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EGYPT's SUGARCANE POLICY AND STRATEGY FOR WATER MANAGEMENT

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RDI ACRONYMS LIST

ACRONYM	*DESCRIPTION*
AC	Agricultural Census
AEnRI	Agriculture Engineering Research Institute
AHD	Aswan High Dam
AIC	Agricultural and Irrigation Committee of the People's Assembly
ALCOTEXA	Alexandria Cotton Exporters Association
APRP	Agricultural Policy Reform Program
ARC	Agriculture Research Center
AY	Agricultural Year Locator (October 1st to September 30th of the following year)
BOD	Board of Directors
CAGA	Central Administration for Governorates Affairs
CAPQ	Central Administration for Plant Quarantine, MALR
CAWD	Central Administration for Water Distribution
CBE	Central Bank of Egypt
CIDA	Canadian International Development Agency
CIF	Cost, Freight and Insurance
CMA	Capital Market Authority
Co.	Company
COP	Chief of Party
CSPP	Egyptian-German Cotton Sector Promotion Program
CTS	Cargill Technical Services
DA	Development Associates, Inc.
DAI/B	Development Alternatives, Inc./Bethesda
ELS	Extra Long Staple Cotton
ERSAP	Economic Reform and Structural Adjustment Program
ESAs	Employee Shareholder's Association
ESOPs	Employees Stock Ownership Program
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
FDIs	Foreign Direct Investments
Fed.	Feddan = 4200 square meter
FIHC	Food Industries Holding company
FOB	Free on Board

ACRONYM	*DESCRIPTION*
FSR	Food Security Research Unit
GA	General Assembly
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GOE	Government of Egypt
HC	Holding Company
IDA	International Development Association
IFC	International Financial Cooperation
IPPC	International Plant Protection Convention
IPO	Initial Public Offering
IIMI	International Irrigation Management Institute
IR	Intermediate Results
Kg.	Kilogram
Kt.	Kentar
Libra	Pound of 0.45359 kilogram, also abbreviated as lb.
LE	Egyptian Pound
LK	Lint Kentar of cotton, 50 kgs.
LS	Long Staple cotton
MALR	Ministry of Agriculture & Land Reclamation
MENA	Middle East North Africa
MEIC	Ministry of Economy & International Cooperation
MIMW	Ministry of Industry & Mineral Wealth
MT	Metric Ton
MoTS	Ministry of Trade & Supply
MPE	Ministry of Public Enterprises
MPWWR	Ministry of Public Works & Water Resources
MLS	Medium-Long Staple cotton
MVE	Monitoring, Verification & Evaluation Unit
NBE	National Bank of Egypt
NCF	National Consulting Firm
NGO	Non-Governmental Organization
O & M	Operation & Maintenance
OSAF	Office for Studies And Finance

ACRONYM	*DESCRIPTION*
PA	People's Assembly
PBDAC	Principal Bank for Development and Agricultural Credit
PEO	Public Enterprise Office
P&L	Privatization & Liberalization
PIDP	Partnership In Development Project
PMU	Project Management Unit
PPC	Program Planning Committee
PRA	Participatory Rapid Appraisal
PU	Purdue University
RDI	Reform, Design & Implementation Unit
ROW	Rest of the World
SCC	Sugar Crops Council
SCRI	Sugar Crops Research Institute
SIIC	Sugar and Integrated Industries Company
SK	Seed Kentar of cotton (157.5 kgs.)
SS	Short Staple cotton
STTA	Short Term Technical Assistance
SWG	Sugarcane Working Group
TA	Technical Assistance
TAMIS	Technical & Administrative Management Information System
TAT	Technical Assistance Team
TF	Task Forces
TO	Training Officer
TOR	Terms of Reference
TNA	Training Needs Assessment
TRG	Training Resources Group
TSG	The Services Group
UMD	University of Maryland
USAID	United States Agency for International Development
US$	United States Dollar
WB	World Bank
WTO	World Trade Organization
WUA	Water User Association

EGYPT's SUGARCANE STRATEGY AND POLICY FOR WATER MANAGEMENT

EXECUTIVE SUMMARY

Water scarcity in Egypt is a critical issue. The increasing demand for limited water resources puts pressure on the MPWWR to formulate policies and programs to improve water allocation. Various water users, in particular the agricultural sector, must reconsider their requirements in order to overcome the problem of water scarcity and keep the national water balance in equilibrium.

The MPWWR and MALR are aware of the implications of not developing new strategies and policies for improving water allocation for irrigation. Most important, the two ministries recently have focused on formulating new policies for water applied to two high water consuming crops, Sugarcane and Rice. This paper reports on the issue of sugarcane and water and provides recommendations for improved water use to this crop.

APRP (RDI/EPIQ) formed a sugarcane Working Group (SWG). The group included experts from the Central Administration for Water Distribution (CAWD/MPWWR), the Sugar Crops Research Institute (SCRI/ARC), the Agriculture Engineering Research Institute (AEnRI/ARC) and others, to review policy issues related to water scarcity and sugarcane plantation in Egypt. The group used the Participatory Rapid Appraisal approach to identify problems and propose alternatives policy options to improve water allocation to sugarcane.

The Working Group examined previous studies, reports, and other information available on this issue. They investigated and interviewed specialists in the fields of agronomy, water distribution, the physical system, on-farm irrigation systems, and economics. They received information on the available water supply, water use, cane production and productivity, improved irrigation systems, and sugar processing mills

in Upper Egypt. The group interviewed cane growers, breeders, sugar producers, and farming practices technicians during their field visits to Luxor, Qena, and Aswan.

The available data and current applied policy for water use in sugarcane areas were reviewed. based on that, the Working Group identified policy alternatives and actions required to conserve water in sugarcane plantation. These policy actions could lead to the optimal use of water in sugarcane plantations, and include :

1. Limit the sugarcane cultivated areas to meet only the requirement of existing factories, this policy option can be achieved through the following actions:
    - Restrict the cultivation of sugarcane in the new reclaimed, high land and outside factory zones.
    - Reduce the sugarcane areas in accordance with any increase of productivity per feddan.
    - Initiate public awareness campaign concerning high water consuming crops.

2. Improving on farm water efficiency and sugarcane productivity through:
    - Improved irrigation techniques (gated pipes) on 65% of main cane producing area (about 160,000 feddans).
    - Enhance research programs in breeding and agronomy to improve productivity (up to 30%) in the next few years.
    - Estimated reduced water diversions (about 2200m^3/feddan) may reach 350 million m^3/fed/year.
    - Design and implement a pilot area in which the MPWWR and SCRI/MALR apply improved irrigation methods and laser land leveling while establishing WUA's.

3. Importing sugar, to reduce cane area in light of water scarcity. The anticipated water saving will depend on how much sugar is imported.

The working group recommended a series of actions to be taken in order to achieve one or more of the proposed policies. It recommended also to continue investigating the potential of gated pipe system as a method of improving irrigation. The group will be able to analyze and evaluate the results of these trials after the sugarcane harvest in January 1999.

1. Introduction:

Agriculture occupies a dominant position in the Egyptian economy, accounting for more than 20% of GDP, about 35% of employment, and about 20% of merchandise export earnings. The land base for agricultural production consists of 7.6 million feddans of arable irrigated land (i.e. about 3 million ha) of which 79.4% are old lands of the Nile Valley and Delta, while 20.6% are new, reclaimed lands. Irrigated farming in Egypt is supported by one of the world's largest single river basin systems, extending more than 1200 km from Aswan High Dam (AHD) to the Mediterranean coast. The perennial irrigation system coupled with sophisticated and effective modern irrigation and drainage networks, has made Egyptian agriculture one of the unique farming systems in the World. Multiple cropping is common and land productivity is very high. The total cropped area reached 13.8 million feddans in 1996 and cropping intensity is 1.86. The sector's single most limiting resource is water. GOE is devoting considerable research and extension resources to develop and adopt sustainable programs to maintain irrigation and drainage network and optimize water to meet the needs of new reclamation programs.

It is natural that, as sector work on irrigation has become more comprehensive, increasing attention is being paid to water allocation and re-allocation. Land as Water demands have. As population and income per capita grow, water consumption grows but the supply of clean, fresh, and non-polluted water does not. To address this issue, Egypt, in early 1980's, started a comprehensive water resource planning effort, to focus attention on balancing water supply and demand by investing in the developing new supply and sources in technologies for reducing demand. Egyptians began making hard choices not only between the different sectoral users but also among each sectors' activities. Careful analysis of

the use of scarce water resources and of matching technical possibilities to reduce current demand is needed.

The new plan for land reclamation, which should be accomplished by the year 2017, aims to reclaim 3.4 million feddans (about 1.4 million ha) of which 1.2 million feddans are to be reclaimed by the year 2002 and 2.2 million feddans are to be reclaimed by the year 2017. As a result of the government's policy to develop new communities in the desert areas in order to reduce the population intensity of the Nile Valley and Delta, MALR and MPWWR coordinate their efforts. The New Valley Project (0.5 million fed. in first stage) and North Sinai Project (0.62 million fed.) are considered the most important reclamation projects in these programs. In the light of a constant water supply, measures have to be taken by both ministries, to provide water for these reclamation programs, while optimizing current water use, especially in agriculture sector.

