data on actual use. This meant that the team was obliged to spend a great deal of time and effort simply trying to estimate the pattern of use for recent years.

As seen in Table III-6, data from CAPMAS (Central Authority for Public Mobilization and Statistics) shows that demand for N declined from around 775,000 tons in 1986 to 676,000 tons in 1994. Over the period 1986-1988, the demand for N increased from 775,000 tons in 1986 to 779,000 tons in 1988, declining to 676,000 tons in 1994.

Table III-6. Quantities of N Consumed by Farmers as Estimated From Different Sources (000 tons)

Years	Sources				
	PBDAC	MOA	EFDC	Producers	CAPMAS
1986	716.7				774
1987	795.3				776
1988	786.6				791
1989	794.6				772
1990	797.7				776
1991	745.1	796.5	754.6	773.1	725
1992		790.4	760.7	760.7	na
1993		849.5	790.9	825.0	731
1994		728.9	821.1	820.6	676
1995				755.2	758.6*

PBDAC data based on sales
MOA (Ministry of Agriculture) estimates from the Economic Statistics Office
EFDC (Egyptian Fertilizer Development Council) estimates based on data from fertilizer producers
Producers estimates were provided to the team
* Producers provided data that resulted in a total of 633,000 tons. This was due to a much lower production figure for ammonia nitrate. The team elected to instead use EFDC values for this figure, as it is in frequent contact with the producers. (An attempt at verification resulted in a value between the two estimates). See Annex F in the second volume of this report for more details.

The following analysis relies on data provided by PBDAC, the production companies, or EFDC. When inconsistencies emerged, we used the largest value (the logic being that an overestimation of fertilizer needs is less costly than an underestimation). Using these numbers, we predict a stabilization of nitrogen consumption at 750,000-850,000 tons N/year. The Ministry of Agricultures provides other input into the debate. The ministry sees consumption as much higher than any other source, assessing nitrogen needs in 1995-1996 at 952,000 tons N.[7] Using a time series analysis with ministry data, one would estimate needs in 1995-1996 as around 800,000 tons N. However, survey data predicts even lower use than any of the official sources. The study team was given the methodology used by the Ministry of Agriculture to estimate nitrogen needs. Using this methodology, the study team has predicted a need for 642,000 tons N per year, much less than the ministry's own published assessment. One possible explanation for the ministry's comparatively high projections is that planners want to avoid fertilizer shortages and hence tend to overestimate needs to ensure supply.[8]

[7]The team was shown a preliminary version of a MOA study on fertilizer needs in December 1995.

[8] In an article published in the "Arab Fertilizer Association Journal" (No. 1, 1994), Abu Qir's chairman predicts 1994-1995 consumption as 670,000 tons. As chairman of a firm that is a major export player, his interests lay in convincing officials who approve export quotas that Egyptian production capacity is in excess of domestic needs. Firms that seek to expand capacity use much higher estimates of national needs to justify expansion financing (the uncertainty of the export market may discourage lenders, while a growing domestic market tends to reassure them).

The study team was presented with an unofficial summary of a report from the Marketing Research and Study Unit of the Ministry of Public Works which puts forth a policy proposal for a new distribution system based on 5 percent growth in nitrogen use, starting from the ministry's 1995-96 estimate of 952,000 tons. Conversations with officials from the various fertilizer companies have elicited the same optimistic numbers.

Data from CAPMAS gives estimates in the range of 650,000 tons N per year. In Annex G in the second volume of this report. Drs. El-Fouly and Fawzi give estimates of nitrogen requirements based on considerations of plant nutritional requirements and an assessment of farmer practices (based on data from over 5000 farms). Their assessment is in line with CAPMAS and the study team's interpretation of ministry methodology.[9]

A correct assessment of nitrogen use is essential for any serious analysis of future demand. The discrepancy in data has led to a wide divergence in estimates of fertilizer use and future demand. One calculation indicates that new factories are required, while another calculation requires exports to soak up surplus production. Some estimates project large seasonal shortages that will require major investments in storage capacity. Other estimates indicate that factories will have enough surplus capacity over domestic needs that virtually no storage is needed. The following sections detail the estimation methods used by the team.

G1. Time Series Analysis

Studies in the past have generally estimated future fertilizer use by means of past trends. This study also makes use of past trends to project future demand. The assumption of time series analysis is that past forces that generated certain results will continue in the future. The only explanatory variable is time itself. Time series-based prediction cannot explain **why** nitrogen use will change in the future, only how it will, based on past experience. For the current analysis, the difficulty lies in assigning the correct relative importance to two very different periods: before the end of the PBDAC monopoly in 1991 and after. In other words, is future demand for nitrogen in Egypt determined largely by events of the past four years or do long-range outweigh the influence of the past several years? To surmount this difficulty, two meth analysis are utilized. First, simple linear projections are presented. These projections have done in two ways: using data from the years 1970-1994, and then using data only the period of 1984-1994. Secondly, a more sophisticated method of time series analysis, ARIMA modeling, is used to predict future demand. In none of the analyses that follow is the data for 1995, an abnormal year, included.

G2. Linear Prediction

Linear prediction is a common technique for projecting future demand. Stone and Webster[10] used this technique to predict a 1993-1994 nitrogen consumption of 1.069 million tons, compared with the 820,000 actually used. Figure III-7 shows fertilizer growth as a linear trend. The high growth line is based on the period 1970-1994, averaging 3.3 percent (note this chart depicts

[9]It was beyond the scope of this study to reconcile the different methodologies used by various agencies. It is hoped that this tasks can be accomplished in the near future.

[10] Stone and Webster, 1986 Egypt: Preinvestment Analysis of Alternatives for Increasing Nitrogen Fertilizer Production in Upper Egypt, pp. III-2-11.

average, rather than actual, growth rates). The low growth curve adds 24,600 tons N per year. A table presenting predicted demand is included in Annex F in the second volume of this report.

G3. ARIMA Prediction

The growth of fertilizer is not linear, however; other prediction methods are needed to accurately forecast future consumption. ARIMA modeling uses a system of trial and error (iteration) to calculate a set of coefficients that can be used to best describe the time series under consideration. Normally, one model is clearly superior to others in explaining variations in the time series. A "good" model has an error of less than 1 percent of the average value in the series. In the ARIMA model used in this case, the error was less than 0.1 percent. Unfortunately two models were statistically equal, but gave different results, one predicting growth and the other, decline. These models are presented as the high and low demand. (The difference in the two models is in the method of estimation. One method uses a longer moving average combined with use of annual differences in the series, rather than the series values themselves.) Figure III-8 contains the high and low projections of fertilizer demand.

The time series analysis, therefore, does not provide a clear prediction, but a choice. As is often the case, other information, both theoretical and empirical, must be used to guide the process of prediction. In this case, both theoretical and empirical evidence supports the prediction of low growth in the demand for nitrogen fertilizer. The following facts support this conclusion:

- Farmers have traditionally over-used nitrogen due to its low cost. They now pay higher prices, but are free to farm as they wish and are learning more effective production techniques. The connection between cultivation techniques and nitrogen loss will become more evident to farmers as time goes on and they will use expensive nitrogen with greater care.

- Egypt will have difficulty maintaining a domestic nitrogen price lower than the international price unless it abandons market reforms. International nitrogen prices are expected to remain high for the foreseeable future. With market reform, farmers will pay the equivalent of the international market prices and hence use less.

- Past growth rates of fertilizer use have been stimulated by the adoption of high yielding varieties. This process is largely completed. While new varieties continue to be introduced, they are not more demanding of nitrogen than older varieties. The long-range trend is for a varietal selection based on reduced nitrogen inputs.

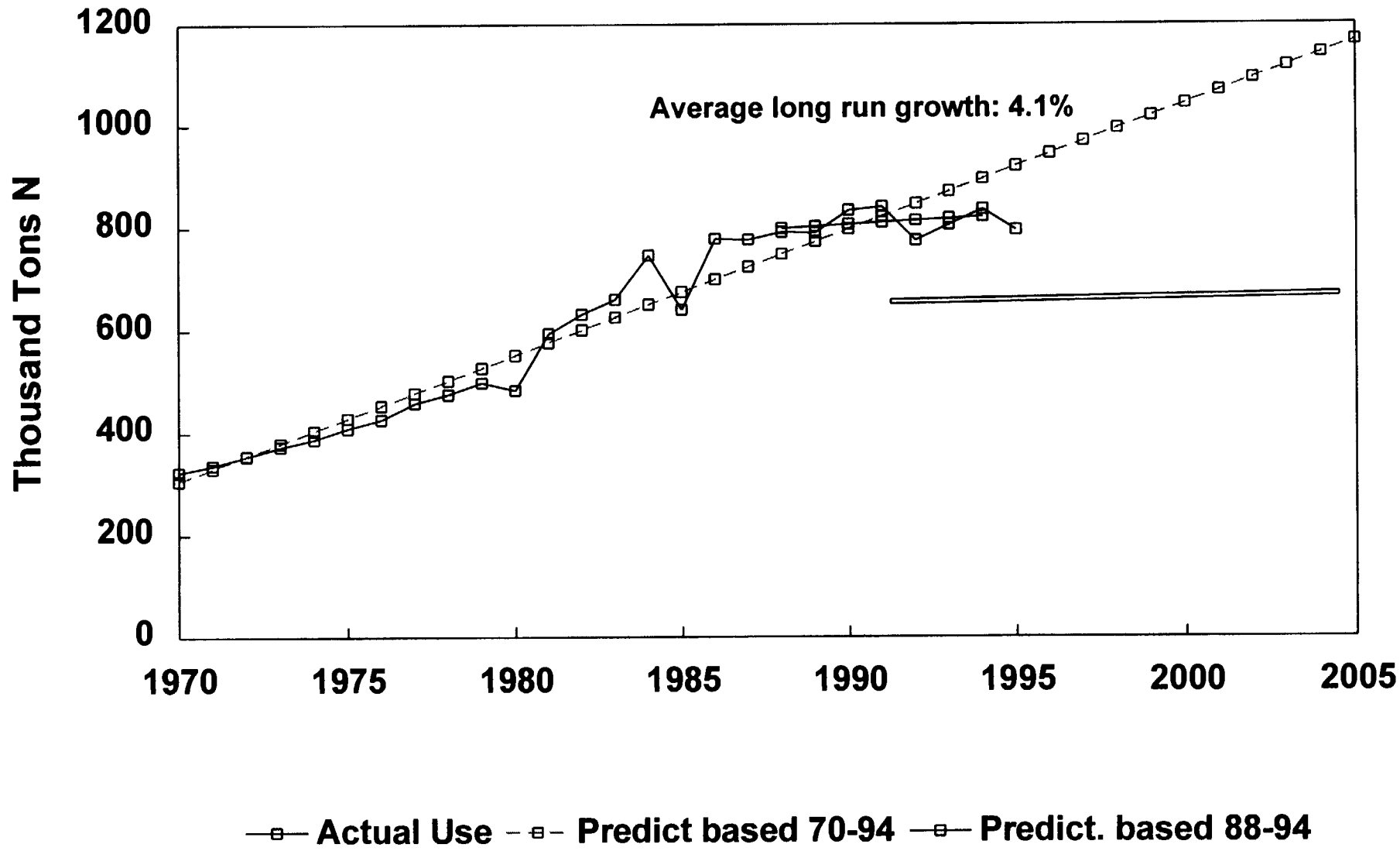
- Decreasing soil fertility is making crops less responsive to nitrogen. Greater attention to fertilizer balance and micronutrients will enable farmers to ensure a more efficient uptake of nitrogen, permitting a reduction in fertilizer application.

H. Price Effect on Nitrogen Use

As discussed above, economic theory predicts that farmers will use less nitrogen as prices rise. Data indicates that less is being used: 835,000 tons were used in 1990 and 821,000 in 1994. Use has remained fairly constant since 1989, when the government began to remove subsidies.

Figure III-7. Linear Predictions

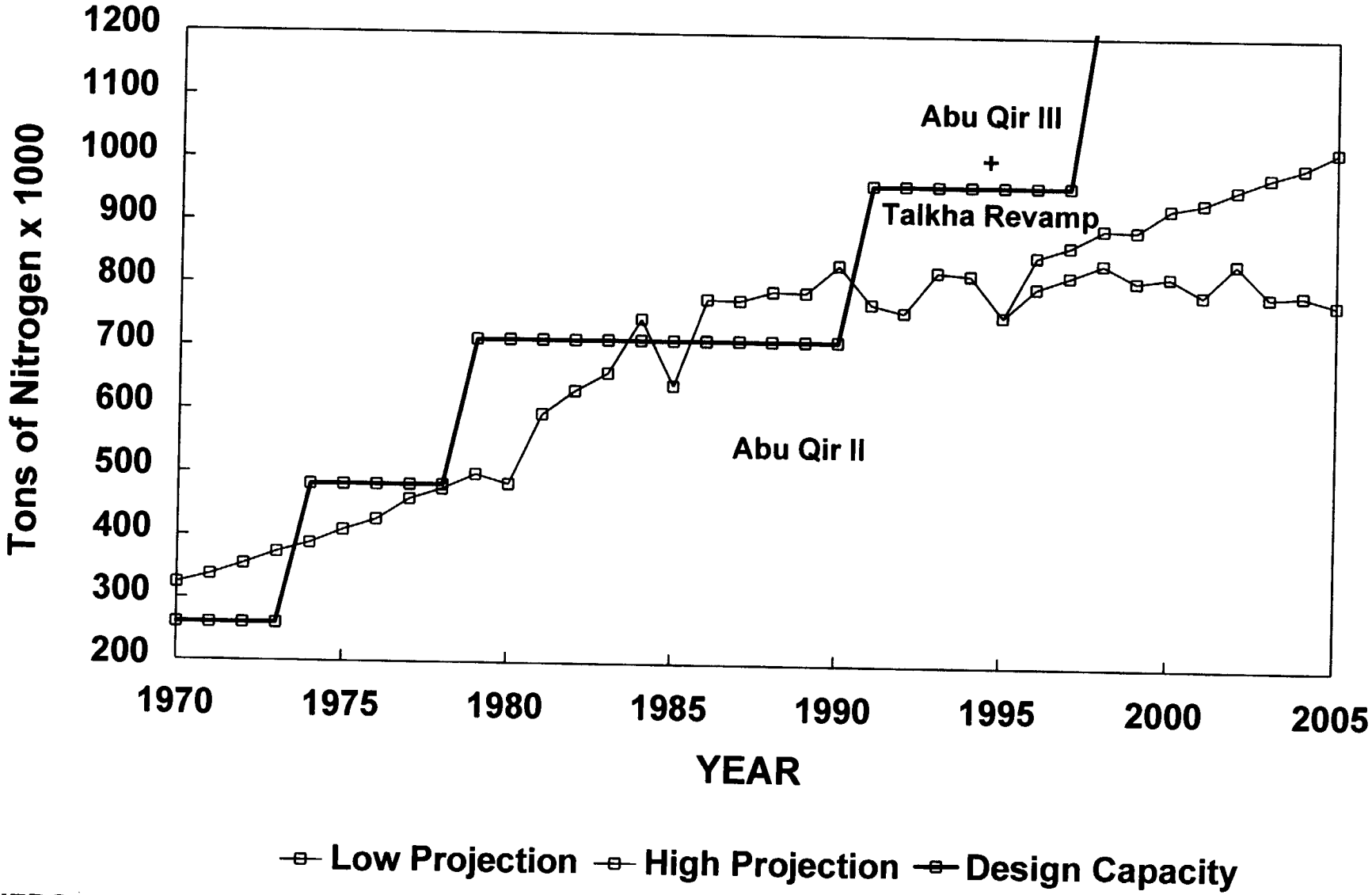
Nitrogen Use in Egypt



Source: IFDC (1993) & company data
Predict. based on 1984-1994
and 1970-1994

Figure III-8. Nitrogen Use 1970-2005

Low and High Projections



Source: IFDC (1993) EFDC and company data
Projections based on ARIMA models
Projections after 2001 are less reliable

In reality, it is not simply the price of fertilizer that determines demand but also the price that the farmer receives for the output. If fertilizer and output prices double, then fertilizer use should remain unchanged. For many years, output prices in Egypt rose more rapidly than fertilizer costs. A study by IFDC in 1993 showed that, on average, a ton of agricultural output could buy 50 percent more nitrogen in 1991 than in 1981.[11] The relevant number for phosphorous and potassium are 40 percent and 20 percent respectively. In recent years, prices have moved in the opposite direction. As shown in Table III-7, farmers must produce an increasing quantity of output to buy a kilo of nitrogen.

H1. Price and Fertilizer Use

Studies consulted or carried out by the study team confirm the inverse relationship between price and fertilizer use. A survey of 300 farmers in 5 governorates carried out by the study team in collaboration with the Ministry of Agriculture provides information on farmer response to higher prices. (See Annex F for a description of the survey data.) During the summer crop of 1995, farmers faced a reduced supply and consequently higher prices. Some farmers bought from cooperatives and the PBDAC but most bought from private merchants at market prices. The elasticity of demand for fertilizer measures the percent change in quantity purchased, for a 1 percent change in the price. The sensitivity of this relationship depends on the output response to fertilizer and the price of the crop. If the addition of one more kilogram of fertilizer to a crop makes a significant difference in output, it is unlikely that a small change in price will affect the farmers' decision to apply that quantity.

An efficient farmer adds fertilizer just until the point that the additional expense for fertilizer equals the additional value of the extra output. As the price of fertilizer rises, less will be used, unless the price of output rises in the same proportion. The sensitivity of fertilizer use to price changes also depends on the substitutes that are available for fertilizer. As noted above, labor and fertilizer are substitutes. More careful, time-consuming applications of fertilizer means that less can be used.

[11] International Fertilizer Development Center (IFDC) 1993, Fertilizer Policy Impact Study, Appendix Table 4.2.4.

Table III-7. Relative Nitrogen and Crop Prices 1990-1995

Crop	1990	1991	1992	1993	1994	1995
Nitrogen LE/KG	0.6	1.0	1.1	1.4	1.8	
Citrus Crop Price LE/kg	0.3	0.4	0.4	0.7	0.8	
Ratio N/P	2.0	2.5	2.8	2.0	2.2	
Nitrogen LE/kg	0.6	1.0	1.0	1.1	1.3	2.0
Summer Crop Price LE/kg	0.5	0.5	0.5	0.5	0.5	0.5
Maize Ratio N/P	1.3	2.0	2.1	2.2	2.6	4.0
Nitrogen LE/kg	0.6	0.8	1.2	1.4	1.5	
Sugar- Crop Price LE/kg	0.6	0.6	0.7	0.7	0.8	
Cane Ratio N/P	1.1	1.4	1.7	2.0	1.9	
Nitrogen LE/kg	0.6	1.0	1.0	1.2	1.5	2.0
Cotton Crop Price LE/kg	1.7	2.1	2.4	2.4	2.1	3.4
Ratio N/P	0.3	0.5	0.4	0.5	0.7	0.6
Nitrogen LE/kg	0.6	0.8	1.1	1.4	1.6	2.0
Rice Crop Price LE/kg	0.4	0.5	0.5	0.5	0.6	0.6
Ratio N/P	1.5	1.7	2.2	2.8	2.7	3.3
Nitrogen LE/kg	0.4	1.0	1.4	1.6	1.6	
Broad Crop Price LE/kg	0.8	1.0	1.2	1.1	1.1	
Beans Ratio N/P	0.6	1.0	1.1	1.4	1.4	
Nitrogen LE/kg	0.5	0.9	1.2	1.3	1.4	
Winter Crop Price LE/kg	0.3	0.4	0.4	0.3	0.3	
Tomato Ratio N/P	1.7	2.2	2.9	4.3	4.5	
Nitrogen LE/kg	0.6	0.6	1.1	1.2	1.4	1.3*
Wheat Crop Price LE/kg	0.6	0.6	0.6	0.7	0.7	0.6
Ratio N/P	0.9	1.0	1.8	1.7	2.1	2.2

Note: Secondary products are included
Fertilizer prices are only estimates as different types of nitrogen fertilizer are not reported on a governorate level by the MALR. 1995 data from survey *=winter 1994-1995.

H2. Elasticity of Demand for Nitrogen Fertilizer

Elasticity of demand is a numerical measure of the sensitivity of quantity demanded to changes in price. The greater the substitution of other goods for the one experiencing price increases, the higher the elasticity. When a good has few substitutes, and we find that a 1 percent increase in price reduces quantity demanded by less than 1 percent, the good is called inelastic. After conversations with many economists, the study team determined that many of them believe that the demand for nitrogen fertilizer in Egypt is inelastic. When assessing the elasticity of demand for nitrogen, it must be recognized that the two common sources in Egypt, urea and

ammonium nitrate are, to some extent, substitutes. Their nitrogen is in different forms and they are not perfect substitutes (ammonium nitrate, for example, is not suitable for rice cultivation), but farmers can choose between them for most crops. It is, therefore, logical to estimate the demand elasticity for nitrogen as a whole.

A survey carried out by the team found that a price increase of 45 percent led to a reduction of nitrogen used by 16 percent for an elasticity of -0.35. This is not a completely true measure of elasticity as a farmer's decision to buy fertilizer during the season depends on his expectations of crop prices. If he believes that crop prices will double but fertilizer prices will increase by only 50 percent, then he will increase fertilizer use even at the higher price. To handle this problem, it was assumed that farmers correctly anticipated price changes for two crops, rice and maize. Elasticity measures were calculated for the change in fertilizer price expressed in terms of the amount of rice or wheat necessary to buy a kilogram of fertilizer. In effect, the impact of the price change of output on the demand for fertilizer has been removed. Calculated in this way, the elasticity of demand for urea used on maize is -0.35, the same as for nitrogen as a whole. The elasticity of demand for urea on rice is -.6. This higher elasticity may reflect the fact that rice farmers reduced their tilling area while maize farmers increased theirs.

In strict terms, elasticity should be calculated under conditions of constant efficiency; however, this is not possible in the current case. These elasticities must therefore be only seen as indicative. Furthermore, elasticity measures are only valid for a small range of price fluctuations, not the 44 percent that we observe in this case. Elasticity also increases over time as substitutes are discovered. In the first year of a price increase, farmers may not be aware of alternatives and thus reduce consumption very little.

In fact, earlier work on elasticity has found greater sensitivity. Price elasticities are a method of measuring the sensitivity of fertilizer purchases to fertilizer prices. A 1986 study[12] found nitrogen purchase to be "elastic" or sensitive to price, with a 1 percent increase in price leading to a 1.7 percent decrease in quantity demanded. The same elasticity was found for phosphate fertilizer.

Agronomic data, however, provides elasticities close to our own estimates. Hamissa provides us with a response function for the new wheat varieties in 1984, illustrating the impact of price changes on fertilizer use[13]. At prevailing prices, the optimum level of nitrogen application was 158 kg/ha (66kg/fed). At world level fertilizer prices (150 percent of the subsidized level), the demand would drop 20 percent to 127 kg (53kg/fed). This implies an elasticity of 0.4. Hamissa's response function represents response under ideal management conditions. The only effect we can therefore see is the price effect. We cannot observe farmers' efficiency improvements that are due to higher fertilizer prices. Mitkees[14] carried out similar

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[12] Agricultural Policy Analysis project, 1987, Demand for Nitrogenous Fertilizer in Upper Egypt. Bremer-Fox et al, p.102.

[13] Hamissa et al, 1991 pp 60-62. The quadratic equation is $Y = 2880 + 21.86 * N - 0.0593 (N)^2$. Where Y=wheat yield in kg/ha, N=nitrogen in kg/ha.

[14] Mitkees, R.A. Hanna, N.S. El Sayed, E.A. M., and Sabah H., 1994, Effect on Different N, P, and K Levels on Wheat Yield Under Saline Conditions at El Fayoum. Agricultural Research Center, unpublished document.

estimates in 1994 for wheat cultivation under saline conditions. His results imply an application rate of 76 kg/feddan when the ratio of fertilizer to wheat price is 2:1 and an application level of 65 kg/ha when the ratio rises to 3:1. The implied elasticity is also 0.4.

H3. Efficiency Improvements

It has already been stated that farmers facing higher prices will improve their efficiency of fertilizer and obtain more output per unit of input. Many earlier studies have noted the inefficiencies and the overuse of nitrogen application by Egyptian farmers but have lacked empirical evidence.[15] While agricultural researchers have carried out researcher managed field trials to estimate the impact of improved technology, no farm-based studies came to the attention of the study team. The most compelling evidence for inefficiency in fertilizer use comes from the research of El-Fouly and Fawzi presented in Annex G in the annex volume. The finding presented below in Table III-8 implies that 45 percent of nitrogen applied to maize is wasted.

Table III-8. Nitrogen Use in Maize and Cotton
Kg/feddan

	Maize	Cotton
1. Plant uptake	147	130
2. Provided by soil, previous crop and manure	90	90
3. Additional needs (2-1)	57	40
4. National recommendations	220	165
5. Loss in chemical nitrogen	163	125
6. Efficiency percent of N used by crop	26 percent	24 percent
7. National loss tons/year	142,000	45,000

While efficiency can never reach 100 percent, even reducing losses by half would provide significant savings. Improved application techniques, however, require that fertilizer prices induce farmers to practice more time-consuming methods such as incorporating fertilizer into the soil.

[15] Stone and Webster, 1986. Egypt: Preinvestment Analysis of Alternatives for Increasing Nitrogen Fertilizer Production in Upper Egypt. pp. III-67-68.

A study of 300 farmers in the delta provides a measure for fertilizer inefficiency (see Annex H in the annex volume for a discussion of data sources). In villages in the same area we would expect high fertilizer use per feddan to correspond with high yields. For all crops except wheat, the expected relationship between fertilizer use and yield does not hold.

Table III-9. Fertilizer Use and Yields per Feddan: Farm Data

	Low Yield	Medium Yield	High Yield
Maize ardabs	4	12.8	18.9
Amm. nit bag	1.3	4.2	4.7
Urea bags	1	7.5	2.1
Kg nitrogen	44.775	242.85	127.025
N use level	LOW	HIGH	MEDIUM
Cotton kentars	1.8	3.6	6.9
Amm. nit bag	0.8	1	0.7
Urea bags	4	1.1	2.4
Kg nitrogen	105.4	42.1	66.9
N use level	HIGH	LOW	MEDIUM
Rice tons	1.2	2.3	3.5
Amm. nit bag	0	1	0.9
Urea bags	1	0	1.4
Kg nitrogen	23	16.8	47.3
N use level	MEDIUM	LOW	HIGH
Wheat ardabs	7.1	11.1	13.8
Amm. nit bag	1.8	3.1	2.9
Urea bags	0.3	0.2	5
Kg nitrogen	37.1	56.5	163.6
N use level	LOW	MEDIUM	HIGH

This figure contains some disturbing findings and requires explanation. We have expected that farmers are always rational operators, able to estimate the crop response to fertilizers. This figure suggests that this may not be a correct assumption as some farmers appear to be using too much nitrogen. In explaining these results, two factors may be relevant. First, farmers are still in the early phases of the learning process. Until recently, state directives determined a large part of their activity. As farmers learn with time that they are able to reduce fertilizer use and still maintain net income, fertilizer demand may well fall. This process will involve a longer or shorter period of adjustment for individual farmers depending on the extent of a farmer's previous experimentation with different levels of fertilizer application.

The second possibility is that fertilizer recommendations in the past were set too high. In the days of the PBDAC monopoly, farmers received fertilizer according to an assessment of crop nutritional requirements. If these recommendations were correct, then fertilizer demand would vary according to the price. If, however, they were too high, then we can assume that farmers

would move to more appropriate levels as they gain experience. Farmers are not completely new to judging fertilizer needs, as they have in the past often sold fertilizer that they considered to be in excess of their needs.

The current recommendation for wheat from the Ministry of Agriculture, used to assess fertilizer needs, is 500 kg of 15.5 percent fertilizer per feddan. If this were applied to Dr. Hamissa's response function, the result would be a loss in yield from the maximum. Using economic criteria rather than yield maximization and 1994-1995 prices, the response function tells us that farmers should apply 68 kg rather than the recommended 77.5 kg. This error in recommendation represents alone a 2 percent overstatement of national fertilizer requirements. If we recognize that farmer responses are not based on optimal management conditions, and that uncertainty and credit may be constraints, then actual application may be even less.

It is difficult to judge the pace of adjustment or its final magnitude, but indications can be seen from the team's survey results.

There have been substantial changes in fertilizer prices over the period examined. One test of efficiency is to see what has happened to income in the time period. A simplified measure was used including crop revenue from the three major field crops minus expenditures on fertilizer. This may be considered a crude gross margin. The following figure shows the results.

Table III-10. Farmer Response to Fertilizer Shortages
1995 Versus 1994 Summer Crop
Percent Change

	Rice	Maize	Cotton	Vegetables
Nitrogen Use	-8.8	-8.7	-12.2	-49
Crop Area	+ 4	+12	-6.8	-45
Production	CONSTANT	CONSTANT	-17	-16
Crude Gross Margin LE	36.4	87.3	319.6	NA

Cotton gross margin is much improved due to higher prices. The other crops show improvement due to a combination of higher prices and more allocational efficiency.

I. Counter Tendencies to Decreased Fertilizer Use

Notwithstanding efficiency improvements discussed above, there are forces in operation that may lead to an increase in fertilizer use. This issue is discussed in detail below with regard to new land development but several other issues were raised in the course of this study that require comment.

It has been suggested that declining animal herds is reducing manure availability, requiring new applications of chemical fertilizer. The table below shows that cattle have decreased since 1982, but all other animals have increased.

Table III-11. Livestock Populations 1982 and 1993

Species	1982 000,000 head	1993 000,000 head
Buffaloes	2.3	2.8
Cattle	2.9	2.7
Sheep	3.4	3.9
Goats	2.8	3.0

Source: 1993 IBRD Country Study: Arab Republic of Egypt, p. 122.
MALR 1993 Summary of Agricultural Statistics, p. 63.

It was often mentioned to the team that increasing orchard cultivation would require substantially more nitrogen. While this may be correct, citrus crops benefit most from the spread of micronutrients and a balanced fertilizer application. In the past, there has been a very inefficient use of nitrogen. Egypt uses 19.5 kg of N to produce one ton of fruit while Morocco and the U.S. use 4.6 and 2.3, respectively. (See Annex G by Dr. El Fouly for more information). Orchards have perhaps the greatest potential for efficiency improvements and should therefore see no increase in the demand for N.

In the case of wheat, it is projected that the wheat area will increase from 2 million feddans in 1994-1995 to 2.15 million in 1996-1997. If farmers were to apply the recommended rate (77.5 kg per feddan on old lands and 91 on new lands), this would generate an additional demand of 39,000 tons of N, less the fertilizer saved on the replaced crop. If the new crop is berseem, then the new net demand is in the region of 30,000 tons. Farmers often do not apply at the recommended rate, however. Wheat has a relatively deep root system, which can take up nitrogen not available to other crops. As farmers often follow berseem with wheat, they use an application rate of 60 kg per feddan. As a result, demand for N due to expanded wheat cultivation will be about 20,000 tons per year. (This aspect of fertilizer demand is examined in detail below in section J2.

The expansion of the new lands at the rate of 100,000 feddans per year may be expected to generate an additional demand for fertilizer of 10,000 tons N per year. This issue is addressed in analyzing the CAPMAS data.

J. Predictions

There are widely different estimates on nitrogen use and growth. It is our assessment that the growth of demand will largely depend on the government's decision with regarding distribution and pricing. If low, government-determined prices dominate the market, consumption will increase. The government-controlled system is capable of moving vast quantities of fertilizer. We believe, however, that this would be a waste of resources. Farmers can be induced to much higher levels of efficiency in fertilizer used. In both a technical and allocative sense, the best way to achieve the goal of efficiency is through an appropriate price policy.

For all of the reasons noted above, unless the policy of liberalization is abandoned, domestic demand growth is likely to be flat for the foreseeable future. The recent declines in fertilizer use due to liberalization should continue until farmers operate at much higher levels of efficiency. While this process continues, certain counter tendencies push up demand. Currently, the two tendencies cancel each other. At some point in the future, the results of new land cultivation and increased horticultural production will generate increased demand for fertilizer in Egypt. However, given the wide range of data on fertilizer consumption that is in current use, the study team is unable to estimate when that event will occur.

The team judges that future nitrogen use can, at present, best be estimated by using the ARIMA model, which predicts stagnant growth. This model incorporates all the recent trends in nitrogen use and predicts a level not exceeding 850,000 tons per year for the next five years. This is a controversial finding given official estimates exceeding 1 million tons. The study team judged that this finding needed verification using a second method. We begin with the 642,000 ton estimate calculated by the team from the MOA methodology, then adjust this estimate for cropping changes predicted by the MOA, and make certain assumptions about efficiency improvements. In order to err on the side of caution, we have also assumed that growth in nitrogen use from all other sources will equal 2 percent per year.

J1. Alternative Demand Estimation: A Cropping Pattern Model

The demand for N will be affected by different factors. We can identify both expansionary upward factors and factors that will reduce demand. The first category includes expansion of both high yielding varieties of wheat in both old lands and new lands and the expansion of horticultural crops in the new lands. Both of these factors will increase the demand for N. The second category deals with the efficiency improvement, both technical and allocative, which will reduce demand.

J2. Demand for Nitrogen for Increased Wheat Cultivation

As regards the expansion of high variety yield wheat, the MOA predicted that wheat area would reach 2.1 million feddans in 1995 and will increase by 100,000 feddans in 1996 and 50,000 feddans in 1997. Assuming the annual increase of high variety yield of wheat is 100,000 feddans, the expected area in 1997 will reach 2.25 million feddans, climbing to 2.95 million feddans in 2000.

In Table III-12, columns 2 and 3 present the expected areas of wheat in both the old land and new lands in thousands of feddans. The MOA predicted that the wheat area will increase from 2 million feddans in 1995 to 2.1 million feddans in 1996, and then to 2.15 million feddans in 1997. Columns 4 and 5 portray the recommended use of N per feddan. Columns 6 and 7 present the total use of N in both old lands and new lands and is calculated as follows: (Note: this is presented in the form used by MOA. Recommendation is presented as if nitrogen were present at 15.5 percent):

Total use of N = Area x N recommended per feddan

Column 8 shows the extra use of N in thousand tons due to expansion of wheat and is calculated as follows:

Extra use of N = Total use of N in both old lands and new lands at time t - Total use of N in both old lands and new lands at time t-1.

Column 9 calculates the fertilizer use in terms of N which is equal to column 8 times 15.5 percent.

Table III-12. Projected Wheat Demand for N 1995-2005

	Area/000 Fed.		N. Rec.*		Use of N 000 tons		Additional Annual Needs (000 tons) 15% N.	
	Old Lands	New Lands	Old Lands	New Lands	Old Lands	New Lands		
1994-1995	2000	200	500	900	1000	180		
1995-1996	2100	400	500	900	1050	360	230	36
1996-1997	2150	500	500	900	1075	450	115	18
1997-1998	2250	600	500	900	1125	540	140	22
1998-1999	2350	700	500	900	1175	630	140	22
1999-2000	2450	700	500	900	1175	630	140	22
2000-2001	2550	800	500	900	1275	720	190	29
2001-2002	2650	800	500	900	1325	810	140	22
2002-2003	2750	900	500	900	1375	810	140	
2003-2004	2850	900	500	900	1425	810	50	
2004-2005	2950	900	500	900	1475	910	50	

* Recommendations from the MOA. The present recommendations based on a 15.5 percent N content.

J3. Horticultural Demand for Nitrogen

The second major source of new fertilizer demand is expected to be horticultural crops and orchards in the new lands. The total area of orchards increased dramatically from 655,000 feddans in 1989 to 866,000 feddans in 1990, reaching 914,000 feddans in 1994. We assume any further growth in fertilizer demand from new orchards to be insignificant for the near future.

Table III-13. Areas of Horticultural Crops 1952-1994 (000 feddans)

Years	Orchards	Vegetables Plus Orchards
1952	94	9308
1989	655	11773
1990	866	12305
1991	896	12566
1992	907	12606
1993	912	12807
1994	914	12807

The MOA expects the area of vegetables in the old lands to be unchanged except for potatoes and tomatoes. Over the 1994-1995 to 1996-1997 period, the area of the major vegetables remains constant, onion at 29,000 feddans, garlic at 20,000 feddans. The area of potatoes is expected to increase from 62,000 feddans in 1994-1995 to 63,000 feddans in 1996-1997, while the area of tomatoes is expected to decline from 102,000 feddans to 100,000 feddans over the same period.

In the new lands, the area under vegetables reached 50,000 feddans in 1993. Assuming annual increase of vegetables area of 5 percent, vegetables area will reach 84,000 feddans in 2000. The average requirement of vegetables of N is 700 kgs per feddan. Therefore, the total extra vegetables requirements of N will increase from 347 tons in 1996 to 434 tons in 2000.

Table III-14. Projected Horticultural Nitrogen Consumption 1995-2005 (Tons)

Years	Area/ 000 fed.	Expansion in area/ 000 fed	Additional N tons	
			15.5 percent	N
1995	66.0			
1006	69.0	3.2	2240	347
1997	72.0	3.4	2380	369
1998	76.0	3.6	2523	391
1999	80.0	3.8	2658	412
2000	84.0	4.0	2800	434
2001	88.2	4.2	2940	456
2002	92.6	4.4	3080	477
2003	97.2	4.6	3220	499
2004	102.1	4.9	3430	532
2005	107.2	5.1	3570	553

J4. Efficiency Adjustments

Efficiency adjustment factors are defined as ones that shift down the demand for nitrogen. There are no studies yet available to estimate farmers increased efficiency of fertilizer use. El-Fouly and Fawzi provide evidence for the impact of efficiency gains on nitrogen demand in Annex G to this report, and the study team's survey also showed efficiency gains. In the case of cotton in 1995, the farmers with the highest yields maintained their 1994 yields while using 6 percent less nitrogen. Farmers were divided into three equal sized groups.

Table III-15. Projected Extra Consumption of N Due to Increased Wheat and Horticulture Production 1995-2005

Years	Consumption	Expansion	Factors		Total Projected Consumption
		Wheat	Horticulture	Total	
1995	642000				642000
1996	655000	36000	347	36347	691347
1997	668000	18000	369	18369	686369
1998	681000	22000	391	22391	705591
1999	695000	22000	412	22412	717412
2000	709000	22000	434	22434	731434
2001	723180	29000	56	29456	752636
2002	737644	22000	47	22477	760121
2003	752396	22000	499	22499	774895
2004	767444	8000	532	8532	775976
2005	782793	8000	553	8553	791346

Note: the base consumption of 642,000 is assumed to grow by 2 percent per year regardless of other factors; this can be considered a margin of safety to ensure adequate fertilizer supplies.

Table III-16. Increased Efficiency of Fertilizer Use in Cotton

Yield 1994 Kentar/fed.	Yield 1995 Kentar/fed.	Percent Change in Urea
2.5-4.5	1.3-4.0	+50%
4.5-6.0	4.5-6.5	- 38 percent
6.7-9.0	6.8-9.0	- 6 percent

As is evident, there is a wide disparity of results. The low yield group increased fertilizer use while experiencing a drop in yields between 1994 and 1995. The other groups obtained the same yields with less fertilizer. Factors other than fertilizer may have entered into play and two years is not adequate time to establish sound estimates for efficiency improvements. This being the case, three different scenarios are presented: (1) upward shift in demand for N and no efficiency improvement; (2) upward shift in demand for N and 1 percent efficiency improvement; and (3) upward shift in demand for N and 2 percent efficiency improvement.

Scenario I: This scenario considers the upward factors that increase the demand for nitrogen. These upward factors are expansion of high yield wheat varieties and expansion of horticultural crops. This scenario assumes farmers have made neither technical efficiency improvements nor allocative efficiency improvements. The projected demand for nitrogen over the next 10 years is presented in Table III-17.

Table III-17. Projected Extra Consumption of N 1995-2005

Years	Consumption	Growth Factors	Efficiency Savings	Projected Consumption
1995	642000			642000
1996	655000	36347	0	691347
1997	668000	18369	0	688538
1998	681000	22391	0	703391
1999	695000	22412	0	717412
2000	709000	22434	0	731434
2001	723180	29456	0	752636
2002	737644	22477	0	760121
2003	752396	22499	0	774895
2004	767444	8532	0	775976
2005	782793	8553	0	791346

Scenario II: In this scenario, a 1 percent efficiency improvement is assumed, which farmers can easily achieve. The same upward factors are functioning. The net change in the projected demand is shown in Table III-18. The projected demand for nitrogen increased from 642,000 tons in 1995 to 784,000 tons in 2005.

Table III-18. Projected Extra Consumption of N 1995-2005 With 1% Efficiency Gains

Years	Consumption	Growth Factors	1% Efficiency Savings	Projected Consumption
1995	642000			642000
1996	655000	36347	6550	684797
1997	668000	18369	6680	679689
1998	681000	22391	6810	696581
1999	695000	22412	6950	710464
2000	709000	22434	7090	724344
2001	723180	29456	7323	745404
2002	737644	22477	7376	752745
2003	752396	2249	7524	767371
2004	767444	8532	7674	768302
2005	782793	8553	7828	783518

Scenario III: In this scenario, 2 percent efficiency improvement is assumed. The same upward factors are functioning. The net change in projected demand is shown in Table III-19. The projected demand for nitrogen increased from 642,000 tons in 1995 to 782,000 tons in 2005.

Table III-19. Projected Extra Consumption of N 1995-2005 With 2% Efficiency Gains

Years	Consumption	Growth Factors	2% Efficiency Savings	Projected Consumption
1995	642000			642000
1996	655000	36347	13100	678247
1997	668000	18369	13360	673009
1998	681000	22391	13620	689771
1999	695000	22412	13900	703512
2000	709000	22434	14180	717524
2001	723180	29456	14460	738176
2002	737644	22477	14740	745318
2003	752396	2249	15020	759875
2004	767444	8532	15340	760636
2005	782793	8553	15640	768008

The proposed three scenarios are summarized in Table III-20. The highest demand for N will reach 791,000, 783,000, and 782,000 tons for the three scenarios, respectively.

Table III-20. Projected Demand for Nitrogen to 2005 (1000 tons)

Years	Scenario I	Scenario II	Scenario III
1995	642000	642000	642000
1995	691347	684797	678247
1997	686369	679689	673009
1998	705591	696581	689771
1999	717412	710464	703512
2000	731434	724344	717524
2001	752636	745504	738176
2002	760121	752745	745318
2003	774895	767371	759875
2004	775976	768302	760636
2005	791346	783518	768008

J5. ARIMA Model versus Cropping Pattern Demand Model

The above model attempts to chart demand for nitrogen based on MOA cropping pattern projections and some simplifying assumptions about efficiency. The ARIMA model presented earlier shows a cyclical pattern to fertilizer use based on past consumption. As the past consumption was perhaps artificially high due to heavy subsidies, the ARIMA model chosen relies heavily on the years since liberalization. The ARIMA model uses data from PBDAC for the start of the series and company or EFDC and official MOA data for the 1991-1995 period. As a result, this model starts from a higher level of consumption than does the unofficial MOA based model, but the two series converge in 2001. As the 642,000 ton starting point of this latter

series conforms to estimates of CAPMAS and El-Fouly, the team feels confident that the correct level of future nitrogen demand lies between the values of the ARIMA model and, to be conservative, scenario #1.

Table III-21. Projected Demand for Nitrogen ARIMA Versus Cropping Pattern Efficiency Model (tons)

Years	Scenario I	Scenario II	ARIMA
1995	642000	642000	755239
1995	691347	684797	801157
1997	686369	679689	819812
1998	705591	696581	840010
1999	717412	710464	812792
2000	731434	724344	820233
2001	752636	745504	791841
2002	760121	752745	841941
2003	774895	767371	790013
2004	775976	768302	793734
2005	791346	783518	778852

In conclusion, the study team is confident that nitrogen demand will not accelerate at the 5 percent rate that has sometimes been assumed. Fertilizer use has stabilized in Egypt and planners will be safe to expect a future demand between 750,000- 850,000 tons of nitrogen per year.

This study has benefited from the following data sources:

1995 Survey: Ministry of Agriculture

This survey was conducted for the study team by MOA in November 1995 in 20 districts in 5 governorates. A total of 300 interviewers were used to interview 60 farmers in each of the concerned governorates. The governorates were: Assiut in Upper Egypt, El Fayum in Middle Egypt, El Behira, El Gharbia, and El Menoufia in the Delta. The survey covered two seasons: 1994 and 1995. The questionnaires were organized into three parts. Part 1 addressed the cropping pattern, yield, and value of output. Part 2 dealt with fertilizer use by farmers' including quantities, prices, and source of supply. Part 3 reviewed the attitudes of farmers about the performance of the private sector and the main problems farmers encountered during the last season.

1994 Survey: Faculty of Agriculture, Cairo University

This survey was conducted in three districts in three governorates in the Delta: El Daqahlia, El Behira, and Kafr El Shiekh. This survey was under grant of NARP/Regional Councils of Research and Extension. The study was entitled Environmental, Social, and Economic Impacts of Applying Tile Drainage Technology in the Delta. The number of farmers interviewed was 180, half of them under tile drainage system.

1993 Survey: Faculty of Agriculture, Cairo University

This survey was conducted in nine districts in three governorates in the Delta. The survey was conducted for the World Bank Completion report of the economic evaluation of the tile drainage system in Delta. The number of farmers interviewed was 5,274.

1990 PDAC Survey: Arab Republic of Egypt, World Bank Country Studies, IBRD, 1993.

Various Data on Nitrogen Use

Ministry of Agriculture

Year	1991	1992	1993	1994	1995
prod. AS	63264	67073	75369	61575	
prod. AN	581857	1119252	1336843	1383984	
prod. CN	225795	212000	113929	53309	
prod. UREA	923856	873844	829606	903752	
prod. N	667926	823595	862646	900308	
import AS	410941	131867	86100	71611	
import AN	206718	109738	0	6000	
import UR	0	0	10524	12184	
export AS	0	0	40	682	
export AN	0	0	79604	237010	
export CN	0	167248	60	0	
export UREA	55000	154732	19567	248122	
domest N	796531	790421	849538	728999	

EFDC (Egyptian Fertilizer Development Centre)

Year	1991	1992	1993	1994	1995
prod. AS	63264	67073	67264	69642	67349
prod. AN	581857	1119240	1337135	1343544	1494895
prod. CN	225795	211882	95561	107485	25205
prod. UREA	923856	873844	836177	930647	916695
prod. N	667926	823572	861250	909191	940250
import AS	410941	131867	86100	71611	22000
import AN	206718	109738		6000	
import UREA	0	0	10524	12184	
export AS	0	0	0	40	7500
export AN	55000	166048	180000	116043	306360
export CN	0	0	60	20	0
export UREA	105974	154732	70750	155416	185581
domest N	754658	760696	790973	821181	755239

Company Data (provided to the team)

Year	1991	1992	1993	1994	1995
prod. AS	63264	67073	67800	69500	67500
prod. AN	581857	1119240	1438500	1343000	1120700*
prod. CN	225795	211882	96000	107000	25000
prod. UR	923856	873844	836000	930000	924000
prod. N	667926	823572	895304	908607	818255
import AS	410941	131867	86100	71611	22000
import AN	206718	109738	0	6000	
import UREA	0	0	10524	12184	
export AS	0	0	0	40	7500
export AN	0	166048	180000	116043	306360
export CN	0	0	60	20	0
export UREA	105974	154732	70750	155416	185581
domest N	773083	760696	825028	820596	633244

*This figure differs substantially from other estimates, the discrepancy was not explained
prod. = production
domest = domestic availability, units of N (prod. + imports-exports)
AS = ammonia sulphate (N = 20.5%) AN = ammonia nitrate (N = 33.5%)
UR = urea (N = 46.5%) CN = calcium nitrate (N = 15.5%)

Time Series Analysis
Linear and ARIMA Model Predictions 1995-2005

Year	Domestic Use of Nitrogen	Linear Estimation		ARIMA Weighed Toward	
		Based on 1984-94 *	Based on 1970-1994 **	1984-94 ***	1970-94
1970	323485		306223.0	323485	323485
1971	336970		330833.1	336970	336970
1972	354640		355443.3	354640	354640
1973	373550		380053.5	373550	373550
1974	388120		404663.7	388120	388120
1975	409510		429273.9	409510	409510
1976	426715		453884.1	426715	426715
1977	459110		478494.3	459110	459110
1978	475850		503104.5	475850	475850
1979	498790		527714.7	498790	498790
1980	484024		552324.9	484024	484024
1981	594339		576935.1	594339	594339
1982	631711		601545.3	631711	631711
1983	660385		626155.5	660385	660385
1984	746326	726076.0	650765.7	746326	746326
1985	640931	737614.1	675375.8	640931	640931
1986	778663	749152.3	699986.0	778663	778663
1987	777037	760690.4	724596.2	777037	777037
1988	791526	772228.5	749206.4	791526	791526
1989	790388	783766.7	773816.6	790388	790388
1990	834297	795304.8	798426.8	834297	834297
1991	796531	806843	823037.0	796531	796531
1992	775465	818381.1	847647.2	775465	775465
1993	825028	829919.2	872257.4	825028	825028
1994	821181	841457.4	896867.6	821181	821181
1995	755239	852995.5	921477.8	755239	755239
1996		864533.6	946088.0	801157	850983
1997		876071.8	970698.2	819812	867421
1998		887609.9	995308.4	840010	895042
1999		899148.0	1019918	812792	893471
2000		910686.2	1044528	820233	928521
2001		922224.3	1069138	791841	938517
2002		933762.5	1093749	841949	959752
2003		45300.6	1118359	790013	980145
2004		956838.7	1142969	793734	995866
2005		968376.7	1167579	778526	1021560

* Similar estimation method based on recent data is used by the Egyptian Fertilizer Development Center (EFDC)

** Method of estimation preferred by MOA

*** Method of estimation preferred by study team

Data for the team's understanding of farm level fertilizer experience came from four sources:

SECTION IV

FINANCIAL ANALYSIS AND PROFILES OF EGYPTIAN FERTILIZER COMPANIES

INDEX OF FINANCIAL TERMS

Sales. Sales or revenue is the amount of money which the business receives for the fertilizer that it sells.

Cost of goods sold. The cost of goods sold represents what it costs the business to manufacture the fertilizer.

Depreciation. The process of taking the estimated usage of an asset each year and charging it as an expense against the business is called depreciation.

Gross profit. The subtraction of cost of goods sold and depreciation from sales leaves a remainder called gross profit. It indicates the income that remains to cover the expenses of selling the fertilizer and administering the business.

Operating expenses. The expenses of selling the fertilizer and of administering the business are referred to as the operating expenses.

Operating profit. The deduction of operating expenses from gross profit leaves the business' operating profit, which is also referred to as operating income.

Net profit before tax. The net profit before tax is the amount of the operating profit remaining following the payment of interest expense, sundry expense, other provisions, and income tax plus the addition of interest income, investment income and sundry income.

Net profit after tax. The net profit after tax is the final result of operating the business for the period covered by the Income Statement. Net profit after tax is also referred to as return on sales. In calculating return on sales, the annual net income is divided by the annual sales figure and the resulting figure expresses net profit or net loss as a percentage of sales.

Return on equity. The return on equity refers to the net income divided by the shareholders equity. It relates the net income of the business to the investment that the shareholders originally made in common stock plus the earning retained in the business.

