DESERT DEVELOPMENT CENTER
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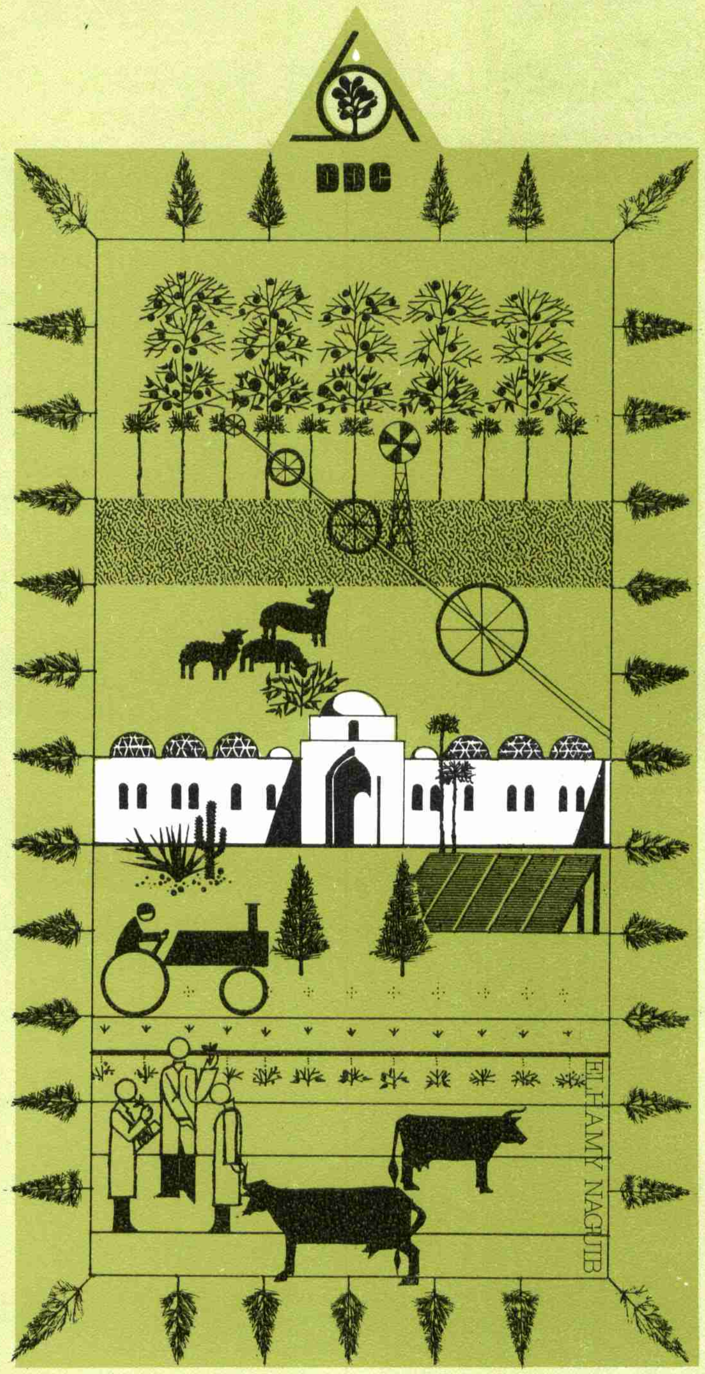

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Desert Irrigation Efficiency
Second Annual Report
To
International Development Research Center of Canada
(IDRC)

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Excutive Summary

This progress report presents the activities of the second year of the project (May, 1995-April, 1996) in 4 parts:

Part I: Presents the historical and measured data on changes in quality of groundwater in the study area. It also gives a briefing on groundwater development studies presented and discussed in the first progress report. Data obtained domestrate that agriculture horizontal expansion in Sadat City and Wadi El-Natrun has gone beyond the groundwater potential in these areas and dicassed identified policy options for groundwater development in the area.

The salinity of groundwater was measured in a number selected wells in the study area and compared with available historic data. Groundwater salinity in 12 wells in Sadat City were monitored over the period 1987-1995. Slight salinity changes with time could be noticed over short periods. Over the past seven years (1987-1995), however, salinity rose in 4 wells by 70-100% but remained below 480 ppm in 3 of these wells. The remaining 8 wells showed very slight and insignificant changes in salinity. In 75% of the tested wells salinity was 255-480 ppm over the period 1987-1995, while the other 25% of the wells had medium salinity (890-1434 ppm). The seasonal variations in groundwater table in Sadat City in 1989 showed a slight difference between spring and summer seasons, which indicate slight fluccuations in this area. At that time the effect of discharge was not detected and the aquifer was characterized to be of good potentiality. However these investigations need to be updated in view of the increasing agriculture expansion in the area in recent years.

In Wadi-El-Natrun, groundwater salinity varied widely with location and showed much higher values than Sadat City especially in the North sector of

Wadi-El-Natrun where it reaches 4000 ppm. Data on groundwater salinity were collected for 31 well for the period 1966-1985 and salinity of these wells was determined in 1995. Salinity of groundwater was mostly 300-700 ppm in 1966 but rose appreciably in 15 wells (mostly in the north sector) to 2-8 times reaching 2000-4000 ppm in 1995. However, changes in groundwater salinity in South sector were slight and groundwater remained of medium to good quality (346-877 ppm) in 1995.

The salinity of groundwater was measured in 1995-1996 in 31 wells in Fath sector, South Tahrir, where it is used as a supplementary source of irrigation during the canal shutdown and when the level of the Nile-water in the irrigation is low. Historic data on salinity of these wells are not available but for South Tahrir area, in general, it was 200-1000 ppm in 1973 but rose in 1993 to 312-1700 ppm. Salinity in 1995-1996 in 31 selected well was higher ranging between 345-2266 ppm. In 28 wells salinity ranged between 450 and 2000 ppm and 50% of tested wells having salinity <1000 ppm. The increase in groundwater salinity with time in the cultivated area of South Tahrir was probably due to the leaching of salts and fertilizers from soil since the static level of groundwater in the tested wells was only 5-12 m below surface.

Part II: Presents and discusses the technical field evaluation of the existing irrigation system in 101 representative desert farms conducted in four areas namely, South Tahrir, Bustan, Sadat City, and Wadi El-Natrun. Bustan and South Tahrir areas use surface water as the main source of irrigation, while Sadat City and Wadi El-Natrun use only groundwater for irrigation. In South Tahrir and Bustan, the most widely used pressurized irrigation system is the preinstalled hand-move sprinkler system. Other systems such as fixed sprinkler, draghose, and drip irrigation cover only a small percentage. While in Sadat City and Wadi El-Natrun, the most widely used pressurized irrigation system is the drip irrigation system. Other systems such as fixed sprinkler covers only a small percentage. However, some irrigators are illegally practicing flood irrigation in the four areas under study. Land holders in Bustan area are small holders, graduates, and private investors, while in South Tahrir are settlers, private investors, and large agricultural companies. In Sadat City and Wadi El-Natrun, however, they are mainly investors.

Sprinkler systems were evaluated in the field by determining the uniformity coefficient (UC), distribution uniformity (DU), and potential application efficiency (PELQ). Drip irrigation systems are evaluated in the field by determining the emission uniformity (Eu) and the application efficiency (Ea).

The results show that sprinkler and drip irrigation systems throughout the project area are performing poorly. About 85% of the fixed and hand-move systems and 78% of the side-roll systems had uniformity coefficien <80% and about 33% of the fixed systems, 36% of the hand-move systems, and 11% of side-roll systems had uniformity coefficient <60%. It was found that the poor water distribution pattern can be improved by using the proper sprinkler nozzle pressure and the proper lateral spacing (50% of the wetted diameter). A total of 50 drip systems have been evaluated throughout the project area. About 80% of the drip systems had emmision unifority (EU) <80% and 70% of the systems had EU's <70%. The low emission uniformity (below 80%) can be raised through preventive maintenance that includes water filtration, field inspection, pipeline flushing, and chemical water treatment.

The project is providing a pilot rehabilitation field (20 feddans) at the DDC farm in South Tahrir to demonstrate that the existing systems can be made to operate correctly and within the design criteria originally established. The pilot project will also demonstrate the costs of any further improvements or modifications and serve as a training and demonstration site for project staff and settlers.

Part III: Discusses and analyzes survey data collected from 109 farms on the technical aspects of desert irrigation efficiency Data obtained included the present status of water source, pump stations, and problems related to irrigation systems in the four areas of study. Thirty three percent of the responding farmers agree that the insufficient water is the most predominant problem through the water source, while this percent reaches 43.6% in South Tahrir and Bustan. Costly spare parts, fuel and electricity, and maintenance and repair are the common problems with pump stations for more than 85% of the responding farmers, while unavailability of skilled technicians was a problem for 71.4 percent. Most of the farmers (90%) felt electricity was very costly and beyond the purchasing capabity of the common farmer.

The sprinkler irrigation systems were less than 10 years old in Bustan area while 90% of the sprinkler systems exceeded the expected life (15 years of age) in South Tahrir. About 56.1% of the responding farmers stated having problems with hand-move systems, all of them located in South Tahrir. Operating at too low a pressure is common problem on 72% of the hand-move sprinkler systems. The more logical explanation for operating at low pressure lies in the exceptionally high level of water losses from the irrigation hydrants (common problem on 42% of the systems). In addition, 36% of the responding farmers attributed the low pressure to the illegally surface irrigation practice. Low pressure also increase droplet size which cause physical damage to plants common problem for 64% of the responding farmers). The hand-move sprinkler has high labor requirements (common problem for 53% of the responding farmers).

Of the 52 farms with drip irrigation systems, 36 farms only had filtration systems. Sand filters were not used in 50% of the cases in Bustan and South Tahrir although the water source contained silt and algae (Nile water). However, screen filters were used in most of the cases (94%). Chemical fertilizers were not applied through the drip systems in 29.2% of the total farms and it reaches 44.5% of the farms in Sadat and Bustan, while in Wadi-El Natron, the fertilizer injection devices are common. Among the injection devices fertilizer tank was the widely used (82.7%). Out of 35 farms using chemical injection devices 27 farms use acid treatments, mainly in the farm of phosphoric acid, which is also used as a fertilizer. Out of 52 farms with drip irrigation, only 28.8% use air release valve, 40.4% use check valve, 26.9% use flow meter, 67.9% use flushing valve, 13.5% use pressure regulator, 15.4% use pressure relief valve, and 59.6% use pressure gauges.

Therefore, large percentage of drip irrigation systems are loosing the essential parts of a well designed irrigation systems.

IV. A social survey of the irrigation efficiency in desert lands aimed to explore the socio-economic characteristics of the holders of desert lands, the systems of irrigation in use, the knowledge level about sprinkler and drip irrigation as the most prevailing modern techniques, and the attitudes towards water and irrigation practices applied in the areas of study.

The survey was planned to be applied on a representative sample of the holders of desert lands. Hence, secondary data about holders of desert lands in four areas selected for this study; South Tahrir, Al-Sadat agricultural zone, Wadi Al-Natron, and Al-Bostan were collected to portray the population of this study. A quota stratified random sample of holders was drawn accordingly.

A questionnaire was designed to collect the field data along with personal interview from the drawn sample. A final version of a pretested and precoded questionnaire was applied to the sample by enumerators trained for this purpose in summer 1995.

Preliminary analysis of data took place after the data verification. However in this report of the social survey only the main findings are presented. A detailed report about the results of the social survey will follow by the end of research project.

Depending on the descriptive statistics of the data and some preliminary statistical analysis a review of some of the main findings are presented in this report. Distribution of the sample by the regions of residency, the farm holding size, and the type of irrigation system(s) used in the farm was discussed. Some of the main social demographic characteristics of the representative sample was discussed too.

An attitude scale related to the various aspects of rational use of water in irrigation and the applied irrigation practices was designed and pretested. The scale is constructed from 29 items that cover all the above mentioned three components and seven dimensions; cultural value of water, economic value of water, information aspects of available water resources, on-farm water management, applied irrigation practices, willingness to share in responsibility of rational use of water and experiences needed in the irrigation process.

About 38% of the items were formulated in passive form to reflect the action tendency component of the scale.

Significant differences of the holders' attitudes were found among the four regions of residency towards the rational use of water and the modern irrigation techniques. These differences could be partially attributed to the distinctive characteristics of settlers more dominant in each area as mentioned before. Analysis showed no significant difference among the various categories of holding size concerning their attitudes towards water. However, a very high significant difference of the holders' attitudes was found among the five categories of users of the various irrigation systems. Those who use modern irrigation systems and techniques tend more to have higher positive attitudes towards the rational use of water and the modern irrigation techniques.

The relationships between some attitude components and some study variables (area of study, education levels, and type of irrigation system used) were analyzed and statistically tested. More than 86% of the sample interviewed have high to very high estimation for the economic value of water specially those of Bustan and Tahrir area with agriculture education and those having medium education (91.4%) and university education (80%). As to the willingness of landholders to share cost of irrigation public works, 83.4% of the sample interviewed showed high to very high attitude. Landholder of Wadi-El Naturn who relay totally on groundwater showed less willingness to share such cost. The percentage of those having high to very high willingness was 95.2% for those having medium education, 78% for university graduate and only 60% for holder who just read and write. The preference of landholders to use modern irrigation systems was related to direct experience of landholder to use those systems and level of education. In Tahrir and Sadat where some landholders practice flood irrigation show lower preference to use modern techniques. Those who have high to very high preference to using modern irrigation techniques represent about 87% of sprinkler and drip irrigation users, 63.6% of those using mixed systems and only 6.7% of those using flood irrigation. The percentage of those having high to very high preference was about 82% for those having medium and university education and only 25% for illiterates.

The knowledge level of holders of desert lands with the various technical aspects of sprinkler irrigation is low in average. This means that there are real training needs that should be satisfied through tailored training and extension programs. However, full detailed training needs assessment should be undertaken prior to any design or planning of such programs . Training needs are not related to technical knowledge only. They are also related to the attitudes and skills related to the recommended irrigation system.

It could be concluded, in general, that the level of technical knowledge with the various aspects of drip irrigation is rather higher than other modern irrigation systems due to the characteristics of users and the importance of using this system efficiently where water resources are more scarce. When the holders are mostly investors they seek more efficient systems regardless of their initial costs.

The characteristics of the holders and their period of practice with farming seem influential in determining their need of knowledge about irrigation systems and practices. Those who had long period of practicing farming those with agricultural background whether by practice or education helped them to feel more satisfied with their knowledge in irrigation. The investors seem more active in getting the knowledge they need regardless of the existence or not of extension service in the area.

Part V. is devoted to the economic evaluation of crop production functions under different irrigation systems. This report sheds the light on the problem of water productivity and water use efficiency in the new lands on the micro level. More importantly, a quantification of the impact of irrigation water on the level and/or value of output is assessed under the three dominant irrigation methods: sprinkler, flooding, and drip. A random sample of 109 farmers was interviewed during the summer and fall of 1995 for the purposes of this study. This sample covers four areas in the new lands (South Tahrir, El-Bostan, Wadi-El-Natroun, and El-Sadat). Eight Cobb-Douglas production functions were estimated for peanuts (sprinkler and flooding), wheat (sprinkler and flooding), summer crops (sprinkler), winter crops (sprinkler and flooding), and vegetables (drip).

Despite a variety of issues related to the measurement of the water input, the positive statistical significance of its estimated coefficient in all of the estimated functions is a telling sign. Equally telling, is its ranking as the most important input in the study area. This implies that water is the limiting factor for desert development.

The study showed that: (1) On the grounds of production (technical) efficiency, the cubic meter of irrigation water for the sprinkler system possesses on the average higher efficiency than the flooding system for the

same crop. Although, this comparison could not be made for the drip system, the highest average value product was obtained in the case of the drip system. This implies the highest production efficiency in the estimated functions. (2) On the grounds of price (allocative) efficiency, which is the other component of economic efficiency of water use, farmers are found to be price efficient in one function only under the first scenario of calculating the imputed cost of water (design expectation of the pump). Under this scenario, the cubic meter of irrigation water is priced at 0.070, 0.124, and 0.143 Egyptian pounds for the flooding, sprinkler, and drip systems, respectively. Under the second scenario, three function are found to achieve price efficiency. Under this scenario (actual operation hours of the pump), the cubic meter of irrigation water is priced at: 0.140, 0.248, and 0.286 pounds for the three irrigation systems, respectively.

It is concluded that, given these figures for the imputed cost of water and that irrigation water is not priced in Egypt, the majority of the estimated functions (seven under the first scenario and four under the second one) displayed that the farmers are under-utilizing irrigation water. This rather striking result could be due to the fact that farmers face problems of water shortages which affect their level of water use. that is to say, the quantities of water they apply per feddan depend upon availability more than choice. In addition, altering the assumption through which the imputed cost of water is calculated from may alter the final results. More investigations are sneeded on this ground. The least of which is to determine the shadow (economic) price of irrigation water in the study area through mathematical programming techniques. In addition, thorough examination of some sample farms is needed to examine their irrigation systems, modify them, and economically evaluate their status before and after modification.

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INTRODUCTION

The plan of work in the original document of the project includes the following activities to be continued or carried out and reported during the second year of the project (May, 1995-April, 1996):

1. Analyze and monitor changes in quantity and quality of groundwater in the project area

2. Survey and quantify on-farm water losses related to irrigation

3. Evaluate existing irrigation systems under specific cropping patterns in desert farming

4. Survey and analyze technical and socio-economic aspects of irrigation practices in representative farms.

5. Evaluate crop production function under different irrigation systems and water salinity levels and to furnish background information for water pricing polices.

The activities carried out in the second year and presented in this second annual report addressed objectives 1, 3, 4, 5.

Changes in groundwater quality are presented and discussed through historic data collected and groundwater salinity determined in 31 wells in South Tahrir, 12 wells in Sadat City and 31 wells in Wadi El-Natrun in DDC laboratory. Data presented cover the period 1973-1996 in South Tahrir, 1987-1996 in Sadat City and 1966-1995 in Wadi El Natrun area. Monitoring these changes in groundwater quality will continue throughout the project period and on to establish data base of groundwater changes in the area.

Objectives 2, and 3 were covered by evaluating the existing irrigation system in 101 selected desert farms representing South Tahrir, Bustan, Sadat City, and Wadi El Natrun areas under different cropping system.

Objective 4, was covered by carrying out the technical and socio-economic survey on 109 desert farms representing the four study areas. Data were collected by visiting all respondents at their farms after preparing and pretesting the questionnaire. The technical aspects of desert irrigation in the questionnaire included source and quality of irrigation water, problems associated with pump stations: problem associated with sprinkler and drip irrigation systems, fertilizer and chemical injection devices, water filtration, and control units in modern irrigation systems. Data were analyzed discussed and presented in this report. The social aspects of desert irrigation concentrated on attitudes and knowledge of farmers towards water use and irrigation practices. The scale of attitudes cover 7 dimensions; cultural values of water, economic values of water, cognitive aspects of available water resources, on farm management, irrigation practices, and sharing responsibility of rational use of water and experiences needed in irrigation.

Analysis of data took into consideration testing the relationship between the attitudes of the farmers toward water use and irrigation practices and three main variables; the region where the farm is located, farm size, type of irrigation system used in the farm. A similar scale of knowledge towards water use and irrigation practices was designed, pretested, used in the questionnaire, and data were similarly analyzed.

Objective 5 is achieved by collecting the required economic data using the questionnaire on 109 forms using different irrigation systems under different cropping systems. Economic analysis was carried out and crop production functions were evaluated under different irrigation systems.

Future Work Plan:

The main activities of the third year of the project will be directed towards:

1- Development of specification for improved irrigation systems and modifications for the exisisting systems to improve their performance and control on farm water losses. This activity will include:

a) Detailed technical observations on a sub-sample farms

A series of detailed technical observations on a sub-sample of around 10 farms selected from the survey sample will be conducted to directly observe what is actually done rather than depending on what a respondent says. This sub-sample of farms could be selected for intensive observation and monitoring over the period of a year. The research team will collect the following information:

1- Crop rotation, crops groun, areas, yields, and other agronomic practices.

2- Type of fertilizers used (amount, timing, method of application).

3- Source of water, and its salinity (EC).

4- Type of irrigation systems used, and the total irrigation time during the season, total discharge thus total amount of water applied.

5- Emitter and/or sprinkler characteristics and hydraulic performance.

6- Water use efficiency in terms of amount of yield per unit of water applied to the crops.

7- Energy consumption.

8- Measurements of water losses from the irrigation systems: flow meters will be installed at the inlet of the field in order to measure the actual amount of water delivered to the system. Losses can be estimated by collecting and measuring water leaking from the system.

9- Water distribution uniformity.

b) Modify and develop specifications for irrigation systems.

Based on the results of the survey and identification and quanitification of the sources of water losses from the irrigation systems, repairs and modifications of both drip and sprinkler systems will be undertaken in the selected farms. In this respect the following will be considered:

1. Introducing screen at the inlet of hand-move lateral line. Sprinkler nozzles are frequently plugged by dirt, grit, weeds, and trash that can be draw into the system by the pump on enter the pipes when they are being moved from one setting to the next. To prevent blockage. filters should be designed and placed at the head of the lateral between the valve elbow and the first section of pipe. The filter can be made from thin aluminum sheet perforated with fine holes.

2. Changing sprinkler spacing from rectangular to triangular patterns on hand move systems can improve water distribution uniformity.

3. Introducing pressure regulators and flow meters and other control devices.

4. Draghose sprinkler systems

The drag hose sprinkler is considered as a modification of the hand-move sprinkler system. The drag-hose will be introduced to South Tahrir through the DDC farm to demonstrate how this system is more convenient, easier to operate, reduces labor demand, and saves deterioration of lateral pipes and fitting.

c) Technical evaluations of the modified and improved systems of irrigation will be carried out in the selected farms. Also economic evaluation of crop production before and after modification will be examined. This is rendered necessary since the results have shown that most farmers are under-utilizing irrigation water. The only reasonable explanation of this, other than the method and/or the assumptions of claculating the inputed cost of water, is that individual farmers face problems of water shortage which alter their problem from a choice problem to an availability one. This is a rather important aspect in economic analysis, since that the economic problem under the theory of production is the problem of choice. That is, the choice among available production alternative some goals taking into consideration scarcity of resources.

2- Dissemination of results, and policy statments drawn. This will be covered through.

a) The establishment of pilot rehabilitation field at the DDC farm in South Tahrir to demonstrate that the exisiting irrigation systems can be made to operate correctly and within the design criteria originally established. The pilot project which will be established on 20 feddan area will also demonstrate the cost of any further improvement and modifications and serve as a training and demonstration site for the most common sprinkler and drip irrigation systems.

b) Two scientific papers presenting some of the achievements in the second year of the project were presented in the Annual AUC Research Conference on April, 22, 1996. The first paper entitled "Irrigation Systems Evaluation in Desert Farming" by Dr. S. Ismail, Dr. A. Metwally and M.A. Sabbah, while the second paper entitled "Attitudes of Desert Farmers Towards Water Use and Irrigation practices in New lands" by Dr. M. Nawar and Dr. M.H. El-Lakany. Copies of the two papers are endorsed to the IDRC. More publications are expected to emerge from results achieved in the second and thirds years of the project especially those dealing with the economic evaluation of crop production functions under different irrigation systems.

c) Brochures containing guidelines for improved irrigation systems efficiencies and reducing on-farm water losses will be made available to farmers using various sprinkler and drip irrigation systems along with tips for better performance and higher yields.

3- Monitoring the change in groundwater quality in the selected wells in South Tahrir, Sadat City, and Wadi El-Natrun will continue during the third year of the project and after to creat data-base on changes in groundwater in the study area.

4- More data will be collected on the quantification of on-farm water losses. Actual measurements will be performed on the selected farms before and after modifications and specifications for improved irrigation systems are carried out.

I. Changes in Quantity and Quality of Groundwater in the Study areas:

A general review on groundwater conditions presented in the first progress report included general outlines and features, geology, and a description of groundwater aquifers in west Nobariya canal area, early Pleistocene Nile sediments (between Rosette branch and east Nobariya and Nasr canal), South west of Nile delta (Wadi El - Farigh and its western extention), and in West of Giza (North of Abu-Rawash).

The groundwater development in the western Nile Delta was also presented and discussed in the first progress report. Identified policy options for groundwater development in the study area that ranged from no further groundwater development to full development of groundwater were also discussed. The study showed that without further development (only 70,000 feddan of cultivated land) there is still a lowering of groundwater head of 10-15 meters in the coming 50 years, whereas uncontrolled or full development to cultivate additional 190,000 feddan will lead to a lowering of the groundwater head of maximum of 80 meters after 50 years. The study sited proposed a controlled groundwater development to cultivate additional 130,000 feddan to limit the groundwater lowering to 25 meters and assure that most of existing wells remain in operation. Controlled groundwater development with additional surface supply is the only option to reclaim all cultivable land in the area (400,000 feddan). Implementation of surface water projects will also prevent uncontrolled drilling of wells in the area and will eventually provide additional recharge to groundwater system.

The data presented in the first progress report showed that the agricultural horizontal expansion in Sadat and Wadi El Natrun areas has already gone beyond the groundwater potential in these areas according to the study of Farid and Tuinof (1991).[1]

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[1] Farid and Tuinof (1991). Groundwater development. Water Sci: Special 43-52.

The controlled groundwater development plan (1990-2000) suggested that cultivable area in Sadat City can be increased from 2000 to 10,000 feddan. The available data show that total cultivable area in Sadat City is being developed to about 30,000 feddan. Groundwater extraction in these area is expected to be three times the safe discharge of 75 million m3/y with the subsequent lowering of groundwater level and possibility and some wells to fall day. In Wadi El-Natrun the controlled development plan suggested that groundwater extraction should not exceed 6 million m3 which irrigate 1000 feddan while the potential cultivable area that is being developed reached 30,000 feddan; 4000 feddan have been under cultivation since the 1960's, 14,000 Fed. have been allocated to agriculture cooperative (some of these started already) and 12000 fed. are available for investors.

Control of the development plans should be implemented by licening system. Licenses for the installation of new wells should include guidelines for the minimum drilling depth and screen depth and minimum distance between wells. Only recently the Groundwater Research Institute has assumed responsibility to such licening system.

The groundwater salinity of some selected wells in different areas of the western desert was also presented. Data showed that South Tahrir, Bustan and Sadat city has good quality water. However salinity slightly increased in these areas from the 1970's to the 1990's. Over three years groundwater salinity in Sadat city slightly rose from 266-812 in 1990 to 312-915 ppm in 1993 .

This report includes the change in groundwater quality in the study area; mainly in Sadat and Wadi El Natrun area where groundwater the sole source of irrigation:

Groundwater Quality in Sadat City

Groundwater Salinity in 12 wells representing the area of Sadat City was measured in DDC laboratory in Sadat City in 1987, 1988, and 1995. The locations of these wells are shown in Fig 1. The salinity values are presented in table 1. In general Sadat City has good groundwater quality. With the exception of wells 90, 92(1), 92(2) located close and along the

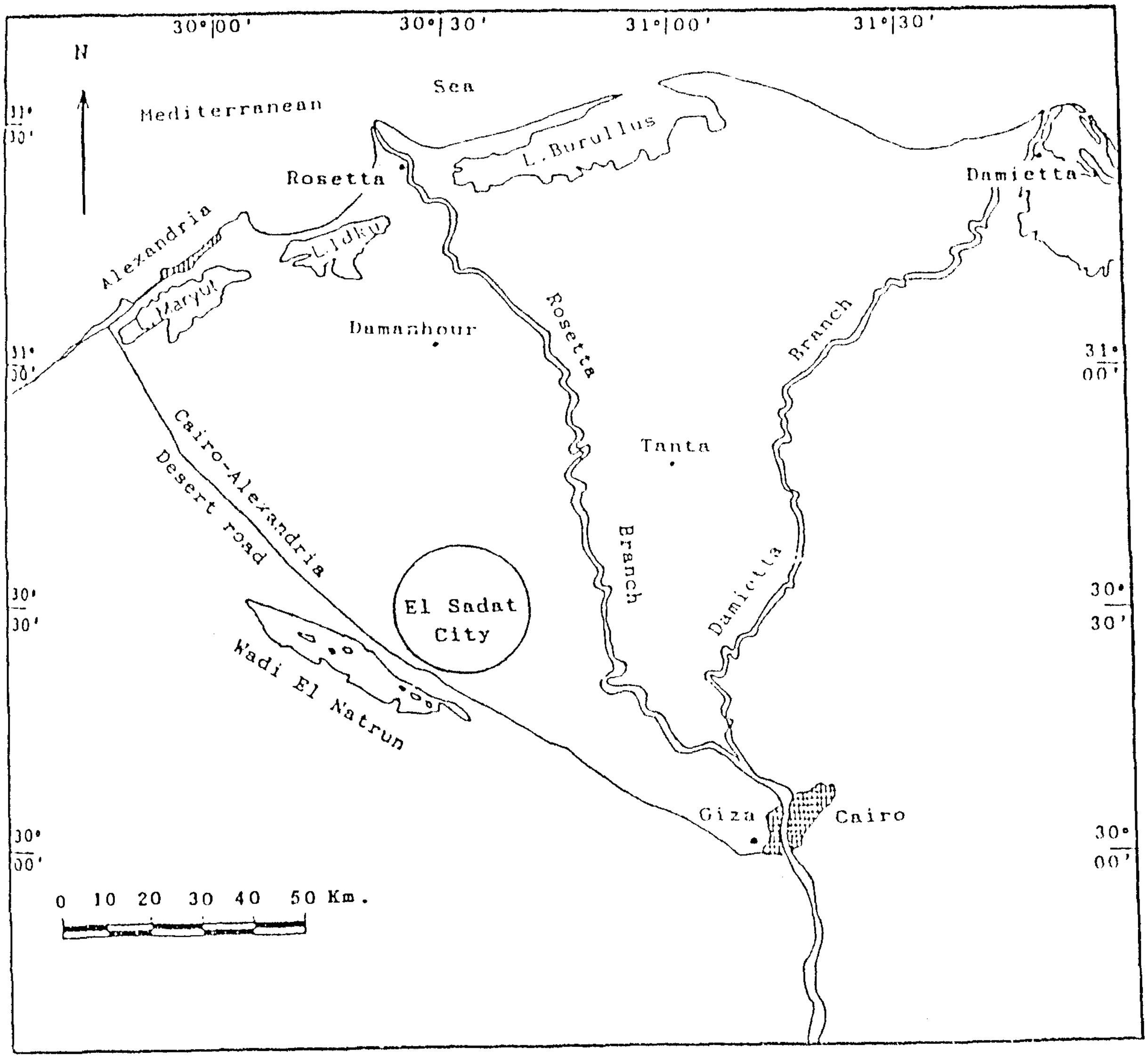

Fig. (1A): Location map of El Sadat City, and Wadi El-Natrun areas

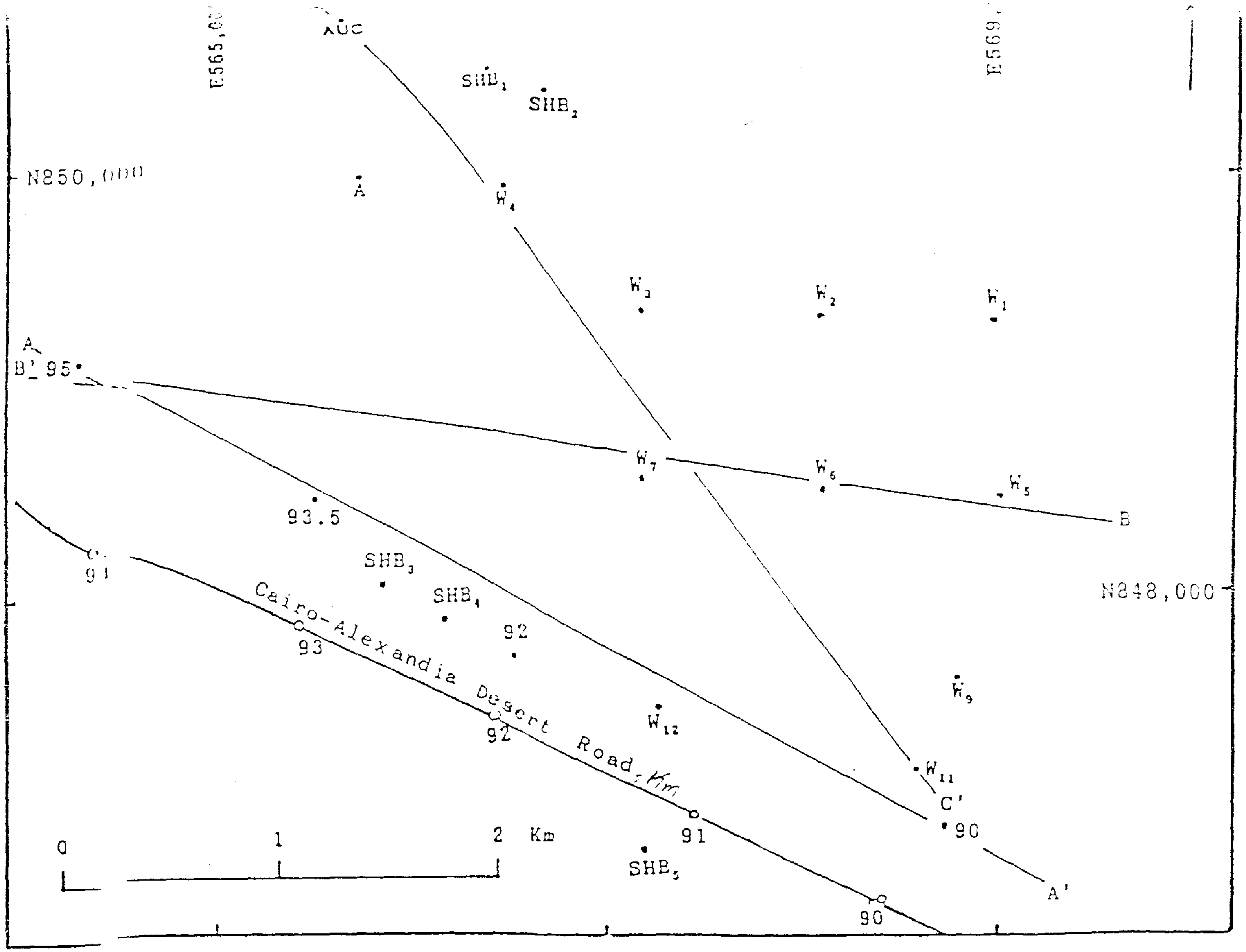

Fig.(1): Well location map in Sadat City.

Table(1):Changes in groundwater salinity in Sadat city wells (1987 - 1995).

WELL	ELECTRICAL CONDUCTIVITY (dS/m)					
#	Jun. 1987	Aug. 1987	Nov. 1987	Feb. 1988	Jun 1988	Oct. 1995
A	0.423	0.420	0.426	0.450	0.410	0.390
AUC	0.450	0.450	0.449	0.450	0.490	0.715
W1	0.404	0.410	0.403	0.420	0.400	0.397
W3	------	------	0.393	0.410	0.400	0.391
W4	0.427	0.420	0.510	0.430	0.480	0.713
W5	0.420	0.440	0.403	0.440	0.430	0.396
W6	------	------	0.410	0.420	0.400	0.411
W7	0.423	0.492	0.427	0.440	0.420	
W9	0.423	0.430	0.425	0.450	0.430	0.750
W11	0.410	0.470	0.414	0.430	0.420	0.421
W12	0.398	0.410	0.466	0.430	0.410	0.453
Km 90	------	0.496	0.651	0.640	0.680	1.527
Km 92.1	2.210	2.100	2.040	2.410	------	2.240
Km 92.2	------	1.540	1.225	1.370	------	1.390

Cairo-Alexandria road, the groundwater salinity ranges between 0,398 and 0.75 dS/m (255-480 pmm) over the period 1987-1995. The higher salinity of groundwater in well 90, 92(1), 92(2) ranged between 1.39 and 2.24 dS/m (890-1434 pmm) and was attributed to the presence of clay lenses and the intercalation of clay and sand in the vicinity of these wells in addition to seepage of wastes from the Egyptian Poultry Company located near well 92..

Slight salinity changes with time could be noticed over short periods between 1987 and 1988 (table 1). Over the past seven years (1988-1995), however, salinity rose by 70-100% in four out of the twelve wells under investigation (Figs. 2-4). These wells are AUC, W_4. W_9 and 90. Although salinity rose by such a high percentage it remained below 0.75 dS/m (480 ppm) in wells of AUC W_4 and W_9 and groundwater in these wells remained of good quality. The remaining 8 wells show very slight and insignificant changes in groundwater salinity over the same period. Monitoring salinity and chemical composition of groundwater will continue in DDC Laboratory in Sadat City to asses changes in groundwater quality as affected by the agriculture expansion in the area.

The water table contour maps of Sadat City in April and July 1989 [1] (Figs 5 and 6) indicated that the general flow pattern of the groundwater in the Pleistocene gravely aquifer in Sadat City coincides with the general flow pattern of groundwater in west of the Nile Delta. Generally the water flows from northeast to southwest in the direction of Wadi El Natrun depression. This provides an additional evidence for the hydraulic connection between Pleistocene aquifer beneath the Delta and the whole region to the west of the aquifer. It also suggests the presence of an important recharge source located in the northwest direction and is presented by Rosette branch. The seasonal variations in groundwater table showed a slight difference between the spring and summer season, which indicate slight fluctuations in this area. At that time the effect of discharge in the area was not detected and therefore, the aquifer was characterized to be of good quality of good potentiality.

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[1] El- Maghraby, M.M. (1990). Geograhpical and hydorological studies of Sadat City, Egypt. M.Sc. Thesis, Fac. Sci., Alexandria University.

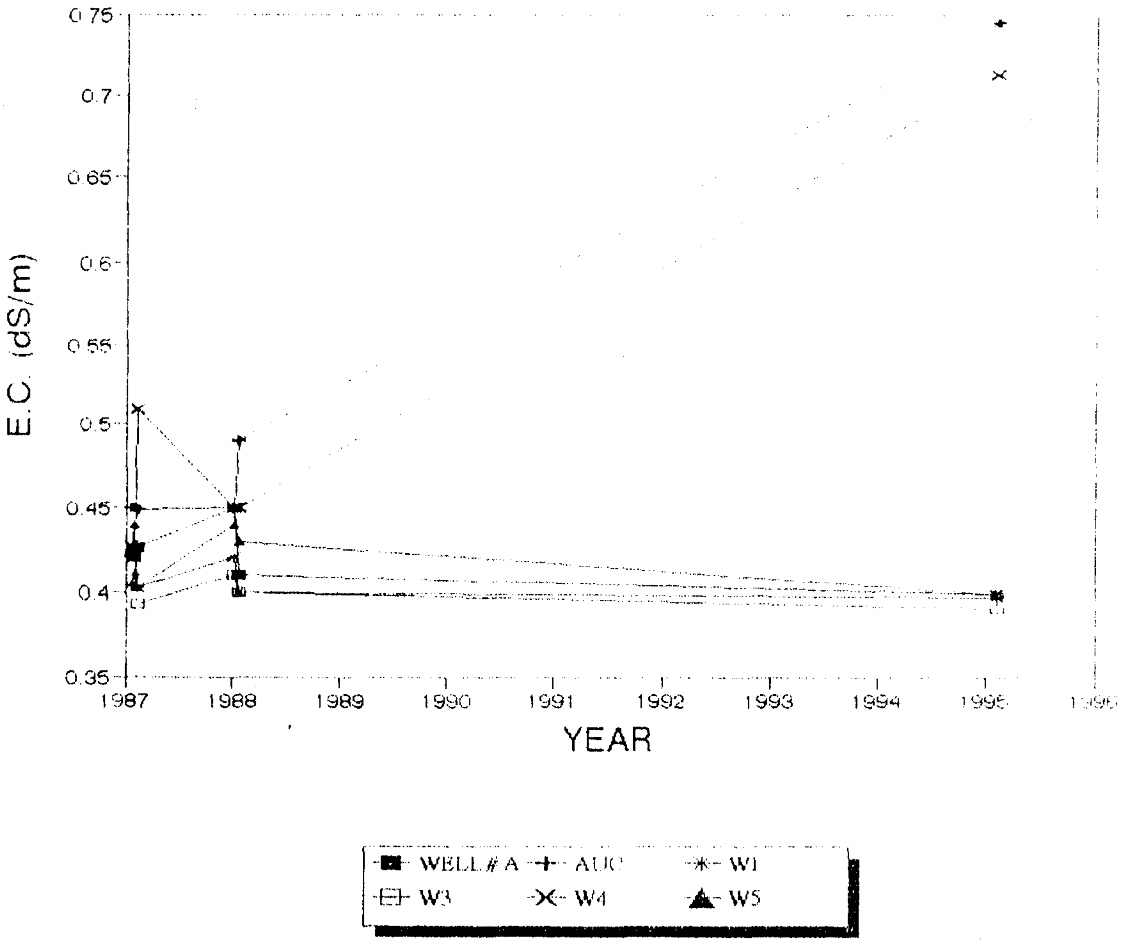


Fig.(2): Changes in groundwater salinity in Sadat city wells (1987 - 1995).

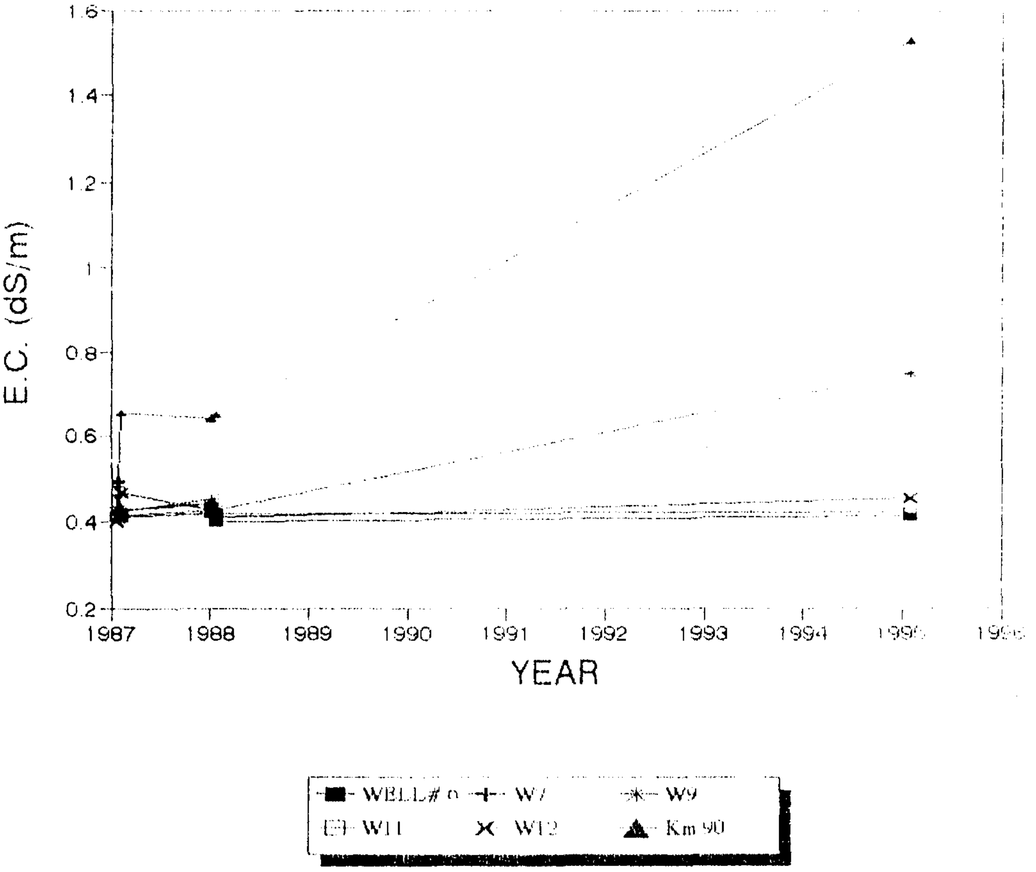


Fig.(3): Changes in groundwater salinity in Sadat city wells (1987 - 1995).