2. Problem Statement:

The objective of this Report is to meet the policy reform goals of the MPWWR and MALR, which focus on improved allocation of water resources. Specifically, the two ministries are committed to the following policy reform benchmarks " establishing a strategy for the optimal use of water for sugarcane production".

The benchmark addresses the problem of water scarcity and how Egypt can reallocate its water resources in order to achieve the reclamation programs in the New Valley Project and in North Sinai (El-Salam Canal Project). Sugarcane is one of the two crops (the other is rice) that consumes more water than all other crops in Egyptian agriculture. Water consumptive use is 2.25 bcm per year, while its field water requirement is 3.0 bcm for 250 000 feddans under cane areas in Upper Egypt.

Therefore, the government will have to choose among policy options to reduce the amount of water required for crops. With the new land, the need for these policy options become more urgent than before. Therefore the time has come to

establish an agreed upon policy or policy options to reallocate water within agricultural sector, in particular reducing water to sugarcane plantations so that water will be available for the horizontal expansion. Policy options must take into account the technical, economic, and social impacts on rural communities in Upper Egypt. The work for this Report was implemented jointly by researchers in the MPWWR and the MALR.

3. Objectives and Scope of the Report :

The objective of this Report is to analyze the current status of water management in sugarcane production regions in Upper Egypt and propose potential policy options and a strategy to achieve optimal water management and conservation.

The following sections of this document include analysis of current status of the cane production, national water balance, water utilization and management in cane plantations, potential solutions and constraints to water conservation in the principal sugarcane production areas, macro-economics of sugar production in Egypt, a proposed strategy and policy options for optimal water management , and recommendations.

4. Methodology and Approach :

The methodology for this investigation was based on the techniques of Participatory Rapid Appraisal (PRA) which involved a multi-disciplinary team (Sugarcane Working Group formulated from MALR, MPWWR, SCC, EPIQ, and RDI) visiting field sites and conducting interviews, dialogue with stakeholders (farmers & producers), to carry on an intensive discussions within the team (SWG) on the problem, to ensure that all members of SWG are oriented to one goal : proposing a strategy or strategies for optimal use of water in sugarcane areas. The PRA approach does not conduct a survey, but rather depends on collecting and analyzing the existing data, documents, reports, and studies which are related to this investigation. The inter-action of the SWG's ideas and suggestions with the analysis from data collection and previous reports, are considered the key to PRA and to reliable conclusions and recommendations.

The working group scheduled many meetings to discuss the issue and exchanged ideas and views about possible solutions. The working group conducted also field visits to Qena and Aswan governorates and Luxor City in Upper Egypt. These regions are the major locations for sugarcane plantations, and processing plants are located in these regions. The group visited private farms and opened dialogue with farmers, local authorities, and governmental officials from agricultural directorates in these regions.

5. Background of Sugarcane areas, yields, and government policy :

5.1 The area :

Sugarcane is cultivated mainly in Upper and to some extent in Middle Egypt. Climatic conditions and soils in Southern Egypt are conducive to highly productive cultivation. This crop is considered a traditional crop in these areas. The area of sugarcane has been constant over the period 1978 to 1996. The annual areas planted, in main producing regions, over this period were between 230,000 to 288,000 feddans as shown in Table (1); while the total cane area were between 306.400 and 291 700 feddans in 1995 and 1997, as shown in Table (2). Main production areas for sugarcane are Menya, Sohag, Qena, and Aswan where sugarcane processing plants (eight factories) are located. These governorates contributed 95.3% of total sugarcane production in the country for 1996, from 94.2% of total sugarcane area. Government policy has been to maintain a constant area as a means of not increasing water consumed in agriculture. Government policy promotes both sugarcane and sugar beet production, through sugarcane area is not anticipated to increase from its current level. The expansion of sugar production will be derived from increased production of sugar beet, which has been grown successfully in the Delta since 1982. By 1996, the area allocated to sugar beets (50,800 feddans) increased to almost 3 times the area planted in 1982, while the beet production (841,500 ton, with an average yield of 16.56 ton/fed.) increased to almost 4 times its level in 1982.

Table (1)

Average acreage and productivity of sugarcane in the main producing governorates during the period 1978 - 1996

ITEMS	1978	1980	1985	1990	1995	1996
Area planted (000'fed)	232.5	231.6	228.2	260.1	287.2	288.6
Average Yield (Ton/fed.)	33.74	35.55	37.56	40.91	46.38	46.55
Production (Million Ton)	7.844	8.232	8.573	10.664	13.319	13.437

Source: Council for Sugar Crops, MALR, 1996.

The area cultivated to sugarcane in Qena governorate is about 47.6% of the country's total, and represents about 51% of the total area cultivated to cane in the four principal producing governorates. This means attention should mainly be focused on this governorate regarding water management policy in future.

The median farm size of cane farmers is 3 to 4 feddans, with an average of 1.5 feddans planted to cane. Farmers indicate a strong preference to grow cane, since it requires less intensive farm management than the other traditional field crops or vegetables grown in Upper Egypt. Furthermore, marketing of cane posses minimal problems for cane farmers.

There was a recent reduction of sugarcane acreage in Upper Egypt by about 11,900 feddans. The government has paid LE 38.6 million as compensation to farmers (at rate of LE 4000 to LE 5000 per each feddan removed). The elimination of sugarcane plantations has had a negative effect on sugar production. These areas could have produced 0.5 million ton of cane (estimated value of LE 45 million). Sugar production, therefore, decreased by about 55,000 tons (with a value of about LE 66.3 million). Further reduction in the areas of sugarcane will be costly for government due to compensations, over and above the anticipated impacts on the activities related to the production of sugarcane. Farmers in these regions,

however prefer to cultivate sugarcane in their rotation because it has a comparative economic advantage over other rotations. Sugarcane is the most profitable crop in these regions, taken into account that farmers cultivate onion, garlic, fababean, or tomatoes as an inter-cropping.

5.2. The Productivity :

Egypt's sugarcane yields are among the highest in the world. The average sugarcane yields under the current cultural practices of about 46.5 tons/feddan, are excellent in comparison with results obtained under similar conditions elsewhere. The current variety, 54C9, which is grown on over 92% of the cane plantations, is about 15 years old. There are five new promising Egyptian varieties which are being developed by Sugar Crops Research Institute (SCRI/ARC) and may replace as much as 50% of the current variety over the next 5 years. The main producing governorates in Upper Egypt achieved the highest yield per feddan [tables (1) and (2)] which is why sugarcane is concentrated in these governorates. Any improvement in future productivity would be likely to take place also in these regions. Future improvement in productivity should coincide with a reduction in sugar cane area in order to maintain the existing level of sugar cane production.

Table (2)

Sugarcane acreage and yield during the seasons

1995 to 1997.

Region/Govern.	Area (000' feddans)			Yield (ton/feddan)		
	1995	*1996*	*1997*	*1995*	*1996*	*1997*
1. Lower Egypt	4.3	4.1	3.7	36.6	36.1	36.7
2. Middle Egypt :	35.3	33.8	26.4	45.2	44.3	44.0
Giza	2.6	3.1	2.8	35.3	33.5	31.4
Ben-Suef	1.0	1.2	1.1	26.3	25.6	24.9
Fayoum	0.6	0.6	0.6	31.6	31.3	31.8
Menya (a)	31.1	28.9	21.9	46.9	46.5	46.5
3. Upper Egypt :	259.2	252.7	252.1	46.5	47.2	46.3
Assuit	1.6	1.8	1.7	40.5	40.8	41.1
Sohag (a)	18.9	20.3	18.8	45.9	47.7	49.0
Qena (a)	167.6	140.2	138.8	46.6	46.9	46.1
Aswan (a)	71.1	68.4	70.2	46.4	47.4	46.1
Luxor city	(b)	22.0	22.6		48.9	49.0
4. New Lands	7.6	9.2	9.5	39.9	40.5	40.2
The Country's total	**306.4**	**299.8**	**291.7**	**46.0**	**46.5**	**46.0**

One)Main producing governorates.

Two)The data for this year included in Qena.

Source: Economic affairs sector- MALR.

The average productivity for the four main producing governorates increased 13.8% from 1990 to 1996. Sohag governorate achieved the highest yield in 1997 (49 ton/fed.), while the yield for Qena governorate (with 50% of total area) was estimated as 46.1 ton/fed.. There is good opportunity to improve productivity in this governorate. The MALR has promoted many techniques to improve productivity through ARC and its research institutions (SCRI, AEnRI). These include laser land leveling, widening the spaces between furrows, providing balanced fertilizers, introducing new high yield varieties, and improving the efficiency of on-farm water management .

5.3. The Production of Sugarcane :

The potential of increasing cane production without additional water requirements lies in the main producing governorates. The goal is to increase yield up to 60 ton/fed. in comparison with 46.55 ton/fed, as an average in 1996 for these governorates. Table (3) illustrates the cane produced in main producing areas from 1995 to 1997.