Return on sales. Return on sales is the net profit or loss expressed as a percentage of sales.

SECTION IV
FINANCIAL ANALYSIS AND PROFILES OF EGYPTIAN FERTILIZER COMPANIES

A. Introduction and Summary

There are four nitrogen and two phosphate fertilizer producing companies in Egypt, each owned by the government. At the request of the Egyptian government, a Chemonics team, funded by USAID, visited each of the companies' plant locations during October and November, 1995. The purpose of the visits was to gather information for the development of a liberalization and privatization plan for fertilizer production, marketing, and trade.

The visits resulted in a profile and a financial analysis of each company. Each profile describes the company and fertilizer plant operations. Profiles also include relevant economic data in addition to information on any expansion or renovation plans. The profile is followed by an historical analysis of the financial results of the company's fertilizer business.

Financial ratios were calculated based on each company's financial information. The calculations involved sales, profitability, asset efficiency, liquidity management, and financial risk. For an understanding of the calculations used, study Spreadsheet 3 in the back of this section entitled Abu Qir Income Statement Common Size. An analysis, based on these calculations and other information, was developed for each of the six companies. Based on the analysis, the candidacy of each company for a privatization strategy was assessed. The period studied was the fiscal year ending June 30, 1995 as well as the three previous fiscal years. A strategy for privatization of the companies is contained in Section V of this report.

Nitrogen sector. There are four nitrogen fertilizer producing companies in Egypt: Abu Qir Fertilizers and Chemical Industries Co., Egyptian Chemical Industries (KIMA), El Nasr Fertilizer and Chemical Company (SEMADCO), and El Nasr Company for Coke and Chemicals. The market share of the four companies for the fiscal year ending June 30, 1995, is shown below in Table IV-1.

Table IV-1

Nitrogen Sector Fertilizer Production (%) **2.5 million tons**	**1995**
Abu Qir	.54
KIMA	.10
SEMADCO	.33
Coke	.03

The growth rate of fertilizer production for the four companies over the past four fiscal years is shown in Table IV-2.

Table IV-2

Average Annual Growth Rate (%) Nitrogen Sector Fertilizer Production	1992-1995
Abu Qir	.05
KIMA	-.02
SEMADCO	.004
Coke	.017
Total Supply	.025

The operating profit for the past four fiscal years for the four companies is shown in Table IV-3 below. The operating profit margin is the sales revenue minus cost of goods sold, depreciation and sales, marketing, and administrative expenses.

Table IV-3

Operating Profit %	1992	1993	1994	1995
Abu Qir	.39	.41	.39	.43
KIMA	.12	.07	.11	.06
SEMADCO	.12	.02	.07	.11
Coke	-.76	-1.02	-1.12	-1.12

A1. Financial Analysis Summary

Abu Qir Fertilizers and Chemical Industries Company. As shown above, the Abu Qir Company had an operating profit of 43 percent in fiscal year 1995. Abu Qir has a cost advantage in nitrogen fertilizer production because of state-of-the-art plant technology made possible through technical and financial assistance from the German government. The geographic location of Abu Qir is another advantage. Located on the coast of the delta, Egypt's largest agricultural area, Abu Qir sells to Egypt's largest domestic fertilizer market and exports fertilizer from its doorstep. Because of such advantages and good plant management and maintenance, the company is the industry leader.

Egyptian Chemical Industries (KIMA). KIMA had a positive operating profit margin in each of the four years under review. The operating profit figures are misleading, as Kima's electrical costs are subsidized. If KIMA paid a fair market rate for electricity, the company would incur an annual loss. KIMA cannot produce fertilizer efficiently due to the high cost of the raw material produced through water electrolysis, which is an obsolete technology. Currently, KIMA pays a subsidized rate of LE 27 per 1,000 KWH. As a point of comparison, Abu Zaabal Company for Fertilizer and Chemicals pays a market rate of LE 180 per 1,000 KWH.

El Nasr Fertilizer and Chemical Company (SEMADCO). SEMADCO has two plants, at Suez City and Talkha City. The Suez plant has been incurring gross profit losses over the past five years due to surplus employment and outdated production facilities, erected in 1948. The plant has 3,000 employees on the payroll, resulting in total salaries amounting to 108 percent of sales revenue in 1995. Total 1995 salaries were LE 25 million.

Talkha, which has 6,500 employees, made a net profit in each of the years under review. The consolidated income statement of Semadco shows a net profit for each of the five years due to the Talkha complex's good performance. Talkha's average sales revenue from urea and ammonia nitrate increased 9 percent and 19 percent respectively each year over the past four years. Fertilizer market liberalization and exports were the chief causes of this positive trend.

SEMADCO's gross profit margin of 16 percent was adversely affected by the negative gross profits of the Suez plant, which compared unfavorably to the 26 percent average gross profit margin of the Talkha plant. Similarly, the return on sales for SEMADCO averaged 8 percent, compared to 18 percent for the Talkha plant. Gross profit margin is the sales revenue minus cost of goods sold and depreciation.

El Nasr Company for Coke and Chemicals. As a result of obsolete technology and the high cost of the coke oven gas that the company charges to the fertilizer plant, the plant incurred a large loss in each of the four years studied. Coke oven gas is a by-product of the company's coke production. Fertilizer sales account for only 4 percent of the company's total sales. Coke oven gas is used to produce ammonia, which is used to produce ammonium nitrate fertilizer for agriculture, ammonium nitrate for military explosives, nitric acid, and other products. However, the technology of using coke oven gas to produce ammonia is expensive and obsolete. The fertilizer plant is in need of an efficient source of ammonia for fertilizer production.

A2. Phosphate Sector

There are two phosphate fertilizer producing companies in Egypt: Abu Zaabal Company for Chemicals and Fertilizers and Egyptian Financial and Industrial Company (EFIC), also known as the Société Financière et Industrielle d'Egypte.

The market share of the two companies for the fiscal year ending June 30, 1995, is shown Table IV-4.

Table IV-4

Phosphate Sector Fertilizer Production (%)	**1995**
Single superphosphate: 913,000 tons	
EFIC	.69
Abu Zaabal	.31
Triple superphosphate: 42,000 tons	
Abu Zaabal	1.00

Table IV-5 shows the growth rate of the two companies for the past four fiscal years.

Table IV-5

Average Annual Growth Rate (%) **Phosphate Sector Fertilizer Production**	**1992-1995**
EFIC	.13
Abu Zaabal	.13

Operating profit margin for two companies for the past four years is shown in Table IV-6.

Table IV-6

Operating Profit (%)	**1992**	**1993**	**1994**	**1995**
Abu Zaabal	-.04	-.11	-.10	.02
EFIC	. 14	.10	.12	.13

A3. Financial Analysis Summary

Egyptian Financial and Industrial Company (EFIC). The Egyptian Financial and Industrial Company has a factory complex at Kafr El Zayat and another at Assiut. The company does not own a phosphate ore mine.

Balance sheets and income statements for the period studied, fiscal years 1992-1995, were available only as consolidated data for the Kafr El Zayat and Assiut factory complexes rather than individually.

The percentage of net income for the four year period ranged from 6 percent to 10 percent. The 1995 net profit, after taxes of LE 10 million, was LE 2.7 million. The 1995 net worth of the company was LE 38.6 million as compared to LE 31.4 million for 1994, and LE 27.2 million at fiscal year-end 1993. Net income is the net profit minus income tax. The net profit is the sales revenue minus cost of goods sold, depreciation sales, marketing and administrative expenses, sundry expense, interest expense, plus interest, investment, and sundry income.

Abu Zaabal Company for Chemicals and Fertilizers. Abu Zaabal Company for Chemical and Fertilizers owns a phosphate mining operation in addition to the fertilizer plant. Although the Abu Zaabal Company had a 2 percent operating profit in 1995, the company incurred large net losses in each of the four years studied because of interest expenses. The company recently negotiated with its creditors, the Bank of Alexandria, the National Bank of Egypt, and Bank Misr, to convert a portion of its overdraft accounts into medium-term loans with reduced interest rates. The parties reached agreement to convert LE 65 million of overdrafts into medium-term loans, which will be paid in annual installments with a simple interest rate ranging between 12-13 percent per annum.

Negotiations are in progress with the National Investment Bank to convert a past due debt from a British loan to equity in the company. The loan proceeds were used to buy mining equipment. The loan was later converted to a grant extended to the Egyptian government. As the loan was in British pounds, the value of the loan increased as the Egyptian pound lost value against the British pound. The company is seeking approval from the Ministry of Finance for the proposed debt-equity swap.

The company's sales increased 26 percent in 1994 and 14 percent in 1995 as a result of increased export sales of triple superphosphate. In 1995, the export of 50,000 tons of triple super phosphate resulted in LE 18 million in revenue. Increased sales in fiscal year 1994 did not result in a gross profit due to high cost of goods sold. However, in 1995, the company realized a gross profit of 10 percent.

A4. Current Fertilizer Company Issues

Expanding production is a commonly sought goal in the fertilizer industry. The four nitrogen fertilizer companies and one of the two phosphate fertilizer producing companies have plans for additional production either through new plant facilities or modifications to existing plants.

Privatization of the fertilizer industry is an even greater issue facing the Egyptian government. The September 24, 1995, "Memorandum of Understanding between the Ministry of Agricultural and Land Reclamation and the United States Agency for International Development for Agricultural Policy Reform Program," includes the following stipulation:

- "Based on the study of fertilizer to be completed by February, 1996, the GOE will adopt a time-phased liberalization and privatization plan for fertilizer production, marketing, and international trade."

- "Privatize one fertilizer plant by September, 1996."

Following is a summary statement concerning privatization of the fertilizer companies:

Abu Qir. Abu Qir is not considered a candidate for the privatization strategy of this study because of the Egyptian government's opinion that the company is already private. If the entire ownership of the Abu Qir Company was to be offered for sale, clearly this profitable, well-managed company would attract investors.

KIMA. KIMA cannot be considered a candidate for privatization as it is currently operating because it is unprofitable without a substantial electricity subsidy. The key to the viability of KIMA is to be able to source ammonia at a competitive market rate. Providing ammonia to KIMA under cost-effective conditions would favor privatization of the company.

SEMADCO. The Suez complex is unprofitable and would not attract investors in its present state. Talkha is profitable and presumably would be attractive to investors if the total ownership were available. A privatization strategy for the company could include an ammonia plant at the Suez complex so that production of fertilizer could be increased.

Coke. The Helwan plant would not be a candidate for privatization in its current unprofitable state. A good case for future privatization of the plant can be made if the proposed

ammonia plant unit at SEMADCO-Suez became a reality. Such a plant unit could also be the needed ammonia source for the El Nasr Coke plant.

EFIC. As a part of the Egyptian Government's privatization strategy, the EFIC is planning a stock offering for January or February 1996. The government is formulating a plan to issue 1.6 million shares valued at about LE 90 per share. It is anticipated that 10 percent of the shares will be offered to the public, while 20 percent will be offered to the company's workers at a discount with financing available either through a bank or through a employee plan, and the balance will be held by the government-owned Mining and Refractories Holding Company. The mechanics of the stock offering are being studied by a USAID-funded Arthur Anderson consulting team.

Abu Zaabal. The Abu Zaabal Company for Chemicals and Fertilizers is seeking approval of the Ministry of Finance for the proposed debt-equity swap with the National Investment Bank. In order to facilitate the swap, a USAID-funded study by Arthur Anderson has conducted a preliminary report for revaluating the company. The nominal value of the company's shares was evaluated by the Research and Studies Center at the Faculty of Commerce at Cairo University. A successful debt-equity swap could help the company become profitable. As a profitable company, Abu Zaabal would be a candidate for privatization.

B. Egypt's Fertilizer Industry Profile and Financial Analysis

This study, conducted by a USAID-funded Chemonics team, assessed Egypt's fertilizer industry. This particular section provides profiles and financial analyses of the companies that produce fertilizer. Study activities were conducted to provide information for the development of a liberalization and privatization plan for fertilizer production, marketing, and trade. Based on the findings of the study team, a proposed liberalization and privation plan was developed and is discussed in detail in Section V of this report.

There are four companies that produce nitrogen fertilizer. They are Abu Qir Fertilizers and Chemical Industries Co., Egyptian Chemical Industries, also known as KIMA, El Nasr Fertilizer and Chemical Company, also known as SEMADCO, and El Nasr Company for Coke and Chemicals. Except for Abu Qir Fertilizer and Chemical Industries Co., these companies are owned by holding companies which in turn are owned by the Egyptian government. Although not owned by a government holding company, Abu Qir Fertilizer and Chemical Company is owned by government-owned businesses.

There are two companies that produce phosphate fertilizer. These companies are Abu Zaabal Company for Chemicals and Fertilizers and the Egyptian Financial and Industrial Company (Société Financière et Industrielle d'Egypte). Both companies are owned and supervised by the government's Holding Company for Mining and Refractories under Law 203.

In assessing the fertilizer companies, the study team visited each of the fertilizer factory sites, interviewed the management personnel, and toured the factories. However, because of security concerns, only the Egyptian technical counterpart visited the Assiut factory.

Prior to the factory visits, a questionnaire was sent to each company chairman through the Ministry of Private Enterprise. Additionally, in the case of the financial assessment, the questionnaire was reviewed at the factory site with the financial manager. Production, marketing, and financial data was sought for the fiscal years ending June 30 of 1992, 1993, 1994 and 1995 as well as data for the first quarter of the 1996 fiscal year.

Despite concerted efforts to obtain information, only limited data was available to the study team. Only global information regarding costs of goods sold, i.e., data for the entire fertilizer company rather than data on individual products, was provided by the companies. In-depth study of the companies will require more specific data. The lack of data delayed the study for some weeks, and affected the study's overall quality. For example, due to the lack of detailed cost data, it was not possible to compare the relative cost of manufactured products by company. Detailed cost data would have made it possible to estimate the projected financial results of additional production under privatization.

Industry overview. For more than 30 years, the government controlled the fertilizer industry through ownership of production and distribution systems. Prior to 1991, the market price and the demand for fertilizer were determined by annual targets set by the Ministry of Agricultural and the Ministry of Industry. The principal client for fertilizer was the government-owned Principal Bank for Development and Agricultural Credit (PBDAC), which distributed fertilizer to farmers.

From 1991 onwards, based on World Bank criteria, PBDAC begin to withdraw from its role as the country's principal fertilizer client and distributor. By 1992, PBDAC had drastically limited its fertilizer activity and by 1993 and 1994 only handled 8-10 percent of the total amount of fertilizer. During the 30 years of the PBDAC era, fertilizer marketing was insufficiently emphasized, with companies looking to PBDAC as their principal client. As PBDAC's fertilizer activities ended, marketing efforts became an important part of fertilizer production business development activity and export markets were sought. With the advent of private fertilizer distributors and an expanded export market, the fertilizer industry adjusted to conducting business without PBDAC.

However, economic changes brought about by liberalization of the fertilizer distribution system and higher world fertilizer prices, which increased drastically in 1994, contributed to a nitrogen fertilizer shortage for the domestic market in 1994 to 1995. The fertilizer shortage resulted in an estimated loss of LE two billion in agricultural production. Unfortunately, a nitrogen fertilizer production shortage has been forecast for the current year.

Expanding production is often sought by fertilizer companies seeking to strengthen their position in a market. In Egypt, the four nitrogen fertilizer companies and one of the two phosphate fertilizer producing companies have plans for additional production, either through building new plant facilities or modifying existing plants.

Privatization is another important fertilizer industry issue. Initial steps toward privatization are shown in the following instances: Abu Qir Fertilizers and Chemical Industries Co. is said by government officials to already be private, although that statement is debatable. El Nasr Company for Coke and Chemicals' expansion plans call for a joint-venture with a minority private investor. Abu Zaabal Company for Chemicals and Fertilizers is in the process of negotiating a debt-equity swap that would include a limited offering of stock to the private sector. Finally, the Egyptian Financial and Industrial Company (Société Financière et Industrielle d'Egypte) has planned a limited offering of stock to the private sector for January or February 1996.

Profile and financial analysis of the fertilizer companies. The profile data was obtained by visiting plants and from information provided by company management. Calculations for financial analysis are based on the audited balance financial statements for the fiscal years ending

June 30, 1992, 1993, and 1994, in addition to the unaudited financial position for 1995. The financial calculations are included in this report.

A comment concerning the feasibility of privatization of each company is including at the conclusion of each financial analysis.

B1. Abu Qir Fertilizers and Chemical Industries Co.

Abu Qir Fertilizers and Chemical Industries Co. is located on the coast of Abu Qir Bay, 20 kilometers east of the port city of Alexandria. The location was selected to secure the supply of natural gas from the Abu Qir gas field. The location offers availability of water, roads, railway connections, and ship transport.

Profile. The company was established in 1975 as a joint stock company and began production in July 1979. Although the company is affiliated with the government-owned Holding Company for Engineering Industries, it is considered by Egyptian officials to be a privately held company. Its shareholders are, with minor exception as shown below, government-owned enterprises. The shareholders are: General Authority of Petroleum, 19.35 percent; General Organization of Industrialization, 12.91 percent; Misr Bank, 7.25 percent; Bank of Alexandria, 11.81 percent; Bank of Cairo, 7.26 percent; National Bank, 9.35 percent; Nasser Bank, 5.85 percent; Misr Insurance Co., 4.72 percent; National Insurance Co., 2.69 percent; Eastern Insurance Co., 2.69 percent; Egyptian Re-insurance Co., 5.00 percent; KIMA Fertilizer Co., 2.69 percent; Workers Union, 3.23 percent; and individuals, 5.19 percent.

The company is presently capitalized at 152 million Egyptian pounds (LE). The capital was increased over the years as follows: In 1975, the initial capital was LE 40 million; from 1988 to 1991, the capital was increased to LE 80 million; on July 9, 1994, the capital was increased to LE 124 million; and on December 29, 1994, the capital was increased to LE 152 million.

The company employs 3,000 people and is a modern, efficient fertilizer complex with two plants. The two plants were designed by the German firm UHDE-Mannesmann, which also procured plant equipment, supervised construction, and managed start-up activities. Following is the data on Abu Qir I and Abu Qir II.

Abu Qir I factory data. The factory is designed as a single train process utilizing the most advanced fertilizer technology. Ammonia is produced by steam reforming of natural gas and urea is produced by the continuous circulation method.

Design capacity. 1000 metric tons per day (MTPD) of ammonia and 1550 MTPD of urea.

Operations—natural gas. Daily natural gas consumption is about 1.2 million cubic meters; 50 percent is used as raw material and 50 percent as fuel.

Operations—raw water. Raw water consumption is 25,000 cubic meters per day. The water is supplied from the Rakta Canal through a pipeline which is 48 inches in diameter.

Operations—electrical power. The plant is electrically self-sufficient, containing a turbo-generator that produces 10 mega watts (MW) of power. The turbo-generator as well as the plant compressors are steam turbine-driven. In addition to the turbo-generator, the plant is also connected to the public electrical network.

Production. Ninety percent of the produced ammonia is directed to the urea plant, while the remaining ten percent is stored in the storage tank at -33 degrees centigrade and atmospheric pressure. The urea is automatically bagged in 50 kilogram capacity plastic bags. The bagged urea is loaded either on trucks or railway cars for forwarding to distribution centers and consumers. Bulk urea is also loaded into specially built trucks for transporting to ships for export.

Ammonia ship-loading project. Surplus liquid ammonia of about 75 MTPD is pumped at minus 34 degrees centigrade to specially equipped tankers which moor at 4 buoys located 8 kilometers northeast of the plant and export the product. The submarine pipeline that carries the refrigerated liquid ammonia is an 8 inch diameter line that is 8 kilometers long and located at a depth of 10 meters.

Abu Qir II factory data. Abu Qir II produces ammonia, nitric acid, and ammonium nitrate. Ammonium nitrate is the one of the most common and important fertilizers used worldwide. The ammonium nitrate fertilizer manufactured at Abu Qir II is produced by the most advanced technology available.

Design capacity. The Abu Qir II production plants are: 1,000 MTPD ammonia plant; 1,800 MTPD nitric acid plant; and a 2,400 MTPD ammonium nitrate plant.

Economics aspects. Abu Qir has a cost advantage in nitrogen fertilizer production due to efficient operations with state-of-the-art technology made possible through technical and financial assistance from the German government. The geographic location of Abu Qir is another advantage. Located on the coast of the delta, Egypt's largest agricultural area, Abu Qir sells to Egypt's largest domestic fertilizer market and exports fertilizer from its doorstep. Because of the company's advantages, and the good management evident in plant operations and maintenance, the company is the industry leader.

Proposed expansion. At the current time, the company's management is having a feasibility study performed for construction of an additional plant to be known as Abu Qir III. Only very limited information was available from company management concerning the proposed plant. The plant is said to be for the production of a large amount of high quality urea which would presumably be for the export market.

Financial analysis. Only limited financial data was available from Abu Qir management on the basis that financial disclosure was not in their interest. The German development bank, KfW, financed the development of Abu Qir I and Abu Qir II through soft loans and insured credit facilities. The total investment cost of the plants had reached LE 1.2 billion by 1990. Abu Qir III will reportedly be financed from equity and earnings.

The profitability indicators illustrated in Table IV-7 show that the company is generating strong profits from sales revenue that increased 37 percent in fiscal year 1993 and has maintained modest growth since that time. The increased sales volume occurred during the time of a strong export market which was accompanied by rising prices for nitrogen fertilizer.

High gross and pre-tax profit margins for 1992, 1993, 1994 and 1995 indicate that the company is well-managed and operating efficiently. Likewise, the return on sales and equity are outstanding, reflecting the advanced technology of the Abu Qir plants.

Table IV-7

Sales and Profitability: Fiscal Year Abu Qir Fertilizers and Chemical Industries Company	**1992**	**1993**	**1994**	**1995**
Sales (LE million)	366	503	521	547
Sales Growth Rate (%)	n/a	.37	.04	.05
Gross Profit (%)	.52	.52	.50	.54
Return on Sales (%)	.28	.23	.23	.30
Return on Equity (%)	.68	.62	.48	.25

Table IV-8

Asset Efficiency: Fiscal Year Abu Qir Fertilizers and Chemical Industries Company	**1992**	**1993**	**1994**	**1995**
Accounts Receivable DOH	6	7	7	7
Inventory DOH	439	474	489	459
Accounts Payable DOH	17	15	9	11
Current Asset Turnover	.69	.70	.74	.43

The asset efficiency of Abu Qir is reflected by the low number of days for accounts receivable and accounts payable. Such low numbers show good cash management. The number of inventory days is somewhat misleading as it consists mostly of spare parts, with only a small quantity of finished goods due to limited storage.

Table IV-9

Liquidity Management: Fiscal Year Abu Qir Fertilizers and Chemical Industries Company	**1992**	**1993**	**1994**	**1995**
Current Ratio	2.35	1.94	2.06	3.46
Quick Ratio	1.76	1.37	1.42	2.84
Revenue/Working Capital	1.2	1.46	1.43	.60

The current ratio and the quick ratio reflect the large amount of cash that the company maintains. The revenue/working capital ratio also reflects the strong cash position of this well-managed company.

Table IV-10

Financial Risk: Fiscal Year Abu Qir Fertilizers and Chemical Industries Company	1992	1993	1994	1995
Debt Ratio (Total Liabilities/Total Assets)	.89	.87	.81	.65
Total Debt/Net Worth	5.77	4.04	2.41	1.04

The debt ratio shows that company assets exceed liabilities by an increasing amount each year, illustrating that the company is financially sound. The total debt/net worth ratio improved each year, which reflects the profitability of the company as the earnings increase net worth by increasing reserves.

Privatization. Abu Qir is not considered to be a candidate for the privatization strategy of this study because of the Egyptian government's opinion that the company is already private. If the entire ownership of the Abu Qir Company was to be offered for sale, clearly this profitable, well-managed company would attract investors.

B2. Egyptian Chemical Industries (KIMA)

KIMA is located in the Upper Egypt city of Aswan, the site of the Aswan High Dam. The Aswan site was chosen so that the company could produce calcium ammonium nitrate fertilizer using cheap surplus electricity from the Aswan hydroelectric power station.

Profile. KIMA was established in 1956 as a joint stock company. The company was capitalized at LE 16 million, with actual production starting in 1960. Ninety percent of the stock is owned by the Government of Egypt's Chemical Industries Holding Company; all but a fraction of the remaining ten percent is owned by government companies.

Like other government-owned companies, the company chairman is appointed by the holding company and the employees are, in effect, government employees. The holding company is the supervisory authority for the company. The company has 1,965 full-time and 600 part-time employees.

At the KIMA factory, electricity is used to produce hydrogen through water electrolysis. In this case, the hydrogen is the main raw material for the production of ammonia, which is used to produce the fertilizer.

Factory data. The factory location is four kilometers southeast of Aswan. The factory was commissioned in 1960 with the following design capacity: ammonia plant by water electrolysis, design capacity 413 metric tons per day (MTPD). Nitric acid plant, 800 MTPD calculated as 100 percent, with a product concentration of 53 percent. Calcium ammonium nitrate plant, 1580 MTPD, with a product concentration of 20.5 percent which was successively increased to 26 percent, 31 percent and finally 33.5 percent nitrogen in order to save packing, transportation, and energy costs.

Economics aspects. Producing nitrogen fertilizer through water electrolysis requires four times the energy consumption of that produced by natural gas. Additionally, electrolysis has become increasingly uneconomical because of the increased cost of electricity.

During the period from 1971 to 1987, the price of electricity increased from LE 1.2 to LE 12.2 per 1,000 kilo watt hour (KWH). By May 1, 1991 the electricity price had increased to LE 17 per 1,000 KWH. On July 1, 1992, the price for electricity rose to LE 47 per 1,000 KWH.

As a result of the increased electricity price, it was no longer feasible to produce ammonia using water electrolysis. As a result, the electricity price to KIMA was set at LE 27 per 1,000 KWH rather then close the plant.

The total electrical energy required to run the plant is estimated to be 1.7 billion KWH per year, of which 88 percent is used for producing ammonia. The balance of the electricity is used as a power source.

Proposals for more efficient production. During the past few years, studies have been carried out concerning phasing out the production of ammonia produced by electrolysis, due to the high costs involved, and replacing it with imported ammonia.

The most recent study, conducted in 1993, called for the construction of a nitric acid plant with a capacity of 205 MTPD and a 10,000 MT ammonia storage tank with the requisite liquid ammonia facilities for storage of imported ammonia.

The study's recommendations were not adopted. Subsequently, KIMA made an agreement with a Canadian firm to produce heavy water for nuclear power plant electricity generation. Current restructuring plans for KIMA include seeking international joint venture activities which could involve such projects as the production of hydrogen peroxide.

Financial analysis. An analysis of the financial data reveals that KIMA made a net profit after tax in each of the years under review. In the past year the net profit was 14 percent. The net profit figures are misleading because KIMA's electrical costs are subsidized. If KIMA paid a fair market rate for electricity, the company would incur an annual loss.

KIMA cannot produce fertilizer efficiently due to the high cost of the raw material produced through water electrolysis. Currently KIMA pays a subsidized rate of LE 27 per 1,000 KWH. As a point of comparison, Abu Zaabal Company for Fertilizer and Chemicals pays a market rate of LE 180 per 1,000 KWH.

Table IV-11

Sales and Profitability: Fiscal Year Egyptian Chemical Industries (KIMA)	**1992**	**1993**	**1994**	**1995**
Sales (LE million)	96	112	111	110
Sales Growth Rate (%)	.18	.17	-.01	-.01
Gross Profit (%)	.23	.16	.21	.17
Return on Sales (%)	.12	.07	.11	.06
Net Profit (%)	.12	.10	.13	.14
Return on Equity (%)	.17	.14	.15	.15

Sales have been steady over the past three years following an 18 percent increase in the growth rate in 1992 and a similar increase in 1993. Profitability indicators show that the company

is generating profits from operations due to capping electricity prices at LE 27 per 1,000 kilo watt, as mandated by the July 1, 1992 decree from the Council of Ministers. By decree, the prices are to be stable for several years while the company prepares for the proposed new price of LE 47 per 1,000 KWH. It is important to note that at LE 47 per 1,000 KWH, with current technology, the company would incur losses.

Ammonia nitrate fertilizer, the company's main product, accounted for 90 percent of sales in fiscal year 1995. Sales, in units of 1,000,000 tons, decreased by 1 percent on average from 272 to 269 from 1992 to 1995.

Table IV-12

Product Mix in Percent: Fiscal Year Egyptian Chemical Industries (KIMA)	**1992**	**1993**	**1994**	**1995**
Ammonia Nitrate Fertilizer	84	86	89	90
Feroslion	13	12	9	9
Other	3	2	2	1
Total	100	100	100	100

Over the same period, the gross profit margin declined due to the increase in electricity expense. In spite of the decline in the gross profit margin, the operating profit margin remained relatively stable. The stability was due to the increase in other revenue and the decline in provisions.

The company's other revenue, which included interest and investment income, ranged from 4 percent of sales in 1992 to 9 percent of sales in 1995. During this period, the revenue from time deposits and investments in shares of companies including Abu Qir Fertilizers and Chemical Industries Company increased from LE 3 million to LE 9 million.

Table IV-13

Asset Efficiency: Fiscal Year Egyptian Chemical Industries (KIMA)	**1992**	**1993**	**1994**	**1995**
Accounts Receivable DOH	46	76	63	62
Inventory DOH	331	273	349	328
Raw Material DOH	30	21	51	43
Packaging Material DOH	10	11	17	12
Spare Parts DOH	233	202	227	215
Accounts Payable DOH	139	184	246	131
Asset Turnover	0.66	0.66	0.53	0.57

Accounts receivable, which accounted for 13 percent of total assets in 1993, declined to 9 percent in 1995 while the collection period increased an average of 16 days. The decline in the quality of accounts receivables was accompanied by stagnant accounts payable. The slow payment of accounts payable is typical of a company with slow sales and a cash short position.

Table IV-14

Inventory Breakdown (%): Fiscal Year Egyptian Chemical Industries (KIMA)	**1992**	**1993**	**1994**	**1995**
Raw Material	9	8	15	13
Packing Material	3	4	5	4
Spare Parts	70	74	65	66
Letters of Credit	15	9	3	3
Other	3	5	12	14
Total	100	100	100	100

The number of inventory days is high. This can be attributed to the large spare parts account, which amounts to 69 percent of total inventory, on average. Like other fertilizer companies, spare parts are shown as a current asset, although spare parts constitute parts for both the short and long-term use.

Table IV-15

Liquidity Management: Fiscal Year Egyptian Chemical Industries (KIMA)	**1992**	**1993**	**1994**	**1995**
Current Ratio	2.19	1.99	1.87	2.18
Quick Ratio	0.95	0.99	1.01	0.99
Revenue/Working Capital	1.60	1.70	1.41	1.45

The company has a strong liquidity ratio of 2:1. This is due to the large inventory and in part to a strong cash position. The company had LE 73 million in cash assets at fiscal year end 1994 and LE 44 million at fiscal year end 1995. The quick ratio reflects a strong cash position. The revenue/working capital ratio is good, reflecting the sound cash position.

Table IV-16

Financial Risk: Fiscal Year Egyptian Chemical Industries (KIMA)	**1992**	**1993**	**1994**	**1995**
Debt Ratio (Total Liabilities/Total Assets)	0.50	0.52	0.54	0.45
Leverage Ratio (Total Liabilities/Equity)	1.0	1.1	1.2	0.8
Total Debt/ Net Worth	0.11	0	0	0

The total liabilities/total assets ratio declined in 1995 due to the decrease in cash balances from LE 73 million to LE 44 million and increase in net worth as reflected in the leverage ratio. The company is un-leveraged and depends on internally generated funds for cash requirements for production and capital expenditure.

Privatization. KIMA cannot be considered a candidate for privatization as it is currently operating, as it is unprofitable without a substantial electricity subsidy. The key to the viability of

KIMA is the ability to source ammonia at a competitive market rate. Providing ammonia to KIMA under cost-effective conditions could allow privatization of the company.

B3. El Nasr Fertilizers and Chemicals Company (SEMADCO)

El Nasr Fertilizers and Chemicals Company is the oldest nitrogen fertilizer company in Egypt and it is the second largest in nitrogen fertilizer production. Abu Qir Fertilizers and Chemical Industries Company is the largest.

Profile. The company is owned by the government-owned Holding Company for Chemical Industries. The company has two factory locations: one is 15 km south of Suez City and the other is located in Talkha City in the delta. There are 3,000 employees at the Suez complex and 6,500 at Talkha City.

Factory data. The two factories have the following plants:

Suez City 1

- Ammonia plant by steam reforming, design capacity 259 metric tons per day (MTPD), commissioned in 1951.
- Five train nitric acid plant, 60 MTPD calculated as 100 percent, were commissioned in 1951. One of the five trains has been phased out due to a lack of spare parts and for safety reasons.
- One nitric acid plant (UHDE), design capacity 150 MTPD, was commissioned in 1958.
- Two calcium nitrate fertilizer trains, 15.5 percent nitrogen, design capacity 450 MTPD each, commissioned in 1958.
- One sulfuric acid plant, design capacity 300 MTPD, 98 percent WT/WT, was commissioned in 1958.
- An ammonium sulphate plant, with a designed capacity of 300 MTPD, 20.6 percent nitrogen, was commissioned in 1963.

Suez City 2

- Ammonia plant by steam reforming, design capacity 400 MTPD, was commissioned in 1992.
- A nitric acid plant with designed capacity of 450 MTPD, calculated as 100 percent, was commissioned in 1986.
- Two granulated ammonium nitrate trains, each with a design capacity of 500 MTPD, produce ammonium nitrate fertilizer of grade 33.5 percent nitrogen.

Talkha 1

- Ammonia plant by partial oxidation of natural gas, with a designed capacity of 360 MTPD, was commissioned in 1975.
- Four nitric acid trains, with a designed capacity of 225 MTPD were commissioned in 1975.
- A prilled fertilizer grade ammonium nitrate plant, design capacity 900 MTPD of 33.5 percent nitrogen, was commissioned in 1975.
- A methanol plant, incorporated in the A/M ammonium plant for the removal of carbon oxides, design capacity 100 MTPD, commissioned in 1995.

Talkha 2

- One train ammonia plant by steam reforming, design capacity 1260 MTPD, was commissioned in 1980.
- A prilled urea plant, with a design capacity 1725 MTPD, was commissioned in 1980.
- Off-site facilities include cooling towers, water treatment, and steam generation plants.

Proposed improvements. At the present time, company management is seeking World Bank or other favorable financing to implement projects in the plants to correct problems that bottleneck production.

The proposed improvements are:

Suez City Factory

- A new ammonia plant producing 400 metric tons per day (MTPD), which will replace the 50 year old ammonia plant.
- New nitric acid plant with 450 MTPD to replace old units.
- Reverse osmosis unit for improving raw water quality.

Talkha City Factory

- Replacing the copper liquor unit with a methanol-producing unit.
- Replacing the low efficiency nitric acid and ammonia neutralizers.
- Replacing the ammonia converters.
- Waste energy recovery by co-generation; the aim of the complementary modifications of the steam network is to decrease noise level, generate 17 MW power, and to improve the performance of the ammonia plant.

- Hydrogen recovery from high pressure purge from ammonia.

Financial analysis. An analysis of financial data revealed that the Suez factory complex had negative gross profits in each of the years under review. In each of those years, the cost of goods sold exceeded sales revenue. Salaries was a dominant factor in costs; fuel and power were also high relative to sales.

Talkha made a net profit in each of the years under review. Cost of goods sold ranged from 56 percent to 79 percent during that five years span. The consolidated income statement of SEMADCO also shows a net profit for each of the four years due to the good performance of the Talkha complex.

Table IV-17

Sales and Profitability: Fiscal Year SEMADCO	**1992**	**1993**	**1994**	**1995**
Sales (LE million)	242	257	285	299
Sales Growth Rate (%)	.08	.06	.11	.05
Gross Profit Margin (%)	.19	.07	.14	.22
Operating Profit (%)	.16	.04	.11	.19
Return on Sales (%)	.12	.02	.07	.11
Return on Equity (%)	.21	.03	.11	.18

The company's low average gross profit margin of 16 percent is attributed to the negative gross profits of the Suez plant which reduced the robust 26 percent average gross profit margin of the Talkha plant. Similarly, the return on sales for the company averaged 8 percent while that of the Talkha plant averaged 18 percent.

Table IV-18

Sales by Product: Fiscal Year Talkha Plant (LE million)	**1992**	**1993**	**1994**	**1995**
Urea 46.5%	133	142	157	179
Ammonia Nitrate 33.5%	54	76	89	95
Gross Sales Revenue	187	218	246	275

The Talkha plant's sales revenue of urea and ammonia nitrate experienced a 9 percent and a 19 percent average annual increase respectively over the past four years. This positive trend resulted from fertilizer market liberalization and increased exports.

Table IV-12 shows sales by product for the Talkha plant. The slight upward trend in the production of both urea and ammonia nitrate reflects a strong demand for nitrogen fertilizer, both domestically and internationally.

Table IV-19

Sales and Profitability: Fiscal Year Talkha Plant	**1992**	**1993**	**1994**	**1995**
Sales (LE million)	187	219	247	275
Sales Growth Rate (%)	.04	.17	.13	.12
Gross Profit (%)	.29	.20	.24	.30
Return on Sales (%)	.22	.15	.17	.19

The sales and profitability data of Talkha plant reflect the successful operation of this plant, which carries the SEMADCO company. The outstanding sales growth rate, the gross profit and the return on sales all reflect the success of this plant which is second only to Abu Qir.

Table IV-20

Sales by Product: Fiscal Year Suez Plant (LE million)	**1992**	**1993**	**1994**	**1995**
Calcium Nitrate 15.5%	38.7	21.3	20.7	6.4
Sulphur Nitrate 20.6%	15.9	16.3	17.1	17.2
Gross Sales Revenue	54.6	37.6	37.8	23.6

The sales revenue of the Suez plant deteriorated over the four year period due to the radical change in the plant's product mix. Sales revenues for calcium nitrate, which accounted for 70 percent of the plant's sales in 1992, experienced a 20 percent average annual decline due to the company's decision to phase out its production. The decision that continued production would be uneconomical was made due to high fixed costs, rising variable costs, and a low demand for the product. During the same period, sales revenue from sulphur nitrate experienced a slight increase.

Table IV-21

Sales and Profitability: Fiscal Year Suez Plant	**1992**	**1993**	**1994**	**1995**
Sales (LE million)	54.8	37.8	38.2	23.8
Sales Growth Rate (%)	.23	-.31	.01	-.38
Gross Profit (%)	-.16	-.66	-.45	-.64
Return on Sales (%)	-.24	-.75	-.56	-.82

The Suez plant incurred gross profit losses over the past five years due to surplus employment and outdated production facilities, erected in 1948. The plant has 3,000 employees on the payroll, with total salaries amounting to 108 percent of sales revenue in 1995. Salaries in 1995 totaled LE 25 million.

Table IV-22

Asset Efficiency: Fiscal Year SEMADCO	1992	1993	1994	1995
Accounts Receivable DOH	25	52	40	16
Inventory DOH	327	255	259	299
Raw Material DOH	72	48	51	62
Finished Goods DOH	8	2	3	4
Spare Parts DOH	175	168	184	188
Accounts Payable DOH	26	40	78	50
Current Asset Turnover	.27	.28	.30	.33

The company's asset efficiency showed a positive trend, with accounts receivable decreasing from 52 days in 1993 to 16 days in 1995. However, accounts payable increased over the same period, which reflects a cash short position due to the inefficiency of the Suez plant. The increase in inventory days on hand is a negative point, as inventory increased from LE 165 million in 1992 to LE 174 million in 1995. The inventory increase is due to a high and increasing level of spare parts, accounting for 63 percent of total inventory at the end of fiscal 1995.

Table IV-23

Inventory Breakdown: Fiscal Year SEMADCO (LE million)	1992	1993	1994	1995
Raw Material	36.4	30.2	32.3	36.3
Spare Parts	88.8	106	116	110
Work in Progress	1.2	2.2	2.7	2.0
Finished Goods	4.3	1.5	1.8	2.3
Letters of Credit	32.4	17.8	7.1	19.5
Other	2.6	3.5	3.1	3.9
Total	166	161	163	174

Spare parts are used for repair and maintenance of the plant. A significant stock must be kept on hand because of the potential wait for imported parts. Raw materials on hand decreased from 72 days in 1992 to 62 in 1995. Similarly, finished goods days on hand experienced a significant drop, from 8 days in 1992 to 4 days in 1995, due to a more efficient distribution system adopted by the fertilizer industry.

Table IV-24

Liquidity Management: Fiscal Year SEMADCO	**1992**	**1993**	**1994**	**1995**
Current Ratio	1.7	1.18	0.89	1.01
Quick Ratio	0.70	0.35	0.20	0.18
Revenue/Working Capital	2.03	7.40	-11.	2.72

The current ratio reflects an unhealthy decrease from a high of 1.7:1 in 1992 to 1.1:1 in 1995. This decrease was mainly due to the drop in the cash balance from LE 75 million in 1992 to LE 10 million in 1995. In addition, receivables decreased from LE 35 million in 1993 to LE 10 million in 1995. Similarly, the quick ratio declined from a high of 0.7:1 in 1992 to a low of 0.18:1, due to high inventories.

Table IV-25

Financial Risk: Fiscal Year SEMADCO	**1992**	**1993**	**1994**	**1995**
Debt Ratio (Liabilities/Assets)	0.77	0.76	0.76	0.75
Leverage (Liabilities/Equity)	3.32	3.21	3.23	3.05
Total Debt/Net Worth	2.16	2.17	1.96	1.97

The debt ratio of SEMADCO is acceptable; however, the ratio has been flat over the four year period studied, which indicates that the company is not making financial progress. The company is leveraged at little more than 3:1, reflecting heavy long term debt. In a similar manner, the total debt/net worth ratio shows that financial obligations due to the lenders and creditors are twice stockholders' total equity.

Privatization. The Suez complex is unprofitable and would not attract a privatization suitor in its present state. Talkha is profitable and presumably would be attractive to investors if the total ownership was available. A privatization strategy for the company could include an ammonia plant at the Suez complex to increase fertilizer production.

B4. El Nasr Company for Coke and Chemicals

The El Nasr Company for Coke and Chemicals is owned by the government-owned Holding Company for Metallurgical Industries. It is located 45 kilometers south of Cairo at Helwan.

Profile. The company began activities in 1964 with the capacity of producing 328,000 metric tons per year of metallurgical coke from coal, which is imported. To meet increased demand, the company increased coke production over the years to 1.5 million tons per annum. Ninety percent of the coke goes to produce iron and steel. Coke oven gas is a bi-product of coke production. The coke gas is used to produce ammonia and, in turn, ammonium nitrate fertilizer for agriculture, ammonium nitrate for military explosives, nitric acid, and other products.

However, the technology for using coke oven gas to produce ammonia is expensive and obsolete. Fertilizer sales account for only 4 percent of the company's total sales.

Factory data. The design capacity of the plant is 120 metric tons per day, but actual production is limited to 45,000 metric tons per year due to the obsolete technology used.

Economic aspects. The fertilizer plant is obsolete. Management stated that the plant cannot be shut down because the costs of closing the plant would exceed the losses incurred in keeping it open. Those losses would result from costs associated with disposing of the coke oven gas. The gas will be burned for fuel if the proposed plant becomes a reality.

Another argument against closing the plant are its 1,200 employees that the company cannot easily dismiss. Also, the Egyptian military depends on the plant for production of 20,000 metric tons per annum of ammonium nitrate for explosives. Finally, there are affiliated industries that depend on products produced by the plant. For example, the soft-drink industry depends on the carbon dioxide that the plant manufactures and the drug industry depends on ammonium bi-carbonate produced by the plant.

Proposed improvements under consideration. A feasibility study is under way concerning the possibility of building a 1,000 metric ton per day ammonia plant and a 750,000 metric ton per year ammonia nitrate plant at the Helwan site. Natural gas would be the raw material for the plant.

Financial analysis. This financial analysis deals solely with the company's fertilizer activity. Because the fertilizer activity represents only 4 percent of the company's business, the balance sheets were not subject to review. The income statements reviewed represent only the company's fertilizer activity.

Table IV-26

Sales and Profitability: Fiscal Year El Nasr Company for Coke & Chemicals	**1992**	**1993**	**1994**	**1995**
Sales (LE million)	16.9	14.2	14.9	16.9
Sales Growth Rate (%)	.24	-.16	.05	.13
Gross Profit (%)	-.74	-1.0	-1.1	-1.1
Return on Sales (%)	-.76	-1.0	-1.1	-1.1

The income statement revealed that the company made a negative gross profit in each of the four years under review. Losses resulted from the high cost of the coke oven gas that the company charges to the fertilizer activity. Because of the excessive charge for coke oven gas, the cost of goods sold exceeded sales revenue in 1994 and 1995.

Asset efficiency. An asset efficiency analysis was not a part of the financial analysis. As mentioned earlier, the balance sheet from which the asset efficiency would be derived was not relevant to this study.

Liquidity and capital structure. The liquidity and capital structure analysis was not a part of the financial analysis. As above, the balance sheet from which this analysis would be derived was not relevant to this study.

Privatization. The plant would not be a candidate for privatization in its current unprofitable state. A good case for future privatization of the plant could be made if the proposed ammonia plant at Suez becomes a reality. Such a plant could also be the needed ammonia source for the KIMA plant.

B5. Egyptian Financial and Industrial Company (EFIC)

The EFIC headquarters and one of its two plants is located at Kafr El Zayat, which is in the delta 100 kilometers north of Cairo; Assiut, in Middle Egypt, 500 kilometers south of Cairo, is the other plant location.

Profile. Founded in 1929, EFIC limited its early business to financial matters. The company eventually became the first phosphate fertilizer company in Egypt, and was nationalized in 1961. In 1993, it came under the supervision of the Holding Company for Mining and Refractories. There are a total of 2,856 workers at EFIC, as follows: Kafr El Zayat: production labor—410; production services labor—582; marketing labor—109; administrative labor—431; other labor—265. Assiut: production labor—390; production services labor—460; marketing labor—135; administrative labor—300.

The company has no mining interests. All of the raw materials for the two EFIC phosphate fertilizer plants are purchased. The principal raw material, rock phosphate, comes from the Red Sea and Nile areas of Egypt as well as from external sources.

A second major raw material is sulfur. The two EFIC phosphate fertilizer plants use 120,000 tons of sulphur each year. The sulphur is imported as a part of an annual tender made by six Egyptian companies for 250,000 metric tons.

Factory data. The company's early production at Kafr El Zayat was 50 metric tons per day of sulfuric acid and 120 metric tons per day of phosphate fertilizer. In 1964, a second Kafr El Zayat plant was added, which had a capacity of 180 metric tons of single superphosphate (SSP) per day. A third plant with a capacity of 300 metric tons of SSP per day was added in 1980. The second EFIC location is in Assiut. The Assiut plant dates from 1960; however, it did not become a part of EFIC until 1970. The two plants are described by the company chairman as being "twins" in production capabilities.

Design capacity. The design capacity of each plant is 165,000 metric tons of sulfuric acid a year. Kafr El Zayat designed to produce 382,000 MT per year of single superphosphate fertilizer in power form; Assiut has the design capacity to produce 255,000 MT per year of single superphosphate powder and 140,000 MT per year of granulated superphosphate fertilizer.

Pending improvements. A 500 MT per day granulated superphosphate plant will be completed at the Kafr El Zayat site in July, 1996. It is anticipated that the Egyptian farmers will be willing to pay an additional LE 30-40 per ton for granulated fertilizer because it is easier and more efficient to apply.

Economic aspects. EFIC's marketplace for fertilizer sales has changed dramatically in the past four years as a result of the major changes in Egypt's fertilizer industry that have occurred in that time frame.

In 1992, EFIC sold 777,000 metric tons of fertilizer in the domestic market; in 1993, however, only 400,000 metric tons were sold to the domestic market. This was due in large part to the fact that PBDAC, the principal client, was no longer in the market.

As a result of the diminished domestic market, EFIC increased marketing efforts to export fertilizer.

In 1993, EFIC's income from fertilizer exports was LE 4 million; in 1994 that amount increased to LE 10 million for 180,000 metric tons of fertilizer; and in 1995, export income figure increased to LE 14 million, mostly realized from granulated fertilizer produced at the Assiut plant. The Kafr El Zayaat plant produces only powder fertilizer.

Exports have continued to increase. Contracts have already been concluded to export 350,000 metric tons of fertilizer for the 1995-1996 fiscal year.

Financial analysis. Balance sheets and income statements for the period studied, fiscal years 1992-1995, were available only as consolidated data for the Kafr El Zayat and Assiut factory complexes rather than individually. The percentage of net income for the four year period ranged from 6 percent to 10 percent. The 1995 net profit, after taxes of LE 10 million, was LE 2.7 million. The 1995 net worth of the company was LE 38.6 million, as compared to LE 31.4 million for 1994, and LE 27.2 million at fiscal year-end 1993.

Table IV-27

Sales and Profitability: Fiscal Year Egyptian Financial & Industrial Co.	**1992**	**1993**	**1994**	**1995**
Sales (LE million)	100	85	104	139
Sales Growth Rate (%)	n/a	-.15	.22	.34
Gross Profit (%)	.32	.30	.32	.32
Operating Profit (%)	.14	.10	.12	.13
Return on Sales (%)	.06	.06	.10	.02
Return on Equity (%)	.28	.17	.32	.07

The consolidated income statement revealed that the company made a gross profit in each of the four years under review. The gross profit for the four year period was steady at 30-32 percent.

The 1995 net profit after taxes of LE 10 million was LE 2.7 million. The company operated at a net profit each of the years under review as indicated by the return on equity figures. The company's sales increased 22 percent in 1994 and 34 percent in 1995 as a result of increased export sales of single superphosphate.

Table IV-28

Asset Efficiency: Fiscal Year Egyptian Financial & Industrial Co.	1992	1993	1994	1995
Accounts Receivable DOH	18	97	86	9
Inventory DOH	311	588	265	223
Accounts Payable DOH	45	127	89	142
Current Asset Turnover	1.02	.58	.90	1.13

The number of days outstanding of the accounts receivable in 1993 and 1994 reflects poor asset management contrasted with the good quality of accounts receivable in 1995.

The extraordinary number of days of inventory reflects a large surplus inventory of spare parts and is typical of Egyptian fertilizer companies' financial statements.

The large number of days of accounts payable is indicative that the company operates on the float of payment of purchased goods. Taken as a common size number, accounts payable represented 8 percent of total liabilities in 1992, 13 percent in 1993, 14 percent in 1994, and 29 percent in 1995.

The large number of days outstanding in 1995 could be indicative of a problem with a supplier as adequate cash was available to pay. The current asset turnover is good considering the excessively high inventory relative to sales.

Table IV-29

Liquidity Management: Fiscal Year Egyptian Financial & Industrial Co.	1992	1993	1994	1995
Current Ratio	1.96	1.43	2.09	1.64
Quick Ratio	.29	.30	.83	.62
Revenue/Working Capital	3.28	2.52	2.51	4.01

The current ratio reflects good financial management in that current assets are more than adequate to pay the current liabilities. The quick ratio compared to current ratio illustrates how the large inventory figure, which includes spare parts, distorts financial calculations. The revenue/working capital ratio also reflects the good cash position and working capital of this company.