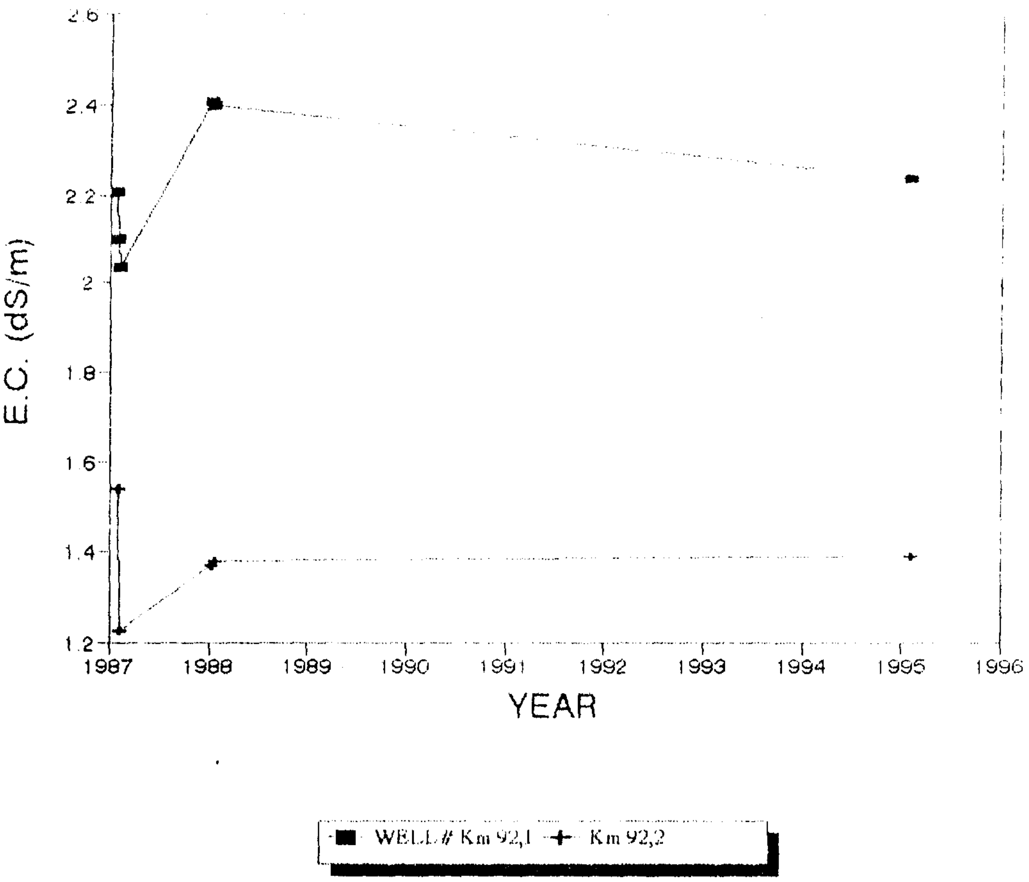


Fig.(4): Changes in groundwater salinity in Sadat city wells (1987 - 1995).

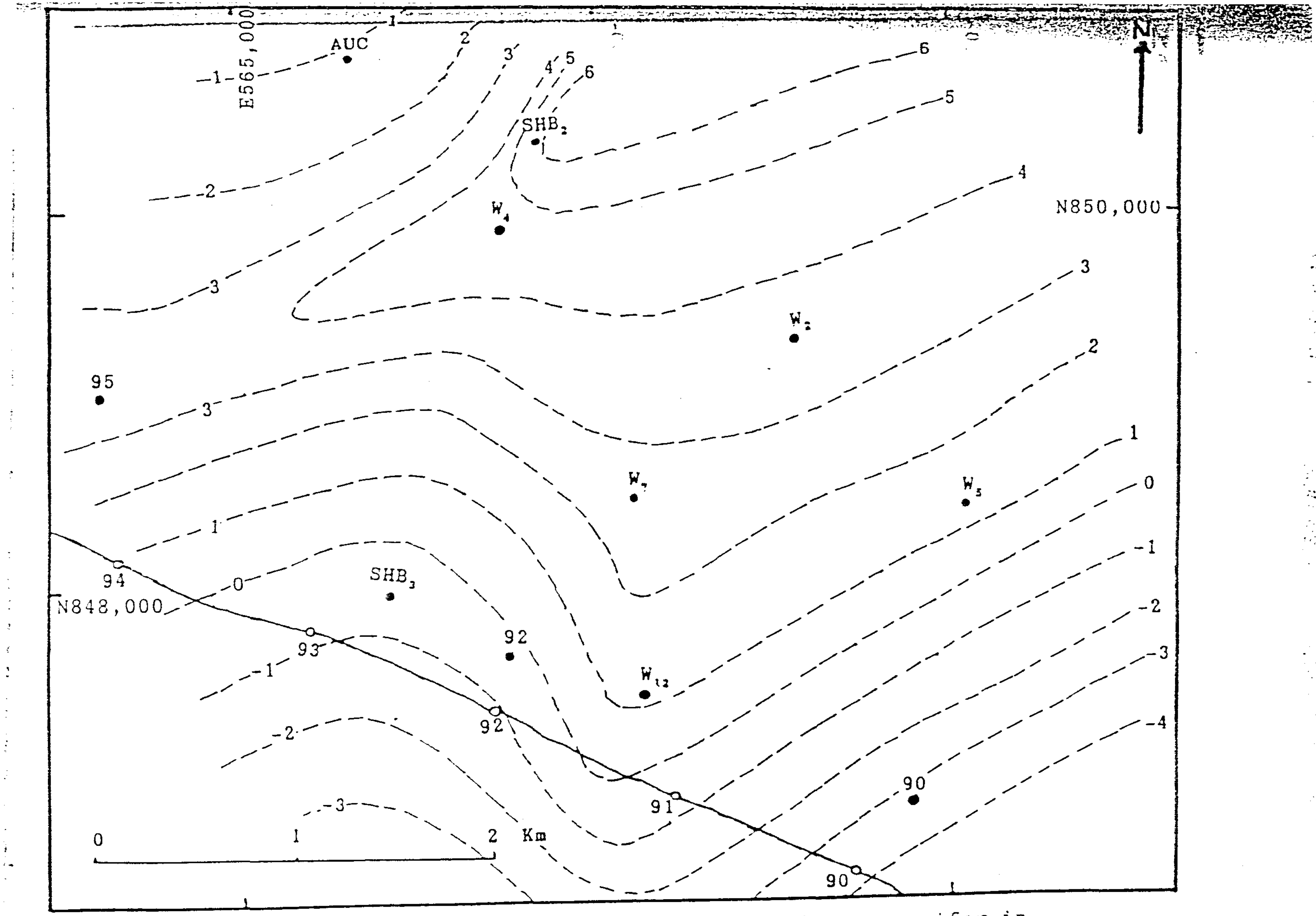


Fig. (55): Water-level contour map of the Pleistocene aquifer in El Sadat City in April 1989. (After El-Maghraby, 1990)

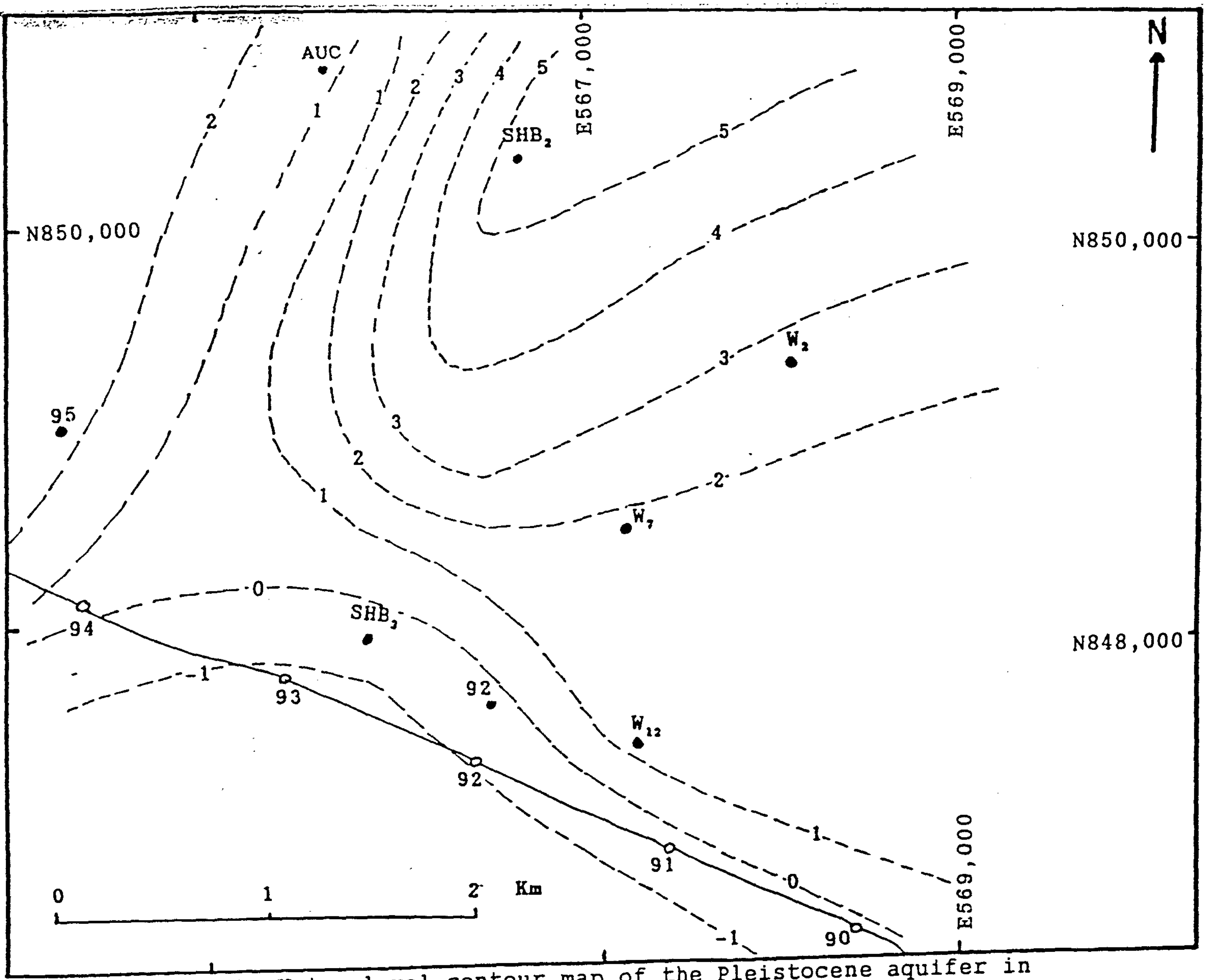


Fig.(6): Water-level contour map of the Pleistocene aquifer in El Sadat City in July 1989. (After El-Maghraby, 1990)

These investigations need to be updated in view of the agriculture expansion in the area in recent years to evaluate its effect on the potentiality of the aquifer.

Table (2) shows that $NaHCO_3$ and NaCl are the major the salinity constituents of Sadat City groundwater at low levels of salinity. However at higher level of salinity (wells #92 (1) and #92 (2) $NaSO_4$ and NaCl became the major salinity constituents.

Changes in Groundwater Quality in Wadi El Natrun Area:

Table 3 and Figs. 7-12 show changes in groundwater salinity in 31 wells in Wadi El Natrun between 1966 and 1995. Data for the period 1966-1985 were collected from Wadi El Natrun authority. Samples from most of these wells where collected and analyzed in 1995 in DDC laboratory in Sadat City.. Data show that groundwater salinity in Wadi El Natrun area varies widely between different locations and shows much higher values compared to Sadat area especially in the Northern sector of Wadi El Natrun where it reached 4000 ppm (6.2 dS/m). Most wells in the southern sector are at much lower salinity (see map for the locations of the wells in Fig. 13) with total salinity ranging between 346-909 ppm.

Data presented show changes in well water salinity between 1966 and 1995. In 1966 groundwater salinity in the monitored wells were mostly between 300 and 700 ppm with the exception of 3 wells where it was slightly higher than 1000 ppm. In 1995, salinity rose appreciably in 15 out of the 31 wells under study to 2-8 times its salinity in 1966 reaching values ranging between 2000 and 4000 ppm in most of these wells especially those located in the northern sector of Wadi El Natrun. However changes in groundwater salinity in most of the well in the southern sector were slight and water quality in terms of total salinity remained of fairly good quality ranging between 346 and 877 ppm in 1995.

Table 2: Chemical analysis of groundwater in Sadat City wells in 1987

Well	pH	T°C	E.C	TDS	Units	Ca	Mg	Na	K	HCO_3	SO_4	Cl	SAR	RSC
A	7.35	30.40	0.423	270.7	ppm	9.00	4.80	81.50	4.15	179.30	13.58	31.95	5.43	2.09
					epm	0.45	0.40	3.54	0.11	2.94	0.28	0.90		
					%	10.00	8.89	78.67	2.44	71.36	6.80	21.84		
AUC	7.43	29.0	0.45	288.0	ppm	11.00	5.40	77.00	4.60	179.30	17.08	42.60	4.76	1.95
					epm	0.55	0.44	3.35	0.12	2.94	0.36	1.20		
					%	12.33	9.87	75.11	2.69	65.33	8.00	26.67		
W_1	7.41	31.1	0.404	258.6	ppm	11.00	5.40	66.00	4.70	184.50	7.41	35.50	4.08	2.03
					epm	0.55	0.44	2.87	0.12	3.02	0.15	1.00		
					%	13.82	11.06	72.11	3.02	72.42	3.60	23.98		
W_2	7.43	30.9	0.395	252.8	ppm	11.00	5.40	65.00	4.50	163.97	10.91	35.50	4.02	1.7
					epm	0.55	0.44	2.83	0.12	2.69	0.23	1.00		
					%	13.96	11.17	71.83	3.05	68.62	5.87	25.51		
W_4	7.33	30.4	0.427	273.3	ppm	9.00	4.20	81.00	4.40	158.80	13.37	42.60	5.57	1.80
					epm	0.45	0.35	3.52	0.11	2.60	0.28	1.20		
					%	10.16	7.90	79.46	2.48	63.73	6.85	29.41		
W_5	7.43	30.4	0.42	269.4	ppm	10.00	4.80	71.00	4.30	158.80	11.32	46.15	4.61	1.70
					epm	0.50	0.40	3.09	0.11	2.60	0.24	1.30		
					%	12.20	9.76	75.37	2.68	62.80	5.80	31.40		
W_7	7.5	31.5	0.423	270.7	ppm	7.00	1.80			169.10	10.29	42.60	7.36	2.27
					epm	0.35	0.15	3.68		2.77	0.21	1.20		
					%	8.37	3.59	88.04		66.27	5.02	28.71		
W_9	7.6	30.8	0.423	270.7	ppm	10.00	6.60	72.00	4.30	174.20	10.29	39.05	4.34	1.82
					epm	0.50	0.54	3.13	0.11	2.86	0.21	1.10		
					%	11.68	12.62	73.13	2.57	68.59	5.04	26.38		
W_{11}	7.38	30.6	0.41	262.4	ppm	8.00	6.60	71.00	4.15	158.84	13.58	39.05	4.51	1.66
					epm	0.40	0.54	3.09	0.11	2.60	0.28	1.10		
					%	9.66	13.04	74.64	2.66	65.33	7.04	27.64		
W_{12}	7.38	31.3	0.393	254.7	ppm	10.00	6.00	67.00	4.30	158.84	12.55	31.95	4.14	1.61
					epm	0.50	0.49	2.91	0.11	2.60	0.26	0.90		
					%	12.49	12.22	72.57	2.74	69.15	6.92	23.93		
SHB_2	7.6	28.8	0.534	341.76	ppm	6.00	3.60	96.00	3.75	174.22	10.70	53.25	7.61	2.26
					epm	0.30	0.30	4.17	0.10	2.86	0.22	1.50		
					%	6.16	6.16	85.63	2.05	62.45	4.80	32.75		

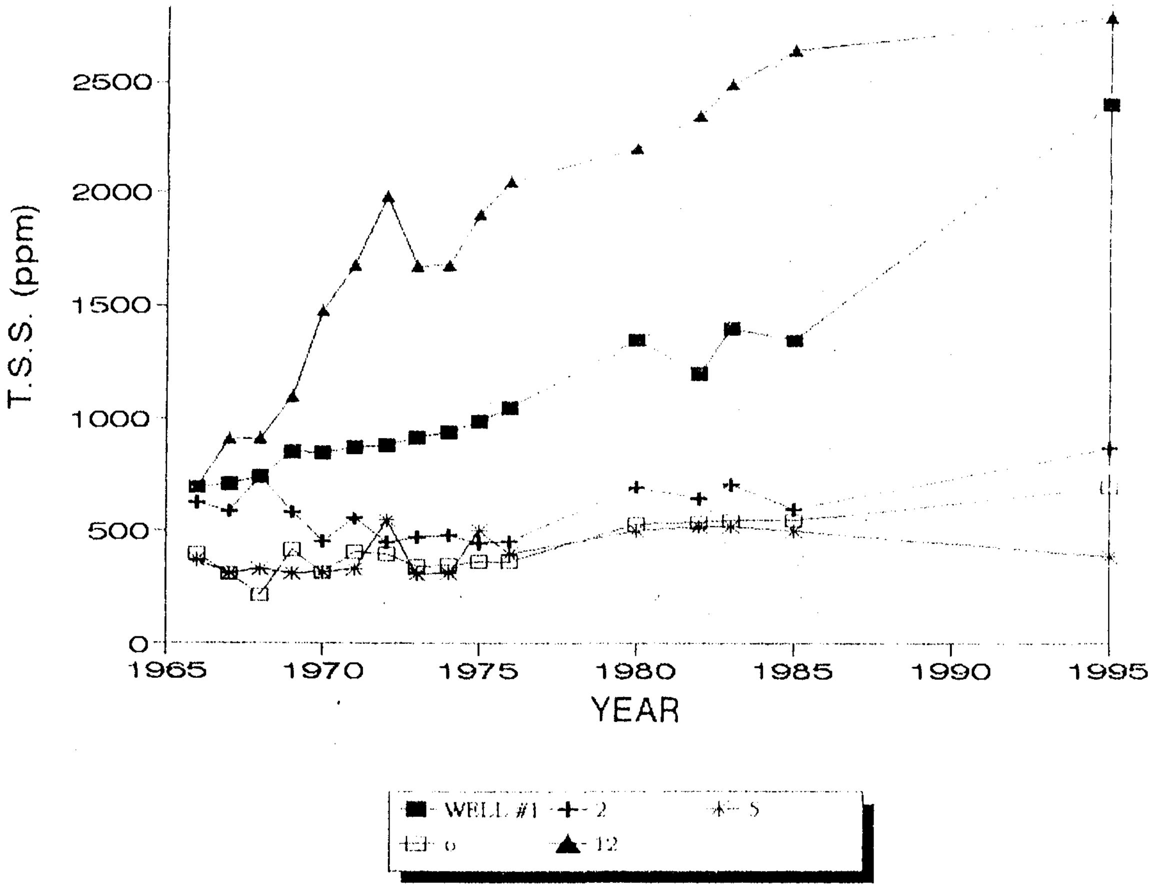
Table 2 Continued: Chemical analysis of groundwater in Sadat City wells in 1987

well	pH	T°C	E.C	TDS	Units	Ca	Mg	Na	K	HCO_3	SO_4	Cl	SAR	RSC
92	7.8	30.3	2.21	1414.4	ppm	25.00	28.20	480.00	7.40	138.30	600.4	255.60	15.6	-1.3
					epm	1.25	2.32	20.87	0.19	2.27	12.5	7.20		
					%	5.08	9.42	84.73	0.77	10.33	56.9	32.77		
93.5	7.4	29.6	0.42	268.8	ppm	11.00	4.80	74.00	4.40	169.09	15.43	31.95	4.67	1.23
					epm	0.55	0.40	3.22	0.11	2.77	0.32	0.90		
					%	12.85	9.35	75.23	2.57	69.42	8.02	22.56		
95	7.42	29.3	0.444	284.16	ppm	6.00	4.80			158.84	19.55	42.60	5.93	1.9
					epm	0.30	0.40	3.51		2.60	0.41	1.20		
					%	7.13	9.50	83.37		61.76	9.74	28.50		

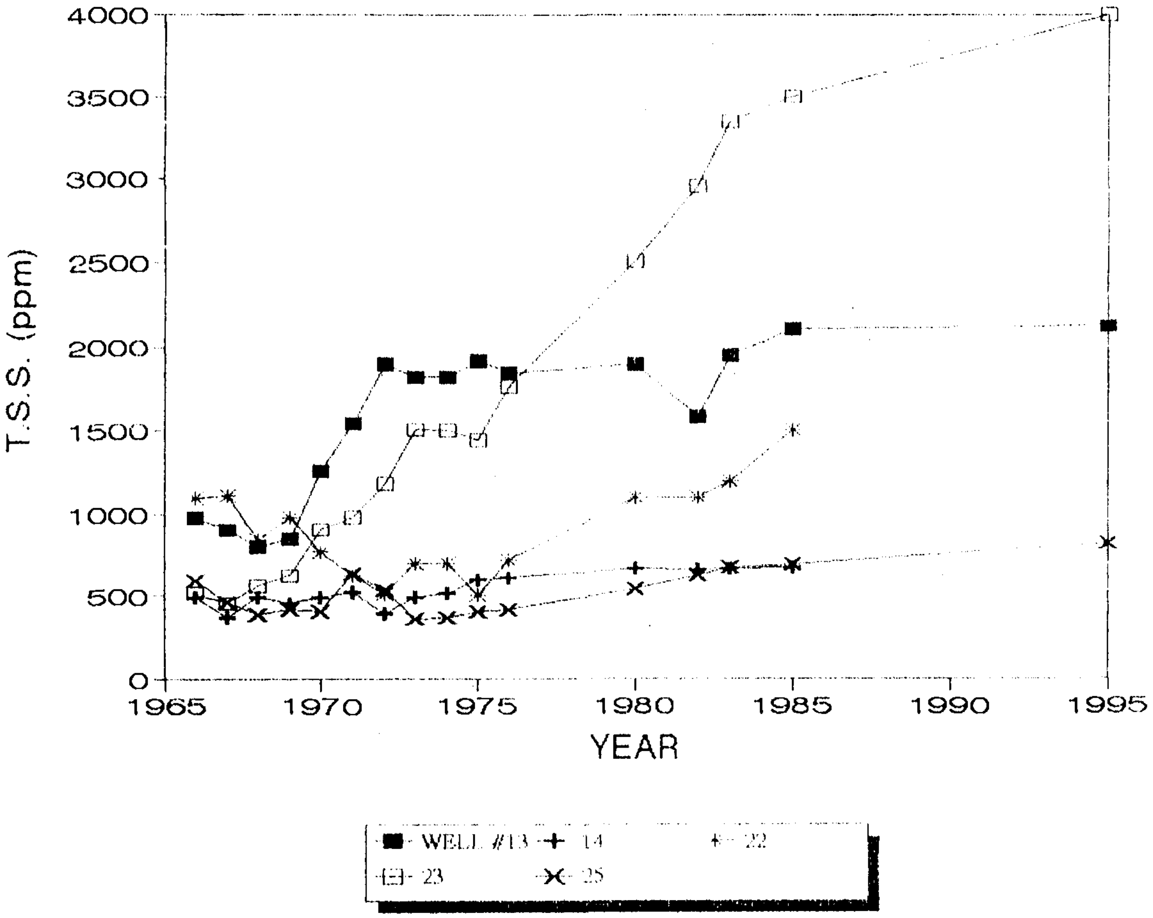
After El-Maghraby, 1990

3 [illegible]

WELL #	D sch m3/hr	1965	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1980	1982	1983	1985	1995
		TOTAL SOLUBLE SALTS (ppm)															
1	140	700	710	750	355	850	875	885	917	940	984	1048	1345	1200	1400	1350	2406
2	90	630	595	750	590	455	550	452	475	480	445	455	700	550	710	600	877
5	90	378	315	332	315	322	336	550	310	312	500	402	500	520	520	500	390
6	125	400	315	215	420	322	406	400	345	350	365	367	530	540	550	550	698
12	171	700	910	910	1100	1470	1680	1980	1670	1675	1900	2050	2200	2345	2495	2650	2797
13	121	980	910	800	850	1260	1540	1900	1820	1820	1910	1850	1900	1580	1950	2100	2118
14	100	490	371	490	455	490	525	392	495	520	500	612	670	550	670	680	--------
22	40	1100	1120	540	980	770	630	512	700	700	504	717	1100	1100	1200	1500	--------
23	110	315	455	560	630	910	980	1180	1505	1500	1442	1767	2500	2950	3350	3500	3994
25	168	595	458	385	420	406	639	535	365	370	406	420	540	625	675	690	819
40	110	380	410	420	427	450	450	474	500	555	513	550	620	630	--------	--------	--------
42	95	385	385	385	390	392	420	406	418	425	420	450	476	495	500	500	531
44	81	320	315	335	350	345	340	320	315	325	335	340	350	375	390	400	390
46	154	330	332	330	340	322	325	330	350	350	347	340	340	345	348	350	358
47	70	317	325	317	315	315	350	335	340	342	350	385	390	410	395	420	--------
50	60	490	385	350	450	525	490	506	490	491	600	385	530	550	580	600	416
51	61	490	525	420	385	392	700	488	335	335	500	455	500	480	520	500	384
52	54	360	385	350	435	507	500	416	385	356	336	332	510	500	480	350	346
54	47	630	770	770	595	539	770	490	553	550	490	455	800	1100	760	1000	819
57	100	1200	1750	1750	1600	1820	1960	1890	1910	2200	2350	2500	2800	3000	2900	3150	3200
58	120	700	840	980	1300	1960	2450	2598	2730	2735	2800	2760	2800	2950	3000	3300	--------
60	45	490	840	1050	1190	1330	1400	1416	1450	1450	1455	1485	1510	1500	1590	1550	--------
61	60	1050	1450	1495	1510	1600	1640	1700	1715	1720	1748	1800	1830	1850	1850	1800	1965
62	95	700	1400	1400	1400	1680	1600	1640	1610	1610	1540	1450	1756	1685	1800	1900	1978
63	172	595	690	850	355	880	770	904	900	902	915	925	800	880	920	1400	1824
64	140	770	700	595	700	490	490	548	425	425	455	435	710	900	--------	--------	--------
67	125	735	1375	1375	1410	1400	1390	1310	1295	1295	1300	1300	1325	1355	1390	1550	1683
70	94	595	910	1400	1925	1890	1960	1936	1940	1942	1900	2030	2000	1955	2150	2500	3654
73	147	490	560	1190	1680	1845	1900	2010	2100	2110	2170	2300	2440	2585	2750	3100	3994
74	105	525	455	385	400	420	425	368	385	385	448	454	610	748	849	1150	1811
76	134	434	570	575	600	620	620	665	650	710	735	800	815	885	900	900	909



g.(7): Salinity variations in groundwater in Wadi El-Natrun between 1966 - 1995.



ig.(8): Salinity variations in groundwater in Wadi El-Natrun between 1966 - 1995.

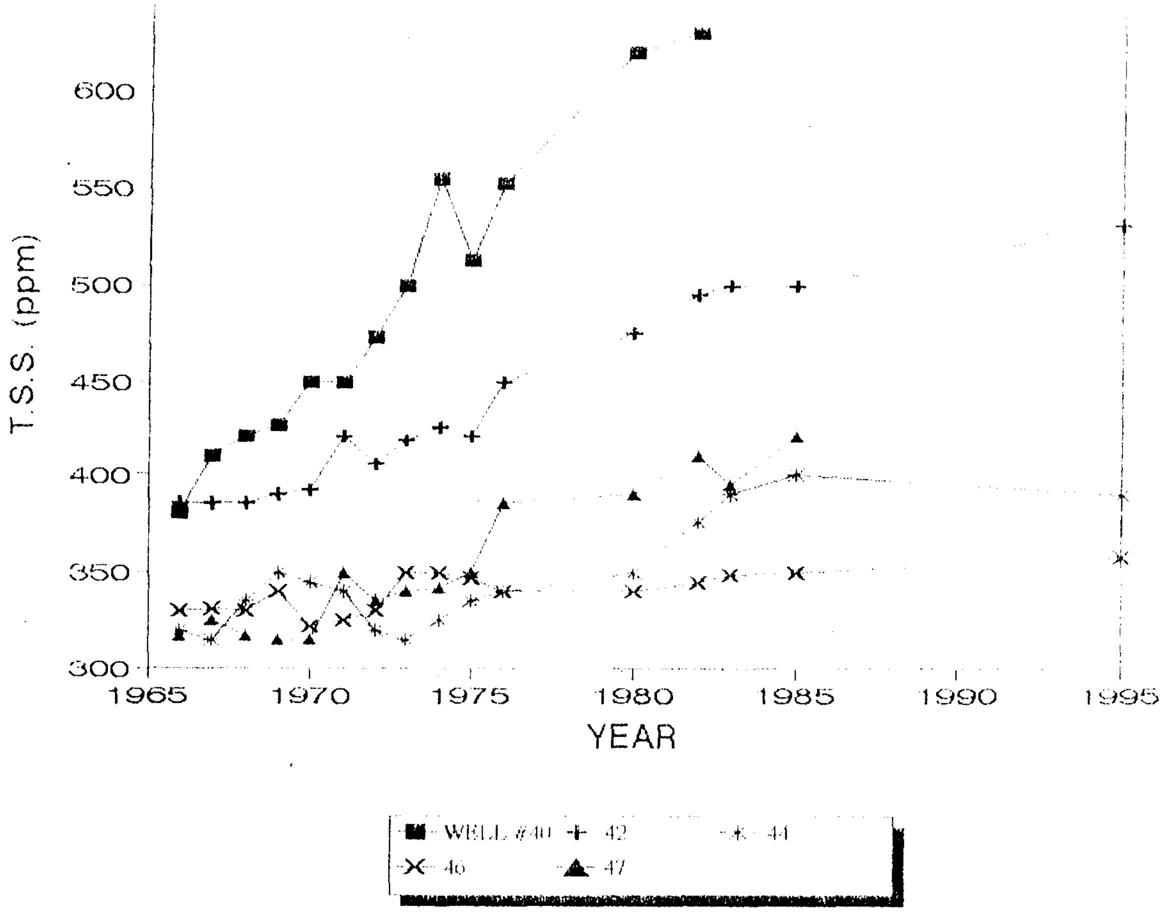


Fig.(9): Salinity variations in groundwater in Wadi El-Natrun between 1966 - 1995.

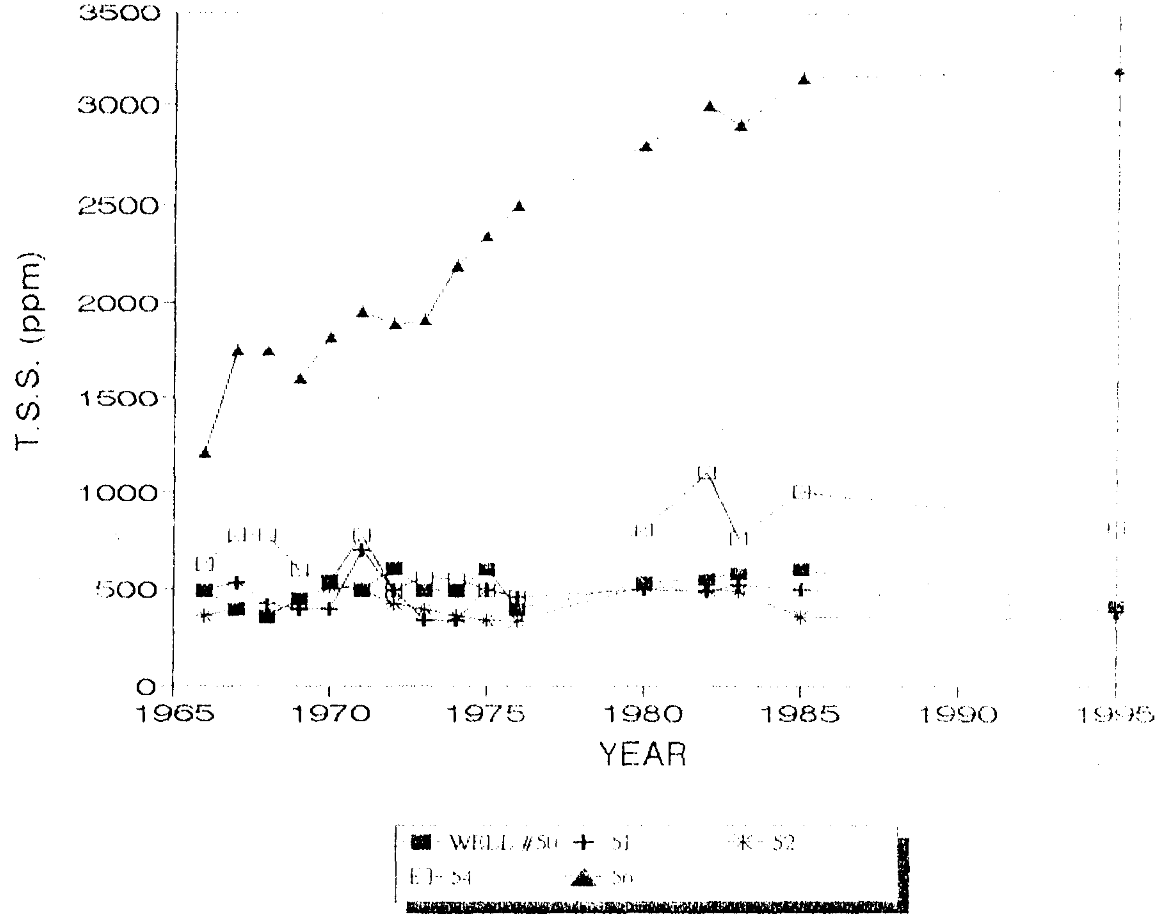


Fig.(10): Salinity variations in groundwater in Wadi El-Natrun between 1966 - 1995.

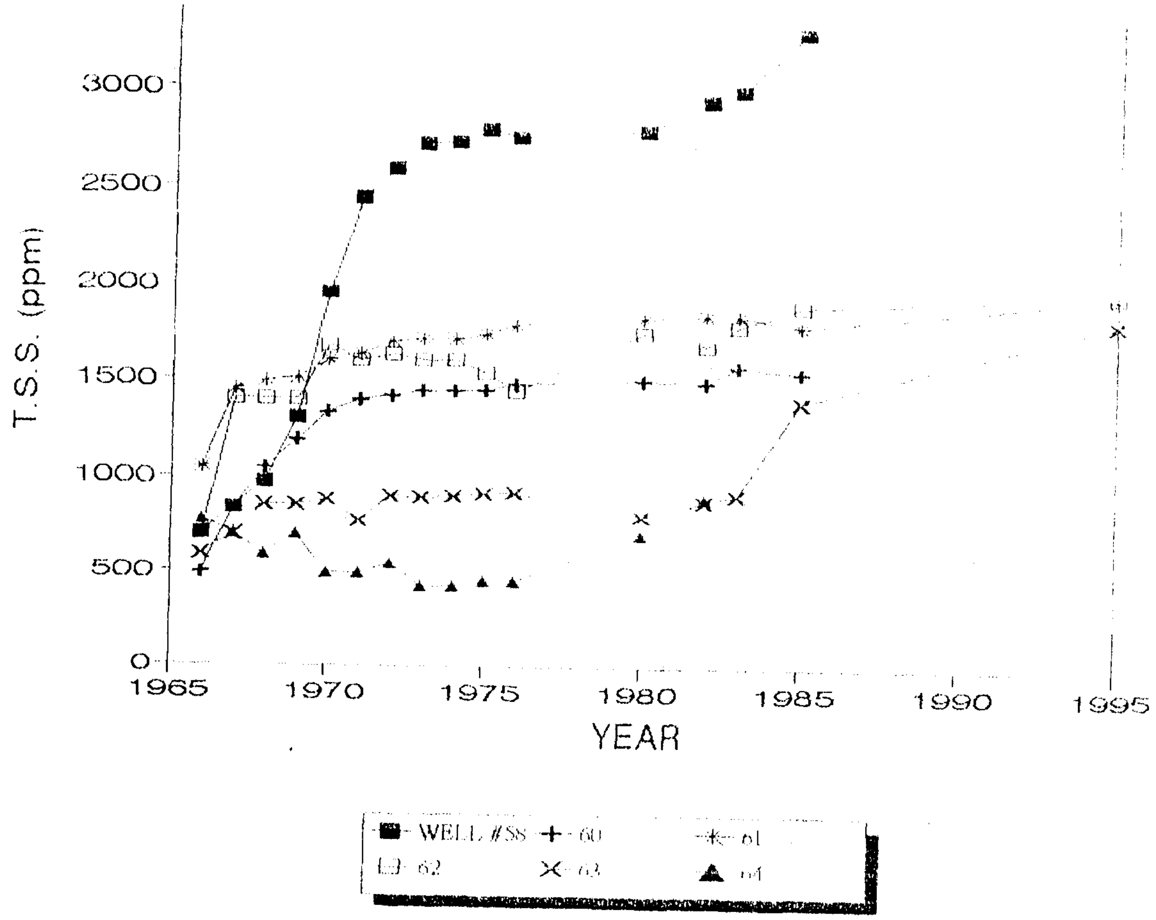


Fig.(11): Salinity variations in grounwater in Wadi El-Natrun between 1966 - 1995.

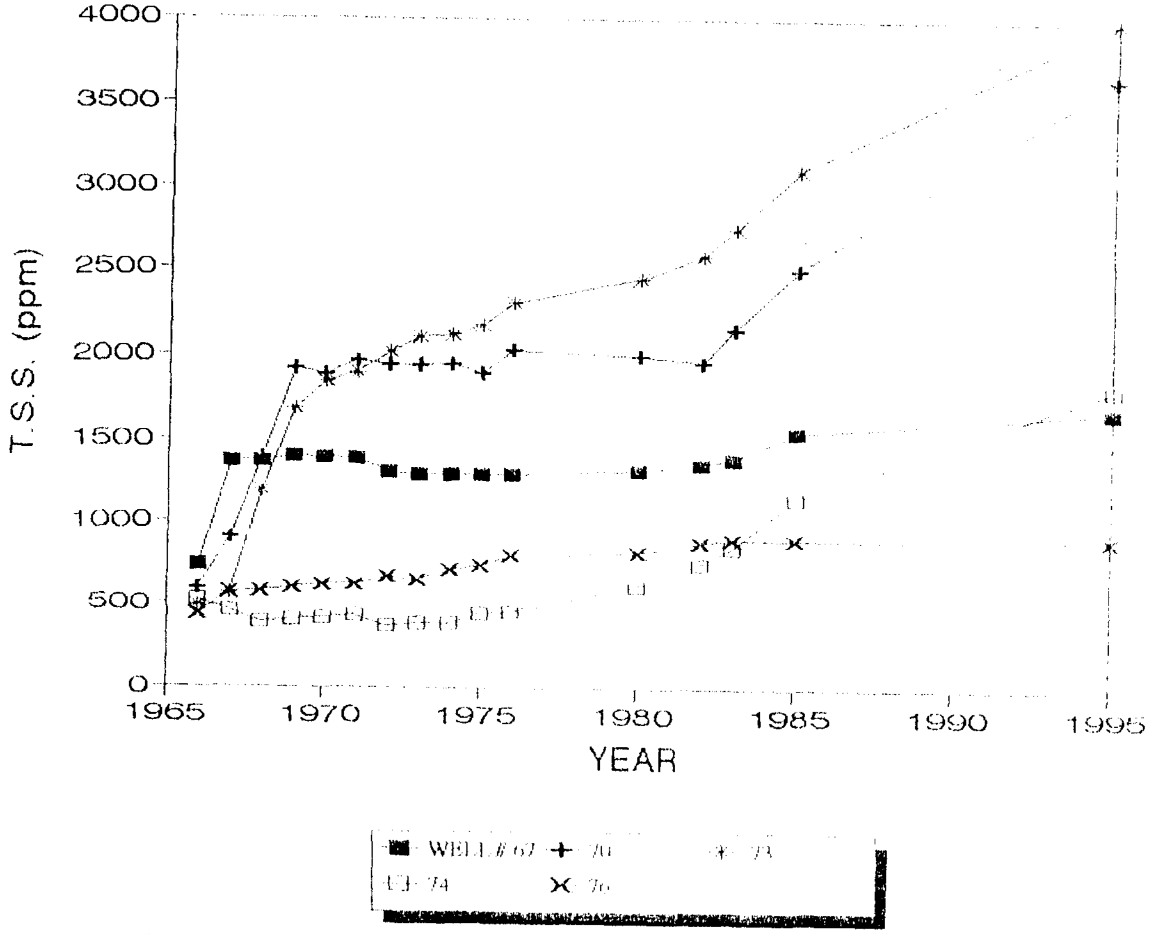
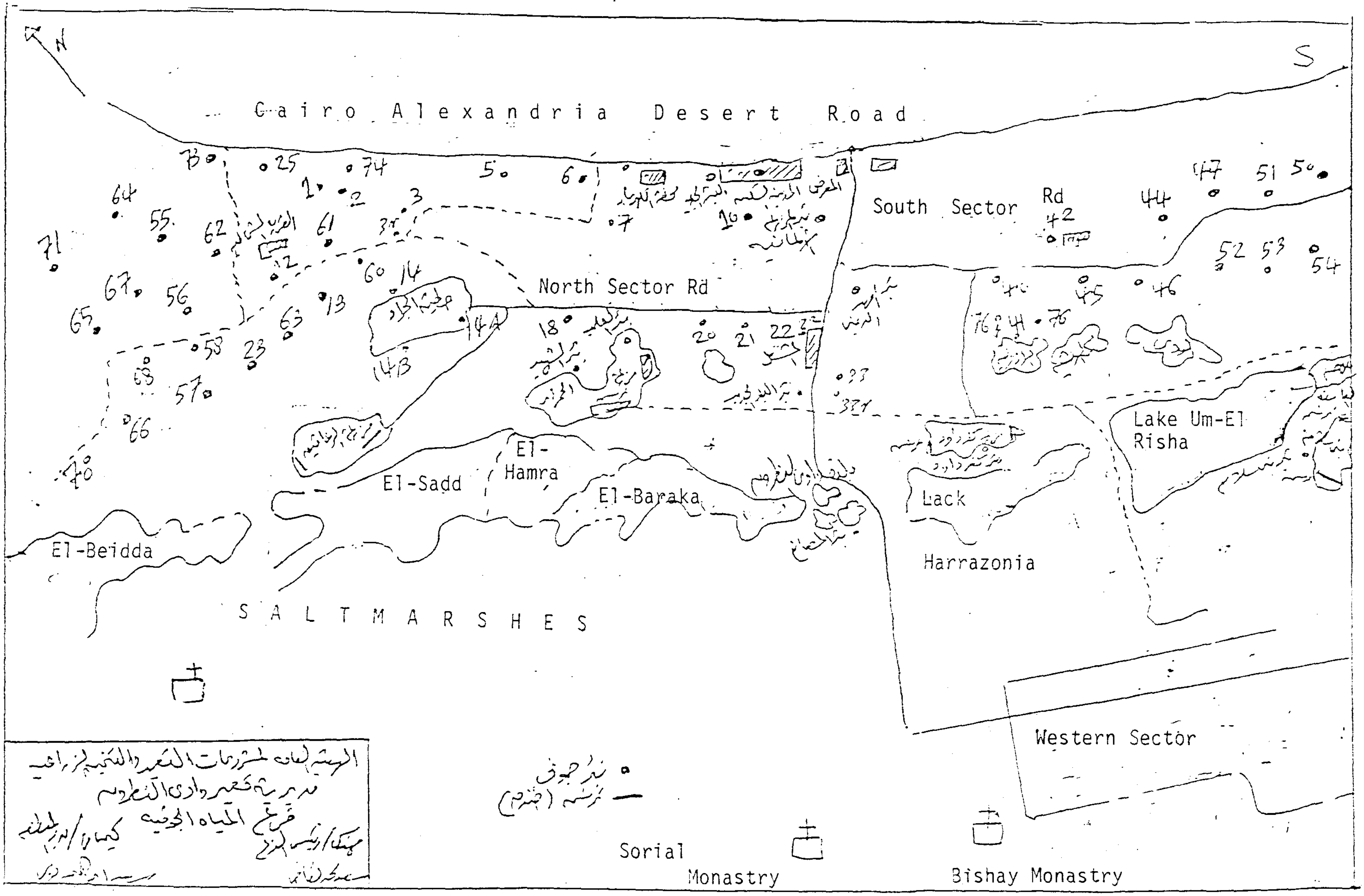


Fig.(12): Salinity variations in groundwater in Wadi El-Natrun between 1966 - 1995.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بئر جوفى
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فرع المياه الجوفية
مهندس/ رئيس الفرع
كيميائي/

Groundwater Salinity in South Tahrir Area:

The salinity of groundwater was measured in 31 wells in Fath sector, South Tahrir area. Groundwater is used for supplementary irrigation during the period of canal shutdown and when the level of Nile water in the irrigation canals are low. Groundwater wells in Tahrir area are usually dug 1.2 km apart along the feeding canals and adjacent to the collective pump station (serving 400-600 feddans) as shown in Fig (14). Groundwater is usually pumped, using desil or electric power to the feeding canals and then pumped to the field irrigation network by the booster pump in the collective pump station.