The total cane production in 1996 was 14.1 million tons, of which about 95.3% was produced from the four major governorates, as shown in Table (3). The cane delivered, from the four governorates, to the processing mills was 9.6 million tons to produce sugar, and 4.6 million tons were allocated to other uses. The distribution of sugarcane produced in 1996 among various users was as follows :

- *Processing plants to produce sugar* *68.2%*
- *For producing syrup* *11.0%*
- *For agriculture (seeds)* *2.8%*
- *Fresh consumption & Juices* *9.0%*
- *Cane cleared for security reason* *3.5%*
- *Other activities* *5.5%*

Table (3)

Sugarcane production in the last three seasons

(million metric tons)

Production	1995		1996		1997	
	Quant.	%	Quant.	%	Quant.(*)	%
Total production	**13.822**	**100.0**	**14.105**	**100.0**	**13.418**	**100.0**
Main Prod. Gover. :	13.320	96.4	13.437	95.3	12.681	95.1
Menya Gover.	1.783	12.9	1.458	10.3	1.018	7.6
Sohag Gover.	0.732	5.3	0.867	6.1	0.921	6.9
Qena Gover.	7.593	54.9	7.812	55.4	7.506	55.9
Aswan Gover.	3.212	23.2	3.300	23.4	3.236	24.1
Cane Delivered to Processing Plants	9.889		9.622		N/A	
Sugar Production	1.004		1.019		N/A	

(*) Estimates , N/A means not available.

Source: Annual Report of Sugar Crops Council, MALR, 1996.

5.4. Why Sugarcane in Upper Egypt ?

Sugarcane is the principal crop for the sugar industry and is the sole source for molasses in Egypt. Moreover, it is considered the most efficient tropical plant in receiving and storing solar energy and converting it into sugar " sucrose". Consequently, it yields the highest calories per unit of land per unit of time. Sugarcane is not only the main source for sugar locally and universally, but it also provides many essential industries with raw materials as shown in the Annex (figures 1 and 2).

Egypt ranks first in the sugarcane yield, on the basis of the standard growth season (12 months). By comparison, USA ranks eleventh. Egypt's high sugar yield is mainly attributed to the following :

- Upper Egypt enjoys an optimum sugar growing environment, i.e. many hours of sun, high light intensity, differences in day and night temperatures,...etc.
- The adaptation of high yielding varieties with shortest duration of growth season.
- The availability of the irrigation water throughout the whole year.
- Knowledgeable and hard working farmers and appropriate agriculture packages.

- Sugarcane, like cotton in the Delta, is considered the best "socio-economic" crop in Upper Egypt. Its profitability per feddan is higher than that of other competing crops in these regions.
- The high potential productivity of cane in Upper Egypt which ranges from 30 ton/fed. up to 65 ton/fed., depending on the site and application of the recommended technical agricultural practices.
- Sugarcane is a tropical and perennial crop, its rapid vegetative growth cycle in Upper Egypt lies between May and September. Cane is planted once and harvested 5-6 times, and thus is not labor intensive crop. The irrigation duration for sugarcane is 9-10 months only and not 12 months.
- Most field crops can not be substitute for sugarcane in Upper Egypt. For example, Maize requires warm, but not hot temperature particularly at pollination period, and Sugar beet requires cool weather. The productivity of most crops grown in Upper Egypt is lower than in the Delta.
- Autumn cane is planted from mid September up to mid November. It is usually intercropped with winter crops mainly fababean, tomatoes, onion. Meanwhile, the Spring planted cane that is cultivated from February to April, and is usually intercropped with tomatoes and soya bean. Intercropping does not reduce cane yield.

6. Government Policy :

The challenge facing GOE, given the country's potential water scarcity issue, is to re-consider its current sugarcane water policy. The main policies regarding sugar crops proposed by Sugar Crops Research Institute (SCRI/ARC) and presented to the MALR, can be summarized as follows :

- No increase in the acreage of sugarcane would be allowed, but more efforts will be focused on improving productivity in order to meet the demand of sugarcane processing plants.
- The expansion of sugar beet areas in the new land in the regions adjacent to the Delta in order to meet the demand of the existing sugar beet processing plants in the Delta (two plants with total capacity of 325 000 ton sugar/year) and proposed processing plants (three plants with total capacities of 300 000 ton/year).

- Undertaking national projects in sugarcane regions that aim at achieving water management efficiency at farm level. These projects include laser land leveling (about 48.8% of total areas was leveled up to 1997 and the estimated cost reached to LE 22 million, paid by SCC), introducing new cane varieties. widening the spaces between furrows, removing weeds from irrigation networks, balancing the required fertilizers, and introducing the improved surface irrigation system.

7. National Water Balance :

The major challenge for Ministry of Public Works and Water Resources (MPWWR) is to close the increasing gap between the limited water resources and the escalating demand from the various sectors of the economy. Therefore, a careful analysis has to be made on the current status of available water resources and water consumption by different users , especially agricultural. This step will allow formulating potential alternative policies to achieve water conservation.

Regarding supply, Egypt relies mainly on the Nile River as its principal source of fresh water. Groundwater in the shallow Nile aquifer is not an independent resource as it is renewed only by seepage lost from the Nile, irrigation canals and drains, and deep percolation from irrigated lands. Egypt depends on the available water storage of Lake Nasser to sustain its annual share of water that is fixed at 55.5 bcm annually by agreement with Sudan in 1959 and other Nile Basin countries.

Average annual water consumed for agriculture, in 1995/96 was 40.8 bcm (Bayoumi, et al. Report of 1997). This irrigated 7.8 million feddans (about 13.8 million fed. of cropped area), and average annual consumptive use was about 5100 m^3/fed./year. This amount represents only crop evapotranspiration and does not include the conveyance losses in the irrigation network or the seepage and deep percolation at the farm level. Total water applied to agriculture, including conveyance and application losses, reached about 54 bcm in 1995/96. This amount does not come only from Nile water, as groundwater abstraction and drainage reuse augment Nile supplies. Table (4): illustrates the current Water Sources and Uses (the national water balance of Egypt).

Irrigation water for agricultural crops (based on consumptive use) represents about 65.8% of the total available water resources (Bayoumi et al., 1997 study), however. it is about 73.5% of the total available water (Elwan H., Working Group, 1998). The competition for water between different sectors puts more pressure on the constant available water in general, but it also requires reconsidering the re-allocation of water within agriculture activities including land reclamation programs. Thus, Egypt has realized that its water resources are under heavy pressure and water scarcity has become a serious problem and should be resolved the sooner the better.

Table (4)

National Water Balance

Water source/Use	Available Water (bcm)	Consumptive use (bcm) 1996/97(a)	Consumptive use (bcm) 1995/96 (b)
High Aswan Dam	55.5		
crops EvapoTranspiration		36.5	40.8
M & In. Consumption		3.0	1.4
Evaporation from system		2.4	3.0
Evaporation from weeds		0.7	
Outflow to Fayoum Depr.		0.5	0.7
Fresh water outflows to sea		0.1	0.3
Drainage outflows to lakes & sea		12.3	12.4(*)

(*)This includes about 8.0 bcm needed to maintain salt balance of the system.

One)Eng. H. Elwan, personal communications to the Sugarcane Working Group, 1998, citing Zhu and Yakoub, 1995.

Two)Dr. A. Bayoumi, et al., 1997; these data include rainfall (1.0 bcm), salt water intrusion (2.0 bcm), and weed evapotranspiration as a part of the estimated crop consumptive use.

GOE is giving increasing attention to overcoming the problem of water scarcity. The MPWWR and MALR coordinate their efforts in this regard. The policy includes increasing water resources both from additional supplies from up stream (High Nile Plateau) sources, and from rationalizing water consumption through better and efficient water management in order to save water for increasing demand.

especially for the land reclamation programs. MPWWR has considered, as a long term strategy, many alternatives to increase Egypt's share of Nile water, including the Jungli Canal Project, the Bahr El-Ghazal Project, and the Mashar Marshes Project. The anticipated increase of Egypt's share from these projects is estimated at about 9 bcm/year. One must bear in mind, however that these projects are located outside the Egyptian boundaries, therefore technical and political efforts and coordination are required. Egypt, however is coordinating its efforts with the other Nile Basin Countries in this regard.

The GOE is facing a critical situation arising from not only a sharp increase in water demand, but also from increasing competition among the different users for limited water resources. New policies are needed for maintaining the balance of national water resources. The only option available on the short-run is to reallocate water within the agriculture sector, besides improving main canals and water networks. Sugarcane and rice are the largest consumers of irrigation water because they have high water requirements, and the areas cultivated to these crops are sizable, occupying a considerable lands. This Report is investigating and analyzing the current water requirements and appropriate water management in relation to cane production in Egypt.