Table IV-30

Financial Risk: Fiscal Year Egyptian Financial & Industrial Co.	1992	1993	1994	1995
Debt Ratio (Liabilities/Assets)	0.78	0.81	0.73	0.69
Leverage Ratio (Liabilities/Equity)	3.5	4.4	2.7	2.2
Total Debt/Net Worth	2.42	1.89	1.26	0.46

The debt ratio trend, which is calculated by dividing total liabilities by total assets, shows that the company is making money and has an increasing net worth. The 1995 net worth of the company was LE 38.6 million, compared to LE 31.4 million for 1994, and LE 27.2 million at fiscal year-end 1993. The leverage reflects the increase in the net worth.

The annual improvement in the debt/net worth ratio reflects the increase in net worth as well as a reduction in bank debt. In 1994 and 1995, the EFIC had no short-term bank debt. In 1995, long-term debt was reduced to LE 17 million, from LE 39 million in 1994.

Privatization. As a part of the Egyptian government's privatization strategy, the EFIC is planning a stock offering for January or February 1996. Plans are being made to issue 1.6 million shares valued at about LE 90 per share. It is anticipated that 10 percent of the shares will be offered to the public, 20 percent offered to the company's workers at a discount with financing available either through a bank or through a employee plan and the balance of shares held by the government-owned Mining and Refractories Holding Company. The mechanics of the stock offering are being studied by a USAID-funded Arthur Anderson consulting team.

B6. Abu Zaabal Fertilizer & Chemical Co.

The Abu Zaabal Fertilizer & Chemical Co. complex is located at Abu Zaabal in the delta; its mine and port facilities, operating since the 1950s, are located on the west bank of the Nile in West Sebeia.

Profile. Abu Zaabal Fertilizer & Chemical Co. is owned by the government-owned Mining and Refractories Holding Company. The company is the only vertically-integrated producer of phosphate fertilizers in Egypt. In addition, it is the only producer of phosphoric acid and triple super phosphate.

Factory data and design capacity. Abu Zaabal Fertilizer & Chemical Co. begin operations in 1947. It has a single superphosphate plant with a rated annual capacity of 320,000 metric tons per year and rated capacity for 500,000 metric tons per year of triple super phosphate. The company has a sulfuric acid plant with a rated capacity of 320,000 metric tons per year, a phosphoric acid plant with a rated capacity of 45,000 metric tons per year, and a rated capacity of 200,000 tons per year of agricultural gypsum. It also has the rated capacity to produce 10,000 tons per year of di-calcium phosphate. Its phosphate mines are rated to produce 500,000 tons of phosphate ore per year.

Economic aspects. The withdrawal of PBDAC from fertilizer marketing activity in 1992 had a negative impact on Abu Zaabal Fertilizer & Chemical Co.—as the action did on all

fertilizer companies—since PBDAC was the principal client. Following the withdrawal of PBDAC, the company's sales department expanded in an effort to market the fertilizer. As a result of marketing efforts, the company's exports increased from LE 13 million in fiscal year 1992-1993 to LE 15 million in fiscal year 1993-1994, and reached LE 18 million in fiscal year 1994-1995.

Financial analysis. The company has an strategic advantage in the production of phosphate fertilizer because it owns a phosphate ore mine. According to the March 1995 phosphate study commissioned by USAID[1], the company has extensive phosphate ore reserves, which should be sufficient for at least the next 10 years. As a result of these reserves, the company is assured of a relatively inexpensive source of phosphate ore.

Table IV-31

Sales and Profitability: Fiscal Year Abu Zaabal Fertilizer & Chemical Co.	1992	1993	1994	1995
Sales (LE million)	74	73	91	104
Sales Growth Rate (%)	n/a	-.01	.26	.14
Gross Profit (%)	.05	.01	.00	.10
Operating Profit (%)	-.04	-.11	-.10	-.02
Return on Sales (%)	-.50	-.62	-.52	-.41
Return on Equity (%)	n/a	n/a	n/a	n/a

As indicated by the return on sales figures, the company incurred a net loss in each of the four years studied. The losses occurred because the company is burdened by a heavy debt load that has increased over the years. The increase in the debt resulted in part from the devaluation of the Egyptian pound against loans made in foreign currency and in unpaid interest charges accumulated since the 1970s. The company recently negotiated with its creditors, namely, the Bank of Alexandria, the National Bank of Egypt, and Bank Misr, to convert a portion of its overdraft accounts into medium-term loans with reduced interest rates. Agreement was reached to convert LE 65 million of overdrafts into medium-term loans that will be paid in annual installments with a simple interest rate ranging between 12-13 percent per annum.

Negotiations are in progress with the National Investment Bank to convert a past due debt from a British loan to equity in the company. The loan proceeds were used to buy mining equipment. The loan was later converted into a grant extended to the Egyptian government. As the loan was in British pounds, the amount of the loan increased as the Egyptian pound lost value against the British pound. The company is seeking approval from the Ministry of Finance for the proposed debt-equity swap.

The company's sales increased 26 percent in 1994 and 14 percent in 1995 as a result of increased export sales of triple superphosphate. In 1995, the export of 50,000 tons of triple super

[1]1995 Diagnostic Study, Domestic Phosphate Industry, USAID, Cairo, Egypt, March 26, 1995.

phosphate resulted in LE 18 million in revenue. Increased sales in fiscal year 1994 did not result in a gross profit that year due to the high cost of goods sold.

In 1995, however, a gross profit margin of 10 percent resulted from gross profits of LE 10.7 million, an increase from the negative gross profit figure of LE 188,000 in 1994. Prospects for the continued export of triple superphosphate should result in a gross profit for 1996. In spite of the projected gross profit, the company will continue to operate at a net loss due to excessive debt.

The return on equity figures are not applicable because the company has a negative net worth as a result of annual losses.

Table V-32

Asset Efficiency: Fiscal Year **Abu Zaabal Chemicals & Fertilizer Co.**	**1992**	**1993**	**1994**	**1995**
Accounts Receivable DOH	79	100	89	65
Inventory DOH	820	817	503	527
Accounts Payable DOH	86	127	96	116
Current Asset Turnover	0.18	0.18	0.24	0.29

The number of days outstanding of accounts receivable reflects poor asset management. The extraordinary number of days of inventory reflects a large surplus inventory of spare parts and excess inventory of phosphate ore. The large number of days of accounts payable is indicative of the short cash position of the company. The low current asset turnover reflects excessively high inventory figures relative to sales.

Table IV-33

Liquidity Management: Fiscal Year Abu Zaabal Chemicals & Fertilizer Co.	**1992**	**1993**	**1994**	**1995**
Current Ratio	1.11	1.05	.83	.95
Quick Ratio	.30	.16	.17	.21
Revenue/Working Capital	4.9	10.9	-.04	-.14

The current ratio appears adequate, but actually is not. It is distorted by the spare parts figure that is carried as a current asset. The quick ratio reflects the company's short cash position for the past three years. When spare parts are deducted from current assets, there is a working capital deficit as indicated by the quick ratio. The revenue/working capital ratio reflects the fact that the company had an inverted working capital position in 1994 and 1995. Considering the distortion of the working capital by the inventory figure, the company actually had a deficit working capital position in each of the four years studied.

Table IV-34

Financial Risk: Fiscal Year Abu Zaabal Chemicals & Fertilizer Co.	**1992**	**1993**	**1994**	**1995**
Debt Ratio (Liabilities/Assets)	1.03	1.14	1.26	1.36
Leverage Ratio (Liabilities/Equity)	n/a	n/a	n/a	n/a
Total Debt/Net Worth	n/a	n/a	n/a	n/a

The annual increase in the debt ratio shows that the company is losing money and reflects increased debt brought on by unpaid interest. The leverage ratio and the total debt/ net worth ratio are not applicable because the company has a negative net worth.

Privatization. The Abu Zaabal Company for Chemicals and Fertilizers is seeking approval by the Ministry of Finance for the proposed debt-equity swap with the National Investment Bank. In order to facilitate the swap, a USAID-funded study by Arthur Anderson has finished a preliminary report for revaluating the company. Additionally, the nominal value of the company's shares was evaluated by the Research and Studies Center at the Faculty of Commerce at Cairo University. A successful debt-equity swap could help the company become profitable. As a profitable company, Abu Zaabal could be a candidate for privatization.

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SEMADCO

9. Consolidated Historical Financial ratios
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Abu Qir Fertilizers and Chemical Industries Co.				
Historical Financial Ratios				
	1992	**1993**	**1994**	**1995**
Growth				
Revenue	NA	0.37	0.04	0.05
Gross Profit	NA	0.38	0.01	0.13
Operating Profit	NA	0.43	(0.01)	0.16
Net Profit Before Tax	NA	0.48	0.19	0.21
Operating Cash Flow (LE 000	NA	216,847	229,006	224,528
Free Cash Flow	NA		220,156	770,254
from operations				
Profitability Ratios				
Gross Profit Margin	0.52	0.52	0.50	0.54
Operating Profit Margin	0.39	0.41	0.39	0.43
Net Profit Margin	0.28	0.23	0.23	0.30
Return on Equity	0.68	0.62	0.48	0.25
Return on Invested Capital	#REF!	0.11	0.12	0.11
Return on Assets	0.08	0.08	0.09	0.09
Financial Risk				
Operating Profit / Interest Exp.	3	4	5	
Total Debt / Net Worth	5.77	4.04	2.41	1.04
Debt ratio	0.89	0.87	0.81	0.65
Asset Management				
Accounts receivable DOH	7	7	8	7
Inventories DOH	439	474	489	459
Accounts payable DOH	61	52	30	36
Asset Turnover	0.27	0.35	0.39	0.30
Liquidity Management				
Current Ratio	2.35	1.94	2.06	3.46
Liquidity Ratio	1.76	1.37	1.42	2.84
Revenue/ Working Capital	1.20	1.46	1.43	0.60

Abu Qir Fertilizers and Chemical Industries Co.				
INCOME STATEMENT, LE 000s				
	1992	1993	1994	1995
Revenues	366,385	503,524	521,858	547,345
Cost of goods sold				
Salaries	16,773	33,353	29,605	34,178
raw material	47,387	68,155	69,345	77,298
fuel & power	27,716	47,976	53,473	53,169
spare parts	5,418	8,252	10,952	11,998
production services	20,387	3,198	5,558	6,371
others	282	164	121	-
adjustment	(7,120)	538	(3,639)	176
Cost of goods sold	(110,843)	(161,636)	(165,415)	(183,190)
Depreciation	(66,702)	(81,767)	(94,660)	(68,895)
Gross Profit	**188,840**	**260,121**	**261,783**	**295,260**
SG&A	(46,211)	(55,455)	(58,229)	(59,453)
Operating income	**142,629**	**204,666**	**203,554**	**235,807**
Interest expense	(44,871)	(54,013)	(44,371)	(39,059)
Interest income	20,143	38,701	39,746	41,769
investment income	140	240	-	-
Sundry income	1,006	1,217	975	1,057
Sundry expense	(30)	(77)	(96)	(397)
Forein currency fluctioations	(13,293)	(12,882)	(8,912)	(7,318)
Other provisions	(2,166)	(25,013)	(9,000)	(11,161)
sub total	(39,071)	(51,827)	(21,658)	(15,109)
Net profit before Tax	**103,558**	**152,839**	**181,896**	**220,698**
Provision for income Tax	(41)	(38,028)	(61,412)	(55,359)
Net Profit (Loss) after Tax	**103,517**	**114,811**	**120,484**	**165,339**
Extraordinary items				
Prior year income	1,112	4,526	7,748	1,674
Prior year expense	(731)	(5,548)	(3,583)	(2,034)
Net Profit (Loss) After	**103,898**	**113,789**	**124,649**	**164,979**
Extraordinary items				

Abu Qir Fertilizers and Chemical Industries Co.				
Common Size				
	1992	**1993**	**1994**	**1995**
Revenues	1.00	1.00	1.00	1.00
Cost of goods sold				
Salaries	0.05	0.07	0.06	0.06
raw material	0.13	0.14	0.13	0.14
fuel & power	0.08	0.10	0.10	0.10
spare parts	0.01	0.02	0.02	0.02
production services	0.00	0.01	0.01	0.01
others	(0.02)	0.00	0.00	-
adjustment	(0.30)	0.00	(0.01)	0.00
Cost of goods sold	(0.30)	(0.32)	(0.32)	(0.33)
Depreciation	(0.18)	(0.16)	(0.18)	(0.13)
Gross Profit	**0.52**	**0.52**	**0.50**	**0.54**
SG&A	(0.13)	(0.11)	(0.11)	(0.11)
Operating income	**0.39**	**0.41**	**0.39**	**0.43**
Interest expense	(0.12)	(0.11)	(0.09)	(0.07)
Interest income	0.05	0.08	0.08	0.08
investment income	0.00	0.00	-	-
Sundry income	0.00	0.00	0.00	0.00
Sundry expense	(0.00)	(0.00)	(0.00)	(0.00)
Other provisions	(0.01)	(0.05)	(0.02)	(0.02)
sub total	(0.11)	(0.10)	(0.04)	(0.03)
Net profit before Tax	**0.28**	**0.30**	**0.35**	**0.40**
Provision for income Tax	(0.00)	(0.08)	(0.12)	(0.10)
Net Profit (Loss) after Tax	**0.28**	**0.23**	**0.23**	**0.30**
Extraordinary items				
Prior year income	0.00	0.01	0.01	0.00
Prior year expense	(0.00)	(0.01)	(0.01)	(0.00)
Net Profit (Loss) After	**0.28**	**0.23**	**0.24**	**0.30**
Extraordinary items				

Abu Qir Fertilizers and Chemical Industries Co.				
HISTORICAL BALANCE SHEET, LE 000s				
	1992	1993	1994	1995
Assets				
cash	274,116	351,402	335,863	796,162
Net Accounts receivable	6,564	10,116	10,968	11,031
Inventory	133,361	210,019	221,526	230,162
Other Current assets	115,520	143,732	140,351	244,841
Total Current Assets	**529,561**	**715,269**	**708,708**	**1,282,196**
Net Fixed assets	792,784	689,290	622,259	554,407
Investments	10,380	10,381	-	-
Other non current assets	29,113	5,865	8,200	6,918
Total Non Current Assets	**832,277**	**705,536**	**630,459**	**561,325**
Total Assets	**1,361,838**	**1,420,805**	**1,339,167**	**1,843,521**
Liabilities & Net Worth				
Accounts payable	18,497	22,983	13,520	18,136
Short term Bank debt	5,457	-	-	-
Other current liabilities	201,372	346,617	330,740	352,843
Total current liabilities.	**225,326**	**369,600**	**344,260**	**370,979**
Long term debt	879,695	748,014	604,088	674,900
Provisions	103,509	117,860	140,100	145,910
Total liab. & provisions	**1,208,530**	**1,235,474**	**1,088,448**	**1,191,789**
Net Worth				
Common stock	80,000	80,000	80,000	151,068
Reserves	73,308	105,331	170,719	500,664
Total Net Worth	**153,308**	**185,331**	**250,719**	**651,732**
Total liab. & net worth	**1,361,838**	**1,420,805**	**1,339,167**	**1,843,521**

Egyptian Chemical Industries (KIMA)					
Historical Financial Ratios					
	1991	**1992**	**1993**	**1994**	**1995**
Growth					
Revenue	0.11	0.18	0.17	(0.01)	(0.01)
Gross Profit	NA	0.11	(0.17)	0.27	(0.19)
Operating Profit	NA	0.26	(0.38)	0.60	(0.45)
Net Profit Before Tax	NA	3.93	(0.14)	0.62	(0.17)
Operating Cash Flow (LE 000s)	11,833	12,970	9,791	14,150	9,419
Free Cash Flow	NA	18,209	17,824	28,919	9,757
from operations					
Profitability Ratios					
Gross Profit Margin	0.25	0.23	0.16	0.21	0.17
Operating Profit Margin	0.12	0.12	0.07	0.11	0.06
Net Profit Margin	0.04	0.12	0.10	0.13	0.14
Return on Equity	0.05	0.17	0.14	0.15	0.15
Return on Invested Capital	0.03	0.13	0.11	0.12	0.12
Return on Assets	0.02	0.08	0.07	0.07	0.08
Financial Risk					
Operating Profit / Interest Exp.	136	240	201	1,322	
Total Debt / Net Worth	0.11	-	0.00	0.00	-
Debt ratio	0.57	0.50	0.52	0.54	0.45
Asset Management					
Accounts receivable DOH	60	46	76	63	62
Inventories DOH	393	331	273	349	328
Accounts payable DOH	192	139	184	246	131
Asset Turnover	0.59	0.66	0.66	0.53	0.57
Liquidity Management					
Current Ratio	1.91	2.19	1.99	1.87	2.18
Liquidity Ratio	0.83	0.95	0.99	1.01	0.99
Revenue/ Working Capital	1.61	1.60	1.70	1.41	1.45

Egyptian Chemical Industries (KIMA)					
INCOME STATEMENT, LE 000s					
	1991	1992	1993	1994	1995
Revenues	81,451	96,381	112,677	111,057	110,109
Cost of goods sold					
Salaries	11,547	11,340	12,868	13,436	14,467
raw material	8,212	10,811	12,079	11,113	9,380
fuel & power	22,662	29,824	46,397	46,113	46,452
spare parts	8,087	11,605	13,469	10,358	10,627
production services	2,236	2,534	2,250	2,328	3,278
Goods for resale	1,675	1,803	-	-	-
Commercial taxes	1,536	2,147	3,187	1,602	3,050
others	95	112	167	240	474
stock adjustment	(240)	(1,116)	(1,223)	(4,075)	(1,854)
Cost of goods sold	(55,810)	(69,060)	(89,194)	(81,115)	(85,874)
Depreciation	(5,528)	(5,045)	(4,894)	(6,295)	(5,100)
Gross Profit	**20,113**	**22,276**	**18,589**	**23,647**	**19,135**
Selling, General & Adminstrative					
marketing expenses	(7,383)	(6,983)	(7,249)	(7,441)	(7,890)
general & admin. expenses	(3,177)	(3,286)	(3,920)	(4,304)	(4,701)
SG&A	(10,560)	(10,269)	(11,169)	(11,745)	(12,591)
Operating income	**9,553**	**12,007**	**7,420**	**11,902**	**6,544**
Interest expense	(70)	(50)	(37)	(9)	-
Interest income	1,719	2,429	4,049	6,823	5,104
investment income	258	657	2,440	1,870	4,041
Sundry income	602	461	595	4,878	1,631
Sundry expense	(24)	(77)	(41)	(21)	(28)
Other provisions	(8,975)	(332)	(1,500)	(4,500)	-
sub total	(6,490)	3,088	5,506	9,041	10,748
Net profit before Tax	**3,063**	**15,095**	**12,926**	**20,943**	**17,292**
Provision for income Tax	(165)	(3,049)	(1,618)	(6,271)	(1,543)
Net Profit (Loss) after Tax	**2,898**	**12,046**	**11,308**	**14,672**	**15,749**
Extraordinary items					
Prior year income	2,709	1,864	1,581	8,498	4,242
Prior year expense	(321)	(645)	(819)	(691)	(320)
Net Profit (Loss) After	**5,286**	**13,265**	**12,070**	**22,479**	**19,671**
Extraordinary items					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
check	(14)	500	2	(19)	(19)

Egyptian Chemical Industries (KIMA)					
Common Size					
	1991	**1992**	**1993**	**1994**	**1995**
Revenues	1.00	1.00	1.00	1.00	1.00
Cost of goods sold					
Salaries	0.14	0.12	0.11	0.12	0.13
raw material	0.10	0.11	0.11	0.10	0.09
fuel & power	0.28	0.31	0.41	0.42	0.42
spare parts	0.10	0.12	0.12	0.09	0.10
production services	0.03	0.03	0.02	0.02	0.03
Goods for resale	0.02	0.02	-	-	-
Commercial taxes	0.02	0.02	0.03	0.01	0.03
others	0.00	0.00	0.00	0.00	0.00
stock adjustment	(0.00)	(0.01)	(0.01)	(0.04)	(0.02)
Cost of goods sold	(0.69)	(0.72)	(0.79)	(0.73)	(0.78)
Depreciation	(0.07)	(0.05)	(0.04)	(0.06)	(0.05)
Gross Profit	**0.25**	**0.23**	**0.16**	**0.21**	**0.17**
Selling, General & Adminstrative					
marketing expenses	(0.09)	(0.07)	(0.06)	(0.07)	(0.07)
general & admin. expenses	(0.04)	(0.03)	(0.03)	(0.04)	(0.04)
SG&A	(0.13)	(0.11)	(0.10)	(0.11)	(0.11)
Operating income	**0.12**	**0.12**	**0.07**	**0.11**	**0.06**
Interest expense	(0.00)	(0.00)	(0.00)	(0.00)	-
Interest income	0.02	0.03	0.04	0.06	0.05
investment income	0.00	0.01	0.02	0.02	0.04
Sundry income	0.01	0.00	0.01	0.04	0.01
Sundry expense	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Other provisions	(0.11)	(0.00)	(0.01)	(0.04)	-
sub total	(0.08)	0.03	0.05	0.08	0.10
Net profit before Tax	**0.04**	**0.16**	**0.11**	**0.19**	**0.16**
Provision for income Tax	(0.00)	(0.03)	(0.01)	(0.06)	(0.01)
Net Profit (Loss) after Tax	**0.04**	**0.12**	**0.10**	**0.13**	**0.14**
Extraordinary items					
Prior year income	0.03	0.02	0.01	0.08	0.04
Prior year expense	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)
Net Profit (Loss) After	**0.06**	**0.14**	**0.11**	**0.20**	**0.18**
Extraordinary items					

KIMA

	1991	1992	1993	1994	1995
Assets					
cash	18,954	28,530	37,387	73,572	44,574
Gross Accounts receivable	13,480	12,193	23,481	19,123	18,604
Provisions	(337)	(313)	(1,755)	(6,220)	(5,932)
Net Accounts receivable	13,143	11,880	21,726	12,903	12,672
Inventory	60,128	62,629	66,770	77,631	77,085
Other Current assets	13,945	7,691	7,096	5,261	6,534
Total Current Assets	**106,170**	**110,730**	**132,979**	**169,367**	**140,865**
Gross Fixed assets	87,665	91,598	93,788	98,219	98,470
Accum. depreciation	(70,911)	(74,113)	(76,932)	(79,513)	(81,493)
Net Fixed assets	16,754	17,485	16,856	18,706	16,977
Projects under construct.	3,657	3,305	4,057	2,134	4,537
Investments	8,902	10,209	10,462	10,350	23,620
Other non current assets	2,395	3,355	5,706	8,348	7,390
Total Non Current Assets	**31,708**	**34,354**	**37,081**	**39,538**	**52,524**
Total Assets	**137,878**	**145,084**	**170,060**	**208,905**	**193,389**
Liabilities & Net Worth					
Accounts payable	29,395	26,223	44,967	54,631	30,923
Short term Bank debt	6,543	-	55	2	-
Down Payment suppliers	89	871	92	1,016	2,413
Dividends Payable	11,549	13,008	12,547	20,631	20,732
Accrued Expenses	779	461	480	437	458
Creditors other than trade	6,301	8,916	7,221	11,771	8,391
Other current liabilities	804	1,095	1,344	2,066	1,749
Total current liabilities.	**55,460**	**50,574**	**66,706**	**90,554**	**64,666**
Long term debt	-	-	-	-	-
Provisions	22,645	22,560	22,538	23,028	22,925
Total liab. & provisions	**78,105**	**73,134**	**89,244**	**113,582**	**87,591**
Net Worth					
Common stock	16,000	16,000	16,000	16,000	16,000
Reserves	43,773	50,676	54,574	69,081	79,555
Retained Earnings		5,274	10,242	10,242	10,243
Total Net Worth	**59,773**	**71,950**	**80,816**	**95,323**	**105,798**
Total liab. & net worth	**137,878**	**145,084**	**170,060**	**208,905**	**193,389**

Semadco - consolidated					
Historical Financial Ratios					
	1991	1992	1993	1994	1995
Growth					
Revenue	NA	0.08	0.06	0.11	0.05
Gross Profit	NA	(0.11)	(0.60)	1.21	0.64
Operating Profit	NA	(0.08)	(0.72)	1.94	0.77
Net Profit Before Tax	NA	0.00	(0.84)	3.05	0.80
Operating Cash Flow (LE 000s	53,716	11,260	2,992	(10,384)	217
Profitability Ratios					
Gross Profit Margin	0.23	0.19	0.07	0.14	0.22
Operating Profit Margin	0.19	0.16	0.04	0.11	0.19
Net Profit Margin	0.11	0.12	0.02	0.07	0.11
Return on Equity	0.22	0.21	0.03	0.11	0.18
Return on Invested Capital	0.07	0.06	0.01	0.03	0.06
Return on Assets	0.05	0.05	0.01	0.03	0.04
Financial Risk					
Operating Profit / Interest Exp.	3	3	1	2	25
Total Debt / Net Worth	1.79	2.16	2.17	1.96	1.97
Debt ratio	0.75	0.77	0.76	0.76	0.75
Asset Management					
Accounts receivable DOH	38	25	52	40	16
Inventories DOH	321	327	255	259	299
Accounts payable DOH	43	26	40	78	50
Asset Turnover	0.30	0.27	0.28	0.30	0.33
Liquidity Management					
Current Ratio	2.01	1.76	1.18	0.89	1.01
Liquidity Ratio	1.09	0.70	0.35	0.20	0.18
Revenue/ Working Capital	1.56	2.03	7.40	(10.52)	272.24

Semadco - consolidated					
INCOME STATEMENT, LE 000					
	1991	1992	1993	1994	1995
Revenues	224,818	242,688	257,548	285,636	299,740
Cost of goods sold					
Salaries	44,549	43,392	42,341	NA	50,483
raw material	40,553	49,993	66,470	NA	61,190
fuel & power	41,863	69,719	95,118	NA	89,003
spare parts	19,435	15,009	13,008	NA	9,510
production services	4,727	6,287	9,973	NA	3,480
Goods for resale	-	-	-	NA	-
Commercial taxes	1,203	2,814	2,874	NA	3,368
others	113	208	138	NA	(5,197)
stock adjustment	(2,672)	(2,266)	806	NA	1,377
Cost of goods sold	(149,771)	(185,156)	(230,728)	(230,657)	(213,214)
Depreciation	(22,498)	(10,947)	(8,260)	(13,991)	(19,302)
Gross Profit	**52,549**	**46,585**	**18,560**	**40,988**	**67,224**
SG&A	(10,428)	(7,642)	(7,607)	(8,777)	(10,253)
Operating income	**42,121**	**38,943**	**10,953**	**32,211**	**56,971**
Interest expense	(13,384)	(15,378)	(14,651)	(14,750)	(2,260)
Interest income	10,455	11,952	11,266	421	60
investment income	120	81	81	81	23
Sundry income	1,291	2,206	1,301	4,831	3,134
Sundry expense	(68)	(106)	(72)	(460)	(96)
Other provisions	(7,743)	(4,826)	(3,768)	(1,629)	(20,632)
sub total	(9,329)	(6,071)	(5,843)	(11,506)	(19,771)
Net profit before Tax	**32,792**	**32,872**	**5,110**	**20,705**	**37,200**
Provision for income Tax	(8,175)	(4,438)	(237)	(246)	(4,217)
Net Profit (Loss) after Tax	**24,617**	**28,434**	**4,873**	**20,459**	**32,983**
Extraordinary items					
Prior year income	100	3,238	2,567	4,303	2,045
Prior year expense	(5,780)	(2,656)	(1,285)	(8,942)	(6,906)
Net Profit (Loss) After	**18,937**	**29,016**	**6,155**	**15,820**	**28,122**
Extraordinary items					

Semadco - consolidated					
Common Size					
	1991	**1992**	**1993**	**1994**	**1995**
Revenues	1.00	1.00	1.00	1.00	1.00
Cost of goods sold					
Salaries	0.20	0.18	0.16	NA	0.17
raw material	0.18	0.21	0.26	NA	0.20
fuel & power	0.19	0.29	0.37	NA	0.30
spare parts	0.09	0.06	0.05	NA	0.03
production services	0.02	0.03	0.04	NA	0.01
Goods for resale	-	-	-	NA	-
Commercial taxes	0.01	0.01	0.01	NA	0.01
others	-	-	-	NA	(0.02)
stock adjustment	(0.01)	(0.01)	0.00	NA	0.00
Cost of goods sold	(0.67)	(0.76)	(0.90)	(0.81)	(0.71)
Depreciation	(0.10)	(0.05)	(0.03)	(0.05)	(0.06)
Gross Profit	**0.23**	**0.19**	**0.07**	**0.14**	**0.22**
SG&A	(0.05)	(0.03)	(0.03)	(0.03)	(0.03)
Operating income	**0.19**	**0.16**	**0.04**	**0.11**	**0.19**
Interest expense	(0.06)	(0.06)	(0.06)	(0.05)	(0.01)
Interest income	0.05	0.05	0.04	0.00	-
investment income	-	-	-	-	-
Sundry income	0.01	0.01	0.01	0.02	0.01
Sundry expense	-	-	-	(0.00)	-
Other provisions	(0.03)	(0.02)	(0.01)	(0.01)	(0.07)
sub total	(0.04)	(0.03)	(0.02)	(0.04)	(0.07)
Net profit before Tax	**0.15**	**0.14**	**0.02**	**0.07**	**0.12**
Provision for income Tax	(0.04)	(0.02)	-	-	(0.01)
Net Profit (Loss) after Tax	**0.11**	**0.12**	**0.02**	**0.07**	**0.11**
Extraordinary items					
Prior year income	-	0.01	0.01	0.02	0.01
Prior year expense	(0.03)	(0.01)	(0.00)	(0.03)	(0.02)
Net Profit (Loss) After	**0.08**	**0.12**	**0.02**	**0.06**	**0.09**
Extraordinary items					

Semadco - consolidated					
HISTORICAL BALANCE SHEET, LE 000s					
	1991	1992	1993	1994	1995
Assets					
cash	86,304	75,247	12,451	5,827	10,964
Gross Accounts receivable	23,683	16,891	36,845	31,209	13,325
Provisions	(1,243)	(1,243)	(1,243)	(1,243)	(3,243)
Net Accounts receivable	22,440	15,648	35,602	29,966	10,082
Advance Payment	36,887	9,799	10,935	6,972	5,994
Inventory	131,617	165,783	161,111	163,364	174,588
Other Current assets	8,705	9,319	7,723	5,935	9,943
Total Current Assets	**285,953**	**275,796**	**227,822**	**212,064**	**211,571**
Gross Fixed assets	347,652	354,340	389,231	396,883	421,072
Accum. depreciation	(245,513)	(259,213)	(274,533)	(291,018)	(309,758)
Net Fixed assets	102,139	95,127	114,698	105,865	111,314
Projects under construct.	206,040	316,868	443,886	503,657	519,947
Investments	2,900	4,051	4,051	4,051	1,159
Other non current assets	-	-	-	-	-
Total Non Current Assets	**311,079**	**416,046**	**562,635**	**613,573**	**632,420**
Total Assets	**597,032**	**691,842**	**790,457**	**825,637**	**843,991**
Liabilities & Net Worth					
Accounts payable	17,442	13,331	24,998	49,378	29,195
Short term Bank debt	-	3,227	20,199	6,584	16,409
Down Payment suppliers	618	4,262	1,246	1,130	5,664
Dividends Payable	11,581	29,790	28,526	39,129	25,664
Accrued Expenses	64,198	71,742	83,021	94,962	7,649
Creditors other than trade	17,367	14,203	11,240	23,584	44,142
Other current liabilities	31,035	19,887	23,788	24,455	81,747
Total current liabilities.	**142,241**	**156,442**	**193,018**	**239,222**	**210,470**
Long term debt	266,614	342,686	386,111	375,829	394,040
Provisions	39,434	32,696	23,934	15,615	31,054
Total liab. & provisions	**448,289**	**531,824**	**603,063**	**630,666**	**635,564**
Net Worth					
Common stock	102,026	102,026	102,026	103,000	103,000
Reserves	46,717	57,992	85,368	91,743	104,796
Retained Earnings	-	-	-	228	631
Total Net Worth	**148,743**	**160,018**	**187,394**	**194,971**	**208,427**
Total liab. & net worth	**597,032**	**691,842**	**790,457**	**825,637**	**843,991**

Semadco - consolidated					
Common Size					
	1991	1992	1993	1994	1995
Assets					
cash	0.14	0.11	0.02	0.01	0.01
Gross Accounts receivable	0.04	0.02	0.05	0.04	0.02
Provisions	0.00	0.00	0.00	0.00	0.00
Net Accounts receivable	0.04	0.02	0.05	0.04	0.01
Advance Payment	0.06	0.01	0.01	0.01	0.01
Inventory	0.22	0.24	0.20	0.20	0.21
Other Current assets	0.01	0.01	0.01	0.01	0.01
Total Current Assets	**0.48**	**0.40**	**0.29**	**0.26**	**0.25**
Gross Fixed assets	0.58	0.51	0.49	0.48	0.50
Accum. depreciation	-0.41	-0.37	-0.35	-0.35	-0.37
Net Fixed assets	0.17	0.14	0.15	0.13	0.13
Projects under construct.	0.35	0.46	0.56	0.61	0.62
Investments	0.00	0.01	0.01	0.00	0.00
Other non current assets	0.00	0.00	0.00	0.00	0.00
Total Non Current Assets	**0.52**	**0.60**	**0.71**	**0.74**	**0.75**
Total Assets	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**
Liabilities & Net Worth					
Accounts payable	0.03	0.02	0.03	0.06	0.03
Short term Bank debt	0.00	0.00	0.03	0.01	0.02
Down Payment suppliers	0.00	0.01	0.00	0.00	0.01
Dividends Payable	0.02	0.04	0.04	0.05	0.03
Accrued Expenses	0.11	0.10	0.11	0.12	0.01
Creditors other than trade	0.03	0.02	0.01	0.03	0.05
Other current liabilities	0.05	0.03	0.03	0.03	0.10
Total current liabilities.	**0.24**	**0.23**	**0.24**	**0.29**	**0.25**
Long term debt	0.45	0.50	0.49	0.46	0.47
Provisions	0.07	0.05	0.03	0.02	0.04
Total liab. & provisions	**0.75**	**0.77**	**0.76**	**0.76**	**0.75**
Net Worth					
Common stock	0.17	0.15	0.13	0.12	0.12
Reserves	0.08	0.08	0.11	0.11	0.12
Retained Earnings	0.00	0.00	0.00	0.00	0.00
Total Net Worth	**0.25**	**0.23**	**0.24**	**0.24**	**0.25**
Total liab. & net worth	**1.00**	**1.00**	**1.00**	**1.00**	**1.00**

Semadco - Suez					
INCOME STATEMENT, LE 000					
	1991	1992	1993	1994	1995
Revenues	44,697	54,822	37,821	38,273	23,889
Cost of goods sold					
Salaries	19,058	17,672	16,496	NA	13,764
raw material	13,292	16,661	14,917	NA	7,938
fuel & power	2,837	18,606	18,844	NA	9,171
spare parts	12,950	3,370	3,316	NA	-
production services	1,870	1,374	1,722	NA	482
Goods for resale	-	-	-	NA	-
Commercial taxes	314	479	670	NA	412
others	78	80	82	NA	68
stock adjustment	(1,077)	(1,558)	2,000	NA	688
Cost of goods sold	(49,322)	(56,684)	(58,047)	(47,403)	(32,523)
Depreciation	(7,820)	(6,670)	(4,625)	(8,211)	(6,659)
Gross Profit	**(12,445)**	**(8,532)**	**(24,851)**	**(17,341)**	**(15,293)**
SG&A	(4,583)	(3,521)	(3,397)	(3,529)	(3,826)
Operating income	**(17,028)**	**(12,053)**	**(28,248)**	**(20,870)**	**(19,119)**
Interest expense	(873)	(760)	(723)	(1,021)	(1,335)
Interest income	-	-	-	-	44
investment income	28	28	28	21	-
Sundry income	237	171	670	986	1,033
Sundry expense	(6)	(30)	(17)	(75)	(22)
Other provisions	(1,360)	(280)	(60)	(451)	(30)
sub total	(1,974)	(871)	(102)	(540)	(310)
Net profit before Tax	**(19,002)**	**(12,924)**	**(28,350)**	**(21,410)**	**(19,429)**
Provision for income Tax	(87)	(107)	(69)	(71)	(81)
Net Profit (Loss) after Tax	**(19,089)**	**(13,031)**	**(28,419)**	**(21,481)**	**(19,510)**
Extraordinary items					
Prior year income	4	176	421	1,368	1,097
Prior year expense	(1,593)	(1,056)	(329)	(2,520)	(2,925)
Net Profit (Loss) After	**(20,678)**	**(13,911)**	**(28,327)**	**(22,633)**	**(21,338)**
Extraordinary items					

Semadco - Suez					
Common Size					
	1991	**1992**	**1993**	**1994**	**1995**
Revenues	1.00	1.00	1.00	1.00	1.00
Cost of goods sold					
Salaries	0.43	0.32	0.44	NA	0.58
raw material	0.30	0.30	0.39	NA	0.33
fuel & power	0.06	0.34	0.50	NA	0.38
spare parts	0.29	0.06	0.09	NA	-
production services	0.04	0.03	0.05	NA	0.02
Goods for resale	-	-	-	NA	-
Commercial taxes	0.01	0.01	0.02	NA	0.02
others	0.00	0.00	0.00	NA	0.00
stock adjustment	(0.02)	(0.03)	0.05	NA	0.03
Cost of goods sold	(1.10)	(1.03)	(1.53)	(1.24)	(1.36)
Depreciation	(0.17)	(0.12)	(0.12)	(0.21)	(0.28)
Gross Profit	**(0.28)**	**(0.16)**	**(0.66)**	**(0.45)**	**(0.64)**
SG&A	(0.10)	(0.06)	(0.09)	(0.09)	(0.16)
Operating income	**(0.38)**	**(0.22)**	**(0.75)**	**(0.55)**	**(0.80)**
Interest expense	(0.02)	(0.01)	(0.02)	(0.03)	(0.06)
Interest income	-	-	-	-	0.00
investment income	-	-	-	-	-
Sundry income	0.01	0.00	0.02	0.03	0.04
Sundry expense	-	-	-	(0.00)	-
Other provisions	(0.03)	(0.01)	(0.00)	(0.01)	(0.00)
sub total	(0.04)	(0.02)	(0.00)	(0.01)	(0.01)
Net profit before Tax	**(0.43)**	**(0.24)**	**(0.75)**	**(0.56)**	**(0.81)**
Provision for income Tax	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Net Profit (Loss) after Tax	**(0.43)**	**(0.24)**	**(0.75)**	**(0.56)**	**(0.82)**
Extraordinary items					
Prior year income	-	0.00	0.01	0.04	0.05
Prior year expense	**(0.04)**	**(0.02)**	**(0.01)**	**(0.07)**	**(0.12)**
Net Profit (Loss) After					
Extraordinary items					

Semadco - Talkha					
INCOME STATEMENT, LE 000s					
	1991	**1992**	**1993**	**1994**	**1995**
Revenues	180,121	187,866	219,727	247,363	275,851
Cost of goods sold					
Salaries	25,491	25,720	25,845	NA	36,719
raw material	27,261	33,332	51,553	NA	53,252
fuel & power	39,026	51,113	76,274	NA	79,832
spare parts	6,485	11,639	9,692	NA	9,510
production services	2,857	4,913	8,251	NA	2,998
Goods for resale	-	-	-	NA	-
Commercial taxes	889	2,335	2,204	NA	2,956
others	35	128	56	NA	(5,265)
stock adjustment	(1,595)	(708)	(1,194)	NA	689
Cost of goods sold	(100,449)	(128,472)	(172,681)	(183,254)	(180,691)
Depreciation	(14,678)	(4,277)	(3,635)	(5,780)	(12,643)
Gross Profit	**64,994**	**55,117**	**43,411**	**58,329**	**82,517**
SG&A	(5,845)	(4,121)	(4,210)	(5,248)	(6,427)
Operating income	**59,149**	**50,996**	**39,201**	**53,081**	**76,090**
Interest expense	(12,511)	(14,618)	(13,928)	(13,729)	(925)
Interest income	10,455	11,952	11,266	421	16
investment income	92	53	53	60	23
Sundry income	1,054	2,035	631	3,845	2,101
Sundry expense	(62)	(76)	(55)	(385)	(74)
Other provisions	(6,383)	(4,546)	(3,708)	(1,178)	(20,602)
sub total	(7,355)	(5,200)	(5,741)	(10,966)	(19,461)
Net profit before Tax	**51,794**	**45,796**	**33,460**	**42,115**	**56,629**
Provision for income Tax	(8,088)	(4,331)	(168)	(174)	(4,136)
Net Profit (Loss) after Tax	**43,706**	**41,465**	**33,292**	**41,941**	**52,493**
Extraordinary items					
Prior year income	96	3,062	2,146	2,935	948
Prior year expense	(4,187)	(1,600)	(956)	(6,422)	(3,981)
Net Profit (Loss) After	**39,615**	**42,927**	**34,482**	**38,454**	**49,460**
Extraordinary items					

Semadco - Talkha					
Common Size					
	1991	**1992**	**1993**	**1994**	**1995**
Revenues	1.00	1.00	1.00	1.00	1.00
Cost of goods sold					
Salaries	0.14	0.14	0.12	NA	0.13
raw material	0.15	0.18	0.23	NA	0.19
fuel & power	0.22	0.27	0.35	NA	0.29
spare parts	0.04	0.06	0.04	NA	0.03
production services	0.02	0.03	0.04	NA	0.01
Goods for resale	-	-	-	NA	-
Commercial taxes	0.00	0.01	0.01	NA	0.01
others	-	-	-	NA	(0.02)
stock adjustment	(0.01)	(0.00)	(0.01)	NA	0.00
Cost of goods sold	(0.56)	(0.68)	(0.79)	(0.74)	(0.66)
Depreciation	(0.08)	(0.02)	(0.02)	(0.02)	(0.05)
Gross Profit	**0.36**	**0.29**	**0.20**	**0.24**	**0.30**
SG&A	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
Operating income	**0.33**	**0.27**	**0.18**	**0.21**	**0.28**
Interest expense	(0.07)	(0.08)	(0.06)	(0.06)	(0.00)
Interest income	0.06	0.06	0.05	0.00	-
investment income	-	-	-	-	-
Sundry income	0.01	0.01	0.00	0.02	0.01
Sundry expense	-	-	-	(0.00)	-
Other provisions	(0.04)	(0.02)	(0.02)	(0.00)	(0.07)
sub total	(0.04)	(0.03)	(0.03)	(0.04)	(0.07)
Net profit before Tax	**0.29**	**0.24**	**0.15**	**0.17**	**0.21**
Provision for income Tax	(0.04)	(0.02)	-	-	(0.01)
Net Profit (Loss) after Tax	**0.24**	**0.22**	**0.15**	**0.17**	**0.19**
Extraordinary items					
Prior year income	-	0.02	0.01	0.01	0.00
Prior year expense	(0.02)	(0.01)	(0.00)	(0.03)	(0.01)
Net Profit (Loss) After	**0.22**	**0.23**	**0.16**	**0.16**	**0.18**
Extraordinary items					

Al Nasr Co. for Coke and Chemicals - Fertilizer activity					
INCOME STATEMENT, LE 000s					
	1991	1992	1993	1994	1995
Revenues	13,625	16,951	14,286	14,949	16,932
Cost of goods sold					
Salaries	1,249	1,364	1,532	1,741	2,017
raw material	22,637	24,144	22,560	24,389	27,757
Electricity	324	448	728	662	666
Water	271	305	348	506	595
Steam	762	951	1,068	1,722	1,787
other expenses	1,552	2,229	2,233	2,298	2,617
Cost of goods sold	(26,795)	(29,441)	(28,469)	(31,318)	(35,439)
Depreciation	(110)	(76)	(76)	(110)	(114)
Gross Profit	**(13,280)**	**(12,566)**	**(14,259)**	**(16,479)**	**(18,621)**
Selling, General & Adminstrative					
marketing expenses	(18)	(17)	(19)	(22)	(15)
general & admin. expenses	(241)	(266)	(305)	(313)	(373)
SG&A	(259)	(283)	(324)	(335)	(388)
Operating income	**(13,539)**	**(12,849)**	**(14,583)**	**(16,814)**	**(19,009)**

Al Nasr Co. for Coke and Chemicals - Fertilizer activity					
Common Size					
	1991	**1992**	**1993**	**1994**	**1995**
Revenues	1.00	1.00	1.00	1.00	1.00
Cost of goods sold					
Salaries	0.09	0.08	0.11	0.12	0.12
raw material	1.66	1.42	1.58	1.63	1.64
Electricity	0.02	0.03	0.05	0.04	0.04
Water	0.02	0.02	0.02	0.03	0.04
Steam	0.06	0.06	0.07	0.12	0.11
other expenses	0.11	0.13	0.16	0.15	0.15
Cost of goods sold	(1.97)	(1.74)	(1.99)	(2.09)	(2.09)
Depreciation	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)
Gross Profit	**(0.97)**	**(0.74)**	**(1.00)**	**(1.10)**	**(1.10)**
Selling, General & Adminstrative					
marketing expenses	(0.00)	(0.00)	(0.00)	(0.00)	-
general & admin. expenses	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
SG&A	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Operating income	**(0.99)**	**(0.76)**	**(1.02)**	**(1.12)**	**(1.12)**

Al Nasr Co. for Coke and Chemicals - Fertilizer activity				
Horizontal Analysis				
	1992	**1993**	**1994**	**1995**
Revenues	24%	-16%	5%	13%
Cost of goods sold				
Salaries	9%	12%	14%	16%
raw material	7%	-7%	8%	14%
Electricity	38%	63%	-9%	1%
Water	13%	14%	45%	18%
Steam	25%	12%	61%	4%
other expenses	44%	0%	3%	14%
Cost of goods sold	10%	-3%	10%	13%
Depreciation	-31%	0%	45%	4%
Gross Profit	-5%	13%	16%	13%
Selling, General & Adminstrative				
marketing expenses	-6%	12%	16%	-32%
general & admin. expenses	10%	15%	3%	19%
SG&A	9%	14%	3%	16%
Operating income	-5%	13%	15%	13%

Egyptian Financial and Industrial Company				
Historical Financial Ratios				
	1992	1993	1994	1995
Growth				
Revenue	NA	(0.15)	0.22	0.34
Gross Profit	NA	(0.20)	0.27	0.37
Operating Profit	NA	(0.38)	0.43	0.46
Net Profit Before Tax	NA	(0.23)	1.13	0.33
Operating Cash Flow (LE 000s	NA	10,328	13,312	16,178
Profitability Ratios				
Gross Profit Margin	0.32	0.30	0.32	0.32
Operating Profit Margin	0.14	0.10	0.12	0.13
Return on Sales	0.06	0.06	0.10	0.02
Return on Equity	0.28	0.17	0.32	0.07
Return on Invested Capital	NA	0.06	0.13	0.04
Return on Assets	0.06	0.03	0.09	0.02
Financial Risk				
Operating Profit / Interest Exp.	2	1	2	9
Total Debt / Net Worth	2.42	1.89	1.26	0.46
Debt ratio	0.78	0.81	0.73	0.69
Asset Management				
Accounts receivable DOH	18	97	86	9
Inventories DOH	311	588	265	223
Accounts payable DOH	45	127	89	142
Asset Turnover	1.02	0.58	0.90	1.13
Liquidity Management				
Current Ratio	1.96	1.43	2.09	1.64
Liquidity Ratio	0.29	0.30	0.83	0.62
Revenue/ Working Capital	3.28	2.52	2.51	4.01

Egyptian Financial and Industrial Company				
INCOME STATEMENT, LE 000s				
	1992	1993	1994	1995
Revenues	100,590	85,285	104,236	139,819
Cost of goods sold	(62,878)	(54,861)	(66,165)	(90,571)
Depreciation	(5,352)	(4,614)	(5,166)	(4,318)
Gross Profit	**32,360**	**25,810**	**32,905**	**44,930**
SG&A	(18,491)	(17,152)	(20,563)	(26,961)
Operating income	**13,869**	**8,658**	**12,342**	**17,969**
Interest expense	(7,893)	(8,473)	(5,601)	(2,026)
Interest income	64	2	261	1,436
investment income	4	4	4	-
Sundry income	1,179	4,673	4,878	4,149
Sundry expense	(127)	(16)	(28)	(41)
Other provisions	(921)	(100)	(1,735)	(8,073)
sub total	(7,694)	(3,910)	(2,221)	(4,555)
Net profit before Tax	**6,175**	**4,748**	**10,121**	**13,414**
Provision for income Tax	(18)	(17)	(18)	(10,708)
Net Profit (Loss) after Tax	**6,157**	**4,731**	**10,103**	**2,706**
Extraordinary items				
Prior year income	-	86	44	10,041
Prior year expense	(116)	-	(60)	(1,618)
Net Profit (Loss) After	**6,041**	**4,817**	**10,087**	**11,129**
Extraordinary items				

Egyptian Financial and Industrial Company				
Common Size				
	1992	**1993**	**1994**	**1995**
Revenues	1.00	1.00	1.00	1.00
Cost of goods sold	(0.63)	(0.64)	(0.63)	(0.65)
Depreciation	(0.05)	(0.05)	(0.05)	(0.03)
Gross Profit	**0.32**	**0.30**	**0.32**	**0.32**
SG&A	(0.18)	(0.20)	(0.20)	(0.19)
Operating income	**0.14**	**0.10**	**0.12**	**0.13**
Interest expense	(0.08)	(0.10)	(0.05)	(0.01)
Interest income	-	-	0.00	0.01
investment income	-	-	-	-
Sundry income	0.01	0.05	0.05	0.03
Sundry expense	(0.00)	-	-	-
Other provisions	(0.01)	(0.00)	(0.02)	(0.06)
sub total	(0.08)	(0.05)	(0.02)	(0.03)
Net profit before Tax	**0.06**	**0.06**	**0.10**	**0.10**
Provision for income Tax	-	-	-	(0.08)
Net Profit (Loss) after Tax	**0.06**	**0.06**	**0.10**	**0.02**
Extraordinary items				
Prior year income	-	0.00	-	0.07
Prior year expense	(0.00)	-	-	(0.01)
Net Profit (Loss) After	**0.06**	**0.06**	**0.10**	**0.08**
Extraordinary items				

Egyptian Financial and Industrial Company				
HISTORICAL BALANCE SHEET, LE 000s				
	1992	1993	1994	1995
Assets				
cash	1,425	622	6,839	26,944
Net Accounts receivable	4,947	22,575	24,628	3,267
Inventory	53,559	88,417	47,967	55,332
Other Current assets	2,784	2	162	3,755
Total Current Assets	**62,715**	**111,616**	**79,596**	**89,298**
Net Fixed assets	32,261	31,521	32,317	28,100
Investments	351	351	306	894
Other non current assets	2,927	3,649	3,507	5,710
Total Non Current Assets	**35,539**	**35,521**	**36,130**	**34,704**
Total Assets	**98,254**	**147,137**	**115,726**	**124,002**
Liabilities & Net Worth				
Accounts payable	7,725	19,050	16,131	35,356
Short term Bank debt	16,936	15,391	-	-
Other current liabilities	7,387	43,360	21,987	19,083
Total current liabilities.	**32,048**	**77,801**	**38,118**	**54,439**
Long term debt	35,596	36,153	39,665	17,762
Deffered taxes	3,804	1,804	2,804	6,457
Provisions	5,063	4,095	3,738	6,660
Total liab. & provisions	**76,511**	**119,853**	**84,325**	**85,318**
Net Worth				
Common stock	16,243	16,243	16,243	16,243
Reserves	10,208	11,041	15,158	22,441
Retained Earnings	(4,708)	-	-	-
Total Net Worth	**21,743**	**27,284**	**31,401**	**38,684**
Total liab. & net worth	**98,254**	**147,137**	**115,726**	**124,002**