The salinity of groundwater in these wells were determination in May, 1995 and Jan., 1996 and presented in table (4). Historical data on water quality of these wells were unavailable. Out of the 31 wells tested only two have groundwater of very good quality with salinity <0.7 dS/m (450 ppm). Only one well had high salinity of >3.0 dS/m (2000 ppm). The rest of the wells have groundwater of medium salinity ranging from 0.7-3.0 dS/m (450-2000 ppm). More than 50% of the tested wells have salinity below 1000 ppm.

However historical data available for the area and presented in the first progress report show that groundwater salinity in cultivated area of South Tahrir were in the range 200-500 ppm in 1973 when HCO3 and Na were dominant and 620-1000 ppm when Cl and Na were dominant. In 1993, however groundwater salinity rose to 312-1700 ppm . Comparing these ranges of salinity with that measured in Fath sector, South Tahrir in 1995-1996 (345-2266 ppm) we could detect a sligh salinity rise of groundwater in the cultivated area, probably due to the leaching of salts and fertilizers to the groundwater since the static level of groundwater ranges between 5 and 12 m below surface.

Data presented in table (1) show that groundwater in Sadat city is of much better quality than in South Tahrir area. Eleven out of the 14 wells tested in Sadat city had groundwater salinity < 500 ppm, two had salinity 500-1000 ppm and only one had salinity of about 1600 ppm in 1995. On the other hand, groundwater salinity in South Tahrir is considerably lower than in Wadi El Natrun (table 3). Thirteen out of the 31 wells tested had

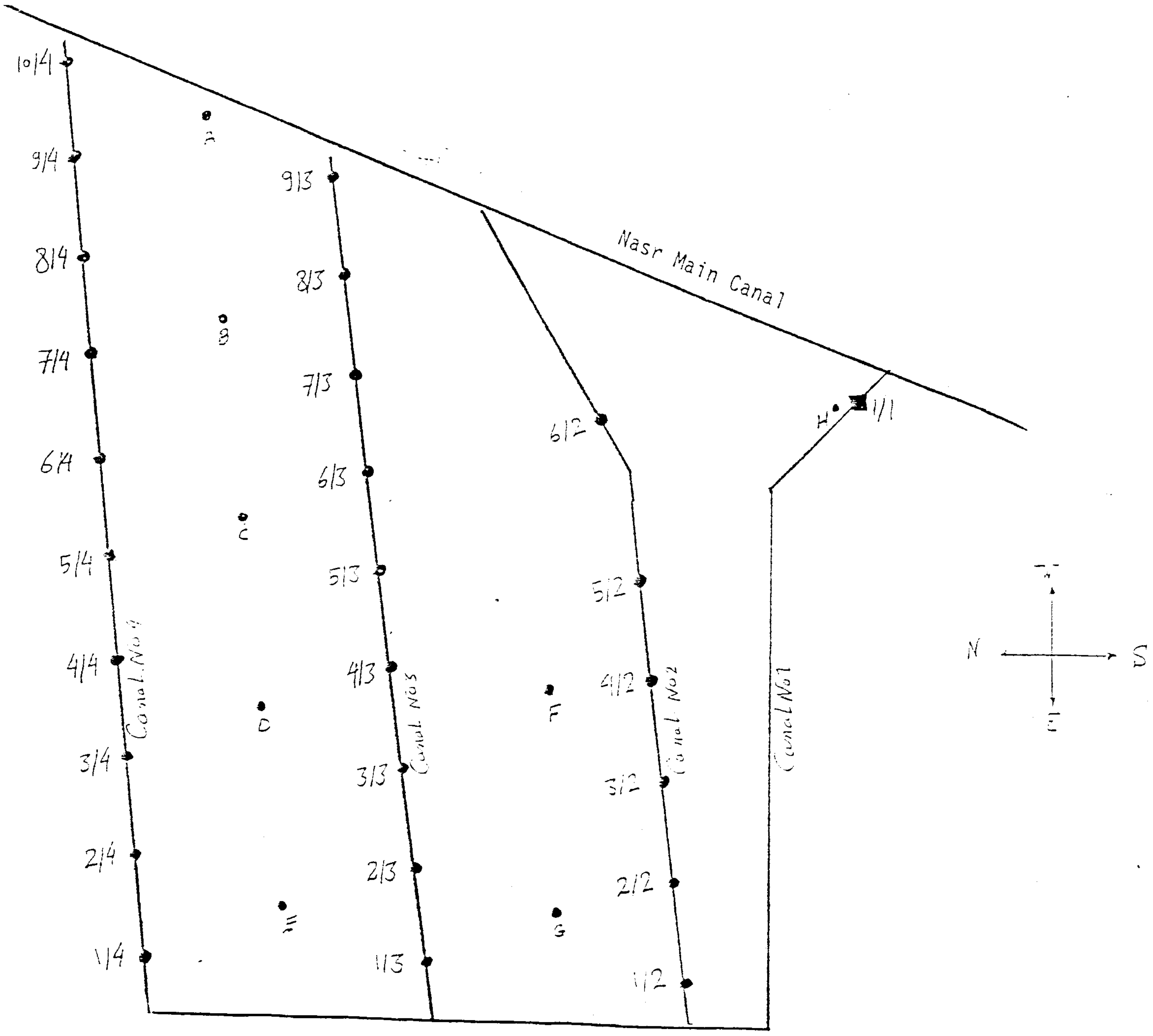

Fig. (14) Location of Wells in Fath Sector, South Tahrir Area

Table (4) : Groundwater Salinity in South Tahrir Area (Fath Sector) (1995-1996)

Well No	*Depth*	*Static level*	*May, 1995*		*Jan. 1996*	
#	*m*	*m*	*EC (dS/m)*	*ppm*	*EC(dS/m)*	*ppm*
1/2	100	10.5	1.00	640	1.02	653
2/2	100	9.5	1.24	797	1.30	832
3/2	100	11.5	1.82	1177	1.74	1114
4/2	100	12.0	2.00	1280	1.74	1114
5/2	40	11.5	1.98	1267	-	-
6/2	100	11.0	2.04	1305	2.14	1370
1/3	100	10.0	-	-	-	-
2/3	100	9.5	0.68	435	0.68	435
3/3	100	9.5	2.14	1369	1.98	1267
4/3	70	9.5	1.2	768	1.14	730
5/3	50	9.5	1.7	1088	-	-
6/3	40	9.5	1.42	908	-	-
7/3	100	7.5	1.26	806	-	-
8/3	100	7.0	1.22	780	1.26	806
9/3	100	6.0	1.12	714	1.24	794
1/4	100	10.5	-	-	-	-
2/4	100	10.5	-	-	1.54	986
3/4	100	10.5	-	-	-	-
4/4	70	10.5	0.86	550	0.72	461
5/4	100	10.5	1.08	691	-	-
6/4	100	10.5	0.7	448	-	-
7/4	70	9.0	-	-	-	-
8/4	70	9.5	1.18	755	1.2	768
A	100	6.0	1.64	1049	1.64	1050
B	100	7.5	1.32	844	1.34	858
C	100	9.5	3.44	2201	3.54	2266
D	100	10.5	1.44	921	1.54	986
E	100	11.0	1.56	998	1.64	1050
F	100	10.5	0.84	537	.88	563
G	100	12.0	2.00	1280	1.74	1114
H	100	5.0	0.54	345	-	-

salinity <1000 ppm while the remaining wells had high salinity in the range 1800-4000 ppm. It should be emphasized that groundwater in both Sadat and Wadi El-Natrun areas is the only source of irrigation water while it only represent a supplementary source of irrigation in South Tahrir area.

Monitoring groundwater quality and quantity in these areas of study will continue to assess the potentiality of this water resource. More historical data may be collected to assess the changes that have been taking place in groundwater.

II. IRRIGATION SYSTEMS EVALUATION

The technical field evaluation of the existing irrigation system in representative desert farms were conducted in four areas namely South Tahrir, Bustan, Sadat City, and Wadi El-Natrun. Bustan and South Tahrir areas use surface water as the main source of irrigation, while sadat city and Wadi El-Natrun use only groundwater for irrigation. In South Tahrir and Bustan, the most widely used pressurized irrigation system is the preinstalled hand-move sprinkler system. Other systems such as fixed sprinkler, draghose, and drip irrigation cover only a small percentage. While in Sadat City and Wadi El-Natrun, the most widely used pressurized irrigation system is the drip irrigation system. Other systems such as fixed sprinkler covers only a small percentage. However, some irrigators are illegally practicing flood irrigation in the four areas under study. Land holders in Bustan area are small holders, graduates, and private investors, while in South Tahrir are settlers, private investors, and large agricultural companies. In Sadat City and Wadi El-Natrun, however, they are mainly investors. A total of 101 sprinkler and drip irrigation systems have been evaluated in a number of selected farms in the four areas under study as follows:

Type of irrigation system	**South Tahrir**	**Bustan**	**Wadi Natrun**	**Sadat**
Hand-move	13	7	-	-
Side-roll	9	-	-	-
Fixed	8	7	6	-
Draghose	-	2	-	-
Drip	-	8	26	15

In Bustan and South Tahrir where settlers and graduates are located, pumping stations are used to supply the hand-move irrigation systems. The settlement areas are provided with the same field irrigation systems throughout, although the land is allocated in either 5.0 feddan units or in 20 feddans units. A typical collective pump station in either Bustan area or South Tahrir area serves about 500 feddans (Fig.1) and consists of three electrical turbine centrifugal pumps, about 100 horsepower each . However, a typical independent pump station in Bustan area serves 20 feddans and consists of 20 horsepower electrical horizontal centrifugal pump.

Sprinkler systems are evaluated in the field by determining the uniformity coefficient (UC), distribution uniformity (DU), and potential application efficiency (PELQ). The test evaluations at the tested area do not include line filling and emptying losses, and gasket leakage. This kind of water losses were included under a separate section titled "water losses". A sample data sheet used for evaluating hand-move, side-roll, draghose, and fixed irrigation system is shown in the Appendix.

Drip irrigation systems are evaluated in the field by determining the emission uniformity (Eu) and the application efficiency (EA). Non-uniformity can be caused by:

1- variability in distribution characteristics due to quality control in the manufacturing processes.

2- faulty or incompetent system design and management.

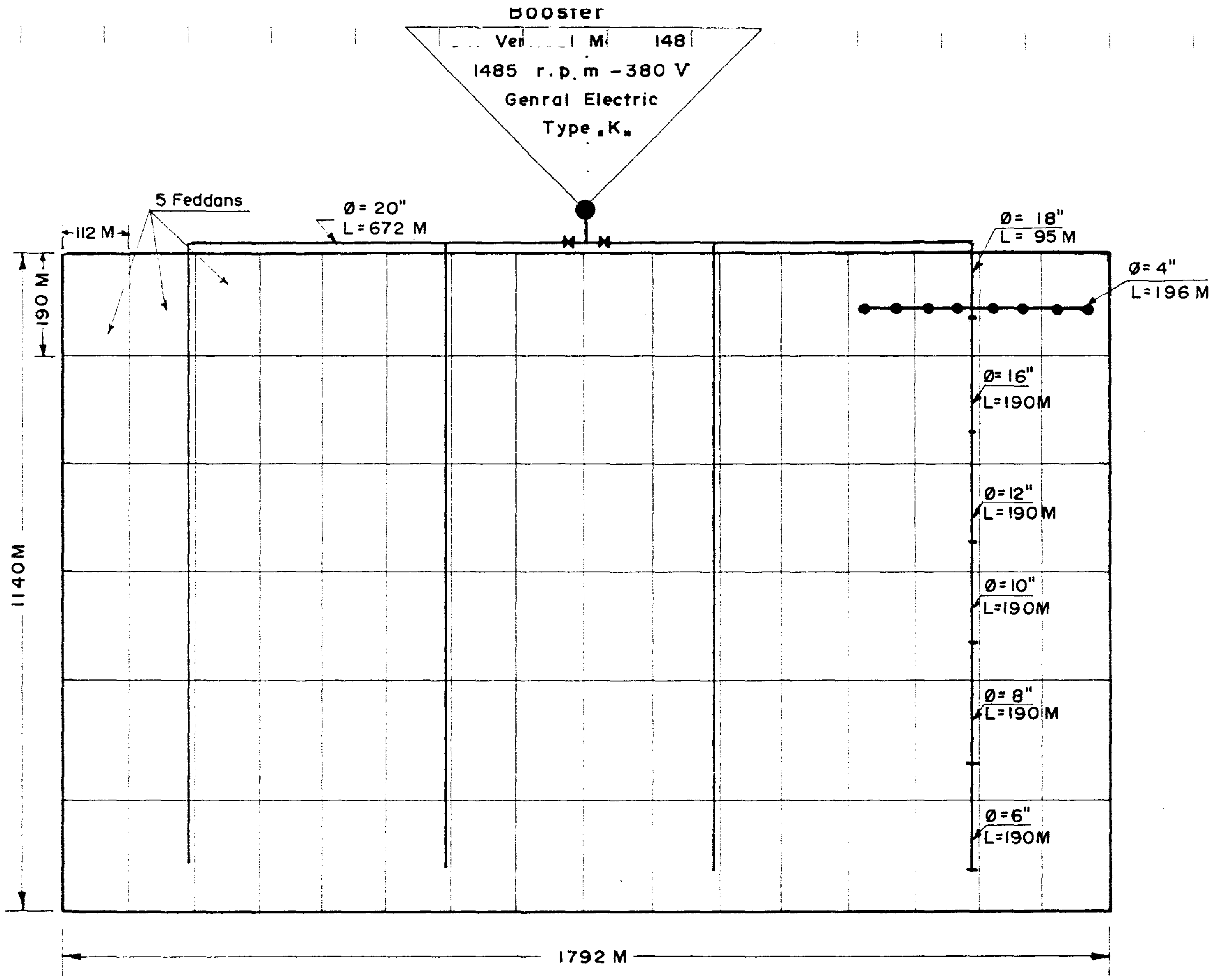

Fig. 1. A typical collective pump station in EL - Bostan.

3- operational pressures outside those suggested for the distribution system being used.

4- physical changes in the system that may have occurred with time.

WATER DISTRIBUTION SYSTEMS

1- EL-Bustan Area

The water is delivered to Bustan area through open concrete-lined secondary and tirtiary canals branch from El-Nasr canal through which water flows under gravity. El-Nasr canal takes water from Nubaria canal. Whilst the Nubaria canal flows wholly under gravity, the El-Nasr canal runs against the slope and water is raised in a number of major pump stations. In the future the El-Bustan area is expected to be irrigated by a new "El-Bustan" canal. In El-Bustan area, where pressurized irrigation systems have been established, water is pumped from tertiary canals using either collective pumping stations (serving 300-600 feddans) or small individual pumps serving 20 feddans.

The pressure distribution system consists of the irrigation pumping station, abstracting water from the tertiary canals, and the buried pipe system, terminating in the hydrants that supply the portable farm laterals.

The pumping stations contain electrically powered centrifugal pumps and designed for a water duty of 2.25 m3/hr per feddan. No stand-by units are provided. There are automatic cut-outs to prevent abstraction where the canal water level is too low.

The pipe work system is asbestos-cement, with pipes ranging in diameter from 4 to 16 inches. The whole area is divided in 5 feddans plots, each having either two hydrants for old design or one hydrant for recent design, rising from the buried branch pipeline. The following are the evaluation of the pressurized irrigation systems used in El-Bustan area.

2- South Tahrir Sector

The water is delivered to South Tahrir Sector through a number of primary, secondary, and tertiary canals branch from El-Riah El-Nasry which is a distributor of the Nile. Branch canals flow under gravity, whilst some of them run against the slope and water is raised in a number of lift pumpstations.

The South Tahrir sector is irrigated by hand-move sprinkler systems, and these are supplied by several irrigated pumpstations taking water from the branch canals. The settlement area is provided with the same field irrigation systems throughout. The land is allocated in 20 feddans to settlers.

The system of field irrigation uses intermediate range, double-nozzle sprinklers mounted on portable, hand-move laterals. Each 20 feddan plot contains 5 hydrants and each hydrant has 3 lateral positions. The designs allow for each 20 feddan plot to be irrigated in three days if the operating hours per day is 15 hours. However, each 20 feddan plot can be irrigated in 5 days if the operating hours per day is reduced to 9 hours, which is the actual situation. One lateral line is provided for each 20 feddan plot.

The South Tahrir sector is subdivided into sections. Each section has a pumping station and a deep-well pump which feeds an area of 200-600 feddans. Each section is subdivided into 20 feddans plots and allocated to settlers. Each section was numbered according to its branch canal number and its location on the branch canal. For example, the section number 6/2 means branch canal number 2 and the pump station number 6 on the branch canal. The water delivery system comprises deep-well pump, irrigation pump station (booster), and pipe system.

Deep-Well Pump. An electrically deep-well turbine pump of about 100 horsepower is used to lift water from underground to discharge into the branch canal. The static underground water level in the area ranges between 20 -40 meter. The deep-well works as an alternate source of water and certainly during the period of shut-down of the canals in January/February.

Irrigation Pump Station. The old installation of pump station includes an electrically powered vertical centrifugal pump house and the suction pipe inlet with trash grate. The electricity of the irrigation pumpstation in some of the old settlement of South-Tahrir is free of charge.

The pumptations are designed for a water duty of about 2 m^3/hr per feddan. This flow is not enough if the operating hours per day is less than 15 hours due to power outage. The pumpstations contain electrically powered centrifugal pumps. No standby units are provided. The settlers operate the irrigation pump stations under the supervision of the staff of the Electrical and Mechanical Division of the Ministry of Public Works and Water resources.

The design sprinkler operating pressure is 3.5 atmospheres, which with allowance for losses in the laterals and buried pipelines plus the suction head, gives a dynamic pumping head of about 5.5 atmospheres depending on ground level variations. Sprinkler pressures as low as 0.5 atmosphere were observed due to different leakage from the irrigation system and wear in the pump impellers. The designers intend the pumpstation to operate 15 hours per day, but it seems that due to shortage of water or electrical failure, and possibly other reasons, they operate on average less than 10 hours per day.

Pipe System. The sprinkler system consists of the buried pipe system, terminating in the hydrants that supply the portable farm laterals. The pipe work system is Asbestos-Cement, with pipes ranging in diameter from 16 inches to 4 inches.

SPRINKLER SYSTEMS EVALUATIONS

Hand-Move Sprinkler System

The field irrigation equipment provided for hand-move system in Bustan area comprises one aluminum 3.0 inch diameter lateral line. One lateral line is shared between two earlier settlers whereas more recent settler has his own lateral. On each lateral six twin nozzle rain bird 70 sprinklers are mounted at 15 m intervals on risers. The sprinkler, manufactured in Egypt, releases 3.7 m3/hr at an operating pressure of 3.5 bar. The designs allow for 15 hours of irrigation per day, with an irrigation interval in the peak period of 4 days which is enough to cover the peak consumptive use (readily available moisture is 28 mm and peak consumptive use is 7 mm/day).

In practice the pumping station operating hours is, on average, 8-10 hours per day. In addition, the design operating pressure is not achieved with a subsequent reduction in sprinkler discharge capacity and a serious impact on the uniformity of water application and efficiency of water application.

The hand-move sprinkler has high labor requirements and subjects equipment to an exceptionally high rate of wear due to the high number of lateral movements required by the large number of irrigations necessary. The policy of sharing one lateral sprinkler line between two earlier settlers is clearly unsatisfactory in relation to the highly intensive use of equipment. The recently designed and constructed sprinkler projects in Bustan area provides one sprinkler lateral for each 5 feddans unit, and thus this problem is limited to the earlier settlers.

From the field evaluation (Table 1), it was observed that on several occasions the sprinklers were operating at low pressure. The more logical explanation lies in the exceptionally high level of water losses from the irrigation hydrants, valve elbows, lateral pipe seals, and sprinkler bearings. In addition, some farmers practice surface irrigation illegally and there are possible leakage from buried main pipelines. All these reasons cause the pumps to deliver much higher discharges than designed with a consequent drop in pressure. As a result of having no desilting basins or sand separator at the pumping stations, there is wear in the impellers caused by sand blown into the irrigation canals.

The direct impact of low operating pressures is a reduction in sprinkler nozzle discharges and distortion of the optimum water distribution pattern thus reducing the application efficiency. Low pressures also increase droplet size which cause physical damage to plants.

The hand-move sprinkler system in El-Bustan area is designed in accordance with the following assumptions of net crop water requirements. The peak water use is 7.0 mm/day and the sprinkler irrigation efficiency is 75%. The water requirements for the originally proposed cropping pattern are not met during summer period, for El-Bustan. All these calculations are based on 15 hours operation per day which is the designer's intention, but due to a shortage of water, or electrical failure or pumps breakdown, the actual working hours reported during the field evaluations is only 8-10 hours per day. As a regular event, this would reduce the area that can reliably be irrigated by about 50%.

The sprinkler irrigation equipment provided in the 20 feddan plot of South-Tahrir comprises one portable aluminum lateral line of 270 meter length with two pipe sizes. The lateral line starts with a diameter of 4 inches for 90 meter length and 3 inches diameter for 180 meter length. On each lateral, thirty twin nozzle Rain Bird 30 TNT sprinklers (Locally manufactured by Helwan Company for Non-Ferrous Industries) have the following characteristics:

- Nozzle diameter: 4.8 x 2.4 mm - 27 degrees (trajectory angle);

-Design operating pressure: 3.5 bar;

- Effective diameter of wetting: 30 m;

- Sprinkler discharge; 34 liter/minute.

At the design spacing of 9 x 18 m, the application rate can be calculated as follows;

$$I = \frac{q}{S_l \times S_m}$$

$$= (34 \times 60) / (9 \times 18) = 12.6 \text{ mm / hr}$$

where q is the sprinkler discharge and sl, sm are sprinkler spacings.

Each 20 feddan plot has 5 hydrants rising from the buried branch pipeline, giving a total of fifteen lateral positions. Irrigation of a 20 feddan plot is to be accomplished in 5 days, with 3 lateral positions per day.

It can be assumed that the available water is 60 mm/m, with irrigation being necessary when 50 % of this is depleted. Thus 30 mm/m is considered readily available water. For a 0.7 m rooting depth (common for most field crops) , the net application depth is 21 mm. This confirms the necessity for a 3 days irrigation interval in the peak period (July / August) for most crops, hence the peak consumptive use of most crops lies between 7 and 8 mm per day. If the 20 feddan plot must be irrigated within 3 days, then 5 lateral movement must be done everyday. According to the above computations, the operating time must be 12 hours at peak period. The irrigation time would be 2.25 hours per lateral position, equivalent to 12.6 mm/m x 2.25 hr = 28.35 mm. If the irrigation efficiency is 75 % then the net application depth is 21 mm. As the irrigation interval in the peak period is 3 days, this is equivalent to a peak crop consumptive use of 7 mm/day. It was observed that the Rain Bird 30 TNT sprinkler is not suitable for all uses. It cannot be used for undertree irrigation of citrus.

Sprinkler Rotation. The rotation rate of sprinklers on the same lateral line are not uniform as presented in the evaluation sheets found in the Appendix. As a consequence, uniformity of water distribution is further reduced. Rotation rate is dependent on the mechanism; the bearing construction and the seals used; the nozzle diameter; the pressure; and the tension on the arm spring. Worn bearings or seals cause a variable rate of rotation and thus a poor distribution pattern. The wetted diameter becomes smaller with the faster rotation for the same sprinkler. If damage has occurred to the oscillating arm, the arm should be replaced. The angle of water-contact of the jet with the arm, if not correct, will change the turning characteristics of the sprinkler.

Wind Speed. Sprinkler systems were designed without adequate consideration of wind. However, it has been shown that the wind greatly affects sprinkler performance (Table 1). If the effect of speed and direction of the wind is not sufficiently considered in the design of a sprinkler irrigation system, the resulting system's performance may be suboptimal. Most researchers agree that uniformity coefficient decreases as wind speed increases. some combinations of nozzle size, pressure, and sprinkler spacing do show a slight increase in uniformity coefficient at low wind speeds. Redditt (1965) credited the reduced uniformities at higher wind speeds to a quicker breakup of the jet of water leaving the nozzle.

The water begins traveling as individual drops sooner, and therefore travels a shorter distance from the nozzle.

Griffin (1978)1 reported that most agricultural sprinkler applications require a uniformity coefficient of at least 80 percent for market acceptance, but the appropriate design uniformity coefficient is a function of available water, crop water response, and crop price (Von Bernuth, 1983)2. Low uniformity coefficient values often indicate an incorrect combination of sprinkler size, operating pressure, and spacing.

Riser Height. Many farmers install the sprinkler heads directly on the lateral line without using risers (Table 1). Risers are short pipes between the sprinkler and its supply pipe (lateral). Their purpose is twofold. They raise the sprinkler above the ground so that the jet will not be interfered with by the growing crop, and they provide a straight section of pipe leading to the sprinkler to help remove the turbulence set up when part of the flow in the lateral pipeline is diverted to an individual sprinkler. If not removed, this turbulence may carry through the nozzle and cause premature stream breakup and reduced diameter of coverage and hence

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1-Griffin,S.B.1978.Computer programming solid set system.ASAE Paper No. 78-2o12, ASAE,St. Joseph, MI 49085.

2-Von Bernuth,R,D.1983. Uniformity design criteria under limited water. Transactions of the ASAE, 26(5):1418-1421.

produce a poor distribution pattern. The length of pipe needed to remove turbulence is about 30 cm. Some research studies indicate that 30 to 60 cm additional height improves the sprinkler distribution efficiency. However, there are obvious disadvantages to this, such as additional wind drift and problems with handling lateral pipes with long risers attached. The preferable riser height is 45- 60 cm except when irrigating higher growing crops or for fixed systems with buried lateral.

Mixed Sprinkler Head. Different type of sprinklers, nozzle sizes, nozzle configurations, and spacings were being used on the same lateral pipeline as shown in Table 1. As a consequence, levels of leakage increased and the efficiency of water application is further reduced.

Sprinkler nozzles are frequently plugged by dirt, grit, weeds, and trash that can be drawn into the system by the pump or enter the pipes when they are being moved from one setting to the next. To prevent blockage, filters should be placed at various places in the pipe system. The convenient location for the filter in the pipe is at the head of the lateral between the valve elbow and the first section of pipe. The filter can be made from thin sheet brass perforated with fine holes.

While making the inspection tours, it was found that most sprinklers are not operating satisfactorily. This was don by pointing out diameter of pattern coverage and improper breakup of nozzle stream.

Sprinkler application efficiency is reduced when worn nozzles unevenly or excessively apply water. The wear of sprinkler nozzles may be checked with a proper size drill bit. If the proper size drill bit fits the nozzle tightly there is little if any wear but if the drill bit fits loosely the nozzle should be inspected for wear. Increasing discharge caused by worn nozzles may cause a pump to produce less pressure and/or maintain pressure and overload the motor.

Replacement equipment is frequently not compatible with existing equipment specifications. Since there is a range of sprinkler types installed, there is a risk of farmers purchasing the incorrect type of equipment and instances were observed during field evaluations where three types of sprinklers, discharge capacities and spacings were being used on the same lateral pipeline. As a consequence, the efficiency of water application is further reduced and levels of leakage increased.

Draghose Sprinkler System. The draghose sprinkler is considered as a modification of the hand move sprinkler system. In Draghose system (Fig. 2), individual sprinklers are supplied by hoses and periodically moved to cover several positions. In this case 7 sprinklers are attached to 7 flexible hoses (48 m length and 25 mm diameter) and the lateral line remains stationary. Sprinklers are mounted on skids and towed periodically to give grid patterns of 12x12 m. Risers should be high enough to keep the sprinklers above the mature crop.

The hand-move sprinkler is labor intensive system. The modification of existing hand-move by introducing draghose sprinklers would reduce labor demand to about half of that required for a comparable hand-move lateral system. It is also more convenient, easier to operate and saves deterioration of lateral pipes and fittings.

Figure 2. Draghose sprinkler system.

Uniformity coefficient (UC). Nine Hand-move sprinkler systems have been evaluated in Bustan area since August 1995 (Table 1). Of these 9 systems, one had an UC between 80-90 %. Four systems had UC's between 60-80%, and three systems had UC's less than 60%. The two draghose systems evaluated in El-Bustan area (#1,#6 in Table 1) had UC's of 76 and 57%. As presented in Table 1, the lower UC can be attributed to high wind, low operating pressure, and wide sprinkler spacing in related to the actual wetted diameter. Another 9 Hand-move sprinkler systems had been evaluated in South Tahrir and presented in the second progress report, May 1995 (Table 2). Of these 9 systems, One had an UC between 80-90%. Five systems had UC's between 60-80%, and three systems had UC's less than 60%. Additional 4 Hand-move sprinkler systems were evaluated in the DDC farm, South Tahrir and presented in the second progress report, May 1995 (Table 3). Of these four systems, one had an UC between 80-90%. Two systems had UC's between 60-80%, and one system had an UC less than 60%. Nine Side-roll sprinkler systems were evaluated in the DDC farm and are presented in Table 3. Of these 9 systems, two had EU's between 80-90%. Six systems had UC's between 60-80%, and one system had an UC less than 60%.

Improvements. Poor water distribution pattern may be improved by the following methods:

(1) use proper sprinkler nozzle pressure as recommended by the manufacturer.

Table (1). Summary of the field evaluations for the Hand-move sprinkler in El-Bostan area

NO	Irrigation system characteristics						Wind	Irrigation system Performance				
	P. bar	q, m^3 /hr	nozzle ϕ mm x mm	spacings m x m	wetted diameter m	Riser height m	speed Km/hr	$\frac{\Delta P}{P'}$	$\frac{\Delta q}{q'}$	DU	UC	PELQ
1	2.2	2.1	2.5 x 4.5	12 x 15	18	0.9	7.5	0.4	0.44	60.6	75.8	54.2
2	1.3	3.5	5 x with out nozzle mixed	9 x 15	21	None	3.6	0.37	0.24	76.7	86.4	71.7
3	1	3.8	5.5 x with out nozzle mixed	9 x 15	18	0.6	5.4	0	0.57	57.7	68	50.6
4	1	6.6	7.5 x with out nozzle mixed	15 x 15	17	0.6	9.6	0.57	0.66	36	56.4	17
5	1	3.9	5 x with out nozzle mixed	15 x 15	18	0.6	10	0.45	0.38	36.5	56.9	27.6
6	1.3	1.8	5.5x2.5 mixed	15 x15	18	0.6	10	0.45	0.38	36.5	56.9	27.6
7	2.5	3.6	mixed	12 x 18	19	0.2	10.8	0.04	0.77	43.9	65.7	28.5
8	1.8	1.7	4.5 x 3 mixed	15 x 15	-	1.2	18.0	0.73	0.31	50.5	68.6	48.1
9	1	3	5.5 x 0 mixed	9 x 15	15	None	9	0.1	0.17	25.5	56.1	18.6

Table (2): Summary of the field evaluations for the hand-move irrigation system at representative farmer's fields in South Tahrir.

Hydrant No.	Pump Station No.	Irrigation System Characteristics				Irrigation System Performance		
		P. bar	q. m³/h	Nozzle o m xm	Spacings m xm	DU	UC	PELQ
1-	1/3	1	1.05	5	9 x 9	51.8	44.2	59.2
5-	1/3	1	1.23	5.5	9 x 9	70.7	84.5	86
10-	1/3	1	2	6.5/2.5	9 x 9	70.7	75.2	53
5	1/3	0.7	0.82	4.5/2.5	9 x 9	13.7	38	8
10	1/3	0.8	1	4.5/2.5	9 x 9	66.6	65.7	59
10	5/3	0.5	1.17	6/2.5	9 x 15	44	51	65.6
5	5/3	1.5	1.55	5.5/2.5	9 x 12	55	67	46
10-	5/3	1	1.46	5.5/2.5	9 x 15	46	60	51.6
1	9/3	1.1	1.51	6	9 x 9	69.3	74.9	76.1

Table (3) Summary of the field evaluations made at the DDC Farm in South Tahrir farm

Field No.	Type of Irrigation System	Irrigation System Characteristics				Irrigation System Performance		
		P , bar	q, m3/h	Nozzle Ø mm x mm	Spacings m x m	DU	UC	PELQ
3	Side-roll	3	2.1	5x3	12x18	59.8	73.5	70
	Side-roll	2	3	7x4	12x18	51.8	68.5	41
5	Side-roll	2.4	1.7	5.5x3.5	12x18	46.0	58	40.5
	Hand-move	2	1.8	5.5x2	9x18	81.4	86	73.6
7	Side-roll	3	2	5.5x2	12x18	53.7	66	62
	Hand-move	3.2	1.9	5x2	9x18	51.4	78.2	54
9	Side-roll	1.5	1.8	5.5x2.5	12x18	67.3	74	54
10	Side-roll	2.1	2.9	6.5x3.5	12x18	75.4	81.5	
12	Side-roll	2.5	2	5x2.5	12x18	54.7	64.8	
	Hand-move	3.3	2.5	5x2.5	9x18	40.0	47	
15	Hand-move	2	1.7	5x2.5	9x18	66.5	72	77
17	Side-roll	2.8	2.3	5.5x2.5	12x18	69.0	79.5	50
	Side-roll	2.6	2.7	6.5x2.5	9x18	78.6	86	40
8	Fixed system	2.1	3.05	7x2.5	18x18	60.8	76	43.6
	Fixed system	2.5	1.63	5x2.5	18x18	56.2	69	46.4
16	Fixed system	2.5	2.8	7x2.5	18x18	62.6	74.7	62.2
	Fixed system	3.4	1.55	5x2.5	18x18	64.0	73,5	69.6
11	Fixed system	3.5	1.7	5x2.5	18x18	65.6	75	51
8	Fixed system	2.4	1.66	5x2.5	18x18	50.0	62.7	58.5
	Fixed system	2.5	3.09	7x2.5	18x18	47.9	71.3	60.6
11	Fixed system	1.95	2.78	7x2.5	18x18	59.8	46.2	70

(2) change lateral spacing. Lateral spacing should not exceed 65 percent of the diameter of the pattern under no-wind conditions. For the prevailing 10 km/hour wind speed, lateral spacing should be limited to 50 percent of the wetted diameter.

Fixed (Solid) Sprinkler system

Two types of sprinklers are used. The RB70, with the sprinklers spaced 15x18 m, and the RB30 with sprinklers spaced at 12x12 m. The discharge of the RB30 sprinkler is 1.4 m3/hr at a working pressure of 2.8 bar.

The evaluated irrigation systems characteristics and performance are calculated and summarized in Table 4. Several observations and some recommendations can be based on the data and computations in Table 4.

Operating Pressure. Operating pressure as low as 0.8 bar was found as indicated in Table 4. The operating pressure for 69% of the systems evaluated are under the minimum manufacturer's recommended operating pressures of 2 bar for the sprinklers used. Operating at too low a pressure is a common problem on many sprinkler systems. It can be concluded that most sprinkler irrigation systems are operating below the correct pressure.

The direct impact of low operating pressure is a reduction in wetted diameter and hence a distortion of the optimum water distribution pattern. As the pressure reduced, the water application pattern changes from the normal triangle shape to the doughnut shape. As a consequence, the uniformity of water application is further reduced. The wetted diameter depends on the operating pressure as follows:-

Table (4). Summary of the field evaluations for the fixed sprinkler in El-Bostan and Wadi El-Natron

O	Irrigation system characteristics						Wind	Irrigation system Performance				
	P. bar	q. m^3 hr	nozzle ϕ mm x mm	spacings m x m	wetted diameter m	Riser height m	speed Km/hr	$\frac{\Delta P}{P'}$	$\frac{\Delta q}{q'}$	DU	UC	PELQ
EL- Bostan												
10	1.4	6.17	-	18 x 18	23	0.6	9.3	0.214	0.17	42	59.4	40.7
11	1.9	1.7	5 x 3	18 x 18	23	0.5	4.8	.21	0.1	53	66.9	50.5
12	2	2.1	5 x 4	18 x 18	22	0.5	18.7	0.54	0.24	8.3	40.5	6.5
13	1.5	7.4	-	18 x 18	24.5	0.5	11.5	0.06	0.02	42.3	59.3	38.5
14	2.2	2.1	5 x 3	15 x 15	16	0.5	6.3	0.17	0.41	51.9	58.8	46.3
15	1.2	4.7	8 x 5	15 x 15	22	0.6	6	0.24	0.47	32.8	53.7	29.4
16	1.5	1.4	-	15 x 15	16	0.6	9.5	0.2	0.39	31.6	50.7	23.1
Wadi El-Natron												
1	0.8	075	3.9 x 3	12 x 12	16	0.75	9.7	0	0.318	45	62.4	33.1
1	1.1	0.7	4 x -	7 x 7	21	1	9	0.09	0.32	72.5	82.3	62.2
2	1.3	1.1	4 x 2.3	12 x 12	21	0.5	9	0.08	0.29	59.5	67	55.5
3	1	0.76	3.9 x 3	12 x 12	16.2	1	11.3	0	0.04	52.5	62.5	50.3
4	2.9	1.55	4.5 x 3	15 x 12	20.5	0.9	14.4	0.34	0.18	72.4	82.7	66.9
5	2	1.3	-	12 x 15	20	1	5.8	0	.14	74.62	82.76	68.15

$$WD = 2.7\ \sqrt{h * d}$$

Where: WD = wetted diameter, m

h = sprinkler operating head, m

d = sprinkler nozzle diameter, mm

The direct impact of low pressure is also a reduction in sprinkler nozzle discharges as described by the following equation :-

$$q = c_d \frac{\pi}{4} d^2 \sqrt{2gh}$$

Where: q = sprinkler discharge

cd = discharge coefficient, cd = 0.95

h = sprinkler operating head.

Low pressures also increase droplet size which damage delicate crops and some soils by breaking down the surface structure and reducing the infiltration rate.

To determine whether the spray from a sprinkler is coarse, fine, or somewhere in between, the coarseness index (CI) is used. This index can be calculated by the following method:

$$CI = \frac{P^{1.3}}{B}$$

Where: P = nozzle operating pressure (psi)

B = nozzle size (64ths of an inch)

If the value of $CI \leq 7$ the spray is coarse

If the value of $CI \geq 17$ then the spray is fine.

Low pressures also cause the rubber ring in the pipe couplers to leak, since it seals only under the correct pressure.

Mixed Sprinkler Head. Different nozzle types and sizes were being used on the same lateral pipeline as indicated in Table 4 and in the evaluation sheets in the Appendix. Heavy wear of nozzles were found when checking with a proper size drill bit. Silt and sand particles in irrigation water can cause wear and increase the size of the bore. Sprinkler efficiency is reduced when worn nozzles unevenly or excessively apply water. Increasing discharge caused by worn nozzles may cause a pump to produce less pressure and/or maintain pressure and overload the motor. Heavy nozzle wear can mean up to 17 % more energy use by pumps to maintain correct operating pressures. This will result in extra cost and over irrigation.

Riser Height. The riser height ranges between 0.5 and 0.6 m in Bustan and reaches 1m in Wadi Natrun, as indicated in Table 4, which is suitable from the hydraulic point of view and also for low height crops. However, the problem lies in the erectness of the riser. Most risers are not in vertical positions. As a consequence, the uniformity of water application is reduced.

Sprinkler Spacings. The sprinkler spacings are either 15 x 15 m or 18 x 18 m in Bustan and mainly 12 x 12 m in Wadi Natrun, as indicated in Table 4. However, it has been shown that the wind greatly affects sprinkler performance as shown in the same Table. It can be seen that when the effect of speed and direction of the wind is not sufficiently considered in the design of the sprinkler irrigation system, the resulting system performance will be suboptimal.

As shown in Table 4, the sprinkler spacing exceeds 65 % of the actual measured wetted diameter of the sprinkler. However, the lateral spacing should not exceed 65 percent of the diameter of the pattern under no-wind conditions. For the prevailing 10 km/hr wind speed in the area, lateral spacing should be limited to 50 percent of the wetted diameter. Generally, highest uniformities are obtained at spacings of 40 percent or less of the diameter, but such close spacings raise both precipitation rates and costs.