8. Water Utilization and Management in Sugarcane Plantations:

Egypt has a unique irrigation network, and the importance of the distribution system in agriculture becomes very crucial. One of the major factors affecting this distribution system is the agriculture holdings pattern. The fragmentation of holdings contributes to inefficient water management in the field. More than 94.5% of total holdings are less than five feddans, therefore the current flood surface irrigation system in the old lands has to be maintained, but considerable improvements for this system are to be investigated to increase water use efficiency, especially in the sugarcane areas.

8.1 Water Sources and Irrigation Systems in Upper Egypt :

The last agricultural census of 1990 revealed that cultivated lands in the major sugarcane producing governorates (Menya, Sohag, Qena, and Aswan) depend mainly

on Nile water. The percentages of lands irrigated by Nile water in these governorates reached about 94%, 87%, 92%, and 99% of total cultivated lands respectively as shown in Table (5). Sugarcane areas in these governorates were estimated in 1995 at about 6.6%, 5.8%, 45.1%, and 51.3% of total cultivated lands respectively. This indicates that large amounts of Nile water are diverted to sugarcane areas in Qena and Aswan in comparison with two other governorates, and improvement of field efficiency should be focused in these two governorates.

Regarding the irrigation systems used in these governorates. table (6) shows that 90% of cultivated land in Aswan governorate uses the flood gravity system, in comparison with 13.3% in Qena, 8.8% in Sohag, and only 5% in Menya. On the other hand, about 94.3%, 89.1%, and 86.3% of cultivated land in Menya, Sohag, and Qena respectively are applying a flood machinery system (pumped water) in comparison with only 6.9% in Aswan. Therefore, Aswan governorate is characterized by gravity flood irrigation system and changing this system to a flood machinery (pumping) system at farm level, as applied now to the old land in the Nile valley, may contribute to saving water. But this requires technical investigation and engineering studies. The gravity system applied in Aswan contributes to excessive diversion of water to distribution canals so that demand of the farms which are located at the ends of these canals can be met. This means that more water than what required is diverted to these regions. It is possible and likely that a change from gravity irrigation to pumping irrigation could reduce diversions and lead to considerable water saving. Therefore the issue of converting flood gravity system to pumping system, at farm level should be carefully investigated by technicians.

Table (5)

Cultivated Land (000' feddan) by main source of irrigation in the major sugarcane producing governorates

Governorate	Nile Water	Ground water	Drainage water	Other sources	T. Cult. Land	(*)Cane as % of TC L
Menya	442.2	26.5	0.50	0.00	469.20	6.6
Sohag	282.9	41.9	0.20	0.00	325.00	5.8
Qena	342.9	28.3	0.08	0.00	371.28	45.1
Aswan	137.6	00.4	0.40	0.20	138.60	51.3

(*) Calculated on the bases of sugarcane areas of 1995.

Source: The Sixth Agricultural Census of 1990, MALR.

Table (6)

Cultivated Land (000' feddan) by main irrigation system in the major sugarcane producing governorates

Governorate	Flood Gravity		Traditional Machines		Flood Machinery		Modern system (*)		Total Areas
	Area	%	Area	%	Area	%	Area	%	
Menya	23.3	5.0	3.5	0.7	442.4	94.3	0.0	0.0	469.2
Sohag	28.5	8.8	6.6	2.0	289.7	89.1	0.2	0.1	324.8
Qena	49.2	13.3	1.0	0.3	320.7	86.3	0.3	0.1	371.2
Aswan	124.8	90.0	2.6	1.9	9.6	6.9	1.6	1.2	138.6

(*) Sprinkler and Drip irrigation systems.

Source: The Sixth Agricultural Census of 1990, MALR.

8.2. Improved Surface Irrigation system in Cane areas :

The MALR (SCRI and AEnRI), MPWWR, Sugar Crops Council (SCC), and Sugar and Integrated Industries Company (SIIC) conducted a program, under SCRI supervision, for using the improved surface irrigation (gated pipes system) in sugarcane areas. This program started 1986 by carrying out field irrigation experiments and trials at the sugarcane extension and research station of the Kom-Ombo sugar processing company in Aswan governorate. The results were significant and a reasonable water saving were realized. This was encouraging to those who wanted to apply the improved

surface irrigation system (gated pipes system) in different farm sizes in cane regions. The SCC is financing the equipment and installation, while the SPC implements the system. The Sugar Crop Research Institute (SCRI/ARC) in collaboration with Agricultural Engineering Research Institute (AEnRI/ARC) who innovated this system, supervised the whole process.

The working group observed, in their visit to the extension farms of the Kom-Ombo processing plant, irrigation experiments implemented on four plots cultivated with sugarcane. These plots are irrigating with different types of irrigation systems. The first plot is two feddans under sprinkler irrigation system, the second plot is also two feddans under sub-surface drip system, the third plot is three feddans under improved surface system (Gated pipes system), and fourth plot is one feddan, as control plot, under traditional flood surface system.

The irrigation water released to these field plots are measured using water gauges, with the exception of the traditional irrigation system. The calculation of field water requirements, based on the crop consumptive use, have estimated according to the equation : ETa = Kc x ETp.
Where (ETa) actual evapotranspiration rate for the crop, (Kc) crop coefficient that identifies specific water requirements of different crops under same ETp, and (ETp) is potential evapotranspiration rate of the area in which the crops are grown. The calculated consumptive use for sugarcane crop in this area is about 9109 m^3 (Table 8).

The recorded results of these trails, based on the calculated crop consumptive use, indicated that sprinkler system requires 11000 to 12000 m^3/fed., sub-surface drip system requires 8000 to 8500 m^3/fed., improved surface irrigation system (gated pipes) requires 8000 to 9000 m^3/fed., and traditional flood surface system requires 12000-13000 m^3/fed.. The improved surface system (gated pipes system), therefore is recommended because sub-surface drip system needs more efforts for maintenance and heavier investment costing comparison with improved surface system. The results revealed that using

improved surface system will save 3000 to 4000 m^3/fed. of the applied water or irrigation requirements, beside increasing cane productivity due to land laser leveling and improved surface irrigation system. Table (7) illustrates the approved results of the trails carried out in Kom-Ombo farms. Upper Egypt for planting seasons 1993/94 and 1994/95. These results based on actual field measurements at Kom-Ombo sugar mill farms, Aswan. They may differ from other results observed elsewhere.

Table (7)

Water requirements (m^3/fed.) for the sugarcane in Upper Egypt , as an average for planting seasons 1993/94 and 1994/95

Irrigation System	Water applied (*) (m^3/fed.)	Cane produced (ton/fed.)
Traditional surface	12400	40.0
Drip system	8121	60.2
Sprinkler system	11438	52.0
Gated pipes system	8474	51.7

(*) Based on calculated water consumptive use formula.

Source:

a) Annual Report of Sugar Crops Council, MALR, 1996.

b) Agricultural Mechanical Engineering Research, Sugar Crops Research Institute/ARC, MALR, Communications with the Working Group, 1998.

It was confirmed, however during the Working Group visits to Upper Egypt, that improved irrigation system (gated pipes) will save 15% to 20% of the applied irrigation water required by the traditional flood system, besides increasing the cultivated area by about 4.5% as a result of eliminating field ditches and passages (i.e. avoiding land waste). The productivity of cane under the improved system (gated pipes) increased 15% in Luxor areas, from about 39 ton/fed. to 45ton/fed. The potential increase in productivity under this system could reached up to 55 ton/feddan , an increase of about 20% to 25%.

Improved irrigation system (gated pipes) coupled with Laser Land leveling will contribute to the reduction of field losses and will increase field application water efficiency. Therefore, MALR in collaboration with SCC extended the applications of the improved surface irrigation system to private farms in Qena and Aswan governorates beside Luxor region. This system was applied to 489 feddans in farmers' fields up to 1998, and is applied in the current planting season (1997/98) about 600 feddans in different locations. The cost of installing the system is covered by the Sugar production and Integrated Industries Company (SIIC). The evaluation of the improved system installed in these areas is anticipated after the next harvesting period (Jan. 1999).

The cost of introducing the improved irrigation system (gated pipes) is estimated for farmers about LE 2100 per feddan, including the pumping machine (LE 400). The Sugar Crops Council (SCC) covers this cost and farmers will pay only the purchase cost of pumping unit and O&M costs. Moreover, SCC provides a line of credit. without interest, for farmers who are willing to improve their sugarcane farms. The credit includes purchase of irrigation equipment (26% disbursed from total credit value), purchase of tractors (22.3% disbursed), Laser equipment (2.2% disbursed), fertilizers (19.2% disbursed), sugarcane seeds (10% disbursed), sub-soiling and gypsum...etc.(1.3% disbursed), and for ditch cleaning and maintenance (about 1% disbursed).

The estimated cost of introducing the improved irrigation system (gated pipes), in 160 000 feddans, represent only 65% of total cane area in Upper Egypt, would be LE 272 million. This is huge investment and required joint efforts from both ministries, MALR and MPWWR, and a long implementation period may extend, at least 5 years. It is worth mentioned that, cane growers contribute with 25% of costs of improved irrigation system through SCC. Price of cane is LE 95 per ton, and growers get LE 94 per ton, while one pound collected by SCC for providing cane growers with the services required including improved irrigation system.