Egyptian Financial and Industrial Company				
Common size				
	1992	**1993**	**1994**	**1995**
Assets				
cash	0.01	0.00	0.06	0.22
Net Accounts receivable	0.05	0.15	0.21	0.03
Inventory	0.55	0.60	0.41	0.45
Other Current assets	0.03	0.00	0.00	0.03
Total Current Assets	0.64	0.76	0.69	0.72
Net Fixed assets	0.33	0.21	0.28	0.23
Investments	0.00	0.00	0.00	0.01
Other non current assets	0.03	0.02	0.03	0.05
Total Non Current Assets	0.36	0.24	0.31	0.28
Total Assets	1.00	1.00	1.00	1.00
Liabilities & Net Worth				
Accounts payable	0.08	0.13	0.14	0.29
Short term Bank debt	0.17	0.10	0.00	0.00
Other current liabilities	0.08	0.29	0.19	0.15
Total current liabilities.	0.33	0.53	0.33	0.44
Long term debt	0.36	0.25	0.34	0.14
Deffered taxes	0.04	0.01	0.02	0.05
Provisions	0.05	0.03	0.03	0.05
Total liab. & provisions	0.78	0.81	0.73	0.69
Net Worth				
Common stock	0.17	0.11	0.14	0.13
Reserves	0.10	0.08	0.13	0.18
Retained Earnings	-0.05	0.00	0.00	0.00
Total Net Worth	0.22	0.19	0.27	0.31
Total liab. & net worth	1.00	1.00	1.00	1.00

Abu Zaabal Company for Chemicals and Fertilizers				
Historical Financial Ratios				
	1992	**1993**	**1994**	**1995**
Growth				
Revenue	NA	(0.01)	0.26	0.14
Gross Profit	NA	(0.75)	(1.22)	(58.34)
Operating Profit	NA	1.61	0.20	(1.17)
Net Profit Before Tax	NA	0.24	0.05	(0.10)
Operating Cash Flow (LE 000s	NA	14,798	13,288	21,623
Profitability Ratios				
Gross Profit Margin	0.05	0.01	(0.00)	0.10
Operating Profit Margin	(0.04)	(0.11)	(0.10)	0.02
Return on Sales	(0.50)	(0.62)	(0.52)	(0.41)
Return on Equity	2.69	0.85	0.49	0.33
Return on Invested Capital	NA	(0.13)	(0.15)	(0.15)
Return on Assets	(0.09)	(0.12)	(0.13)	(0.12)
Financial Risk				
Operating Profit / Interest Exp.	(0)	(0)	(0)	
Total Debt / Net Worth	(27.97)	(7.14)	(4.07)	(3.19)
Debt ratio	1.03	1.14	1.26	1.36
Asset Management				
Accounts receivable DOH	79	100	89	65
Inventories DOH	820	817	503	527
Accounts payable DOH	86	127	96	116
Asset Turnover	0.18	0.18	0.24	0.29
Liquidity Management				
Current Ratio	1.11	1.05	0.83	0.95
Liquidity Ratio	0.30	0.16	0.17	0.21
Revenue/ Working Capital	4.96	10.90	(3.54)	(14.03)

Abu Zaabal Company for Chemicals and Fertilizers				
INCOME STATEMENT, LE 000s				
	1992	1993	1994	1995
Revenues	73,538	72,875	91,480	104,241
Cost of goods sold	(47,091)	(51,938)	(72,054)	(72,923)
Depreciation	(23,045)	(20,075)	(19,614)	(20,538)
Gross Profit	**3,402**	**862**	**(188)**	**10,780**
SG&A	(6,469)	(8,858)	(9,397)	(9,136)
Operating income	**(3,067)**	**(7,996)**	**(9,585)**	**1,644**
Interest expense	(25,123)	(37,861)	(44,500)	(47,364)
Interest income	36	36	96	301
investment income	3	4	3	2
Sundry income	156	2,332	9,885	3,428
Sundry expense	(265)	(878)	(640)	(73)
Provisions for doubtful reciev.	(8,320)	(1,140)	(3,250)	(998)
sub total	(33,513)	(37,507)	(38,406)	(44,704)
Net profit before Tax	**(36,580)**	**(45,503)**	**(47,991)**	**(43,060)**
Provision for income Tax	(3)	(3)	(10)	(5)
Net Profit (Loss) after Tax	**(36,583)**	**(45,506)**	**(48,001)**	**(43,065)**
Extraordinary items				
Prior year income	-	-	-	5,880
Prior year expense	(180)	-	(25)	(150)
Net Profit (Loss) After	**(36,763)**	**(45,506)**	**(48,026)**	**(37,335)**
Extraordinary items				

Abu Zaabal Company for Chemicals and Fertilizers				
Common Size				
	1992	**1993**	**1994**	**1995**
Revenues	1.00	1.00	1.00	1.00
Cost of goods sold	(0.64)	(0.71)	(0.79)	(0.70)
Depreciation	(0.31)	(0.28)	(0.21)	(0.20)
Gross Profit	**0.05**	**0.01**	**(0.00)**	**0.10**
SG&A	(0.09)	(0.12)	(0.10)	(0.09)
Operating income	**(0.04)**	**(0.11)**	**(0.10)**	**0.02**
Interest expense	(0.34)	(0.52)	(0.49)	(0.45)
Interest income	-	-	0.00	0.00
investment income	-	-	-	-
Sundry income	0.00	0.03	0.11	0.03
Sundry expense	(0.00)	(0.01)	(0.01)	-
Provisions for doubtful reciev.				
sub total	(0.46)	(0.51)	(0.42)	(0.43)
Net profit before Tax	**(0.50)**	**(0.62)**	**(0.52)**	**(0.41)**
Provision for income Tax	-	-	-	-
Net Profit (Loss) after Tax	**(0.50)**	**(0.62)**	**(0.52)**	**(0.41)**
Extraordinary items				
Prior year income	-	-	-	0.06
Prior year expense	(0.00)	-	-	(0.00)
Net Profit (Loss) After	**(0.50)**	**(0.62)**	**(0.52)**	**(0.36)**
Extraordinary items				

Abu Zaabal Company for Chemicals and Fertilizers				
HISTORICAL BALANCE SHEET, LE 000s				
	1992	1993	1994	1995
Assets				
cash	16,390	745	2,201	1,317
Net Accounts receivable	15,902	19,960	22,321	18,541
Inventory	105,845	116,216	99,370	105,207
Other Current assets	7,597	348	1,219	10,079
Total Current Assets	**145,734**	**137,269**	**125,111**	**135,144**
Net Fixed assets	247,693	245,872	233,700	213,609
Investments	66	65	34	632
Other non current assets	12,324	12,481	14,969	7,006
Total Non Current Assets	**260,083**	**258,418**	**248,703**	**221,247**
Total Assets	**405,817**	**395,687**	**373,814**	**356,391**
Liabilities & Net Worth				
Accounts payable	11,115	18,089	18,963	23,256
Short term Bank debt	111,237	85,059	95,411	80,589
Other current liabilities	8,562	27,433	36,592	38,727
Total current liabilities.	**130,914**	**130,581**	**150,966**	**142,572**
Long term debt	269,031	298,070	305,858	331,469
Deffered tax	700	700	900	900
Provisions	18,768	20,021	14,679	10,550
Total liab. & provisions	**419,413**	**449,372**	**472,403**	**485,491**
Net Worth				
Common stock	39,248	39,248	39,248	43,248
Reserves	6,391	11,809	14,929	17,757
Retained Earnings	(59,235)	(104,742)	(152,766)	(190,105)
Total Net Worth	**(13,596)**	**(53,685)**	**(98,589)**	**(129,100)**
Total liab. & net worth	**405,817**	**395,687**	**373,814**	**356,391**

SECTION V

STRATEGIES FOR LIBERALIZATION AND PRIVATIZATION OF THE FERTILIZER INDUSTRY

SECTION V
STRATEGIES FOR LIBERALIZATION AND PRIVATIZATION OF THE FERTILIZER INDUSTRY

USAID and the GOE have expressed an interest in the formulation of a privatization plan for the fertilizer industry, which would guide this sector's departure from state ownership during the next five years. An important purpose of this report is to identify those fertilizer companies that can be privatized in the near term and to provide for the consideration of GOE and USAID a justification for their imminent divestiture.

The most important underlaying assumption to this privatization plan is that the GOE leadership has made a strong political commitment, in word and in deed, to proceed with a more rapid pace of privatization. A second underlying assumption is that the GOE will take substantial and concrete steps to encourage both domestic and foreign investment in general and investment in the fertilizer section in particular. This commitment also means the enactment of new legislation which has been pending in parliament for the last 18 months on the encouragement of private investment, provision of tax incentives, and the reduction of bureaucratic procedures. In addition, this commitment means that the GOE will provide a series of attractive incentives to investors who create substantial new employment opportunities. The underlying assumption is that the GOE will give reasonable assurances and incentives to the private sector that it will return to its former role as the primary fertilizer distributor in the country.

A major objective of this study is to initiate a dialogue among GOE officials, top management of the holding companies, fertilizer company chairmen, and USAID staff in order to determine the types and levels of support that can be provided in the future to implement a privatization plan similar to that which we discuss in this section.

The following are the fertilizer company privatization candidates and a step-by-step plan for their privatization.

A. Candidates for Privatization

Short-term privatization candidates. We recommend that one company, Talkha Fertilizer Company, be seriously considered for immediate privatization. We recommend that the parent company, SEMADCO, be separated into two companies, Talkha Fertilizer Company and Suez Fertilizer Company, based on the locations of the two plants. We estimate that establishment of the two companies should not take more than three months. Subsequently, a study of the Talkha Fertilizer Company would identify all the problems and solutions for the increase of production efficiencies and economic and financial viability. We estimate that this study will take three calendar months. After these two, three month periods, Talkha Fertilizer Company will be ready to undergo what we call the pre-privatization phase of activities. These are (1) undertake a full audit; (2) create plans for employee training, and out placement (3) prepare an equity distribution plan; (4) assemble a portfolio of documents to assist a strategic investor to undertake its due diligence analysis; (5) identify attorneys and investment bankers to represent the company; (6) search, identify, and negotiate with one or more strategic investors; (7) prepare management/labor ESOPs, if any; and (8) prepare and issue an initial public offering.

We estimate that these activities will take six months. Assuming that GOE and USAID agree to such a plan by March 1, 1996, the Talkha Fertilizer Company would be privatized by early to mid-summer 1997, allowing for several months lag time or unforseen contingencies.

The strategic investor for the purchase of the Talkha Fertilizer Company may come forth from the group of fertilizer distributors who are anxious to secure a reliable and uninterrupted supply of fertilizer for their customers. Given a transparent process, fair pricing of shares and a friendly (versus adversarial) attitude towards the new shareholders, including private investors, workers, and management, we do not foresee any serious problems in the realization of the privatization exercise in 12 to 18 months.

The justification for choosing the Talkha Fertilizer Company as the single candidate most appropriate for immediate privatization is that, despite substantial over employment, it seems well managed, is profitable, and has retrofitting requirements that are not overwhelming. In addition, the efforts and investments required for environmental improvements can be undertaken before or after privatization, subject to specific and concrete agreements with the GOE.

In the dialogue to take place between the GOE and USAID, assuming that the privatization of Talkha is acceptable to both parties, USAID and GOE may wish to access the resources available through three separate projects for the implementation of the plan described above. The first is the upcoming Agricultural Policy Reform project, which will be effective in calendar 1996. The second is the Partnership in Development project, effective since mid-1995. The third project is the Energy Conservation and Protection of the Environment project, or EP3. The nature of the resources that could be provided through these three projects for specific activities could be decided upon over a period of several weeks if there are agreements in principal to proceed with the approach described above.

Medium-term privatization candidates. Three companies fall into this group: Suez Fertilizer Company, El Nasr Company for Coke and Chemicals, and KIMA Fertilizer Company. All three of these companies are dependent on a secure and reliable ammonia source. Therefore, their privatization should coincide with the commissioning of the new 1000MTPD ammonia tolling plant expected in December 1998. During 1996, all the studies for each plan would be completed. The pre-privatization phase of activities will be undertaken in 1997 and early 1998, and the three companies taken to market by the end of 1998.

The Suez Fertilizer Company will have more serious retrofitting and environmental abatement requirements than some of the other fertilizer producers in the country and will therefore will take time to prepare for privatization.

The El Nasr Company for Coke and Chemicals will need special attention in order to separate it from its traditional coke-producing parent, in addition to addressing its retrofitting and environmental abatement problems.

The KIMA Fertilizer Company is envisioned as a new entity born from the division of the currently existing company into separate companies. The KIMA Heavy Water Company is envisioned as a new Egyptian-Canadian joint venture that will be more than 51 percent privately owned at its creation. The KIMA Fertilizer Company will be privatized shortly after it is converted for use of the ammonia provided by the new tolling operation proposed in Suez.

The companies indicated above would also be able to access the resources of the three USAID-funded projects mentioned earlier, subject to agreements between GOE and USAID.

Long-term privatization candidates. There are three companies that are candidates for privatization over the long term. We expect to create a certain amount of controversy in suggesting that these three companies are long-term rather than medium-term candidates for privatization. The three companies are Abu Qir, EFIC, and Abu Zaabal.

Although Abu Qir has commissioned a privatization study by KPMG/Frankfurt financed by KFW, it is not certain that this study will be divulged outside Abu Qir top management and board of directors in the near future. The main reason why we consider Abu Qir a long term privatization candidate is that the state-owned institutions that own 92 percent of its equity will not easily give up or dilute their ownership. Nor will these state-owned shareholders be privatized themselves in the near future. Consequently, Abu Qir, which is a well-managed and highly profitable company at present, without any formal ties to a holding company, will continue to exhibit corporate behavior identical to that of a private company. Depending on the decision of Abu Qir management and shareholders, it would be relatively easy to move Abu Qir Fertilizer Company from a long term to a short term privatization candidate. However, given the information available at this time, it is doubtful that 51 percent of the equity could be transferred to private investors in the near or medium term.

Taken by itself, EFIC may be considered a short term privatization candidate. It is profitable and well managed. Retrofitting and environmental abatement problems could be resolved in the short term with the acquisition of a knowledgeable strategic partner. However, taken as one of the two participants of the phosphate fertilizer subsector, in which the other participant has serious financial, operational, technical, and environmental problems, EFIC's privatization potential is affected. The issue at stake is the combination of these two companies as a single entity that will be privatized. Another important issue is the preparation and implementation of a regulatory framework under which this single company would operate. The market at present has a government owned and operated structure. Combining EFIC and Abu Zaabal does not change this structure. In fact, until Abu Tartur is fully operational, the new single and privately owned entity may be a monopoly itself for a short period of time, especially if other phosphate mines close due to exhaustion of reserves. Regardless of whether the market is dominated by one or several players, a regulatory framework will be needed. For the reasons stated above, EFIC and Abu Zaabal are considered long term privatization candidates.

At the time of the writing of this report, EFIC is preparing to divest itself of 30 percent of its shares to its workers and the public. It is possible that the company has already undertaken a full audit and has determined the value of its shares to be floated under its first IPO through recognized financial procedures. It is also a possibility that the company has a detailed and comprehensive privatization plan that identifies how the receipts of the 30 percent divestiture will be utilized. The upcoming divestiture could be the first step of a complete or majority share divestiture that will take place according to a well defined calendar. The company may also have undertaken full disclosure on the risks and expected returns that potential investors will face when investing in company shares, including the expected performance of the company in domestic and international markets over the next five years. In the absence of such information, it is difficult to judge the purpose and significance of the 30 percent divestiture.

In conclusion, there seems to be a real opportunity at this moment in time to open the fertilizer industry to improved technologies, new investments, and increased competition. The final privatization plan that will be implemented in the near or distant future will be drawn up and executed by the Government of Egypt according to its political and economic priorities.

B. State-Owned Production Companies

Within the universe of the six fertilizer producers in Egypt that are under the purview of four holding companies, the three nitrogen producers will receive more attention in this section than the two phosphate producers and Abu Qir.

B1. Abu Qir

Abu Qir can be distinguished in five respects from the other fertilizer producers:

- The holding company does not own shares in Abu-Qir.
- Outstanding shares are owned by entities (SOE) and individuals.
- The firm has a long-standing relationship with UHDE and KFW, which has led to the latter's financing of a privatization plan undertaken by KPMG/Frankfurt.
- Abu Qir is more profitable than the other producers, with more advanced technology. This fact led to the decision to finance the third line out of retained profits.
- The company is well situated to export to European markets.

Abu Qir management and the GOE consider the company private despite the fact that the majority of shareholders are state-owned institutions. As is the case for other SOEs, Abu Qir has five years to comply with the 1995 environmental regulations, while private sector companies have only three years. Without access to operational and financial data, it is difficult to consider and recommend privatization strategies for Abu Qir. Nevertheless, based on the limited information we have on this company, we believe that ownership can be diversified in the near future along the lines indicated in this section.

With a capital of 152 million LE, Abu Qir has 12 shareholders. These shareholders, which are state-owned enterprises, own 91.58 percent of the total outstanding shares. As far as can be determined, the workers' union owns 3.23 percent and individuals own 5.19 of shares. Whether the union is truly private or government controlled could not be determined.

Assuming that the union is private, we deduce that 8.42 percent of shares are privately owned and the rest state owned. The shareholders are:

General Authority of Petroleum	19.35
General Organization of Industrialization	12.91
Misr Bank	7.25
Bank of Alexandria	11.81
Bank of Cairo	7.26
National Bank	9.35

Nasson Bank	5.83
Misr Insurance Company	4.72
National Insurance Company	2.69
Eastern Insurance Company	2.69
Egyptian Insurance Company	5.00
KIMA Fertilizer Company	2.69
Workers Union	3.23
Individuals	5.10

Abu Qir management has indicated several points to the study team. First, we understand that the third line will be financed through retained earnings. Abu Qir management also indicated that the present shareholders do not feel that the company needs new investors or lenders at this time. Finally, the company's management has let it be known that should the need for additional funds arise in the future, they would be willing to put up the necessary capital without diluting their equity.

As the team was about to leave Egypt at the end of the assignment, we were informed that Abu Qir would float a public offering at 45 LE a share. We were also told that the active buyers were current shareholders, though this could not be confirmed.

Given the situation, the privatization strategy suggested below is based on the premise that the present shareholders would be willing to dilute their present holdings from 91.58 percent to about 60 percent in order to benefit an expanded management/worker ESOP or a new investor when a new public offering is undertaken in the future.

The strategy suggested for future study includes a strategic investor if needed as a result of the KPMG study. In addition, 5 percent equity could be made available to senior management of perhaps 10 to 20 individuals, 10 percent equity for middle management of about 100 individuals and 25 percent to workers under an ESOP, a total of 40 percent equity with a 60 percent share held by the current shareholders.

Shares would be purchased by an Employee Shareholder Association through a loan from a local or international bank. Shares under the ESOP would be paid out of dividends and liquidated in three to five years, during which time shares could not be traded. USAID could support this effort by making funds available to the Ministry of International Cooperation to guarantee the loan. For true privatization to take place (i.e., more than 51 percent in private hands), the current shareholders would either have to sell their equities or be privatized. However, it is unrealistic to expect either of this to happen in the near or medium term.

B1. Al Nasr Fertilizer and Chemical Co. (SEMADCO)

SEMADCO has two plants in different locations. One plant is located in Talkha and has 6,500 employees; the second plant is in Suez and has 3,000 employees. The company is under the umbrella of the Holding Company for Chemical Industries, which owns 100 percent of the total shares outstanding.

The privatization strategy recommended for SEMADCO, subject to further study and analysis of additional data not available to the study team, is as follows:

- Should there be a new 1000T/day ammonia plant in Suez, it should be a privately owned, financed, and managed tolling operation. The toll operator would transfer ownership according to a pre-determined formula and time frame. One option would be a minimum of 10 to 20 years for the transfer, which would be made to the highest bidder in the private sector or through the Cairo Stock Exchange, which will have by then matured sufficiently to handle such a transaction. The tolling operation would be a stand-alone entity completely financed by a foreign investor/operator with no local capital.

- During the first phase of privatization, subsequent to a valuation of assets and a complete study of its operations, management, and labor utilization, SEMADCO would be divided into two separate companies, with the shares held by SEMADCO Holding Company whose shares in turn will be held by the Holding Company for Chemical Industries.

The shares of the two new companies, which could be called for simplicity's sake Suez Fertilizer Co. and Talkha Fertilizer Co., would be sold to a strategic investor plus an IPO and an Employee Share Association under the following formula.

Suez Fertilizer Co.

Holding Co. for Chemical Industries (To be totally divested through stock market or by selling to current shareholders in five years.)	10 percent
Suez Fertilizer Co. Top and middle management	10 percent
Suez Fertilizer Co., work force	29 percent
Strategic investor and/or public	51 percent

In order to move toward privatization, the SEMADCO Suez plant needs three critical changes: a secure, reliable, and continuous supply of ammonia at reasonable cost; a technical and engineering restructuring involving the replacement of some equipment and rehabilitation of others; and a management and financial restructuring to improve management and labor efficiency and productivity. This financial restructuring would include the installation of new financial systems as well as debt rescheduling.

There is no doubt that once separated from SEMADCO, Suez Fertilizer Company will require funds for technical, management, and financial restructuring. A public offering should provide the needed funds, while at the same time a search for a strategic investor could be initiated, followed by negotiations for the transaction.

Suez is the site recommended for the establishment of the build, own, operate, and transfer (BOOT) based, foreign investor-owned tolling operation to provide ammonia to the old plants in Suez, Helwan, and KIMA.

Talkha Fertilizer Company. As an independent and profitable company, Talkha would be relatively easy to privatize, should the GOE wish to do so. It would be easier and quicker to privatize Talkha than any other fertilizer company, except for perhaps Abu Qir.

Initially, 100 percent of the stock of Suez and Talkha Fertilizer Companies would be owned by SEMADCO Holding. SEMADCO would disappear once Talkha Fertilizer Company and Suez Fertilizer Company became independent entities owned by their respective shareholders. The strategy suggested for Talkha, again subject to additional study, data collection, and analysis, is the transfer of majority control of the new company to an individual or group of strategic investors who would control at least 51 percent of the shares and the board of directors. The 49 percent would be owned by a combination of management/labor ESOP and a public offering.

As far the Employee Stock Ownership Plan approach is concerned, it is important to explain why it is being suggested.

The suggested ESOP is based on the premise that it would be preceded by an appropriate reduction in labor. Those workers retired and laid off would participate in the ESOP as partial compensation for their redundancy.

The ESOP concept should be thoroughly explained to workers. If workers do not approve of the concept, it should be scrapped, and management can look into a partially leveraged buy-out in collaboration with the new strategic investor.

Since an ESOP is a democratization of assets among a group of workers, it is an attractive option to the government of a previously controlled economy. However, establishment of an ESOP does not mean transfer of assets—for the sake of transfer—to an incompetent management or an unqualified, bloated labor force. It is a mechanism to inject enthusiasm and profit-driven motivation.

The privatization strategy suggested for the Talkha Fertilizer Company involves identifying and negotiating with a strategic investor who would purchase a controlling interest in the company after due diligence and all studies are completed. The design of the ESOP would be undertaken at the same time as the needed valuation studies and the search for investors.

Under a well thought-out, conceived, and implemented Employee Stock Ownership Plan (ESOP), an Employee Share Association (ESA) would borrow the money to buy the shares using the shares as collateral. The risk to the lender and the cost of the loan to the borrower could be reduced by an MIC issued guarantee backed by USAID. The loan would be liquidated over 5 to 10 years from dividends paid out on each share.

The holding company would own Class A shares negotiable at any time. The ESA would own Class B shares released to owners as they are paid for the shares would be negotiable by owners a year after shares are received from the ESA. The strategic investor and/or public would own a type of C share, or preferred stock, for the majority ownership of the company.

Past debt would either be forgiven or converted into long-term bonds, possibly guaranteed by MIC and backed by USAID if a financial analysis proves the soundness of the transaction. The reason a debt/equity swap is not suggested is that this would further dilute ownership. Since the debt is owed to state-owned banks, majority ownership would not be passing into private hands through a debt/equity swap but rather to an SOE bank.

B2. Helwan

The Helwan plant has two critical problems that should be resolved before a realistic privatization strategy can be formulated and a plan drawn up and implemented. The first is the technology and equipment utilized. These are outdated and need substantial rehabilitation; in other words, they require investment. The second problem is the company's financial condition, which is weak and is not conducive to impressing a prospective investor. With a thorough rehabilitation, financial restructuring, and the establishment of a new tolled ammonium plant in Suez that provides the needed supply to Helwan at market cost, a privatization strategy along the following lines becomes feasible.

Option one:

Phase I: Now ammonia plant: tolling operation 1996-1999

Phase Ia: Parallel to phase I: financial restructuring 1996-1999

Phase II: New nitric acid and new ammonium nitrate plant: 2000-2005 privately owned and operated by private strategic investor

Phase IIa : Parallel to phase II: establish an ESOP with an ESA

Phase I: Equity distribution-1996-1999

Holding Company	25 percent
Helwan management	10 percent
Helwan workers	25 percent
Strategic investor	40 percent

Phase III: The holding company divests its 25 percent share by selling it to:

- Strategic investor (private)
- New investor
- Stock exchange

Timing framework

Phase I: Phase I is expected to start when the GOE deliberates on the recommendations of this report in January 1996. If allowed, tolling operation will go on line no earlier than January 1999, assuming rapid decision making by GOE in 1996. This three-year period provides ample time for financial restructuring to take place, as indicated in Phase I.

Phase II: If approved by the GOE, phase II will go on line no earlier than January 2000 or 2001 although it would be preferable to have the new nitric acid and ammonium nitrate plant on line at about the same time that the new ammonium plant owned and operated by the foreign investor comes on stream. Parallel to the establishment of the new nitric acid and ammonium nitrate plants, which we recommend be owned by the private sector during phase IIa, an ESOP would be organized, creating an Employee Share Association (ESA). This strategy and implementation calendar attempts to map out a realistic time frame, assuming that the GOE will

need one or two more years before adopting a consistently more favorable attitude toward further industry liberalization and eventual privatization of one or more fertilizer producers.

Option Two:

Option two differs from option one in that it replaces the construction and installation of a new nitrate and plant and an ammonium nitrate plant, which would cost nearly $100 million, by the rehabilitation and capacity expansion of the current plants, at an approximate cost of 10 million. In this option, only the required investment changes. The suggested privatization strategy remains the same.

B3. KIMA

The privatization strategy for this company is different than the other plans due to the unique circumstances of the electrolysis technology utilized. KIMA shows a small profit but technology and equipment need rehabilitation. The company requires a continuous and reliable source of ammonia. It would also benefit from technical and management restructuring. Once these improvements take place, the following privatization strategy becomes feasible:

Phase I: Equipment rehabilitation 1996-1998

Phase Ia: Management and technical restructuring 1996-1998

Phase II: New ammonia supplied 1998-1999

Phase IIa: Formulate ESOP and create ESA 1997-1999

Privatization starts with following distribution:

Strategic investor	40 percent
Holding company	25 percent.
KIMA management	10 percent
KIMA workers	25 percent

Phase III: The holding company divests its 25 percent share by 2000 by selling to

- Strategic investor (private)
- New investor (private)
- Stock exchange (general public)

Timing Framework

Phase I:

Equipment rehabilitation is expected to start between 1996 and 1998. This activity will occur at the same time as a management and technical restructuring.

Phase II:

KIMA will eventually receive ammonia from a new plant in Suez, but it cannot control the timing of the plant's completion. Once this new ammonia plant is under construction, KIMA can initiate Phase IIa, which prepares the plant for privatization several years later.

Phase III:

The full implementation of an ESOP and the completion of the privatization process for KIMA will be sometime during 2000.

B4. Abu Zaabal

The company's major problem is a substantial debt accumulated over the last 20 years that has reached almost LE 300 million, which it is having difficulty repaying. This debt hampers privatization in the near term. The company is attempting a debt/equity swap with its creditors. However, such a swap would only accomplish the transfer of ownership from one SOE (the holding company) to another (the bank).

In the final analysis, creditors will need to write off a substantial portion of the company's debt if they want to keep the company a going concern, which they are naturally reluctant to do. Theoretically, creditors could bankrupt the company and liquidate its assets. However, it is doubtful they will recover a sufficient sum through liquidation, and politically the creditors most probably would not be allowed to liquidate.

Abu Zaabal will require massive financial restructuring in addition to thorough technical and management restructuring to determine which one of the two privatization strategies should be pursued. The first option is to rely on its own restructuring, turning into a lean and profitable operation that could be attractive to a strategic investor and eventual privatization. The second option is to first restructure and then merge with Kafr El Zayat prior to privatization. In both cases the company needs a strategic investor and a minority management/labor ESOP for restructuring.

B5. Kafr El Zayat

The company is profitable, seems well managed and could be considered ready for privatization after the necessary studies are undertaken. As this report was written in December 1995, the team was informed that the Ministry of Public Enterprise had approved a divestiture plan for this company, under which 1.6 million shares would be soon offered for sale at LE 90 a share. Ten percent of the shares would be disposed of in a public offering. Another 20 percent would be sold to the workers under concessional terms. A total of 70 percent of equity will be held by the holding company. This is not a rational route to privatization, since the holding company will continue to hold 70 percent equity without a definite plan and calendar for divesting the remaining shares. It may be considered apply to raise relatively inexpensive funds (cheaper than a loan) to feed an inefficient operation which should reduce costs.

Under the first option of a possible privatization strategy, Kafr El Zayat should be sold to a strategic investor who would own a minimum of 51 percent with the rest of the 19 percent divided between an expanded ESOP and a public offering. However, under the second option of

merging the company with Abu Zaabal, this would require substantial further study to determine an optimal and equitable privatization mechanism for the two companies.

There are two additional ways to increase private sector participation in fertilizer production in Kafr El Zayat. The first is by means of production of potassium sulfate. This could be a tolling operation similar to the ammonia plant in Suez. A foreign investor operating under the premise of build, own, operate, transfer would produce this intermediate product for 10 to 20 years, divesting by selling its share to a strategic local investor and through an IPO.

The second opportunity for private sector participation would be via the provision of specialized transportation services. Kafr El Zayat needs the transport of phosphate rock from two Red Sea Phosphate Companies, mines located in Al Nasr. The current number of rail wagons are insufficient and the service does not meet Kafr El Zayat's requirements. A strategic investor could purchase the number of rail wagons needed and transport rock from the two mines on a long-term contract basis. This is an interesting opportunity for both Kafr El Zayat and the proposed transport company. Barge transport is not possible, and trucking is currently four to five times more expensive than rail.

In summary, privatization strategies suggested for the six companies revolve around an equity distribution involving strategic investors, public offerings, and management/labor ESOPs. However, it must be noted that despite the pros and cons involved in the approaches for each company, this sector will remain under government control for the foreseeable future until the GOE deems it necessary that these producers be privatized.

Liberalizing distribution has not been mentioned in this section, as distribution should revert to the private sector under a regulatory framework. Any controls imposed on farmers, distributors, wholesalers, and retailers of fertilizer will continue to distort the market and can backfire, leading to crises that force the government to consider both rational and irrational responses.

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ANNEX A

SCOPE OF WORK

I. Work to be Performed by the Contractor

Assessment of Fertilizer Supply and Potential for Liberalization and Privatization of Fertilizer Production

Background:

In the past few years the GOE has liberalized the marketing and distribution of fertilizer and has removed all subsidies on fertilizer, except for K20. As policy barriers fell, the private sector responded by marketing over 80 percent of the fertilizer in 1992/3, with cooperatives and other semi-public institutions accounting for the remaining 20 percent. The GOE still controls the fertilizer production industry, although one of the six plants (Abu Kir) is in the process of being privatized. Private management of production could be expected to improve the efficiency of the entire fertilizer production and distribution system by: (1) setting prices at the competitive optimum; (2) adopting new cost-saving technology at a faster pace than the public sector; (3) operating without protection from imports; (4) producing products more closely reflecting farmers' requirements; and (5) awarding efficient management with adequate compensation.

Phosphate supply and distribution has been the subject of a separate study. The results will be integrated into the present analysis in order to present a comprehensive picture of the domestic fertilizer industry. This study will concentrate on nitrogen fertilizer production.

In addition to assessing the economic status of the present, publicly-owned domestic nitrogen and phosphate fertilizer industry, and developing a privatization and liberalization strategy, this study will assess future demand for fertilizers not traditionally produced in Egypt and explore future possibilities for developing a domestic production capacity. Two factors will be studied in this regard: (1) the potential for domestic production of potassium fertilizer, and (2) the possibilities for private sector expansion in the production of specialized fertilizers such as NPK, fertigation materials, and foliar fertilizers.

Objective:

The purpose of the contract is to assess the structure of the publicly-owned fertilizer industry, develop a liberalization/ privatization plan, and recommend a strategy for liberalizing the industry. A secondary objective is to analyze the supply, demand, and price situation in the fertilizer industry as presently structured, evaluate the expected situation under free-

market conditions, and derive measures of relative economic efficiency.

Scope of Work:

(1) Assess the structure of the Egyptian nitrogen fertilizer industry to determine: number and location of firms at each production level; management structure; shares of production and plant capacity utilization; trade arrangements; trading rules and regulations; employment; costs and returns; industry productivity (labor, capital); financial valuation of assets; and level of technology. The assessment will provide the basis for evaluating the privatization potential for the existing public sector companies, determining competitive conditions confronting prospective private investors and estimating benefits and costs of liberalizing the sector. The assessment will also describe and appraise the existing system for marketing, pricing, transporting and allocating nitrogen fertilizer to dealers. It will identify and quantify the efficiency and eventual marketability of public enterprises, given the current level of debts, employment requirements, and outlook for fertilizer demand.

(2) Identify barriers to entry of private firms, such as legal, economic, policy, trade and institutional factors. Study the present distributors' network for fertilizers. Assess the extent to which barriers prohibit growth in private investment. Recommend measures, particularly policy changes, for removing such barriers and a plan for implementing the measures.

(3) Estimate the impact of the liberalization of fertilizer production on employment, efficiency and value-added. Estimate trends in compound fertilizer manufacturing and applications. Develop estimates of the growth in exports and imports and in domestic production, make a preliminary estimate of private sector shares in this

growth, estimate the effect of privatization on employment, and predict the net effect of privatization on employment and growth in the fertilizer industry.

(4) Analyze the impact of the fertilizer tariff on economic efficiency at each level of production, marketing, and utilization of fertilizer.

(5) Determine the required institutional and support services for full liberalization and/or privatization of the Egyptian fertilizer industry and develop a plan for organizing and restructuring them. Options may include restructuring, selling or renting publicly-owned institutions and facilities.

(6) Assess the demand, supply and price outlook for nitrogen fertilizers over the next ten years, under a liberal market structure, and assess the impact of the demand, supply and price outlook on the plan to

liberalize/ privatize the production industry. Study the technology of applying fertilizer in liquid form, which is becoming a normal practice in the European community countries where they apply ammonium nitrate fertilizer. Examine new processes and know-how in the field of nitro-phosphatic fertilizer for possible application in Egypt.

(7) Assess supply and demand conditions for NPK fertilizers in Egypt, assess production technology, farmer acceptance and utilization, and predict future demand. Assess the supply outlook for basic NPK ingredients, costs and returns for existing production plants, and projected economic pre-feasibility of investing in production capacity in Egypt.

(8) Assess supply and demand conditions for specialty fertilizers such as liquid compounds for fertigation, phosphate, blends, and liquid foliar fertilizers. Assess the economic feasibility of future private investment in production capacity in Egypt.

(9) Assess supply and demand conditions for potassium fertilizers, assess production technology, farmer acceptance and utilization, and product future demand. Assess the feasibility of producing potassium fertilizers in Egypt.

(10) Develop a time-phased liberalization and privatization strategy and plan for enhancing competition, opening up the industry to private investment, removing remaining price and trade controls and implicit and explicit subsidies, and removing remaining policy barriers to private investment in fertilizer production. The plan should take into consideration the need to stimulate private investment in traditional fertilizer production as well as investment in more specialized products such as NPK, fertigation, and chemigation.

II. Time and Place of Performance

The work will be performed in Egypt and will start in Sept. 1995 according to the following schedule.

1. Weeks 1 and 2. Full team arrives, workplan is developed, and data needs are identified.

2. Weeks 3 through 14. Data collection, interviews, data analysis, and report drafted. All team members except the Team Leader depart at the end of week 14.

3. Weeks 15 and 16. Complete data analysis and report writing. Submit final report to GOE and USAID at the end of week 16.

III. Effective/Completion Date of the Delivery Order

The effective date of the delivery order will be Sept. 1, 1995; and the completion date will be Dec. 22, 1995.

IV. Contractor Furnished Personnel

A. Industry Economist and Team Leader

1. Qualifications: Ph.D. in Economics with at least ten years of experience as an analyst and practitioner in the fertilizer industry. At least five years of experience related to third-world fertilizer production and marketing problems. Experience in leading an economic study in a

third world setting. The expert must be skilled in developing and using quantitative economic models, using state of the art methods, including programming models, time series analysis,
and multi-equation, partial equilibrium systems. The expert must be fully conversant with the economic and technical characteristics of fertilizer production, marketing and use.

2. Level of Effort: 16 weeks, six days per week.

3. Primary Responsibilities:

- As team leader, plan and coordinate team members' field work, analyses, and drafting activities.

- Take responsibility for local arrangements, including logistics, employing Egyptian technical experts, and meetings with USAID, GOE, and private entrepreneurs.

- Take primary responsibility for tasks 1-3, and 10.

B. Agricultural Economist, Marketing and Price Analyst

1. Qualifications: Ph.D. in Agricultural Economics with a strong background in quantitative methods of price analysis. At least five years of experience as an analyst of crop production and fertilizer relationships, with at least two years experience working on such problems in the third world. Experience with irrigated agriculture is highly desirable. The expert must be experienced in developing and using quantitative models, including developing aggregate demand functions for fertilizer based on farm budget data and using sophisticated techniques of price analysis. The expert should be thoroughly conversant with on-farm fertilizer technology, especially under small farmer situations in the third world.

2. Level of Effort: 14 weeks, six days per week.

3. Primary Responsibilities:

- Carry out the supply demand and price analysis, developing input/output coefficients, types of fertilizers by regions and crops, develop aggregate demand functions by type of fertilizer,

and prepare long-range demand and supply forecasts.

- In collaboration with the Industry Economist, using estimated supply and demand functions, analyze the price relationships and trends expected under free market conditions, given crop prices, and prices of other inputs.

- Primarily responsible for tasks 4, 5, 6; contribute to 7, 8, and 9.

C. Chemical Engineer

1. Qualifications: Professional Chemical Engineer with at least ten years of hands on experience in the fertilizer industry. Third world advisory experience is desirable.

2. Level of Effort: 14 weeks, six days per week.

3. Primary Responsibilities:

- Review technical efficiency factors for all publicly-owned fertilizer production facilities.

- Assist the Industrial Economist in assessing industry production efficiency. Develop technical coefficients necessary to develop product supply functions.

- Contribute to tasks 1 and 3; take the lead in tasks 7, 8, and 9.

D. Financial Analyst

1. Qualifications: Equivalent of a B.A. in Accounting, CPA, or an equivalent of a MBA in Finance. Strong background in analysis of private and public financial systems with at least 5 years of experience in such analyses in developing countries. Experience in privatizing public enterprises is essential; experience with fertilizer companies is desirable.

2. Level of Effort: 8 weeks, six days per week.

3. Primary Responsibilities:

- Carry out a complete financial analysis of the six fertilizer production companies.
- With the Industry Economist, take primary responsibility for Task 1.
- Contribute to tasks 1 and 10.

E. Egyptian Counterpart Team

An (1) Industry Economist, (2) Agricultural Economist, (3) Chemical Engineer and (4) Financial Analyst will be contracted to provide local industry expertise. Each will have a minimum of five years of hands on experience in the Egyptian Fertilizer Industry and appropriate advanced degrees in the relevant disciplines.

The expatriate contract team will be responsible for contracting the Egyptian Team.

Principal tasks will be:

1) Provide insights into the structure of the Egyptian Fertilizer Industry;

2) Compile data and documents to complete the quantitative requirements of the study;

3) Assist in completing all specific tasks;

4) Assist in interpreting analytical results in the Egyptian economic, political, and social context.

V. Reporting and Deliverables

1. A detailed workplan will be completed during the first two weeks.

2. USAID and the GOE will be briefed on progress and preliminary results every two weeks thereafter.

3. A draft report will be prepared at the end of the 14th week.

4. Following review and comment by USAID and the GOE, a final report will be submitted (30 copies - i.e., 15 in English and 15 in Arabic) to USAID and the GOE at the end of the 16th week.

VI. Relationships and Responsibilities

The team will work under the technical direction of Dr. Rollo Ehrich, Agricultural Economist and Mr. Mohamed Omran, Agricultural Economist at the USAID Mission in Egypt. All coordination with the Government of Egypt will be carried out through the USAID Technical Office.

The Ministry of Public Enterprises (MPE) and representatives of the Holding Companies for Chemical Industries will be the main GOE contacts for the study.

ANNEX B

QUESTIONS AND ANSWERS

ANNEX: QUESTIONS AND ANSWERS

Following is a list of questions posed by H.E. Atef Obeid, Minister of Public Enterprises, during the study team's final report of its findings. The final report was presented at a meeting held on December 17, 1995, five days prior to the study team's departure from Egypt.

The following response to the questions was written by a member of the Chemonics PRE/IQC fertilizer study team for USAID's consideration in responding to the minister.

1. Product mix recommended and reasons.

Fertilizer product mix was not a subject of the current study. Data from the Ministry of Agriculture, the Principal Bank for Development and Agricultural Credit, and from various studies done by consultants indicate that a product mix recommendation could be the subject of a three-month study by a consultant.

2. Present and future demand for different types of fertilizers.

The present study addresses the current and future demand for nitrogen fertilizer. A recent study of the phosphate fertilizer industry addressed the demand for that sector of the industry.

3. Detailed explanation on the different models utilized in forecasting demand.

An explanation of the forecasting models can be found in this study in Section III concerning the demand for nitrogen in Egypt.

4. Identify and analyze different scenarios for the supply, demand and consumption of fertilizer.

The present study contains three scenarios in Section III concerning the projected consumption of nitrogen fertilizer in Egypt for the period from 1996 through the year 2005.

5. What will be the world demand for different types of fertilizer in the future? Determine the international demand by specific markets and countries, and analyze the reasons for the expected changes in future demand.

CRU International Ltd., the parent company of British Sulphur Consultants, publishes studies concerning the five-year outlook for various fertilizers. The Five Year Outlook for Ammonia, 1995-2000 was purchased as a part of the present study. The recent phosphate study included a British Sulphur Consultants report, which was specific for Egypt.

6. What will be the future price for all the different types of fertilizers, including those recommended in the product mix?

The recognized authority for the forecasting of fertilizer prices is British Sulphur Consultants. It would be necessary to check with British Sulphur Consultants to learn about the availability of fertilizer data that is more specific for Egypt than the data contained in The Five Year Outlook for Ammonia, 1995-2000.

7. ***What are the expected changes in supply, demand, consumption, and production of all types of fertilizers in Egypt and the world?***

This study addresses the current condition of the Egyptian fertilizer industry as well as expected changes in supply, demand, consumption, and production of fertilizer in Egypt. Data concerning changes in the world supply, demand, consumption, and production of fertilizer can be found in British Sulphur Consultants outlook reports described earlier in this document.

8. ***All existing studies should be made available, including those done by the individual production companies.***

I agree.

9. ***What would be the estimated cost of rehabilitating all of the production companies that need such a program?***

This study contains a recommendation, in the technical section, that a study be authorized regarding the rehabilitation of the fertilizer production companies. Such a study would include an estimation of the rehabilitation costs.

10. ***What are all the investments required for new plants and rehabilitating the existing ones?***

This study contains a recommendation that a study be authorized by USAID concerning the economic viability of constructing a 1,000 metric ton per day ammonia production facility to replace the old inefficient ammonia units at Suez I, El Nasr Coke, and KIMA. The facility would be privately owned and financed under the build, own, and operate tolling concept. The investment cost of the facility is expected to be between $200-250 million U.S. The cost of rehabilitating the old plants could be determined by a study referred to in response to question 9.

11. ***What are all the elements of modernization that need to be undertaken in marketing and production?***

This study contains recommendations for improvements in fertilizer production. The marketing of fertilizer can best be done by the private sector, as has been demonstrated.

12. ***How can we get private investors interested in investing? How can they be motivated?***

This initial section of this study, in the discussion concerning constraints and barriers to trade, refers to investor incentives. In the case of the proposed ammonia production tolling facility, an incentive would involve a guarantee from the government concerning the price of natural gas.

13. ***How can we establish a system to receive international know-how so that we can be informed about changes in technology?***

The design and implementation of a management information system concerning fertilizer technology could be accomplished by a consultant in a one-year period.

14. How can we get the private sector to be as efficient as the public sector in the distribution of fertilizer?

The private sector fertilizer distribution can be more efficient than the public sector system if it is allowed to function in an environment that is free from government intervention.

15. How can we establish a market information system to get continuous updates on market changes?

The design and implementation of a management information system, referred to in the response to question number 13, could include fertilizer market information as a part of that system.

ANNEX C

LIST OF CONTACTS

ANNEX C
PERSONS CONTACTED FOR SECTION IV

Sabry Aglan	Advisor to the minister, Ministry of Public Enterprises
A.A. Akeel	Chairman and managing director, SEMADCO
Emad El Din Abd Alla	Finance head, Abu Qir Fertilizer, Alexandria
David L. Alverson	Director, Office of Agriculture Credit and Economics, USAID, Cairo
Mohamad Ashmawi	Executive manager, Chemonics Egypt
Wilmot Averill	Team leader, APCP, Cairo
Soliman El Azab	Finance director, KIMA, Aswan
Mamdouh A. Baki	Senior vice president, Fertrade International, Cairo
Hala El Barkoury	Financial consultant, Cairo
Ron Bielen	Consultant, Cairo
Martin Dorschel	KfW, resident projects coordinator, Cairo
Gunvant M. Desai	Senior associate, John Mellor Associates
Rollo L. Ehrich	Senior agricultural economist, USAID, Cairo
Gamil Eous	Director of finance, EFIC, Kafr El Zayat
Saber El Enany	Accounts manager, Abu Zaabal Fertilizer, Abu Zaabal
Mohammed El-Fouly	National Research Center, Cairo
Abd El Wahab Fahmy	Director, Public Enterprise Office, Cairo
Osama El Ganainy	Chairman, Abu Qir Fertilizer, Alexandria
Michael Farag Gergis	Accountant, KIMA, Aswan
Abdul El Grieb	Accountant, KIMA, Aswan
Aly Mohammed Kassen	Cost manager, Abu Qir Fertilizer, Alexandria
Yehia M. Kolb	Chairman, EFIC, Kafr El Zayat

M. Mokhtar El Kordy	Commercial sector head, SEMADCO, Suez
Dahlia A. El-Hawary	Restructuring research assistant, Public Enterprise Office, Cairo
Monir Hamdy	Restructuring specialist, Public Enterprise Office, Cairo
Hassan M. Hussein	Chief executive, The International Investment Advisor, Cairo
Ronald D. Krenz	Agricultural production economist, Cairo
Ali Kamel	Agricultural economist, USAID, Cairo
Emad El Khashab	Managing director, Hagrpota, Cairo
Saad El Din Mahmoud	Sales manager, Abu Zaabal Fertilizer, Abu Zaabal
Samir Makary	Professor of economics, American University, Cairo
Taher Bishr Moustafa	Chairman, Chemical Industries, Cairo
Iman El-Moshneb	Office manager, Chemonics Egypt, Cairo
Mohmoud El Said Neur	Advisor, Principal Bank for Development & Agricultural Credit, Cairo
John O'Donnell	Agricultural policy specialist, Chemonics, Washington, D.C.
Mohammed Omran	Agricultural economist, USAID, Cairo
Hans-H. Prestele	Representative, KfW, Frankfurt
Awad Sorrel	Finance manager, El Nasr Coke, Helwan
Claire E. Starkey	President, FINTRAC, Washington, D.C.
Rhonda L. Yokely	Booz-Allen & Hamilton Inc.
Mohammed A. Youssef	Finance specialist, APCP, Cairo
Ahmed Mousa Abu Zied	Managing director, SEMADCO, Suez

ANNEX D

FERTILIZER WORKSHOP AGENDA AND QUESTIONS

ANNEX D
FERTILIZER STUDY FINDING PRESENTATION

SUNDAY, DECEMBER 17, 1995

10:00	Opening Session H.E. Dr, Youssuf Wally H.E. Dr. Atef Obeid USAID: Dr. John Westley Dr. Rollo Ehrich Chief of Party: Dr. Rifat Barokas
10:30 - 11:00	Dr. Bruce Smith, agricultural economist
11:00 - 11:05	Dr. Samir Makary, senior economist
11:05 - 11:35	Chemical engineer, Robert Gorman
11:35 - 12:00	Questions and Answers
12:00 - 12:30	Coffee Break
12:30 - 13:00	John Gardner and Ramsay Abdul Saoud
13:00 - 13:30	Dr. Rifat Barokas and Dr. Samir Makary
13:30 - 14:30	Questions and Answers
14:30 - 15:30	Lunch
15:30 - 16:30	Wrap up

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ANNEX E

ENVIRONMENTAL SCREENING FOR SOME EGYPTIAN FERTILIZER COMPANIES

By
Dr. El-Mohamedy Eid

ANNEX E: ENVIRONMENTAL SCREENING FOR SOME EGYPTIAN FERTILIZER COMPANIES

by Dr. El Mohamadi Eid

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1.0 Introduction

A review of environmental screening at some Egyptian Nitrogen and phosphate fertilier companies (TALKHA, EL SUEZ, HELWAN, ABU AABAL and KAFR EL AYAT) is presented below. A general review of the environmental conditions include:

- Identification of environmental status and conditions
- Determining whether or not the company is in compliance with Egyptian environmental legislation and regulations
- Identification of areas of non compliance .
- Definition of technically and financially sound alternatives to bring the facilities into compliance

The following report outlines :

- The approach and assumptions used in undertaking this assessment
- A summary of relevant Egyptian Environmental Legislation.
- Description of the facilities at each site
- An assessment of environmental conditions
- Areas of non-compliance.
- Proposal for remedial solutions

2.0 Approach and assumptions

The usage of chemical fertilizer in Egypt has multiplied over the last two decades while organic fertilizer usage remained nearly unchanged. This has increased chemical pollution and decreased land fertility. Excessive use of phosphorous and nitrogenous fertilizers beyond permissible limits may lead to oxygen consumption of waterways and the precipitation of heavy metals, which in turn may affect fish and plant growth.