Head Loss in Laterals. Sprinkler discharge is approximately equivalent to that of an orifice.

$$q_s = C\sqrt{H}$$

Where H is the head at sprinkler, and C is a coefficient. In order to obtain the same discharge at every sprinkler along a lateral, H must be equal at each sprinkler. This does not usually occur in an installation and it is common practice to limit the difference in H along the lateral to 20 percent of the average H. Thus,

$$H_{max} = 0.2\overline{H}$$

Where $\overline{H}$ is the average of the heads for all sprinklers along the lateral line, and H_{max} is the maximum allowable difference in head between any two sprinklers on a lateral. This can result in a probable maximum dischalge differential of

$$e = \frac{\sqrt{1.1H}}{\sqrt{0.9H}} = 1.11$$

or the maximum discharge rate is 11 percent greater than the minimum discharge rate. The value of H at any point (and hence of H for the line) is a function of the head loss in the laterals, the difference in elevation, and the pressure at the head of the line.

Uniformity Coefficient. Seven fixed irrigation systems have been evaluated in El-Bustan area since May 1995 (Table 4). Of these 7 systems, one had an UC between 60-80%, and six systems had UC's less than 60%. However, of the six fixed systems evaluated in Wadi Natrun, three had UC's between 80-90%, and three had UC's between 60-80%. In addition, 8 Fixed sprinkler systems were evaluated in the DDC farm, South Tahrir and are presented in Table 3. Of these 8 systems, seven had UC's between 60-80%, and one had an UC less than 60%. The lower UC can be attributed to high wind, low operating pressure, and wide sprinkler spacing in relation to the actual wetted diameter

Improvements. Poor water distribution pattern may be improved by the following methods:

(1) use proper sprinkler nozzle pressure as recommended by the manufacturer.

(2) change lateral spacing. For the prevailing 10 km/hour wind speed, lateral spacing should be limited to 50 percent of the wetted diameter.

DRIP IRRIGATION EVALUATION

Field Procedure

The emission uniformity can be determined in the field by the following procedure:

1. Select a subunit representative of average operating conditions in all subunits.

2. locate 4 laterals along an operating submain; one lateral near the inlet end, one lateral near the far end, two laterals evenly spaced in the middle section.

3. measure the pressures at the inlet and at the far end of each lateral.

4. on each lateral select 2 adjacent emitters at 4 different plant locations - at the inlet, 1/3rd of the way down the lateral, 2/3rds and at the end points of laterals in situations where three or more emitters are located at a single plant location.

5. measure the discharge from emission points selected according to 4 above. Collect the flow for a full number of minutes - 1, 2, 3 etc. to obtain a volume between 100 and 250 ml for each emitter.

6. Enter the information collected into the data sheet in Table 5.

7. Compute the average discharge for each pair of emitters.

8. Use the average of the lowest 4 discharges of all the readings as the minimum rate of discharge.

9. The average of all the readings is the average rate of discharge per emitter.

10. Calculate the field emission uniformity (EU) by the following equation:

$$\mathbf{EU} = \frac{\textbf{minimum rate of discharge per plant}}{\textbf{average rate of discharge per plant}}$$

11. Estimate the application efficiency (AE).

Table (5) . Summary of the field evaluation for the drip irrigation systems in El-Bostan

No	location	crop	EC ppm	Emitter type	P.bar	q_e . L/H	spacing m x m	Lateral line			Filter		Fertilizer unit type	Performance		liter/day /plant
								Diameter mm	Lenght m	(Pmax-Pmin) bar	Type	P loss		E_u	Ea	
1	El-bostan	citrus +apple	-	spaghetti	0.5	90	4 x 2.5	16	20	0.2	Non	-	Non	78.4	70.5	90
2	El-bostan	citrus	-	spaghetti	0.5	50	4 x 4	11	20	0.2	Non	-	Non	41%	36.9	50
3	El-bostan	citrus	-	spaghetti	0.5	90	4 x 2.5	16	20	0.2	Non	-	Non	78.4	70.5	90
4	El-bostan	vegetable	-	GR	1.4	4	1.75 x 0.5	16	40	0.3	screen 60 - m3/h	-	-	87.4	78.6	2
5	El-bostan	vegetable	-	GR	1.5	4	1.85 x 0.5	16	45	0.3	screen	-	-	85.5	76.9	4
6	El-bostan	vegetable	-	GR	1	4	185 x 0.5	16	42	0.1	screen	-	-	89.8	80.8	8
7	El-bostan	squash + egg plant	-	GR	1.4	4	1.8 x 0.5	16	42	0.2	screen	-	-	72.7	65.4	4
8	El-bostan	Tomato	-	GR	0.7	4	1.7 x 0.5	16	45	0.1	screen	-	-	71.6	64.4	4
9	El-bostan	vegetable	-	GR	0.5	4	1.8 x 0.5	16	55	0.1	screen	-	-	71.2	64.1	4

Drip irrigation has significant advantages over other techniques in minimizing or preventing water loss because leakage from the delivery system is negligible. Evaporation is minor as water is not discharged in the air, as with sprinkler irrigation, or left on the soil surface as with surface irrigation methods. Only a small fraction of the soil surface is wet. Therefore, the only considerable water loss in drip irrigation is deep percolation. With drip irrigation it is always very difficult to determine the soil moisture deficit in the field because of the small soil moisture variations which occur in the wetted soil before and after irrigation. Therefore reasonable deep percolation will be taken as 10 percent of the amount of water applied. The application efficiency is therefore: Ea = 0.9 . Eu.

Data Analysis and Recommendations

In Bustan area, trickle irrigation is used mainly to irrigate citrus, apple, tomatoes, and vegetables as cucumber, pepper, squash, and eggplant. However, in wadi Natrun area, trickle irrigation is used mainly to irrigate citrus, mango, peaches, apple, tomatoes, and apricot.

The source of water in El-Bustan area is the Nile water, which contains organic matter, silt, and sand. Therefore, the filtration system should contain both media filter and screen filter, but as indicated in Table 5 about 33% of the drip systems have no filter at all. However, 66% of the drip systems have only screen filters. The screen filter does not remove organic materials, which is common in surface water.

The drip irrigation system in Sadat area is underdesigned and poorly constructed and used mainly for irrigating olives and fruit trees. As presented in Table 6, the groundwater salinity is variable and had values between 256-1523 ppm. Fifteen evaluations were conducted since September 1995 on drip systems in Sadat area. All of the 15 evaluations had EU's less than 70 %, as presented in Table 6. Of the 15 evaluations, only 3 systems had screen filter, and only 4 systems had fertilizer injection device. The most common problems were with low pressure in the lateral lines (less than 0.5 bar) and clogged emitters. The low pressure was related to low system pressure, due to the low pressure at the deep-well pump. There were instances that mixed emitters were used due to emitters from different manufacturers being used in the same zone and/or emitters in the same zone having different flow rates. Problems from leaks in laterals were due to leaks and/or cuts in the lateral along the length of the rows. In one instance, there were missing parts from the emitters, resulting in low emission uniformity.

In Wadi El-Natrun area the source of water is wells. Therefore, screen filter or disc filter is satisfactory for the filtration system. As indicated in Table 7, only 30% of the drip systems contain pressure gages before and after the filter to enable monitoring the pressure loss across the filter and hence know the time of cleaning and also figure out the filter efficiency. As also presented in Table 7, the pressure loss across the filter reached 3 bar in some drip systems which indicate a large pressure loss due to filter blockage and may need to change the media.

Table (6) . Summary of the field evaluation for the drip irrigation systems in Sadat

No	location	crop	EC ppm	Emitter type	P.bar	q_e , L/H	spacing s m x m	Lateral line			Filter		Fertilizer unit type	Performance		liter/day /plant
								Diameter mm	Lenght m	(Pmax-Pmin) bar	Type	P loss		E_u	Ea	
2	Sadat	olives	-	spagetti	0.25	30.9	6 x 5	16	55	0.2	Non	-	Non	24.8	22.3	23.2
3	Sadat	olives	294	spaghetti	0.15	17.9	5 x 7	16	40	0.1	Non	-	Non	5.02	4.52	13.44
4	Sadat	apple	256	E2	0.6	34.7	6 x 6	16	65	0	Non	-	Non	40.2	36.2	11.6
5	Sadat	Gawafa	-	spaghetti	1.0	60	5 x 2.5	16	30	0.6	gravel+ screen	-	-	69.5	62.5	45
6	Sadat	Lemon	-	spaghetti	0.25	26.73	5 x 5	16	60	0.2	Non	-	Non	11.22	10.09	26.73
7	Sadat	pepper	435	katif	0.2	4.05	0.5 x 1.9	16	30	0.1	Non	-	200 liter tank	58.8	53	8.1
8	Sadat	cucumber	435	katif	0.15	3.96	0.5 x 1.8	16	34	0.1	2 screen 3"	-	200 liter tank	57.8	52	1.32
9	Sadat	Mendalin	1203	microjet	0.7	35.96	4 x4	16	35	0.4	3 screen4"	0.2	venturi1"	49.4	44.46	95.9
10	Sadat	olives	-	spaghetti	0.3	36.23	4 x 4	16	35	0.3	Non	-	Non	45.37	40.84	18.11
11	Sadat	olives	294	E2	0.2	30.78	6 x 6	16	36	0.1	Nin	-	Non	38.3	34.47	25.65
12	Sadat	olives	1523	spaghetti	0.45	57.7	6 x 5	16	60	0.3	Non	-	Non	62.95	56.65	8.24
13	Sadat	Tomatoes	256	katif	0.3	8	0.5 x 1.5	16	30	0.2	2 screen3"	-	100 liter tank	46.8	42.12	8
14	Sadat	olives	-	spaghetti	0.55	91	6 x 6	16	78	0.2	Non	-	Non	69.3	62.37	45.5
15	Sadat	apple	-	saghetti	0.4	74.34	6 x 6	16	75	0.4	Non	-	Non	27.4	24.6	18.6
16	Sadat	olives	493	E2 without cap	0.4	54	6 x 5	16	75	0.5	Non	-	Non	40	36	18

Table (7) . Summary of the field evaluation for the drip irrigation systems in Wadi-El Natron

No	location	crop	EC ppm	Emitter type	P.bar	q_e . L/H	spacings m x m	Lateral line			Filter		Fertilizer unit type	Performance		liter/day /plant
								Diameter mm	Lenght m	(Pmax-Pmin) bar	Type	P loss		Eu	Ea	
1	North section	orange	442	spaghetti	0.3	50	5 x 5	16	35	0.1	Non	-	Non	65	58.5	16.7
2	North section	olives	1107	spaghetti	0.6	81	5 x5	16	70	0.5	Non	-	150 liter tank	37.4	33.7	40.5
3	North section	appel	595	katif	0.68	7.5 x 2	3 x 4	16	45	0.1	4 screen	-	hydraulic	88.1	79.3	15
4	North section	olives	499	spaghetti	0.3	55.8	7 x 7	16	45	0.1	screen 2"	-	venturi 3/4"	60.7	54..7	37.2
5	North section	olives	704	Jet sprink	1.3	38.48	6 x 6	16	36	0.1	2 screen 3"	-	Non	91.6	82.44	64.1
6	North section	olives	1760	katif	0.77	8.8	5 x 5	16	100	0.2	4 screen	0.2	150 liter tank	67.3	68.7	92.4
7	North section	Grapes	-	microject	0.3	13.27	2.5 x 2.5	16	75	0.5	2 screen 3"	0.2	150 liter tank	34.36	30.93	2.6
8	North section	olives	448	spaghetti	0.15	38	7.5 x 7.5-	16	55	0.1	disc 3"	0.2-	150 liter tank	43.36	39.03	28.5
1	South section	citrus	505	microjet	0.4	27.4	3.5 x 3.5	16	30	0.1	3 screen filter 4"	0.2	hudraulic injection pump	45	40.5	27.4
2	South section	peaches	307	Rain bird	0.6	3.46	4 x 6	16	80	0.1	screen	3.0	150 liter tank	60.7	54.6	27.7
3	South section	citrus	480	microjet	0.475	24.3	3 x 4.5	16	50	0.3	3 screen4"	-	150 liter tank	71.3	64.1	18.23
4	South section	appel	342	microjet	0.64	33.6	3 x 4	18	48	0.2	screen. 6"	0.20	Non	74.6	67.1	33.6
5	South section	tomatoes	237	Gr	0.4	2.0	0.5 x 1.6	16	45	0.1	screen. 6"	0.1	250 liter tank	86.3	77.6	8
6	South section	citrus	256	turbo-key	1.3	7.8	3.5 x 4	18	50	0.3	screen. 6"	0.1	250 liter tank	44.1	39.7	31.2
7	South section	Apricot	295	katif	0.7	4.47	4 x 6	16	50	0.1	screen + sand sep.	0.1	200 liter tank	78.9	70.97	17.9
8	South section	Tomatoes	384	GR	0.6	2.9	0.5 x 1.6	16	35	0.1	3 screens 3"	-	150 liter tank	95.8	86.2	5.8
9	South section	Apple	262	metalic plastic	0.33	5.53	3 x 4	16	45	0.3	3 disc 3" 120 mesh	-	200 liter tank	39	35.1	44.2
10	South section	olives	288	microjet	0.46	22.45	3 x 5	16	105	0.4	screen 6"	0.6	150 liter tank	39	35.1	44.2
11	South section	olives	-	spaghetti	0.54	95.4	6 x 6	16	90	0.5	3 screen	0.2	basin	53.8	48.5	95
12	South section	Apricot	250	turbo-key	1	3.93	3 x 6	16	85	0.2	screen 6"	0.25	venturi 1.3"	774	69.4	23.6
13	South section	Tomatoes	448	GR	0.9	3.2	0.5 x 2	16	45	0.2	screen 6"	0.2	venturi - 1"	83.2	74.9	12.6
14	South section	citrus	250	micro.spr	1.2	36.1	3.5 x 7	16	55	0.1	screen 6"	0.25	venturi 1.3"	84.4	76	54
15	South section	olives	288	Rainbird	1.0	4.57	6 x 6	16	100	0.1	4 screen 3"	0.2	200 liter tank	61.3	55.1	18.3
16	South section	Tomatoes	525	Gr	0.9	2.8	0.5 x 1.5	16	80	0.6	2 disc 3"	-	120 liter tank	60.8	54.7	1.4
17	South section	olives	396.8	microject	0.4	19.65	6 x 6	16	66	0.2	4 screen 6"	-	200 liter tank	53	47.7	14.7
18	South section	peaches	269	Rain Bird	0.6	4.5	5 x 5	16	50	0	2 screen 6"	0.1	venturi 1"	83.8	75.4	6.75

No fertilizer injection device was found in the drip systems evaluated in El-Bustan area. However, in Wadi Natrun area, the fertilizer injection devices are common. In drip irrigation, the fertilizer spread on the soil surface does not leach into the root zone, therefore it has to be injected into the drip system. The differential pressure tank of 150 liter capacity is the most widely used fertilizer injection device.

In Bustan area, the most widely used emitter types are GR dripper line, which deliver 4 liter/hour at 50 cm spacing and used for vegetables and tomatoes as well, and spaghetti tubes which used for irrigating citrus and deciduous trees as well. In Sadat City area, the most widely used emitter type is the spaghetti tubes for fruit trees. However, in Wadi Natrun area, the most widely used emitter types are GR for tomatoes, Turbo-key, Microjet, and Katif for fruit trees. Two emitters per tree is a common practice.

Table 7 presents a great difference in the irrigation water application in different areas for the same crop. For example a crop as tomatoes is given 8 liter per day per plant in Wadi Natrun, while is given 4 liter per day per plant in Bustan. Another example is citrus, the tree is given different amount of water at the same age which ranges between 12 to 32 liter/day per tree. However, the citrus tree in Bustan is given 50 to 90 liter/day per tree.

The spacing between driplines ranges between 1.6 - 1.85 m for vegetables. However, it ranges between 3.5 to 4 m for citrus and fruit trees, except for a small percentage which reaches 6 m.

The calculated crop water requirement for the previous crops during the month of september is as follows:-

2. Tomatoes at emitters spacing of 0.5 x 1.75 m,

crop water use (liter / day) = ETo × kc × Sl × Sm

Lpd = 6.2 × 0.6 × 0.5 × 1.75 = 3.25 lpd

where

Eto: potential evapotranspiration, mm/day

kc : crop coefficient

Sl : emitter spacing on lateral line, m

Sm: lateral spacing, m

2. Deciduous fruit trees at spacing 3.5 x 4 m.

Tree water use (liter / day) = ETo x kc x St x Sr

Lpd = 6.2 x 0.8 x 3.5 x 4 = 69.44 Lp

where

St: tree spacing in row, m

Sr: row spacing, m

3. Citrus trees at spacing 3.5 x 4 m

Tree water use (liter / day) = Eto x kc x St x Sr

Lpd = 6.2 x 0.85 x 3.5 x 4 = 73.78 Lpd

The typical irrigation frequency is either daily or every other day which is reasonable according to the following calculations:

$$\mathbf{dn = AW \times Dr \times depletion}$$

$$\mathbf{= 60\ mm/m \times 0.7\ m \times 0.30 = 12.6\ mm}$$

$$\mathbf{F = \frac{dn}{ETo \times kc} = \frac{12.6}{6.2 \times 0.8} = 2.54 \cong 2\ days}$$

where

dn: net application depth, mm

AW: soil available water, mm/m

Dr : Active root zone depth, m

F : irrigation frequency, days

The average emitter operating pressure for 67% of the drip systems evaluated is below one bar which is the correct design pressure.

The typical lateral line length is 50 meter and the typical lateral diameter is 16 mm. As a consequence, the pressure drop along the lateral line is limited to 0.3 bar, according to the line discharge. However, in Bustan area, the preinstalled drip system has lateral length of 90 m and lateral diameter of 13 mm, which is considered as a poor design. As a consequence, the graduates change the system to 50 m lateral length with a diameter of 16 mm.

The spaghetti tubing in El-Bustan gave an emission uniformity as high as 78% and application efficiency as high as 70%. The GR dripline used for vegetables in Wadi El-Natrun showed a high performance of 95% emission uniformity and 86% application efficiency, while in Bustan area the emission uniformity is as high as 87% and the associated application efficiency is 78%. The Katif emitter in Wadi El-Natrun showed emitter uniformity as high as 79% and application efficiency of 71%. However, the Microjet showed an emission uniformity of 74% and application efficiency of 67%.

The low emission uniformity (below 80%) can be attributed to:

1- low operating pressure

2- no water filtration or using unsuitable filter.

3- emitter clogging.
4- no line flushing.
5- no chemical water treatments.
6- leaks in laterals.

Clogged emitters were determined when the flow rate from an emitter was not at the manufacturer's recommended rate at the operating pressure. The clogging was due to either a buildup of chemical precipitation or to mineral and organic particles. The problem with excessive and under watering was due to either operating schedule or unavailability of water. In most cases, the irrigator was unaware of how much water the system was delivering. Based on the calculations made by the research team, the irrigation duration was not correct on most cases. The problem with non-uniform pressure in the delivery system was due to design or installation errors. In many instances, the lateral pipe diameter was not the correct size for the length and total number of laterals in the zone. The problem with mixed emitters occurred where the irrigator replaced missing or clogged emitters with emitters that were from a different manufacturer or had a different flow rate.

Improvements. A major improvements would be to increase the percent of wetted area. this could be achieved by adding one or two emitters at each tree or increasing the duration of application, hence longer application wet more soil volume.

The number of emitters per plant is determined by two factors. First is the number of liters per day required and the number of hours of operation available to apply the quantity of water. For the required 80 liters per day per tree, 4 emitters of 4 liters per hour are required, or 2 emitters of 8 liters per hour. Both cases would then operate for 5 hours.

The second factor affecting the number of emitters per tree is the requirement to wet a given portion of the root zone. It is recommended that at least 50% of the root zone be wetted. In sandy soil, the average area wetted by one emitter is 1.8 m^2. The number of emitters required can be calculated as follows:

$$\textbf{No. of emitters} = \frac{\textbf{(Area per plant) m}^2 \textbf{ x 0.5 (50\% of the soil)}}{\pi \textbf{R}^2 \textbf{ (Area wetted by each emitter)}}$$

For the tree spacing of 3.5 x 4 m in sandy soil (1.8 m^2 - average area wetted by one emitter);

$$\textbf{No. of emitters} = \frac{\textbf{3.5 x 4 x 0.5}}{\textbf{1.8 m}^2} \cong \textbf{4 emitters}$$

The preinstalled drip irrigation system in Bustan was designed for Citrus trees planted at 6x6 m spacing and no provision was made for growing other crops. Each tree is provided with 4 drippers each giving 4 *liter/hour* at a working pressure of 1 bar. Polyethylene 13 mm outside diameter lateral line of a length of about 80-90 m serving 14 trees is used.

The drip system introduced to El-Bustan is underdesigned and poorly constructed and no provision was made for more drippers once the trees have grown. The design working hours of pumping stations of 15 hours per day are not met. In addition, since the unit is designed for the production of fruit trees only, this would mean settlers have no income for the first 3-5 years. The modification of existing drip system by adding new drip laterals for vegetable cultivation (high value crops) would help the settlers to increase their income until their orchards came into production.

Most farmers are either adding fertilizer after filtration or adding fertilizer by spreading or broadcasting over the soil surface. Under trickle irrigation, the water does not leach the fertilizer spread or broadcast over the soil surface into the root zone; therefore, it is necessary to add much of the required fertilizer, especially nitrogen, directly to the irrigation water. Any fertilizer applied through the trickle irrigation system should be added before the screening or filtration.

Prevention, rather than reclamation, has been the best solution to reducing or eliminating emitter clogging. Preventive maintenance includes water filtration, field inspection, pipeline flushing, and chemical water treatment.

SUMMARY OF THE IRRIGATION SYSTEMS PERFORMANCE

A total of 101 sprinkler and drip irrigation systems have been evaluated in a number of selected farms in the four areas under study.

Nine Hand-move sprinkler systems have been evaluated in Bustan area since August 1995 (Table 1). Of these 9 systems, one had an UC between 80-90 %. Four systems had UC's between 60-80%, and three systems had UC's less than 60%. The two draghose systems evaluated in El-Bustan area had UC's of 76 and 57%. As presented in Table 1, the lower UC can be attributed to high wind, low operating pressure, and wide sprinkler spacing in related to the actual wetted diameter. Another 9 Hand-move sprinkler systems had been evaluated in South Tahrir and presented in the second progress report, May 1995 (Table 2). Of these 9 systems, One had an UC between 80-90%. Five systems had UC's between 60-80%, and three systems had UC's less than 60%. Additional 4 Hand-move sprinkler systems were evaluated in the DDC farm, South Tahrir and presented in the second progress report, May 1995 (Table 3). Of these four systems, one had an UC between 80-90%. Two systems had UC's between 60-80%, and one system had an UC less than 60%. Nine Side-roll sprinkler systems were evaluated in the DDC farm and are presented in Table 3. Of these 9 systems, two had EU's between 80-90%. Six systems had UC's between 60-80%, and one system had an UC less than 60%.

Seven fixed irrigation systems have been evaluated in El-Bustan area since May 1995 (Table 4). Of these 7 systems, one had an UC between 60-80%, and six systems had UC's less than 60%. However, of the six fixed systems evaluated in Wadi Natrun, three had UC's between 80-90%, and three had UC's between 60-80%. In addition, 8 Fixed sprinkler systems were evaluated in the DDC farm, South Tahrir and are presented in Table 3. Of these 8 systems, seven had UC's between 60-80%, and one had an UC less than 60%.

Nine evaluations were conducted on drip systems in El-Bustan area since July 1995. Of the 9 evaluations (Table 5), three had Eu's between 80-90%: five had Eu's between 70-80%, and one had an Eu less than 70%. Fifteen evaluation were also conducted on drip systems in Sadat area since November 1995. Of the 15 evaluations (Table 6), non of them had Eu above 70%; two had Eu's between 60-70% ; and thirteen had Eu's less than 60%. Of the 15 evaluations, twelve had operating pressures less than 0.5 bar. A total of 26 drip irrigation systems have been evaluated in Wadi Natrun area since September 1995. Of these 26 systems (Table 7), two had Eu's above 90%; five had Eu's between 80-90%; four had Eu's between 70-80%; and fifteen had Eu's less than 70%. It can be seen that a total of 50 drip systems have been evaluated throughout the project area. Of the 50 evaluations; two had Eu's greater than 90%; eight had Eu's between 80-90%; nine had Eu's between 70-80%; and 31 had Eu's less than 70%.

Pilot Rehabilitation Field

The sprinkler and drip irrigation systems throughout the project area are performing poorly. The project would provide a pilot rehabilitation field at the DDC farm in South Tahrir to demonstrate that the existing systems can be made to operate correctly and within the design criteria originally established. The pilot project will also demonstrate the costs of any further improvements or modifications and serve as a training and demonstration site for project staff and settlers.

Pilot activities would cover the full range of irrigation systems in the project area, details are provided in Fig. 1. The irrigation systems considered are:

1- hand-move sprinkler (5 feddans).
2- drip irrigation system (5 feddans).

3- drip (vegetables + orchard) and fixed sprinkler (total 5 feddans).

4- drip (vegetables + orchard) and draghose sprinkler (total 5 feddans).

SUMMARY

The technical field evaluation of the existing irrigation system in 101 representative desert farms were conducted in four areas namely South Tahrir, Bustan, Sadat City, and Wadi El-Natrun. Bustan and South Tahrir areas use surface water as the main source of irrigation, while Sadat city and Wadi El-Natrun use only groundwater for irrigation. In South Tahrir and Bustan, the most widely used pressurized irrigation system is the preinstalled hand-move sprinkler system. Other systems such as fixed sprinkler, draghose, and drip irrigation cover only a very small percentage. While in Sadat City and Wadi El-Natrun, the most widely used pressurized irrigation system is the drip irrigation system. Other systems such as fixed sprinkler covers only a small percentage. However, some irrigators are illegally practicing flood irrigation in the four areas under study. Land holders in Bustan area are small holders, graduates, and private investors, while in South Tahrir are settlers, private investors, and large agricultural companies. In Sadat City and Wadi El-Natrun, however, they are mainly investors.

In Bustan and South Tahrir where settlers and graduates are located, pumping stations are used to supply the hand-move irrigation systems. The settlement areas are provided with the same field irrigation systems throughout, although the land is allocated in either 5.0 feddan units or in 20 feddans units. A typical collective pump station in either Bustan area or South Tahrir area serves about 500 feddans and consists of three electrical turbine centrifugal pumps, about 100 horsepower each (Fig.1). However, a typical independent pump station in Bustan area serves 20 feddans and consists of 20 horsepower electrical horizontal centrifugal pump. In practice the pumping station operating hours is, on average, 8-10 hours per day. In addition, the design operating pressure is not achieved with a subsequent reduction in sprinkler discharge capacity and a serious impact on the uniformity of water application and efficiency of water application.

Sprinkler systems are evaluated in the field by determining the uniformity coefficient (UC), distribution uniformity (DU), and potential application efficiency (PELQ). Drip irrigation systems are evaluated in the field by determining the emission uniformity (Eu) and the application efficiency (EA).

A total of 101 sprinkler and drip irrigation systems have been evaluated in a number of selected farms in the four areas under study. A total of 21 fixed sprinkler systems have been evaluated throughout the project area. Of the 21 evaluations; three had UC's between 80-90 %; eleven had UC's between 60-80 %; and seven systems had UC's less than 60 %. A total of 22 Hand-Move sprinkler systems have been evaluated throughout the project area. Of the 22 evaluations; three had UC's between 80-90 %; eleven had UC's between 60-80 %; and eight had UC's less than 60 %. Nine Sid-roll sprinkler systems were evaluated in the DDC farm. Of these 9 systems, two had UC's between 80-90 %. Six systems had UC's between 60-80 %, and one system had an UC less than 60 %.

Poor water distribution pattern may be improved by the following methods:

(1) use proper sprinkler nozzle pressure as recommended by the manufacturer.

(2) change lateral spacing. For the prevailing 10 km/hour wind speed, lateral spacing should be limited to 50 percent of the wetted diameter.

A total of 50 drip systems have been evaluated throughout the project area. Of the 50 evaluations; two had Eu's greater than 90%; eight had Eu's between 80-90%; nine had Eu's between 70-80%; and 31 had Eu's less than 70%.

The low emission uniformity (below 80%) can be attributed to:

1- low operating pressure

2- no water filtration or using unsuitable filter.

3- emitter clogging.

4- no line flushing.

5- no chemical water treatments.

6- leaks in laterals.

Prevention, rather than reclamation, has been the best solution to reducing or eliminating emitter clogging. Preventive maintenance includes water filtration, field inspection, pipeline flushing, and chemical water treatment.

The sprinkler and drip irrigation systems throughout the project area are performing poorly. The project would provide a pilot rehabilitation field at the DDC farm in South Tahrir to demonstrate that the existing systems can be made to operate correctly and within the design criteria originally established. The pilot project will also demonstrate the costs of any further improvements or modifications and serve as a training and demonstration site for project staff and settlers.

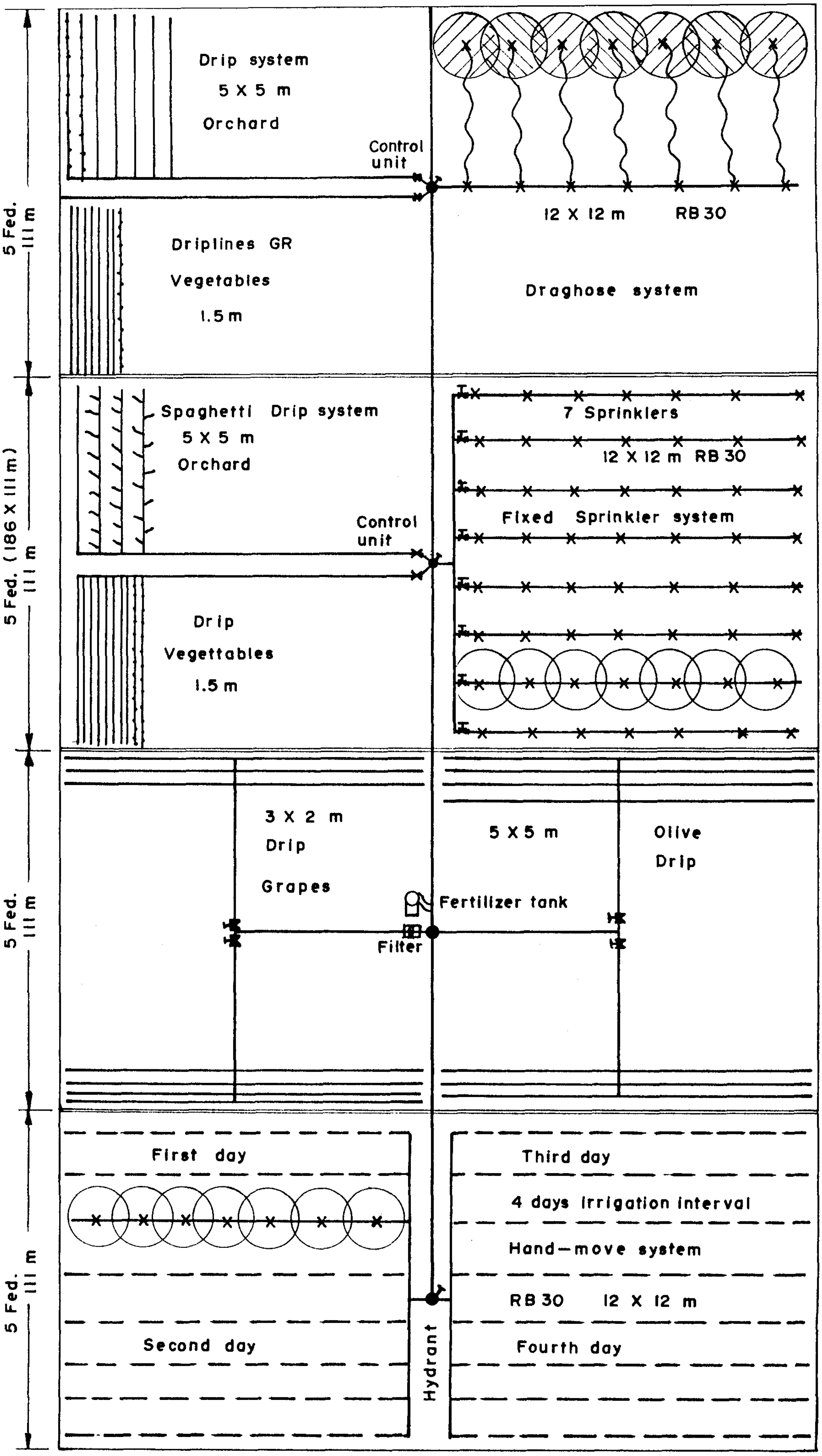

Fig. 3. Pilot Rehabilitation Field.

III. IRRIGATION TECHNICAL SURVEY

A total of 109 farmers were selected for this survey. All respondents were visited and interviewed at their farms. The irrigation technical questionnaire is a survey of the following information : water source, pump stations, and irrigation systems.

WATER SOURCE

The main source of irrigation water in south Tahrir and Bostan is Nile water. However, Wadi-Natron and Sadat depend only on groundwater as presented in Table 1. Most of the responding farmers (85%) in Wadi-Natron use their own private wells, while 15% use collective wells. In South Tahrir, small percent of the responding farmers (5.1%) use private wells (Table 1), hence the main source of irrigation water is Nile water.

Table 1. Distribution of the sample in areas of study according to the main source of irrigation water.

Main source of irrigation	Tahrir		Sadat		W.N		Bostan		Total	
	#	%	#	%	#	%	#	%	#	%
Nile water	37	94.9	-	-	-	-	30	100	67	61.5
Private well	2	5.1	9	45	17	85	-	-	28	25.7
Collective well	-	-	11	55	3	15	-	-	14	12.8
Total	39	100	20	100	20	100	30	100	109	100

Most of the responding farmers (63.3%) face problems in obtaining the irrigation water through the source, the major percentage of them are located in South Tahrir (47.8%), Bustan (27.5%), and Sadat (17.4%). Thirty three percent of the responding farmers agree that the insufficient water is the most predominant problem through the water source in South

Tahrir (43.6%) and Bostan (43.6%). However, thirty five percent of the responding farmers in Sadat area, attributed the problem of the water source to the illegal practice of flood irrigation that some farmers usually do. Twenty four of the responding farmers have a well as a secondary water source, most of them located in south Tahrir (65.4%).

Irrigation water quality is commonly assessed in terms of soluble salt content. The greater the soluble salt content the bigger the risk of creating a saline soil or of making soil water less available to plants.

The irrigation water electrical conductivity was measured in situ during the interview (Table 2). The water salinity in South Tahrir and Bostan is less than 480 ppm since the Nile is the source of water and consequently the water can be used for irrigating most crops on most soils. However, the water salinity in 20% of the farms in Sadat and 15% in Wadi-Natron are considered relatively high (>1440 ppm) since the groundwater is the source of water. Changes in groundwater salinity in the study area has been presented and discussed in part I in this report. High salinity water can only be used for salt-tolerant crops with good management on well-drained permeable soils. Salinity may reduce the yields of crops by as much as 25% without visible symptoms. Crops grown on infertile soil may seem more salt-tolerant than those grown with adequate fertility, because fertility is the primary factor limiting growth. The addition of extra fertilizer will not alleviate growth inhibition by salinity. Climate is a major factor affecting salt tolerance. Most crops can tolerate greater salt stress if the weather is cool and humid than if it is hot and dry. Yield is reduced more by salinity when humidity is low. Drip irrigation, if properly designed, minimizes salinity and matric stresses because the soil water content is maintained at a high level and the salts are leached to the perimeter of the wetted volume, where rooting activity in minimal. Drip irrigation is usually the method of choice when the water is high in salts, though the high build-up of salts in the fringe of the wetted area may eventually become a problem. For tree crops, a low head bubbler system provides excellent control and distribution if water while minimizing pressure requirements. Irrigation by sprinkling allows superior control of the amount and distribution of water. It, therefore, is often used on steep land. There is tendency to apply too little water for leaching requirements with this method, and leaching of salts beyond the root zone often requires special effort. Sprinkling irrigation is more efficient than other methods at removing salt from small pores in the soil profile (Neilsen et al. 1966). Crusting is more likely to become a problem with sprinkler irrigation in calcareous soils. Another potential hazard of sprinkler irrigation is foliar uptake of salt and leaf burn to contact with water. Sprinkler irrigation should be avoided if the water contains excessive levels of sodium and chloride, although sprinkling at night can help in such cases.

Table 2. Distribution of the sample in areas of study according to the irrigation water salinity (Summer, 1995).

Salinity Hazard	**Tahrir**		**Sadat**		**W.N**		**Bostan**		**Total**	
	#	%	#	%	#	%	#	%	#	%
< 480 ppm	37	94.9	8	40	13	65	30	100	88	80.7
480 - 1440 ppm	1	2.6	8	40	4	20	-	-	13	11.9
> 1440 ppm	1	2.6	4	20	3	15	-	-	8	7.3
Total	39	100	20	100	20	100	30	100	109	100

PUMP STATIONS

Most pumps (55%) were new (Table 3). About 84.6% of the pumps were under 5 years old in South Tahrir, 75% in Sadat, 75% in Wadi-Natron, and 100% in Bostan. This suggests that an extensive program of maintenance and repair will be needed in the near future. In addition, skilled technicians and spare parts should be available.

Table (3) Distribution of the sample in areas of study according to pump age.

Pump age years	Tahrir		Sadat		W.N.		Bostan		Total	
	#	%	#	%	#	%	#	%	#	%
0	20	51.3	11	55	1	5	28	93.3	60	55
<5	13	33.3	4	20	14	70	2	6.7	33	30.3
5 - 10	5	12.8	4	20	5	25	-	-	14	12.8
> 10	1	2.6	1	5	-	-	-	-	2	1.8
Total	39	100	20	100	20	100	30	100	109	100

Over half (55%) of the responding farmers (Table 4) had no private pumps or additional pumps in case of using collective pump stations. About 39.4% of the responding farmers were using Diesel engines to operate their private pumps. However, 5.5% of the responding farmers were using Electric motors to operate their private pumps. The reason for wide use of Diesel engine could be attributed to either the unavailability of electricity in the farm or the feeling that electricity is costly. About 15.6% of the responding farmers stated having had frequent problems in operating their private pumps.

Table 4. Private pumps and type of engine distribution in areas of study.

Private pump and type of engine	Tahrir		Sadat		W.N		Bostan		Total	
	#	%	#	%	#	%	#	%	#	%
No private pump	20	51.3	11	55	1	5	28	93.3	60	55
Diesel engine	18	46.2	9	45	14	70	2	6.7	43	39.4
Electric motor	1	2.6	-	-	5	25	-	-	6	5.5
Total	39	100	20	100	20	100	30	100	109	100

The various problems with pump stations responding farmers faced are categorized and given in Table 5. Costly spare parts, fuel and electricity, and maintenance and repair are the common problems with pump stations for more than 85 % of the responding farmers, while unavailability of skilled technicians was a problem for 71.4 percent. Most of the farmers (90%) felt electricity was very costly and beyond the purchasing capacity of the common farmer without capital subsidy.

Table 5. Frequency of problems with pump stations.

Problems	Tahrir		Sadat		Natron		Total	
	#(per 10)	%	# (per 6)	%	# (per 5)	%	# (per2)	%
Frequent cut-off of electricity	1	10	0	0	1	20	2	9.5
Low water pressure	4	40	2	33.3	2	40	8	38.1
Low water level	1	10	0	0	0	0	1	4.8
unavailable spare parts	3	30	0	0	2	40	5	23.8
Costly spare parts	9	90	5	83.3	4	80	18	85.7
Costly fuel & electricity	9	90	6	100	4	80	19	90.5
Costly maintenance & repair	9	90	5	83.3	5	100	19	90.5
Unavailable skilled technicians	8	80	3	50	4	80	15	71.4
Inappropriate design of pumps	4	40	1	16.7	0	0	5	23.8
Wearing of pump impeller	3	30	6	100	2	40	11	52.4

SPRINKLER IRRIGATION SYSTEMS

About 26.6% of the responding farmers changed their preinstalled irrigation system, while 56.7% of the responding farmers in El-Bostan area changed their preinstalled irrigation system. The reason for the wide change of irrigation system in El-Bostan area could be attributed to the unsuitability of the preinstalled hand-move sprinkler irrigation system. The hand-move sprinkler system supplied to the settler is cheap and very inflexible, and it is not entirely suitable. It cannot be used for orchards, and the farmers with supplementary employment off-farm are unable to fully utilize their irrigation system.

The sprinkler irrigation systems were less than 10 years old in Bostan area. However, 90% of the sprinkler systems exceeded the expected life (15 years of age) in South Tahrir. Sprinkler nominal discharge rates were less than 1.8 m^3/hr for 76 percent of the systems. Seventeen percent of the responding farmers installed the sprinkler heads directly on the lateral line without using risers. The risers raise the sprinkler above the ground so that the jet will not be interfered with by growing crop.

About 56.1% of the responding farmers stated having had problems with hand-move systems, all of them located in south Tahrir.

The various problems farmers faced when using hand-move sprinkler system are categorized and given in Table 6. Thirty six evaluations were conducted on hand-move sprinkler systems. The most common problems were with low pressure in the lateral lines and unsuitability of hand-move for either orchard irrigation or supplementary off-farm employment. The hand-move system that has been designed and provided for the settlers is cheap and very inflexible, and it is not entirely suitable. In particular it does not allow the farmer to take up supplementary employment. At the root of the problem is the high application rate and the small soil moisture reservoir which requires the laterals to be moved every 2.25 hours. With movement of this frequency night-time irrigation, which could facilitate off-farm employment, is not socially acceptable, nor even practical. Night-time irrigation is usually based upon a ten to twelve hours irrigation shift, which eliminates the need to move laterals at night. The hand-move is unsuitable for all uses. It cannot be used for undertree irrigation of citrus, because the branches interfere with the water jet. Branches blocking spray occurred where low tree branches deflected the spray pattern; while not affecting the flow rate, the intended wetted diameter was not uniformly irrigated. Operating at too low a pressure is common problem on 72 % of the hand-move sprinkler systems. The direct impact of low pressure is a reduction in wetted diameter and sprinkler nozzle discharge and hence a distortion of the optimum water distribution pattern. Low pressure also increase droplet size which damage delicate crops and some soils by breaking down the surface structure and reducing the infiltration rate. Low pressures also cause the rubber ring in the pipe couplers to leak, since it seals only under the correct pressure.

The more logical explanation for operating at low pressure lies in the exceptionally high level of water losses from the irrigation hydrants (common problem on 42 % of the systems), valve elbows (common problem on 33% of the systems), lateral pipe seals (common problem on 22 % of the systems), sprinkler bearings (common problem on 25 % of the systems), and buried main pipelines(common problem on 14 % of the systems). In addition, 36 % of the responding farmers attributed the low pressure to the illegally surface irrigation practice. All these reasons cause the pumps to deliver much higher discharges than designed with a consequent drop in pressure. Low pressures also increase droplet size which cause physical damage to plants (common problem for 64 % of the responding farmers).