8.3. Policy Aspects for Water Saving in Sugarcane Regions :

This Report focuses on the issue of water saving in cane areas in the light of water scarcity, thus the potential policy aspects related to this issue should be identified and analyzed. There are physical, technical , and financial factors which prevent the reduction of water consumed at the farm level. Some of these factors are conflicting, others look important from farmers' point of view, while some others are important for the national interests. Somehow a trade off among the different involved and interested parties has to be made to reach the best financial and economic alternatives. The advantages and limitations of each aspect are to be identified and clarified. These conflicting issues include the following physical, technical, and financial and economic aspects.

8.3.1. Physical and Technical Aspects :

- Maintain sugarcane areas at minimum level:

Total sugarcane area is around 300 000 feddans, most of which is concentrated in Menya, Sohag, Qena, and Aswan governorates. The sugarcane area in these governorates represent 94% of the total cane area in Egypt. The general trend of conserving irrigation water includes limitation of cane areas around 200 000 feddans. MALR has maintained sugarcane areas almost constant since 1980, and has applied its research efforts for increasing cane productivity. The potential decrease in the cane areas, without affecting sugarcane production required for processing plants, lies mainly in the areas cultivated north of Sohag governorate. The decrease of cane areas in Sohag, Qena, and Aswan to reduce water consumptive use, is very limited by the existing industrial capacities. However, the decrease in cane areas depends on the potential increase in productivity in these areas over time.

One potential aspect of water saving (based on the concept of decreasing consumptive use of sugarcane) may imply:

One)decrease areas planted by sugarcane north of Sohag governorate (including Menya governorate),

Two)restricting cultivation of sugarcane in the new lands, particularly in newly reclaimed areas.

The anticipated water saving would reached about 115 million m^3/vear (based on: eliminated area of 41,300 fed. X 2800 m^3/fed./year, as an average for the differences in "ETa" saving anticipated from substituting other rotations by sugarcane, table 8).

Another potential aspect may be area limitations in the major producing governorates (Sohag, Qena, and Aswan) without affecting the operational capacities of sugar plants. If the cane areas decrease by 10%, the areas cultivated with cane would reached 225.000 feddans, and water saving would be 70 million m^3/year (25,000 fed. X 2800 m^3/fed/year). This limitation should be off-set by a significant increase in cane productivity. The potential anticipated increase of productivity is great, the estimated increase in yield could be 20%, and up to 55 ton/fed. compared to an average of 46 ton/fed. in 1997.

A third potential aspect, as recommended in the Revised Integrated Water-Land Plan (Bayoumi, et al. 1997), may be maintaining the sugarcane areas around 200000 feddans. This option would save an additional 255 million m^3/vear.

The advantage of these policy aspects imply that water saving would be reached about 255 million m^3/year, or at least about 115 million m^3/year, if the cane's areas in main producing governorates are kept at their level of 1997 (i.e. 250 000 feddans). But if the area were reduced to 200 000 feddans, the water saving would reach about 140 million m^3/year.

The limitations of these policy aspects include:

Three)Many current existing traditional activities which depend on cane production, such as juice extraction mills and fresh sugarcane consumption and other by-product based industries, would be seriously affected.

Four)Legal action or legislation may be required, this may be difficult because farmers, in a free market economy, are free to choose their own crop rotations.

Five)Sugarcane producers in these areas would not voluntary accept replacing sugarcane because its profitability is relatively high, compared to other competing summer crops. The suggestion of replacing sugarcane by maize in Upper Egypt regions may not be technically feasible and not accepted due to the profitability issue.

Six)Sugar Processing plants would be affected if no increase has been achieved in the productivity before reducing the areas or if the reduction is not done gradually along matching with the anticipated increase in the yields.

- Reducing water consumptive use :

Water saving can be achieved through the reduction of consumptive use for high water consuming crops in Upper Egypt. Replacing sugarcane (its consumptive use is about 9100 m^3/fed./year) by maize & wheat rotation (its consumptive use is about 5900 m^3/fed./year) would save about 3200 m^3/fed./year. If sugarcane was replaced by Cotton & S. Berseem rotation (its consumptive use is about 6500 m^3/fed./year), the water saving would be about 2600 m^3/fed./year, and if it was replaced by wheat & soybean rotation, water saving would be about 3300 m^3/fed./year, as shown in table (8). While crop substitution can achieve potential water saving, it also can cause harm through several important factors. However, any policy that implies reduction of water consumptive use, will lead to the same conclusion discussed above.

Regarding the issue of cultivating sugar beet in Upper Egypt as a substitution for sugarcane, it is found not to be possible due to agronomic factors. However, the difference in consumptive use between the two crops is estimated at about 3000 m^3/fed./year (based on 2538 m^3/fed. as consumptive use of sugar beet in Delta). The agronomists anticipate a higher consumptive use by sugar beet as well as other crops, if it is cultivated in Upper Egypt. than that of Delta because of the higher evaporation rates. In spite of that, sugar beet cultivated recently in Menya, as an experiment in 4200 fed., beside the Abu Qurqas

processing mill, in Menya, has converted to be able to process sugar beet. This plant will process 6000 ton of sugar beet per day.

The advantage of the crop substitution to reduce consumptive use, let us say in 50 000 feddans, is anticipated to be about 140 million m^3/year, similar to the previous option.

The limitations, however can be summarized as followings:

a) Some crops are not agronomically substitutable because they grow under different conditions. Sugar beet requires cool weather, while Maize requires warm weather, and sugarcane requires hot weather. Vegetative period and dry cool weather during last four months, before harvesting, are necessary for accumulation of sucrose. Thus the agronomic zones have to be considered.

b) The sugarcane cycle is 5-6 years, the farmer's effort concentrated in the first year of planting the cane, while fewer effort are needed afterwards. This also encourages the farmers to prefer sugarcane .

c) Crops with the highest (Kc) values also tend to be crops with the highest yields in terms of biomass, calories, or sometimes protein. Sugarcane yields the highest calories per unit of land per unit of time, while alfalfa yields the highest protein. Thus the physical biomass yield per unit of water consumptively used may be highest in the highest (Kc) crops.

d) The economic value of the crop yield has to be considered along with the agronomic factors.

e) All these conditions must be adjusted to the length of the growing season and crop rotation in relation to water needs, availability and value. Sugarcane has a growing season of 12 months, while wheat requires 5 to 6 months, maize requires 4 to 5 months, and sugar beet 5 to 6 months. Thus one might need to compare sugarcane with a wheat and maize rotation over several years to obtain proper results.

f) Wheat and maize yields decrease sharply beyond the northern half of Sohag governorate. This will affect the productivity of these crops, and thus their profitability.

Table (8)

Consumptive use and Field water requirements for major crop rotations in Middle and Upper Egypt (*).

Crop Rotations	Consumptive use (m^3)		Field requirements (m^3)	
	M. Egypt	U. Egypt	M. Egypt	U. Egypt
Wheat & Soybean	4514	5807	7165	9217
Wheat & Maize	4726	5875	7502	9325
L. Berseem & Maize	5137	6508	8154	10330
S. Berseem & Cotton	5040	6469	8000	10268
Sugarcane	7170	9109	11381	14459

(*) An average of theoretical efficiency.

Source: a) Hussein, Z. And D. Seckler, 1994 " Crop substitution for more efficient water use in Egypt" Working paper No. 1- 4. SRP, WRC, MPWWR, Cairo

b) For sugarcane, See Institute of Water Distribution and Irrigation Methods Research, WRC, MPWWR, " A preliminary study for water requirements of Egypt, 1987".

- Improving On-farm water efficiency :

The water requirements of any irrigated land depend mainly on the consumptive use (ETa) of the irrigated crops, and on the on-farm irrigation efficiency. If the irrigated crops have high crop coefficient (Kc) and high consumptive use, the only possible way of reducing water demand required for irrigated areas is to improve irrigation methods. Introducing the improved irrigation systems in sugarcane areas will avoid water losses by surface evaporation and reduce water percolation to the aquifer. The following section will reveal the progress in this regard and working group observations on the improved irrigation systems (gated pipes), during their visits to Upper Egypt. Improved surface irrigation (gated pipes) will increase field water efficiency and reduce water requirements at the farm level. The difference between field water requirements and consumptive use for sugarcane in Upper Egypt, as shown in table (8) is about 5350 m^3/fed./year, and represents 58% of cane consumptive use. If the improved irrigation system (gated pipes) decreases applied water at field level, excess water use will be avoided. Figure (3) in the Annex, shows the consumptive use in function of age of cane, while Figures (4-a)

and (4-b) in the Annex illustrate irrigation requirements for cane field harvested in December. and April.