Table (1)* Chemical and Organic Fertilizers Usage in Egypt

Year	Chemical Fertilizer Thousand To N	Organic Fertilizer Thousand To N
1970	2356.8	140.1
1975	2974.2	149.2
1980	3859.5	151.7
1985	5497.0	152.0
1995 ⊗	7500.0	-

*Central Agency for Public Mobilization and Statistics .
⊗ not published

The environmental review is intended to assess the status of compliance with environmental regulations at each factory. The assessment is based on readily available information, without independent verification of the submitted information. Review of the existing practices at each factory is limited to air emissions control, water treatment & waste-water management, solid waste management, and occupational health & safety. Each factory was visited to observe operations and procedures implemented for pollution control and protection. Conversation with key staff at each location provided the basis for this assessment. (Appendix 1)

3.0 Summary of environmental legislation and regulations

The Egyptian Environmental Affairs Agency (EEAA), through the Prime Minister's Cabinet, established Presidential Decree 631 of 1982 and modified its organic structure (appendix 7) to address new environmental issues through law no. 4 of 1994 (attached). Article (5) of law 4 - 1994 enables the EEAA to carry out a field inspection determine compliance with environmental norms, and to sanction violators.

Egyptian environmental legislation covering air emissions, water quality, solid waste, natural protectorates, and occupational health & safety are summarized below. Some regulations elaborated very general requirements, establishing few specific standards and limits. Factories do not maintain any control reporting records for environmental monitoring of air, water, solid waste, and workplace environments.

Air emissions:

Ministerial Decree No. 470 of 1971, Air pollution control
This decree sets general requirements ambient and workspace air quality. The decree limits the release of gases, vapors, poisonous materials, and dust in residential and industrial areas.

Article 34, Public Law 4 - 1994
Potential project sites must be appropriate for the type of associated activities to ensure that permissible limits of air pollutants are not exceeded, and that the gross air pollution for the whole area also remains within accepted standards. The Act's Ensuring Statutory Regulations specify the type of establishments subject to these provisions as well as the authority responsible for site approval and limit-setting for air pollutants and noise level in the area. (Appendix 2)

Article 36, Public Law 4 - 1994
Use of machines, engines, or vehicles which emit exhaust products beyond the limits set by the Ensuring Statutory Regulations to this act is not allowed (50 - 200 m.g. / m3).

Article 38, Public Law 4 - 1994
The use of pesticides or any other chemical compounds for agricultural, public health, or any other purposes is not permitted except under the conditions, limitations, and guarantees specified by the Ensuring Statutory Regulations to this act in such a way as not to expose man, animals, plants, waterways, or other parts of the environment, directly or indirectly, to the harmful effects of these pesticides and chemical compounds.

Article 40, Public Law 4 - 1994
Harmful constituent in smoke, gas and steam produced from the burning of fuel in industry, power generation, construction works or any other commercial shall be within the limits allowed.

Article 42, Public Law 4 - 1994
All agencies and individuals engaged in service or production activities must adhere to the permissible limits on sound levels when operating machinery. The licensing authorities shall ensure that the total sound produced from fixed sources in one area shall be within the permissible limits by only allowing the use of appropriate equipment.

Water quality:

Law 48 - 1982, Protection of the River Nile and waterways
This law supersedes previous regulations covering water quality control, including law no. 93 of 1962, law no. 38 of 1967, and law no. 74 of 1971. The discharge or discarding of solid, liquid, or gaseous water from commercial, industrial, or tourist facilities, shops, establishments, or from sanitary drainage and other operations into waterways is prohibited unless a license is obtained from the Ministry of Irrigation (Ministry of Public Works and Water Resources). The license must also define the standards and specifications to be applied to each individual case. Article 60, 62, 66 and 68 of the Ministry of Irrigation Decree No. 8 of 1983 restricts the release of treated industrial drainage into freshwater and groundwater bodies, while articles 66 through 69 of the same decree restrict the release of industrial drainage to non-fresh bodies of water (Annexes 3,4,5 and 6).

Solid waste:

Law 38 of 1967 & its amendment by Law 31 of 1976
This law regulates collection and disposal of waste from houses, public places, and commercial and industrial areas. It forbids disposal of garbage in any place not specified and licensed by the local council.

Public Law 4 - 1994
Chapter 2 concerns dangerous materials and wastes, while articles 29, 30 and 31 regulate solid waste management as the concerned administrative authority determines.

Public Law 4 - 1994, Article 37
Dumping, processing, or incineration of refuse and solid waste are not permitted, except in the designated places outside residential, industrial and agricultural areas and away from waterways. Specifications for these activities shall be determined by the ensuring Ensuring Statutory Regulations to this act.

Occupational health & safety

Ministerial decree No. 380 of 1975& No. 55 of 1983

- Requires commercial and industrial businesses to meet general safety and health standards at all workplaces.

Public law 4 of 1994, Articles 43, 44, 45, 46 & 47

- It establishes precautions and measures to prevent the leakage or emission of air pollutants inside the workplace, maintain temperature and humidity within permissible limits, and provide adequate ventilation.

4.0 Description of Existing Facilities

Some nitrogen fertilizer companies, like TALKHA, EL SUEZ and HELWAN, and phosphate fertilizer companies like ABU ZAABAL and KAFR EL ZAYAT, were visited during November 1995. A brief description of the operations, resources, and raw materials usage at each factory are shown in table (4-1).

4.1 TALKHA

The TALKHA fertilizer manufacturing plant was moved from Suez to TALKHA in 1970 and began producing fertilizer products in 1975. It is now situated on the other side of the Nile, in front of EL MANSOURA city, 130 Km northeast of CAIRO. Factories and residential areas total approximately 350 feddans (plant area ≅ 150 feddans). TALKHA (1) & (2) plants produce ammonium nitrate and urea fertilizer, respectively. Manpower totals 6500 employees working three shifts over 24 hrs. TALKHA consists of an ammonia plant (TALKHA 1);, 4 Nitric acid trains, prilled fertilizer grade Ammonium Nitrate, and one Ammonia Train (TALKHA 2); two trains prilled urea plant and a polyethylene bag manufacturing plant.

Raw Materials:

- Natural Gas (40 Kg/cm^2) containing methane (84-92%)
- Liquefied Air
- Potassium Carbonate

Main production processes:

- Gasification
- Air liquification
- Primary & secondary reforming
- CO-Shift Converter
- CO_2 removal
- CO removal
- NH_3 converter & refrigeration
- Neutralization & prilling

Main products:
- Urea46.5% N
- Amm. nitrate33.5% N
- Urea-Amm. NO_3 Soln32% N

Intermediate products:
- Methanol99.8% conc.
- Ammonia liq.99.8% conc.
- Ammonia soln14-20% conc.
- Nitric acid55% conc.
- Industrial urea
- Nitrogen liq.
- Oxygen liq.

4.2 EL SUEZ

The EL SUEZ factory has manufactured fertilizer since 1950. It is situated 16 Km south of Suez, 135 Km east of Cairo. Factory and residential areas total about 360 feddans (256 factory - 114 residential area). Manpower totals 3000, working three shifts over 24 hrs. EL SUEZ consists of an ammonia plant, seven trains nitric acid plant, two calcium nitrate trains, one sulfuric acid plant, two ammonium sulfate trains, one ammonia plant, and two granulated ammonium nitrate fertilizer-grade trains.

Raw materials:
- Natural gas
- Limestone
- Sulfur ore
- Liquid air

Main production processes:
- Neutralization by nitric acid for limestone
- Evaporation & screening for Ca nitrate production
- Melting and atomization for sulfur ore
- CO - shift converter
- Co_x removal
- NH_3 converter & refrigeration
- Neutralization & prilling

Main products:
- Nitrolin 33.5 % N
- Calcium nitrate15.5 % N
- Ammonium sulfate20.6 % N
- Calcium nitrate solution11 % N

Intermediate products:
Same products as TALKHA factory, plus sulfo-nitrate liquid fertilizer & Calcium nitrate liquid.

4.3 HELWAN COKE

Helwan Coke Co., established in 1969, is one of the major Egyptian coke producers. It is situated 45 Km south of Cairo. The fertilizer plant covers 12 Feddans and has 1150 employees.

Raw materials:
- Coke oven gas (COG)
- Liquefied air
- Potassium carbonate
- Limestone

Main production processes:
- COG compressed at 32 bar
- Hydrogenation
- H_2S removal
- Cracking, partial oxidation
- CO-shift converter
- CO_2 removal (soft drinks - amm. bicarb.)
- Comp. to 150 bar (CO removal)
- Comp. to 300 bar (NH_3 converter)
- Neutralization by HNO_3 (HNO_3 storage)
- Evaporation
- Prilling

Products:
- Calcium ammonium nitrate fertilizer 33-5% N
- Pure ammonium nitrate (explosives)
- Ammonium sulfate fertilizer 20-6% N
- Conc. and fuming nitric acid

4.4 ABU ZAABAL

Abu-Zaabal Co. is one of the largest fertilizer and chemical manufacturers in the Middle East. Operations began in 1947. ABU ZAABAL is situated at Km 30 on EL MOAHADA road, on the western side of the ISMAILIA canal, east of Cairo. Factories extended over 250 Feddans and have 2500 employees, working 3 shifts over 24 hrs. The company is comprised of sulfuric acid, phosphoric acid, and fertilizer plants, as well as dicalcium phosphate and pure sulfuric acid units.

Raw materials:
- Phosphate rock
- Sulfur ore
- Limestone

Main production processes:
- Crushing for phosphate rock
- Treating and concentration for phosphate rock
- Treatment with sulfuric acid
- Concentration of phosphoric for production TSP
- Granulation

Products:
Sulfuric acid, 320 000 Ton/Year
Phosphorous pentoxide (P2O5), 4500 Ton/Year
Agriculture gypsum, 200 000 Ton/Year
Single super phosphate (S.S.P.), 320 000 Ton/Year
Triple super phosphate (T.S.P.), 120 000 Ton/Year
dicalcium phosphate10 000, Ton/Year
Pure sulfuric acid, 0.8 - 2.5 Tons/Year

4.5 KAFR EL ZAYAT

KAFR ELZAYAT is a pioneer fertilizer manufacturing plant situated in Kafr ElZayat, 130 Km northeast of Cairo city. It covers 56 Feddans and has been producing fertilizer since 1940. Employees in the Kafr ElZayat and Assiut factories total 2856, working in three shifts over 24 hrs. The factory contains the following plants: Sulfuric acids units (1,2,3), SO3 unit, labs, a sulfuric acid unit, a Lim. super phosphate unit, a Ferrous sulfate unit and a Sodium F/o - silicate unit.

Raw materials:
- Phosphate rock
- Sulfur ore
- Limestone
- Sodium chloride

Main production processes:
- Grinding for phosphate
- Treating with sulfuric acid and concentration- treatment by NaCl for Na Floilicate production

Products:
Calcium super phosphate fertilizer, 700, 000 / year
Sulfuric acid ($H_2 SO_4$), 320, 000 / year
Ferrous sulfate ($Fe SO_4 - 7 H_2O$), 650 T/year
Sodium flosilicate 200 T/year
Liquid follar micro elements fertilizer, 5000 L/year

Table (4 - 1): Resources and raw materials

Factory → Parameter ↓	TALKHA	SUEZ	COKE	ABU ZAABAL	KAFR EL ZAYAT
Power KW-Hr/mo	224,233,3				1,563,724
N-Gas Kg/mo	11,935,920		———		———
Water m^3/mo	———		288 000	108 000	704800
Fuel-Oil T/mo	16 952.5		25		35.52
Phosphate T/mo				33 333	
Sulfur T/mo				8 333	

T/mo= tons per month

5.0 Environmental status

The Environmental status in TALKHA, EL SUEZ, HELWAN, ABU ZAABAL and KAFR EL ZAYAT was reviewed by examining: Aire Emission control, water treatment & wastewater management, solid waste management, and occupational health & safety. Each factory was visited to watch and observe the prevention, operations, and procedures implemented for pollution warning, control and protection.

5.1 Air Emission Control

TALKHA

TALKHA factories utilize natural gas for the production of urea and ammonium nitrate as main fertilizer products. Ammonia (NH3), carbon oxides (CO & CO2), nitrogen oxides (NOx) and dust are the main pollutants produced. However, the company collects and reuses some of these gases into friendly environment products.

- Create amounts of ammonia have been controlled and collected for the manufacture processes to produce ammonium nitrate and ammonium hydroxide solutions. Some fugitive ammonia is still uncontrolled and escapes into the air, especially when power failures occurr.
- Carbon oxides (CO & CO2) are treated, oxidized, and collected for the manufacturing, carbonated gaseous soft drink production, and methanol production processes. The TALKHA (1) plant still emits some fugitive carbon dioxide.
- Nitrogen oxides (NOx) are absorbed by the absorption tower, but some brown fugitive nitrogen
- oxides were still visible at the TALKHA (1) plant.
- Dust particles could be seen at the prilling tower.
- Air pollutants monitoring for nitrogen oxides and ammonia is periodically tested and recorded.

EL SUEZ

- Nitrogen oxides (NOx), sulfur oxides (SOx), carbon oxides (CO, CO2), hydrogen (H2), ammonia gas, water vapor, ammonium nitrate dust, and noise pollution are emitted from the fertilizer manufacturing operations at the Suez factory.
- Great efforts have been undertaken to minimize gas emissions from the manufacture process, but the plant still poses a dangerous problem to a power station down-wind from the factory, especially due to ammonium nitrate dust particles (the factory has partially minimized the dust particles with a water-spray solution).

HELWAN COKE

- Coke oven gas, which is produced during coking process, is used in heating coke ovens, and also in producing ammonium nitrate fertilizer. Ammonia (NH3), carbon oxides (CO & CO2), nitrogen oxides (NOx), and Dust are the main pollutants.
- The company succeeded in trapping CO2 and liquefying it for soft drink manufacturing (90% of total production in Egypt). Some CO2 is still emitted into the air.
- Ammonia gas could clearly be smelled in the workspace in concentrated ratios.
- Fugitive brown nitrogen oxides are emitted from the fertilizer plant.
- Dust and soot particles emitted from the prilling tower.

ABU ZAABAL

- Resulting from to the production of phosphate fertilizer, the most significant air pollutants are sulfur oxides (SOx), hydrogen fluoride (HF), carbon oxides (COx), water vapor (H2O), and dust.
- Sulfur oxides (SOx) are trapped through a clean operation method, and no fugitive gases are emitted from the absorption tower.
- While Hydrogen fluoride (HF) is showered with water and treated chemically in a closed system, drained to a well-sealed bond, some hydrogen fluoride gas still escapes.
- Carbon oxides and water vapor are released into the air.
- Dust pollution particles are present in the workspace areas.

KAFR EL ZAYAT

- The most important air pollutants are sulfur oxides (SO_X), hydrogen fluoride (HF), carbon oxides (CO_X), water vapor (H_2O), and fertilizer dust.
- Most of the gases emitted to the air are trapped by clean operation methods, but some fugitive gases like CO_X are still emitted into the air.
- Dust particles from the fertilizer manufacturing processes are present in the workplace areas.

5.2 Water treatment & waste water management

TALKHA

- Wastewater and industrial drainage at TALKHA (1) & TALKHA (2) is estimated at about 4,4 74,000 m^3/year and 4,4 65,000 m^3/year respectively. After treatment, it is released into the EL TAWELA agriculture drainage canal.
- Sanitary drainage is estimated at 881 900 m^3/year. It is released into the main sewer system after treatment.
- Water pollutants levels of ammonia and nitrates in the Nile is periodically tested and recorded.

EL SUEZ

- All industrial and sanitary drainage is released directly to the Suez Gulf without treatment.
- The industrial drainage contains highly toxic CU liqour, acids and ammonia.
- Water monitoring programs are frequently conducted.

HELWAN COKE

- Industrial drainage effluent is estimated at 30 - 40 m^3/H. It is collected for cyanide treatment, and its ph is raised from 7 to 10 with lime stone and chlorination process. The ph at the outlet of the drainage is 6 - 8.5.
- All wastewater is collected in basins for sedimentation and then released to Helwan Sewer System.
- Some wastewater leaks, resulting in occasional puddling.
- Sanitary drainage is released directly into the Helwan sewer system.

ABU ZAABAL

- Industrial drainage is treated and released to a basins.
- Cooling water is treated and released into the Ismailia canal.
- Hydrofloric acid is collected in a well sealed bond and in a closed circuit after water showering.
- Sanitary drainage is treated and released into the sewer system.

KAFR EL ZAYAT

- Industrial drainage is collected, separated from suspended solids through precipitation, and released into the town sanitary system.

5.3 Solid waste management

TALKHA

- The primary source of solid wastes in the urea manufacture process (which produces waste urea fertilizer) is collected and sold as liquid fertilizer.
- The oil-waste is collected and sold.
- Floating residual coal is collected from basins and dumped at a garbage area.

EL SUEZ

- Solid waste dust particles from unpaved roads and the ammonium nitrate plant poses a threat to the power station down-wind from the factory.

HELWAN COKE

- Most of the solid waste is collected, reused as bi-products and sold.
- Some areas have a scrabe and reuse solid waste.

ABU ZAABAL

- The primary source of solid waste is the phosphate fertilizer plant. Waste is piled everywhere and reused.
- The roads at the phosphate plant is unpaved, resulting in dust and mud.

KAFR EL ZAYAT

- Phosphate fertilizer dust particles and dust particles originating from the unpaved roads are present in the workspace areas.

5.4 Occupational health and safety

TALKHA

- The workspace is potentially uncomfortable due to high temperature and humidity levels.
- Fire detectors, thermometers, and humidity meters are lacking.
- Self-protection equipment (gloves, boots, anti-noise, helmets, etc.) are available but not used.
- Fire - Extinguishing Units - see table 5.4.

EL SUEZ

- The workplace is unhealthy. It has potentially high ammonia vapor, dust particle, and humidity levels.
- Fire detectors, thermometers, and humidity meters are lacking.
- Most self protection equipment (gloves, boots, anti-noise helmets, etc.) are available, but few workers use them.
- Fire - extinguishing units - see table 5.4.

HELWAN COKE

- Working conditions present a risk to the health and safety of the work force.
- Waste-water flows onto the floor, creating puddling and slippery conditions.
- The workspace is saturated with fugitive gases (ammonia), soot, and dust.
- Fire - extinguishing units - see table 5.4.

ABU ZAABAL

- The first aid facility is insufficient and primitive (only one ambulance vehicle).
- The workspace in the phosphoric sector is unhealthy, poorly lit and dusty, with the dangerous HF emission.
- Fire detection equipment, thermometers, and humidity-meters are lacking.
- Self protection equipment is available but not used.
- Fire - extinguishing units - see table 5.4.

KAFR EL ZAYAT

- First aid provision is completely dependent on Kafr ElZayat town facilities.
- Protection equipment is sufficiently present but not used.
- Fire - extinguishing units - see table 5.4.

Table 5.4 Fire Extinguishing Units

	Carbon Dioxide			Powder			Liquid		Hallons	
	6Kg	10Kg	20Kg	3-6Kg	12Kg	50Kg	2Gal	10Gal	6Kg	12Kg
TALKHA	915	9	77	308	172	24	(N)	(N)	(N)	10
EL SUEZ	400	148	235	660	340	(N)	260	95	(N)	(N)
COKE HELWAN	(N)	150	(N)	(N)	400	(N)	(N)	(N)	(N)	(N)
ABU ZAABAL	40	200	(N)	90	50	(N)	39	40	(N)	(N)
KAFR EL ZAYAT	34	48	4	98	69	15	37	3		

(N) Not Available

6.0 Areas of noncompliance

None of the factories has formal plans for environmental management systems or for controlling emissions. The factories are operated without regard to resource conservation or control. The workspaces lacking basic measures to protect the health and safety of the employees.

According to existing Egyptian environmental legislation, the factories are in violation of standards for general equipment, obtaining permits, controlling the release of pollutants, protecting the ambient environment, and safeguarding workspaces. But since these regulations are rarely enforced, few records are maintained at some factories. Staffs recognize the importance of and need for environmental protection but lacks the resources and commitment for full implementation, which could be expected within the 3-5 years public law excursion.

TALKHA

- Although most ammonia has been controlled, some fugitive ammonia still escapes in to the air, especially when power failures occurr
- Nitrogen oxides (NOx) and carbon oxides (COx) are emitted into the air in the old plant TALKHA (1).
- Ammonium nitrate particles are emitted from the prilling tower.
- High noise levels exist, especially at the old plant TALKHA (1).
- High steam flow rate represents a considerable deficiency in the on-stream factor of the ammonia plant.
- The old copper liquor wash is released to the EL TAWELA drainage canal without treatment.
- Some wastewater contaminated with ammonia from the old plant is released to the agriculture TAWELA drainage canal.
- Collected floating residual coal from basins is dumped at garbage areas without treatment.
- Unpaved passages and dusty workspaces.
- The workspace has high temperature, humidity and noise levels.

- None of the employees use protective gear (ear coverings, boots, gloves, etc).
- No monitoring exists for noise, heat or other hazards in the workspace.

EL SUEZ

- Large amounts of fugitive gases (ammonia, carbon oxides (COx), nitrogen oxides (NOx)) and high steam flow.
- High operating pressures in ammonia loops results in frequent downtimes and potential for serious accidents.
- The foundry section lacks all air emission control to protect against ammonia nitrate particles, ammonia, and fugitive gases.
- Old copper liquor wash is used for the removal of carbon monoxide and carbon dioxide traces.
- High noise level at the old plant.
- Industrial and sanitary drainage is released directly into the Gulf of Suez without treatment.
- Unpaved passages and dusty workspaces.
- The workplace environment is lacks basic measures to protect the health and safety of the employees.
- None of the workers use protective equipment.

HELWAN COKE

- The plants are in violation of the general permit requirements for controlling the release of ammonia, carbon dioxides, nitrogen oxides and ammonium nitrate particles caused by extensive consumption of energy.
- All wastewater is collected in basins and released to the Helwan sewer system with treatment.
- Some wastewater leaks onto the floor, resulting in occasional pudding.
- Dust and soot particles spread everywhere.
- The workplace environment lacks basic measures to protect the health and safety of employees.
- Protective equipment is not used.
- No monitoring for noise, heat, or other hazards.

ABU ZAABAL

- Highly toxic hydrogen fluoride, carbon oxides, and steam are emitted into the air.
- High noise level generated by old units.
- Dust pollution originating from unpaved passages and ammonium phosphate particles are within tolerable limits.
- Wastewater is released to basins without treatment.
- The plants are operating without resource optimization and waste reduction or control.
- The conditions inside the workspace area are uncomfortable due to high humidity, dust generation and poor lighting.
- Fire detection, and heat and humidity reduction measures are lacking.

- None of the employees use self protection gear.

KAFR EL ZAYAT

- Some fugitive gases (hydrogen fluoride (HF), carbon oxides (COx) and sulfur oxides (SOx)) are emitted into the air.
- Dust and noise pollution.
- Unpaved passages.
- Industrial drainage is sedimented and released to the sewer system.
- The workplace environment is lacking basic measures to protect the health and safety of employees.
- None of the plants seem to encourage or mandate protective equipment.

7.0 Recommended remedial solutions

Upgrading the existing fertilizer factories to fully comply with Egyptian environmental regulation will require significant modifications to existing facilities. These modifications would achieve two main goals: Conserving the environment and improving the fertilizers quality and quantity, thus assuring sustainable development. The estimated costs presented here are general orders of magnitude, based on in-house data that has not been verified. Potential remedies are defined in very broad terms, corresponding to the limited evaluation of these factories.

Table 7.0 Costs in millions EGP

Parameter	TALKHA	EL SUEZ	COKE	ABU ZAABAL	KAFR EL ZAYAT
Methanator * (CO removal)	——	5	5	——	——
Granulation * Unit	2.5	2.5	2.5	7	7
Coating Belt * Conveyor	——	——	——	1	1
Wet Disposal* Unit	3	3	3	1	1
Water * Treatment Unit	3	3	3	3	3
Ammonium * NO3 Scrubbing	3	3	4	——	——
Radial Amm.* Converter	4	4	——	——	——
Energy * Recovery	3	3	3	3	3
Training * & Awareness	0.5	0.5	0.5	0.5	0.5

* Top Priority

Appendix 1: Names of managers contacted for this study

TALKHA

Eng. Abdul ElMeneam Okail	Board Chairman
Eng. Ahmad Ayoub	Chairman, Factories Sector
Chem. Mohammed Helal	Chairman, Labs. Sector
Eng. Mohammed Sourour	Director of Oxidation Plant
Eng. Mostafa ElShinawy	Director of Factories
Eng. Sherif Mostafa	Director of Urea Plant
Eng. Mahmoud Gad ElHak	Director of Occupational HQS

EL SUEZ

Eng. Abdul Meneam Okail	Board Chairman
Eng. Ahmad Mousa	Chairman, Factories Sector
Eng. Saied Zakaria	Chairman, Fertilizer & Acids Sector
Chem. M. Abdul Meneam	Chairman, Commercial Sector
Chem. Amin Abu ElOla	Chairman, Laboratories Sector
Chem. Hasan Mohyia	Director, Occupational H & S

HELWAN COKE

Eng. Adel ElMouzy	Board Chairman
Eng. Salah Moumen	Chairman, Factories Sector
Chem. Ibrahim Gohar	Chairman, Fertilizer Sector
Eng. Shoukry Botros	Director, Engineering Sector
Chem. Ahmad Shaker	Director, Labs. Sector

ABU - ZAABAL

Chem. Refay Morsy Ibrahim	Board Chairman
Chem. Abdul Fatah Agwa	Chairman, Factories Sector
Chem. M. Abdul Aziz	G.M. Phosphoric Sector
Eng. M. Arafa	G.M. Superphosphate Sector
Eng. Youssef M. Youssef	G.M. Acids Sector
Eng. Abdul ElMalik	G.M. Mining Sector
Eng. Salah Mahrous	G.M. Research & Development
Eng. Metwaly ElBasiony	G.M. Acids Sector
Chem. Gamil M. ElNagar	Director Occupational HQS

KAFR ELZAYAT

Chem. Yehia M. Kotb	Board Chairman
Chem. Zakaria ElManf	Chairman, Factories Sector
Chem. Abdul Gawad Saber	Chairman, Production Sector
Chem. Abdul Moneam Darwish	Chairman, Commercial Sector
Chem. Mohammed Labeeb Khalil	Director, Health & Safety

Appendix 2: Max. limits for external air pollutants (m.g. / m^3)

Name	Max. Limit	Exposure Time
Sulfur Dioxide	350 150 60	1 Hour 24 Hour 1 Year
Carbon Monoxide	30 m.g./m^3 10 m.g./m^3	1 Hour
Nitrogen Dioxide	400 150	1 Hour 24 Hour
Ozone	200 120	1 Hour 8 Hour
Black Smoke Particles	150 60	24 Hour 1 Year
Total Air Particles	230 90	24 Hour 1 Year

Appendix 3

Art. 60 :The freshwater bodies in which it is permitted to discharge treated industrial liquid effluents must remain within the following (quality) standards and specifications:

Parameter	Standards & Specifications (mg/Liter unless otherwise noted)
Color	Not to exceed 100 degrees
Total Solids	500
Temperature	$5^{o}C$ above normal
Dissolved Oxygen	Not less than 5
PH	Within the range 7 - 8.5
Biochemical Oxygen Demand	Not to exceed 6
Chemical Oxygen Demand	Not to exceed 10
Organic Nitrogen	Not to exceed 1
Ammonia	Not to exceed 0.5
Oils and Grease	Not to exceed 0.1
Total Alkalinity	Within the range 20 - 150
Sulfate	Not to exceed 200
Nitrate	Not more than 45
Phenol	Not to exceed 0.02
Synthetic Detergents	Not to exceed 0.05

Appendix 4

Art. 61 :The standards set by the Ministry of Health for permits to discharge treated industrial liquid effluents into freshwater bodies and groundwater reservoirs (All standards in mg/Liter unless otherwise noted)

Parameter	**The max. limits of constituents in treated industrial liquid effluents discharged to :**	
	River Nile from its Southern Egyptian border to the Delta Barrages	Nile branches, main canals, branch canals, ditches & groundwater reservoirs
Temperature	35°C	35°C
PH	6 - 9	6 - 9
Color	No. Col. Substance	No. Col. Substance
Biochemical Oxygen Demand	30	20
Chemical Oxygen Demand	40	30
Total Dissolved Solids	1200	800
Fixed (Ash of) Diss. Solids	1100	700
Suspended Solids	20	20
Sulfides	1	1
Oils and Grease and Resins	5	5
Phosphate (inorganic)	1	1
Nitrate - N	30	30
Phenol	0.002	0.001
Total Heavy Metals	1	1
Residual Chlorine	1	1

Appendix 5

Art. 62 : Without violating the rules in Art (60) of this decree, the Ministry of Irrigation can allow discharge to exceed some of the limits of treated industrial liquid effluent discharged to fresh surface water bodies not greater than 100 m3/day. In these cases, the effluent quality must not exceed the limits stated in the following table :

Parameter	**Max. limit to the quality of treated industrial liquid effluents discharged in :**	
	River Nile from South limits up to Delta Barrage	Branches, Ryah, canals, groundwater reservoirs
Biochemical Oxygen Demand	40	30
Chemical Oxygen Demand	60	40
Chemical Oxygen	20	15
Total Solids	1500	1500
Fixed Ash of Solids	1000	900
Suspended Solids	40	40
Oils and Grease and Resins	10	10
Nitrate	40	30
Phenol	0.05	0.002

Appendix 6

Art. 68 : The brackish or saline surfacewater bodies into which discharge of treated liquid effluents is permitted must comply with the following standards and specifications :

Parameter	**Standards & Specifications**
Temperature	Not to exceed 5°C above normal average
Dissolved Oxygen	Not less than 4 mg/L at any time
PH	Within the range 7 - 8.5
Synthetic Detergent	Not to exceed 0.5 mg/L
Phenol	Not to exceed 0.005
Turbidity	Not to exceed 50 units
Total Dissolved Solids	Not to exceed 650 mg/L
Total Coliforms (MPN/100ml)	Not to exceed 5000

ANNEX F

EXPORT MARKET POTENTIAL

ANNEX F
EXPORT MARKET POTENTIAL

A. Egyptian Production Capacity

The fertilizer industry in Egypt is expected to expand production capacity over the next few years. The most significant expansion for which tenders have been sought is the Abu Qir III line. This expansion is expected to add an ammonia nitrate capacity of 1,200 tons per day and a urea capacity of 2,000 tons per day. Assuming that the factory runs at 330 days per year, this will add 303,000 tons of nitrogen to the country's 1994-1995 output of 940,250 tons N. As discussed in the first volume of the study team's report, local consumption will likely stagnate around 800,000 tons for the near future. It is clear, therefore, that the international market will play an increasingly important role in the fortunes of the Egyptian fertilizer industry, as can be seen in Figure F-1. All fertilizer companies interviewed by the team expressed an interest in expanding. SEMADCO has a two-phase plan to revamp existing capacity to generate an additional 50,000 tons per year of nutrient and a long-term proposal to develop a 2,400 ton per day ammonia nitrate plant (265,000 tons per year of nitrogen). El-Nasr Coke at Helwan is considering creating a 1,000 ton per day ammonia nitrate plant. Both Abu Qir and SEMADCO expect to produce the granulated product necessary for the export market.

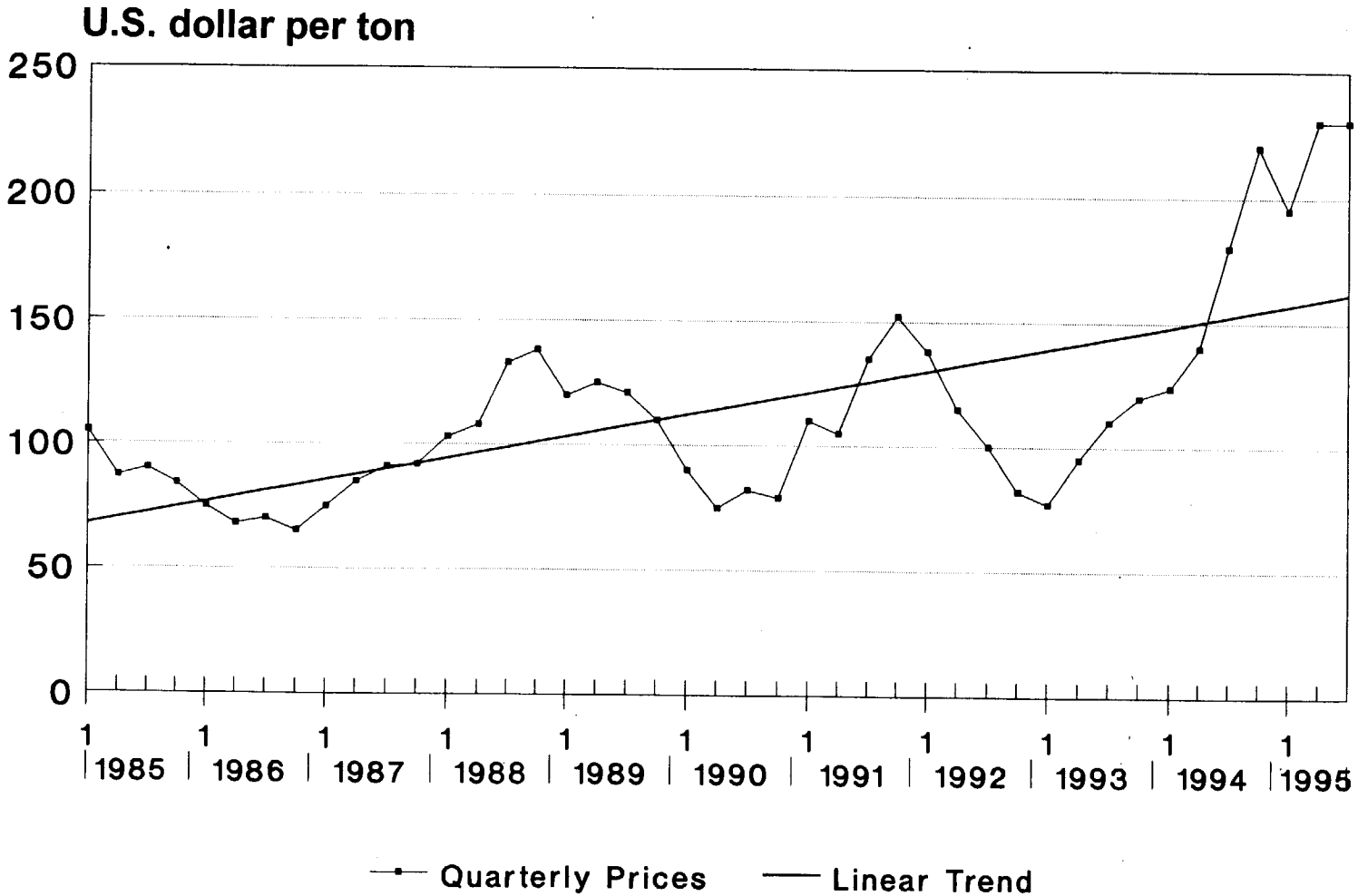
B. Cycles in Fertilizer Demand

Worldwide demand for urea in 1994 was 80MMT, 2.5 percent higher than in 1993. Urea now accounts for 40 percent of world nitrogen consumption and is growing due to Asian demand. Global capacity is 96 million tons per year, supplied by 200 plants in 57 countries. The urea market is cyclical, following the natural gas market, which is linked in turn to the petroleum market (called the OPEC macro cycle). The phenomenon of economic cycles is well documented but its causes are debated. Suffice it to say that periods of high relative demand result in high profits, leading to increases in production capacity. Increased capacity eventually causes prices and profits to decline. Reduced profits shrink capacity utilization and investment, while accumulated losses and bankruptcies further reduce capacity. Demand slowly begins to exceed supply from the reduced capacity, with low-cost second-hand plants allowing for lower cost production. These two factors increase profits and investment and the cycle begins once again.

The urea industry is now in the phase of capacity expansion in this cycle. After very low prices in the early 1990s ($60-70/ton ammonia FOB Black Sea), urea and ammonia led the substantial price rises for all fertilizer in 1993-1994. These price rises were associated with the increase of natural gas prices from the former Soviet Union (FSU) to world levels. At the same time, many European producers shut down due to rising raw material prices, making their used plants available to fuel the next upturn. Figure F-1 clearly shows the successive cycles and the point we are at in the current cycle.

At the current point in the cycle, two features dominate: the former Soviet Union (FSU) and Ukraine dominate the export market, and are responsible for about 25 percent of all exports. Black Sea urea prices will continue to be the price leaders for urea for the next cycle. The import side is dominated by Asian demand, with China and India importing about 25 percent of world trade.

Figure F-1
Black Sea Urea Prices (U.S. dollars per ton fob)



Source British Sulphur

As a result, these two regions will dominate the next cycle. The FSU now establishes its natural gas prices based on the value of its gas in Europe, resulting in a price to FSU ammonia producers of $1.10 to $1.60 per million BTU (mmBTU). This implies a shut-down price for urea producers of $140-150 per ton of urea. On the import side, both India and China are planning major expansions. When this new capacity comes on stream, we can expect to see the beginning of the downturn of the next cycle.

Table F-1. World Urea Production Capacity

	Confirmed Start-up Capacity 000 t Urea	Plant Revamps Capacity 000 t Urea	NH3 Plant Closures (Lost Capacity)	Potential Projects
1995	495	90	912	
1996	2811(2100)	1142(338)	840	
1997	2655(1070)	488(470)		100
1998	1919	415		2540(880)
1999	4046(1972)			1825
2000				600(600)

Numbers in brackets are expansion in India and China.

The question facing any firm embarking on an export oriented expansion plan is the following: When will greater capacity brought about by increased prices and profits come on stream and reduce prices? Secondly, will firms' products be competitive in a low-price environment?

India and China will remain the key players on the demand side. The annual growth in demand for urea from these two countries is expected to rise from the 34 MMT consumed in 1995 to 41 MMT in 1999, or at the rate of 1.2 to 1.8 of increased MMT per year. This implies a temporary drop in imports in late 1996 and 1997 as capacity grows faster than consumption, at 2.4 MMT. The need for imports will rise again in 1997, stabilizing in 1999. This will introduce uncertainty in the short term. But, overall, the market should remain strong for the next five years, when overcapacity will start to make itself felt.[1] There are other positive factors in the short term. Over the past three years, stocks of wheat and coarse grains have been reduced substantially. Europe and America are expected to release production controls, which will increase acreage and demand. The recovery of Eastern European agriculture is beginning, which should also fuel demand. Taking all of this into account, the outlook for continued high prices in the export market is therefore positive, particularly as planned Chinese expansion may be delayed or canceled due to financing constraints.

[1]One additional aspect of uncertainty is the fate of Iraq's 578,000 MMT capacity and when it may re-enter the world market

C. Egypt and the Fertilizer Cycle

The key question for Egypt is: Can the Egyptian fertilizer industry survive the next downturn? This question turns on the price of natural gas used to make fertilizer. Natural gas represents approximately 45-60 percent of the cost of ammonia fertilizer. Egypt has a substantial cost advantage with regard to other producers.

Table F-2. Country Comparisons of Natural Gas Prices
1995 Gas Price/mmBTU

U.S.	$1.50-2.00
Trinidad	$1.20
Western Europe	$2.50-3.00
Central Europe	$2.50-3.00
FSU	$2.20-2.50
Russia	$1.10-1.60
Egypt	$1.07-1.20
Arab Gulf	$0.50*

* This is the price sold to state-owned enterprises. Private buyers might face higher prices.

As can be seen in Table F-2, Egypt has advantageous gas prices. This may change if the price of gas rises due to increases in domestic demand or the development of natural gas exports. In the latter case, we would expect that the fertilizer producers would have to pay competitive prices. An issue that should be mentioned is that favorable gas prices have recently been offered to joint venture partners in major new development schemes. This may be a trend that will affect future price competition. To date, the team is aware of the following gas price arrangements:

- Arcadian Corp. and Petroleos Venezuela: two 600,000 t/year ammonia plants and one 700,000 t/year urea plant. $.50-60 per mmBTU

- India and Iran, India Farmers Fertilizer Cooperative and the Qeshm Free Zone Authority: 445,000 t/year ammonia and 363,000 t/year urea.

- Oman and India, Oman Oil Company and two Indian producers: 900,000 t/year ammonia and 1.5 MMT/year of urea. Gas at $.75/mmBTU. However, this deal is running into difficulties.

This provides justification for producers to demand similar arrangements in the next downturn. The World Trade Organization enforcement agencies will undoubtedly be called on to rule on the issue of subsidized natural gas prices. Producers and users of natural gas should be aware of the implications of such decisions.

D. Exchange Rate Concerns

The long-run rate of price change for urea (1980-1994) is around 4 percent a year. This rate is substantially less than the Egyptian rate of inflation. This rate of inflation has not been corrected by currency devaluation. This puts fertilizer exporters at risk if the trend continues. Mellor[2] has shown that the Egyptian exchange rate of LE 3.33=$1.00 does not reflect the relative rates of inflation of the two currencies.

Table F-3. The Dollar Exchange Rate and Inflation in Egypt

	CPI Egypt	CPI USA	Exchange Rate *	Egypt CPI/ USA CPI	Constant Exchange Rate **
1987	100	100	1.27	100	1.27
1988	118	104	1.76	139	1.99
1989	143	109	1.94	153	2.53
1990	167	114	2.23	176	3.25
1991	199	119	3.01	237	5.01
1992	227	123	3.32	261	6.10
1993	254	127	3.33	262	6.66

* LE per dollar
** The constant exchange rate would keep consumer prices in both countries relatively unchanged.

If the long-run price of urea is rising in line with American inflation, then Egyptian producers facing costs rising twice as rapidly as prices will become uncompetitive.

E. Locational Advantages

The urea market is becoming geographically divided between Asia and the rest of the world. Only a small amount of product from the major Black Sea suppliers passes through the Suez Canal. The major growth, on the other hand, is in the developing economies of Asia. Egypt is ideally located to serve both markets: well placed for urea exports to Asia and well placed for ammonia nitrate exports to Europe.

F. Government Policy and the Fertilizer Sector

While the above discussion indicates that the fertilizer sector will increase its dependence on the export sector, the Government of Egypt has adopted a price and distribution policy that moves in the opposite direction. At present, there is a ban on fertilizer exports and the factories must deliver all output to PBDAC. This situation arose in stages. A shortage of urea first appeared in February 1995, prompting a directive from the Minister of Public Enterprises to the factories to cease deliveries to the private sector until March 6, 1995. Private sector distribution resumed in March until a new directive ordered the factories to increase their deliveries to PBDAC from 20 to 50 percent. At the same time, it was announced that exports would cease.[3] It

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[2]Mellor and Associates, 1995 Strategic Priorities for Sustainable Agricultural Growth in Egypt. For USAID, p. 47.

[3]USAID Annex VI to the tranche VII report on the Agricultural Policy Reform Program of the Agricultural Production and Credit Program, pp. 34-38.

was announced on August 3, 1995 that PBDAC would handle all the output from the domestic producers until December 31, 1995. This was extended in December to March 31, 1996. This annex attempts to analyze the forces that generated the shortage discussed above. It will be argued that fixing factory prices below world levels actually made farmers worse off. The government tried to mix a market economy and a command economy, and the result was predictable. The rationing system put in place in October 1995 will probably reduce prices below levels reached during the summer of 1995, and may also slow the pace of needed efficiency improvements in fertilizer use.

G. Partial Liberalization 1993-1995

G1. Two Tiered Price Policy

The fertilizer economy had a two tiered price policy between 1993 and 1995, though this was not evident at the policy's inception in 1993. While established factory prices were at first equal to world prices, they soon diverged. Prices paid to factories for fertilizer destined for domestic consumption are set by government policy. To determine the modalities of price formation, the study team met with the marketing managers of the nitrogen producers. We were unable to get a clear picture of process, which involved confidential discussions between the company representatives and representatives of the Ministry of Agriculture and the Ministry of Public Enterprise.

In 1993, each company board developed a desired price based on perceived market conditions and costs. The companies then met and arrived at a common price. This price may have been set to cover the costs of the least efficient producer. The fertilizer committee, containing members of the above ministries, reviewed the price. Whether they amended it is not known. This price, with minor adjustments largely to cover increased costs, has been in place since 1993. The price does not fluctuate according to conditions of supply and demand and has evolved in the following way:

Table F-4. Ex-Factory Prices LE Per Ton

	January 1993	1995
Urea		
Abu Qir	450	450
El Nasr	450	450
AN		
Abu Qir (granulated)	395	380
El Nasr		
Talkha	345	380
Suez		380
Coke	338	380
KIMA	338	380
AS		
Suez	316	346
Coke	281	360
CN		
Suez	205	275*

* This is the official price, but as it does not cover costs, the company sells under special contract for 475.
Source: company data.

Prices for the export market are determined by a tender process. Abu Qir made export sales of urea and ammonia nitrate at $230 (760 LE) and $150 (500 LE) in 1995; these sales were mainly in the spot market. Until this year's policy change, factories' export quota was 20 percent of targeted output. Tenders were apparently not publicly announced in Egypt, instead appearing in foreign journals such as *Fertilizer Week*. However, once announced, tenders were open to all the factories' clients, who could compete with foreign buyers. Exports took place three weeks after the offer was announced.

The creation of a two tiered (export-domestic) market is always hard to maintain. There is a temptation to buy in the domestic market and export when world prices exceed domestic prices. In this situation, producers prefer to export rather than supply the local market. In the opposite case, if local prices exceed import prices, then import duties must be imposed to keep out the cheaper foreign product.

When local prices are below world prices, this type of market puts the distributors at a disadvantage when dealing with factories. Distributors have no bargaining power as they cannot seek out alternative sources of supply. One large cooperative that was interviewed was unable to meet its members' needs and sought to import urea. The best response obtained was $220/ton FOB Bulgaria. They did not proceed, however, for fear that they would end up having to sell at nearly 50 LE a bag when domestic urea could trade at LE 26.[4] Had they been able to buy the urea that Abu Qir sold at $230 FOB, they could have marketed it at 42 LE. Though prices

[4]Interview with the marketing manager Multi-Purpose Cooperative, November 1995.

exceeded this level in the summer of 1995, the cooperative assessed the possibility of government price control as high.[5]

That fertilizer dealers are in a very weak position with regard to factories is clearly seen in the nature of the contract process.

G2. Contract/Delivery System

Factories chose their distribution partners from a list of annual applicants. The criteria for successful application were unclear, as many applicants met the requirements but few were chosen. Requirements included an adequate line of credit, an agricultural engineer on staff, suitable storage facilities, experience in the area of input supply, etc. Once selected, the distributors placed an annual order with the factory, broken down into monthly requirements. This contract was only an indicator of what the buyer would actually receive. The factory exported 20 percent of its target, delivering the rest to distributors in proportion to monthly orders. One large cooperative received 90 percent of its contract in 1994 but only 57 percent in 1995. Other buyers report even more drastic reductions. Such erratic outcomes hinder adequate inventory planning. Furthermore, it induces buyers to over-order, given their reasonable expectation that orders will not be completely filled. All of this uncertainty raises costs. Factories can also require the dealer to purchase up to 20 percent more than the contract stipulates. In short, the factories acted as an oligopoly which did not extract maximum prices (they could not, with controlled prices), but instead used the distribution network to absorb the risks of uneven production and fluctuations in demand.

The contract allowed for interruption of deliveries due to force majeure. In this case, force majeure includes government directives to redirect output away from private distributors or to maintain exports even when production targets are not met. As the fertilizer companies are owned by public sector entities, this amounts to a conflict of interest. When the determination of force majeure lies within the power of the owners (albeit indirect owners), the contract has little force.

G3. Marketing Margins

At its inception, the process was shaky. The producer companies provided substantial assistance to the distributors. Many of the smaller companies soon abandoned the activity due to losses in the first year. The market matured quickly, however, and several large distributors emerged as the market leaders. This process has been well documented.[6] [7] It is not necessary to repeat these findings except to say that marketing margins were found to be low and though there were relatively few distributors, there was no evidence of excessive profits. The study team confined itself to verifying that this situation continued until the responsibility for fertilizer marketing was returned to PBDAC. We found that profit margins remained low at 5-10 LE per

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[5]Lack of access to alternative international sources because of high tariffs has the same impact in terms of bargaining power.

[6]International Fertilizer Development Centre,1993, Egypt Fertilizer Policy Impact Study. This study is a comprehensive analysis the private system as it evolved. Its recommendations remain valid.

[7]Report to the U.S. Agency for International Development, 1995. Tranche VII Monitoring and Verification Report. This report verified margins by asking buyers and sellers along the distribution chain about changes in prices paid and received. This lessened substantially the problems of under or over-reporting.

ton. One cooperative reported profits as a percent but it was not clear that the cooperative made an adequate assessment of its marketing costs. The cooperative reported a 5 percent rate of profit. Perhaps because of the low margins, previous studies found that farmers throughout the country had some problems with availability both in terms of quantity and variety, mainly in Middle Egypt. The nearly complete replacement of PBDAC by cooperatives and the private sector in two years was, however, largely constructive.

The MOA rural survey carried out for the team confirmed that private sector prices in 1994 were only marginally higher than the cooperatives and the PBDAC. Prices paid for urea for wheat in the fall of 1994 (before the shortage became apparent) were as follows:

Table F-5. Prices for Urea Applied to Wheat
Fall 1994

	LE/50 kg sack	Percent Purchased
PBDAC	25.9	18 percent
Merchant	27.7	48 percent
Cooperative	26.6	34 percent

Source: MOA Survey

G4. The Private Sector's Uncertain Future

If private sector entities return to the market in the future, they should do so under very different circumstance. Buyers should be able to choose their suppliers, and domestic producers should be able to bid to fill contracts that are internationally tendered. There is no reason why local producers should not win most of the tenders, given the savings in transport costs, but buyers must have the choice. At the same time, producers should be free to sell where they wish. Factories should be obliged to fill contracts, with failure to do so resulting in a substantial penalty. Such a policy would induce factories to keep adequate inventory levels to compensate for lost production due to shutdowns. In extreme cases, factories might have to import to meet contracted orders.

The real problem of the contract lies in the imbalance of power between distributors and producers. Due to low ex-factory prices (by world standards), distributors are not free to seek other sources (i.e., imports). Allowing world prices to prevail will help equalize the relationship between distributors and producers.

The above recommendation implies that farmers will pay world prices for their fertilizer. This is inevitable if there is to be a market distribution of fertilizer.

H. The Situation in 1995

H1. Export and Domestic Markets

For the reasons listed above, maintaining a two-tiered price system has led to many difficulties in fertilizer marketing. With the world market becoming a major component in the market for Egyptian fertilizer, Egyptian fertilizer prices will approximate world prices unless the government abandons its commitment to liberalization.

Two questions emerge:

- What will be the impact of higher fertilizer prices on the farmer (and ultimately the consumer)?
- What are the social justice implications of transferring resources from farmers and consumers to fertilizer producers?