The hand-move sprinkler has high labor requirements (common problem for 53 % of the responding farmers) and subjects equipment to an exceptionally high rate of wear due to the high number of lateral movements required by the large number of irrigations necessary. The policy of sharing one lateral sprinkler line between two earlier settlers is clearly unsatisfactory for 39% of the responding farmers in relation to the highly intensive use of equipment. The recently designed and constructed sprinkler projects in Bostan area provides one sprinkler lateral for 5 feddans unit, and thus this problem is limited to the earlier settlers.

Table 6 . Frequency of problems with Hand-move sprinkler system.

Problems	**Tahrir**		**Bostan**		**Total**	
	# (per20)	%	# (per 15)	%	# (per 36)	%
Sprinkler operating at low pressure	17	85	8	53	26	72
Leakage from irrigation hydrants	10	50	5	33	15	42
Leakage from valve elbows	10	50	2	13	12	33
Leakage from lateral pipe seals	6	30	2	13	8	22
Leakage from sprinkler bearings	8	40	1	7	9	25
Leakage from buried main pipe line	3	15	2	13	5	14
Some farmers practice surface irrigation illegally	11	55	2	13	13	36
Physical damage to plants from large water droplets	17	85	6	40	23	64
Not possible to share one lateral line between settlers	9	45	5	33	14	39
Most of the lateral pipes are damaged	12	60	3	20	15	42
Lateral pipes and seals are not available	14	70	10	67	24	67
Hand move is unsuitable for supplementary off-farm employment	17	85	12	80	29	81
Hand-move is unsuitable for irrigating orchards	19	95	12	80	31	86
It is difficult to move lateral pipes six or even four times everyday	15	75	2	13	17	47
The system is high labor requirement	7	35	12	80	19	53

DRIP IRRIGATION SYSTEMS

1- Filtration System. Of the 52 farms with drip irrigation systems, 36 farms only had filtration systems. In all of the 36 farms, the filters are cleaned manually. Although all filters are cleaned manually, 59.6% only had pressure gauges attached to the filters to indicate when cleaning is required. Out of the 36 farms, 29 farms use only screen filters, 2 farms use only gravel (sand media) filters, while 5 farms use gravel and screen filters. Out of 19 farms in Sadat area, only 8 farms use filters, while the percentage are 94% in Wadi-Natron and 64% in Bostan. It can be said that sand filters were not used though the water source contained silt and algae (Nile water) in 50% of the cases in Bostan and South Tahrir. However, screen filters were used in most of the cases (94%). In Wadi-Natron and Sadat the source of water is wells. Therefore, screen or disc filter is satisfactory for the filtration system.

2-Fertigation. Fertigation is necessary for more efficient use of fertilizers, especially nitrogen, for fields irrigated with drip systems. This is because dry fertilizer broadcasted over the soil surface will not move into the plant root zone by the irrigation water. The same type of equipment can be used to inject either fertilizer solutions or chemicals that help prevent emitters from clogging.

Out of 48 farms with drip irrigation systems, 14 farms had no fertilizer injection device (Table 7). Chemical fertilizers were not applied through the drip systems in 29.2% of the total farms and it reaches 44.5% of the farms in Sadat and Bostan, while in Wadi-Natron, the fertilizer injection devices are common. In drip irrigation, the fertilizer spread on the soil surface does not leach into the root zone, therefore it has to be injected into the drip system.

Table 7. The distribution of using fertilizer injection device in the survey sample

Study area	**Tahrir**		**Sadat**		**W.N**		**Bostan**		**Total**	
Distribution	#	%	#	%	#	%	#	%	#	%
Yes	4	80	10	55.5	15	93.7	5	55.5	34	70.8
No	1	20	8	44.5	1	6.3	4	44.5	14	29.2
Total	5	100	18	100	16	100	9	100	48	100

The distribution of drip sets according to type of injection device is presented in Table 8. Fertilizer-injection equipment employed (Table 8) are: tanks (85.7%), venturi type (2.9 %), and hydraulic pump (11.4%). The maximum number of drip sets (85.7%) used fertilizer tank as injection device. The fertilizer tank is simple and does not require additional motorized pump for injection. The concentration of chemicals injected into the irrigation system from the fertilizer tank changes continuously with time; consequently uniformity of distribution may be a problem, if the fertilizer is to be applied to several blocks through a cycles system.

Table 8. Distribution of drip sets according to type of injection device.

Type of injection device	Tahrir		Sadat		W.N		Bostan		Total	
	#	%	#	%	#	%	#	%	#	%
Fertilizer tank	4	80	10	100	11	73.3	5	100	30	85.7
Venturi	-	-	-	-	1	6.7	-	-	1	2.9
Injection pump	1	20	-	-	3	20	-	-	4	11.4
Total	5	100	10	100	15	100	5	100	35	100

3- Acid Treatment. The injection of acid is generally done to lower the pH as a control mechanism for various water quality problems. Out of 35 farms with chemical injection device, 27 farms use acid treatments, mainly in the form of phosphoric acid, which is also used as a fertilizer (adds phosphate to the root zone). Phosphoric acid has been applied successfully through trickle irrigation systems and causes no precipitation or clogging of emitters even when the irrigation water is relatively high in bicarbonate plus calcium and magnesium. Because phosphoric acid will form insoluble precipitates and keep the pH low enough.

4-Emitters. The most widely used emitter types are: GR driplines (40%), Katif point source emitter (25%), and E2 point source emitter (20%). Most of the GR and E2 in the market are locally made, while Katif is totally imported.

5-Valves. Valves form an integral part of drip irrigation systems. The nature of the valving for a given installation will depend on the level of automation, degree of pressure regulation, and number of set required. Several types of automatic, manual, check and air release valves are used in drip systems. Check valves are normally used only at the pump station and particularly when pumping out of a sump or deep well. Air release and vacuum relief valves are located at high points or mains, submains, and laterals. Air release valves are generally placed at high points in mainlines, submains, and pump stations. They release entrapped air on system start up, and allow air to enter the pipeline under conditions of negative pressure. Check valves are used to prevent unwanted flow reversal. They are used to prevent possibly damaging backflow through a pump, to prevent pump suction lines from draining (cause loss of "prime"), or to protect water supplies against contamination. Pressure relief valves are used to relieve excessive pressure surges. They are usually spring loaded and set to open above the operating pressure. Flushing valves are usually hand-operated and on the end of a line for flushing out dirt and debris. Pressure regulators are installed to keep a constant pressure regardless of whether the pipelines go up or downhill. Pressure gauges are used to indicate the pressure at the pump or at the beginning and the end of filters and lateral lines to check the pressure loss. Flow meter offers the farmer an unprecedented degree of control over his water and power costs, and over the growing conditions of his crop. To take full advantage of this ability to control the irrigation system, it is necessary to have useful feedback information on flow rates and total water applied during a given time period. Accurate flow rate information is also indispensable for the analysis of crop response to water and nutrients, and for monitoring the continuing performance of the irrigation system. A good quality system flow meter is therefore an essential part of a well designed irrigation system.

Out of 52 farms with drip irrigation, 28.8% use air release valve, 40.4% use check valve, 26.9% use flow meter, 67.9% use flushing valve, 13.5% use pressure regulator, 15.4% use pressure relief valve, and 59.6% use pressure gauges.

SUMMARY

Irrigation technical survey was conducted to study the present status of water source, pump stations, and irrigation systems in the four areas of study. Thirty three percent of the responding farmers agree that the insufficient water is the most predominant problem through the water source, while this percent reaches 43.6% in South Tahrir and Bostan.. Costly spare parts, fuel and electricity, and maintenance and repair are the common problems with pump stations for more than 85 % of the responding farmers, while unavailability of skilled technicians was a problem for 71.4 percent. Most of the farmers (90%) felt electricity was very costly and beyond the purchasing capacity of the common farmer without capital subsidy. The sprinkler irrigation systems were less than 10 years old in Bostan area. However, 90% of the sprinkler systems exceeded the expected life (15 years of age) in South Tahrir. About 56.1% of the responding farmers stated having problems with hand-move systems, all of them located in south Tahrir.Operating at too low a pressure is common problem on 72 % of the hand-move sprinkler systems.

The more logical explanation for operating at low pressure lies in the exceptionally high level of water losses from the irrigation hydrants (common problem on 42 % of the systems). In addition, 36 % of the responding farmers attributed the low pressure to the illegally surface irrigation practice. Low pressures also increase droplet size which cause physical damage to plants (common problem for 64 % of the responding farmers). The hand-move sprinkler has high labor requirements (common problem for 53 % of the responding farmers).

Of the 52 farms with drip irrigation systems, 36 farms only had filtration systems. Sand filters were not used in 50% of the cases in Bostan and South Tahrir though the water source contained silt and algae (Nile water). However, screen filters were used in most of the cases (94%). Chemical fertilizers were not applied through the drip systems in 29.2% of the total farms and it reaches 44.5% of the farms in Sadat and Bustan, while in Wadi-Natron, the fertilizer injection devices are common. Among the injection devices used fertilizer tankwas the most (85.7%) common. Out of 35 farms using chemical injection devices, 27 farms use acid treatments, mainly in the form of phosphoric acid, which is also used as a fertilizer. Out of 52 farms with drip irrigation, 28.8% use air release valve, 40.4% use check valve, 26.9% use flow meter, 67.9% use flushing valve, 13.5% use pressure regulator, 15.4% use pressure relief valve, and 59.6% use pressure gauges. Therefore, large percentage of drip irrigation systems are loosing the essential parts of a well designed irrigation systems.

IV. The Social Aspects of Desert Irrigation in the New Lands

1. Introduction:

It was planned in the first stage of this research to investigate the social aspects of irrigation through the application of a sample survey on the holders of desert lands. This is to explore the possible relations between these aspects and the efficiency of using water and irrigation systems there. Man and his behavior are considered from among the important determinant factors for such efficiency. Experience of holders with technical aspects of irrigation, their approach to acquire needed knowledge and their attitudes towards using water and related irrigation systems are some of the social aspects to be clarified in such situations. Facts about these aspects could be very informative in the interpretation of the relationships between these social factors and present situation of efficiency of irrigation of desert lands. Meanwhile such findings could be used in projection of the potential changes in irrigation efficiency and assessing the applicability of certain irrigation practices and related trainning, extension and maintenance programs in future, given the continuity of present conditions.

Nevertheless, in the light of the main objectives of the social component of study a specific methodology was adopted (First progress report, Nov. 1994, pp. 35-38). This is to use the sample survey to afford needed information about variables that have the potential of having relationships with the irrigation in desert lands.

Secondary data about holders of lands in the four areas selected for this study; South Tahrir, Al-Sadat agricultural zone, Wadi Al-Natron, and Al-Bostan were collected to portray the population of this study. A quota stratified random sample of 109 holders was drawn accordingly.

In the social survey interest was directed towards the exploration of sample socio-economic characteristics, the systems of irrigation in use, the knowledge level about sprinkler and drip irrigation as the most prevailing modern techniques, the attitudes towards water and irrigation practices applied, and some other aspects related to the social organization of community that are likely to be linked with irrigation. A specific questionnaire was designed to collect the field data from the drawn sample. A final version of a pretested and precoded questionnaire was applied to the sample by enumerators trained for this purpose.

Preliminary analysis of data took place after the data verification. However in this report of the social survey only the main findings are presented. A detailed report about the results of the social survey will follow by the end of research project.

2. Distribution of the Sample Study

Sample was selected from among all the farm holders in the four regions of the newly reclaimed lands; South Tahrir, Al-Sadat City agricultural zone, Albostan and Wadi Alnatron. Based on the secondary data collected about the number of land holders and their holding size in each of the above mentioned regions a quota stratified random sample was selected. About 120 holders were interviewed during the period of field data collection. Due to the uncooperative attitudes of some interviewees and the false or ambigious responses of some others only 112 interviews were completed. Yet, after the verification of data only 109 questionnaires were accepted and processed for statistical analysis.

Depending on the descriptive statistics of the data and some preliminary statisttical analysis a review of some of the main findings are presented in this report. However, distribution of the sample by the region of residency, the farm holding size, the type of irrigation system(s) used in the farm, and some other social demographic characteristics are shown in the following section.

a) Distribution of the sample by region of residency:

Distribution of the sample according to the area of study is shown in table (1) below.

Table (1) Distribution of the Sample by the Area of Study

Region	South Tahrir		Al-Sadat		Wadi Alnatron		Albostan		Total	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
Total	39	35.8	20	18.3	20	18.3	30	27.5	109	100.

The highest percentage of the sample (35.8%) was selected from South Tahrir where the bulk of them have settled there since the fifties and the sixties. However, they represent more than one category of settlers; small holders, old graduates and investors. The second higher sub-sample is that of Al-bostan (27.5%) which represents only the new graduates who have been resettled in this area relatively recently. The other two sub-samples in Al-Sadat and Wadi Al-Natron are equal (18.3%). They represent only investors who most of them started their productive activities recently. Yet this category itself is not homogenous. It includes holders of different occupational background. They mostly delegate some other fulltime manager to take care of the daily productive process in their farms.

b) Distribution of the Sample by farm holding size

Following is the distribution of the sample of study according to the categories of farm holding size. Due to the specific tenure system applied in the newly reclaimed lands, land holdings less than 3 feddans except that resulted from application of the inheritance system are rare. Hence, the categories of farm holding size were classified into six intervals; less than 5 feddans, 5 to less than 10, 10 to less than 20, 20 to less than 50, 50 to less than 100, and finally 100 and more feddans. Table (2) shows the sample distribution according to the above mentioned categories.

Table (2) Distribution of the Sample by farm holding size (fed.)

Size (fed.)	>5		5-		10-		20-		50-		100+		Total	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
Total	15	13.8	32	29.3	21	9.3	19	7.4	9	8.3	13	1.9	09	100

The highest percentage of farm holding size is that of the second category (5 to less than 10) feddans which represents 29.3% of the whole sample. Then ranked second the category of 10 to less than 20 feddans. The least percentage (8.3%) was that of the category of 50 to less than 100 feddans. This means that the majority of sample (62.4%) have farms with size less than ffity feddans.

c) Distribution of the Sample by Irrigation System(s)

Distribution of the sample according to the irrigation system(s) used in their farms is shown in table (3).

Table (3) Distribution of the Sample by Irrigation System(s)

Irrig. System	Sprink		Drip.		Surface		Sprink & Drip		Mixed		Total	
	No	%	No	%	No	%	No	%	No	%	No	%
Total	44	40.4	23	21.1	15	13.8	16	14.7	11	0.1	109	00.1

The highest percentage of irrigation system adopted as the sole system used by the sample was that of the sprinkler irrigation (40.4%). Drip irrigation is applied solely in only 21.1% of the farms. Yet both sprinkler and drip irrigation systems are used in 14.7% of the cases. However surface irrigation is used only in 13.8% of the cases. Mixed systems of irrigation are used by the same farmer in only 10.1% of the cases. This means that more than three fourthes of the sample of study applys one or more of the modern irrigation techniques in their farms.

Testing the difference of distribution of the subsamples of the four regions of study according to the different systems of irrigation using chi^2 technique of analysis showed very high significant differences as presented in table (8). For instance in South Tahrir 56.4% of the sub-sample uses sprinkler irrigation while 28.2% uses surface irrigation which is the highest among all regions . In Sadat region half of the sub-sample uses drip irrigation, 30% uses mix of the three systems of irrigation and 15% uses both sprinkler and drip irrigation . In Wadi Al-Natron 40% of the sub-sample uses drip irrigation, 35% uses both sprinkler and drip irrigation while 15% uses surface irrigation . In Al-Bostan area the majority (73.3%) uses sprinkler irrigation while 20% uses both sprinkler and drip irrigation . There is no surface irrigation in any case in this region as in contrary to the case in South Tahrir . Holders in this region are only graduates while in South Tahrir there are a lot of resettled small holders .

Obviously the highest percentage of those who are using modern techniques of irrigation exists in Bostan area, then Wadi Al- Natron area , Sadat area and lastly in the South Tahrir area .

Table (4) Distribution of the Sample in Areas of Study by Type of Irrigation System

Irrig.	S. Tahrir		Sadat		W.Natron		Bostan		Total	
System	No	%	No	%	No	%	No	%	No	%
Sprink.	22	56.4	-	-	-	-	22	73.3	44	40.4
Drip	3	7.7	10	50	8	40	2	6.7	23	21.1
Surface	11	28.2	1	5.0	3	15.0	--	--	15	13.8
Sp.&Drip	-	-	3	15.0	7	35.0	6	20	16	14.7
Mixed	3	7.7	6	30	2	10	--	--	11	10.1
Total	39	100	20	100	20	100	30	100	109	100

$chi^2 = 78.511^{**}$ df = 12 Prob. = 8.07 E - 12 V = 0.49

3. The Main Social Demographic Characteristics of Sample

a) Sample Distribution by Age : Table (5) presents the distribution of the sample of study by age. The age categories were set as 25 to 35 years, 36 to 40, 41 to 45, 46 to 50, 51 to 55, 56 to 60 and 61 years and more .

Table (5) Sample Distribution by Age

Age category	No.	%
25-35	33	30.3
36-40	9	8.2
41-45	21	19.3
46-50	15	13.8
51-55	11	10.1
56-60	10	9.1
61 +	10	9.1
Total	109	99.9

In the above mentioned table it was found the highest percentage was that of the young category who were less than 36 years old. It represents 30.3 % of the sample . The second highest category was that of the farm holders who were between 41 and 45 years old (19.3%) . Those who were between 46 and 50 years represented 13.8% of the sample .

b) Sample Distribution by marital status : Table (6) shows that 93% of the sample are married . Yet , in Boston and Wadi El - Natron areas this percentage is less than the average at the sample level . This is due to the relatively new settlement of graduates in Boston and the new investments started recently in W. Natron area .

Table (6) Distribution of the sample in the Areas of study by Marital Status

Marital Status	S. Tahrir		Sadat		W. Natron		Bostan		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Single	1	2.6	-	-	1	5.0	2	6.7	4	3.7
Married	38	97.4	20	100	19	95.0	28	93.3	105	96.3
Total	39	100	20	100	20	100	30	100	109	100

c) Sample Distribution by Educational Status : Table (7) presents the distribution of sample by their educational status in each of the regions of study .

Table (7) Distribution of the sample in the Areas of study by Educational status

Education level	South Tahrir		Sadat		W. N.		Bostan		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
lliterate	6	15.4	6	30	-	-	-	-	12	11
ead & write	6	15.4	1	5	3	15	-	-	10	9.2
lementary	2	5.1	2	10	2	10	-	-	6	5.5
reparatory.	1	2.6	-	-	-	-	-	-	1	0.9
econdary	9	23.1	2	10	-	-	20	66.7	31	28.4
igh Tech.	1	2.6	1	5	-	-	20	6.6	4	3.7
niversity	12	30.8	6	30	11	55	8	26.7	37	33.9
raduate Studies	2	5.1	2	10	4	20	-	-	8	7.4
Total	39	100	20	100	20	100	30	100	109	100

From the above table it was found that only 11% of the whole sample are illiterate, 9.2% read and write while the others have got formal education that vary widely . Those who have only elementary or preparatory education were 5.5% and 0.9% of the sample respectively .

Distribution of the sample according to their educational status and region of residency shows that those who are illiterate or read and write only represent 35% of the sub-sample in Sadat , 30.8% in South Tahrir and 15% in Wadi Al- Natron. Yet those who have got only elementary or preparatory education represent about 10% in each of the Sadat and Wadi Al - Natron areas and 7.7% in South Tahrir. The percentage of those who have got medium education represent 73.3% in Albostan, 25.7% in South Tahrir and 15% in Sadat areas . However those who have got University or higher education represent 75% of the sample in Wadi Al - Natron , 40% in Sadat , 35.9% in South Tahrir and only 26.7% in Al- bostan area. Distribution of the two subsample in South Tahrir and Sadat areas seem relatively similar to each other than that in Al - Bostan and Wadi Al-Natron . The later areas where all holders are investors they seem to have in average higher education than in the former ones .

d) Sample Distribution by Type of Education: Table (8) presents the distribution of holders who got formal education higher than preparatory according to the type of their education whether agricultural or non-agricultural.

Table (8) Distribution of the sample in the Areas of study by type of Education

Type of Education	S. Tahrir		Sadat		W. Natron		Bostan		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Agric.	13	54.2	2	18.2	3	20	7	23.3	25	31.25
Non - gric.	11	45.8	9	81.8	12	80	23	67.7	55	68.75
Total	39	100	20	100	29	100	30	100	100	100

It is shown from the above mentioned table that the highest percentage of those who have agricultural educational background is that of the South Tahrir holders (54.2%). Bostan area has relatively the second higher percentage of holders with agricultural educational background (23.3%) though it is far less than the counter rate in Tahrir. The other counter percentages in Wadi Al-Natron and Al-Sadat are rather less. They are 20% and 18.2% respectively.

4. Attitudes of Holders of Desert Land Towards Water Use and Irrigation Practices

Introduction:

Attitudes are considered important aspects of personality that reflect the action tendency of a person towards all various objects in his life in future situations. These objects could be persons, social or economic situations, specific agricultural practices or any other thing. Attitudes are related to all aspects of life. They show the preference patterns of behavior of specific individual or group in a very wide area of human activities. Attitudes are composed of the person's cognition, his feelings and action tendencies developed through his past experience whether acquired by practice or transmission by some other means. They could be seen as relatively stable interrelated systems of the above mentioned three components.

Hence, an attitude scale related to the various aspects of rational use of water in irrigation and the applied irrigation practices was designed and pretested. The scale is constructed from 29 items that cover all the above mentioned three components and seven dimensions; cultural value of water, economic value of water, information aspects of available water resources, on-farm water management, applied irrigation practices, willingness to share in responsibility of rational use of water and experiences needed in the irrigation process. About 38% of the items were formulated in passive form to reflect the action tendency component of the scale. Table (9) below presents the component structure of the applied attitudes scale.

Table (9)
Component Structure of the Attitudes Scale

Type of item	Dimension														Total
	Cultural		Economic		Information		On Farm Water Manage.		Irrigation Practices		Participation		Experience in Irrigation		
	Item	No.	Item	No.	Item	No.	Item	No.	Item	No.	Item	No.	Item	No.	No.
Positive	12	1	7& 17	2	6	1	13, 15, 16 & 25	4	9, 10, 11& 29	4	2,5, 20& 21	4	24 & 27	2	18
Negative	1	1	19	1	3	1	14& 26	2	8& 18	2	4	1	22, 23& 28	3	11
Total		2		3		2		6		6		5		5	29

The scale was designed using the Likert pattern of attitude scales. This is to locate the response to each item on a five point continuum starts with "strongly agree" to "strongly disagree" on the statement. Responses to each item ranked between 5 to 1 for the positive statements and vise versa for the negative statements respectively. Thus each respondent total score ranged between 29 and 145 . Accordingly five categories of attitude were identified; highly positive (123-145), positive (100-122), neutral (77-99), negative (53-76) and highly negative (less than 53).

Analysis of data took into consideration testing the relationship between the attitudes of holders towards water use and irrigation practices and three main variables; the region of residency where the farm is located, the farm holding size, and the kind of irrigation system(s) in use in the farm . Following are the results of this analysis .

2. Attitudes of farmers in the various regions of study :

The average value of attitudes and its standard deviation were calculated for each of the four subsamples of South Tahrir , Sadat , Wadi Al- Natron and Al- Bostan regions . Results are shown in the table (10) below .

Table (10) Average values of farmers' attitudes towards water and irrigation practices by region of residency

Region	Mean	Std. Dev.	Cases
S.Tahrir	112.05	11.90	39
Sadat	106.95	8.49	20
W. Natron	111.55	13.39	20
Bostan	116.77	8.74	30
Total	112.32	11.21	109

Figures in the above table show that the average value of attitudes for the whole sample is 112.32 which is positive with standard deviation 11.21 . The averages of attitudes of all subsamples are positive and ranged between 106.95 in Sadat region and up to 116.77 in Bostan region . The averages in South Tahrir and Wadi Al- Natron are very near to each other with the values of 112.05 and 111.55 respectively. However, the average values of attitudes in the other two areas are highly different. They are 106.95 in Sadat and 116.77 in Bostan areas. Standard deviations for the extreme averages of Sadat (8.49) and Bostan (8.74) are so close and less than that of the other two areas of South Tahrir (11.9) and Wadi Alnatron (13.39). This shows rather stable attitudes among the farmers in both Sadat and Bostan which denotes to some real reasons for the differences between the farmers of these two areas.

Analysis of variance was applied on the above mentioned data . It revealed a significant difference among the average attitudes towards water for the four regional subsamples at a 0.0219 level of significance as it is shown in the following ANOVA table (11) .

Table (11) ANOVA for the Attitudes Towards Water in the Four Regions of Study

Source	D.F	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Group	3	1184.60	394.87	3.35	0.0219
Within Group	105	12377.16	117.88		
Total	108	13561.76			

The above mentioned significant differences among the holders' attitudes towards water could be partially attributed to the distinctive characteristics of settlers more dominant in each area . All settlers in Bostan are new graduates while they are mostly small investors with variable background in Sadat and Wadi Al-Natron. Yet, South Tahrir is characterized by a wide variety of settlers; small holders, old graduates, and recently small investors. However, the situation in Bostan and South Tahrir areas, where attitudes are relatively high, is characterized by a wide application of the sprinkler irrigation. About 73.3% and 56.4% of the sub-samples in these two areas use sprinkler irrigation respectively.

3. Attitudes towards water among the various land holders' categories of farm size :

Average values of the holders' attitudes were calculated for all categories of farm holding size. Means and standard deviations of the attitudes for all categories are shown in table (12) below .

Table (12) Average values of attitudes by farm holding size categories

Holding Size	Mean	Std. Dev.	No. of Cases
> 5	106.53	9.04	15
5 -	115.63	10.62	32
10 -	111.33	14.58	15
15 -	110.00	4.86	6
20 -	112.26	10.50	19
50 -	110.33	7.55	9
100 +	114.54	14.10	13
Total	112.32	11.21	109

It is shown from the table above that all categories have positive attitudes towards water ranged between 106.5 and 115.6 on the scale. Distribution of all categories spread over a range of 9 degrees difference . It is obvious that the least average is that of the less than 5 feddans category where they are mostly old settlers having low educational background. Yet, the highest average is that of the category of five to less than ten feddans which mostly represent the new university graduates. Dispersion for all categories ranged between 4.9 and 14.6.

Analysis of variance was applied to the data related to the mean values of attitudes of the various categories of farm holding size . ANOVA table (13) is shown below .

Table (13) ANOVA of the average attitudes towards water for farm holding size categories

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Group	6	998.28	166.38	1.35	0.24
Within Group	102	12563.48	123.1714		
Total	108	13561.76			

Analysis showed that there is no significant difference among the various categories of holding size concerning their attitudes towards water.

4. Attitudes towards water among land holders according to their irrigation systems :

Average values of farmers' attitudes were calculated for all categories of farmers classified according to the irrigation systems they use . Means of the attitudes of the farmers classified into five categories ; sprinkler only , drip only , surface only , sprinkler and drip together and surface and drip together are shown in table (14) below .

Table (14) Average Values of Attitudes by Irrigation System

Irrigation system	Mean	St. Dev.	Cases
Sprink.	115.66	8.77	44
Drip	108.35	9.28	23
Surface	103.00	10.09	15
Sprink.&Drip	118.12	13.9	17
Drip & Surface	110.90	11.05	10
Total	112.32	11.21	109

It was found that all categories have positive attitudes towards water . Yet their means are dispersed on a relatively wide range extends from 103 to 118.1. The data showed that those who use both drip and sprinkler irrigation systems together have relatively the highest positive attitudes (118.1) among all users of all different irrigation systems . The users of sprinkler irrigation system alone come next (115.7) then the users of both drip and surface systems together (110.9). The users of drip irrigation system alone come fourth (108.3) while the users of surface irrigation have the lowest attitudes towards water (103).

Application of ANOVA to the above mentioned data is presented in table (15) below .

Table (15) ANOVA of the attitudes towards water
for users of different irrigation systems

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Group	4	2747.99	687.00	6.607	0.0001
Within Group	104	10813.77	103.90		
Total	108	13561.76			

Analysis of variance of the data showed a very high significant difference among the attitudes of the five categories of users of the various irrigation systems .

These results seem very logical . Those who invest high capital in establishment of two modern systems of irrigation together have high costs of using water. Thus they estimate the value of water accordingly . Yet, on the contrary, the users of surface irrigation who do not cost the water they use much, estimate the water itself accordingly .

Though all farmers categories have positive attitudes towards water the significant differences of their attitudes towards water and the irrigation practices could be attributed to the costs they pay and the knowledge background for using specific irrigation techique. Hence it seems logical to conclude that there is a positive relationship between the farmers' attitudes towards irrigation water and the investments they allocate to cover the costs of water they use. Meanwhile the users of modern irrigation techniques should have more knowledge about the pros and cons of each irrigation technique and related infromation to decide to cost their irrigation more than the useres of surface irrigation.

5- Analysis of the Relationship Between Some Attitude Components and Area of Study, Education Level, and the Irrigation System Used

The following is the analysis of the relationship between each of the three components of the attitude namely; the estimation of the economic value of water, the willingness to share costs of irrigation public works, and the preference of landholders to using modern irrigation systems in relation to area, the level of education and the type of irrigation system used.

a) Landholders Estimation of the Economic Value of Water

Measurement of the estimation of the economic value of water was undertaking using a three items scale. The range of scale was between 3 and 15. Table (16) presents the distribution of the sample by the area of study and the economic value of water.

Table (16)
Distribution of the Sample by Estimation of Economic Value of Water and Area of Study

	Area									
Category	South Tahrir		Al-Sadat		Wadi Alnatron		Albostan		Total	
	No	%	No	%	No	%	No	%	No	%
5 -	0	0	0	0	2	10	0	0	2	1.8
8 -	2	5.1	5	25	4	20	2	6.7	13	11.9
11-	18	46.2	10	50	9	45	14	46.7	51	46.8
14- 15	19	48.7	5	25	5	25	14	46.7	43	39.5
Total	39	100	20	100	20	100	30	100	109	100.

Chi2 = 18.49 D.F.= 9 Prob. = 0.0299

The range of scale was classified into four categories; low (<8) medium (8 to 10), high (11 to 13) and very high(14 to 15). The distribution shows that more than 70% of the landholders of each area have high to very high estimation of the economic value of water. More the 86% of the sample interviewed fall in this category. The above categories showed some differences which were found significant at 0.03 using Chi2. Those who have high to very high economic value of water represent 94.9% in South Tahrir and 93.4% in Bustan areas. Landholders of these two areas include young and old graduates and small holder who have agricultural background through education or practice. Landholder of Sadat City and Wadi El-Natrun area have 75% and 78% of those with high to very high economic value of water. Settler of these two areas are mainly small investors with variable background and less agricultural education.

These results suggest that the estimation of the economic value of water is high among desert landholders and is higher at those of agriculture education. Yet this does not reflect the approval of direct water pricing which was refused by all categories during the pretest of the questionnaire.

Table (17) represents the distribution of sample by the education status and estimation of the economic value of water. The percentage of those who have high to very high estimation for the economic value of water was 91.4% of the holder of medium education, about 80% for the university graduate but only 70% for those who read and write. Testing the difference of distribution, however, show that the relationship is insignificant using Chi2. It was noticed, however, that those who have less education tend generally to have low estimation of the economic value of water.

Table (17)
Distribution of the Sample by estimation of Economic Value of Water and Educational Status

	Educational Status											
Category	Illiterate		Read& Write		Basic Ed.		Medium Ed.		Univer. Ed.		Total	
	No	%	No	%	No	%	No	%	No	%	No	%
5 -	0	0	0	0	0	0	0	0	2	0	2	1.8
8 -	2	16.7	3	30	1	14.3	3	8.6	4	8.9	13	11.9
11-	5	41.7	4	40	5	71.4	16	45.7	21	46.7	51	46.8
14- 15	5	41.7	3	30	1	14.3	16	40.0	18	40.0	43	39.5
Total	12	100	10	100	7	100	35	100	45	100	109	100

Chi2 = 9.320 D.F.= 12 Prob. = 0.6754

b) Landholders' willingness to share cost of irrigation public works.

Table (18) shows the sample distribution by the area of study and willingness to share cost of irrigation public works. This willingness was measured on a continuum ranging between 5 and 25 degree. The categories of willingness were; low (5-10), medium (11-15), high (16-20) and very high (21-25). On the basis of the whole survey sample, 83.4% of the interviewed landholder have high to very high willingness to share cost of the irrigation works. Testing the difference of distribution of the subsamples using Chi2, it was found to be significant at the level of 0.05.

Table (18)
Distribution of the Sample by Willingness to share in the Costs of Irrigation public Works and area of study

	Area									
Category	South Tahrir		Al-Sadat		Wadi Alnatron		Albostan		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
5 -	1	2.6	0	0	3	15	0	0	4	3.7
11 -	6	15.4	2	10	5	25	1	3.3	14	12.8
16-	22	56.4	13	65	8	40	17	56.7	60	55.0
21- 25	10	25.6	5	25	4	20	12	40	31	28.4
Total	39	100	20	100	20	100	30	100	109	100.

Chi2 = 17.008 D.F.= 9 Prob. = 0.0486

Those who have high to very high willingness represent 96.7% in Bustan area, 90% in Sadat area, 82% in Tahrir and only 60% in Wadi El-Natrun area. Land holders of Wadi El-Natrun are investors relying totally on groundwater and therefore they have the lowest willingness to share cost of irrigation works, since they do not benefit from public irrigation works. The situation in Bustan is different since they all use Nile water and benefit directly from irrigation works. The relatively lower percentage of willingness in Tahrir is probably due to high percentage of small holders with low education background and using flood irrigation which affect their awareness of the benefit of such irrigation public works. This is beside the long history of reliance on state and public authorities in providing these farmers with all its needs free of charge. The high percentage of willingness in Sadat City is probably due to their hope of having Nile water reaching their lands since they have been trying to convince the authorities to dig a canal through the area to prevent the groundwater wells from falling dry.

The relationship between the willingness to share such costs and the level of education of the landholders is presented in table (19). The percentage of those having to very high willingness of sharing such costs ranges between 60% of the holder who just read and write to 95.2% for those having medium education. The university graduates show less willingness to share costs compared to those having medium education. Only about 78% of those have high to very high willingness. The difference of this distribution was, however, statistically insignificant using Chi2.

Table (19)
Distribution of the Sample by Willingness to share in the Costs of Irrigation Public Works and Educational Status

	Educational Status											
Category	**Illiterate**		**Read & Write**		**Basic Ed.**		**Medium Ed.**		**Univer. Ed.**		**Total**	
	No	%	No	%	No	%	No	%	No	%	No	%
5 -	0	0	1	10	0	0	0	0	3	6.7	4	3.9
11 -	2	16.7	3	30	1	14.3	1	2.9	7	5.6	14	12.8
16-	7	58.3	5	50	5	71.4	24	68.6	19	2.2	60	55.1
21- 25	3	25	1	10	1	14.3	10	26.6	16	5.6	31	28.4
Total	12	100	10	100	7	100	35	100	45	100	109	100

Chi2 = 15.048 D.F.= 12 Prob. = 0.2388

Table (20) shows that those who have high to very high willingness to share costs represent 90.9% of the users of sprinkler irrigation systems, 86.7% of those using surface irrigation, 81.8% of the users of mixed irrigation systems, 75% of the users of drip and sprinkler irrigation systems and 74% of the users of drip irrigation systems. The difference between these categories was, however, insignificant using Chi square.

The results, however, show that more than 83% of the land holders interviewed have high to very high willingness to share costs and at least 74% of the users of any irrigation system fall in this category.

Table (20)
Distribution of the Sample by Willingness to share Costs of Irrigation Public Works and Irrigation System(s) used

	Irrigation System											
Category	**Sprinkler**		**Drip**		**Surface**		**Sprink.&Drip**		**Mixed**		**Total**	
	No	%	No	%	No	%	No	%	No	%	No	%
5 -	0	0	3	13.0	0	0	1	6.2	0	0	4	3.7
11 -	4	9.1	3	13.0	2	13.3	3	18.8	2	18.2	14	12.8
16-	30	68.2	12	52.3	9	60.0	4	25.	5	45.4	60	55.1
21- 25	10	22.7	5	21.7	4	26.7	8	50	4	36.4	31	28.4
Total	44	100	23	100	15	100	16	100	11	10.1	109	100

Chi2 = 17.562 D.F.= 12 Prob. = 0.1297

c) Preference of Desert Land Holders to Using Modern Irrigation Systems:

The preference to use modern irrigation systems and techniques was measured on a scale of six items ranged between 6 and 30. It was classified into five categories; very low (6-10), low (11-15), medium (16-20), high (21-25) and very high (26-30). Table (21) presents the distribution of sample by preference in the four areas of study.

Table (21)
Distribution of the Sample by Preference of Modern Irrigation Systems and Areas of Study

Category	Area									
	South Tahrir		Al-Sadat		Wadi Alnatron		Albostan		Total	
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%
6 -	5	12.8	0	0	2	10	0	0	7	6.4
11 -	3	7.7	2	10	1	5	1	3.3	7	6.4
16-	10	25.6	6	30	0	0	1	3.3	17	15.6
21-	15	38.5	10	50	14	70	21	70	60	55.1
26 -30	6	15.4	2	10	3	15	7	23.3	18	16.5
Total	39	100	20	100	20	100	30	100	109	100.

Chi2 = 23.786 D.F.= 12 Prob. = 0.0218

On the basis of the whole sample interviewed 71.6% have high to very high preference to using modern irrigation systems and techniques. Difference between areas was found significant at 0.02 level using Chi square. Those who have high to very high preference represent 93.3% of the land holders in Bustan area, 85% in Wadi Al-natron, 60% in Sadat and only 53.9% in Tahrir. This trend seems to be in accordance with the diversity of irrigation systems in use in these areas. In Bostan only sprinkler and drip irrigation systems are used. In Wadi AL-Natron drip irrigation is the dominant system used. In Tahrir and Sadat flood irrigation is practiced along with other systems of irrigation. This means that the direct experience with modern irrigation system beside the availability of alternatives strongly affect the preference of land holders to use these modern systems and techniques.

The relation between the level of education and the preference to modern irrigation systems and techniques is illustrated in table (22)

Table (22)
Distribution of the Sample by Preference of Modern Irrigation Systems and Educational Status

	Educational Status											
Category	**Illiterate**		**Read & Write**		**Basic Ed.**		**Medium Ed.**		**Univer. Ed.**		**Total**	
	No	%	No	%	No	%	No	%	No	%	No	%
6 -	3	2.5	1	10	2	28.6	1	2.9	0	0	7	6.4
11 -	2	16.7	1	10	1	14.3	1	2.9	1	2.2	6	5.5
16-	4	33.3	1	10	2	28.6	4	11.4	7	15.6	18	16.5
21-	3	25	5	50	2	28.6	23	65.7	27	60.0	60	55.1
26- 30	0	0	2	20	0	0	6	17.1	10	22.2	18	16.5
Total	12	100	10	100	7	100	35	100	45	100	109	100

Chi2 = 32.408 D.F.= 16 Prob. = 8.844E-03

The percentage of those having high to very high preference to using modern irrigation systems and techniques represent 82.8% of landholders having medium education, 82.2% of the university graduates and only 25% of the illiterates. The difference of distribution was found significant at 0.0088 level using Chi2. It could be concluded that there is a positive trend of relationship between the educational status and the preference of using modern irrigation systems and technique.

The preference of various landholder using specific irrigation system to using modern irrigation systems and techniques is illustrated in table (23).

Table (23)

Distribution of the Sample by Preference of Modern Irrigation Systems and used Irrigation System(s)

	Irrigation System											
Category	**Sprinkler**		**Drip**		**Surface**		**Sprink. & Drip**		**Mixed**		**Total**	
	No	%	No	%	No	%	No	%	No	%	No	%
6 -	0	0	0	0	7	46.7	0	0	0	0	7	6.4
11 -	2	4.6	1	4.3	3	20.0	0	0	0	0	6	5.5
16-	6	13.6	2	8.7	4	26.7	2	12.5	4	36.4	18	16.5
21-	30	68.2	17	73.9	0	0	7	43.8	6	54.5	60	55.1
26- 30	6	13.6	3	13.1	1	6.7	7	43.8	1	9.1	18	16.5
Total	44	100	23	100	15	100	16	100	11	100	109	100

Chi2 = 76.315 D.F.= 16 Prob. = 7.638E-10

It was found that the users of drip systems and the users of sprinkler and drip systems together have the highest percentages of the categories of high and very high Preference. They were 87% and 87.6% respectively. The users of sprinkler systems came third with 81.8%, while the users of mixed systems came fourth with 63.6%. Users of surface irrigation came far behind with 6.7% only. Testing these differences of the distribution using Chi2 was found very highly significant at (7.638 E-10) level. The conclusion is clear that practical experience with any irrigation system affects and is highly correlated with the preference of modern irrigation systems and techniques.

6. The Sample Knowledge Levels of Modern Irrigation Techniques

In this section interest will be directed towards the assessment of the technical knowledge level related to the different aspects of sprinkler and drip irrigation techniques separately. Related data were collected from those who were using these techniques either solely or in parallel with other techniques at the time of data collection.

a) Technical Knowledge of Sprinkler Irrigation

The data used in this part were that collected from 60 farmers who were using this technique either alone or along with some other systems. Table (24) below presents the distribution of this sub-sample by item grouping of knowledge scale and the areas of study.

TABLE (24)
Sample Distribution by Area of Study and Technical Knowledge of Sprinkler Irrigation

ITEM	S. Tahrir N = 21		Sadat N = 4		W. Al-Natron N = 11		Bostan N = 24		TOTAL N == 60	
	No	%	No	%	No	%	No	%	No	%
Manage. (8	110	65.5	19	59.4	44	50	102	53.1	275	57.3
Op. Cond.(3	13	20.6	9	75.0	22	25	43	59.7	87	48.3
Fertigation (1)	12	57.1	2	50	10	90.9	7	29.2	31	51.7
Efficiency (1	20	95.2	4	100	11	100	23	95.8	58	96.7
Labor Req.(1)	11	52.4	2	50	00	00	3	12.5	16	26.7
Crop Serv.(1)	1	4.8	1	25	3	27.3	8	33.3	13	21.7
Total (15)	167	53.0	37	55	90	54.5	186	51.7	480	53.3

It is shown from the above table that the whole sample has relatively low level of knowledge with the measured items. The average level was found 53.3% for the whole sample while it ranged between 51.7% and 55% for the four areas of study. However when this level was measured for each group of items it was found very high with the knowledge related to the measure of efficiency of sprinkler irrigation system (96.7%). However, the level of knowledge was found very low for the items related to labor requirements and the crop service advantage of this system. They were found 26.7% and 21.7% respectively. Average knowledge level with operating conditions, fertigation and on farm water management groups of items ranged between 48.3% and 57.3%.

It seems that knowledge level of holders of desert lands with the various technical aspects of sprinkler irrigation is low in average. This means that there are real training needs that should be satisfied through tailored training and extension programs. However, full detailed training needs assessment should be undertaken prior to any design or planning of such programs . Training needs are not related to technical knowledge only. They are also related to the attitudes and skills related to the recommended irrigation system.

b) Technical Knowledge of Drip Irrigation

Data were collected from the users of drip irrigation whether alone or along with some other system. Table (25) presents the distribution of the sample by areas of study and the groups of items of technical knowledge with drip irrigation.