Gated pipes irrigation system will also contribute to increased productivity. Table (9) shows that sugarcane yields average under improved surface irrigation 55 ton/fed. in Upper Egypt compared with about 46.5 ton under traditional surface irrigation system, an 18.6% increase in yield/feddan. This was primarily due to laser land leveling and gated pipes system. Under the drip irrigation system the yield increased by 42.7%, but the implementation of the system is very costly. The required investment is about LE 4000/fed. plus operating costs. Maintenance is costly and cost of labor is very high. Therefore reasons of cost were assumed that gated pipes and laser land leveling are the options for improving water use efficiency. Water saving from this option could reach 350 million m^3/year (160 000 fed. X 2200 m^3/fed./year).

The limitations, however, could be the high costs for installing this system, even in 65% of sugarcane areas in Upper Egypt. The estimated cost is LE 272 million (160000 fed. X LE 1700 per fed.) excluding the purchase of pump which will be paid by farmers. Besides who will cover and finance this operations? The Sugar Crops Council (SCC) is currently financing which are implemented in farmers' fields. The introduction of this system would also require a longer period to implement the basic system in all sugarcane fields.

Therefore, gradual implementation of such improved irrigation systems requires designing a national program, like the laser land leveling program, the investment required and source of fund should be identified . MPWWR and MALR should jointly implement such a program and implement in phases perhaps take 5-10 years. It is also possible for the cane growers to contribute in the costs when they realize the increase in productivity which resulted from the improved irrigation system.

Table (9)

On-farm water requirements and yields for sugarcane by irrigation systems in the major production regions

Irrigation systems	Middle Egypt				Upper Egypt			
	Water Requirements		Productivity		Water Requirements		Productivity	
	m^3/f.	%	Ton/f	%	m^3/f.	%	Ton/f.	%
Traditional surface	11381	100	45.21	100	14459	100	46.47	100
Sprinkler system	11860	104.2	59.8	132.3	11860	82.0	59.8	128.7
Drip system	8450	74.3	66.3	146.6	8450	58.4	66.3	142.7
Improved system	9003	79.1	55.1	121.9	9003	62.3	55.1	118.6

Source: El-Ibiary, M.M " A strategy for integration between sugarcane and sugar beet for sugar production and its complementary industries in A.R.E." Center for Leaders Training, Ministry of Public Works Sector and Environmental Affair, Tune 1997.

8.3.2. Financial Aspect :

The liberalization of agriculture allows farmers to choose their cropping patterns and determine what they perceive to be best for their own interests. The prices of crops have been determined by market forces since the early 1990's. This implies that farmers' main objective is to maximize their net returns. Farmer's decisions for crop selection based on the anticipated profitability of appropriate crops within the cropping pattern. Economic theory, in the free market economy, focuses mainly on profit and utility maximizing behavior to justify choices that can be made. Farmers or producers, therefore are attracted every-where, to the highest possible financial returns. Given the technical feasibility of crops' selection, their production decisions are mainly based on maximizing their profits from the available resources.

Calculations of the gross margins, as a measure for the farm size output in relation to the variable costs, illustrate that the gross margin of sugarcane higher compared with the gross margins of any other crop as shown in table (10). Moreover, farmers indicate a strong preference to grow cane, as it requires less

intensive farm management than other traditional field crops, and farmer income can be increased by inter-cropping cultivation. Thus, sugarcane rotation in Upper Egypt is the most favorite rotation for the majority of farmers.

Table (10)

The Gross Margins (LE/fed.) of the major crops in Upper Egypt

Crop	Growing season (months)	Country' average 1995	Country' average 1996
Sugarcane	12	3567	3571
Maize	4-5	1112	1324
Wheat	5-6	1482	1754
Cotton	7-8	2882	2968
L. berseem	5-6	1755	2078
S. berseem	2-3	866	1027
Soya bean	4-5		968

a) Farm Gross Margin is obtained by subtracting the variable costs from the gross output of the farm.

Source: Bulletin of agricultural economic 1995 and 1996, Agricultural Economic Affairs Sector, MALR.

Although profitability of (cotton & s.berseem) rotation or (wheat & maize) rotation is higher than sugarcane, it is worth mention that the sum of sugarcane net return and of intercropping net returns (e.g. tomatoes, garlic, onion, and fababean) is higher than other crop rotations, as shows in table (11). That is why farmers in these regions favor growing cane, because they anticipate additional income from intercropping. The reason for the highest profitability of (berseem/cotton) rotation, however is mainly due to the floor prices of cotton which set and guaranteed by the government. The profitability of sugarcane increased in 1997 in comparison with other rotations because the price of cane increased by 5.5% in 1997 over the 1996 price. In addition, the Sugar Crops Council (SCC) provides credit for farmers who cultivate cane for the purchase of seeds, machinery, tractors, laser's units, and nitrogen fertilizers. The

Sugar and Integrated Industries Company (SIIC) is contract with cane's farmers for one year and the contract renewable for 3 or 4 years, the duration of the crop. This forward contracting favors farmers because it guarantees the market of the cane crop. While prices of cane are announced by the SCC (for 1996 it was LE 90/ton, and increased to LE 95/ton in 1997), sugarcane farmers can also receive a bonus based on the sugar extraction rates of the delivered cane. The farmer gets LE 94/ton of cane delivered to the processing plants, and one pound per ton goes to the Sugar Crops Council (SCC).

Table (11)

Financial Returns (Profitability) per (LE/feddan)

for major crop rotations, and inter-cropped in Upper Egypt

Rotation	Menya		Sohag		Qena		Aswan	
Year	*1995*	*1996*	*1995*	*1996*	*1995*	*1996*	*1995*	*1996*
Sugarcane	1705	1609	1627	1666	1581	1530	1300	1384
Cotton + S. Berseem *(a)*	1404 *(b)*	2350	2613	3453	---	---	---	---
Maize + L. Berseem	1765	388 *(c)*	2296	2512	236 *(c)*	585 *(c)*	324	595
Maize + Wheat	1187	1496	1590	1796	799	1287	858	1375
Soya bean + Wheat	840	1323	1217	1403	563 *(d)*	702 *(d)*	534 *(d)*	780 *(d)*
Inter-cropping :								
Winter Tomatoes	1555	1547	6498	6728	5834	6575	549	685
Summer Tomatoes	3798	4771	---	5407	---	---	---	---
Winter Onion	884	661	2030	1990	---	---	---	---
Garlic	1603	1919	1627	1850	---	---	681	706
Faba-bean	381	345	783	639	804	474	55	509

(*) Financial returns calculated by subtracting the total cost of production (Fixed and Variable costs) from the total value of farm output (using farm gate prices).

(a) Cotton + S. Berseem, and L. Berseem are not cultivated in Qena and Aswan.

(b) Not includes S. Berseem. (c) Not includes L. Berseem. (d) Not includes Soya bean.

Source: Bulletin of agricultural economic 1995 and 1996, Agricultural Economic Affairs Sector, MALR.

The production and profitability of sugarcane differs from one region to another. Table (12) shows the net returns of sugarcane in the major producing governorates.

This calculation does not include the income from crops which can be inter-cropped in the first year of cane: tomatoes, onion, and faba-bean are inter-cropped with autumn planted cane, while tomatoes or soya-bean are inter-cropped with spring planted cane. The net returns estimated in 1996 for winter tomatoes, for example in Sohag and Qena, average net returns for 1995 and 1996 were LE 6613/fed. and LE 6205/fed. respectively, while for winter onion in Sohag was LE 1739/fed., and for soya-bean in Sohag LE 350/fed., and in Aswan LE 155/fed. as shown in table (11). These additional net returns per feddan encourage farmers in these regions to cultivate sugarcane. However, it is important to understand that intercropping usually increases the total crop evapotranspiration per unit area.

Table (12)

Net Returns for sugarcane (LE/fed.) in main production regions in Egypt

Governorate	Production			Cost of Production			Net Returns
	Yield (ton/f)	Prices (LE/ton)	Revenues (LE/fd.)	Variable Cost (LE/fd.)	Rent value (LE/fd.)	Total Costs (LE/fd.)	(LE/fd.)
Menya (1995)	46.5	90.0	4223.4	1844.0	674.0	2518.0	1705.4
(1996)	46.5	90.0	4188.7	1905.5	674.0	2579.5	1609.2
(1997)	46.5	95.0	4417.5	1906.0	674.0	2580.0	1837.5
Sohag (1995)	45.9	90.0	4132.4	1845.0	660.0	2505.0	1627.4
(1996)	47.7	90.0	4289.5	1963.9	660.0	2623.9	1665.6
(1997)	49.0	95.0	4655.0	1975.0	660.0	2635.0	2020.0
Qena (1995)	46.6	90.0	4196.3	2004.1	611.0	2615.1	1581.2
(1996)	46.9	90.0	4218.8	2077.3	611.0	2688.3	1530.5
(1997)	46.1	95.0	4379.5	2100.0	611.0	2711.0	1668.5
Aswan (1995)	46.4	90.0	4175.4	2225.2	650.0	2875.2	1300.2
(1996)	47.4	90.0	4267.4	2233.2	650.0	2883.2	1384.2
(1997)	46.1	95.0	4379.5	2310.0	650.0	2960.0	1419.5

Source: Compiled from: Bulletin of agricultural economic, Agricultural economic affairs sector, MALR, 1995-1997.