Egyptian farmers are no stranger to world prices, as the table below shows. Prilled urea is used as the product of comparison, as it is more widely traded than ammonia nitrate)

Table F-6. Egyptian Versus U.S. Prilled Urea Prices

Year	Egyptian Ex-Factory Price Per Ton		U.S. Gulf Prilled Urea Bagged Per Ton
	L.E.	$	$
1990-91	289	120	140-180*
1991-92	380	115	150-160
1992-93	420	127	155-165
1993-94	455	137	130-140
1994-95	450	136	140-240

* U.S. prices are given as the yearly range.

Egyptian prices were equal to world prices in 1993 and the beginning of 1993-1994. World prices for urea in December 1995 were 220 bagged FOB Eastern Europe, which equates to over 800 LE landed in Egypt. Urea prices overstate the "subsidy" received by Egyptian farmers. In October 1995, ammonia sulphate was trading for $100/ton bagged, equal to the ex-factory price of L.E. 330. Ammonia nitrate currently trades in Egypt near world prices. Ammonia nitrate was sold out of Alexandria at $134/ton bagged FOB. At the exchange rate of 1$=3.3, this equates to L.E. 446, versus the current ex-factory price of 380. It should be noted that there is no Egyptian shortage of AS.

H2. Origins of the Summer Crisis of 1995: The Export Quota System

The discussion that follows is based on information obtained in interviews with both producers and distributors. Factories had an export quota, which amounted to 20 percent of targeted output. While it is not clear how that quota was determined, it evidently was believed that this quota would permit supply and demand to balance in Egypt.[8] As export prices rose above domestic prices in 1994, producers had a strong incentive to export. This led to two strategies. Abu Qir apparently understated its capacity to produce. This allowed them to export 20 percent of capacity and 100 percent of all production above capacity. SEMADCO followed another strategy: knowing that it was having technical problems, the company overstated its capacity and then exported. In both cases, exports ended up as larger than 20 percent of production. The point is not to blame companies for following commercial interests but to blame a policy that forces companies to export because of low administered domestic fertilizer prices.

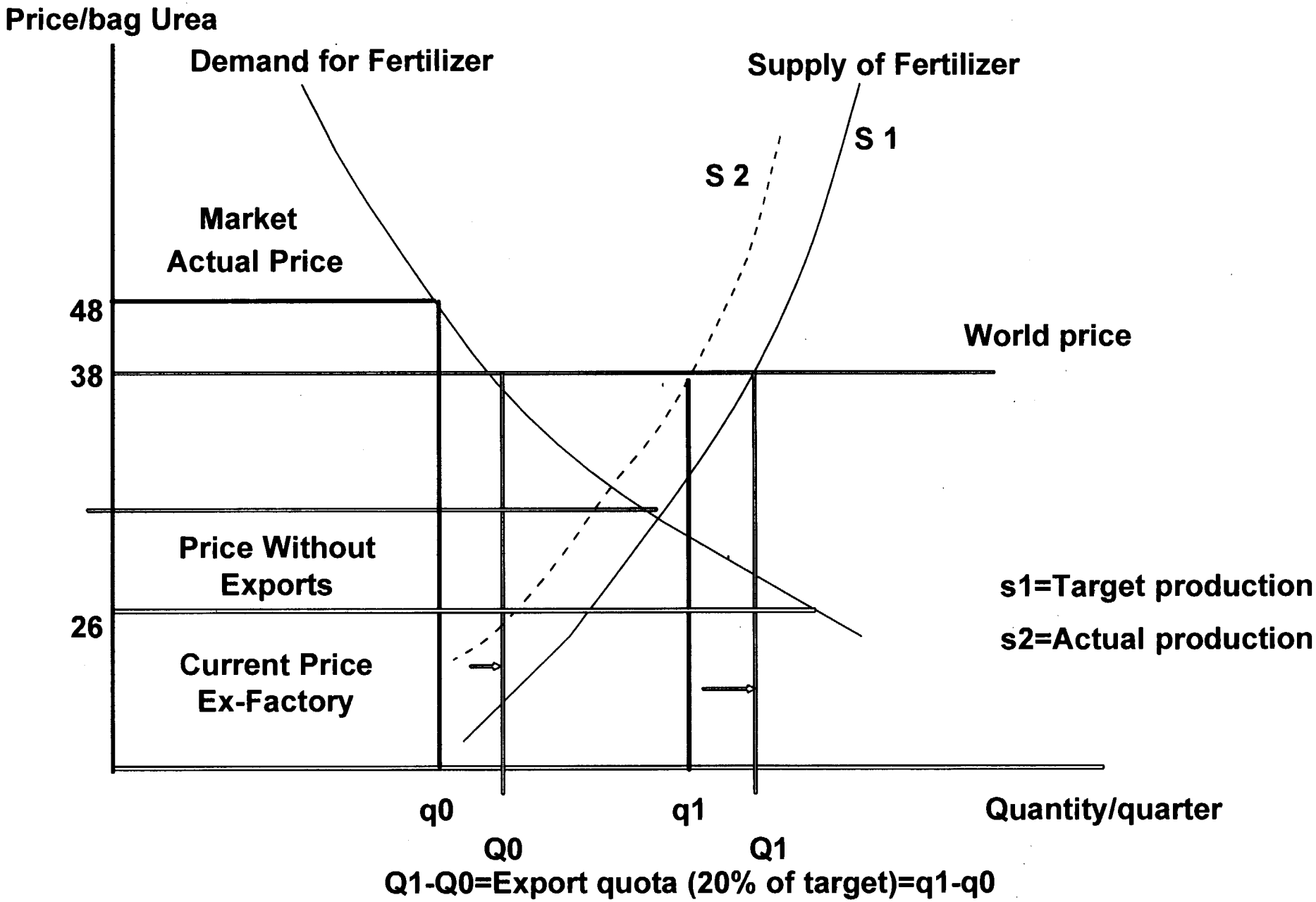
Table F-7. 1994-1995 Production and Exports

	Abu Qir 000 mt	SEMADCO (Suez) 000 mt
Capacity AN	792	280
Production	823	105
Exports	255 (30 %)	47 (45 %)
Capacity Urea	515	
Production	522	
Exports	117 (22 %)	

Figure F-2 illustrates what occurred. With expected supply at S1 and quota Q1-Q0, prices would be at world levels (now higher than the previous year). With the fall in production due to difficulties at Suez and a maintenance of the same quota (shown as q1-q0), prices rose above world levels. In a market economy, this would not happen. When shortages are foreseen, then imports are increased and S2 shifts back to S1. The shortages were foreseen in early 1995 when FOB prices for urea were $200 per ton, but the establishment of low factory prices prevented imports. The survey carried out by the study team found that farmers paid more than world prices for fertilizer (as economic theory predicts). Farmers paid on average 46.8 per bag for urea and 32 for ammonia nitrate. Based on previous surveys, we know that the markup from factory to farmer is 15 percent. It was assumed that had dealers been able to order fertilizer in January

[8]As noted above, discussion of supply and demand for fertilizer in Egypt is dominated by the interest in farmers' needs and the factories' ability to produce. Price is often omitted from the debate. This may partly explain the government's reaction to the 1995 shortage.

Figure F-2
Impact of Fixed Export Quota On Price When Supply Falls



when the coming shortage was evident, they would have paid LE 660 and 446 per ton respectively for urea and ammonium nitrate. This translates into a farmer cost of LE 38 per bag for urea and LE 25.6 per bag for AN. These higher than world prices cost the average urea and ammonia nitrate user LE 67.4 and 70.5, respectively. Some farmers did get their fertilizer from cooperatives and PBDAC, but the vast majority relied on the market. Cost incurred by not paying world prices was, by size group, as follows:

Table F-8. Costs of Market Interference
Amounts Paid by Farmers in Excess of World Prices
(L.E.)

	Urea	AN
Fertilizer use < 2 bags	12.7	9.8
Fertilizer use 3-5 bags	42.8	30.8
Fertilizer use 6-10 bags	78.4	33.9
Fertilizer use 10-25 bags	145.7	95.1
Fertilizer use 25+	90.3*	429.2

* It would appear that the large urea users have better access to cheaper fertilizer.

The question then is not whether Egyptian farmers should pay world fertilizer prices. They have paid these prices in the past, and continue at times to pay world prices for some products. But the following question might be posed: Should farmers be exposed to world fertilizer price fluctuations or should a stabilization scheme be set to smooth the extremes? Such a scheme could feature a fund into which farmers and companies pay, withdrawing money when prices move against them. When world fertilizer prices rise above a given rate, companies pay into a fund fed from increased profits that provides farmers with a rebate at the end of the year. When world prices fall below a certain level, farmers pay above world prices. However, this scenario is not attractive to factories when prices are expected to move upward for the foreseeable future. At the same time, it has the inherent disadvantages of any two-tiered market. A more interesting solution would be to have cooperatives own a substantial share of the fertilizer companies. As coop members, farmers would then share in the profits from the high-price years. However, such a scheme might put coop owners in conflict with other owners if they wanted to trade lower fertilizer prices against lower profits.

ANNEX G

FERTILIZER USE IN EGYPT

By
Dr. Mohamed M. El-Fouly
Dr. Ahmed F.A. Fawzi

ANNEX G: FERTILIZER USE IN EGYPT

by Mohamed M. El-Fouly and A.F.A. Fawzi
Botany Department, National Research Centre, Cairo- Dokki - Egypt

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1. Introduction

During the last 3 decades, Egyptian farmers grew their crops subject to a governmental supply monopoly on agricultural inputs and obligatory delivery of yields of major crops. This policy involved both the subsidy of inputs and the compulsary total or partial delivery of the strategic crop yields (wheat, favabean, cotton , rice, peanut , sesame and sugarcane) at below international prices (*66*). Compulsory cropping patterns determined that farmers grew crops according to rotations planned by the Ministry of Agriculture (MOA). The Principal Bank for Development and Agricultural Credit (PBDAC) was the responsible agency for implementing the policy of MOA through its widely distributed branches that reached farmers in their villages (*30*).

By the end of 80's, the government started reforming the national economy by moving towards privatization, giving priority to the agricultural sector. Subsidies and compulsory cropping were eliminated for most crops (except for cotton and sugarcane, where the government is moving towards liberalization), and farmers became subject to free-market forces.

2. Background information on Fertilizer use

2.1. Fertilizer use under subsidization

Among other inputs, fertilizer was distributed to farmers according to:

1. Generalized results of field trials in 7 experimental stations of MOA, which provided only general recommendations (*92*).

2. Seasonal availability of certain fertilizers, regardless their suitability for crops or soils (*80, 81, 82, 92*).

3. Shortage of farmers service laboratories and consequent dependence on old, inherited information, i.e.: Soils of the Delta and Valley are rich in available potassium and micronutrients, even with intensive cropping under basin irrigation (*36, 42, 51, 54, 63*).

Consequently, subsidized fertilizer was given to the farmers as a "ration" rather than on the basis of actual crop requirements (*41*). Meanwhile, the role of Agricultural Extension (MOA) was mainly to disseminate MOA's instructions on using the "ration" rather than providing training, demonstrations, and feedback. In spite of higher-yielding crop varieties introduced by MOA, farmers' net returns dropped lower than expected. The farmers' perception of this policy was reflected by the following :

1. Farmers tended to avoid growing strategic crops, replacing them with others out of compulsory delivery. This led to decreased areas planted with strategic crops (*12, 66*). Furthermore, cotton sowing was delayed by 2-3 months to get more cuts of berseem clover, which contributed to the reduction of cotton yields (*69*).

2. Soil began to deteriorate because some farmers were selling their surface soil (0-50 cm) to neighboring brick-factories (this was later prohibited by law). Amounts of applied organic manure for major crops decreased with higher prices, from 10-20 m^3/year/crop to 5-15 m^3/year (*67 ,77*).

3. Intensity of intercropping strategic and non-strategic crops was considerably increased, while the fertilizer "ration" was used for earning more income from non-strategic crops. The use of fertilizer by farmers deviated from MOA recommendations from - 50% to +328% (*89*). Also, a black market for fertilizer emerged (*62*).

4. Fertilizer (mainly nitrogenous) was excessively applied due to farmers' insufficient awareness of balanced plant nutrition and low prices and high doses recommended by MOA (*50*) (see tables (1) and (2)).

Table (1) : Nitrogen amounts applied / crop rotation (*41*).

Crop rotation	Total N-dose (Kg N / fed.*)
Clover/Cotton /Vegetables	156
Clover/Maize/Vegetables	163
Wheat/Maize/Potato	168

* fed. (feddan) = 4200 m^2

Table (2) : Amounts of nutrients applied to produce one ton of oranges, and average yields in different countries (*50*).

COUNTRY	Kg per ton fruits			Fruit yield/fed. (t)
	N	P_2O_5	K_2O	
USA	2.3	1.5	2.5	> 20
Morocco	4.6	3	4.5	15-20
Egypt	19.5	4	0.5	5.9-8.4

These factors led to serious negative impacts on the national level. The burden on the state budget was considerably increased (*10*), not only because of subsidies and insufficient agricultural production, but also due to increasing amounts of fertilizer used by the farmers (Nitrogen) (*12, 13*). Excessive use of N-fertilizer also led to pollution of drainage and ground drinking water with nitrates (*5, 50*) as shown in figures (1, 2).

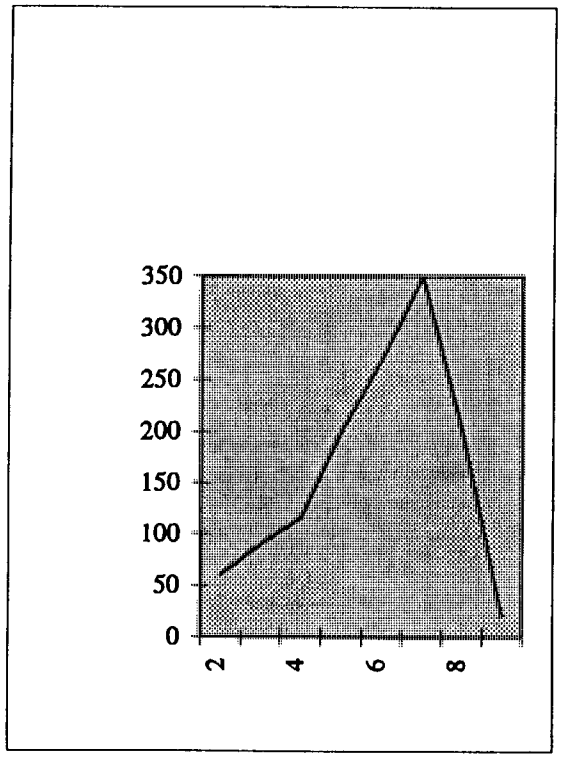


Fig.(1) NO3 Concentration in drainage water of Sharkia governorate (Delta)

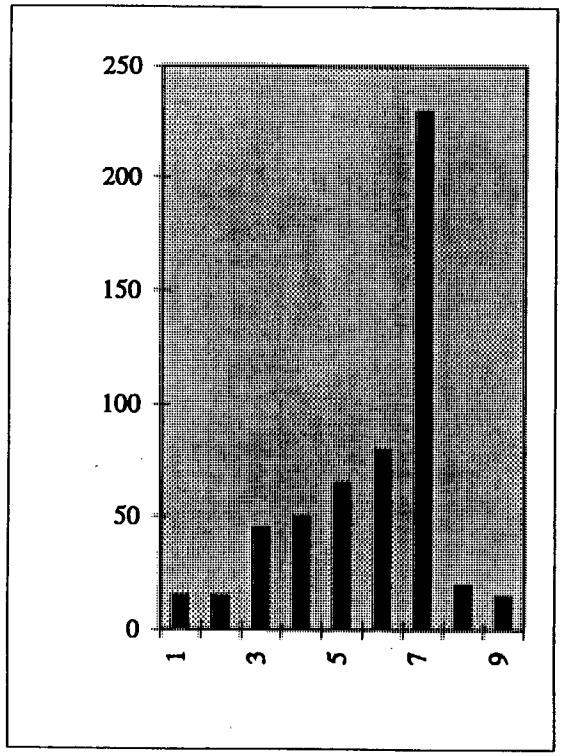


Fig .(2) NO3 Concentration in ground - drinking water of Sharkia governorate (Delta)

2.2. Fertilizer use under removal of subsidy

The removal of subsidies was accompanied by privatization of the agricultural sector, diverting the role of PBDAC to financial service and confining the role of MOA to research, extension service, and economic policies (*66*). Meanwhile, the rate of fertilizer price increases was accelerated, which reduced the demand for fertilizer (*10, 13*). Positive impacts were achieved on the national level, particularly (*66*) :

1. Total cultivatable area increased by 11.8%, due to reclamation of desert land.

2. The cropping pattern was changed to incorporate an increased proportion of crops no longer subject to regulation. Productivity and national production increased in most of major crops as shown in table (3).

Table (3) : Changes in cropping pattern, productivity and national production of major crops between 1985 and 1992 (*66*).

Parameter	Status of governmental control on crop		
	Liberalized		Not liberalized
	Change from 1985		
	Wheat	Rice	Cotton
Total area (1000 fed.)	+ 76%	+ 31%	- 22%
Crop proportion (% of total area)	+ 67%	+ 18%	- 31%
Yield (t/fed.)	+ 40%	+ 29%	+ 5%
National production (1000t)	+ 147%	+ 69%	- 18%

It is particularly interesting to note that these yield increases occurred as farmers reduced demand for fertilizer, which illustrates the high doses of nitrogen previously recommended by MOA (tables 4, 5).

Table (4) : Change in crop production after removal of fertilizer subsidy in Egypt between 1989 and 1993 (*21, 22*) .

Egyptian Total	Status of subsidy		Difference from 88/89
	Existing 1988/89	Removed 1992/93	
1. Crop area (1000 feddan)	11773	12807	+ 1034 (9%)
2. Crop production (1000 t)	39504	46143	+ 6639 (17%)
3. Fertilizer consumed (1000 t nutrient)			
N	770 (79%)	745 (78%)	- 25 (3%)
P_2O_5	181 (19%)	112 (19%)	- 69 (38%)
K_2O	21 (2%)	29 (3%)	+ 8 (38%)
Total fertilizer	972 (100%)	956 (100%)	

Table (5) : Average macronutrient consumption by 1 t primary yield in Egypt (*21, 22*).

Year	Total (1000 t)				Average nutrient consumption (Kg / t produced)		
	Nutrient used			Yield produced			
	N	P_2O_5	K_2O		N	P_2O_5	K_2O
1989	770	181	21	39504	19.5	4.6	0.5
(Ratio)					1 :	0.24	0.03
1993	745	112	29	46143	16.1	2.40	0.60
(Ratio)					1 :	0.10	0.04
Difference from 1989 : Kg / t produced					- 3.4 (17%)	- 2.2 (48%)	+ 0.1 (20%)

Yield increases were attributed mainly to progressive use of higher-yielding crop varieties, improved seed quality, and effective extension programs (especially through national campaigns) (*66*). Achieving such increases within 7 years indicates a good potential for further yield increases resulting from the adoption of modern technologies for crop production, and are indicative of the positive impacts of privatization.

3. The current fertilizer recommendations of MOA

The move to privatization and consequent removal of subsidies was followed by changes in recommended fertilizer doses for some crops :

3.1. Nitrogen (Table 6) :

Doses/feddan were the same in 1993 as in 1989 (*14, 59, 87*). Changes occurred only in minor crops through decreases for soybean and mango; decreases for onion in Upper Egypt; increases for sesame and sorghum in Upper Egypt and on new lands; and increases for grape. This means that recommended doses will continue to be higher than required for most of major crops, at the expense of farmers.

Table (6) : The current fertilizer recommendations of The Ministry of Agriculture (MOA) for nitrogenous fertilizer.

Crop	Cultivated variety	Kg N/ fed.							
		1988				1993			
		1			2	1			2
		L	M	U	N	L	M	U	N
Wheat	Common	70	70	70	70	67.5	67.5	67.5	67.5
	High yielding	78	78	78	78	75	75	75	75
Clover	All	15	15	15	15	15	15	15	15
Favabean	All	15	15	15	15	15	15	15	15
Onion	All	93	133	133	93	60	133	133	60
Cotton	All	62	70	70	-	67.5	72	72	-
Rice	Common (short grain)	41	41	-	41	40	40	-	40
	High-yield (long grain)	62	62	-	62	60	60	-	60
Maize	Common	93	93	93	93	90	90	90	90
	High yielding	108	108	108	108	120	120	120	120
Sugarcane	All	62	62	232	62	60	60	230	230
Soybean	All	77	77	77	77	50	50	30	30
Peanut	All	31	31	31	31	30	30	30	30
Sesame	All	31	39	39	39	30	45	45	30
Sorghum	All	-	70	70	62	-	73	73	73
Potato	All	124	124	124	124	125	125	125	125
Tomato	Open field	124	124	124	124	125	125	125	125
	House - protected	434	434	434	434	-	-	-	-
Citrus	All	186	186	186	186	180	180	180	180
Grape	All	93	93	93	93	120	120	120	120
Mango	All	155	155	155	155	105	105	105	105

1 : Alluvial soils 2: Desert (sandy and calcareous) soils
L = Lower Egypt , M = Middle Egypt, U= Upper Egypt, N = Newly reclaimed lands

Since high-yielding varieties consume less N/t yield than low-yielding ones (*50*), major non-leguminous crops (e.g.; maize and cotton) use only about 25% of the N-dose applied in chemical fertilizer when preceded by clover as shown in table (7).

Table (7): Nitrogen balance in maize and cotton sown after clover (*41*).

Parameter	MAIZE 000 ha 869	COTTON 000 ha 358
	(t / ha)	
Yield in t/ha (National average 1991)	5.89	2.22
	(Kg N / ha)	
1) Total plant uptake	147	130
2) Provided from soil + previous crop + manure	90	90
3) To be provided by chemical fertilizer (1-2)	57	40
4) Provided by chemical fertilizer	220	166
5) Loss in chemical fertilizer (4-3)	163 (74%)	125 (76%)
% Use of available N= 1 / (2+4)%	47%	51%
Use of chemical fertilizer N= 100 - (5) (%)	26%	24%
National loss in N /crop / year (1000 t)	142	45

The national loss of nitrogen from chemical fertilizer applied to major crops was roughly estimated as 316124 t/year in 86% of cropping area (*40*). Data in table (8) indicate that N-losses from summer crops are much higher than from winter crops since most legumes are grown in the winter (approx. 40% of winter area).

Table (8) : Nitrogen balance under 1990/91 cropping pattern (*40*).

Parameter	Cropping season		
	Winter	Summer	Total
	(1000 t)		
(1) N-uptake by crop plants	328.841	283.572	635.609
(2) N-Provided by : Soil* + organic manure	118.107	127.034	263.530
(3) N-Needed from chemical fertilizer = (1) - (2)	210.734	156.538	372.241
(4) N-Provided by : Recommended chemical	263.530	387.737	715.367
(5) N-loss from chemical fertilizer (4) - (3)	25.793 (25%)	231.199 (60%)	316.124 (48%)

* Including N-fixed by legumes; mainly clover.

The loss in N-chemical fertilizer is attributed to inappropriate application practices, excessive irrigation, and unbalanced crop-nutrition (*34, 51, 52, 53, 63, 79, 92*).

3.2. Phosphorus (Table 9)

In major crops, the only change in from 1989 to 1993 is that P_2O_5 doses were raised by 50% for cotton, while doses for high yielding (H.Y.V.) varieties of other crops, like maize, remained unchanged. Doses also increased for sorghum and decreased for potato.

3.3. Potassium (Table 10)

As in 1989, potassium was not recommended in 1993 for major and strategic crops, except for cotton and sugarcane in Upper Egypt, in spite of the recommendations reported by the Soil and Water Research Institute (SWRI), ARC, and MOA (*8*). Meanwhile, potassium application is recommended by MOA for minor field (agronomic) crops in 1993 at twice the 1988 dose, which conforms to SWRI-recommendations (*8*). This may be because subsidies for potassium fertilizer have not yet been completely removed.

Table (9) : The current fertilizer recommendations of The Ministry of Agriculture (MOA) for phosphate fertilizer.

Crop	Cultivated variety	Kg P_2O_5/ fed.							
		1988				1993			
		1			2	1			2
		L	M	U	N	L	M	U	N
Wheat	Common	15	15	15	15	15	15	15	15
	High yielding	15	15	15	15	15	15	15	15
Clover	All	15	15	15	15	15	15	15	15
Favabean	All	30	30	37	30	30	30	-	30
Onion	All	15	15	30	15	15	15	45	15
Cotton	All	15	15	15	-	22.5	22.5	22.5	22.5
Rice	Common (short grain)	15	15	15	15	15	15	15	15
	High-yielding (long grain)	15	15	15	15	15	15	15	15
Maize	Common	15	15	15	15	15	15	15	15
	High-yielding	15	15	15	15	15	15	15	15
Sugarcane	All	15	15	15	15	15	15	15	15
Soybean	All	22.5	15	15	15	15	15	15	15
Peanut	All	30	30	30	30	15	15	15	15
Sesame	All	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Sorghum	All	7.5	7.5	7.5	7.5	30	30	30	30
Potato	All	67.5	67.5	67.5	67.5	60	60	60	60
Tomato	Open field	45	45	45	45	45	45	45	45
	House - protected	120	120	120	120	120	120	120	120
Citrus	All	30	30	30	30	30	30	30	30
Grape	All	45	45	45	45	30	30	30	30
Mango	All	30	30	30	30	30	30	30	30

1 : Alluvial soils 2: Desert (sandy and calcareous) soils
L = Lower Egypt , M = Middle Egypt, U= Upper Egypt, N = Newly reclaimed

Table (10) : The current fertilizer recommendations of The Ministry of Agriculture (MOA) for potassium fertilizer (where available) .

Crop	Cultivated variety	Kg K_2O/ fed.							
		1988				1993			
		1			2	1			2
		L	M	U	N	L	M	U	N
Wheat	Common	0	0	0	0	0	0	0	0
	High-yielding	0	0	0	0	0	0	0	0
Clover	All	0	0	0	0	0	0	0	0
Favabean	All	0	0	0	0	24	24	24	24
Onion	All	0	0	0	0	24	24	48	24
Cotton	All	0	0	0	0	0	0	24	0
Rice	Common (short grain)	0	0	0	0	0	0	0	0
	High-yielding (long grain)	0	0	0	0	0	0	0	0
Maize	Common	0	0	0	0	0	0	0	0
	High yielding	0	0	0	0	0	0	0	0
Sugarcane	All	0	0	0	0	0	0	48	0
Soybean	All	0	0	0	0	24	24	24	24
Peanut	All	0	0	0	0	24	24	24	24
Sesame	All	0	0	0	0	24	24	24	24
Sorghum	All	0	0	0	0	0	0	0	0
Potato	All	48	48	48	48	48	48	48	48
Tomato	Open field	48	48	48	48	48	48	48	48
	House - protected	384	384	384	384	384	384	384	384
Citrus	All	24	24	24	24	48	48	48	48
Grape	All	24	24	24	24	45	45	45	45
Mango	All	24	24	24	24	48	48	48	48

1 : Alluvial soils 2: Desert (sandy and calcareous) soils
L = Lower Egypt , M = Middle Egypt, U= Upper Egypt, N = Newly reclaimed

3.4. Micronutrients and foliar fertilizer

These compounds were neither subsidized nor officially recommended by MOA (soil application of Zn sulphate was recommended for rice nurseries). However, PBDAC began distributing some of these compounds under the name "foliar fertilizer" in the 1980s. Most of these compounds did not contain adequate amounts of Zn, Mn, Fe or Cu to correct micronutrient deficiencies (*33, 35, 37*). Yet, under governmental control, some companies could market their products through PBDAC channels, regardless of the actual utility of these products to farmers. Recommendations started with 24 Kg Zn SO_4 / feddan nursery (*28*). The joint Egyptian-German Program "Micronutrients and Other Plant Nutrition Problems in Egypt" played a role in disseminating appropriate information on micronutrients, describing their role in producing high yields from field and horticultural crops, and demonstrating their effects on large-scale production throughout the '80s and '90s (*67-88*). Results of this program were taken into consideration by ARC and MOA, and most of ARC's extension materials in the 90's recommend micronutrient foliar application to field and horticultural crops in Egypt (*15-20, 90*).

4. Fertilizer use under the current liberalized conditions

Data was collected from farms served by the "Optimizing Fertilizer Use in Egypt" project, which applied the results of the "Micronutrients and Other Plant Nutrition Problems in Egypt" program. During 1991/92 - 1993/94, the project described fertilizer regimes practiced by farmers before developing the project's soil-based fertilizer recommendations. Through testing and plant analysis, information was gathered on crops grown in the areas shown in tables (11, 12). The results are summarized in table (13).

Table (11): Areas surveyed for common fertilizer practices during 1991/92 - 1993/94

Year	Area (fed.)*					
	Old land	**New land**	**Total**	**Old land**	**New land**	**Total**
	Field crops			**Horticultural crops**		
1991/92	2574	834	3408	5060	3977	9037
1992/93	4853	260	5113	5520	1718	7238
1993/94	6620	200	6820	3000	1340	4040
Total	14047	1294	15341	13580	7035	20315

* From internal project reports.

Table (12): Farmers surveyed for common fertilizer practices during 1991/92 - 1993/94.

Year	Number of farms		
	Old land	New land	Total
1991/91	3850	150*	4000
1992/93	5850	200*	6000
1993/94	6700	385*	7085

* Including agricultural companies (according to internal project reports)

Table (13): Fertilizer use for major crops under current liberalized conditions (estimated from farm data).

Crop	% of total area	Kg/ feddan							
		N		P_2O_5		K_2O		Micronutrients	
		range	average	range	average	range	average	range	average
		Old land : Nile Delta and Valley (alluvial soils)							
Wheat	15.0	50-100	60	0-31	15	0	0	0	0
Rice	11.0	30-60	33	0-31	15	0	0	0	0
Maize	13.0	116-162	120	23-31	23	0	0	0	0
Clover	14.0	13-46	20	23-39	30	0	0	0	0
Cotton	7.0	0-60	40	23-45	30	0	0	0	0
Potato	1.2	210-350	250	75-155	90	0	0	0	0
Tomato	2.4	250-400	300	30-60	45	0	0	0	0
Citrus	1.4	150-200	180	30-60	45	0-24	6	0-0.3	0.01
Grape	0.6	150-300	200	30-60	45	0-24	6	0-0.2	0.006
		New land : Desert (sandy soils)							
Wheat	2.8	80-100	90	15-30	23	0	0	0	0
Maize	0.6	80-130	110	23-45	30	0	0	0	0
Clover	0.4	10-33	20	23-45	30	0	0	0	0
Tomato	0.6	300-500	350	30-60	45	0	0	0	0
Citrus	0.8	140-220	200	45-75	60	24-48	36	0.1-0.5	0.04
Grape	0.3	150-200	180	30-60	45	24-96	48	0.3-0.8	0.081
Olive	0.4	45-90	60	23-45	30	0	0	0	0

Comparing the doses applied by farmers to those recommended by MOA (tables 14 and 15-figs. 3,4 and 5), the following can concluded:

- **Nitrogen dose:** Lower than recommended for wheat, rice and cotton, but higher for clover and maize, which may reflect a point of departure for increasing returns with use of less N-fertilizer. However, doses applied to horticultural crops are higher than recommended.

- **Phosphorus dose:** Higher than recommended by MOA in most crops, probably to realize benefits of the fertilizer in decreasing soil compactness and salinity because of its $CaSO_4$ content.

- **Potassium dose:** Field and vegetable crop growers on the old lands do not use K-fertilizer recommended by MOA, which reflects both their insufficient awareness of a balanced macronutrient concept and the irregular availability of this imported fertilizer.

- **Micronutrients:** As in the case of rice, micronutrients are applied mainly to fruit orchards, through national campaigns. Yet the average dose is much lower than required to correct deficiencies. In addition, the micronutrients applied are rarely used for specific requirements.

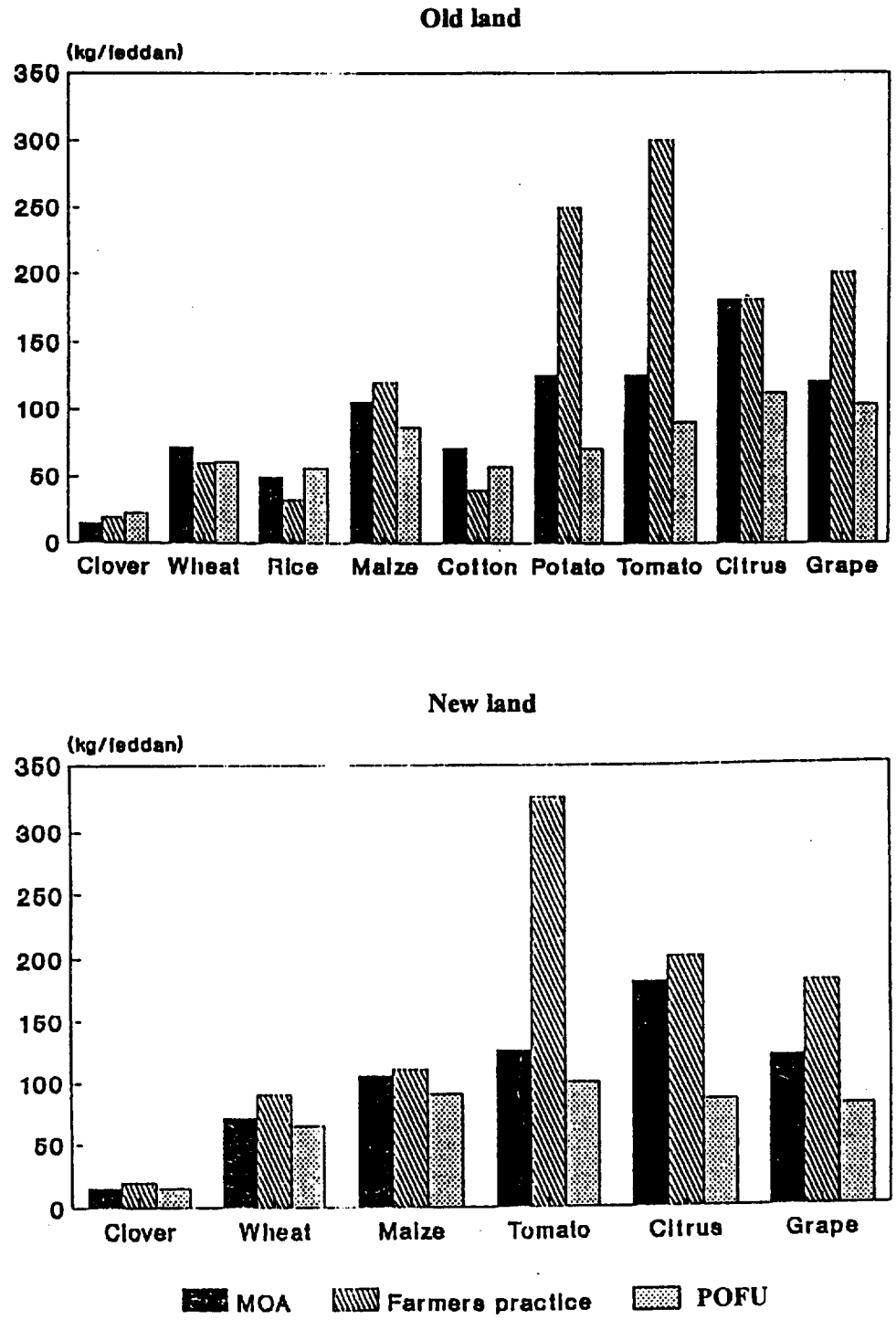
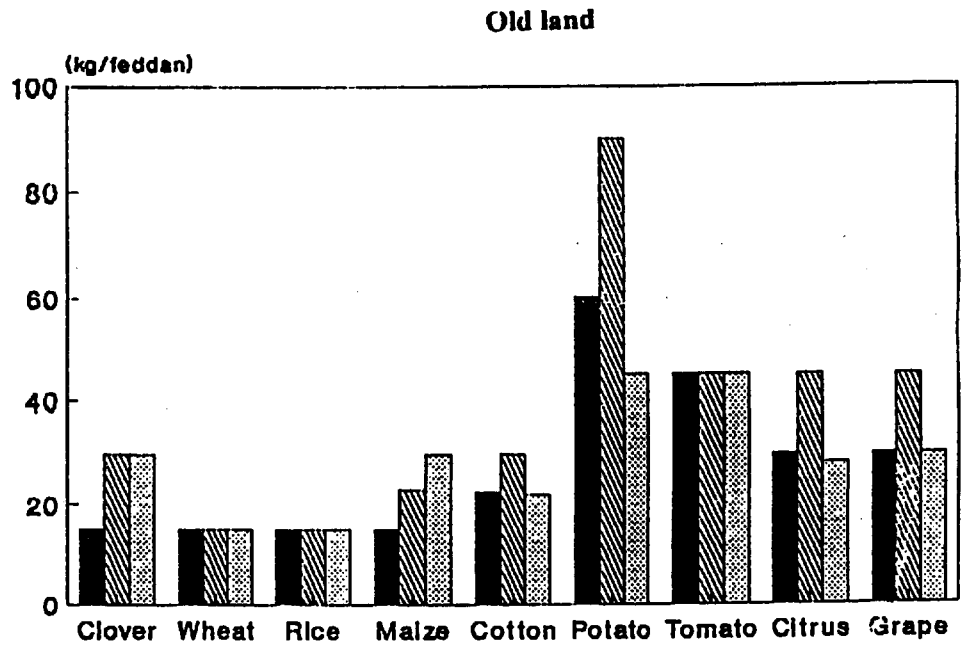


Fig. (3) : The farmers N fertilizer use and recommendations by MOA and Project of optimizing fertilizer use (POFU).



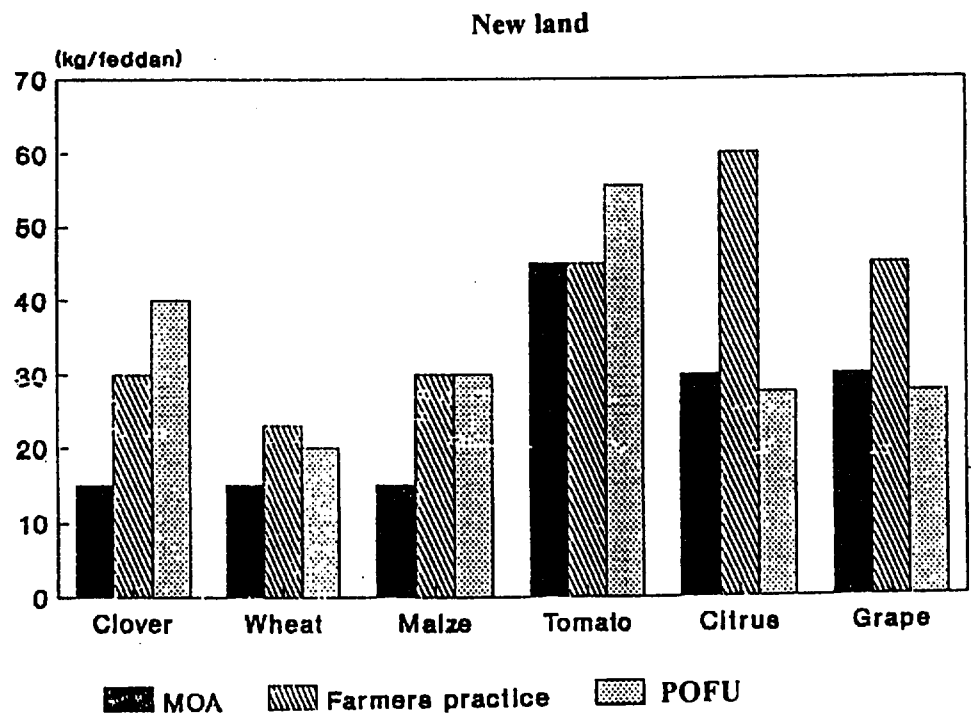
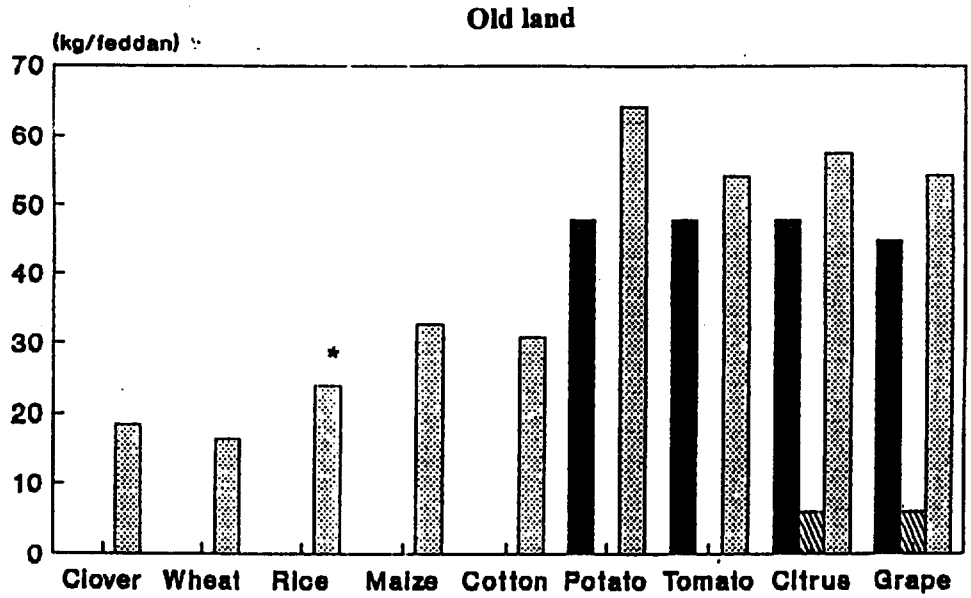
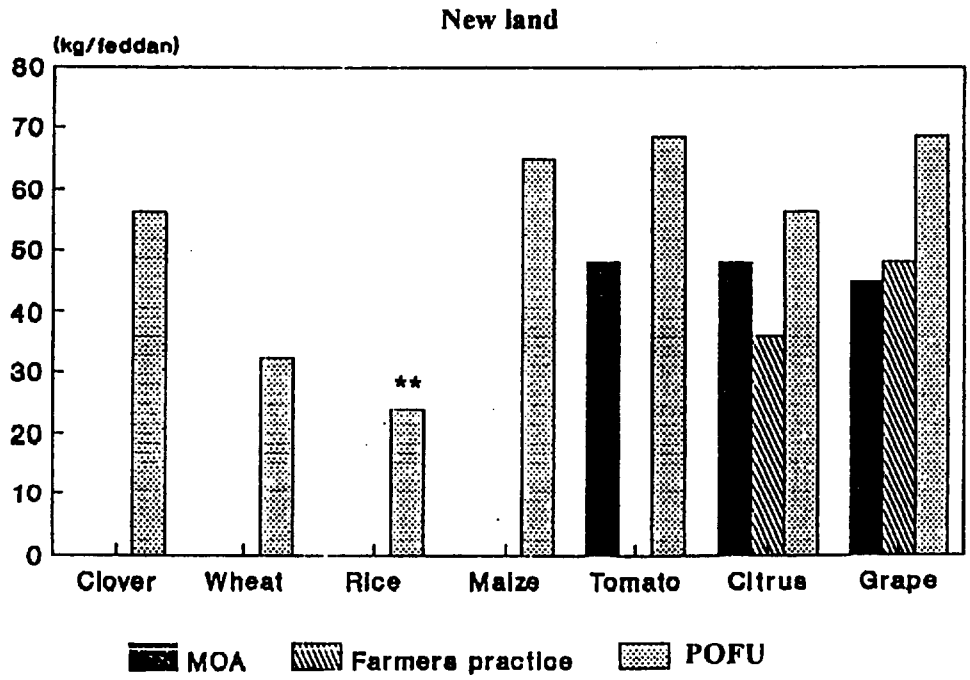


Fig. (4) : The farmers P fertilizer use and recommendations by MOA and Project of optimizing fertilizer use (POFU).





* Only in middle Egypt

** Only in non-calcareous soils

Fig. (5) : The farmers K fertilizer use and recommendations by MOA and Project of optimizing fertilizer use (POFU).

Table (14): Fertilizer use and MOA recommendations for some major crops (old lands).

Crop	Average (Kg/fed.)										
	N			P_2O_5			K_2O			MN*	
	1	2	3	1	2	3	1	2	3	1	2
Clover	15	20	23	15	30	30	0	0	18.3	0	0
Wheat	71	60	61	15	15	15	0	0	16.4	0	0
Rice	50	33	56	15	15	15	0	0	24***	1**	0.05
Maize	105	120	86	15	23	30	0	0	32.8	0	0
Cotton	70	40	57	22.5	30	22	3.7	0	31	0	0
Potato	125	250	70	60	90	45	48	0	64.4	0	0
Tomato	125	300	90	45	45	45	48	0	54.2	0	0
Citrus	180	180	112	30	45	28.3	48	6	57.5	0	0.01
Grape	120	200	105	30	45	30	45	6	54.3	0	0.006

1 = MOA recommendation, 2 = Farmers' practice, 3 = Project Optimizing fertilizer use

* Micronutrients
** Zn- Sulfate on soil of nursery, only 5% of farmers accept it.
*** Only in Middle Egypt.

Table (15): Fertilizer use and MOA recommendations for some major crops (new lands).

Crop	Average (Kg/fed.)										
	N			P_2O_5			K_2O			MN*	
	1	2	3	1	2	3	1	2	3	1	2
Clover	15	20	15	15	30	40	0	0	56.4	0	0
Wheat	71	90	65	15	23	20	0	0	32.4	0	0
Maize	105	110	90	15	30	30	0	0	68.8	0	0
Tomato	125	352	100	45	45	55.5	48	0	68.4	0	0
Citrus	180	200	85	30	60	27.6	48	36	56.4	0	0.04
Grape	120	180	80	30	45	27.6	45	48	68.4	0	0.08

1 = MOA recommendation, 2 = Farmers' practice, 3 = Project Optimizing fertilizer use

* Micronutrients

The comparison indicates that farmers apply fertilizer in doses mostly differing from those recommended by MOA, especially in the case of horticultural crops. This reflects insufficient communication between extension services and farmers.

5. The expected fertilizer consumption

5.1. Based on MOA recommendations:

Fertilizer recommendations anticipated by MOA (*65*) seem to respond to farmers' decreased demand in the years followed the removal of subsidies (*91*). The MOA-anticipated amounts after 1993/94 are much lower than those predicted in the 80's (*24, 30, 60*), as shown in table (16). The yearly increases range from 1.7% to 2%, 3% for P2O5 / and 1% for K2O.

Table (16): Anticipated fertilizer need according to MOA recommendations (1000 t/year).

F. Year	Year of estimation		
	1989		1995
	N		
1994/1995	1011	930	642
1995/1996			653 (+ 1.7%)
1996/1997			666 (+ 3.8%)
1999/2000	1141 (+12.5%)	1023 (+10%)	707 (+10%)
2004/2005		1116 (+ 20%)	780 (+21%)
2009/2010		1209 (+ 30%)	860 (+ 34%)
	P_2O_5		
1994/1995	254	221	275
1995/1996			265 (301)
1996/1997			274 (+ 606)
1999/2000	331 (+ 30%)	239 (+ 8%)	298 (+16%)
2004/2005		262 (+ 10%)	345 (+ 34 %)
2009/2010		284 (+ 8%)	400 (+ 56%)
	K_2O		
1994/1995	80		250
1995/1996			251 (+ 0.4 %)
1996/1997			253 (+ 1.2%)
1999/2000	180 (+ 35%)		263 (+ 5.2%)
2004/2005			276 (+ 10%)
2009/2010			290 (+ 16%)
Reference	(*30,60*)	(*24*)	(*91*)

5.2. Based on other estimates:

Estimates other than those of MOA authorities are compiled from results of field experiments (*6-9, 25-27*), on-farm trials (*11, 31, 32, 34, 38, 39, 42-46, 48-51, 54-57, 67-82*) and feedback from farmers' advisory services (*50-52, 85, 88*), as well as other sources (*23, 29, 47, 58, 61, 64, 88*). The cumulative data indicate that yields and net returns of crops can be increased through more balanced nutrient application, achieved through : Reductions in N and P, accompanied by application of K and micronutrients.

- **Macronutrient fertilizer:** Data in appendix (1) are summarized in table (17) as the projected national N, P, and K requirements by the year 2005.

Table (17) N , P and K fertilizer requirements according to recommended doses (year 2005)

Region	(1000 t)		
	N	P_2O_5	K_2O
1. Nile Delta and Valley			
1.1. Lower Egypt	372	149	134
1.2. Middle Egypt	160	59	83
1.3. Upper Egypt	153	50	81
sub-total	685	254	298
2. Desert - irrigated			
2.1. Sandy-non calcareus soils	24	7	14
2.2. Sandy-calcareous soils *	129	66	118
Sub - total	153	73	132
Total	838	327	430

* including the expected reclaimed lands (approx. 750000 feddans, i.e. 15000 feddans yearly)

- **Sources for yield increases :**

According to the above estimates (2.2.), sources of yield increases by 2000-2005 are projected in table (18) .

Table (18): Projected yield increases for major crops.

Crop	Average yield		Yield increase		Source of increase(%)	
	1993	2000-20005	t/feddan	%	1*	2**
Wheat	2.33	3.07	0.84	32	10	22
Clover	24.70	30.80	6.10	25	5	20
Rice	3.0	3.92	0.92	31	13	18
Maize	2.58	3.52	0.95	37	12	25
Cotton	1.23	1.62	0.83	31	14	17
Tomato	12.94	17.24	4.30	33	10	23
Potato	7.68	10.13	2.45	32	6	26
Citrus	6.86	9.20	2.33	34	3	31
Grape	6.44	9.56	2.12	48	20	28
Mango	4.57	5.65	1.08	24	2	22

* Variety Potential + seed quality + farming practices. ** Balanced nutrition including micronutrient application.

Such increases can be described as the recovery of yield lost because of micronutrient deficiencies and consequent nutrient imbalance. Using micronutrients as part of a balanced plant nutrition concept enables crops to better express their genetic potential through improved plant-physiological performance. Such an interpretation was indicated by results showing increased root growth in response to foliar micronutrient application (*3, 4, 64, 65*). Consequently, plants can absorb more nutrients from the soil. Therefore, macronutrient contents in plants is increased with the spraying of micronutrients (*4, 8, 49, 64, 65*), as shown in table (19)

Table (19) : Increase of macronutrients content with seasonal micronutrients foliar application on major crops in Egypt.

Crop	plant part	Increase % over untreated								
		Old land (Clay-loamy soils)			New land (Sandy soils)					
					non-calcareous			calcareous		
		N	P	K	N	P	K	N	P	K
1. Wheat	Shoot	18	19	6	25	21	8			
2. Clover	Shoot				53	13	15			
3. Maize	Shoot	26	23	24	40	50	35			
4. Cotton	Shoot	29	20	38						
5. Rice	Shoot	20	15	10						
6. Fababean	Shoot	29	25	33						
7. Citrus	Leaves	13	27	23	7	12	14	10	11	22
8. Grape	Leaves	5	15	9				8	11	19
9. Potato	Leaves	23	38	14				13	0	11

In addition, results also showed that levels of N, P, and K in orange and grape leaves tend to adjusted to the satisfactory range with successive yearly micronutrients spraying (*68, 82*) as shown in table (20).

T: e results in tables (19, 20) reflect the possibility of saving considerable amounts (around 20%) of the commonly applied nitrogen dose.