The over all average of knowledge level of the sample with the technical aspects of drip irrigation was found 67.3%. It is relatively higher than that of the users of sprinkler irrigation. It ranged between 65.2% in Tahrir and 68.8% in Sadat.

When these averages were estimated for the groups of items they were found very high for advantages of the system for crop service, the costs of the system and efficiency measures of the system. They were 93.9%, 87.8% and 81.6% respectively. Knowledge level was found moderate with the groups of items of advantages of the system, maintenance and the operating conditions where they were 76.9%, 72.2% and 71.0% respectively. The groups of other

TABLE (25)
Sample Distribution by Region and Technical Knowledge of Drip Irrigation

ITEM	Tahrir N = 5		Sadat N = 19		W. Alnatron N = 19		Bostan N = 6		TOTAL N = 49	
	No	%	No	%	No	%	No	%	No	%
Mainten. (5)	18	72	71	74.7	65	68.4	23	67.7	177	72.2
Oper.Cond. (5)	20	80	69	72.6	63	66.3	22	73.3	174	71.0
Fertigation (4)	10	50	56	73.7	54	71.1	16	66.7	136	69.4
Manage. (3)	7	46.7	28	49.1	24	42.1	8	44.4	67	45.6
Advantage (3)	10	66.7	44	77.2	46	80.7	13	72.2	113	76.9
Weeding (2)	5	50	25	65.8	20	52.6	7	58.3	57	58.2
Costs	4	80	14	73.7	19	100	6	100	43	87.8
Labor	2	40	3	15.8	3	15.8	0	0	8	16.3
Efficiency	5	100	13	68.4	17	89.5	5	83.3	40	81.6
Pesticide	3	60	12	63.2	11	57.2	4	66.7	30	61.2
Crop Service	4	80	18	94.7	18	94.7	6	100	46	93.9
Total (27)	88	65.2	353	68.8	340	66.3	110	67.9	891	67.3

items ranged between 45.6% for the group of on farm water management and 69.4% for fertigation. The lowest level of knowledge was that related to the labor requirements of the system (16.3).

It could be concluded, in general, that the level of technical knowledge with the various aspects of drip irrigation is rather higher than other modern irrigation systems due to the characteristics of users and the importance of using this system efficiently where water resources are more scarce. This system is mostly used in Sadat and Wadi Al-natron areas (see table (8) above) where holders are mostly investors and seek more efficient systems regardless of their initial costs.

c) Irrigation Knowledge Needs:

Table (26) presents the distribution of the sample by the areas of study and their need or not of some knowledge related to irrigation systems and practices.

TABLE (26)
Sample Distribution by Area of Study and Irrigation Knowledge Needs

Response	Tahrir		Sadat		W. Alnatron		Bostan		TOTAL	
	No	%	No	%	No	%	No	%	No	%
Yes	11	28.2	9	45	14	70	20	66.7	54	49.5
No	28	71.8	11	55	6	30	10	33.3	55	50.5
TOTAL	39	100	20	100	20	100	30	100	109	100

In general it was found that about 49.5% of the whole sample were in some need of knowledge related to irrigation. The percentage of those who were in some need of irrigation knowledge was found the highest in Wadi Al-natron (70%), then in Bostan (66.7%), and moderate in Sadat area (45%), while it was the least in Tahrir (28.2%). These figures show again that characteristics of the holders and their period of practice with farming seem influential in determining their need or not of knowledge about irrigation systems and practices. The lower proportion of needy holders in Tahrir confirm that the long period of practicing farming beside their agricultural background whether by practice or education helped them to feel more satisfied with their knowledge in irrigation. However this does not mean they have the right knowledge they need for their farming conditions.

Table (27) presents the distribution of those who were in need of knowledge related to irrigation and whether they got the knowledge they need or not.

TABLE (27)
Sample Distribution by Area of Study and getting Required Knowledge

Response	T.		S.		W.N.		B.		TOTAL	
	No	%	No	%	No	%	No	%	No	%
Yes	8	72.7	9	100	14	100	18	90	49	90.7
No	3	7.3	--	00	--	00	2	10	5	9.3
TOTAL	11	100	9	100	14	100	20	100	54	100

It is shown from the table that the majority of the needy holders (90.8%) have got the knowledge they needed. The percentage was the least in Tahrir. Yet, it was the highest in Sadat and Wadi Al-natron where settlers are mostly investors. This reflects the fact that the wealthy holders can get the knowledge they need regardless of the existence or not of extension service in the area.

V. Economic Evaluation of Crop Production Functions Under Different Irrigation Systems

Preface:

In Egypt, water is considered to be the most important constraint which hinders agricultural expansion. Decision makers can no longer plan any agricultural expansion without seriously considering the limited supply of water provided by the Nile River. Moreover, the demand for water, for almost all uses, has risen and is continually rising, to the point that Egypt is currently using more than its share of 55.5 billion cubic meters. Pressure of rising population, by itself, underscores the need to revitalize the agricultural sector. This will definitely possess important implications for water use and constitutes a pressing need for the country to maximize the returns to this valuable resource in an environmentally sound manner.

One of the major steps the Egyptian government has taken in recent years to increase agricultural production is to reclaim new lands. Land reclamation is another major water consumer and promises to become an increasingly important component of demand in the near future. Originally, this practice has started in the early fifties. The government has restarted its land reclamation program in the mid seventies with ambitious objectives based on its experience with old new lands (the Tahrir area). This interest in reclamation stems mainly from the government's need for an outlet to deal with the demands of a growing population.1/ The political and social importance of thisactivity explains the government insistence on expanding its reclaiming efforts despite of a widespread criticism of the economic costs and high water consumption.

Since 1952, the government has reclaimed 1.6 million feddans and has lost approximately one million feddans of the old Delta lands to urban encroachment during this period. Accordingly, net gains have been significantly reduced. Moreover, the productivity on the new lands did not meet expectations due to a number of administrative, technical, and natural constraints. Of the 900,000 reclaimed feddans between 1967 and 1975, only 500,000 feddans were farmed, with only 200,000 feddans of that reaching submarginal productivity.2/

the reasons for this disappointing performance are believed to be economic inefficiency combined with some technical bottlenecks. High investment cost is the character of land reclamation. In other words, it takes an average of ten years before reclaimed lands reach submarginal productivity. Not enough attention was paid to irrigation and drainage infrastructure. Moreover, 500,000 feddans had to be completely excluded from crop rotations because of salination problems in some areas; in other areas the water table rose an average of three meters a year.3/ Water shortages were common, and the cost of lifting water became an issue, as did the problem of an unreliable electricity supply. Egypt's Water Master

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1/Waterbury, J., and Rignall, K. Agriculture and Water Use in Egypt: Policy Task Force 402(e), Managing a Vital Resource: Conflict and Cooperation in the Nile Basin. USAID/Cairo, Development Information Center. April 29, 1991.

2/ Barth, H.K., and Shata, A.A., Natural Resources and Problems of Land reclamation in Egypt. Wiesbaden: Dr. Ludwig Reichert Verlag, 1987.

3/ El-Batran, M.M. "The Impact of Alternative Policies on the Food Gap for Strategic Crops in Egypt." Diss. Colorado State University, 1989.

Plan predicted future reclamation to require 5,400 cubic meters per feddan, while IBRD considered 9,200 cubic meters per feddan more realistic given current methods of reclamation.4/

The fiscal constraints of the mid seventies as well as the recognized inefficiencies in reclamation efforts spurred a reassessment of the government's program in the early eighties. With a revised plan based on improved planning and more appropriate technology, the government hopes to achieve greater economic and water use efficiency in future reclamation.

This report sheds the light on the problem of economic and water-use efficiency in the new lands on the micro level. Marginal analysis is used through the estimation of crop production functions under different irrigation systems. The objective is to assess the role of irrigation water for some chosen crops under each system, in addition to testing the economic efficiency of the farmers residing in the new lands. More specifically, a quantification of the impact of irrigation water on the level of agricultural output is made. A random sample of 109 farmers (this represents the number of farmers who responded) was interviewed during the summer and fall of 1995. This sample covers four areas in the new lands: South Tahrir, El-Bostan, Wadi-El-Natroun, and El-Sadat. All of which are located in El-Beheira governorate.

4/ Waterbury, J. Riverains and Lacustrines: Toward International Cooperation in the Nile Basin. Research program in Development Studies 107. Princeton: Princeton U, Undated.

The Production Function Approach:5/ and 6/

Knowledge of water response functions constitutes an important set of information needed in either private or public decisions on optimal water use. Unfortunately, however, yield response functions for water have seldom been known before large or small irrigation practices have been initiated from either surface or groundwater. Decision rules for optimal water use depend upon: (a) the knowledge of the water production function relative to various soils, environmental variables, and management variables with which it can be used, and (b) the stochastic, i.e., probabilistic or uncertain, nature of the water supply. In this report, soil types and environmental variables are found to be of no importance due to their relative homogeneity in the study area; while the stochastic nature of water supply is not considered.

A production function represents a schedule or mathematical formulation expressing the relationships between inputs and outputs. It also indicates the maximum amount of product obtainable from a specified quantity of inputs given the existing technology governing the input-output relationships. By definition, a production function embodies technical efficiency. This requires that a specified set of inputs cannot be recombined to produce a larger output or that a specific level of output cannot be produced with fewer inputs. The input-output relationships are assumed to be known with certainty, i.e., the farmer knows the eventual outcome of the production process at the beginning of the production period. Since these relationships are neither fully known nor controllable,

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5/Hexem, R.W. and E.O. Heady. Water Production Functions for Irrigated Agriculture. Center for Agricultural and Rural Development CARD, The Iowa State University Press, Ames, Iowa, USA, 1978.

6/Doll, J.P. and F. Orazem. Production Economics: Theory with Applications. Grid Inc., Columbus, Ohio, USA. 1978.

a distribution of yields would be associated with each input-use level. This range of expected yields depends on the estimated variability of the predicted yield corresponding to the specified input use-level. Finally, inputs included in a production function are assumed to be homogeneous and prices of inputs and outputs are known with certainty.

A production function can be expressed in different ways: in written form; enumerating and describing the inputs that have a bearing on output; by listing inputs and the resulting outputs numerically in a table; in the form of a graph or a diagram; and as an algebraic equation.

A single-variable production function is of little practical significance. Few, if any, actual production relationships involve a single input. A more meaningful relationship is expressed symbolically as follows:

$$Y = f(X1, X2, X3 \ldots\ldots\ldots\ldots Xn) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where Y denote output (or Total Physical Product TPP), X1 denote the variable input (water in our case), X2 to Xn stand for the levels of other variable inputs, and f is the mathematical form of the input-output relationship that transforms inputs into output.

Some important derivatives which could be obtained once a production function is estimated include: Average physical Product (APP), Marginal Physical Product (MPP), and elasticity of production Ep. The first, APP, is obtained by dividing total output Y by the total amount of the variable input X. Geometrically, it is defined in terms of the slope of a particular straight line. This slope represents the average rate at which the input X is transformed into product Y. The straight line (ray) must always pass through the origin and intersects the estimated production function. The second, MPP, is the change in output Y resulting from a unit increment or unit change in the variable input. It measures the amount that total output increases or decreases as input increases. Geometrically, MPP represents the slope of the estimated production function. The third, the elasticity of production Ep, is a concept that measures the degree of responsiveness between output Y and input X. Like any other elasticity, Ep is independent of units of measure.

Furthermore, there is a duality between production and cost functions, i.e., cost functions and production functions are by nature inversely related to each other. Knowledge of one implies knowledge of the other (when input prices are known).

Economic Efficiency:

This concept refers to the combinations of inputs that maximize individual or social objectives. It is defined in terms of two conditions: necessary and sufficient. The first is met in the production process when: (a) there is no possibility of producing the same amount of product Y with fewer inputs and (b) there is no possibility of producing more product Y with the same amount of inputs. This necessary condition for economic efficiency is met when estimating a production function (given that the previously-mentioned assumptions are satisfied) in the second stage of production, i.e., when Ep is equal to or greater than zero and equal to or less than one.

The second, i.e., the sufficient condition of economic efficiency, varies with the objectives of the individual farmer. It is called the choice indicator. An individual farmer whose objective is to increase yield per feddan will be different from that of an individual whose objective is maximization of profits per feddan. It is assumed in this report, like most of the economic literature under perfect knowledge, that the individual's farmer main objective is to maximize profits. This implies that the sufficient condition for economic efficiency will turn out to be what is known as the price or allocative efficiency. This efficiency is defined as profit maximization through equating the value of marginal product of the input VMP(X) (water in this case) to its unit price. Where VMP(X) is the outcome of multiplying the MPP of water which is derived from the estimated production function by the unit price of output (the farmgate price). Because irrigation water is not priced in Egypt, a method had to be deduced in this report to calculate the imputed cost of water, which is a measure of the opportunity cost of water. In other words, the cost the farmer would bear should water was not delivered to him free of charge. In this report, the imputed cost of water is the cost of constructing a well taking into consideration the type of irrigation system utilized.

Input and output measurements:

Eight per-feddan production functions of the Cobb-Douglas (double-logarithmic type) are estimated separated by the type of crop grown and method of irrigation. They are: peanuts (sprinkler) PNT1, peanuts (flooding) PNT2, wheat (sprinkler) WHT1, wheat (flooding) WHT2, winter crops (sprinkler) WC1, winter crops (flooding), summer crops (sprinkler) SC1, and vegetables (drip) VEG3. Two equally-good functions are found to represent VEG3. The numbers 1, 2, and 3 stand for the three irrigation systems: sprinkler, flooding, and drip, respectively. Winter crops include: wheat, onions, peas, and clover. Summer crops include: peanuts, maize (corn), darawa, kidney-beans for forage, sorghum, and sesame. Vegetables include: watermelons, watermelons for seeds, green beans, potatoes, egg plant, squash, strawberries, tomatoes, cucumbers, bell peppers, green beans, and melons (cantaloup). This almost includes all of the major crops grown in the study area but citrus. Although data for citrus was collected and analyzed, no functions could be estimated due to the problem of having different maturity dates for citrus. In other words, farmers who have mature and productive citrus trees were characterized by having great output with very few inputs; while some other farmers who have young nonproductive citrus trees were characterized by employing lots of inputs and having a slim or no output. When a trial was made to group the trees of the same age together in one function the problem of having few degrees of freedom was raised. This eventually prevented a correct statistical estimation of production functions for citrus utilizing the sprinkler or the drip systems.

Functions such as winter crops (drip), summer crops (flooding or drip), vegetables (sprinkler or flooding), peanuts (drip), and wheat (drip) could not be estimated due either to the nonexistence of enough degrees of freedom or the fact that no farmer utilized a certain irrigation system for a particular crop.

The dependent variables in the estimated functions are either the quantity of output in physical units, i.e., kilograms/feddan, or monetary unit, i.e., value of output in L.E./feddan. The first was employed for the functions which portrayed one output, i.e., wheat (sprinkler and flooding) and peanuts (sprinkler and flooding). For the functions where the dependent variable was a collection of products, i.e., winter crops (sprinkler and flooding), summer crops (sprinkler), and vegetables (drip), the dependent variable was the value of output per feddan.

The explanatory (independent) variables are: education measured as a dummy variable 1, 2, and 3 which stand for elementary, intermediate, and high education, respectively; seeds in kilograms; organic fertilizers in cubic meters, nitrate fertilizer, phosphate fertilizer, and potassium fertilizer, all measured by the quantity of active ingredient; machinery in monetary units, labor in man/days, and water in cubic meters.

Analysis and Results

Production Function Estimates:

Table (1) presents a summary of the production function estimates. The F-ratios of all of the estimated functions (regressions) are found to be statistically significant. All of the estimated coefficients are statistically significant (at different significance levels as shown by the P-values in parentheses). The adjusted R2 and the number of observations N are shown at the extreme right of the table. The first indicates the contribution of the explanatory variables in the estimated function in explaining the variation in the level of the dependent variable (physical output for the first four functions and the value of output for the next four functions). For instance, an adjusted R-square of 0.55 for the function PNT1 implies that the explanatory variables: water, nitrogen fertilizer, and labor account for 55% of the variation in output. The second, N, shows the number of observations. The table also shows that VEG3 has two equally-good functions which represent it.

Because all of the estimated functions are of the Cobb-Douglas type, the estimated regression coefficients shown in table (1) are the elasticity of production for the corresponding inputs. For instance, for peanuts (sprinkler) PNT1, a water coefficient of 0.231 means that an increase in the level of water by 100% results in increasing the level of output by 23.1%, and so forth for the rest of the estimated coefficients. On the other hand, the table shows that most of the signs of the estimated coefficients are positive and match with economic logic (except for four variables scattered in PNT2, WHT2, and WC1).

Table (1) Summary of Production Function Estimates

Function	Explanatory Variables (P-Values)											
	Edu.	Water	Seeds	Orgf.	N.	P.	K.	Mach.	Labor	F-ratio	Adj.R2	N
PNT1		0.231			0.244				0.383	19.75	0.55	47
		(0.01)			(0.004)				(0.001)	(0.000)		
PNT2		1.227				-0.296	-0.09		1.421	18.02	0.84	14
		(0.002)				(0.09)	(0.02)		(0.001)	(0.000)		
WHT1		0.901	0.304		0.145	0.054				14.51	0.65	30
		(0.000)	(0.06)		(0.07)	(0.07)				(0.000)		
WHT2	-0.347	0.491				0.097			0.269	8.41	0.68	15
	(0.02)	(0.02)				(0.01)			(0.002)	(0.003)		
SC1		0.447			0.232	0.103			0.366	7.69	0.42	47
		(0.03)			(0.04)	(0.06)			(0.004)	(0.000)		
WC1		1.330			0.164	0.088		-0.144	0.195	15.46	0.60	50
		(0.000)			(0.003)	(0.08)		(0.03)	(0.002)	(0.000)		
WC2		0.923			0.508				0.271	10.07	0.63	17
		(0.03)			(0.08)				(0.03)	(0.001)		
VEG3												
(1)		1.400	1.111	1.400						8.85	0.54	21
		(0.04)	(0.01)	(0.001)						(0.000)		
(2)		1.340		0.774			0.333			7.68	0.50	21
		(0.06)		(0.04)			(0.03)			(0.001)		

Legend: PNT, WHT, SC, WC, and VEG stand for peanuts, wheat, summer crops, winter crops, and vegetables, respectively. The numbers 1, 2, and 3 which are attached to those symbols represent the three irrigation systems under study: sprinkler, flooding, and drip, respectively. The explanatory variables: Edu., Orgf., N., P., K., and Mach. stand for education, organic fertilizer, Nitrogen, phosphate, potassium, and machinery, respectively.

Source: Calculated through multiple regression analysis.

Ranking of Inputs:

The inputs of the eight estimated production functions are ranked according to their relative importance in affecting the level (or value) of output. This is done by estimating the standardized regression coefficients (Beta). This could be obtained utilizing the previously estimated regression coefficients and the standard deviation of both the input and the output. Table (2) shows the standardized regression coefficients for the eight estimated functions. Comparisons should be made within the estimated function only (not across functions) according to the size of the Beta coefficient (including the sign). The bigger the Beta coefficient the more important the variable becomes.

Table (2) The Estimated Standardized Regression Coefficients for the Estimated Production Functions

Function	Explanatory Variables								
	Edu.	Water	Seeds	Orgf.	N.	P.	K.	Mach.	Labor
PNT1		2.29			0.03				0.01
PNT2		2.17				-0.008	-0.002		0.01
WHT1		1.00	0.01		0.02	0.002			
WHT2	-0.0006	0.76				0.004			0.005
SC1		0.57			0.02	0.003			0.009
WC1		0.81			0.01	0.002		-0.02	0.007
WC2		1.32			0.04				0.006
VEG3 (1)		0.09		0.002			0.002		
(2)		0.09	0.003	0.003					

Source: Calculated form the estimated functions and standard deviations of inputs and output.

The table shows that within the eight estimated functions, water is by far the number one input for the above indicated crops. For peanuts (sprinkler) PNT1, nitrogen and labor followed; for peanuts (flooding) PNT2, labor, phosphate, and potassium followed; for wheat (sprinkler)

WHT1, seeds, nitrogen, and phosphate followed; for wheat (flooding) WHT2, labor, phosphate, and education followed; for summer crops (sprinkler) SC1, nitrogen, phosphate, and labor followed; for winter crops (sprinkler) WC1, nitrogen, phosphate, and labor followed; for winter crops (flooding) WC2, nitrogen and labor followed; and finally for vegetables (drip), organic fertilizer and potassium fertilizer were of the same relative importance (for the first function), while seeds and organic fertilizer were of the same relative importance (for the second estimated function).

Economic Efficiency of Water Use:

Technical (or production) efficiency, as defined earlier, could be explicitly deduced from the estimated production functions through the calculation of the Average Physical Product APP of water. That is to say, a measure of the number of units of output produced by one unit of water. Table (3) shows a summary of the calculated APP for the water input for the eight estimated functions. The APP for water could be calculated in either one of two ways: by solving the estimated function to obtain Y/X, where Y is the level of output per feddan (in physical or monetary units) and X represents the amount of water in cubic meters applied per feddan; or directly by dividing the average amount of Y by the average amount of X. Both ways are found to yield the same results (which is a proof that the estimated functions are statistically correct). For the first four estimated functions, Y was measured in physical units (kilograms), while for the last four functions Y was measured in Egyptian pounds. In the latter case, it is not proper to call it APP but rather Average Value Product (AVP). For instance, for PNT1, an APP of water of 0.476 implies that a cubic meter of water increases on the average the level of output by 0.476 kilogram. On the other hand, for a value function like SC1, a cubic meter of water results in increasing the value of output by 0.482 pound. Comparisons of the calculated APP or AVP of water are of value only when we consider the comparisons between the production efficiency of the sprinkler and the flooding irrigation systems for the same crop, i.e., when we compare between PNT1 and PNT2 or WHT1 and WHT2 or WC1 and WC2. These comparisons reveal one simple fact: the cubic meter of irrigation water for the sprinkler system possesses on the average high production efficiency than the flooding system. Note also the high AVP of water in case of vegetables. This may indicate the high production efficiency of drip irrigation against either the flooding or the sprinkler systems, in addition to the fact that vegetables are considered cash crops and it pays to water them (a cubic meter of water on the average increases the value of output by almost three pounds). Unfortunately, statistical analysis could not be performed for other crops utilizing the drip system either because of the nonexistence of enough degrees of freedom to allow a justifiable statistical estimation of the production function, or that the drip system already is not installed yet for some crops.

Table (3) Production (Technical) Efficiency of Water for the Estimated Production Functions

Production Function	Average Physical Product of Water (APP)
Peanuts (sprinkler) PNT1	0.476
Peanuts (flooding) PNT2	0.327
Wheat (sprinkler) WHT1	0.687
Wheat (flooding) WHT2	0.634
	Average Value Product of Water (AVP)
Summer Crops (sprinkler) SC1	0.482
Winter Crops (sprinkler) WC1	0.422
Winter Crops (flooding) WC2	0.331
Vegetables (drip) VEG3	2.969

Source: Calculated from the estimated production functions.

On the other hand, the farmer is considered price efficient in the use of irrigation water if he gets a high value for the unit of output compared with the unit cost of water. In other words, if the Value of Marginal Product VMP of water is equal to the unit cost of water. Stated differently, if the ratio of the VMP of water to its own price equals one. If this ratio is greater than one then the farmer is under utilizing water. While if the ratio is less than one then the farmer is over utilizing water.

In Egypt, irrigation water is not priced. Consequently, some assumptions have to be made to calculate the imputed cost of water which in this case represents the opportunity cost of water. That is to say, the cost the farmer would have paid should water was not delivered to him free of charge.

The assumptions used in this report to deduce the cost of one cubic meter of irrigation water in the study area are as follows: The area the well serves is 50 feddans; the discharge of the pump is 150 cubic meter/hour; the cost of digging the well, the pump, and the diesel engine is estimated at L.E. 73,000; the well is of an average depth of 100 meters; the average life of the well that is adequately maintained is 15 years; the costs of the flooding, sprinkler, and drip systems are: zero, 1500, and 3000 Egyptian pounds per feddan, respectively; average annual fixed costs are 4867, 12367, and 19867 Egyptian pounds for the flooding, sprinkler, and drip systems, respectively; cost of fuel (diesel) is estimated at 9600, 17600, and 15360 pounds per year for the flooding, sprinkler, and drip systems, respectively; oil and lubricant costs per year are estimated at 200, 366, and 320 pounds for flooding, sprinkler, and drip systems, respectively; annual cost of repairs and maintenance for the engine and pump for the three systems is estimated at 2920 pounds; annual maintenance and repair costs of the whole irrigation system are estimated at zero, 375, and 750 pounds, for flooding, sprinkler, and drip systems, respectively; total annual fixed and variable costs for the three systems are 17587, 33628, and 30217 pounds, respectively; the pump discharges 300,000 cubic meter per year on the basis that the number of operating hours for the system is estimated at 2000 hours (design expectation) and 1000 hours (actual operation in the study area).

Accordingly, two scenarios are made for the cost of one cubic meter of irrigation water in the study area. The first is based on an annual operating hours of 2000/year; the second on 1000 hours/year. Under the first scenario, the cost of the cubic meter of water for the flooding, sprinkler, and drip systems is estimated at: 0.07, 0.124, and 0.143 pounds, respectively. Under the second scenario, these same figures are multiplied by two yielding an imputed cost of the cubic meter of water in the study area of: 0.14, 0.248, and 0.286 pounds for the flooding, sprinkler, and drip irrigation systems, respectively.

Table (4) shows the ratio of the VMP of water and its imputed cost along with the corresponding t-statistic when rendered necessary (that is to say, only when the tested ratio is close to one). The null hypothesis (Ho) is that the ratio is equal to one. These VMP's for water are deduced form the estimated functions by multiplying the estimated water coefficient by the average value of output over the average value of the water input.

Furthermore, output prices were based on the average of the years 1991 through 1993 (the last available published data).

Table (4) Results of the Price (Allocative) Efficiency of Water Under the Two Scenarios of the Imputed Cost of Water for the three irrigation systems

Function	VMP(W) L.E.	C(W) L.E./m3		VMP(W)/C(W)		Estimated t-test (When Necessary)*		Ho: The Ratio Equals One	
		(1) Design	(2) Actual	(1)	(2)	(1)	(2)	(1)	(2)
PNT1	0.118	0.124	0.248	0.952	0.476	-0.235	-7.232	do not reject	reject
PNT2	0.429	0.070	0.140	6.129	3.064			reject	reject
WHT1	0.318	0.124	0.248	2.565	1.282		1.352	reject	do not reject
WHT2	0.160	0.070	0.140	2.286	1.143		1.006	reject	do not reject
SC1	0.215	0.124	0.248	1.734	0.867	2.099	-0.659	reject	do not reject
WC1	0.561	0.124	0.248	4.524	2.262			reject	reject
WC2	0.305	0.070	0.140	4.357	2.179			reject	reject
VEG3									
(1)	3.978	0.143	0.286	27.818	13.909			reject	reject
(2)	4.156	0.143	0.286	29.063	14.531			reject	reject

Source: Calculated through the estimated production functions, the imputed cost of water in the study area, and the cross section data.

* The level of significance is the 1% level.

The table shows that allocative (price) efficiency was achieved in four cases (that is to say, the ratio was equal to one in only four case). Under the first scenario of the imputed cost of water (where the design expectations of operating hours is embodied), only one function displayed allocative efficiency, peanuts (sprinkler) PNT1. Under the second scenario of the imputed cost of water (where actual operating hours are considered), three functions portrayed allocative efficiency, Wheat (sprinkler) and (flooding) WHT1 and WHT2, and summer crops (sprinkler) SC1. Of course, any alteration in the assumptions through which the imputed cost of water is calculated from will result in changing these results.

Conclusions

The results of the study could be summarized as follows: (1) The sprinkler system is more production efficient than the flooding irrigation system in terms of the amount or value of output obtained from the unit of irrigation water. (2) The drip system possesses the highest production efficiency in terms of water use. (3) Water is by far the most important input in desert agriculture in the new lands in the study area. The water coefficient was always positive and statistically significant across all estimated production functions. (4) Because irrigation water is not priced in Egypt, a method has to be developed to calculate the imputed cost of water. Two scenarios for the price of the cubic meter of irrigation water are presented in the study area. Under the first scenario (design expectation of pump-operating hours of 2000 hours/year), the imputed cost of the cubic meter of irrigation water was estimated at: 0.070, 0.124, and 0.143 pounds for the flooding, sprinkler, and drip systems, respectively. Under the second scenario (actual operating hours of the pump of 1000 hours/year), which portrays the problem of water shortage in the area, the cubic meter of irrigation water was priced at 0.140. 0.248, and 0.286 pounds for flooding, sprinkler, and drip irrigation systems, respectively. (5) As far as allocative (price) efficiency is concerned, one function (peanuts sprinkler) out of possible eight is found to achieve it under the first scenario (design expectation); while three functions (wheat sprinkler, wheat flooding, and summer crops sprinkler) are found to achieve it under the second scenario (actual operation).

Implications for further research:

The marginal analysis employed in this study, though considered sound in the economic literature, has some deficiencies. These shortcomings are embodied in its main assumptions of: perfect knowledge of the prices of inputs and outputs, perfect competition in input and output markets, the knowledge of the technical relationships between inputs and outputs on behalf of individual farmers, and the unconsideration of the stochastic nature of any variable and specially irrigation water. this type of analysis is in need to be complemented with other analyses to strengthen it. For instance, one of the items in this study which affected the results obtained concerning economic efficiency is the imputed cost of irrigation water. It is clear that altering any of the assumptions through which this cost is calculated from will alter the results.

Accordingly, another economic analysis is needed to complement the results of the production function estimation. This could be in the form of a mathematical programming technique through which the shadow (economic) price of irrigation water is determined. The mathematical programming technique will also help in determining the optimal cropping pattern in the study area, in addition to the area that should be grown of each crop given the existing resources if the farmer is to maximize profits or any other function.

Furthermore, a closer examination of a sample farmers (who were originally included in the analysis) should help in determining the status of their irrigation systems, allow modification to their systems, and eventually evaluating their economic status before and after modifications. This is rendered necessary since the results of this study showed that most farmers are under-utilizing irrigation water. The only reasonable explanation of this, other than the method and/or assumptions of calculating the imputed cost of water, is that individual farmers face problems of water shortages which alter their problem from a choice problem to an availability one. This is a rather important aspect in economic analysis, since that the economic problem under the theory of production is the problem of choice. That is, the choice among available production alternatives to achieve some goals taking into consideration scarcity of resources.

APPENDIX

IRRIGATION SYSTEMS FIELD EVALUATION SHEETS

TRICKLE IRRIGATION EVALUATION

Location: *El Bostan -Mohamed Esmaiel* ,

Observer: Eng . Yasser , *Date: 14/8/95*

Crop: *Type Tomato* , *Age: 2 days* *Spacing: 0.5x1.85*

Soil: *Texture Sandy* , *Available Moisture 60%*

Irrigation *: Duration 4 hr* , *Frequency: 2 days*

Filter Type And Performance. *Screen filter*

Pressure Inlet: , *Pressure outlet:* , *Loss:*

Fertilizer Unit Characteristics. *No filtilizer exists .*

NEmitter: *Make: local* ,*Type: Gr* , *Point Spacing 0.5 m*

Rated Discharge per Emission Point *: 4 l/h* *At Pressure: 1 bar*

Emission Points Per Plant : 1 , *giving 8 liter/day*

Laterals: *Diameter: 16 mm, Material : P.E* , *Length 42 m*

Spacing: *1.85 m.*

E.C. *(if groundwater is used): ppm*

Outlet location on lateral		Lateral location on the Manifold							
		inlet end		1/3 down		2/3 down		far end	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	29	3.48	23	2.76	28	3.36	30	3.6
Inlet end	B	29	3.48	26	3.12	28	3.36	30	3.6
	Time	30	30	30	30	30	30	30	30
	Average	29 ,	3.48	24.5	2.94	28	3.36	30	3.6
	A	26	3.12	23	2.76	29	3.48	26	3.12
1/3 down	B	27	3.24	24	2.88	28	3.36	25	3
	Time	30	30	30	30	30	30	30	30
	Average	26.5	3.18	23.5	2.82	28.5	3.42	25.5	3.06
	A	26	3.12	26	3.12	30	3.6	28	3.36
2/3 down	B	26	3.12	25	3	30	3.6	27	3.24
	Time	30	30	30	30	30	30	30	30
	Average	26	3.12	25.5	3.06	30	3.6	27.5	3.3
	A	29	3.48	20	2.4	30	3.6	30	3.6
Far end	B	26	3.12	19	2.28	27	3.24	29	3.48
	Time	30	30	30	30	30	30	30	30
	Average	27.5	3.3	19.5	2.34	28.5	3.42	29.5	3.54
Pressure	inlet end	1		1.1		1.1		1.2	
	far end	1		1		1.1		1	
minimum rate of discharge	2.89								
average rate of discharge	3.22	EU= 89.8 %		Ea= 80.8 %					

TRICKLE IRRIGATION EVALUATION

Location: *El-Bostan- Rady Nabawy ElHousieny ,*

Observer: Eng. Yasser , Date: 20/8/95

Crop: *Type squash + eggeplant , Age: 30 day Spacing: 0.5x 1.8 m.*

Soil: *Texture Sandy , Available Moisture 60 %*

Irrigation *: Duration 3/4 hr , Frequency: daily*

Filter Type And Performance. *Screen Filter*

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics.

Emitter: *Make: local ,Type: Gr , Point Spacing 0.5 m.*

Rated Discharge per Emission Point *: 4 l/h At Pressure: 1 bar*

Emission Points Per Plant : 1 , giving 3 liter/day
Laterals: *Diameter: 16 mm, Material : P.E , Length 42 m*
Spacing: *1.8 m.*
E.C. *(if groundwater is used): ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**39**	**4.68**	**25**	**3**	**37**	**4.44**	**28**	**3.36**
Inlet end	B	**42**	**5.04**	**33**	**3.96**	**39**	**4.68**	**29**	**4.68**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**40.5**	**4.86**	**34**	**4.08**	**38**	**4.56**	**33.5**	**4.02**
	A	**40**	**4.8**	**41**	**4.92**	**34**	**4.08**	**31**	**3.72**
1/3 down	B	**40**	**4.8**	**31**	**3.72**	**38**	**4.56**	**37**	**4.44**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**40**	**4.8**	**36**	**4.32**	**36**	**4.32**	**34**	**4.08**
	A	**31**	**3.72**	**52**	**6.24**	**26**	**3.12**	**28**	**3.36**
2/3 down	B	**25**	**3**	**31**	**3.72**	**10**	**1.2**	**24**	**2.88**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**41.5**	**4.98**	**41.5**	**4.98**	**18**	**2.16**	**26**	**3.12**
	A	**26**	**3.12**	**23**	**2.76**	**35**	**4.2**	**34**	**4.08**
Far end	B	**34**	**4.08**	**27**	**3.24**	**34**	**4.08**	**33**	**3.96**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**25**	**3**	**25**	**3**	**34.5**	**4.08**	**33.5**	**4.02**
Pressure	inlet end	1.6		1.3		1.3		1.4	
	far end	1.4		1.4		1.4		1.5	
minimum rate of discharge	2.9								
average rate of discharge	4	**EU=72.7 %**		**Ea= 65.4 %**					

TRICKLE IRRIGATION EVALUATION

Location: *El Bostan-Ahmed ElSayed Husien ,*

Observer: Eng. YAsser , Date: 20/8/95

Crop: *Type Tomato , Age: Spacing: 0.5x1.7 m.*

Soil: *Texture Sand , Available Moisture 60%*

Irrigation *: Duration 2hr , Frequency: 2 days*

Filter Type And Performance*. screen filter*

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics.*No filtilizer unit exist .*

Emitter: *Make: Local ,Type: Gr , Point Spacing 0.5 m*

Rated Discharge per Emission Point *: 4 l/h At Pressure: 1 bar*

Emission Points Per Plant : 1 , giving 4 liter/day

Laterals: *Diameter: 16 mm, Material : P.E , Length 45 m*

Spacing: *1.7 m.*

E.C.*(if groundwater is used): ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**31**	**3.72**	**30**	**3.6**	**29**	**3.48**	**20**	**2.4**
Inlet end	B	**29**	**3.48**	**29**	**3.48**	**30**	**3.6**	**19**	**2.28**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**30**	**3.6**	**29.5**	**3.54**	**29.5**	**3.54**	**19.5**	**2.34**
	A	**28**	**3.36**	**28**	**3.36**	**22**	**2.64**	**19**	**2.28**
1/3 down	B	**28**	**3.36**	**29**	**3.48**	**22**	**2.64**	**15**	**1.8**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**28**	**3.36**	**28.5**	**3.42**	**22**	**2.64**	**17**	**2.04**
	A	**28**	**3.36**	**29**	**3.48**	**21**	**2.52**	**20**	**2.4**
2/3 down	B	**28**	**3.36**	**29**	**3.48**	**22**	**2.64**	**20**	**2.4**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**28**	**3.36**	**29**	**3.48**	**21.5**	**2.58**	**20**	**2.4**
	A	**18**	**2.16**	**28**	**3.36**	**15**	**1.8**	**19**	**2.28**
Far end	B	**27**	**3.24**	**29**	**3.48**	**12**	**1.44**	**18**	**2.16**
	time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**22.5**	**27**	**28.5**	**3.42**	**13.5**	**1.62**	**18.5**	**2.22**
Pressure	inlet end	**1.1**		**0.6**		**0.7**		**0.7**	
	far end	**1.1**		**1.1**		**0.6**		**0.6**	
minimum rate of discharge	**2.07**								
average rate of discharge	**2.89**	EU= 71.6 %		Ea= 64.4 %					

TRICKLE IRRIGATION EVALUATION

Location: *El-Bostan Zakaria Tawfek Abas ,*

Observer: Eng.Yasser , Date: 20/8/95

Crop: *Type Tomato , Age: 7 Days Spacing: 0.5x1.8 m*

Soil: *Texture Sandy , Available Moisture 60 %*

Irrigation *: Duration 1 hr , Frequency: daily*

Filter Type And Performance. *Screen filter*

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics. *No fertilizer exist*

Emitter: *Make: local ,Type: Gr , Point Spacing 0.5 m*

Rated Discharge per Emission Point *: 4 l/h At Pressure: 1 bar*

Emission Points Per Plant : 1 , giving 4 liter/day

Laterals: *Diameter: 16 mm, Material : P.E , Length 55 m*

Spacing: *1.8 m.*

E.C.(if groundwater is used): ppm

Outlet location on lateral		**Lateral location on the Manifold**							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
Inlet end	A	**26**	**3.12**	**16**	**1.92**	**18**	**2.16**	**21**	**252**
	B	**34**	**4.08**	**13**	**1.56**	**18**	**2.16**	**18**	**2.16**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**30**	**3.6**	**14.5**	**1.74**	**18**	**2.16**	**19.5**	**2.34**
1/3 down	A	**20**	**2.4**	**17**	**2.04**	**17**	**2.04**	**20**	**2.4**
	B	**22**	**2.64**	**18**	**2.16**	**16**	**1.92**	**17**	**2.04**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**21**	**2.52**	**17.5**	**2.1**	**16.5**	**1.98**	**18.5**	**2.22**
2/3 down	A	**14**	**1.68**	**11**	**1.32**	**16**	**1.92**	**33**	**3.96**
	B	**21**	**2.52**	**12**	**1.44**	**14**	**1.64**	**20**	**2.4**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**17.5**	**2.1**	**11.5**	**1.38**	**15**	**1.8**	**26.5**	**3.18**
Far end	A	**17**	**2.04**	**9**	**1.08**	**15**	**1.8**	**11**	**1.32**
	B	**25**	**3**	**14**	**1.68**	**15**	**1.8**	**14**	**1.68**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**21**	**2.52**	**12.5**	**1.5**	**15**	**1.8**	**12.5**	**1.5**
Pressure	inlet end	**0.7**		**0.5**		**0.5**		**0.5**	
	far end	**0.6**		**0.5**		**0.5**		**0.5**	
minimum rate of discharge	1.53								
average rate of discharge	2.14	**EU=71.2 %**		**Ea= 64.1%**					

TRICKLE IRRIGATION EVALUATION

Location: *El Bostan -Osama Said AboShaea* ,

Observer: Eng. Yasser , *Date: 24/7/95*

Crop: *Type Citrus* , *Age: 6 Years* *Spacing: 4x4 m*

Soil: *Texture Sandy* , *Available Moisture 60%*

Irrigation : *Duration 3 hr* , *Frequency: 3 day*

Filter Type And Performance. *No filter exist.*

Pressure Inlet: , *Pressure outlet:* , *Loss:*

Fertilizer Unit Characteristics. *No fertilizer unit exist .*

Emitter: *Make: Local* ,*Type: Spaghetti* , *Point Spacing 4 m*

Rated Discharge per Emission Point : *50 l/h* *At Pressure: 0.5 bar*

Emission Points Per Plant : 1 , *giving 50 liter/day*

Laterals: *Diameter: 16 mm*, *Material : P.E* , *Length 20 m*

Spacing: *4 m*.