9. Macro-Economics of Sugar Production in Egypt :

The sugar industry is a main strategic industry in Egypt. The first sugar factory in Egypt (Armant plant) was established in 1869, as shown in table (13). As an important "national crop" sugarcane ranks second to cotton. Yet, the liberalization of the economy and Egypt's participation in WTO/GATT, requires a close look at this crop, and its economies nationally and internationally. For example there is a need to compare the cost of local production and the cost of importation, as this will shed light on opportunity cost of economic resources used for producing sugar domestically. This does not means that Egypt should not produce sugar. It means that Egyptian policy makers should be completely aware of the advantages and disadvantages of maintaining a positive policy toward sugar production.

The government has a monopoly on sugar processing since 1963. The existing eight sugar mills, as well as the one sugar refinery and distillery at Hawamdia, are under the Sugar Integrated Industries Company (SIIC), which is one of nineteen public sector companies operated by the Food Industries Holding Company (FIHC) set up under Law 203 of 1991. In addition to the cane sugar mills, a beet sugar factory was established in the Delta in 1982 (Kafr el Sheikh) as an autonomous company, with private sector participation and support from the International Finance Corporation (IFC). A second beet sugar factory, also under public sector ownership, is under construction in Dakahleya (capacity 120 000 tons refined sugar/year). Proposals have been prepared for setting up beet sugar mills in Fayoum (capacity of 60,000 tons) and Nubaria (100,000 tons).

9.1. Local Production of Sugar:

The existing processing capacity in Egypt is about 10 million tons of sugarcane per year. Seven cane sugar mills are located in Upper Egypt, and one, the Abu Qurqas mill is located in Middle Egypt (Menya). The capacities range between 4,500 to 12,000 tons of cane per day. The dates of establishment, designed capacity and the level of capacity utilization are summarized in table (13).

These mills depend mainly on the cane cultivated in Menya, Sohag, Qena, and Aswan. Menya and Sohag mills require only 7.1% and 9.1% respectively of the total required cane for operating the designed capacities, while Qena, and Aswan mills require 55.5%, and 28.3% respectively. The cane delivered to Menya and Sohag plants in 1995 and 1996 were 1.613 and 1.479 million tons respectively. Cane delivered to Qena plants were 5.532 and 5.358 million ton respectively, and cane delivered to Aswan plants were 2.845 and 2.785 million ton respectively. Sugar mills in Qena and Aswan processed 83.6% and 82.3% of total cane produced in 1995 and 1996 respectively.

The production of sugar increased from 0.895 million ton in 1990 to 1.132 and 1.125 million ton in 1995 and 1996. A total increase of about 25.6% was achieved from 1990 to 1996. Sugar extraction rates obtained in the mills are good by world standards, and sugar recoveries as a percentage of cane are similar to or better than those obtained by countries with similar ecological conditions. Good quality cane results from low winter temperatures, which would be effective for about four months (December to March). Quality declines as temperatures increase. The percent sucrose in cane ranging from 12-13%, is not as high as could be expected under Egyptian conditions. With the introduction of new varieties, and possible changes in cultural practices, a sucrose content in cane of 14% should be possible. Utilization rates are high. In 1996, the processing of 9.62 million tons of cane was 97.2% of design capacity. The sugar produced was 1.019 million tons, the extraction rate was 10.6%, and purity of produced sugar was 83%.

Prior to the implementation of the economic reform program, the sugar industry in effect operated as a mechanism for implementing government policy. It continues to be so. The government controls overall production for the sector and the required investment in production facilities. Until recently, all sugar mills were required to sell their entire output to the Ministry of Trade and Supply (MOTS), which sold the sugar at subsidized prices. In addition sugar imports used for direct consumption were also regulated by the government. The Sugar and Integrated Industries Company (SIIC) produces sugar for the domestic

market. SIIC will deliver around 600 000 tons this year to the Ministry of Trade and Supplies (MoTS).

The government initiated a program of reforms for the sugar subsector, and certain measures aimed at partial liberalization in sugar trading have been introduced since April 1993. This reform program includes correcting sectoral inefficiencies, enhancing the market orientation in overall policy through rescinding of the ban on private sector marketing and handling of both locally produced and imported sugar. The private sector can import sugar without any restrictions on amounts and grades of imported sugar. Nevertheless, the subsidy provided under sugar ration system remains.

Table (13)

Local production capacity of sugar mills

('000 ton/year) in Egypt

Plant	Date of Establish	Designed Capacity	Capacity used in 1996	Utilization (%)	Production of 1996
Abu Qurqas	1904	700	614.3	87.8	67.1
Guirga	1987	900	865.1	96.1	86.8
Nag Hamadi	1896	1600	1631.0	101.9	186.0
Dishna	1977	1000	999.6	100.0	107.3
Kous	1968	1600	1492.1	93.3	160.5
Armant	1869	1300	1235.5	95.0	138.6
Edfu	1962	1100	1097.8	99.8	115.6
Kom Ombo	1912	1700	1686.5	99.2	175.4
Total		9900	9622.0	97.2	1019.4

Source: Sugar Crops in Egypt 1996 , Sugar Crops Council, MALR, 1996

9.2. Consumption and Sugar Imports:

Sugar consumption has increased significantly since early 1970's. Then the per capita consumption was 16.6 kg/year, and local production met this demand. Now, per capita consumption is 26 kg./year. The sharp increase in per capita consumption coupled with high rate of population growth has led to increasing imports of sugar. Self sufficiency in sugar in 1996 was about 71.4%. (Table 14).

Table (14)

Sugar production, imports, self-sufficiency ratio,

and per capita consumption in Egypt

	Quantity	1985	1990	1995	1996
Total Local sugar production:	000' ton	829.0	895.1	1131.5	1124.6
From sugarcane	000' ton	748.7	829.2	1004.1	1019.4
From sugar beets	000' ton	80.7	65.9	127.0	105.2
Imported Sugar	000' ton	610.0	897.0	455.0	450.0
T. Sugar Consumption	000' ton	1439.4	1792.1	1586.5	1574.6

	Quantity	1985	1990	1995	1996
self-sufficiency	%	57.6	49.9	71.3	71.4
per capita consumption	kg/year	29.8	33.0	26.3	26.0

Source : Sugar Crops in Egypt 1996 , Sugar Crops Council, MALR, 1996

In 1996, Egypt produced 1.125 million tons of sugar, of which 1.190 million tons was cane sugar and 0.105 million tons was beet sugar. Sugar consumption in 1997 was 1.575 million tons, of which 0.450 million tons was imported. Sugar demand is expected to be 1.675 and 2.1 million tons in 2000 and 2010 respectively, while local production will be 1.250 and 1.650 million tons respectively. The anticipated sugar gap (which can be covered through imports) is 0.425 and 0.550 million tons respectively, as shown in table (15).

Sugar and Integrated Industries Company (SIIC) is obligated to deliver Ministry of Trade and Supplies (MOTS) requirements for distribution through ration cards, regardless of world market price. However, any problem which may prevent deliveries will cause an increase in of sugar imports. Thus the importation of sugar fluctuates from one year to another. It was about 0.5 million ton in 1996, about 28.6% of total consumption.

Table (15)

Projections of supply and demand of sugar in Egypt

	Population (million)	Consumption (kg/capita/yr)	Demand (M. tons)	Production (M. tons)	Sugar gap (M. tons)
2000	67	25	1.675	1.250	0.425
		27	1.809		0.550
		29	1.943		0.693
2010	84	25	2.100	1.650	0.550
		27	2.268		0.618
		29	2.436		0.686

Source: Sugar Crops Research Institute, Agricultural Research Center, Sugarcane Working Group Communications, April 1998.

Domestic self sufficiency of sugar, is a priority for the GOE in order to protect the local sugar industry from world market distortions and sharp fluctuations in market prices. This is especially important in view of high and rapidly increasing sugar demand. The GOE considers sugar to be a strategic commodity, and there is a desire to achieve a measure of stabilization in producer and consumer prices. The GOE allocates about LE 600 million per year for sugar subsidy, in order to achieve the ration program diverted to the poor.

Significant investments related to both cane and beet processing have recently been completed. The main objective of these investments is to protect domestic producers and consumers from the uncertainties of the world sugar market, with a view to reaching a high level of self sufficiency. The policy of pursuing public sector investments for achieving self sufficiency has resulted in a situation where market forces play a minor role in the allocation of resources, and where the private sector is absent in financing investments.

It must be mentioned that, from a purely economic perspective, investments in the sugar subsector should be guided by economic considerations, not by volatility of world sugar prices. Egypt would have a comparative advantage in domestic production, when net benefits valued at their efficiency or true economic prices can be expected to exceed costs also similarly valued. This is discussed in the following section.

9.3. Revenues and Costs of Sugar Production and Value added:

Sugar mills are only responsible for production and have no direct involvement in marketing. Marketing is a central function of the SIIC. While there is a system of cost control in each of the operating units within SIIC, there is no scope for determining the profitability of each unit, as revenues from sales are not accounted for at the factory level. Operating costs of production units are aggregated, and financial statements prepared for the group as a whole, and profitability is determined on an aggregate basis.