Table (20) : Macronutrients content in leaves of fruit trees sprayed with micronutrients for successive seasons.

Year Of application	Orange (Balady)			Grape (Romy-Red)		
	Content (% on dry weight basis)					
	N	P	K	N	P	K
1 st	2.15	0.29	0.82	2.32	0.06	1.07
3 rd	2.71	0.15	1.24			
5 th				2.57	0.19	1.43
Satisfactory range (58,61)						
Minimum	2.40	0.12	0.70	2.25	0.19	1.20
Maximum	2.60	0.16	1.40	2.75	0.24	1.40

The results in tables (19,20) reflect the possibility of saving considerable amounts (around 20%) of the commonly applied nitrogen dose.

The estimated net return on using micronutrients are shown in table (21).

Table (21) Net return to farmers (L.E./ feddan) through micronutrient use (1994/1995).

Crop	Added expenditure			Yield increase (t/fed.)	Price*** /t (L.E.)	Added income (L.E. /fed.)	Net return	
	MN*	Others **	Total				/fed.	/L.E.
1. Field Crops:								
Barley	16	25	41	0.21	500	105	64	1.6
Wheat	30	25	55	0.38	650	247	192	3.5
Maize	28	28	56	0.48	565	271	215	3.8
Rice	19	25	44	0.58	510	296	252	5.7
Clover (4Cuts)	42	28	70	7.85	40	314	244	3.5
Cotton (hair+seed)	28	30	58	0.11	2857	314	256	4.4
Favabean	33	25	58	0.20	1075	215	157	2.7
Soybean	35	25	60	0.25	900	225	165	2.8
Lentil	33	25	58	0.22	1557	343	285	4.9
Peanut	26	25	51	0.19	1333	253	202	4
Sesame	27	25	52	0.06	2240	134	82	1.6
Sugar cane	29	50	79	5.5	73	402	323	4.1
Sugar beet	35	40	75	6.20	60	372	297	4
Others	16	25	41	0.25	550	138	97	2.4
2. Vegetable Crops :								
Tomato	41	65	106	2.42	300	726	620	5.8
Potato	31	65	96	2.29	450	1031	935	9.7
Others	25	65	90	1.8	400	720	630	7
3. Fruit Crops :								
Citrus	95	70	170	2.6	350	910	740	4.4
Grape	68	60	136	1.8	400	720	584	4.3
Mango	118	70	188	0.5	1000	500	312	1.7
Others	75	50	125	0.7	700	490	365	2.9

* Micronutrient
** Costs of application + harvest of extra yield
*** Farm gate price

The continuous increase in fertilizer prices is considered the main factor in encouraging farmers to seek information on the appropriate techniques for applying fertilizer. The results of experiments on timing and placement of macronutrient fertilizer (*1, 2, 25, 26-28*) are accessible through different media channels, such as extension bulletins and brochures (*15-20*), as well as TV and radio broadcasts. Accordingly, farmers can optimize the use of N and P fertilizer. The reduction of the exess N-doses will be accompanied by more K-application, in response to both scientific results and extension advisory services (*8, 15-20, 32, 38, 39, 42-, 44, 51-54, 56, 58, 61-86, 88, 90*), for gaining higher return on high-yielding varieties.

6. Micronutrients and balanced fertilizer use

In view of the national yield increases achieved from 1985 to 1992 (*66*), crops show good potential for further yield increases. The use of modern technology for producing higher yields also indicates promising possibilities. Meanwhile, the dissemination of high yielding varieties and the National Campaigns on improving practices for growing major crops, mainly wheat, maize, rice etc., are progressing. Access to good-quality seeds is expected to cover the country through activities of the national "Improvement of Seed Production and Supply" project within the coming 5-7 yeas. In addition, both the results of ARC experiments (*6, 7, 9*) and on-farm application of the "Micronutrients and Other Plant Nutrition Problems in Egypt" program (*11, 31-35, 38, 39, 41, 42, 45-50, 52, 53, 55-57, 67-82*) showed satisfactory yield increases with micronutrients (table 22).

Table (22): Average yield increase in response to micronutrients foliar spray (1980/81 - 1993/94)*

crop	Yield increase / fed.									
	Lower Egypt		Middle Egypt		Upper Egypt		Desert sandy soils			
							non-calcareous		calcareous	
	t	%	t	%	t	%	t	%	t	%
1. Field crops										
• Barely									0.210	13
• Wheat	0.365	22	0.485	21	0.412	22	0.150	12	0.435	25
• Maize	0.540	22	0.430	20	0.220	32	0.440	29	0.623	44
• Rice	0.575	18								
• Sugarcane			3.380	10	8.370	19				
• Favabean	0.231	21	0.240	20	0.387	26			0.160	23
• Soybean	0.275	24	0.261	24	0.187	25	0.300	37		
• Lentil	0.219	42								
• Peanut			0.180	19			0.231	23		
• Clover (4 cuts)	8.000	20	8.600	20	8.200	18	12**	43**	5.280	30
• Cotton	0.137	19	0.104	14	0.080	12				
• Sesame			0.048	18			0.126	17		
2. Vegetable corps										
• Tomato	2.250	25	3.000	21	3.000	19	2.500	25	2.000	22
• Potato	2.650	30	2.000	23	1.300	13	4.000	50**	1.440	20
• others	1.800	21	2.100	25	2.600	20	1.200	26	1.000	33
3. Fruit crops										
• Citrus	2.8	35	3.100	26	2.000	25	2000	33	1.1800	24
• Grape	1.8	25	2.332	38	1.600	22	1.000	40	1.100	38
• Mango	0.5	20	0.560	22	0.600	18	0.500	40	0.250	40
• Others	0.7	25	0.800	20	0.850	20	0.40	35	0.350	30

* Carried out on a total area of 93600 feddans . ** Pivot - irrigated.

7. Micronutrient fertilizer use and future estimates

Tables (23, 24) show figures for imported and locally produced foliar fertilizer. Until now, there has been no clear distinction between NPK and micronutrient-containing foliar fertilizer. The categorization given in tables (23, 24) is based on a proposed classification, which is not used for statistical purposes. Moreover, import or local production in a year does not necessarily indicate the use in the same year.

It should be noted that the collected information is far less than what is actually used, since full information on imported and locally produced amounts is not available. In addition, about 1000 t/year of zinc sulfate is used for rice as soil treatment. The estimated micronutrient requirements are given in table (25), which shows high requirements for Zn, Mn, and Fe, and less for Cu.

Table (23): Total imported and locally produced foliar fertilizer for the period 1981-88.

	1981-5	1986	1987	1988	Total
Macronutrient compounds*	4784	432	442	2280	7938
Macro-and micronutrient compounds**	900	157	127	54	1238
Single micronutrients chelated compounds	312	35	52	47	446
Complex micronutrient compounds	962	25	160	160	1307

In addition to approximately 900 t zinc sulfate per year for rice.
* With less than 2% micronutrient (Mn + Fe + Zn) in chelated form
** With higher than 2% micronutrient (Mn + Fe + Zn) in chelated form.

Table (24) Locally produced and imported micronutrient fertilizer (1989-1995).

Year	Ton/1000 compound						Overall Total
	Single micronutrient			Complex compound			
	Local	Imported	Total	Local	Imported	Total	
1989	n.a.	99	99	n.a.	37	37	136
1990	n.a.	37	37	n.a.	24	24	61
1991	n.a.	81	81	n.a.	20	20	101
1992	n.a.	18	18	n.a.	-	-	18
1993	54	120	174	-	109	109	283
1994	30	120	150	67	33	100	250
1995	-	146	146	55	23	78	224
Total	84	621	705	122	246	368	1073

The figures in table (24) are far below actual requirements, even if we allow that these amounts are only a part of real consumption (data is not complete). The names of the used compounds and the manufacturers are given in the appendixes.

Table (25): Estimated crop requirements for zinc, manganese, iron and copper used as foliar fertilizer in chelated form (*35*).

Crop	Micronutrient requirement (g /fed.)			
	Zn	Mn	Fe	Cu
Wheat	40	30	15	22.5
	(80%)	(70%)	(60%)	(5%)
Maize	50	45	20	22.5
	(80%)	(30%)	(60%)	(5%)
Sorghum	50	40	20	20
	(80%)	(30%)	(10%)	(5%)
Cotton	35	22	15	10
	(85%)	(70%)	(70%)	(5%)
Sugarcane	60	45	25	20
	(80%)	(80%)	(25%)	(5%)
Rice	50	40	20	20
	(90%)	(60%)	(30%)	(5%)
Vegetables	75	60	50	10
	(100%)	(100%)	(50%)	(5%)
Orchards	150	100	100	20
	(100%)	(100%)	(100%)	(15%)
Legumes	50	40	40	20
	(100%)	(100%)	(100%)	(15%)

Numbers in parentheses are percentage of total crop area requiring micronutrients.

According to the data in table (25) and the appendixes, the National estimated needs for micronutrient foliar fertilizer will reach the figures given in table (26).

Table (26): Estimated national needs for micronutrient fertilizer *

Year	area using micro-nutrient (% of total area needs micro.)	(tones)	
		Nutrient	chelated compounds (10% nutrient)
2000	10	120	1200
2005	20	240	2400
2010	50	600	6000

* Except Zn sulfate for rice

* Upon estimated 80% of the crop area requiring micronutrients

8. Recommendations for the use of micronutrient fertilizer:

1. Except for the use of zinc sulfate in rice, it is recommended to use micronutrients in Egypt as foliar fertilizer. Due to the high soil pH, calcium carbonate content, and texture, micronutrients used in the soil are very ineffective, and the very few suitable chelated ones are very expensive and less economic compared with foliar treatment.

2. Producers of soil N, P, K + micronutrient compounds are advised not to add the micronutrients to the compounds, either in chelated or non-chelated form.

3. Treatment with micronutrient foliar fertilizer should distinguish between preventive and curative doses, particularly on fruit trees and protected agriculture.

4. Foliar fertilizer should be classified. Micronutrient content of 2% in chelated form and 5% in non chelated form should be the minimum to classify the product as micronutrient foliar fertilizer.

5. Under Egyptian conditions, compound foliar fertilizer containing Zn, Mn and Fe are recommended instead of using single compounds mixed on-farm.

6. In some cases, Cu in also required.

7. Very little work has been done on Boron, but there are indicators that sugar beets in some areas suffer from B-deficiency.

8. Fertilizer producers are used to producing an adequate number of compound fertilizer to suit the needs of major crops in concentration areas (not one for all conditions and not one for each crop in each location).

9. It is preferable to import solid products or suspensions rather than liquid ones to reduce transportation of water. This also applies to some extent to local production.

9. Role of extension services in optimizing fertilizer use

The fast-changing conditions and practices of fertilizer use, together affected by the liberalization of the market, give more emphasis to the role of extension service. Until recently, extension agents were considered deliverers of fertilizer and could not officially give any advice, except the rates fixed by the MOA.

As has been demonstrated, crops in Egypt need to be fertilized according to the yield expected, location, and environmental considerations. In addition, the registered fertilizer compounds are increasing in number and have different formulations and nutrient contents and ratios. The needed nutrients are no longer N and P only; K is a very important fertilizer nutrient which is still not given the needed attention. Also, sometimes Mg and S and different micronutrients should be taken into consideration. Extension agents are generally not able and do not have the basic knowledge to advise farmers to be accurate and selective when buying fertilizer. A country-wide training program should be designed to acquaint farmers with the needed information.

The following steps are proposed:

1. Specialized extension courses should be developed and conducted at the district level to train fertilizer specialists (duration : minimum 6 months)

2. Regional extension courses at the village level (duration : minimum one weeks). These courses can only be designed and conducted through international cooperation.

3. Keeping extension agents informed about new knowledge, new fertilizer products on the market, and new research results

4. Sales agents of companies and dealers should also be trained on the basics of plant nutrition.

5. The MOA should encourage establishing soil testing and plant analysis laboratories which offer services to the farmers in return for cost contributions.

6. Enhancing a modern system for estimation of fertilizer needs based on target yields, soil testing, plant analysis, and field observation (see page 75).

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REFERENCES

1. Academy for Scientific Research and Technology (ASRT) - Agricultural Research Centre (ARC), (1989): The National Campaign for Rice: Final report. Ed. M. S. El-Ballal. pp. 52.

2. Academy for Scientific research and Technology (ASPRT) - MOA (1986): The National Campaign for Maize: Results of 1986, pp. 55.

3. Abdalla, F. E. and Mobarak, Zeinab, M. (1992-a): Shoot intake of nutrients from different micronutrient fertilizer formulations in favabean. African J. Agric. Sci. 19, 147-160.

4. Abdalla, F. E. and Mobarak, Zeinab, M. (1992-b): Uptake of NPK and Mg by favabean after foliar treatment with chelated and non-chelated micronutrient fertilizers. African J. Agric. Sci. 19, 161-172.

5. Abd El-Ghani, M. B. ; Abd El-Dayem, M. S. ; EL-Sayed, A. A. and El-Fouly, M. M. (1993): Importance of protecting the environment and water resources from pollution with fertilizers. Proc. German / Egyptian / Arab Workshop "Environmentally Sound, Location and Crop Specific Application of Fetilizers in Arid Areas of North Africa and The Near East", 6-17 June, 1993, Cairo - Ismailia, Eds. M. M. El-Fouly and F. E. Abdalla, pp. 91-103 (Arabic with English Summary).

6. Abd El-Hadi, A. H., Asy, AH. ; Doring, H. - W. ; Khadr, M. S. ; Mohamed, Y. H., Mostafa, A. A. and Taha, M. E. (1986): Effect of foliar fertilization in different crops under Egyptian conditions. In. Foliar Fertilization. Ed. A. Alexander, pp. 126-141, Martinus Nijhoff Publ., Dordrechit/Boston/Lancaster.

7. Abd El-Hadi, A. H. (1987): Effect of foliar fertilizers on productivity of agronomic and horticultural crops in Egypt. Proc. Workshop "Special Fertilizers", 21-23 Feb. 1988, Alexandria. Eds. M. M. El-Fouly, R. Eibner and G. Hahr. pp. 49-72 (Arabic).

8. Abd El -Hadi, A. H. (1993-a): Potassium: Its Effect on Crops Productivity on Egyptian Soils (1980-1991). Bull. Soil and Water Research Inst. (SWRI), Agricultural Research Centre (ARC), Ministry of Agriculture (MOA). pp. 48.

9. Abd El -Hadi, A. H. (1993-b): Micronutrients and Foliar Fertilizers: Their Effect on Productivity of Agronomic and Horticultural Cops on Egyptian Soils. Bull. SWRI, ARC, MOA. pp. 60.

10. Allam, S. T. (1992): Economical liberation of Agricultural Sector. Proc. Seminar "Privatization of Seed Sector in Egypt", 16-18 Jan . 1994, Cairo. Eds. S. Abd El-Wanis, Angail, I. Saad, B. Homeyer and Ch. Weisbecker, pp. 26-35.

11. Amberger, A. ; Fawzi, A. F. A. and El-Fouly, M. M. (1988): Diagnostic and remedial measures of micronutrients problems in grapes grown on calcareous soils in Egypt. Agrochimica, 32 (1) 41-53.

12. Central Administration of Agricultural Economy (CAAE), MOA (1991): The Agricultural Economy Bulletin, 1985 - 1987, Ed. Khadr, A. H., pp. 960 (Arabic).

13. Central Administration of Agricultural Economy (CAAE), MOA (1993): The Agricultural Economy Bulletin, 1990-1991, Ed. Nassar, S., pp. 1043 (Arabic).

14. Central Administration of Agricultural Economy (CAAE), MOA (1995): The Agricultural Economy Bulletin, 1993, Ed. Nassar, S., pp. 509 (Arabic).

15. Central Administration of Agricultural Extension (CAAE), MOA (1990): Technical Recommendations for Growing Winter Crops. Ed. F. Abd El-Aziz and Sh. Harb, pp. 92.

16. Central Administration for Agricultural Extension, CAAE (1991): Summer Crops Bullet. 122, pp. 107 (Arabic).

17. Central Administration for Agricultural Extension, CAAE (1992): Barley growing Bullet. 167, pp. 19 (Arabic).

18. Central Administration for Agricultural Extension, CAAE (1994): Lentil growing. Bullet. 230, pp. 16 (Arabic).

19. Central Administration for Agricultural Extension, CAAE (1995): Cotton. Bullet 231, pp. 63 (Arabic).

20. Central Administration for Agricultural Extension, CAAE (1995): Favabean. Bull. 250, pp. 43 (Arabic).

21. Central Authority for Public Mobilization and Statistics (CAMPS), (1992): Statistical Yearbook pp. 62-65 (Arabic).

22. Central Authority for Public Mobilization and Statistics (CAMPS), (1995): Statistical Yearbook pp. 63-86 (Arabic).

23. Cottenie, A. (1983) Ed. Trace Elements in Agriculture and in Environment pp. 1-24.

24. Dawoud, O. (1989): Egyptian chemical fertilizer industry. Proc. Special Workshop "The Egyptian Fertilizer Development Centre (EFDC)-UNIDO Project DP/EGY/CS/105. Apr. 1989. Muscle Shoals, Alabama, USA, Appendix 2, pp. 1-26.

25. Eid, M. T. ; Hamissa, M. R. ; Abd El-Samie, M. ; El-Banna, E. ; Khadr, M. S. and El-Mallah, M. (1981): Efficiency of fertilizer utilization for wheat using N15 and p32 labeled fertilizers. Agric. Res. Rev. 59(4) 80-103.

26. Eid, M. T. ; Abd El-Samie, M., Hamissa, M. R. ; El-Banna, E. ; Serry, A. and Omar, S. (1974): Efficiency of nitrogen fertilizer applied to wheat as affected by time of application Agric. Res. Rev., 52 (5) 125-133.

27. Eid, M. T. ; Serry, A. A. ; Hamissa, M. R. ; Abd El-Samie, M. E. ; El-Hadidi, H. ; Keleg, A. M. ; Abd El-Aziz, M. S. ; El-Hossini, T. M. and Khedr, M. S. (1971): The application of isotopes and radiation in rice cultivation. IV. Efficiency of fertilizer nitrogen applied to rice, as affected by placement and the interaction with phosphorus placement. Agric. Res. Rev., 49, 27-47.

28. El-Ballal, M. S. Ed. (1990): The National Campaign for Rice. Final Report 1989. Ministry of Agriculture (MOA) and Academy of Scientific Research and Technology (ASRT), PP. 52 (Arabic).

29. El-Ganainy, O. (1994): The changing fertilizers situation in Egypt. AFA. J. 1, 1-10 (Arabic).

30. El-Khashab, E. (1989): The role of the Principal Bank for Development and Agricultural credit in marketing and distribution of fertilizers in Egypt. Proc. Special Workshop. "The Egyptian Fertilizers Development Centre (EFDC), UNIDO Project DP/EGY/85/005. Apr. 1989. Muscle-Shoals, Alabama, USA, Appendix 2, pp 1-26. Publ. IFDC (mimeograph - unpublished).

31. El-Fouly (1987): Use of micronutrients under practical conditions in Egypt. Proc. Workshop "Special Fertilizers", 21-23 Feb., Alexandria. Eds. M. M. El-Fouly, R. Eibner and G. Hahr. pp. 85-107. (Arabic).

32. El-Fouly, M. M. (1989): Micronutrients and potassium needs in Egypt. Proc. Special Workshop "The Egyptian Fertilizers Development Centre - EFDC-UNIDO Project DP/EGY/85/005, APR. 1989, Muscle-Shoals, Alabama, USA, Appendix 2, pp. 1-34. Publ. IFDC (unpublished).

33. El-Fouly, M. M. (1991): Foliar Fertilization and re-consideration in plant nutritional studies in Arab countries. Proc. Syrian-Egyptian Workshop "Micronutrients in Soil and Plant", 9-13 June, 1990, Damascus, Ed. M. M. El-Fouly, pp. 131-147 (Arabic).

34. El-Fouly, M. M. (1992): Integrated fertilization and environment. Proc. Egypto- German Seminar "Environmental and Cultural Aspects of Fertilizer Use", 25-28 Nov. 1991, Cairo, Ed. M. M. El-Fouly pp. 17-22 (Arabic).

35. El-Fouly, M. M. (1993-a): Fertilizers. In. The Agriculture of Egypt. Ed. Craig, G. M. pp. 363-493. Publ. Oxford Sci. Publications.

36. El-Fouly, M. M. (1995): Effect of removing subsidy and liberation of fertilizer trade on systems of fertilizers recommendations, farmers' fertilizer use and the role of fertilizer companies Arab-Fertilizers (AFA), 19(3) 22-32 (Arabic).

37. El-Fouly, M. M. (1995): Registration and use of foliar and micronutrients fertilizers. Proc. 2nd Sudanese-Egyptian Workshop. Dec. 1992 Wad-Medani, Sudan. Eds. M. M. El-Fouly and A. I. Rezk pp. 81-92 (Arabic).

38. El-Fouly, M. M. ; Amberger, A. and Fawzi, A. F. A. (1988): Response of Balady orange to macro- and micro-nutrient fertilizers in Egypt. Agrochimica, 32(1) 72-40.

39. El-Fouly, M. M., Amberger, A. and Fawzi, A. F. A. (1992): Balanced fertilizers use with micronutrients under Egyptian conditions (The Micronutrient Project). African J. for Agric. Sci, 19 (1). pp. 41-61.

40. El-Fouly, M. M. and El-Sayed, A. A. (1995): Nitrogen balance in some crops. Proc. Seminar "Production and Use of Chemical Fertilizers and Environment", 17-21 Dec. 1994, Cairo (in press).

41. El-Fouly, M. M. and Fawzi, A. F. A. (1995): Higher and better yields with less environmental pollution in Egypt through balanced fertilizer use. Proc. 8th International. Symp. "Fertilizers and Environment" 26-28 Sept. 1994, Salamanca, Spain (in press).

42. El-Fouly, M. M. ; Fawzi, A. F. A. and El-Sayed, A. A. (1995): Optimizing fertilizer use in oranges through fertigation-a case study. Proc. Dahlia Geridinger Internatl. Symp. "Fertigation". 26030-1. 4. 1995, Technion, Haifa, pp. 3030-312.

43. El-Fouly, M. M. ; Fawzi, A. F. A. and Firgany, A. H. (1987): Removal of nutrients by Trifolium alexandrinum and effect of NPK fertilization on yield. Mediterranean Potash News., 3, 8-10.

44. El-Fouly, M. M. ; Fawzi, A. F. A; Firgany, A. H. and El-Baz, F. K. (1991): Uptake and removal of potassium by maize and effect of potassium sulfate on yield . Der Tropenlandwirt, zeitschrift fur Landwirtschaft in den Tropen and Sub-Tropen, 92, 73-79.

45. El-Fouly, M. M. and Rezk, A. I. (1986): Micronutrients status of some food crops and increasing yields through micronutrient foliar application in Behira, Egypt. In. Foliar Fertilization, Ed. A. Alexander, p. 153-169. Martinus Nijhoff Publ., Dordrecht/ Boston/Lancaster.

46. El-Sayed, A. A. ; Abdalla, F. E. A and Fawzi, A. F. A. (1992-a): Increase in fava bean yield after micronutrients foliar application under farmers conditions in Fayoum. African. J. Agric. Sci., 19(1) 63-72.

47. El-Sayed, A. ; Abdalla, F. E. and Fawzi, F. A. (1992-b): Intake and partitioning of micronutrients in favabean grown on all alluvial soil. Agric. J. Agric. Sci. 19, 173-180.

48. Fawzi,. A. F. A. (1991-a): Effect of micronutrients on productivity of agronomic crops in Egypt, Proc. Jordanian-Egyptian Workshop "Micronutrients in Soil and Plant", 18-22 Feb., 1989, Amman, Eds. M. M. El-Fouly and A. F. A. Fawzi, pp. 75-82.

49. Fawzi, A. F. A. (1991-b): Role of micronutrients in increasing the production of agronomic and horticultural crops. Proc. Syrian-Egyptian Workshop "Micro-nutrients in Soil and Plant", 9-13 June 1990, Ed. M. M. El-Fouly, pp. 47-56 (Arabic).

50. Fawzi, A. F. A. (1992): Fate of Nitrogen Fertilizer in soil to major crops. Proc. Egypto-German Seminar "Environmental and Cultural Aspects of Fertilizer Use", 25-28 Nov. 1991, Cairo, Ed. M. M. El-Fouly pp. 23-37 (Arabic).

51. Fawzi, A. F. A. (1993): Principles of optimizing fertilizer use. Proc. German / Egyptian / Arab Workshop "Environmentally Sound, Location and Crop Specific Application of Fertilizers in Arid

Areas of North-Africa and The Near East" 6-17 June, 1993, Cairo - Ismailia, Eds. M. M. El-Fouly and F. E. Abdalla, pp. 81-86. (Arabic with English Summary).

52. Fawzi, A. F. A, Amberger, A. and El-Fouly, M. M. (1987): Nutrient status of field crops in the Nile Valley area. Agrochim. 31(6), 535 - 545.

53. Fawzi, A. F. A. and El-Fouly, M. M. (1993): Inputs for computerized expert system for fertilizer recommendations in Fayoum governorate. NRC-GTZ report (unpublished) p 94.

54. Fawzi, A. F. A., El-Fouly, M. M. and El-Baz, F. K. (1990): Problems of Potassium nutrition in citrus (Citrus Sinensis) orchards in Egypt. Plant Nutrition - Physiology and Applications, Ed. M. L. Van Beusichem, pp. 729 - 733, Kluwer Academic Publishers.

55. Fawzi, A. F. A, El-Fouly, M. M. and Zayed, A. A. (1986): Effect of micronutrients application on favabean yield. African J. Agric. Sci., 13(1+2), 111-123.

56. Fawzi, A. F. A. ; Firgany, A. A. ; Sanad, S. H. and El-Baz, F. K. (1984): Mineral nutrition of "Navel orange" at alternate bearing. Proc. 6th. Internal Colloq. "Optimization of Plant Nutrition", 2-8 Sept. 1984, Montpellier, Ed. Martin - Prevel, P., pp 199-206.

57. Fawzi, A. F. A. ; Rezk, A. I. and El-Fouly, M. M. (1994): Fertilizer specific recommendations for rice, wheat, favabean and lentil in Beheira, Dakahlia, Kafr El-Sheikh and Sharkia. NRC-GTZ report (unpublished).

58. Fink, A. (1982): Fertilizers and Fertilization, pp. 438. publ. Verlag Chemic., Weinheim. Dear Field Beach, Florida. Basel.

59. Hamissa, M. R. (1989): Fertilizers and fertilizer use in Egypt. Proc. Special Workshop, IFDC "The Egyptian Fertilizer Development Centre, EFDC.

60. Hamissa, M. R. ; Abd El-Samie, M. E. ; El-Banna, E. and Khader, M. S. (1974): Corn fertilization program in A. R. E.: Utilization of nitrogen by maize as affected by time and method of application. Agric. Res. Rev. 52, 25-48.

61. Halliday, D. J. and Trenkel, M. E. (Eds.) (1992): IFA World Fertilizer Use Manual. Publ. International Fertilizer Industry Association (IFA), Paris. pp. 632.

62. Hassanein, H. G. (1992): Cultural and economical status of Upper-Egypt (Assiut) farmers application and its environmental impacts. Proc. Egypto-German Seminar "Environmental and Cultural Aspects of Fertilizer Use" 25-28 Nov. 1991, Cairo, Ed. M. M. El-Fouly, pp. 71-78 (Arabic).

63. Kishk, M. A. (1991): Problems of transferring and disseminating the information and obstacles of using micronutrients fertilizers. Proc. Syrian-Egyptian Workshop "Micronutrients in Soil and Plant", 9-13 June, 1990 Damascus Ed. M. M. El-Fouly, pp. 157-168 (Arabic).

64. Mobarak, Zeinab, M. and Abdalla, F. E. (1992-b): Nutrients uptake by maize plants as affected by foliar micronutrients application. African J. Agric. Sci. 19, 193-205.

65. Mobarak, Zeinab, M., El-Sayed, A. A. ; Abdalla, F. E. and El-Bendary, A. A. (1992-b): Differential responses of soybean varieties to micronutrients foliar application. African J. Agric. Sci. 19, 123-136.

66. Nassar, S. (1994): The economic impact of reform programs in the Agricultural Sector in Egypt. Proc. Seminar "Privatization of Seed Sector in Egypt", 16-18 Jan. Cairo 1994 . Eds. S. Abd El-Wanis, Angail, I. Saad, Homeyer, B and Weisbecker, Ch., pp. 15-25.

67. National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991) :The Final Achievement Reports on Phases I and II (1976-1986): Studies carried out in Monofia governorate. report(3), Ed., M. M. El-Fouly, pp, 173., Publ. NRC, Dokki-Cairo. ISBN 977-5041-07-4 (Arabic).

68. National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried-out in Behera governorate; report (4), Ed., M. M. El-Fouly, pp. 207., Publ. NRC, Dokki-Cairo. ISBN 977-5041-11-2 (Arabic).

69. National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried-out in Dakahlia governorate; report (5), Ed., M. M. El-Fouly, pp. 159, Publ. NRC, Dokki-Cairo. ISBN 997-5041-10-4 (Arabic).

70. National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried out in Qaliobia governorate; report (6), Ed., M. M. El-Fouly, pp. 151, Publ. NRC, Dokki-Cairo. ISBN. 977-5041-09-0 (Arabic).

71. National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried-out in Ismailia governorate; report (7), Ed. M. M. El-Fouly, pp. 210, Publ. NRC, Dokki-Cairo. ISBN 977-5041-09-B (Arabic).

72. National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried-out in Fayoum governorate; report (8), Ed. M. M. El-Fouly, pp. 173, Publ. NRC, Dokki-Cairo. ISBN 977-5041-08-0 (Arabic).

73. National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried out in Minia governorate; report (9), Ed. M. M. El-Fouly, pp. 153, Publ. NRC, Dokki-Cairo. ISBN 977-5041-12-O (Arabic).

74. National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried out in Nobaseed company ; report (11), Ed. M. M. El-Fouly, pp. 74, Publ. NRC, Dokki-Cairo. ISBN 977-5041-16-3 (Arabic).

75. National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried-out in Mariut, North-Tahrir and Gianaclis companies, report (12), Ed. M. M. El-Fouly, pp. 187, Publ. NRC, Dokki-Cairo, ISBN 977-5041-17-1 (Arabic).

76. National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried-out in South-Tahrir companies, report (14), Ed. M. M. El-Fouly, pp. 89, ISBN 977-5041-17-6 (Arabic).

77. National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Multiplier Program for Optimizing Micronutrients Fertilizer Use, report (15). Ed. A. F. A. Fawzi, pp. 254, Publ. NRC, Dokki-Cairo. ISBN 977-5041-22-8. (Arabic).

78. National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1993): Studies and Experiments Carried-out during 1984-1986, report (14-1). Ed. A. I. Rezk, pp. 329. ISBN 977-5041-28-7 (Arabic).

79. National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1993): Report on serving farmers on Agricultural Reform (ARO) land. Season 1991/92. Eds. Fawzi A. F. A. and El-Sayed, A. A. pp. 99 (Arabic - unpublished).

80. National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1994-b): Report on serving farmers on Agricultural Reform (ARO) lands. Season Summer 1994. Ed. Rezk, A. I. pp. 130 (Arabic-unpublished).

81. National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1994-a): Report on serving farmers on Agricultural Reform (ARO) lands. Season Winter 1993/1994. Ed. Rezk, A. I. pp. 72 (Arabic-unpublished).

82. National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1992): Final Achievement reports on Phases I and II (1976-1986): Studies carried -out in Assiut governorate report (10), Ed. M. M. El-Fouly, pp. 220. ISBN 977-5041-27-9 (Arabic).

83. National Program for Agric. Research-ARC (1991): Technical Recommendations for Rice. Ed. M. S. El-Ballal, PP. 44.

84. National Program for Agric. Research (1990): Winter legumes. Bullet. 100, pp. 32.

85. Nour, Y. M. (1992): Cultural role of the Egypto-German Project "Micronutrients and Other Plant Nutrition Problems in Egypt" in the field of fertilizer use in Egypt. Proc. Egypto-German Seminar "Environmental and Cultural Aspects of Fertilizer Use", Cairo, 25-28 Nov. 1991, Ed. M. M. El-Fouly, pp. 161-174 (Arabic).

86. Nour, Y. M and El-Sayed, A. A. (1991): Multiplier Development Extension Program for Potato Growers in Itai El-Baroud, Beheira governorate", Egypt, Season 1986/87. Ed. M. M. El-Fouly, pp. 87 (Arabic with English summary).

87. Principal Bank for Development for Agricultural Development and Credit: PBDAC (1988): Fertilizer recommendations for season 1988/89. Exec. circular No. 98 (unpublished).

88. Rezk, A. I. (1991): Effect of micronutrients on productivity of fruit crops in Egypt. Proc. Jordanian-Egyptian Workshop "Micronutrients in Soil and Plant". 18-22-Feb., 1989, Amman, Eds., M. M. El-Fouly and A. F. A. Fawzi, pp. 63-74.

89. Sallam, M. Sh. (1992): Socio- economic and cultural factors affecting fertilizer application and its environmental impacts. Proc. Egypto-German Seminar "Environmental and Cultural Aspects of Fertilizer Use", 25-28 Nov. 1991, Cairo, Ed. M. M. El-Fouly, pp. 63-69 (Arabic).

90. Shalaby, G. and Metwally, M. A. (1987): Advice on growing modern varieties of tomato. Tech. Bulletin 7/1987, pp. 16.

91. The Economic Sector, MOA (1995): Estimated fertilizer needs in 1994/95, 1995/96 and 1996/97 (unpublished)

92. Zeid, F. A. ; Khater, E. A. H., and Seif El-Yazal, S. A. (1992): Use of fertilizers and the impact of economic and cultural levels of farmers on that; use in El-Fayoum governorate. Proc. Egypto-German Seminar "Environmental and Cultural Aspects of Fertilizer Use", 25-28 Nov., 1991, Cairo, Ed. M. M. El-Fouly pp. 75-88 (Arabic).

APPENDIXES

Appendix (1): Projected yields in years 2000 - 2005.

	Crop	(t/fed.)			
		L (57%)*	M (19%)*	U (14%*)	N (10%*)
1	Barley	2.0	1.7	1.6	1.2
2	Wheat	3.5	3.0	2.7	1.3
3	Clover	32	30	34.0	21.0
4	Favabean	1.6	1.4	1.8	1.3
5	Lentil	1.1	1.0	0.9	0.3
6	Onion	14	12	16.0	9.0
7	Garlic	9	14	10.0	8.0
8	Cotton	1.6	1.7	1.6	-
9	Rice	4.5	3.2	-	2.0
10	Maize	3.6	3.9	4.2	2.2
11	Sugarcane	42	47	49.0	-
12	Sugar beet	26	21	26.0	18.0
13	Soybean	1.3	1.2	1.4	-
14	Peanut	1.2	1.3	1.5	0.9
15	Sesame	0.6	0.8	0.7	0.5
16	Sorghum	-	2.5	3.0	2.0
17	Chickpea	1.5	0.8	0.9	0.2
18	Lupin	0.9	1.3	1.2	0.8
19	Fenugreek	0.8	1.1	0.9	0.7
20	Sunflower	1.0	1.2	1.4	0.9
21	Flax **	4.3 *	1.7 *	-	-
22	Others	1.5	1.6	1.6	1.0
23	Potato	10.5	8.5	11.5	9.2
24	Tomato	15	21.0	20.0	19.0
25	Others	9	12.0	7.5	5.5
26	Citrus	10.3	7.0	10.0	6.0
27	Grape	10.0	9.5	11.5	4.5
282	Mango	5.5	7.4	5.8	3.0
9	Others	10.0	9.0	13.2	9.5

* of total crop area in Egypt

** Fibre + seed

L: Lower Egypt, M : Middle Egypt, U : Upper Egypt, N : New lands.

Appendix (2): Expected cropping pattern in 1995/1996 and 1996/1997 in Egypt (92).

Crop	(1000 fed.)					
	1995/1996			(1996/1997)		
	Old land	New land	Total	Old land	New land	Total
1. Winter season						
1.1. Field (agronomic) crops						
• Clover (4 cuts)	1400	100	1500.0	1400	100	1500
• Wheat	2100	400	2500.0	2150	500	2650
• Barely	80	250	330.0	8.0	300	380
• Favabean	350	55	405.0	350	55	405
• Lentil	20	5	25.0	20	5	25
• Fenugreek	15	1	16.0	15	-	15
• Chickpea	20	-	20.0	20	-	20
• Lupin	10	5	15.0	10	-	10
• Flax	30	-	30.0	30	-	30
• Sugarbeet	70	10	80.0	75	10	85
1.2. Vegetable crops						
• Onion	29	15	44.0	29	15	44
• Garlic	20	-	20.0	20	-	20
• Potato	63	15	78.0	63	-	63
• Tomato	100	-	100.0	100	-	100
• Others	100.6	-	100.6	100.6	-	100.6
1.3. Aromatic/medic-crops	45.7	-	45	45.7	-	45.7
Sup-total	4453.3	856	5309.3	4508.3	985	5493.3
2. Summer season						
2.1. Field (agronomic) crops						
• Maize	1600	91	1691	1600	91	1691
• Sorghum	341	30	371	350	30	380
• Rice	999	-	999	999	-	999
• Peanut	35	80	115	35	80	115
• Sesame	50	40	90	50	40	90
• Soybean	70	1	71	70	1	71
• Sunflower	75	25	100	75	25	100

Appendix (2-continued): Expected cropping pattern in 1995/1996 and 1996/1997 in Egypt.

Crop	(1000 fed.)					
	1995/1996			(1996/1997)		
	Old land	New land	Total	Old land	New land	Total
2.2. Vegetable crops						
• Onion	11	-	11	11	-	11
• Potato	48	-	48	48	-	48
• Tomato	96	-	96	96	-	96
• Others	218.9	-	218.9	218.9	-	218.9
2.3. Aromatic crops	8.5	-	8.5	8.5	-	8.5
Sub-total	3552.4	267	3819.4	3561.4	267	3828.4
3. Nile season						
3.1. Field crops						
• Maize	400	9	409	400	9	409
• Sorghum	20	-	20	20	-	20
• Rice	1	-	1	1	-	1
3.2. Vegetable crops						
• Onion	10	-	10	10	-	10
• Potato	120	-	120	120	-	120
• Tomato	61	-	61	61	-	61
• Others	110.3	-	110.3	110.3	-	110.3
Sub-total	722.3	9	731.3	722.3	9	731.3
Cotton	900	-	900	900	-	900
Sugarcane	275	-	275	275	-	275
Corn (yellow)	100	50	150	100	50	150
Alfalfa	25	25	50	25	25	50
Others (Berseem 1 cut)	800	-	800	800	-	800
Sub-Total	2100	75	2175	2100	75	2175
4. Fruit corps						
• Citrus	175	-	175	175	-	175
• Grape	67	-	67	67	-	67
• Mango	72	-	72	72	-	72
• Others	172.1	51	223.1	172.1	51	172.1
		500	500	-	500	

Appendix (2-continued): Expected cropping pattern in 1995/1996 and 1996/1997 in Egypt.

Crop	(1000 fed.)					
	1995/1996			(1996/1997)		
	Old land	New land	Total	Old land	New land	Total
5. Forage	-	125	125	-	125	125
6. Other crops	-	450	450	-	450	450
Sub-total	441.1	1126	1567.1	441.1	1126	1567.1
TOTAL	11269.1	2333	13602.1	11333.1	2462	13795.1

Appendix (3) : Recommended fertilizer doses.

Based on results of program : Micronutrients and Others Plant Nutrition Problems in Egypt

Lower Egypt

Crop	Dose / fed.						
	(Kg)			(g)			
	N	P2O5	K2O	Zn	Mn	Fe	Cu
Field crops							
Barley	30	15	24	25	17	8	0
Wheat	60	15	12	30	20	10	3
Rice	55	15	0	30	20	10	3
Maize **	100	30	24	32	22	11	3
Sugarcane	50	30	24	40	30	15	5
Sorghum*							
Onion	50	15	24	16	25	8	0
Garlic	35	20	24	20	13	7	0
Fababean	22	30	24	27	40	13	0
Soybean	40	30	24	45	30	15	0
Lentil	22	30	24	65	45	22	0
Fenugreek	10	15	12	25	17	8	0
Chickpea	15	15	12	25	17	8	0
Lupin	15	15	12	25	17	8	0
Sunflower	30	22	12	30	20	10	0
Peanut	33	30	24	45	30	15	0
Clover (4 cuts)	25	30	12	50	35	17	0
Cotton **	50	22	24	40	26	13	0
Sesame	20	22	12	45	30	15	0
Sugarbeet	100	30	48	65	42	21	0
Flax	33	15	12	30	20	10	0
Others	45	15	0	25	17	8	0
Vegetable crops							
Potato **	60	45	60	50	35	17	0
Tomato **	80	45	48	75	45	22	0
Others **	55	30	24	40	27	13	0
Fruit crops							
Citrus	120	30	60	150	100	50	0
Grape	100	30	48	90	60	30	0
Mango	90	30	48	175	125	65	0
Others	70	30	36	120	80	40	0

Based on :(6-8, 31, 32, 38, 42, 44, 45, 48, 49, 51, 52, 55, 60, 61, 67-69, 77, 81, 83, 85, 86)
* Not grown in the region
** 10 Kg N/ feddan is reduced if the crop is preceded by clover

Appendix (4) : Recommended fertilizer doses

Based on results of program : Micronutrients and Others Plant Nutrition Problems in Egypt.

Middle Egypt

Crop	Dose / fed.						
	(Kg)			(g)			
	N	P2O5	K2O	Zn	Mn	Fe	Cu
Field crops							
Barley	40	15	24	25	17	8	0
Wheat	65	15	24	45	31	16	0
Rice	60	15	24	30	20	10	0
Maize **	110	30	48	60	40	20	0
Sugarcane	180	45	96	60	40	20	0
Onion	95	30	48	25	16	8	0
Garlic	75	15	36	20	30	10	0
Sorghum	60	22	24	20	30	10	0
Fababean	20	30	24	30	45	15	0
Soybean	45	30	24	45	30	15	0
Lentil	20	30	24	45	30	15	0
Fenugreek	15	20	36	20	30	10	0
Chickpea	20	20	36	20	30	10	0
Lupin	20	20	36	20	30	10	0
Sunflower	30	20	48	30	20	10	0
Peanut	30	15	24	45	30	15	0
Clover (4 cuts)	20	30	24	70	93	35	0
Cotton **	70	22	48	67	45	22	0
Sesame	30	22	36	30	40	15	0
Sugarbeet	110	30	48	50	35	17	0
Flax	40	15	24	30	20	10	0
Others	40	15	0	25	17	8	0
Vegetable crops							
Potato **	80	45	72	30	45	15	0
Tomato **	100	45	60	43	67	22	0
Others **	70	30	36	27	40	13	0
Fruit crops							
Citrus	90	22	48	150	100	50	10*
Grape	110	30	60	135	90	45	0
Mango	120	30	60	180	120	60	0
Others	90	22	48	120	80	40	0

Based on : (6-9, 25, 27, 44, 46, 47-55, 60, 63, 72, 73, 77, 78)

* Some orchards in Beni-Sweif

** 10 Kg N/ feddan is reduced if the crop is preceded by clover

Appendix (5) : Recommended fertilizer doses

Based on results of program : Micronutrients and Others Plant Nutrition Problems in Egypt.

Upper Egypt

Crop	Dose / fed.						
	(Kg)			(g)			
	N	P2O5	K2O	Zn	Mn	Fe	Cu
Field crops							
Barley	45	22	24	30	20	10	0
Wheat	60	15	24	90	135	45	0
Rice*							
Maize **	120	30	48	75	50	35	0
Sugarcane	200	45	96	30	50	15	0
Sorghum	70	30	36	20	30	10	0
Onion	120	45	72	20	30	10	0
Garlic	80	30	48	30	45	15	0
Fababean	30	30	36	90	135	45	0
Soybean	50	30	36	90	135	45	0
Lentil	20	30	36	30	45	15	0
Fenugreek	20	30	48	30	35	15	0
Chickpea	30	30	48	30	45	15	0
Lupin	30	30	48	30	45	15	0
Sunflower	45	30	72	30	45	15	0
Peanut	30	22	36	20	30	10	0
Clover (4 cuts)	20	30	36	70	95	35	0
Cotton **	70	22	40	35	50	17	0
Sesame	30	22	36	50	35	15	0
Sugarbeet	110	30	48	30	45	15	0
Flax *							
Others	20	15	24	20	30	10	0
Vegetable crops							
Potato **	100	45	72	40	60	20	0
Tomato **	120	45	72	50	75	25	0
Others **	90	45	48	30	45	15	0
Fruit crops							
Citrus	110	30	60	120	180	60	0
Grape	120	30	72	100	150	50	0
Mango	100	30	72	150	255	75	0
Others	90	30	60	90	144	45	0

Based on : (6-9, 25-27, 32, 40, 48, 49, 51-54, 58, 60, 62, 77, 78, 82)

* Not grown in the region

** 10 Kg N/ feddan is reduced if the crop is preceded by clover

Appendix (6) : Recommended fertilizer doses

Based on results of program : Micronutrients and Others Plant Nutrition Problems in Egypt.

Desert - irrigated lands : Sandy, non-calcareous soils

Crop	Dose / fed.						
	(Kg)			(g)			
	N	P2O5	K2O	Zn	Mn	Fe	Cu
Field crops							
Barley	50	15	24	20	13	7	0
Wheat	65	15	24	30	20	10	0
Rice	55	15	24	25	15	7	3
Maize	90	30	48	25	15	7	2
Sugarcane*							
Sorghum	70	20	48	21	14	7	0
Onion	45	22	48	30	20	10	0
Garlic	40	22	48	21	14	7	0
Fababean	25	22	48	30	45	15	0
Soybean	33	22	48	45	30	15	0
Lentil	10	15	36	0	0	0	0
Fenugreek	15	22	24	25	17	8	0
Chickpea	15	22	24	25	17	8	0
Lupin	20	22	24	25	17	8	0
Sunflower	33	22	24	35	23	11	0
Peanut	20	22	36	50	35	17	0
Clover (4 cuts)	15	30	48	75	50	25	0
Cotton*							
Sesame	25	30	36	30	20	10	0
Sugarbeet	110	30	48	50	35	17	0
Flax *							
Others	20	22	24	25	17	8	0
Vegetable crops							
Potato **	90	45	72	65	45	22	5
Tomato **	100	45	60	100	66	33	0
Others **	45	22	48	50	35	17	0
Fruit crops							
Citrus	85	22	48	120	90	45	15
Grape	80	22	60	100	75	32	12
Mango	70	22	60	180	120	60	20
Others	65	22	48	90	60	30	10

Based on : (6-9, 32, 39, 42, 49-54, 56, 71, 76, 88)

* Not grown in the area

** 10 Kg N/ feddan is reduced if the crop is preceded by clover

Appendix (7) : Recommended fertilizer doses

Based on results of program : Micronutrients and Others Plant Nutrition Problems in Egypt.

Desert - irrigated lands : Sandy, calcareous soils

Crop	Dose / fed.						
	(Kg)			(g)			
	N	P2O5	K2O	Zn	Mn	Fe	Cu
Field crops							
Barley	50	22	36	50	35	17	0
Wheat	65	22	36	35	35	35	0
Rice *							
Maize **	90	30	72	30	30	30	0
Sugarcane *							
Sorghum	70	30	60	20	20	20	0
Onion	45	30	60	25	25	25	0
Garlic	40	30	60	15	15	15	0
Fababean	25	30	60	35	35	35	0
Soybean	33	30	60	40	40	40	0
Lentil	10	22	48	30	20	10	0
Fenugreek	20	30	36	20	20	20	0
Chickpea	20	30	36	20	20	20	0
Lupin	15	30	36	20	20	20	0
Sunflower	45	30	48	20	20	20	0
Peanut	20	30	48	50	35	15	0
Clover (4 cuts)	15	45	60	50	50	50	0
Cotton *							
Sesame	25	45	48	30	30	30	0
Sugarbeet	110	45	60	43	43	43	0
Flax	30	22	36	20	20	20	0
Others	65	22	48	20	20	20	0
Vegetable crops							
Potato **	90	60	96	40	40	40	0
Tomato **	100	60	72	60	60	60	0
Others	45	30	60	20	20	20	0
Fruit crops							
Citrus	85	30	60	150	150	150	0
Grape	80	30	72	120	120	120	0
Mango	70	30	72	180	180	180	0
Others	65	30	60	100	100	100	0

Based on : (6-9, 11, 31, 32, 39, 44, 48, 49, 51, 53, 54, 57, 68, 74, 75, 77, 78)

* Not grown in the area

** 10 Kg N/ feddan is reduced if the crop is preceded by clover

Appendix (8): Average yield increase in response to micronutrients (foliar spray)

Lower Egypt: Clay and loam soils

(Beheira, Kafr El-Shikh, Dakahlia, Gharbia, Monofia, Qaliubia, Sharkia)

Crop	Yield increase / fed.	
	(t)	(%)
1.0.0 Field crops		
1.1.0 Cereal		
1.1.1 Grain		
Wheat	0.375	22
Rice	0.575	18
Maize	0.540	22
1.2.0 Legume		
1.2.1 Grain		
Favabean	0.231	21
Soybean	0.275	24
Lentil	0.219	42
1.2.2 Forage		
Clover *	8.000	20
1.3.0 Fiber		
Cotton	0.137	19
2.0.0 Vegetable crops		
2.1.0 Tomato	2.250	25
2.2.0 Potato	2.650	30
2.3.0 Others	1.800	21
3.0.0 Fruit crops		
3.1.0 Citrus	2.8	35
3.2.0 Grape	1.8	25
3.3.0 Mango	0.5	20
3.4.0 Others	0.7	25

* 4 Cuts

References : (6-8, 31, 32, 38, 42, 44, 45, 48, 49, 51, 52, 55, 60, 61, 67-69, 77, 81, 83, 85, 86)

Appendix (9): Average yield increase in response to micronutrients (Foliar spray)

Middle Egypt: Clay and loamy soils

(Giza, Beni Suef, Fayoum, Minia)

Crop	Yield increase / fed.	
	(t)	(%)
1.0.0 Field crops		
1.1.0 Cereal		
1.1.1 Grain		
Wheat	0.485	21
Maize	0.430	20
1.1.2 Sugar		
Sugar cane	3.380	10
1.2.0 Legume		
1.2.1 Grain		
Favabean	0.240	20
Soybean	0.216	24
Peanut	0.180	19
1.2.2 Forage		
Clover *	8.600	20
1.3.0 Fiber		
Cotton	0.104	14
1.4.0 Oil		
Sesame	0.048	18
2.0.0 Vegetable crops		
2.1.0 Tomato	3.000	21
2.2.0 Potato	2.000	23
2.3.0 Others	2.100	25
3.0.0 Fruit crops		
3.1.0 Citrus	3.100	26
3.2.0 Grape	2.332	38
3.3.0 Mango	0.560	22
3.4.0 Others	0.800	20

* 4 Cuts

References : (6-9, 25, 27, 44, 46, 47-55, 60, 63, 72, 73, 77, 78)

Appendix (10): Average yield increase in response to micronutrients (Foliar spray)

Upper Egypt: Clay and loamy soils

(Assiut, Souhag, Qena)

Crop	Yield increase / fed.	
	(t)	(%)
1.0.0 Field crops		
1.1.0 Cereal		
1.1.1 Grain		
Wheat	0.412	22
Maize	0.220	32
1.12 Sugar		
Sugar cane	8.370	19
1.2.0 Legume		
1.2.1 Grain		
Favabean	0.387	26
Soybean	0.187	25
1.2.2 Forage		
Clover *	3.200	18
1.3.0 Fiber		
Cotton	0.080	12
2.0.0 Vegetable crops		
2.1.0 Tomato	3.000	19
2.2.0 Potato	1.300	13
2.3.0 Others	2.600	20
3.0.0 Fruit crops		
3.1.0 Citrus	2.000	25
3.2.0 Grape	1.600	22
3.3.0 Mango	0.600	18
3.4.0 Others	0.850	20

* 4 Cuts

References : (6-9, 25-27, 32, 40, 48, 49, 51-54, 58, 60, 62, 77, 78, 82)

Appendix (11): Average yield increase in response to micronutrients (Foliar spray)

Desert irrigated lands: Sandy, non - calcareous soils

(Different governorates, mainly : Ismailia, Beheira, Sharkia)

Crop	Yield increase / fed.	
	(t)	(%)
1.0.0 Field crops		
1.1.0 Cereal		
1.1.1 Grain		
Wheat	0.150	21
Maize	0.440	29
1.2.0 Legume		
1.2.1 Grain		
Soybean	0.300	37
Peanut	0.231	23
1.2.2 Forage		
Clover *	12.000 **	43 **
1.4.0 Oil		
Sesame	0.126	17
2.0.0 Vegetable crops		
2.1.0 Tomato (H.y.)	2.500	25
2.2.0 Potato (H.y.)	4.000 **	50 **
2.3.0 Others	1.200	26
3.0.0 Fruit crops		
3.1.0 Citrus	2.000	33
3.2.0 Grape	1.000	40
3.3.0 Mango	0.500	40
3.4.0 Others	0.40	35

* 4 Cuts,
** Pivot - irrigated,
H. Y. : High yielding varieties

References : (6-9, 32, 39, 42, 49-54, 56, 71, 76, 88)

Appendix (12): Average yield increase in response to micronutrients (Foliar spray)

Desert irrigated lands: Sandy, calcareous soils

(Different governorates, mainly: Beheira, Matrouh, Fayoum, North-Sinai)

Crop	Yield increase / fed.	
	(t)	(%)
1.0.0 Field crops		
1.1.0 Cereal		
1.1.1 Grain		
Barley	0.210	13
Wheat	0.435	25
Maize	0.623	44
1.2.0 Legume		
1.2.1 Grain		
Favabean	0.160	23
1.2.2 Forage		
Clover *	5.280	30
1.2.3 Sugar beet	6.200	28
2.0.0 Vegetable crops		
2.1.0 Tomato	2.000	22
2.2.0 Potato	1.440	20
2.3.0 Others	1.000	33
3.0.0 Fruit crops		
3.1.0 Citrus	1.1800	24
3.2.0 Grape	1.100	38
3.3.0 Mango	0.250	40
3.4.0 Others	0.350	30

* 4 Cuts

References : (6-9, 11, 31, 32, 39, 44, 48, 49, 51, 53, 54, 57, 68, 74, 75, 77, 78)

Appendix (13) :Area of farmers' fields and orchards treated with micronutrients, under balanced plant nutrition concept.