E.C.(if groundwater is used): *ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		1/3 down		2/3 down		far end	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharg l/h
EInlet end	A	624	47.9	542	65	500	60	440	52.8
	B								
	Time	30	30	30	30	30	30	30	30
	Average	624	47.9	542	65	500	60	440	52.8
	A	795	95.4	453	54.4	609	73.1	564	67.7
1/3 down	B								
	Time	30	30	30	30	30	30	30	30
	Average	795	95.4	453	54.4	609	73.1	564	67.7
	A	415	49.8	300	36	569	68.3	610	73.2
2/3 down	B								
	Time	30	30	30	30	30	30	30	30
	Average	415	49.8	300	36	569	68.3	610	73.2
	A	312	37.4	55	6.6	58	7	230	27.6
Far end	B								
	Time	30	30	30	30	30	30	30	30
	Average	312	37.4	55	6.6	58	7	230	27.6
Pressure	inlet end	0.7		0.7		0.6		0.6	
	far end	0.4		0.3		0.4		0.4	
minimum rate of discharge	21.75								
average rate of discharge	53.1	EU= 41 %		Ea= 36.9 %					

TRICKLE IRRIGATION EVALUATION

Location: *El Bostan -Essam Mohamed Abo ElAneen* ,

Observer: Eng. Yasser , *Date: 24/7/95*

Crop: *Type* ***Citrus+ apple*** , *Age: 1 year + 2years* *Spacing:* ***4x2.5 m***

Soil: *Texture* ***Sandy*** , *Available Moisture* ***60 %***

Irrigation : *Duration* ***3 hr*** , *Frequency:* ***3 days***

Filter Type And Performance. *Nofilter exist.*

Pressure Inlet: , *Pressure outlet:* , *Loss:*

Fertilizer Unit Characteristics. *No filtilizer unit exist.*

Emitter: *Make:* ***local*** ,*Type:****Spagetti*** , *Point Spacing* ***2.5 m***

Rated Discharge per Emission Point : ***90*** *l/h* *At Pressure:* ***0.5*** *bar*

Emission Points Per Plant : ***1*** , *giving* ***90*** *liter/day*
Laterals: *Diameter:* ***16*** *mm, Material :* ***P.E*** , *Lenght* ***20*** *m*
Spacing: *2.5x4* *m.*
E.C.(if groundwater is used): *ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		**1/3 down**		**2/3 down**		**far end**	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**815**	**97.8**	**780**	**93.6**	**786**	**94.3**	**634**	**76.1**
Inlet end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**815**	**97.8**	**780**	**93.6**	**786**	**97.3**	**634**	**76.1**
	A	**748**	**89.8**	**725**	**87.1**	**700**	**84**	**712**	**85.4**
1/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**748**	**89.8**	**725**	**87.1**	**700**	**84**	**712**	**85.4**
	A	**900**	**108**	**660**	**79.2**	**710**	**85.2**	**551**	**66.1**
2/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**900**	**108**	**660**	**79.2**	**710**	**85.2**	**551**	**66.1**
	A	**890**	**106.8**	**786**	**94.2**	**643**	**77.2**	**490**	**58.8**
Far end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**890**	**106.8**	**786**	**94.2**	**643**	**77.2**	**490**	**58.8**
Pressure	inlet end	0.4		0.5		0.4		0.5	
	far end	0.5		0.3		0.4		0.2	
minimum rate of discharge	67.8								
average rate of discharge	86.5	EU= 78.4 %		Ea= 70.5 %					

TRICKLE IRRIGATION EVALUATION

Location: *El Bostan- Ramadan AbdElmohsen ,*

Observer: Eng. Yasser , Date: 24/7/95

Crop: *Type Cucumber , Age: 20 days Spacing: 0.5x 1.75 m*

Soil: *Texture Sandy , Available Moisture 60%*

Irrigation *: Duration 0.5 hr , Frequency: daily*

Filter Type And Performance. *Screen 60 m3/hr*

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics. *No filter exist .*

Emitter: *Make: local(Eloropia) ,Type: Gr. , Point Spacing 0.5 m*

Rated Discharge per Emission Point *: 4 l/h At Pressure: 1 bar*

Emission Points Per Plant : 1 , giving 2 liter/day

Laterals: *Diameter: 16 mm, Material : P.E , Length 40 m*

Spacing: *1.75 m.*

E.C. *(if groundwater is used): ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		1/3 down		2/3 down		far end	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**30**	**3.6**	**32**	**3.84**	**34**	**4.08**	**34**	**4.2**
Inlet end	B	**33**	**3.96**	**35**	**4.2**	**34**	**4.08**	**36**	**4.08**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**31.5**	**3.78**	**33.5**	**4.02**	**34**	**4.08**	**35**	**4.2**
	A	**29**	**3.48**	**31**	**3.72**	**33**	**3.96**	**33**	**3.96**
1/3 down	B	**34**	**4.08**	**34**	**4.08**	**33**	**3.96**	**34**	**4.08**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**31.5**	**3.78**	**32.5**	**3.9**	**33**	**3.96**	**33.5**	**4.02**
	A	**34**	**4.08**	**29**	**3.48**	**32**	**3.84**	**29**	**3.48**
2/3 down	B	**35**	**4.2**	**29**	**3.48**	**32**	**3.84**	**29**	**3.48**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**34.5**	**4.14**	**29**	**3.48**	**32**	**3.84**	**29**	**3.48**
	A	**30**	**3.6**	**31**	**3.72**	**30**	**3.6**	**27**	**3.24**
Far end	B	**34**	**4.08**	**32**	**3.84**	**39**	**3.48**	**19**	**2.28**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**32**	**3.84**	**31.5**	**3.87**	**29.5**	**3.54**	**23**	**2.76**
Pressure	inlet end	1.4		1.4		1.4		1.5	
	far end	1.3		1.1		1.1		1.2	
minimum rate of discharge	**3.31**								
average rate of discharge	**3.78**	EU= **87.4** %		Ea= **78.6** %					

TRICKLE IRRIGATION EVALUATION

Location: *El Bostan- Fathy Hegazy , Observer: Eng.Yasser , Date: 14/8/95*

Crop: *Type pepper , Age: Spacing: 0.5x1.85 m*

Soil: *Texture Sandy , Available Moisture 60%*

Irrigation *: Duration 1 hr , Frequency: daily*

Filter Type And Performance. *Screen filter*

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics. *No fertilizer unit exist .*

Emitter: *Make: local ,Type: Gr , Point Spacing 0.5 m*

Rated Discharge per Emission Point *: 4 l/h At Pressure: 1 bar*

Emission Points Per Plant : 1 , giving 4 liter/day

Laterals: *Diameter: 16 mm, Material : P.E , Length 45 m*

Spacing: *1.85 m.*

E.C. *(if groundwater is used): ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		1/3 down		2/3 down		far end	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**43**	5.16	**40**	**4.8**	**36**	4.32	**34**	**4.08**
Inlet end	B	**46**	5.52	**41**	**4.92**	**36**	4.32	**34**	**4.08**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**44.5**	**5.34**	**40.5**	**4.86**	**36**	**4.32**	**34**	**4.08**
	A	**35**	**4.2**	**55**	**6.6**	**49**	**5.88**	**46**	**5.52**
1/3 down	B	**38**	**4.56**	**46**	**5.52**	**34**	**4.2**	**49**	**5.88**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**36.5**	**4.38**	**50.5**	**6.06**	**41.5**	**4.98**	**47.5**	**5.7**
	A	**34**	**4.08**	**39**	**4.68**	**36**	**4.32**	**30**	**3.6**
2/3 down	B	**32**	**3.84**	**36**	**4.32**	**33**	**3.96**	**32**	**3.84**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**33**	**3.96**	**37.5**	**4.5**	**34.5**	**4.14**	**31**	**3.72**
	A	**44**	**5.28**	**34**	**4.08**	**39**	**4.68**	**33**	**3.96**
Far end	B	**31**	**3.72**	**33**	**3.96**	**40**	**4.8**	**33**	**3.96**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**37.5**	**4.5**	**33.5**	**4.02**	**39.5**	**4.74**	**33**	**3.96**
Pressure	inlet end	**1.5**		**1.5**		**1.5**		**1.5**	
	far end	**1.4**		**1.2**		**1.2**		**1.4**	
minimum rate of discharge	3.91								
average rate of discharge	4.57	EU= **85.5** %		Ea= **76.9** %					

SPRINKLER-LATERAL IRRIGATION EVALUATION

*Type of irrigation system : **Fixed system***
Location : Wady ElNatron Soauth Sector - ElHassad farm ,
Observer : Eng. A. Maher Date: 24/10/95
Crop: Alfalfa ,
***Soil** : texture: Sandy , available water : 60 mm/m*
***Sprinkler:** make : U.S.A , model:Rain Bird ,*
Sprinkler spacing: 12 by 15 m , Irrigation duration : 2 hrs
Rated sprinkler discharge: 1.3 m3/hr, @ pressure : 2 Kg/cm2 .
***Lateral :** diameter : 3 inch , slope : 0 %, riser height: 1 m .*

No. of sprinklers in the field	*1*	*2*	*1**	*2**	*5 end*
Pressure , bar	2	2	2	2	2
Disharge , m3/hr	1.36	1.38	1.25	1.18	1.3

Actual sprinkler pressure and discharge rates :

***Wind:** speed, Km/ hr relative to lateral line*
5.22 initial , 8.46 during , 3.6 final
Duration of the exp. : 1 hr.
Container rim diameter : 71 mm .
Container grid spacing (3 by 3 m.)

*Sp2** *Sp1**

35	24	28	25	26
16	19	22	26	22
30	20	20	24	24
31	35	30	29	36

Sp2 *Sp1*

Sprinkler raddius of throw: 10 m .
Sprinkler's speed of rotation: 2.1 rpm.
Sprinkler trajectory angle: 20°

Temp.= °c. , R.H= %. , EC.= 268.8 ppm.

NOTES :

SULTS

Cu= 82.76 %. , Eu=74.62 % , Ea= 68.15 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : Fixed system
Location Wady ElNatron South sector -Ibrahim Zaher ,
Observer : Eng. Yasser , Date: 25/9/95
Crop دراوة ,

***Soil** : texture: Sandyloam , available water 80 mm/m*
***Sprinkler:** make Israel , model Daan , nozzles 4.5 by 3 mm*
Sprinkler spacing 15 by 12 m , Irrigation duration 2 hrs/ 3 days
Rated sprinkler discharge 1.6 m3/hr, @ pressure 3 Kg/cm2 .
***Lateral :** diameter 2.5 inch , slope 0 %, riser height 0.9 m .*

No. of sprinklers in the field	*1*	*2*	*1**	*2**	*5 end*
Pressure , bar	*2.9*	*2.9*	*2.9*	*2.9*	*2.8*
Disharge , m3/hr	*1.66*	*1.59*	*1.37*	*1.58*	*1.57*

Actual sprinkler pressure and discharge rates :

***Wind:** speed, Km/ hr relative to lateral line*
14.6 initial , 14.2 during , 14.4 final

Container rim diameter 71 mm .
Container grid spacing (3by 3 m.)

Sp 1 *Sp 1**

44	34	28	33	42
36	31	22	21	30
31	28	26	21	24
36	39	39	30	35

Wind direction Sp 2 *Sp2**

Sprinkler raddius of throw: 10.25 m .
Sprinkler's speed of rotation 1.3 rpm.
Sprinkler trajectory angle 20°

Temp.= 40 °c. , R.H= 54 %. , EC.= 342 ppm.

NOTES :

ESULTS

Cu= 82.7 %. , Eu= 72.38 % , Ea= 66.9 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : **Fixed system**
Location Wady ElNatron South sector - Saad Eldeen farm ,
Observer : Eng. Yasser , Date: 3/10/95
Crop: barssem ,
Soil *: texture Sandyloam , available water 80 mm/m*
Sprinkler: *make Israel , model Daan , nozzles 3.9 by 3 mm*
Sprinkler spacing 12 by 12 m , Irrigation duration 4 hrs daily
Rated sprinkler discharge 0.75 m3/hr, @ pressure 1 Kg/cm2 .
Lateral : *diameter 3 inch , slope 0 %, riser height 1 m .*

No. of sprinklers in the field	*1**	*2**	*1*	*2*	*3 end*
Pressure , bar	*1*	*1*	*1*	*1*	*1*
Disharge , m3/hr	*0.761*	*0.756*	*0.773*	*0.752*	*0.786*

Actual sprinkler pressure and discharge rates :

Wind: *speed, Km/ hr relative to lateral line*
19 initial , 7.9 during , 7 final

Container rim diameter 71 mm .
Container grid spacing (3 by 3 m.)

Sp 1 *Sp1**

12	14	30	19
6	11	34	17
12	13	18	20
27	27	41	25

Sp 2 *Sp2**

wind direction
Sprinkler raddius of throw: 8.1 m .
Sprinkler's speed of rotation 1.2 rpm
Sprinkler trajectory angle 20°

Temp.=29 °c. , R.H= 72 %. , EC.=243 ppm.

NOTES :

ESULTS

Cu=62.5 %. , Eu=52.5 % , Ea=50.3 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : Fixed system
Location : Wady ElNatron South sector - Kareem & Rania farm ,
Observer : Eng.A.Maher , Date: 9/10/95
Crop Bearly ,
Soil : texture: Sandyloam , available water: 80 mm/m
Sprinkler: make : Israel , model :Naan ,
Sprinkler spacing :12 by 12 m , Irrigation duration :1.5 hrs
Rated sprinkler discharge : 1.2 m3/hr, @ pressure:1.3 Kg/cm2 .
Lateral : diameter:2 inch , slope 0 %, riser height : 0.5 m .

No. of sprinklers in the field	*1*	*2*	*3*	*2**	*3**	*4**	*8 end*
Pressure , bar	*1.3*	*1.3*	*1.3*	*1.3*	*1.3*	*1.3*	*1.2*
Disharge , m3/hr	*4*	*1.18*	*1.17*	*1.16*	*1.2*	*0.93*	*0.88*
Nozzel diam. , mm.	*4 / 2.3*	*4.3/ 2.3*	*3.9/ 2.3*	*4.2/ 2.3*	*4.5/ 2.3*	*4/0*	*4/0*

Actual sprinkler pressure and discharge rates :

Wind: speed, Km/ hr relative to lateral line
9 initial , 9 during , 9 final

Container rim diameter 71 mm .
Container grid spacing (3 by 3 m.)

Sp2 *Sp2**

7	*15*	*35*	*54*
28	*31*	*22*	*30*
24	*34*	*60*	*13*
19	*23*	*29*	*41*


wind direction

Sp3 *Sp3**

Sprinkler raddius of throw: 10.5m .
Sprinkler's speed of rotation 1 rpm.
Sprinkler trajectory angle 20°

Temp.= ℃. , R.H= %. , EC.=ppm.

NOTES :

ESULTS

Cu=67 %. , Eu= 59.5 % , Ea= 55.5 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : *Fixed system*
Location :**Wady ElNatron South sector - Dr. Diaa Usef farm,**
Observer : **Eng. Yasser ,** *Date: 10/10/95*
Crop : **Alfalfa ,**
Soil : texture: طفلة سمراء *, available water 90 mm/m*

Sprinkler: make : **American** *, model :* **Lego** ,
Sprinkler spacing : 7 by 7 m , Irrigation duration: 1 hrs
Rated sprinkler discharge: 0.7 m3/hr, @ pressure: 1 Kg/cm2 .
Lateral : diameter : 3 inch , slope: 0 %, riser height : 1 m .

No. of sprinklers in the field	*1*	*4*	*5*	*4**	*5**	*13* *end*
Pressure , bar	*1.2*	*1.1*	*1.1*	*1.1*	*1.1*	*1.1*
Disharge , m3/hr	*0.852*	*0.624*	*0.645*	*0.625*	*0.695*	*0.702*
Nozzel diam. , mm.	*4.1*	*3.9*	*4*	*3.9*	*4*	*4*

Actual sprinkler pressure and discharge rates :

Wind: speed Km/ hr relative to lateral line
9 initial ,9 during , 9 final

Container rim diameter 71 mm .
Container grid spacing (1 by 1 m.)
Sp4
*Sp4**

47	50	56	61	51	50	66
43	59	57	60	58	48	41
52	58	47	60	45	36	29
42	48	52	60	45	30	28
37	46	50	47	36	27	28
39	37	44	41	42	42	34
39	38	34	35	41	45	51

5 *Sp5**

Sprinkler raddius of throw:10.5 m .
Sprinkler's speed of rotation 1 rpm
Sprinkler trajectory angle 20 °

Temp.= °c. , R.H= %. , EC.= ppm.

NOTES :

R

ESULT

Cu= 82.3 %. , Eu= 72.5 % , Ea= 62.2 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : **Fixed system**
Location :Wady ElNatron North sector- Shatila farm ,
Observer :Eng yasser , Date: 17/10 /95
Crop: Alfalfa ,
Soil *: texture: Sandy , available water 60 mm/m*
Sprinkler: *make Israil , model Daan*
Sprinkler spacing 12 by 12 m , Irrigation duration 2.5 hrs/2 days
Rated sprinkler discharge: 0.75 m3/hr, @ pressure: 1 Kg/cm2 .
Lateral : *diameter 2.5 /2 inch , slope: 0 %, riser height : 0.75 m .*

No. of sprinklers in the field	*1*	*3*	*4*	*3**	*4**	*9* *end*
Pressure , bar	*0.8*	*0.8*	*0.8*	*0.8*	*0.8*	*0.8*
Disharge , m3/hr	*0.95*	*0.75*	*0.77*	*0.735*	*0.72*	*0.98*
Nozzel diam. , mm.	*4.4/3*	*3.9/3*	*3.9/3*	*3.9/3*	*3.9/3*	*4.4/3*

Actual sprinkler pressure and discharge rates :

Wind: *speed, Km/ hr relative to lateral line*
13.7 initial ,5.7 during , 5.7 final

Container rim diameter 71 mm .
Container grid spacing (3 by 3 m.)

wind direction

Sp4 *Sp4**

30	*10*	*14*	*18*
24	*18*	*21*	*29*
13	*3*	*10*	*14*
14	*4*	*11*	*19*

Sp3 *Sp3**

Sprinkler raddius of throw: 8 m .
Sprinkler's speed of rotation 0.75 rpm
Sprinkler trajectory angle : 20 °

Temp.= 31 °c. , R.H= 74 %. , EC.= 614 ppm.

NOTES :

ESULTS

Cu= 62.4 %. , Eu= 45 % , Ea=33.14 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : Hand Move / Side-roll / [✓ Fixed system]
Location Wady ElNatron South sector -Ibrahim Zaher ,
Observer : Eng. Yasser , Date: 25/9/95
Crop دراوة ,

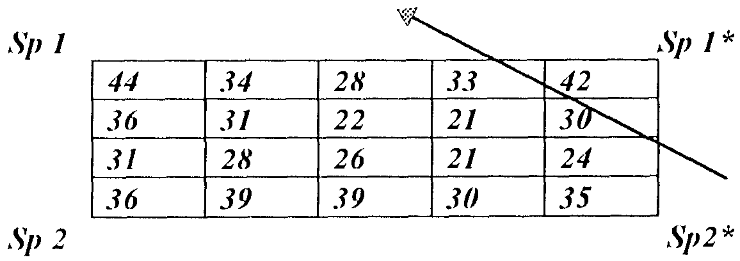
***Soil** : texture: Sandyloam , available water 80 mm/m*
***Sprinkler:** make Israel , model Daan , nozzles 4.5 by 3 mm*
Sprinkler spacing 15 by 12 m , Irrigation duration 2 hrs/ 3 days
Rated sprinkler discharge 1.6 m3/hr, @ pressure 3 Kg/cm2 .
***Lateral :** diameter 2.5 inch , slope 0 %, riser height 0.9 m .*

No. of sprinklers in the field	*1*	*2*	*1**	*2**	*5 end*
Pressure , bar	*2.9*	*2.9*	*2.9*	*2.9*	*2.8*
Disharge , m3/hr	*1.66*	*1.59*	*1.37*	*1.58*	*1.57*

Actual sprinkler pressure and discharge rates :

***Wind:** speed, Km/ hr relative to lateral line*
14.6 initial , 14.2 during , 14.4 final

Container rim diameter 71 mm .
Container grid spacing (3by 3 m.)



Sp 1 *Sp 1**

44	34	28	33	42
36	31	22	21	30
31	28	26	21	24
36	39	39	30	35

Sp 2 *Sp2**

Sprinkler raddius of throw: 10.25 m .
Sprinkler's speed of rotation 1.3 rpm.
Sprinkler trajectory angle 20 °

Temp.= 40 °c. , R.H= 54 %. , EC.= 342 ppm.

NOTES :

ESULTS

Cu= 82.7 %. , Eu= 72.38 % , Ea= 66.9 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

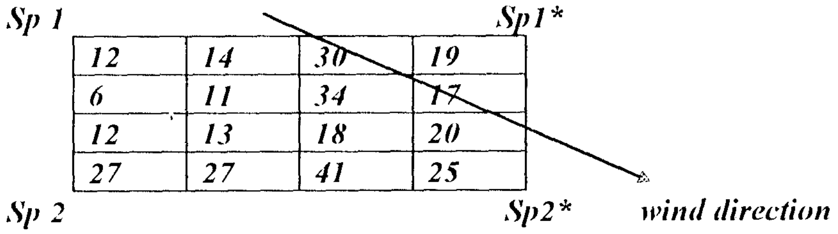
Type of irrigation system : *Hand Move* / *Side-roll* / [✓ *Fixed system*]
Location Wady ElNatron South sector - Saad Eldeen farm ,
Observer : Eng. Yasser , Date: 3/10/95
Crop: barssem ,
Soil : texture Sandyloam , available water 80 mm/m
Sprinkler: make Israel , model Daan , nozzles 3.9 by 3 mm
Sprinkler spacing 12 by 12 m , Irrigation duration 4 hrs daily
Rated sprinkler discharge 0. 75 m3/hr, @ pressure 1 Kg/cm2 .
Lateral : diameter 3 inch , slope 0 %, riser height 1 m .

No. of sprinklers in the field	*1**	*2**	*1*	*2*	*3 end*
Pressure , bar	*1*	*1*	*1*	*1*	*1*
Disharge , m3/hr	*0. 761*	*0. 756*	*0. 773*	*0. 752*	*0. 786*

Actual sprinkler pressure and discharge rates :

Wind: speed, Km/ hr relative to lateral line
19 initial , 7.9 during , 7 final

Container rim diameter 71 mm .
Container grid spacing (3 by 3 m.)



12	14	30	19
6	11	34	17
12	13	18	20
27	27	41	25

Sprinkler raddius of throw: 8.1 m .
Sprinkler's speed of rotation 1.2 rpm
Sprinkler trajectory angle 20 °

Temp.=29 °c. , R.H= 72 %. , EC.=243 ppm.

NOTES :

ESULTS

Cu=62.5 %. , Eu=52.5 % , Ea=50.3 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

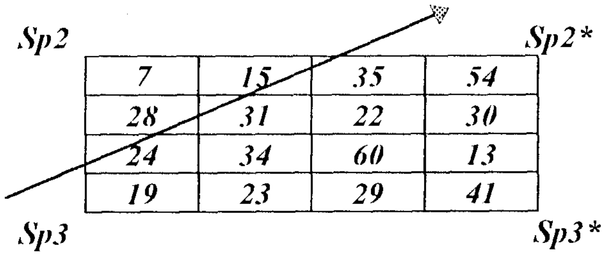
Type of irrigation system : *Hand Move / Side-roll /* [✓ *Fixed system*]
Location : Wady ElNatron South sector - Kareem & Rania farm ,
Observer : Eng.A.Maher , Date: 9/10/95
Crop Bearly ,
Soil : texture: Sandyloam , available water: 80 mm/m
Sprinkler: make : Israel , model :Naan ,
Sprinkler spacing :12 by 12 m , Irrigation duration :1.5 hrs
Rated sprinkler discharge : 1.2 m3/hr, @ pressure:1.3 Kg/cm2 .
Lateral : diameter:2 inch , slope 0 %, riser height : 0.5 m .

No. of sprinklers in the field	*1*	*2*	*3*	*2**	*3**	*4**	*8 end*
Pressure , bar	*1.3*	*1.3*	*1.3*	*1.3*	*1.3*	*1.3*	*1.2*
Disharge , m3/hr	*4*	*1.18*	*1.17*	*1.16*	*1.2*	*0.93*	*0.88*
Nozzel diam. , mm.	*4 / 2.3*	*4.3/ 2.3*	*3.9/ 2.3*	*4.2/ 2.3*	*4.5/ 2.3*	*4/0*	*4/0*

Actual sprinkler pressure and discharge rates :

Wind: speed, Km/ hr relative to lateral line
9 initial , 9 during , 9 final

Container rim diameter 71 mm .
Container grid spacing (3 by 3 m.)



7	15	35	54
28	31	22	30
24	34	60	13
19	23	29	41

Sprinkler raddius of throw: 10.5m .
Sprinkler's speed of rotation 1 rpm.
Sprinkler trajectory angle 20°

Temp.= °c. , R.H= %. , EC.=ppm.

NOTES :

ESULTS

Cu=67 %. , Eu= 59.5 % , Ea= 55.5 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : Hand Move(draghose) system
Location: ElBostan-Mohamed Abd ElRahman Elnagar ,
Observer : Eng. Yasser , Date:20/8/95
Crop :Soil bean ,
Soil : texture : Sandy , available water: 60 mm/m
Sprinkler: make: France , model : Roland ,
Sprinkler spacing: 12 by 15 m , Irrigation duration 3 hrs/3 days
Rated sprinkler discharge: 2 m3/hr, @ pressure: 2.5 Kg/cm2 .
Lateral : diameter : 3 inch , slope :0 %, riser height :0.9 m .

No. of sprinklers in the field	*1*	*3*	*4*	*9 end*
Pressure , bar	*2.5*	*2.5*	*2.3*	*1.6*
Disharge , m3/hr	*1.83*	*2.09*	*2.11*	*1.3*
Nozzel diam. , mm.	*4/2.5*	*4.5/2.5*	*5/3*	*4/3*

Actual sprinkler pressure and discharge rates :

Wind: speed, Km/ hr relative to lateral line
6.3 initial , 7.2 during , 9 final

Duration of experiment: 3/4 hr
Container rim diameter 71 mm .
Container grid spacing (3 by 3 m.)

Sp3 *Sp3**

20	*18*	*19*	*31*	*34*
14	*25*	*27*	*33*	*39*
31	*27*	*33*	*44*	*49*
34	*23*	*34*	*53*	*32*


Sp4 *Sp4**

wind direction

Sprinkler raddius of throw:9 m .
Sprinkler's speed of rotation 10 rpm
Sprinkler trajectory angle 20 °

Temp.= 32 °c. , R.H= %. , EC.= 472.8 ppm.

NOTES :

RESULTS

Cu= 75.8 %. , Eu=60.6 % , Ea= 54.2 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : Fixed system
Location: ElBostan -Sami Abd Elmohsen ,
Observer :Eng. Yasser , Date: 2/9/95
Crop: Peanut ,
Soil : texture : Sandy , available water: 60 mm/m
Sprinkler: make: , model : ,
Sprinkler spacing: 18 by 18 m , Irrigation duration: 1 hrs /3 days
Rated sprinkler discharge:6.15 m3/hr, @pressure: 1.5 Kg/cm2 .
Lateral : diameter :3 inch , slope : 0 %, riser height: 0.6 m .

No. of sprinklers in the field	*1*	*2*	*1**	*2**	*5 end*
Pressure , bar	*1.4*	*1.4*	*1.5*	*1.5*	*1.2*
Disharge , m3/hr	*6.06*	*6.8*	*6.15*	*6.15*	*5.7*

:

Actual sprinkler pressure and discharge rates :

Wind: speed Km/ hr relative to lateral line
9 initial , 10 during , 9 final
Duration of the exp.: 1 hr
Container rim diameter : 71 mm .
Container grid spacing (3 by 3 m.)

Sp1 *Sp1**

34	*73*	*138*	*65*	*19*	*25*
58	*100*	*103*	*170*	*27*	*53*
103	*84*	*29*	*68*	*70*	*105*
119	*50*	*7*	*59*	*116*	*104*
95	*51*	*57*	*118*	*135*	*119*
60	*57*	*106*	*150*	*58*	*34*

wind direction *Sp2* *Sp2**

Sprinkler raddius of throw:11.5 m .
Sprinkler's speed of rotation : 0.75 rpm
Sprinkler trajectory angle:20 °

Temp.= 31 °c. , R.H= 80 %. , EC= 472.8ppm.

NOTES :

RESULTS

Cu= 59.4 %. , Eu= 42 % , Ea= 40.7 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : ***Fixed system***
Location: ElBostan- Osama Belal ElMasry ,
Observer : Eng. Yasser , Date: 24/7/95
Crop : خيار ,

Soil *: texture: Sandy , available water: 60 mm/m*
Sprinkler: *make: France & Israel , model: Roland & Naan 5033 ,*
Sprinkler spacing 18 by 18 m , Irrigation duration:3 hrs / 3 days
Rated sprinkler discharge: 1.8 m3/hr, @ pressure 2 Kg/cm2 .
Lateral : *diameter : 3 inch , slope: 2 %, riser height : 0.5 m .*

No. of sprinklers in the field	*1 Naan*	*2 Roland*	*1* Naan*	*2* Roland*	*5 Roland*
Pressure , bar	*1.9*	*2*	*1.9*	*2*	*1.6*
Disharge , m3/hr	*1.79*	*1.77*	*1.75*	*1.78*	*1.6*
Nozzel diam. , mm.	*4.8/3*	*4.5/3*	*4.8/3*	*4.5/3*	*4.5/3*

Actual sprinkler pressure and discharge rates :

Wind: *speed Km/ hr relative to lateral line*
1.8 initial , 7.2 during , 5.4 final
Duration of the exp. : 1 hr
Container rim diameter: 71 mm .
Container grid spacing (3 by 3 m.)

Sp2 *Sp2**

14	*22*	*25*	*25*	*20*	*22*
15	*15*	*25*	*17*	*16*	*17*
12	*12*	*17*	*14*	*20*	*26*
34	*22*	*7*	*14*	*23*	*23*
17	*83*	*24*	*11*	*14*	*18*
20	*20*	*28*	*12*	*13*	*10*

Sp1 *Sp1**

wind direction
Sprinkler raddius of throw:11.5 m .
Sprinkler's speed of rotation 1.25 rpm
Sprinkler trajectory angle : 20 °

Temp.=31 °c. , R.H= 84 %. , EC.=472.8 ppm.

NOTES : *The drop in efficiency is due to the big distance which the spr are designed on.*

RESULTS

Cu= 66.9 %. , Eu= 53 % , Ea= 50.5 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : Fixed system
Location: ElBostan- Hassan Abd ElRasole ,
Observer : Eng. Yasser , Date: 23/7/95
Crop: فلفل ,

***Soil** : texture : Sandy , available water : 60 mm/m*
***Sprinkler:** make: France , model : Roland ,*
Sprinkler spacing: 18 by 18 m , Irrigation duration: 3 hrs/ 3 days
Rated sprinkler discharge: 2.5 m3/hr, @ pressure : 2.5 Kg/cm2 .
***Lateral :** diameter: 3 inch , slope: 3 %, riser height: 0.5 m .*

No. of sprinklers in the field	*1*	*2*	*1**	*2**	*5 end*
Pressure , bar	*1.9*	*1.9*	*2.5*	*2.4*	*1.4*
Disharge , m3/hr	*2.01*	*2.17*	*2.41*	*2.1*	*1.9*
Nozzel diam. , mm.	*4.8/4*	*5/4*	*5/4*	*4.8/4*	*5/4*

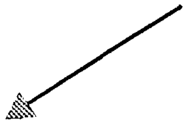
Actual sprinkler pressure and discharge rates :

***Wind:** speed Km/ hr relative to lateral line*
initial , during , final
Duration of the exp.:1hr
Container rim diameter : 71 mm .
Container grid spacing (3 by 3 m.)

Sp1 *Sp1**

28	*12*	*8*	*13*	*25*	*47*
12	*12*	*6*	*2*	*6*	*21*
24	*23*	*2*	*0*	*1*	*12*
9	*23*	*15*	*0*	*5*	*26*
23	*25*	*26*	*9*	*41*	*33*
29	*38*	*29*	*16*	*59*	*59*

Sp2 *Sp2**



wind direction
Sprinkler radious of through: 11.2 m.
Sprinkler's speed of rotation :.3 rpm
Sprinkler trajectory angle: 20°

Temp.= 33 °c. , R.H= 72 %. , EC.= 472.8 ppm.

NOTES :

** The drop in efficancy is due to : a) Wind.*
b) wide spacings.

***RESULTS** Cu= 40.5 %. , Eu= 8.3 % , Ea= 6.5 % .*

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : **Fixed system**
Location: ElBostan- Mohamed Abd Elhafez ,
Observer :Eng. Yasser , Date: 23/7/95
Crop : Peanut ,
Soil *: texture: Sandy , available water : 60 mm/m*
Sprinkler: *make: Russian , model : Russian 100 ,*
Sprinkler spacing: 18 by 18 m , Irrigation duration: 1 hrs/3 days
Rated sprinkler discharge: 1.5 m3/hr, @ pressure: 1.5 Kg/cm2 .
Lateral : *diameter: 3 inch ., slope: 2 %, riser height :0.5 m .*

No. of sprinklers in the field	*1*	*2*	*1**	*2**
Pressure , bar	*1.5*	*1.6*	*1.5*	*1.6*
Disharge , m3/hr	*7.42*	*7.5*	*7.41*	*7.56*

Actual sprinkler pressure and discharge rates :

Wind: *speed Km/ hr relative to lateral line*
16.2 initial , 6.84 during , 11.52 final
Duration of the exp.: 1 hr
Container rim diameter: 71 mm .
Container grid spacing (3 by 3 m.)

Sp1 *Sp1**

112	148	68	72	38	54
108	122	37	32	56	58
103	123	27	13	34	50
78	54	86	114	18	154
64	68	108	120	128	152
126	110	84	92	68	75

Sp2 *Sp2**

wind direction

Sprinkler raddius of throw: 12.2 m .
Sprinkler's speed of rotation: 0.75 rpm
Sprinkler trajectory angle: 20°

Temp.= 33 °c. , R.H= 72 %. , EC.= 472.8 ppm.

NOTES :

* *There were an efficiancy drop because of a drop in pressure on the spr. , and this appears in the rpm of the spr. And if we try to raise the pressure by decreasing the no. of spr. there will be damages in the system.*

ESULTS

Cu= 59.3 %. , Eu= 42.3 % , Ea= 38.5 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : Fixed system
Location:ElBostan- Belal Abd ElAziz Moustafa ,
Observer :Eng Yasser , Date:3/9/95
Crop: Corn ,
Soil *: texture:Sandy , available water : 60 mm/m*
Sprinkler: *make: U.S.A , model:Rain Bird ,*
Sprinkler spacing 15 by 15 m , Irrigation duration: 3 hrs\ 3 days
Rated sprinkler discharge: 1.5 m3/hr, @ pressure: 2.2 Kg/cm2 .
Lateral : *diameter: 3 inch , slope: 0 %, riser height : 0.5 m .*

No. of sprinklers in the field	1	2	3	2*	3*	6 end
Pressure , bar	2.4	2.3	2.3	2.2	2.2	2
Disharge , m3/hr	2.27	1.36	1.59	1.9	1.93	2.11
Nozzel diam. , mm.	5/4	4.5/3	4.5/2.5	5/3	5/3	5/4

Actual sprinkler pressure and discharge rates :

Wind: *speed Km/ hr relative to lateral line*
9 initial , 5.4 during ,4.5 final
Duration of the exp.: 3/ 4 hr
Container rim diameter: 71 mm .
Container grid spacing (3 by 3 m.)

Sp2 *Sp2**

28	33	19	10	11
22	24	17	7	8
11	10	9	11	27
16	8	11	23	24
21	10	12	15	45

Sp3 *Sp3**

wind direction
Sprinkler raddius of throw : 8 m .
Sprinkler's speed of rotation : 3 rpm
Sprinkler trajectory angle: 20 °

Temp.= 35 °c. , R.H= 70 %. , EC= 472.8 ppm.

NOTES :

RESULTS

Cu= 58.8 %. , Eu= 51.9% , Ea= 46.3 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : **Fixed system**
Location: ElBostan - Tarek Fadel ElRopy ,
Observer :Eng. Yasser , Date:18/8/95
Crop: Peanut ,
Soil *: texture: Sandy , available water: 60 mm/m*
Sprinkler: *make: U.S.A & Russian , model: Rain Bird 70 B & Russian 100 ,*
Sprinkler spacing: 18 by 18 m , Irrigation duration : 2 hrs / 3 days
Rated sprinkler discharge: 3.5 & 5 m3/hr, @ pressure: 1 Kg/cm2 .
Lateral : *diameter: 3 inch , slope: 0 %, riser height 0.6 m .*

No. of sprinklers in the field	*1*	*2*	*1* russ.*	*2* russ*	*5 end*
Pressure , bar	*1.2*	*1.2*	*1.4*	*1.2*	*1.1*
Disharge , m3/hr	*5.51*	*4*	*4.11*	*6.23*	*3.7*
Nozzel diam. , mm.	*10.5/5.5*	*7/7*	*8/5*	*11.2/5.5*	*7/5*

Actual sprinkler pressure and discharge rates :

Wind: *speed Km/ hr relative to lateral line*
9 initial , 5.4 during , 3.6 final
Duration of exp.: 0.4 hr.
Container rim diameter : 71 mm .
Container grid spacing (3 by 3 m.)

*Sp1** *Sp1*

27	*19*	*12*	*35*	*15*	*49*
49	*21*	*21*	*14*	*18*	*7*
41	*38*	*30*	*10*	*7*	*23*
49	*4*	*2*	*22*	*52*	*16*
19	*12*	*17*	*7*	*36*	*19*
13	*9*	*22*	*6*	*30*	*32*

wind direction *Sp2** *Sp2*

Sprinkler raddius of throw: 11 m .
Sprinkler's speed of rotation: 0.5 rpm
Sprinkler trajectory angle: 20°

Temp.= 33 °c. , R.H= 87 %. , EC.= 472 .8 ppm.

NOTES :

RESULTS

Cu= 53.7 %. , Eu= 32.8 % , Ea= 29.4% .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : **Fixed system**
Location: ElBostan - Ibrahim Abd ElAziz Salem ,
Observer : Eng. Yasser , Date: 2/9/95
Crop: Citrus ,
Soil *: texture: Sandy , available water: 60 mm/m*
Sprinkler: *make: France , model : Roland ,*
Sprinkler spacing: 15 by 15 m , Irrigation duration : 3 hrs/ 3 days
Rated sprinkler discharge : 1.7 m3/hr, @ pressure: 1.5 Kg/cm2 .
Lateral : *diameter: 3 inch , slope: 0 %, riser height: 0.6 m .*

No. of sprinklers in the field	*1*	*2*	*1**	*2**	*5 end*
Pressure , bar	*1.5*	*1.5*	*1.5*	*1.5*	*1.2*
Disharge , m3/hr	*1.64*	*1.33*	*1.68*	*1.58*	*1.1*

Actual sprinkler pressure and discharge rates :

Wind: *speed Km/ hr relative to lateral line*
3.6 initial , 10 during , 15 final
Duration of the exp.: 0.5 hr
Container rim diameter: 71 mm .
Container grid spacing (3 by 3 m.)

*Sp1** *Sp1*

12	11	12	16	15
37	15	24	9	10
11	5	3	11	11
5	4	5	16	12
3	0	3	7	5

*Sp2** *Sp2*

wind direction
Sprinkler raddius of throw: 8 m .
Sprinkler's speed of rotation: 5 rpm
Sprinkler trajectory angle: 20°

Temp.= 27 °c. , R.H= 90 %. , EC.= 472.8 ppm.

NOTES :

RESULTS

Cu= 50.76 %. , Eu= 31.6 % , Ea= 23.1 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : Hand Move
Location:Elbostan- Said Abd ElAziz Khodeer ,
Observer : Eng. Yasser , Date: 14/8/95
Crop: Soil bean ,
Soil : texture: Sandy , available water : 60 mm/m
Sprinkler: make:U.S,A , model : Rain Bird 30 TNT ,
Sprinkler spacing: 9 by 15 m , Irrigation duration : 1 hrs/ 3 days
Rated sprinkler discharge : 3.5 m3/hr, @ pressure: 1.5 Kg/cm2 .
Lateral : diameter: 3 inch , slope: 0 %, riser height:(Without)

No. of sprinklers in the field	*1*	*2*	*3*	*7 end*
Pressure , bar	*1.5*	*1.4*	*1.4*	*1*
Disharge , m3/hr	*3.14*	*3.59*	*3.5*	*4*
Nozzel diam. , mm.	*4.5/#*	*5/#*	*5/#*	*#/#*

Actual sprinkler pressure and discharge rates :

Wind: speed Km/ hr relative to lateral line
0 initial , 3.6 during , 3.6 final
Duration of the experiment: 3/4 hr.
Container rim diameter 71 mm .
Container grid spacing (3 by 3 m.)

Sp2 *Sp2**

73	*75*	*61*
98	*76*	*52*
85	*69*	*86*
80	*80*	*44*
77	*70*	*67*

Sp3 *Sp3**

wind direction

Sprinkler radius of throw:10.5 m .
Sprinkler's speed of rotation : 4.5 rpm
Sprinkler trajectory angle: 20 °

Temp.= 32 °c. , R.H=85 %. , EC.= 472.8 ppm.

NOTES :

 # = without nozzel.

There is a leakage between the pipes no. 5 , 6 and this is because of the damaged gaskets. And this causes the difrence in pressure between Spr. no. 3 & 7 .

RESULTS

Cu=86.4 %. , Eu=76.7 % , Ea=71.8 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : ***Hand Move***
Location: ElBostan - Mostafa Gabre Sira ,
Observer :Eng. Yasser , Date: 12/8/95
Crop: Peanut ,
Soil *: texture: Sandy , available water: 60 mm/m*
Sprinkler: *make:U.S.A. , model: Rain Bird 30 TNT ,*
Sprinkler spacing : 9 by 15 m , Irrigation duration: 1 hrs/ 3days.
Rated sprinkler discharge: 3.8 m3/hr, @ pressure: 1 Kg/cm2 .
Lateral : *diameter: 3 inch , slope: 3 %, riser height 0.6 m .*

No. of sprinklers in the field	*1*	*2*	*3*	*6* *end*
Pressure , bar	*1*	*1*	*1*	*1*
Disharge , m3/hr	*2.33*	*3.88*	*3.8*	*4.4*
Nozzel diam. , mm.	*4.5/#*	*5.5/#*	*5.5/#*	*6/#*

Actual sprinkler pressure and discharge rates :

Wind: *speed Km/ hr relative to lateral line*
0 initial ,3.6 during , 7.2 final

Duration of the experiment: 3/4 hr.
Container rim diameter: 71 mm .
Container grid spacing (3 by 3 m.)

Sp2 *Sp2**

30	*30*	*77*
52	*80*	*54*
65	*64*	*57*
62	*81*	*73*
160	*74*	*146*

Sp3 *Sp3**

Sprinkler radius of throw: 9 m .
Sprinkler's speed of rotation : 2.5 rpm
Sprinkler trajectory angle: 20 °

Temp.= 32 °c. , R.H= 85 %. , EC.=472.8 ppm.

NOTES :

 # = without nozzel .

RESULTS

Cu= 68 %. , Eu= 57.7 % , Ea= 50.58 % .

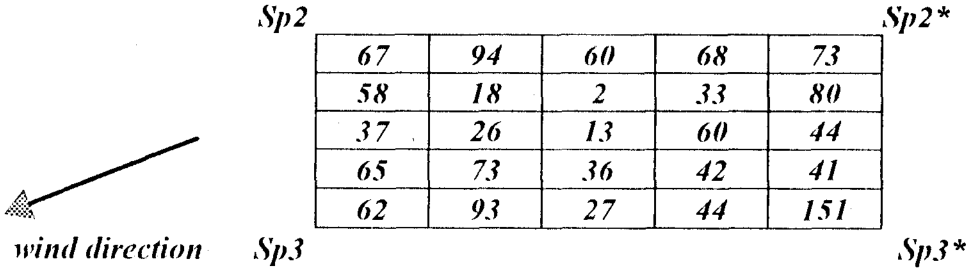
SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : ***Hand Move***
Location: ElBostan- Ibrahim Abd ElMoneem Rashed ,
Observer :Eng Yasser , Date:12/8/95
Crop : Peanut ,
Soil *: texture: Sandy , available water : 60 mm/m*
Sprinkler: *make: U.S.A , model: Rain Bird 30 TNT ,*
Sprinkler spacing: 15 by 15 m , Irrigation duration: 1 hrs/ 3 days
Rated sprinkler discharge: 6.5 m3/hr, @ pressure: 1 Kg/cm2 .
Lateral : *diameter: 3 inch , slope: 0 %, riser height : 0.6 m .*

No. of sprinklers in the field	*1*	*2*	*3*	*7 end*
Pressure , bar	*1.4*	*1*	*1*	*0.8*
Disharge , m3/hr	*3.54*	*6.31*	*6.91*	*3.6*
Nozzel diam. , mm.	*5/#*	*5/#*	*7.5/#*	*3.5/#*

Actual sprinkler pressure and discharge rates :

Wind: *speed, Km/ hr relative to lateral line*
9 initial , 12.6 during , 7.2 final
Duration of experiment: 1 hr.
Container rim diameter : 71 mm .
Container grid spacing (3 by 3 m.)