SIIC delivers around 600 000 ton per year to the Ministry of Trade and Supplies (MoTS) at price of LE 1400/ton. The revenue from the by-products (Molasses, bagass, filler muds, and other by-products) is estimated at about LE 85/ton. The local cost of producing one ton of sugar is estimated to be LE 1200. Variable costs represent 88% of total cost (based on personal communications with SIIC), while fixed costs are only 12%. The cost of cane represents 85% of variable costs and about 75% of total costs. Of the total revenues generated of LE 1400 per ton of sugar, about 64% accrues to the growers, and the remaining 36% is attributable to mills, in addition to the revenues of by-products.

Calculation of value added (based on 1996' prices) was LE 9745 per feddan in 1996. The value of output was LE 15882 and the value of purchased inputs was LE 6137. The contribution of agriculture (from cane as raw material) was estimated at 41.4% of total value added, while the contribution of industry was estimated at 58.6%. This is shown in table (16).

Since 1993, when the government initiated economic reforms in the sugar subsector, the GOE anticipated that the private sector will increase sugar imports if the world prices were less than local sugar prices. As mentioned above, there are no restrictions on private sector marketing and handling of both locally produced and imported sugar, except for the 600,000 tons of refined sugar needed for ration cards of MoTS. Thus the private sector, as a result of this policy, has been responsible for all sugar imports during the last four years, and the private sector has been free to sell on the open market. The prices of sugar are as follows:

- *MoTS purchase price from SIIC* *LE 1400 per ton*
- *Partial subsidies price (MoTS)* *LE 750 per ton*
- *Full subsidies price (MoTS)* *LE 600 per ton*
- *Wholesale (market price)* *LE 1450 per ton*
- *Free market price (fine grade)* *LE 1600 per ton*
- *Free market price (lower grade)* *LE 1500 per ton*

Table (16)

Estimates of value added (LE/fed.) from cane plantation and processing in 1996 *(*)*

Product	**Output**		**Purchased inputs**		**Value Added**
	Yield (ton)	**Value (LE)**	**Items of inputs**	**Value (LE)**	**(LE)**
Agriculture:					
Raw cane	46	4370	Seed, Fertilizer,	634	3736
Cane tops		300		----	300
Total agriculture		4670		634	4036
Industry:					
Sugar	4.8	6720	Cane	4370	
			chemicals, petrol		
			materials, others	408	
			Total	4778	1942
Molas (a)	1.9	655		-----	655
Bagasse :					
50%	3.7	3626	bagasse, others	725	2901
processing	3.7	163		-----	163
50% fuel	1.9	48		-----	48
Filter mud					
Total industry		11212		5503	5709
Total Value Added		**15882**		**6137**	**9745**

(*) Value Added defines as the amount of economic value generated by the activity carried on within each production unit in the economy. Value Added is measured by subtracting the value of all externally purchased inputs from the value of output.

(a) Processing 50%, direct use 50%.

Source: Calculations based on data from : Sugar Integrated Industries Company (SIIC) and Bulletin of Agricultural Economic, MALR, 1996.

9.4. Import Parity Price for Imported Sugar :

With private sector unrestricted marketing and handling of both locally produced sugar and imports sugar, and with participation in the WTO/GATT, it is important to assess the opportunity cost of sugar imports compared with locally produced sugar. The " Import parity price" is the comparable local price paid for an import, while " Export parity price " is the comparable local price received for an export. The import parity price can be determined directly from the existing C.I.F price, though an assessment of the opportunity cost of imports, requires that the import parity price should be estimated from the F.O.B price in the port from which the commodity is to be shipped. The following calculations illustrate the estimated import parity price for one ton of sugar from European ports, based on the average F.O.B. price for the period 1993 to 1997:

F.O.B. at port of Export	$ 318.14
Freight & Insurance to Alex.	$ 50.00
C.I.F. price at Alex.	$ 368.14
Equivalent (using Ex. Rate LE 3.4 = $ 1.0)	LE 1251.7
Tariffs (11% of FOB price 10% handling)	LE 122.0
Local port charges & Local Transport	LE 125.0
Sale Tax	LE 55.6
Other Fees (Export Promotion Organization)	LE 10.0
Financial Market Price	LE 1564.3
Economic Price (assuming Shadow E.R=3.4)	LE 1251.7

It is worth mentioning that, the " financial or market price" is defined as a price at which a good or service is actually exchanged for another good or service (as an in-kind payment) or for money (in which case it is a financial price). A market price can refer to a transaction that occurs at any location, not necessarily a village or wholesale market. The " economic or efficiency price " is defined as an economic value used in economic analysis that reflects the opportunity cost or value in use of a good or service used or produced, it is the price that reflects the true value of the resources used.

The financial price of imported sugar is LE 1564/ton. or about 11.7% more than the MOTS price offered to SIIC. The economic price, which is an adjusted financial price, is estimated at LE 1252/ton. This means that economic price, which reflects the opportunity cost of one ton of imported sugar, is less than the MOTS price by 10.6%. This conclusion is important in light of opportunity costs of scarce natural resource, especially water. In addition, the GATT agreement requires complete elimination of all tariffs on sugar imports by the end of transition period.

10. Recommended Strategy and Policy Options for Optimizing Water Management in Sugarcane Plantations in Upper Egypt :

The following policy options are proposed based on the analysis in the previous sections. The proposed options, particularly the first two, would have significant impacts on water saving.

10.1. Policy Option (1):

Limit the sugarcane cultivated areas to meet only the requirement of existing factories, this policy option can be achieved through the following actions:

a. Restrict the cultivation of sugarcane in the new reclaimed, high land and outside factory zones.
b. Reduce the sugarcane areas in accordance with any increase of productivity per feddan.
c. Initiate public awareness campaign concerning high water consuming crops.

10.2. Policy Option (2): Improving on-farm water efficiency and sugarcane productivity :

This option includes:

- Improved irrigation techniques (gated pipes) on 65% of main cane producing area (about 160,000 feddans).
- Enhance research programs in breeding and agronomy to improve productivity (up to 30%) in the next few years.

- Estimated reduced water diversions (about 2200m^3/feddan) may reach 350 million m^3/fed/year.
- Design and implement a pilot area in which the MPWWR and SCRI/MALR apply improved irrigation methods and laser land leveling while establishing WUA's.

10.3. Policy Option (3): Importing sugar

This option includes:

- The local consumption of sugar could be supplemented by imports. This could reduce cane areas.
- Current self sufficiency of sugar is 71.4%, which means that Egypt imports sugar from abroad.
- Water saving will depend on how much sugar is imported.
- Expansion of sugar production should be through sugar beat cultivation.

11. RECOMMENDATIONS :

- MALR and MPWWR should conduct a joint national program for improving water efficiency, at the farm level, in principal producing cane governorates in Upper Egypt. this will include Laser Land leveling and Improved surface irrigation system (gated pipes).
- Total production of the area under sugarcane should not exceed the production capacity of the sugar mills. Any potential increase in production should be reflected in a reduction of sugarcane cropped area.
- The improved irrigation system (gated pipes system) should be expanded for about 65% of cane in Upper Egypt, to reduce applied water irrigation losses in the fields which caused by applying surface flooded irrigation system. This traditional system causes deep water percolation and increase surface evaporation due to unleveled land surface, beside slow water run-off at the field. This will significantly contribute increasing water farm efficiency.

- Laser land leveling program has to be continued to cover the whole cane area, and this should be implemented every 3-5 years. MALR undertakes the technical aspects of this program. AEnRI calculated the cost paid by farmers in 1997 at LE 180 per feddan (3 hours/fed x LE 60/hour).
- Transportation system of cane from the fields to the mills (Docoville system) should be changed. This system contributes in field losses by about 5% of production, and causes a considerable reduction in the extracted sugar.
- Changing gravity irrigation system in Aswan governorate to pump irrigation system would contributes in water saving, therefore it is recommended conducting more technical investigation to find out the possibility of such modification and whether it is feasible.
- To increase water availability, a significant improvement should be made for the traditional methods used for maintaining basic irrigation networks, beside using a new technologies for weed resistance to minimize evaporation and conveyance losses.
- In allocating sugarcane area, great attention should be given for satisfying requirements of sugar mills in Upper Egypt (at least about 10 million tons of cane/year). It is highly recommended not expanding the existing industrial capacities.
- Improving the efficiency of processing mills to increase the extraction rates and the quality of produced sugar, would contribute relatively in the reduction proposed for cane areas.
- MPWWR and MALR jointly should introduce and support the application of Water User Associations (WUAs) in sugarcane plantations in Upper Egypt, as an effective approach for conserving irrigation water.
- It recommended to extend the assignment of sugarcane policy to water management for next tranche, in order to analyze and evaluate the on going experiments of improved irrigation system (gated pipes) during or after harvesting period which will be in Jan.1999.

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