Crop	Served area (fed.)*
1. Field corps	
• Wheat	8508
• Maize	2618
• Rice	2380
• Cotton	6093
• Clover	5998
2. Vegetable corps	
• Tomato	1261
• Potato	4142
3. Orchards	
• Citrus	47600
• Grape	12000
• Others	5000
Total	93600

* Service rendered to farmers against

Appendix (14) : Imported Micronutrient Fertilizers (1989)

Compound	Content (%)							Origin	Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S			
1. Single										
Zinc sulphate	22.3	0	0	0	0	0	0	n.a.*	1009.340 tons	n.a.*
Lebrel Fe 13.2%	13.2	0	0	0	0	0	0	England	2.5 tons	Interlates
Ferblex	0	6.65	0	0	0	0	0	England	20 tons	ABM
Sequestrene Mn	0	0	12	0	0	0	0	Switzerland	5 tons	Ciba Geigy
Sequestrene Fe	0	10	0	0	0	0	0	Switzerland	5 tons	Ciba Geigy
Lebrel Mn 13%	0	0	12.89	0	0	0	0	England	5 tons	Interlates
Fetrilon Fe 13%	0	13	0	0	0	0	0	Germany	1.080 ton	BASF
Nervanaid Zn 15%	15	0	0	0	0	0	0	England	10 tons	ABM
Nervanaid Mn 13%	0	0	13	0	0	0	0	England	10 tons	ABM
Ferblex	0	6.65	0	0	0	0	0	England	15 tons	ABM
Lebrel Zn 14%	14	0	0	0	0	0	0	England	3.5 tons	,Interlates
Sequestrene Zn	6.3	0	0	0	0	0	0	Switzerland	10 tons	Ciba Geigy
Sequestrene Mn	0	0	12	0	0	0	0	Switzerland	5 tons	Ciba Geigy
Sequestrene Fe 138	0	6	0	0	0	0	0	Switzerland	2 tons	Ciba Geigy
Greenzit S100 SB	0	4.34	0	0	0	0	0	Switzerland	5 tons	Ciba Geigy

n.a.* : not available
Total without zinc sulphate 99.08 Ton/1000 litres
Zinc sulphate 1009.34 tons

Appendix (14 - continued) : Imported Micronutrient Fertilizers (1989)

Compound	Content (%)							Origin	Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S			
2. Compound										
Greenzit $100 SB	7.027	0.54	5.054	0.005	0.052	0.054	0	Switzerland	5 tons	Ciba Geigy
Multi micro E	4.7	1.5	3.2	0.5	0	0	0	Germany	20000 L.	Hoechst
Metalosates multi mineral	0.5	0.5	0.5	0.5	0	0	0	U.S.A	12272 L.	Albion Lab.
Total multi compounds									37.272	ton/1000 liter

Appendix (15 - continued) : Imported Micronutrient Fertilizers (1990)

Compound	Content (%)							Origin	Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S			
Compound										
Lebrel BMX	0.5	3.38	1.73	1.6	0	0	0	England	1 ton	Interlates
Fetrilon combi 7	6.5	2.25	4.5	0.5	0	0	0	Germany	5 tons	BASF
Fetrilon combi Sahara	5	1.75	3.4	0	0	0	0	Germany	9 tons	BASF
Fetrilon combi Giri	3.6	3.8	3.8	0	0	0	0	Germany	9 tons	BASF
Total multi compounds									24 tons	

Appendix (16) : Imported Micronutrient Fertilizers (1991)

Compound	Content (%)							Origin	Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S			
1. Single										
Zinc sulphate 22-32%	22	0	0	0	0	0	0	Germany	1330 tons	n.a.*
Zinc sulphate	22	0	0	0	0	0	0	Germany	20 tons	n.a.*
Zinc sulphate	22	0	0	0	0	0	0	Germany	200 tons	n.a.*
Ferblex	0	6.65	0	0	0	0	0	England	30 tons	ABM
Nervanaid Mn	0	0	13	0	0	0	0	England	20 tons	ABM
Nervanaid Zn	15	0	0	0	0	0	0	England	20 tons	ABM
This iron	0	5	0	0	0	0	0	U.S.A	5000 L.	Stoller Chem.
This manganese	0	0	5	0	0	0	0	U.S.A	2000 L.	Stoller Chem.
This Zinc	7	0	0	0	0	0	0	U.S.A	4000 L.	Stoller Chem.
2. Compound										
Maltimicro E11	4.7	1.5	3.2	0.5	0	0	0	Germany	20000 L.	Hoechst

n.a.* : not available

Total without zinc sulphate — 81 ton/1000 liter

Zinc sulphate — 1550 tons

Total multi compounds — 20 ton/1000 liter

Appendix (17) : Imported Micronutrient Fertilizers (1992)

Compound	Content (%)							Origin	Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S			
Single compounds										
This Mn	0	0	5	0	0	0	0	U.S.A	4300 L.	Stoller Chem.
This iron	0	5	0	0	0	0	0	U.S.A	9400 L.	Stoller Chem.
This Zinc	7	0	0	0	0	0	0	U.S.A	4300 L.	Stoller Chem.

Total without zinc sulphate

18 ton/1000 liter

Appendix (18) : Egypt- Locally produced micronutrient fertilizers (1993)

Compound	Content (%)							Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S		
1. Single									
Salinite Zn 12% (chelated)	12	0	0	0	0	0	0	5 tons	Kafr El-Zayat
Salinite Mn 12% (chelated)	0	0	12	0	0	0	0	5 tons	Kafr El-Zayat
Salinite Fe 12% (chelated)	0	12	0	0	0	0	0	5 tons	Kafr El-Zayat
Manganese oxide 8.5%	0	0	8.6	0	0	0	0	1500 L.	Mac
Zinc chelated 9%	9.9	0	0	0	0	0	0	1500 L.	Mac
Zinc chelated 12%	12	0	0	0	0	0	0	8 tons	El-Nasr for fertilizers
Manganese chelated 12%	0	0	12	0	0	0	0	8 tons	El-Nasr for fertilizers
Iron chelated 12%	0	12	0	0	0	0	0	8 tons	El-Nasr for fertilizers
Sequestred 12% (chelated)	0	6	0	0	0	0	0	12 tons	El-Nasr for fertilizers

Total without zinc sulphate

54 ton/1000 liter

Appendix (19) : Imported micronutrient fertilizers (1993)

Compound	Content (%)							Origin	Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S			
1. Single compounds										
Ferblex	0	6.65	0	0	0	0	0	England	10 tons	ABM
Nervanaid Zn	15.21	0	0	0	0	0	0	England	10 tons	ABM
Nervanaid Mn	0	0	12.92	0	0	0	0	England	10 tons	ABM
This zinc	7	0	0	0	0	0	0	U.S.A	3 tons	Stoller Chem.
This iron	0	5	0	0	0	0	0	U.S.A	2 tons	Stoller Chem.
This manganese	0	0	5	0	0	0	0	U.S.A	3 tons	Stoller Chem.
Sequestrene 138 Fe 100 SG	0	6	0	0	0	0	0	Switzerland	5 tons	Ciba Geigy
Lebrel Zn 13%	13	0	0	0	0	0	0	England	1 tons	Interlates
Lebrel Fe 7%	0	7	0	0	0	0	0	England	.5 ton	Interlates
Lebrel Mn 12%	0	0	12	0	0	0	0	England	1 tons	Interlates
Libfer SP	0	6	0	0	0	0	0	England	.25 ton	Interlates
Liquid Mn (chelated)	0	0	5	0	0	0	0	U.S.A	8000 L.	Stoller Chem.
This chelated Zn (liquid)	7	0	0	0	0	0	0	U.S.A	10000 L.	Stoller Chem.
This chelated Fe (Liquid)	0	5	0	0	0	0	0	U.S.A	10000 L.	Stoller Chem.

Total without zinc sulphate

73.750 ton /1000 liter

Appendix (19 - continued) : Imported micronutrient fertilizers (1993)

Compound	Content (%)							Origin	Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S			
Librel Fe 13.2%	0	13.2	0	0	0	0	0	England	1 ton	Interlates
Sequestrene 138 Fe 100 SG	0	6	0	0	0	0	0	Switzerland	5 tons	Ciba Geigy
Ferblex	0	6.65	0	0	0	0	0	England	10 tons	ABM
Ferblex	0	6.6	0	0	0	0	0	England	8.88 tons	ABM
Micromel Zn 14 %	14	0	0	0	0	0	0	Holland	5 tons	Melchemic Holland B.V.
Micromel Fe 6%	0	6	0	0	0	0	0	Holland	5 tons	Melchemic Holland B.V.
Micromel Fe 13%	0	13	0	0	0	0	0	Holland	5 tons	Melchemic Holland B.V.
Micromel Mn 14%	0	0	14	0	0	0	0	Holland	5 tons	Melchemic Holland B.V.
Librel Fe 13.2%	0	13.2	0	0	0	0	0	England	1.500 ton	Interlates

Total without zinc sulphate 46.38 ton/1000 liter

Table (19 - continued) : Imported micronutrient fertilizer (1993)

Compound	Content (%)							Origin	Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S			
2. Compound										
Pholaz D	2.8	2.8	9.2	0	0	0	0	England	5 tons	Phosyn International
Fetrilon combi 7	6.5	2.25	4.5	0.5	0	0	0	Germany	14 tons	BASF
Librel BMX	0.5	3.38	1.73	1.7	0	0	0	England	1 ton	Interlates
Metalosate Grop up	1.75	0.25	2.5	0.25	0	0.5	2.5	U.S.A	72576 L.	Albion Lab.
Greenzit S100 SP (powder)	67.12	0.22	48.18	0.06	0	0.06	0	Switzerland	1.3 tons	Ciba Geigy
Librel BMX	0.5	3.38	1.73	1.6	0.8	0	0	England	1.5 tons	Interlates
Multimicro E	4.7	1.5	3.2	0.5	0	0	0	Germany	8000 L.	Hoechst
Maltimicro E	4.7	1.5	3.2	0.5	0	0	0	Germany	6000 L.	Hoechst

Total multi compounds 109.376 ton/1000 liter

Appendix (20) :Egypt - locally produced micronutrient fertilizers (1994)

Compound	Content (%)							Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S		
1. Single									
Manganese chelated 13%	0	0	13	0	0	0	0	10 tons	El-Nasr for Fertilizers
Zinc chelated 13%	13	0	0	0	0	0	0	10 tons	El-Nasr for Fertilizers
Iron chelated 6%	0	6	0	0	0	0	0	10 tons	El-Nasr for Fertilizers
2. Compound									
* Baraka 10	1	2	0.1	0	0	0.4	0	20 tons	Modern chemicals
Foliar (2)	1	3	2	0	0	0	0	47 tons	El-Nasr for Fertilizers

* Compound cont. 1% N + H% K2O

Total without zinc sulphate 30 ton/1000 liter
Multi compounds 67 ton

Appendix (21) : Imported micronutrient fertilizers (1994)

Compound	Content (%)							Origin	Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S			
1. Single compounds										
Ferblex	0	6.55	0	0	0	0	0	England	10 tons	ABM
Sequestrene Zn 14 %	14	0	0	0	0	0	0	Switzerland	1.840 tons	Ciba Geigy
Manganese sulphate	0	0	32.5	0	0	0	0	n.a.*	10 tons	n.a.*
Ferblex	0	6.65	0	0	0	0	0	England	10 tons	ABM
Nervanaid Zn	15.21	0	0	0	0	0	0	England	5 tons	ABM
Nervanaid Mn	0	0	12.92	0	0	0	0	England	5 tons	ABM
Zinc sulphate 22%	22	0	0	0	0	0	0	Yugoslavia	80 tons	n.a.*
This iron	0	5	0	0	0	0	0	U.S.A	2000 L.	Stoller Chem.
This iron	0	7.15	0	0	0	0	0	U.S.A	3000 L.	Stoller Chem.
This manganese	0	0	5	0	0	0	0	U.S.A	3800 L.	Stoller Chem.
This zinc	7	0	0	0	0	0	0	U.S.A	2800 L.	Stoller Chem.
This zinc	7	0	0	0	0	0	0	U.S.A	4000 L.	Stoller Chem.
Lebrel zinc	13.94	0	0	0	0	0	0	England	1.5 tons	Interlates
Lebfer SP	0	6	0	0	0	0	0	England	250 kg	Interlates

n.a.* : not available
Total without zinc sulphate 59.19 ton/1000 liter
Zinc sulphate 80 tons

Appendix (21 - continued) : Imported micronutrient fertilizers (1994)

Compound	Content (%)							Origin	Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S			
Lebrel Cu	0	0	0	14	0	0	0	England	100 Kg	Interlates
Ferblex	0	6.65	0	0	0	0	0	England	10 tons	Interlates
Nervanid Mn 13%	0	0	12.92	0	0	0	0	England	3 tons	ABM
Nervanaid Mn 13%	0	0	12.92	0	0	0	0	England	2 tons	ABM
Nervanaid Zn 15%	15.3	0	0	0	0	0	0	England	10 tons	ABM
Iron chelated 6%	0	6	0	0	0	0	0	Adan	2 tons	Etehad Kameera
Iron chelated 13%	0	13	0	0	0	0	0	Adan	2 tons	Etehad Kameera
Iron chelated	0	6	0	0	0	0	0	Adan	0.9 ton	Etehad Kameera
This Manganese (liquid)	0	0	5	0	0	0	4	U.S.A	9.450 tons	Stoller Chem.
This zinc	7	0	0	0	0	0	0	U.S.A	11.550 tons	Stoller Chem.
This iron	0	5	0	0	0	0	0	U.S.A	9.450 tons	Stoller Chem.

* Compound cont. 13.5% N
* Compound cont. 14% N
Total without zinc sulphate 60 450 ton
Zinc sulphate

Appendix (21 - continued) : Imported micronutrient fertilizers (1994)

Compound	Content (%)							Origin	Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S			
2. Compound										
Fetrilon combi (7)	6.5	2.2	4.5	0.5	0	0	0	Germany	16 tons	BASF
Pholaz D	7.8	2.8	9.2	0	0	0	0	England	3 tons	Phosyn International
Pholaz D	7.8	2.8	9.2	0	0	0	0	England	3 tons	Phosyn International
Lebrel BMX	0.5	3.38	1.73	1.6	0.8	0	0	England	2 tons	Interlates
Wuxal suspension Micro (Fe-Zn-Mn)	2.8	2.8	2.8	1.4	0	0	0	Germany	3000 L.	Schering
*Wuxal Suspension Micro Zn	4	1.35	2	1.35	0	0	0	Germany	3000 L.	Schering
**Wuxal suspension Micro Mn	2.8	1.4	4.2	0.014	0.014	0	0	Germany	3000 L.	Schering

Total multi compounds 33 tons

Appendix (22) :Egypt - locally produced micronutrient fertilizers (1995)

Compound	Content (%)								Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S			
1. Compound										
Amino multiminerals	2	2	2	2	0	0	0		2500 L.	El- Nasr for Fertilizers
* Foliar (1)	1.2	1.5	1	0	0	0	0		5 tons	El- Nasr for Fertilizers
x-250	2	2	2	0.05	0	1	0		5 tons	El- Nasr for Fertilizers
Foliar combi	4	4	3	0.5	0	2	0		2 tons	El- Nasr for Fertilizers
** Foliar potato	0.8	1.2	1	0	0	2	0		30 tons	El- Nasr for Fertilizers
x-Hada ek 4-4-4	4	4	4	0	0	0	0		10 tons	El- Nasr for Fertilizers

* Compound cont. 15% N + 3% K_2O

** Compound cont. 10% N + 8% K_2O

Total multi compounds 54.500 tons

Appendix (23) : Imported micronutrient fertilizers (1995)

Compound	Content (%)							Origin	Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S			
1. Single										
Ferblex	0	6.65	0	0	0	0	0	England	2 tons	ABM
Ferblex	0	6.65	0	0	0	0	0	England	7.680 tons	ABM
This manganese	0	0	5	0	0	0	0	U.S.A	4 tons	Stoller Chem.
This iron	0	5	0	0	0	0	0	U.S.A	5 tons	Stoller Chem.
Nervanaid Zn	15	0	0	0	0	0	0	England	9.600 tons	ABM
Ferblex 6%	0	6	0	0	0	0	0	England	9.600 tons	ABM
This iron (Liquid)	0	5	0	0	0	0	0	U.S.A	520 L.	Stoller Chem.
This Zinc (liquid)	7	0	0	0	0	0	0	U.S.A	8000 L.	Stoller Chem.
* SET (liquid)	0	0	0	0	1	0	0	U.S.A	10000 L.	Stoller Chem.
Zinc sulphate	22	0	0	0	0	0	0	Yugoslavia	120 tons	n.a.*
Lebrel Fe 13.2 %	0	13.2	0	0	0	0	0	England	1 ton	Interlates
Lebrel Mn 12%	0	0	13.94	0	0	0	0	England	1 ton	Interlates
Lebrel Zn 13%	13.14	0	0	0	0	0	0	England	1 ton	Interlates
This iron	0	5	0	0	0	0	0	U.S.A	4900 L.	Stoller Chem.

* compound cont. 8% Ca
n.a.* : not available
Total without zinc sulphate 64.3 ton/1000 liter
Zinc sulphate 120 tons

Appendix (23 - continued) : Imported micronutrient fertilizers (1995)

Compound	Content (%)							Origin	Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S			
This zinc	7	0	0	0	0	0	0	U.S.A	580 L.	Stoller Chem.
This manganese	0	0	5	0	0	0	4	U.S.A	3880 L.	Stoller Chem.
Super floro Mn (chelated)	0	0	5	0	0	0	0	England	2000 L.	Collingham Marketing
Super floro Fe (chelated)	0	5	0	0	0	0	0	England	2800 L.	Collingham Marketing
Super floro Zn (chelated)	7	0	0	0	0	0	0	England	2000 L.	Collingham Marketing
This Zinc	7	0	0	0	0	0	4	U.S.A	5000 L.	Stoller Chem.
Zinc sulphate	22	0.0001	0.005	0	0	0	0	Germany	10 tons	n.a.*
Nervanaid Mn 13%	0	0	12.92	0	0	0	0	England	10 tons	ABM
Ferblex	0	6.65	0	0	0	0	0	England	10 tons	ABM
Nervanaid Zn	15.21	0	0	0	0	0	0	England	9.8 tons	ABM
This iron	0	5	0	0	0	0	0	U.S.A	1580 L.	Stoller Chem.
This Zinc	7	0	0	0	0	0	4	U.S.A	2420 L.	Stoller Chem.
This manganese	0	0	5	0	0	0	4	U.S.A	2120 L.	Stoller Chem.
Sequestrene zinc	14	0	0	0	0	0	0	U.S.A	0.799 ton	Ciba Geigy
Sequestrene manganese	0	0	12	0	0	0	0	U.S.A	0.900 ton	Ciba Geigy

n.a.* : not available
Total without zinc sulphate 53.879 ton/1000 liter
Zinc sulphate 10 tons

Table (23- continued) : Imported micronutrient fertilizers (1995)

Compound	Content (%)							Origin	Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S			
Ferblex	0	6.65	0	0	0	0	0	England	9.6 tons	ABM
Bumeen Fe	0	5	0	0	0	0	0	U.S.A	96 L.	JH Biotech, Inc.
Bumeen Zn	7	0	0	0	0	0	0	U.S.A	96 L.	JH Biotech, Inc.
Ferblex	0	6.65	0	0	0	0	0	England	3.375 tons	ABM
* NFe	0	4	0	0	0	0	0	U.S.A	1500 L.	Hickson Kerley
*Nzn	5	0	0	0	0	0	0	U.S.A	1500 L.	Hickson Kerley
Key Feeds Born	0	0	0	0	10	0	0	England	5460	Stoller Chem.
Ferblex	0	6.65	0	0	0	0	0	England	6.620 tons	ABM

* Compound cont. 16% N
Total without zinc sulphate

28.247 ton/1000 liter

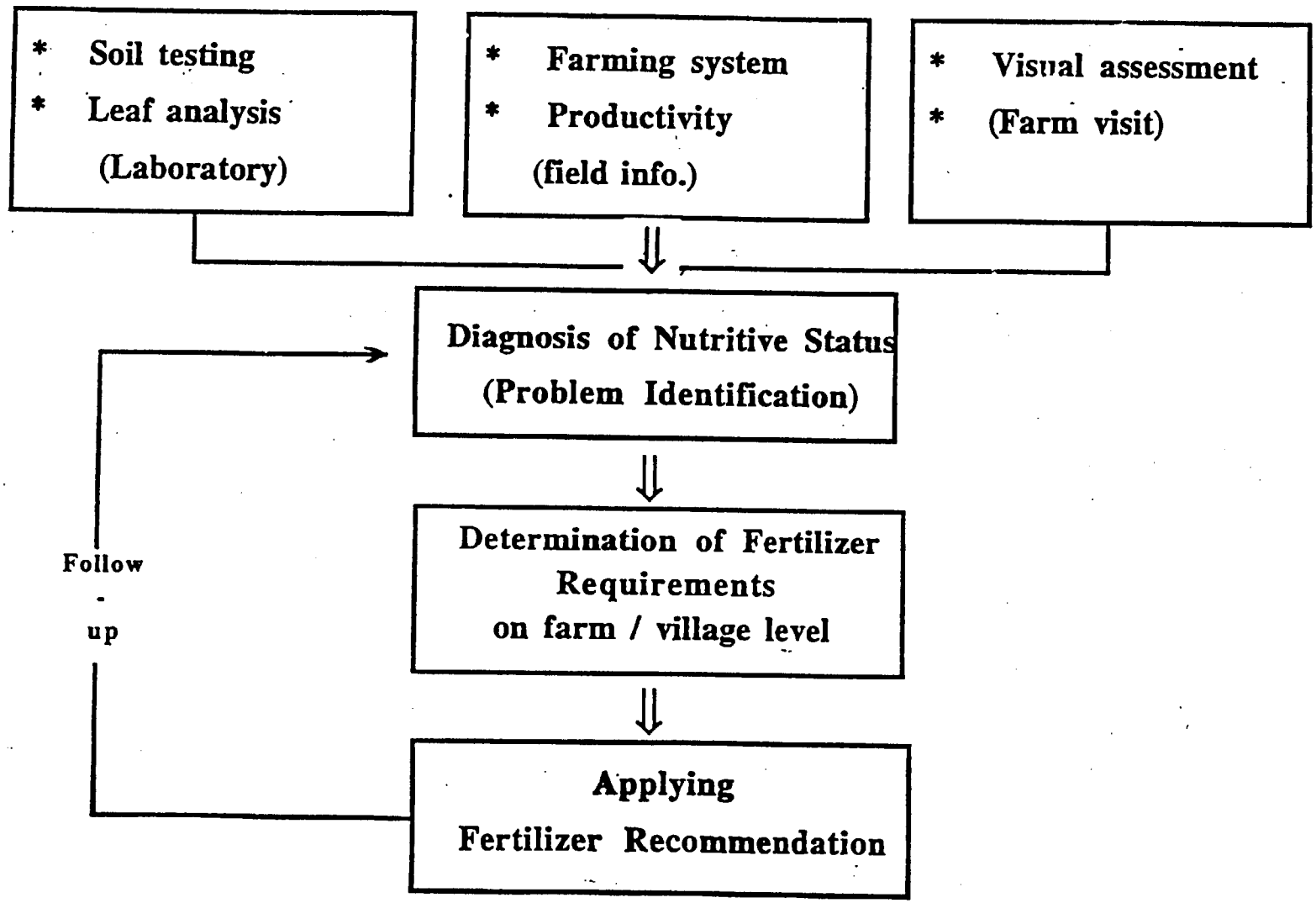
Appendix (23 - continued) : Imported micronutrient fertilizers (1995)

Compound	Content (%)							Origin	Quantity	Manufacturer company
	Zn	Fe	Mn	Cu	B	Mg	S			
2. Compound :										
Lebrel BMX	0.5	3.38	1.73	1.6	0	0	0	England	5 tons	Interlates
Microsol	1.7	6.8	3.4	0.26	0	0	0	Israel	.5 ton	Fertilizers and Chemicals
Lebrel BMX	0.5	3.38	1.73	1.6	0	0	0	England	5 tons	Interlates
Bumeen Boster 221	1	2	2	0.5	0	0.5	0	U.S.A	1008 L.	JH Biotch, Inc.
Bumeen Boster 221	1	2	2	0.5	0	0.5	0	U.S.A	2172 L.	JH Biotch, Inc.
Bumeen Boster 235	2.5	1	1.5	0.5	0	0.5	0	U.S.A	2172 L.	JH Biotch, Inc.
*Wuxal suspension micro Zn	4	1.35	2	1.35	0	0	0	Germany	4800 L.	Schering
Microsol	1.7	6.8	3.4	0.26	0	0	0	Israel	2 tons	Fertilizers and Chemicals LTD.

* Compound cont. 13.5% N
Total multi compounds

22.652 ton/1000 liter

Systymatic determination of fertilizer requirements



ANNEX H

BIBLIOGRAPHY

ANNEX H
BIBLIOGRAPHY FOR SECTION II

Academy for Scientific Research and Technology (ASRT) - Agricultural Research Centre (ARC), (1989): The National Campaign for Rice: Final report. Ed. M.S. El-Ballal. pp. 52.

Academy for Scientific research and Technology (ASPRT) - MOA (1986): The National Campaign for Maize: Results of 1986, pp. 55.

Abdalla, F.E. and Mobarak, Zeinab, M. (1992-a): Shoot intake of nutrients from different micronutrient fertilizer formulations in faba bean. African J.Agric. Sci. 19, 147-160.

Abdalla, F.E. and Mobarak, Zeinab, M. (1992-b): Uptake of NPK and Mg by faba-bean after foliar treatment with chelated and non-chelated micronutrients fertilizers. African J. agric. Sci. 19, 161-172.

Abd El-Ghani, M.B.; Abd El-Dayem, M.S.; EL-Sayed, A.A. and El-Fouly, M.M. (1993): Importance of protecting the environment and water resources from pollution with fertilizers. Proc. German/Egyptian/Arab Workshop "Environmentally Sound, Location and Crop Specific Application of Fetilizers in Arid Areas of North Africa and The Near East," 6-17 June, 1993, Cairo - Ismailia, Eds. M.M. El-Fouly and F.E. Abdalla, pp. 91-103 (Arabic with English Summary).

Abd El-Hadi, A.H., Asy, AH.; Doring, H.-W.; Khadr, M.S.; Mohamed, Y.H., Mystify, A.A. and Taha, M.E. (1986): Effect of foliar fertilization in different crops under Egyptian conditions. In. Foliar Fertilization. Ed. A. Alexander, pp. 126-141, Martinus Nijhoff Publ., Dordrechit/Boston/Lancaster.

Abd El-Hadi, A.H. (1987): Effect of foliar fertilizers on productivity of agronomic and horticultural crops in Egypt. Proc. Workshop "Special Fertilizers," 21-23 Feb. 1988, Alexandria. Eds. M.M. El-Fouly, R. Eibner and G. Hahr. pp. 49-72 (Arabic).

Abd El -Hadi, A.H. (1993-a): Potassium: Its Effect on Crops Productivity on Egyptian Soils (1980-1991). Bull. Soil and Water Research Inst. (SWRI), Agricultural Research Centre (ARC), Ministry of Agriculture (MOA). pp. 48.

Abd El -Hadi, A.H. (1993-b): Micronutrients and Foliar Fertilizers: Their Effect on Productivity of Agronomic and Horticultural Cops on Egyptian Soils. Bull. SWRI, ARC, MOA. pp. 60.

Allam, S.T. (1992): Economical liberation of Agricultural Sector. Proc. Seminar "Privatization of Seed Sector in Egypt," 16-18 Jan . 1994, Cairo. Eds. S. Abd El-Wanis, Angail, I. Saad, B. Homeyer and Ch. Weisbecker, pp. 26-35.

Amberger, A.; Fawzi, A.F.A. and El-Fouly, M.M. (1988): Diagnostic and remedial measures of micronutrients problems in grapes grown on calcareous soils in Egypt. Agrochimica, 32 (1) 41-53.

Central Administration of Agricultural Economy (CAAE), MOA (1991): The Agricultural Economy Bulletin, 1985 - 1987, Ed. Khadr, A.H., pp. 960 (Arabic).

Central Administration of Agricultural Economy (CAAE), MOA (1993): The Agricultural Economy Bulletin, 1990-1991, Ed. Nassar, S., pp. 1043 (Arabic).

Central Administration of Agricultural Economy (CAAE), MOA (1995): The Agricultural Economy Bulletin, 1993, Ed. Nassar, S., pp. 509 (Arabic).

Central Administration of Agricultural Extension (CAAE), MOA (1990): Technical Recommendations for Growing Winter Crops. Ed. F. Abd El-Aziz and Sh. Harb, pp. 92.

Central Administration for Agricultural Extension, CAAE (1991): Summer Crops Bullet. 122, pp. 107 (Arabic).

Central Administration for Agricultural Extension, CAAE (1992): Barley growing Bullet. 167, pp. 19 (Arabic).

Central Administration for Agricultural Extension, CAAE (1994): Lentil growing. Bullet. 230, pp. 16 (Arabic).

Central Administration for Agricultural Extension, CAAE (1995): Cotton. Bullet 231, pp. 63 (Arabic).

Central Administration for Agricultural Extension, CAAE (1995): Fababean. Bull. 250, pp. 43 (Arabic).

Central Authority for Public Mobilization and Statistics (CAMPS), (1992): Statistical Yearbook pp. 62-65 (Arabic).

Central Authority for Public Mobilization and Statistics (CAMPS), (1995): Statistical Yearbook pp. 63-86 (Arabic).

Cottenie, A. (1983) Ed. Trace Elements in Agriculture and in Environment pp. 1-24.

Dawoud, O. (1989): Egyptian chemical fertilizer industry. Proc. Special Workshop "The Egyptian Fertilizer Development Centre (EFDC)-Unido Project DP/EGY/CS/105.Apr. 1989. Muscle Shaols, Alabama, USA, Appendix 2, pp. 1-26.

Eid, M.T.; Hamissa, M.R.; Abd El-Samie, M.; El-Banna, E.; Khadr, M.S. and El-Mallah, M. (1981): Efficiency of fertilizer utilization for wheat using N15 and p32 labeled fertilizers. Agric. Res. Rev. 59(4) 80-103.

Eid, M.T.; Abd El-Samie, M., Hamissa, M.R.; El-Banna, E.; Serry, A. and Omar, S. (1974): Efficiency of nitrogen fertilizer applied to wheat as affected by time of application Agric. Res. Rev., 52 (5) 125-133.

Eid, M.T.; Serry, A.A.; Hamissa, M.R.; Abd El-Samie, M.E.; El-Hadidi, H.; Keleg, A.M.; Abd El-Aziz, M.S.; El-Hossini, T.M. and Khedr, M.S. (1971): The application of isotopes and radiation in rice cultivation. IV. Efficiency of fertilizer nitrogen applied to rice, as

affected by placement and the interaction with phosphorus placement. Agric. Res. Rev., 49, 27-47.

El-Ballal, M.S. Ed. (1990): The National Campaign for Rice. Final Report 1989. Ministry of Agriculture (MOA) and Academy of Scientific Research and Technology (ASRT), PP. 52 (Arabic).

El-Ganainy, O. (1994): The changing fertilizers situation in Egypt. AFA. J. 1, 1-10 (Arabic).

El-Khashab, E. (1989): The role of the Principal Bank for Development and Agricultural Credit in marketing and distribution of fertilizers in Egypt. Proc. Special Workshop. "The Egyptian Fertilizers Development Centre (EFDC), UNIDO Project DP/EGY/85/005. Apr. 1989. Muscle-Shoals, Alabama, USA, Appendix 2, pp 1-26. Publ. IFDC (mimeograph - unpublished).

El-Fouly (1987): Use of micronutrients under practical conditions in Egypt. Proc. Workshop "Special Fertilizers," 21-23 Feb., Alexandria. Eds. M.M. El-Fouly, R. Eibner and G. Hahr. pp. 85-107. (Arabic).

El-Fouly, M.M. (1989): Micronutrients and potassium needs in Egypt. Proc. Special Workshop "The Egyptian Fertilizers Development Centre - EFDC-UNIDO Project DP/EGY/85/005, APR. 1989, Muscle-Shoals, Alabama, USA, Appendix 2, pp. 1-34. Publ. IFDC (unpublished).

El-Fouly, M.M. (1991): Foliar Fertilization and re-consideration in plant nutritional studies in Arab countries. Proc. Syrian-Egyptian Workshop "Micronutrients in Soil and Plant," 9-13 June, 1990, Damascus, Ed. M.M. El-Fouly, pp. 131-147 (Arabic).

El-Fouly, M.M. (1992): Integrated fertilization and environment. Proc. Egypt- German Seminar "Environmental and Cultural Aspects of Fertilizer Use," 25-28 Nov. 1991, Cairo, Ed. M.M. El-Fouly pp. 17-22 (Arabic).

El-Fouly, M.M. (1993-a): Fertilizers. In. The Agriculture of Egypt. Ed. Craig, G.M. pp. 363-493. Publ. Oxford Sci. Publications.

El-Fouly, M.M. (1995): Effect of removing subsidy and liberation of fertilizer trade on systems of fertilizers recommendations, farmers' fertilizer use and the role of fertilizer companies Arab-Fertilizers (AFA), 19(3) 22-32 (Arabic).

El-Fouly, M.M. (1995): Registration and use of foliar and micronutrients fertilizers. Proc. 2nd Sudanese-Egyptian Workshop. Dec. 1992 Wad-Medani, Sudan. Eds. M.M. El-Fouly and A.I. Rezk pp. 81-92 (Arabic).

El-Fouly, M.M.; Amberger, A. and Fawzi, A.F.A. (1988): Response of Balady orange to macro- and micro-nutrient fertilizers in Egypt. Agrochimica, 32(1) 72-40.

El-Fouly, M.M., Amberger, A. and Fawzi, A.F.A. (1992): Balanced fertilizers use with micronutrients under Egyptian conditions (The Micronutrient Project). African J. for Agric. Sci, 19 (1). pp. 41-61.

El-Fouly, M.M. and El-Sayed, A.A. (1995): Nitrogen balance in some crops. Proc. Seminar "Production and Use of Chemical Fertilizers and Environment," 17-21 Dec. 1994, Cairo (in press).

El-Fouly, M.M. and Fawzi, A.F.A. (1995): Higher and better yields with less environmental pollution in Egypt through balanced fertilizer use. Proc. 8th International Symposium "Fertilizers and Environment" 26-28 Sept. 1994, Salamanca, Spain (in press).

El-Fouly, M.M.; Fawzi, A.F.A. and El-Sayed, A.A. (1995): Optimizing fertilizer use in oranges through fertigation-a case study. Proc. Dahlia Geridinger Internatl. Symp. "Fertigation". 26030-1.4.1995, Technion, Haifa, pp. 3030-312.

El-Fouly, M.M. ; Fawzi, A.F.A. and Firgany, A.H. (1987): Removal of nutrients by Trifolium alexandrinum and effect of NPK fertilization on yield. Mediterranean Potash News., 3, 8-10.

El-Fouly, M.M.; Fawzi, A.F.A; Firgany, A.H. and El-Baz, F.K. (1991): Uptake and removal of potassium by maize and effect of potassium sulphate on yield . Der Tropenlandwirt, zeitschrift fur Landwirtschaft in den Tropen and Sub-Tropen, 92, 73-79.

El-Fouly, M.M. and Rezk, A.I. (1986): Micronutrients status of some food crops and increasing yields through micronutrient foliar application in Behira, Egypt. In. Foliar Fertilization, Ed. A. Alexander, p. 153-169. Martinus Nijhoff Publ., Dordrecht/ Boston/Lancaster.

El-Sayed, A.A.; Abdalla, F.E.A and Fawzi, A.F.A. (1992-a): Increase in faba bean yield after micronutrients foliar application under farmers conditions in Fayoum. African. J. Agric. Sci., 19(1) 63-72.

El-Sayed, A.; Abdalla, F.E. and Fawzi, F.A. (1992-b) : Intake and partitioning of micronutrients in fababean grown on all alluvial soil. Agric. J. Agric. Sci. 19, 173-180.

Fawzi, .A.F.A. (1991-a): Effect of micronutrients on productivity of agronomic crops in Egypt, Proc. Jordanian-Egyptian Workshop "Micronutrients in Soil and Plant," 18-22 Feb., 1989, Amman, Eds. M.M. El-Fouly and A.F.A. Fawzi, pp. 75-82.

Fawzi, A.F.A. (1991-b): Role of micronutrients in increasing the production of agronomic and horticultural crops. Proc. Syrian-Egyptian Workshop "Micro-nutrients in Soil and Plant," 9-13 June 1990, Ed. M.M. El-Fouly, pp. 47-56 (Arabic).

Fawzi, A.F.A. (1992): Fate of Nitrogen Fertilizer in soil to major crops. Proc. Egypto-German Seminar "Environmental and Cultural Aspects of Fertilizer Use," 25-28 Nov. 1991, Cairo, Ed. M.M. El-Fouly pp. 23-37 (Arabic).

Fawzi, A.F.A. (1993): Principles of optimizing fertilizer use. Proc. German/Egyptian/Arab Workshop "Environmentally Sound, Location and Crop Specific Application of Fertilizers in Arid Areas of North-Africa and The Near East" 6-17 June, 1993, Cairo - Ismailia, Eds. M.M. El-Fouly and F.E. Abdalla, pp. 81-86. (Arabic with English Summary).

Fawzi, A.F.A, Amberger, A. and El-Fouly, M.M. (1987): Nutrient status of field crops in the Nile Valley area. Agrochim. 31(6), 535 - 545.

Fawzi, A.F.A. and El-Fouly, M.M. (1993): Inputs for computerized expert system for fertilizer recommendations in Fayoum governorate. NRC-GTZ report (unpublished) p 94.

Fawzi, A.F.A., El-Fouly, M.M. and El-Baz, F.K. (1990): Problems of Potassium nutrition in citrus (Citrus Sinensis) orchards in Egypt. Plant Nutrition - Physiology and Applications, Ed. M.L. Van Beusichem, pp. 729 - 733, Kluwer Academic Publishers.

Fawzi, A.F.A, El-Fouly, M.M. and Zayed, A.A. (1986): Effect of micronutrients application on fababean yield. African J. Agric. Sci., 13(1+2), 111-123.

Fawzi, A.F.A.; Firgany, A.A.; Sanad, S.H. and El-Baz, F.K. (1984): Mineral nutrition of "Navel orange" at alternate bearing. Proc. 6th. Internal Collog. "Optimization of Plant Nutrition," 2-8 Sept. 1984, Montpelier, Ed. Martin - Prevel, P., pp 199-206.

Fawzi, A.F.A.; Rezk, A.I. and El-Fouly, M.M. (1994): Fertilizer specific recommendations for rice, wheat, fababean and lentil in Beheira, Dakahlia, Kafr El-Seikh and Sharkia. NRC-GTZ report (unpublished).

Fink, A. (1982): Fertilizers and Fertilization, pp. 438. publ. Verlog Chemic., Weinheim. Dear Field Beach, Florida. Basel.

Hamissa, M.R. (1989): Fertilizers and fertilizer use in Egypt. Proc. Special Workshop, IFDC "The Egyptian Fertilizer Development Centre, EFDC.

Hamissa, M.R.; Abd El-Samie, M.E.; El-Banna, E. and Khader, M.S. (1974): Corn fertilization program in A.R.E.: Utilization of nitrogen by maize as affected by time and method of application. Agric. Res. Rev. 52, 25-48.

Halliday, D.J. and Trenkel, M.E. (Eds.) (1992): IFA World Fertilizer Use Manual. Publ. International Fertilizer Industry Association (IFA), Paris. pp. 632.

Hassanein, H.G. (1992): Cultural and economical status of Upper-Egypt (Assiut) farmers application and its environmental impacts. Proc. Egypto-German Seminar "Environmental and Cultural Aspects of Fertilizer Use" 25-28 Nov. 1991, Cairo, Ed. M.M. El-Fouly, pp. 71-78 (Arabic).

Kishk, M.A. (1991): Problems of transferring and disseminating the information and obstacles of using micronutrients fertilizers. Proc. Syrian-Egyptian Workshop "Micronutrients in Soil and Plant," 9-13 June, 1990 Damascus Ed. M.M. El-Fouly, pp. 157-168 (Arabic).

Mobarak, Zeinab, M. and Abdalla, F.E. (1992-b): Nutrients uptake by maize plants as affected by foliar micronutrients application. African J. Agric. Sci. 19, 193-205.

Mobarak, Zeinab, M., El-Sayed, A.A.; Abdalla, F.E. and El-Bendary, A.A. (1992-b): Differential responses of soyabean varieties to micronutrients foliar application. African J. Agric. Sci. 19, 123-136.

Nassar, S. (1994): The economic impact of reform programs in the Agricultural Sector in Egypt. Proc. Seminar "Privatization of Seed Sector in Egypt," 16-18 Jan. Cairo 1994 . Eds. S. Abd El-Wanis, Angail, I.Saad, Homeyer, B and Weisbecker, Ch., pp. 15-25.

National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991) :The Final Achievement Reports on Phases I and II (1976-1986): Studies carried out in Monofia governorate. report(3), Ed., M.M. El-Fouly, pp, 173., Publ. NRC, Dokki-Cairo. ISBN 977-5041-07-4 (Arabic).

National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried-out in Behera governorate; report (4), Ed., M.M. El-Fouly, pp. 207., Publ. NRC, Dokki-Cairo. ISBN 977-5041-11-2 (Arabic).

National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried-out in Dakahlia governorate; report (5), Ed., M.M. El-Fouly, pp.159, Publ. NRC, Dokki-Cairo. ISBN 997-5041-10-4 (Arabic).

National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried-out in Qaliobia governorate; report (6), Ed., M.M. El-Fouly, pp. 151, Publ. NRC, Dokki-Cairo. ISBN. 977-5041-09-0 (Arabic).

National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried-out in Ismailia governorate; report (7), Ed. M.M. El-Fouly, pp.210, Publ. NRC, Dokki-Cairo. ISBN 977-5041-09-B (Arabic).

National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried-out in Fayoum governorate; report (8), Ed. M.M. El-Fouly, pp.173, Publ. NRC, Dokki-Cairo. ISBN 977-5041-08-0 (Arabic).

National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried-out in Minia governorate; report (9), Ed. M.M. El-Fouly, pp.153, Publ. NRC, Dokki-Cairo. ISBN 977-5041-12-O (Arabic).

National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried-out in Nobaseed company ; report (11), Ed. M.M. El-Fouly, pp.74, Publ. NRC, Dokki-Cairo. ISBN 977-5041-16-3 (Arabic).

National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried-out in Mariut, North-Tahrir and Gianaclis companies, report (12), Ed. M.M. El-Fouly, pp.187, Publ. NRC, Dokki-Cairo, ISBN 977-5041-17-1 (Arabic).

National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Studies carried-out in South-Tahrir companies, report (14), Ed. M.M. El-Fouly, pp.89, ISBN 977-5041-17-6 (Arabic).

National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1991): Multiplier Program for Optimizing Micronutrients Fertilizer Use, report (15). Ed. A.F.A. Fawzi, pp. 254, Publ. NRC, Dokki-Cairo. ISBN 977-5041-22-8. (Arabic).

National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1993): Studies and Experiments Carried-out during 1984-1986, report (14-1). Ed. A.I. Rezk, pp. 329. ISBN 977-5041-28-7 (Arabic).

National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1993): Report on serving farmers on Agricultural Reform (ARO) land. Season 1991/92. Eds. Fawzi A.F.A. and El-Sayed, A.A. pp. 99 (Arabic - unpublished).

National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1994-b): Report on serving farmers on Agricultural Reform (ARO) lands. Season Summer 1994. Ed. Rezk, A.I. pp. 130 (Arabic-unpublished).

National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1994-a): Report on serving farmers on Agricultural Reform (ARO) lands. Season Winter 1993/1994. Ed. Rezk, A.I. pp. 72 (Arabic-unpublished).

National Research Centre (NRC) - German Agency for Technical Cooperation (GTZ) (1992): Final Achievement reports on Phases I and II (1976-1986): Studies carried -out in Assiut governorate report (10), Ed. M.M. El-Fouly, pp. 220. ISBN 977-5041-27-9 (Arabic).

National Program for Agric. Research-ARC (1991): Technical Recommendations for Rice. Ed. M.S. El-Ballal, PP. 44.

National Program for Agric. Research (1990): Winter legumes. Bullet. 100, pp. 32.

Nour, Y.M. (1992): Cultural role of the Egypto-German Project "Micronutrients and Other Plant Nutrition Problems in Egypt" in the field of fertilizer use in Egypt. Proc. Egypto-German Seminar "Environmental and Cultural Aspects of Fertilizer Use," Cairo, 25-28 Nov. 1991, Ed. M.M. El-Fouly, pp. 161-174 (Arabic).

Nour, Y.M and El-Sayed, A.A. (1991): Multiplier Development Extension Program for Potato Growers in Itai El-Baroud, Beheira governorate," Egypt, Season 1986/87. Ed. M.M. El-Fouly, pp. 87 (Arabic with English summary).

Rammah, A. (1994): Egyptian Clover. Tech. Bull . 8/1994. General Administration for Agricultural Education, pp. 20.

Principal Bank for Development for Agricultural Development and Credit: PBDAC (1988): Fertilizer recommendations for season 1988/89. Exec. circular No. 98 (unpublished).

Rezk, A.I. (1991): Effect of micronutrients on productivity of fruit crops in Egypt. Proc. Jordanian-Egyptian Workshop "Micronutrients in Soil and Plant". 18-22-Feb., 1989, Amman, Eds., M.M. El-Fouly and A.F.A. Fawzi, pp. 63-74.

Sallam, M. Sh. (1992): Socio- economic and cultural factors affecting fertilizer application and its environmental impacts. Proc. Egypto-German Seminar "Environmental and Cultural Aspects of Fertilizer Use," 25-28 Nov. 1991, Cairo, Ed. M.M. El-Fouly, pp. 63-69 (Arabic).

Shalaby, G. and Metwally, M.A. (1987): Advices on growing modern varieties of tomato. Tech. Bulleto 7/1987, pp. 16.

The Economic Sector, MOA (1995): Estimated fertilizer needs in 1994/95, 1995/96 and 1996/97 (unpublished)

Zeid, F.A.; Khater, E.A.H., and Seif El-Yazal, S.A. (1992): Use of fertilizers and the impact of economic and cultural levels of farmers on that; use in El-Fayoum governorate. Proc. Egypto-German Seminar "Environmental and Cultural Aspects of Fertilizer Use," 25-28 Nov., 1991, Cairo, Ed. M.M. El-Fouly pp. 75-88 (Arabic).

BIBLIOGRAPHY FOR SECTION IV

"Abu-Zaabal Fertilizer and Chemical Co.," brochure, Abu Zaabal, Egypt, undated.

"Abu Qir Fertilizers and Chemical Industries Co.," brochure, Alexandria, Egypt, undated.

"Al-Nasr Company for Coke and Chemical," brochure, Helwan, Egypt, undated.

"Egyptian Chemical Industries (KIMA)," brochure, Aswan, Egypt, undated.

"Egypt: Fertilizer Sector Review," Dr. Heba A. Handoussa, World Bank, Cairo, Egypt, May, 1987.

"Egyptian Fertilizer Development Center," brochure, Talkha, Egypt, undated.

"Fertilizer Policy Impact Study," International Fertilizer Development Center, USAID, Cairo, Egypt, June, 1993.

"Summary and Recommendations of Feasibility Study for Complementary Debottlenecking Two Projects (Phase I in SEMADCO)," Egyptian Fertilizer Development Center, Talkha, Egypt, November, 1995.

"The Egyptian Phosphate Industry, A 1995 Diagnostic Study," Bechtel Associates, USAID, Cairo, Egypt, March 23, 1995.