67	94	60	68	73
58	18	2	33	80
37	26	13	60	44
65	73	36	42	41
62	93	27	44	151

Sprinkler radius of throw: 8.5 m .
Sprinkler's speed of rotation: 5 rpm.
Sprinkler trajectory angle: 20 °

Temp.= 33 °c. , R.H= %. , EC.= 472.8 ppm.

NOTES :

#= without nozzel .

RESULTS

Cu= 56.4 %. , Eu= 36 % , Ea= 17 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : ***Hand Move***
Location: ElBostan- Hegazy Abd ElMoneem Gomaa ,
Observer : Eng. Yasser , Date: 12/8/95
Crop: Peanut ,
Soil *: texture: Sandy , available water: 60 mm/m*
Sprinkler: *make :U.S.A , model : Rain Bird 30 TNT ,*
Sprinkler spacing: 15 by 15 m , Irrigation duration : 1 hrs/ 3 days.
Rated sprinkler discharge: 2.5 m3/hr, @ pressure: 1 Kg/cm2 .
Lateral : *diameter: 3 inch , slope: 2 %, riser height : 0.15 m .*

No. of sprinklers in the field	*1*	*2*	*3*	*6* *end*
Pressure , bar	*1.2*	*0.9*	*0.8*	*1*
Discharge , m3/hr	*2*	*3.59*	*4.23*	*2.69*
Nozzle diam. , mm.	*7/0*	*4.5/#*	*5/ #*	*6/#*

Actual sprinkler pressure and discharge rates :

Wind: *speed Km/ hr relative to lateral line*
9 initial , 10.8 during , 9 final
Duration of the exp. : 1 hr
Container rim diameter:71 mm .
Container grid spacing (3 by3 m.)

Sp2 *Sp2**

77	*55*	*58*	*51*	*93*
82	*65*	*15*	*10*	*54*
56	*70*	*15*	*25*	*46*
29	*38*	*71*	*60*	*50*
45	*40*	*83*	*50*	*40*

Sp3 *Sp3**

wind direction
Sprinkler radius of throw: 8 m .
Sprinkler's speed of rotation : 2.5 rpm
Sprinkler trajectory angle:20 °

Temp.= 33 °c. , R.H= %. , EC.= 472.8 ppm.

NOTES :

#= without nozzle .

RESULTS

Cu= 67.57 %. , Eu= 43.1 % , Ea= 32.1 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : ***Hand Move(draghose)***
Location: ElBostan - Kareem Abd ElHameed Ezat ,
Observer :Eng. Yasser , Date: 3/9/95
Crop: Peanut ,
***Soil** : texture : Sandy , available water : 60 mm/m*
***Sprinkler:** make: French , model: Roland ,*
Sprinkler spacing: 15 by 15 m , Irrigation duration 4 hrs / 3days
Rated sprinkler discharge : 2 m3/hr, @ pressure: 1.5 Kg/cm2 .
***Lateral :** diameter : 3 inch , slope: 0 %, riser height : 0.6 m .*

No. of sprinklers in the field	*1*	*2*	*3*	*2**	*3**	*6 end*
Pressure , bar	*1.6*	*1.6*	*1.1*	*1.5*	*1.1*	*1*
Discharge , m3/hr	*1.56*	*2.06*	*1.79*	*2.06*	*1.88*	*1.38*
Nozzle diam. , mm.	*5/5*	*5/5*	*5/5*	*4.5/4.5*	*5.5/2.5*	*5/2.5*

Actual sprinkler pressure and discharge rates :

***Wind:** speed Km/ hr relative to lateral line*
14.4 initial , 10 during , 6 final
Duration of the exp. : 1 hr
Container rim diameter : 71 mm .
Container grid spacing (3 by 3 m.)

Sp2 *Sp2**

19	*63*	*23*	*34*	*35*
27	*13*	*32*	*15*	*7*
23	*1*	*35*	*18*	*32*
25	*18*	*2*	*42*	*57*
17	*25*	*13*	*34*	*29*

wind direction *Sp3* *Sp3**

Sprinkler radius of throw: 9 m .
Sprinkler's speed of rotation: 4 rpm
Sprinkler trajectory angle: 20°

Temp.= 30 °c. , R.H= 74 %. , EC= 472.8 ppm.

NOTES :

RESULTS

Cu= 56.9 %. , Eu= 36.5 % , Ea= 27.6% .

Crop: Citrus ,
Soil *: texture : Sandy , available water: 60 mm/m*
Sprinkler: *make: Greece & U.S.A , model: Jersey & RB 70 ,*
Sprinkler spacing 12 by 18 m , Irrigation duration : 2 hrs/ 3 days
Rated sprinkler discharge: 3.5 & 5.5 m3/hr, @ pressure: 2.5 Kg/cm2 .
Lateral : *diameter: 3 inch , slope: 0 %, riser height : 0.2 m .*

No. of sprinklers in the field	1	2	3	7 end
Pressure , bar	2.5	2.5	2.5	2.4
Discharge , m3/hr	2.69	3.36	5.44	2.73

Actual sprinkler pressure and discharge rates :

Wind: *speed km/ hr relative to lateral line*
3.6 initial , 12.6 during , 16.2 final
Duration of the exp.:3/4 hr
Container rim diameter: 71 mm .
Container grid spacing (3 by 3 m.)


wind direction

*Sp3** *Sp3*

29	57	34	19	26	35
43	43	38	9	14	11
53	46	38	41	50	35
85	75	50	43	48	63

*Sp2** *Sp2*

Sprinkler radius of throw: 9.5 m .
Sprinkler's speed of rotation: 3 rpm
Sprinkler trajectory angle: 20°

Temp.=34 ℃. , R.H= 80 %. , EC= 472.8 ppm.

NOTES :

RESULTS

Cu= 65.7 %. , Eu=43.9 % , Ea= 28.5 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : Hand Move

Location: ElBostan - Mohamed Abd ElGawad ,

Observer : Eng. Yasser , Date: 3/9/95

Crop: Peanut ,

Soil : texture: Sandy , available water 60 mm/m

Sprinkler: make: Israel , model : Naan 5033 ,

Sprinkler spacing: 15 by 15 m , Irrigation duration 2.5 hrs/ 3 days

Rated sprinkler discharge : 1.8 m3/hr, @ pressure: 2 Kg/cm2 .

Lateral : diameter: 3 inch , slope: 0 %, riser height: 1.2 m .

No. of sprinklers in the field	*1*	*2*	*1**	*2**	*5* *end*
Pressure , bar	*2.4*	*2*	*1.8*	*1.6*	*1.1*
Discharge , m3/hr	*1.84*	*1.79*	*1.33*	*1.71*	*1.5*
Nozzle diam. , mm.	*4.5/3*	*4.5/3*	*4.5/3*	*5/3.5*	*4.5/3*

Actual sprinkler pressure and discharge rates :

Wind: speed km/ hr relative to lateral line

18 initial , 32.4 during , 25 final

Duration of the exp.: 1 hr.

Container rim diameter: 71 mm .

Container grid spacing (3 by 3 m.)

*Sp1** *Sp1*

23	13	31	39	32
4	8	31	33	34
33	22	26	37	45
39	41	28	37	38
15	27	38	49	27

*Sp2** *Sp2*

wind direction

Sprinkler radius of throw: m .

Sprinkler's speed of rotation

Sprinkler trajectory angle 20 °

Temp.= °c. , R.H= 80 %. , EC.= 472.8 ppm.

NOTES :

RESULTS

Cu= 68.6 %. , Eu= 50.5 % , Ea= 48.1 % .

SPRINKLER-LATERAL IRRIGATION EVALUATION

Type of irrigation system : **Hand Move**
Location: El Bostan-Elsaid Abd Elmgid Azab
Observer :Eng Yasser , Date:12/8/95
Soil: *texture: Sandy , Available water: 60 mm/ m*
Sprinkler: *make : U.S.A , model : Rain Bird 30 TNT ,*
Sprinkler spacing: 9 by 15 m , Irrigation duration : 1 hrs/ 3 days
Rated sprinkler discharge: 3 m3/hr, @ pressure: 1 Kg/cm2 .
Lateral : *diameter: 3 inch , slope: 0 %, riser height: (without) .*

No. of sprinklers in the field	1	2	6 end
Pressure , bar	1	0.9	0.9
Discharge , m3/hr	3.24	2.98	3.54
Nozzle diam. , mm.	5.5/0	5.5/0	6/0

Actual sprinkler pressure and discharge rates :

Wind: *speed km/ hr relative to lateral line*
12.6 initial , 9 during , 5.4 final
Duration of the exp. 3/4 hr
Container rim diameter: 71 mm .
Container grid spacing (3 by 3 m.)

Sp1 *Sp1**

45	65	58
49	81	60
4	3	5
39	43	129
49	48	70

Sp2 *Sp3**

wind direction

Sprinkler radius of throw:7.5 m .
Sprinkler's speed of rotation : 4 rpm
Sprinkler trajectory angle: 20°

Temp.= 32 °c. , R.H= 80 %. , EC=472.8 ppm.

NOTES :

RESULTS

Cu= 56.14 %. , Eu= 25.5 % , Ea= 18.6 % .

TRICKLE IRRIGATION EVALUATION

Location*: Wady ElNatron- South section- ElHassed .*

Observer: Eng. Yasser , Date: 24/10/95

Crop*: Type : Peaches , Age: 1.5 year , Spacing: 5x5 m.*

Soil*: Texture : Sandy loam , Available Moisture: 80 %*

Irrigation *: Duration : 1 hr , Frequency: every 2 days.*

Filter Type And Performance*. 2x Screen 6 in. - American.*

Pressure Inlet: 1.9 bar , Pressure outlet: 1.8 bar , Loss: 0.1 bar.

Fertilizer Unit Characteristics*. Venturi meter 1 in.*

Emitter*: Make: American ,Type: Rain Bird , Point Spacing: 5 m.*

Rated Discharge per Emission Point *: 4.5 l/h At Pressure: 0.6 bar*

Emission Points Per Plant : 3 , giving 7 liter/day
Laterals*: Diameter: 16 mm, Material : P.E. , Length: 50 m*
Spacing*: 5 m.*
E.C.(if groundwater is used): 268.8 ppm

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**48**		**39**		**37**		**38**	
Inlet end	B	**36**		**38**		**30**		**22**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**42**	**5.04**	**38.5**	**4.62**	**33.5**	**4.02**	**30**	**3.6**
	A	**41**		**39**		**38**		**31**	
1/3 down	B	**38**		**46**		**38**		**35**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**39.5**	**4.74**	**42.5**	**5.1**	**38**	**4.56**	**33**	**3.96**
	A	**41**		**40**		**40**		**35**	
2/3 down	B	**37**		**40**		**38**		**45**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**39**	**4.68**	**40**	**4.8**	**39**	**4.68**	**40**	**4.8**
	A	**39**		**40**		**19**		**40**	
Far end	B	**38**		**37**		**40**		**36**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**38.5**	**4.62**	**38.5**	**4.62**	**29**	**3.48**	**38**	**4.56**
Pressure	inlet end	**0.6**		**0.6**		**0.6**		**0.6**	
	far end	**0.6**		**0.6**		**0.6**		**0.6**	
minimum rate of discharge	3.765								
average rate of discharge	4.4925	**EU= 83.81 %**		**Ea= 75.43 %**					

TRICKLE IRRIGATION EVALUATION

Location: *Wady ElNatron South sector- Ahmed Masoued Khaliel farm ,*

Observer: Eng. Yasser , Date: 17/10/1995

Crop: *Type Olives' , Age: 3 years Spacing: 6x6 m.*

Soil: *Texture Sandy , Available Moisture 60%*

Irrigation *: Duration 3/4 hrs , Frequency: every 2 days.*

Filter Type And Performance. *4x Screen 3in -local.*

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics. *local 200 liter*

Emitter: *Make: local ,Type: Microjet , Point Spacing 6 m.*

Rated Discharge per Emission Point *: 19.65 l/h At Pressure: 0.4 bar*

Emission Points Per Plant : 2 , giving 14.74 liter/day
Laterals: *Diameter: 16 mm, Material : P.E , Length 66 m*
Spacing: *6 m.*
E.C.(if groundwater is used): 396.8 ppm

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l h
	A	**74**		**330**		**56**		**194**	
Inlet end	B	**175**		**167**		**75**		**65**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**124.5**	**14.94**	**248.5**	**29.82**	**65.5**	**7.86**	**129.5**	**15.54**
	A	**88**		**153**		**129**		**127**	
1/3 down	B	**154**		**375**		**38**		**175**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**121**	**14.52**	**264**	**31.68**	**83.5**	**10.02**	**151**	**18.12**
	A	**151**		**154**		**168**		**26**	
2/3 down	B	**85**		**203**		**128**		**135**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**118**	**14.16**	**178.5**	**21.42**	**148**	**17.76**	**80.5**	**9.66**
	A	**128**		**130**		**278**		**340**	
Far end	B	**128**		**290**		**182**		**340**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**128**	**15.36**	**210**	**25.2**	**230**	**27.6**	**340**	**40.8**
Pressure	inlet end	**0.4**		**0.5**		**0.6**		**0.4**	
	far end	**0.3**		**0.3**		**0.4**		**0.4**	
minimum rate of discharge	10.425								
average rate of discharge	19.65	**EU= 53.05%**		**Ea=47.75 %**					

TRICKLE IRRIGATION EVALUATION

Location: *Wady ElNatron South sector- Hamdy Elshazly ,*

Observer: Eng. A. Maher , Date: 17/10/95

Crop: *Type Tomato , Age: 30 days Spacing: 0.5x1.5 m.*

Soil: *Texture Sandy , Available Moisture 60 %*

Irrigation *: Duration 1/2 hrs , Frequency: daily*

Filter Type And Performance. *2x Arkal 3 in.- Israel.*

Pressure Inlet: 4.3 , Pressure outlet: , Loss:

Fertilizer Unit Characteristics. *120 liter-local.*

Emitter: *Make: local ,Type: Gr , Point Spacing 0.5 m.*

Rated Discharge per Emission Point *: 2.8 l/h At Pressure: 0.9 bar*

Emission Points Per Plant : 1 , giving 1.4 liter/day
Laterals: *Diameter: 16 mm, Material : P.E , Length 80 m*
Spacing: *1.5 m.*
E.C.(if groundwater is used): 524.8 ppm

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**31**		**35**		**30**		**24**	
Inlet end	B	**32**		**33**		**30**		**27**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**31.5**	**3 .78**	**34**	**4.08**	**30**	**3.6**	**25.5**	**3.06**
	A	**25**		**24**		**28**		**16**	
1/3 down	B	**28**		**23**		**27**		**19**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**26.5**	**3.18**	**23.5**	**2.82**	**27.5**	**3.3**	**17.5**	**2.1**
	A	**25**		**23**		**23**		**7**	
2/3 down	B	**18**		**20**		**26**		**8**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**21.5**	**2.58**	**21.5**	**2.58**	**24.5**	**2.94**	**7.5**	**0.9**
	A	**26**		**23**		**31**		**11**	
Far end	B	**213**		**32**		**17**		**11**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**24.5**	**2.94**	**27.5**	**3.3**	**24**	**2.88**	**11**	**1.32**
Pressure	inlet end	**1.3**		**1.3**		**1.4**		**0.7**	
	far end	**0.7**		**0.7**		**0.9**		**0.3**	
minimum rate of discharge	1.725								
average rate of discharge	2.835	**EU= 60.85%**		**Ea= 54.76%**					

Irrigation : *Duration 2 hrs , Frequency: daily*

Filter Type And Performance. *4x Screen 3in - Germany*

Pressure Inlet:2 bar , Pressure outlet: 1.8 bar , Loss: 0.2 bar

Fertilizer Unit Characteristics. *200 liter- local*

Emitter: *Make:American ,Type: Rain bird S.C. , Point Spacing : 6 m.*

Rated Discharge per Emission Point *: 4.57 l/h At Pressure: 1 bar*

Emission Points Per Plant : 2 , giving 18.3 liter/day
Laterals: *Diameter:16 mm, Material : P.E , Length 100 m*
Spacing: *6 m.*
E.C. *(if groundwater is used): 288 ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**31**		**29**		**50**		**54**	
Inlet end	B	**25**		**28**		**43**		**51**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**38**	**4.56**	**28.5**	**3.42**	**46.5**	**5.58**	**52.5**	**6.3**
	A	**63**		**37**		**38**		**22**	
1/3 down	B	**58**		**47**		**48**		**22**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**60.5**	**7.26**	**42**	**5.04**	**43**	**5.16**	**22**	**2.64**
	A	**42**		**47**		**28**		**6**	
2/3 down	B	**35**		**30**		**26**		**28**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**38.5**	**4.72**	**38.5**	**4.62**	**27**	**3.24**	**17**	**2.04**
	A	**90**		**40**		**43**		**27**	
Far end	B	**5**		**40**		**12**		**56**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**47.5**	**5.7**	**40**	**4.8**	**27.5**	**3.3**	**41**	**4.92**
Pressure	inlet end	**1.1**		**1**		**0.9**		**0.8**	
	far end	**1.1**		**1**		**0.9**		**0.9**	
minimum rate of discharge	2.805								
average rate of discharge	4.575	**EU= 61.31%**		**Ea= 55.18%**					

TRICKLE IRRIGATION EVALUATION

***Location**: Wadi ElNatron South sector- Eng. Adel Mansour farm ,*

Observer: Eng. Yasser , Date: 10/10/95

***Crop**: Type Orange , Age: 2.5 years Spacing: 3.5x7 m.*

***Soil**: Texture Sandyloam , Available Moisture 80 %*

***Irrigation** : Duration 1.5 hr , Frequency: daily.*

***Filter Type And Performance**. 1x screen filter -local 6 in.*

Pressure Inlet: 4.5 bar , Pressure outlet: 4.25 bar , Loss: 0.25 bar

***Fertilizer Unit Characteristics**.Venturi meter 1 in.*

***Emitter**: Make: American ,Type: Micro-sprinkler , Point Spacing 3.5 m.*

***Rated Discharge per Emission Point** : 36 l/h At Pressure: 1.2 bar*

Emission Points Per Plant : 1 , giving 54 liter/day
***Laterals**: Diameter: 16 mm, Material : P.E , Length 55 m*
***Spacing**: 7 m.*
***E.C.**(if groundwater is used): 249.6 ppm*

** The lateral line goes uphill and downhill.*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**290**	**34.8**	**305**	**36.6**	**322**	**38.64**	**335**	**40.2**
Inlet end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**290**	**34.18**	**305**	**36.6**	**322**	**38.64**	**335**	**40.2**
	A	**260**	**31.2**	**285**	**34.2**	**315**	**37.8**	**330**	**39.6**
1/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**260**	**31.2**	**285**	**34.2**	**315**	**37.8**	**330**	**39.6**
	A	**233**	**27.96**	**293**	**35.16**	**243**	**29.16**	**295**	**35.4**
2/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**233**	**27.96**	**293**	**35.16**	**243**	**29.16**	**295**	**35.4**
	A	**397**	**47.64**	**280**	**33.6**	**322**	**38.64**	**310**	**37.2**
Far end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**397**	**47.64**	**280**	**33.6**	**322**	**38.64**	**310**	**37.2**
Pressure	inlet end	**1.2**		**1.1**		**1.3**		**1.3**	
	far end	**1.2**		**1.2**		**1.3**		**1.3**	
minimum rate of discharge	30.48								
average rate of discharge	36.1125	**EU=84.4 %**		**Ea=75.96 %**					

TRICKLE IRRIGATION EVALUATION

Location: *Wady ElNatron South sector- Arab Agriculture development center ,*

Observer: Eng. A. Maher , Date: 10/10/95

Crop: *Type Tomato , Age: 60 days Spacing: 0.5x2 m.*

Soil: *Texture Sandy , Available Moisture 70 %*

Irrigation *: Duration 2 hrs , Frequency: daily.*

Filter Type And Performance. *Y shape - Screen 6 in.- Irriesrra.-Italian.*

Pressure Inlet: 2 bar , Pressure outlet: 1.8 bar , Loss: 0.2 bar.

Fertilizer Unit Characteristics. *Venturi meter 1 in.*

Emitter: *Make: local ,Type: Gr , Point Spacing 0.5 m.*

Rated Discharge per Emission Point *: 3.2 l/h At Pressure: 0.9 bar*

Emission Points Per Plant :2 , giving 12.8 liter/day
Laterals: *Diameter: 16 mm, Material : P.E , Length 45 m*
Spacing: *2 m.*
E.C.(if groundwater is used): 448 ppm

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume d ml	e l/h	volume d ml	e l/h	volume d ml	discharge l h
	A	**28**		**27**		**26**		**25**	
Inlet end	B	**28**		**27**		**30**		**26**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**28**	**3.46**	**27**	**3.24**	**28**	**3.36**	**25.5**	**3.06**
	A	**28**		**26**		**27**		**25**	
1/3 down	B	**31**		**26**		**29**		**24**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**29.5**	**3.54**	**26**	**3.12**	**28**	**3.36**	**24.5**	**2.94**
	A	**30**		**28**		**29**		**21**	
2/3 down	B	**29**		**27**		**26**		**18**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**29.5**	**3.54**	**27.5**	**3.3**	**27.5**	**3.3**	**29.5**	**2.34**
	A	**28**		**25**		**25**		**16**	
Far end	B	**30**		**26**		**30**		**20**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**29**	**3.48**	**25.5**	**3.06**	**27.5**	**3.3**	**18**	**2.16**
Pressure	inlet end	**1.2**		**1**		**1**		**0.8**	
	far end	**1**		**0.9**		**0.9**		**0.3**	
minimum rate of discharge	2.625								
average rate of discharge	3.154	**EU=83.23 %**		**Ea=74.91 %**					

TRICKLE IRRIGATION EVALUATION

***Location**: WadyElNatron Southsector- Mohamoud ElGandour farm .*

Observer: Eng. A.Maher Date: 10/10/95

***Crop**: Type Apricot , Age: 1 year Spacing: 3x6 m.*

***Soil**: Texture Sandy loam , Available Moisture 80 %*

***Irrigation** : Duration 4 hrs , Frequency: every 2 days.*

***Filter Type And Performance**. Screen- local 6 in.*

Pressure Inlet: 4.5 bar . Pressure outlet: 4.25 bar , Loss: 0.25 bar

***Fertilizer Unit Characteristics**. Venturi. 1 in.*

***Emitter**: Make American ,Type: Turbo key , Point Spacing 3 m.*

***Rated Discharge per Emission Point** : 3.93 l/h At Pressure: 1 bar*

Emission Points Per Plant : 3 , giving 23.58 liter/day
***Laterals**: Diameter: 16 mm, Material : P.E , Length 85 m*
***Spacing**: 6 m.*
***E.C.**(if groundwater is used): 249.6 ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**35**		**37**		**35**		**26**	
Inlet end	B	**35**		**38**		**34**		**26**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**35**	**4.2**	**37.5**	**4.5**	**34.5**	**4.14**	**26**	**3.12**
	A	**35**		**37**		**36**		**26**	
1/3 down	B	**36**		**35**		**36**		**27**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**35.5**	**4.26**	**36**	**4.32**	**36**	**4.32**	**26.5**	**3.18**
	A	**35**		**36**		**35**		**25**	
2/3 down	B	**33**		**35**		**36**		**26**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**34**	**4.08**	**35.5**	**4.26**	**35.5**	**4.26**	**25.5**	**3.06**
	A	**35**		**36**		**20**		**23**	
Far end	B	**42**		**37**		**33**		**24**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**38.5**	**4.62**	**36.5**	**4.38**	**26.5**	**3.18**	**23.5**	**2.82**
Pressure	inlet end	**1.3**		**1.3**		**1.2**		**0.8**	
	far end	**1.1**		**1.1**		**1**		**0.6**	
minimum rate of discharge	3.045								
average rate of discharge	3.93	**EU= 77.4%**		**Ea= 69.44%**					

TRICKLE IRRIGATION EVALUATION

Location: *Wady ElNatron South sector-Rania & Kareem*

Observer: *Eng. Yasser.* *Date: 9/10/95*

Crop: *Type Olives ,Age:6 Years Spacing: 6x6 m.*

Soil: *Texture Sandyloam , Available Moisture 80%*

Irrigation : *Duration 1 hr , Frequency: daily*

Filter Type And Performance. *3x Screen3 in.-Local.*

Pressure Inlet: 1.7 bar , Pressure outlet: 1.5 bar , Loss: 0.2 bar

Fertilizer Unit Characteristics. *basin.*

Emitter: *Make: Local ,Type: Spaghetti , Point Spacing : 6 m.*

Rated Discharge per Emission Point : *95 l/h At Pressure: 0.5 bar*

Emission Points Per Plant : 1 , giving 95 liter/day
Laterals: *Diameter 16 mm, Material : P.E , Length 90 m*
Spacing: *6 m.*
E.C.(*if groundwater is used): ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**1280**	**153.6**	**1080**	**129.6**	**800**	**96**	**1220**	**146.6**
Inlet end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**1280**	**153.6**	**1080**	**129.6**	**800**	**96**	**1220**	**146.6**
	A	**680**	**81.6**	**908**	**109**	**668**	**80.16**	**1035**	**124.2**
1/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**680**	**81.6**	**908**	**109**	**668**	**80.16**	**1035**	**124.2**
	A	**915**	**109.8**	**720**	**86.4**	**378**	**45.36**	**893**	**10.16**
2/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**915**	**109.8**	**720**	**86.4**	**378**	**45.36**	**893**	**107.2**
Far end	B								
	A	**814**	**97.68**	**562**	**67.44**	**493**	**59.16**	**280**	**33.6**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**814**	**97.68**	**562**	**67.44**	**493**	**59.16**	**280**	**33.6**
Pressure	inlet end	**0.9**		**0.6**		**0.5**		**0.7**	
	far end	**0.4**		**0.4**		**0.4**		**0.4**	
minimum rate of discharge	51.39								
average rate of discharge	95.445	**EU= 53.84%**		**Ea= 48.46%**					

TRICKLE IRRIGATION EVALUATION

Location: *Wady ElNatron South sector- Said Aly Baza farm ,*

Observer: Eng. Yasser , Date: 3/10/95

Crop: *Type Olives , Age: 5 years Spacing: 3x5 m.*

Soil: *Texture Sandy loam , Available Moisture 80 %*

Irrigation *: Duration 1 hr , Frequency: Daily*

Filter Type And Performance. *6 in. Bertinoro-y type- Irriserra*

Pressure Inlet: 2 bar , Pressure outlet: 1.4 bar , Loss: 0.6 bar

Fertilizer Unit Characteristics. *Local 150 liter*

Emitter: *Make: local ,Type: Microjet , Point Spacing 5 m.*

Rated Discharge per Emission Point *: 22.45 l/h At Pressure:0.46 bar*

Emission Points Per Plant : 2 , giving 44.8 liter/day
Laterals: *Diameter: 16 mm, Material : P.E , Length 105 m*
Spacing: *3 m.*
E.C.(if groundwater is used): 288 ppm

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**173**		**233**		**215**		**316**	
Inlet end	B	**135**		**226**		**204**		**276**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**154**	**18.48**	**224.5**	**27.54**	**209.5**	**25.14**	**296**	**35.52**
	A	**172**		**322**		**98**		**190**	
1/3 down	B	**210**		**214**		**122**		**139**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**191**	**22.92**	**268**	**32.16**	**110**	**13.2**	**164.5**	**19.74**
	A	**261**		**322**		**118**		**135**	
2/3 down	B	**203**		**251**		**157**		**68**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**232**	**27.84**	**286.5**	**34.38**	**132.5**	**15.9**	**101.5**	**12.18**
	A	**229**		**217**		**104**		**48**	
Far end	B	**273**		**181**		**101**		**84**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**251**	**30.12**	**199**	**23.88**	**102.5**	**12.3**	**60**	**7.92**
Pressure	inlet end	**0.8**		**0.6**		**0.5**		**0.5**	
	far end	**0.6**		**0.4**		**0.2**		**0.1**	
minimum rate of discharge	11.4								
average rate of discharge	22.45	**EU= 50.78 %**		**Ea= 45.7 %**					

Pressure Inlet: 2.6 bar , Pressure outlet: , Loss:

Fertilizer Unit Characteristics*. local 200 liter.*

Emitter*: Make: local ,Type: Metalic plastic E2 . Point Spacing 3 m.*

Rated Discharge per Emission Point *: 5.5 l/h*

At Pressure: 0.3 bar

Emission Points Per Plant : 2 , giving 44 liter/day
Laterals*: Diameter: 16 mm, Material : P.E, Length 45 m*
Spacing*: 4 m.*
E.C.*(if groundwater is used): 262.4 ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		**1/3 down**		**2/3 down**		**far end**	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**65**		**51**		**52**		**25**	
Inlet end	B	**74**		**70**		**92**		**79**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**69.5**	**8.34**	**60.5**	**7.26**	**72**	**8.64**	**52**	**6.24**
	A	**39**		**46**		**60**		**103**	
1/3 down	B	**32**		**69**		**25**		**39**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**35.5**	**4.26**	**57.5**	**9.6**	**42.5**	**5.1**	**71**	**8.52**
	A	**9**		**26**		**44**		**20**	
2/3 down	B	**28**		**34**		**53**		**20**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**18.5**	**2.22**	**30**	**3.6**	**51**	**6.12**	**20**	**2.4**
	A	**41**		**22**		**30**		**21**	
Far end	B	**64**		**18**		**112**		**10**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**52.5**	**6.3**	**20**	**2.4**	**71**	**8.52**	**15.5**	**1.86**
Pressure	inlet end	**0.1**		**0.5**		**0.5**		**0.4**	
	far end	**0.2**		**0.5**		**0.3**		**0.1**	
minimum rate of discharge	2.155								
average rate of discharge	5.526	**EU=39 %**		**Ea= 35.1 %**					

TRICKLE IRRIGATION EVALUATION

Location: *Wady ElNatron South sector- Hussien AbdElbary farm ,*

Observer: Eng. Yasser , Date: 27/9/95

Crop: *Type Tomato , Age: 62 days Spacing: 0.5x1.6 m.*

Soil: *Texture Sandy loam , Available Moisture 80 %*

Irrigation *: Duration 2 hrs , Frequency: daily*

Filter Type And Performance*. 3x Screen 3in.-local.*

Pressure Inlet: 1.5 bar , Pressure outlet: , Loss:

Fertilizer Unit Characteristics*. local- 150 liter*

Emitter: *Make: local ,Type: Gr , Point Spacing 0.5 m.*

Rated Discharge per Emission Point *: 4 l/h At Pressure: 1 bar*

Emission Points Per Plant : 1 , giving 5.8 liter/day
Laterals: *Diameter: 16 mm, Material : P.E , Length 35 m*
Spacing: *1.6 m.*
E.C. *(if groundwater is used): 384 ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	24		25		25		25	
Inlet end	B	24		23		25		27	
	Time	30	30	30	30	30	30	30	30
	Average	24	2.88	24	2.88	25	3	26	3.12
	A	23		23		22		27	
1/3 down	B	26		24		25		24	
	Time	30	30	30	30	30	30	30	30
	Average	24.5	2.94	23.5	2.82	23.5	2.82	25.5	3.06
	A	24		23		22		24	
2/3 down	B	24		23		24		24	
	Time	30	30	30	30	30	30	30	30
	Average	24	2.88	23	2.76	23	2.76	24	2.88
	A	24		22		23		22	
Far end	B	26		24		23		25	
	Time	30	30	30	30	30	30	30	30
	Average	25	3	23	2.76	23	2.76	23.5	2.76
Pressure	inlet end	0.6		0.5		0.4		0.6	
	far end	0.6		0.5		0.6		0.5	
minimum rate of discharge	2.76								
average rate of discharge	2.88	EU= 95.83%		Ea= 86.247 %					

TRICKLE IRRIGATION EVALUATION

Location: *Wady ElNatron South sector- Hussien AbdElbary farm ,*

Observer: Eng. Yasser , Date: 27/9/95

Crop: *Type Tomato , **Age:** 62 days Spacing: 0.5x1.6 m.*

Soil: *Texture Sandy loam , Available Moisture 80 %*

***Irrigation** : Duration 2 hrs , Frequency: daily*

***Filter Type And Performance.** 3x Screen 3in.-local.*

Pressure Inlet:1.5 bar , Pressure outlet: , Loss:

***Fertilizer Unit Characteristics.** local- 150 liter*

***Emitter:** Make: local ,Type: Gr , Point Spacing 0.5 m.*

***Rated Discharge per Emission Point** : 4 l/h At Pressure: 1 bar*

Emission Points Per Plant : 1 , giving 5.8 liter/day
***Laterals:** Diameter: 16 mm, Material : P.E , Length 35 m*
***Spacing:** 1.6 m.*
E.C.(if groundwater is used): 384 ppm

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**24**		**25**		**25**		**25**	
Inlet end	B	**24**		**23**		**25**		**27**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**24**	**2.88**	**24**	**2.88**	**25**	**3**	**26**	**3.12**
	A	**23**		**23**		**22**		**27**	
1/3 down	B	**26**		**24**		**25**		**24**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**24.5**	**2.94**	**23.5**	**2.82**	**23.5**	**2.82**	**25.5**	**3.06**
	A	**24**		**23**		**22**		**24**	
2/3 down	B	**24**		**23**		**24**		**24**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**24**	**2.88**	**23**	**2.76**	**23**	**2.76**	**24**	**2.88**
	A	**24**		**22**		**23**		**22**	
Far end	B	**26**		**24**		**23**		**25**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**25**	**3**	**23**	**2.76**	**23**	**2.76**	**23.5**	**2.76**
Pressure	inlet end	**0.6**		**0.5**		**0.4**		**0.6**	
	far end	**0.6**		**0.5**		**0.6**		**0.5**	
minimum rate of discharge	2.76								
average rate of discharge	2.88	**EU= 95.83%**		**Ea= 86.247 %**					

TRICKLE IRRIGATION EVALUATION

Location: *Wady ElNatron South sector- Kamal Goneem farm ,*

Observer: Eng. Yasser , Date: 25/9/95

Crop: *Type: Apricot Age: 1 year , Spacing: 4x6 m.*

Soil: *TexturSandy loam , Available Moisture 80 %*

Irrigation : *Duration 2 hr , Frequency: daily.*

Filter Type And Performance. *Irrieserra Screen filter-Italian + local Sand separator*

Pressure Inlet: 1.1 bar , Pressure outlet: 1 bar , Loss: 0.1 bar.

Fertilizer Unit Characteristics. *local 200 liter*

Emitter: *Make: Israel ,Type: Kativ , Point Spacing 4 m.*

Rated Discharge per Emission Point : *4.47 l/h At Pressure: 0.7 bar*

Emission Points Per Plant : 2 , giving 17.9 liter/day
Laterals: *Diameter: 16 mm, Material : P.E , Length 50 m*
Spacing: *6 m.*
E.C.*(if groundwater is used): 294.5 ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**37**		**40**		**49**		**39**	
Inlet end	B	**45**		**50**		**45**		**39**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**41**	**4.92**	**45**	**5.4**	**47**	**5.64**	**39**	**4.68**
	A	**30**		**45**		**37**		**41**	
1/3 down	B	**28**		**29**		**35**		**56**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**29**	**3.48**	**37**	**4.44**	**36**	**4.32**	**48.5**	**5.82**
	A	**34**		**40**		**36**		**39**	
2/3 down	B	**26**		**38**		**37**		**38**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**30**	**3.6**	**39**	**4.68**	**36.5**	**4.38**	**38.5**	**4.62**
	A	**33**		**36**		**33**		**21**	
Far end	B	**37**		**36**		**33**		**30**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**35**	**4.2**	**36**	**4.32**	**33**	**3.96**	**25.5**	**3.06**
Pressure	inlet end	**0.7**		**0.7**		**0.8**		**0.6**	
	far end	**0.6**		**0.6**		**0.7**		**0.7**	
Minimum rate of discharge	3.525								
average rate of discharge	4.47	**EU= 78.86 %**		**Ea= 70.9%**					

TRICKLE IRRIGATION EVALUATION

Location: *Wady ElNatron South sector-Yehia ElKomy farm 1 .*

Observer: Eng. A.Maher , Date: 27/9/95

Crop: *Type citrus \ Mango , Age: 1 year Spacing: 3.5x4 m.*

Soil: *Texture Sandy , Available Moisture 60 %*

Irrigation : *Duration 2 hrs , Frequency: daily*

Filter Type And Performance. *Screen Irriserra -6 in.-Italian*

Pressure Inlet: 2 bar , Pressure outlet: 1.9 bar , Loss: 0.1 bar

Fertilizer Unit Characteristics. *local 200 liter.*

Emitter: *Make: American ,Type: Hardy Turbokey , Point Spacing 3.5 m.*

Rated Discharge per Emission Point *:7.8 l/h At Pressure:1.2 bar*

Emission Points Per Plant : 2 , giving 31.2 liter/day
Laterals: *Diameter: 16 mm, Material : P.E , Length 50 m*
Spacing: *4 m.*
E.C.(if groundwater is used): 256 ppm

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**49**		**84**		**50**		**51**	
Inlet end	B	**8**		**67**		**143**		**74**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**28.5**	**3.42**	**9.06**	**9.06**	**96.5**	**11.58**	**62.5**	**7.5**
	A	**30**		**36**		**38**		**50**	
1/3 down	B	**39**		**91**		------		**36**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**34.5**	**4.14**	**63.5**	**7.62**	**38**	**4.56**	**33**	**3.96**
	A	**42**		**80**		**42**		**19**	
2/3 down	B	**140**		**35**		**260**		**75**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**91**	**10.92**	**57.5**	**6.9**	**151**	**18.12**	**47**	**5.64**
	A	**90**		**100**		**24**		**18**	
Far end	B	**89**		**127**		**32**		**31**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**89.5**	**10.74**	**113.5**	**13.62**	**28**	**3.36**	**24.5**	**2.84**
Pressure	inlet end	**1.5**		**1.5**		**1.5**		**1.4**	
	far end	**1.2**		**1.1**		**1.3**		**1.2**	
minimum rate of discharge	3.42								
average rate of discharge	7.755	**EU= 44.1 %**		**Ea= 39.69 %**					

TRICKLE IRRIGATION EVALUATION

Location: *Wady ElNatron South sector- YehiaElKomy farm II ,*

Observer:Eng.A.Maher , Date: 26/9/95

Crop: *Type Tomato , Age: 70 days Spacing: 0.5 x1.6 m*

Soil: *Texture Sandy , Available Moisture 60 %*

Irrigation *: Duration 4 hr , Frequency: daily*

Filter Type And Performance. *Screen-Y shape-Irriserra-6 in.-Italian .*

Pressure Inlet: 1.9 bar.', Pressure outlet: 1.8 bar , Loss: 0.1 bar.

Fertilizer Unit Characteristics. *Local - 250 liter*

Emitter: *Make: Local ,Type: Gr , Point Spacing 0.5 m*

Rated Discharge per Emission Point *: 2 l/h At Pressure: 0.4 bar*

Emission Points Per Plant : 1 , giving 8 liter/day
Laterals: *Diameter: 16 mm, Material : P.E , Length 45 m*
Spacing: *1.6 m.*
E.C. *(if groundwater is used): 236.8 ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**20**		**16**		**17**		**18**	
Inlet end	B	**19**		**15**		**17**		**16**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**19.5**	**2.35**	**15.5**	**1.86**	**17**	**2.04**	**17**	**2.04**
	A	**19**		**15**		**16**		**15**	
1/3 down	B	**15**		**15**		**16**		**15**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**17**	**2.04**	**15**	**1.8**	**15.5**	**1.86**	**15**	**1.8**
	A	**18**		**13**		**18**		**14**	
2/3 down	B	**18**		**15**		**13**		**12**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**18**	**2.16**	**14**	**1.68**	**15.5**	**1.86**	**13**	**1.56**
	A	**14**		**13**		**14**		**27**	
Far end	B	**15**		**27**		**16**		**14**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**14.5**	**1.74**	**20**	**2.4**	**15**	**1.8**	**20.5**	**2.46**
Pressure	inlet end	**0.5**		**0.4**		**0.4**		**0.4**	
	far end	**0.4**		**0.4**		**0.3**		**0.3**	
minimum rate of discharge	1.695								
average rate of discharge	1.965	**EU= 86..26%**		**Ea= 77.63 %**					

TRICKLE IRRIGATION EVALUATION

Location: *Wady ElNatron South sector - Ibrahim Zaher farm* ,

Observer: Eng.A.Maher , Date: 25/9/95

Crop: *Type Apple ,   Age: 3 years   Spacing: 3x4 m .*

Soil: *Texture Sandy loam   , Available Moisture 80 %*

Irrigation : *Duration 1 hr , Frequency: every 2 days*

Filter Type And Performance. *Screen 6 in.-American-RainBird-Y shape .*

Pressure Inlet : 3 bar , Pressure outlet: 2.8 bar. , Loss: 0.2 bar

Fertilizer Unit Characteristics. *No Fertilizer unit exist .*

Emitter: *Make: Local ,Type: Microjet , Point Spacing 3 m.*

Rated Discharge per Emission Point : *33.6 l/h   At Pressure: 0.7 bar*

Emission Points Per Plant : 2 , giving 33.6 liter/day
Laterals: *Diameter: 16 mm, Material : P.E , Length47.5 m*
Spacing: *4 m.*
E.C.*(if groundwater is used): 342 ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**385**		**415**		**240**		**301**	
Inlet end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**385**	**43.2**	**415**	**49.8**	**240**	**28.8**	**301**	**36.12**
	A	**331**		**316**		**304**		**195**	
1/3 down	B	**395**		**340**		**321**		**255**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**363**		**328**	**39.36**	**312.5**	**37.5**	**225**	**27**
	A	**190**		**310**		**271**		**210**	
2/3 down	B	**325**		**160**		**340**		**170**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**257.5**		**235**	**28.2**	**305.5**	**36.66**	**190**	**22.8**
	A	**281**		**145**		**250**		**245**	
Far end	B	**252**		**333**		**135**		**215**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**266.5**	**31.98**	**239**	**28.68**	**192.5**	**23.1**	**230**	**27.6**
Pressure	inlet end	**0.8**		**0.7**		**0.7**		**0.6**	
	far end	**0.6**		**0.6**		**0.5**		**0.6**	
minimum rate of discharge	25.1								
average rate of discharge	33.64	**EU= 74.61 %**		**Ea=67.15 %**					

TRICKLE IRRIGATION EVALUATION

Location: *Wady ElNatron South sector- Mohamed Aly AboSief* ,

Observer:Eng. A.Maher , Date: 27/9/95

Crop: *Type Citrus , Age: 3 years Spacing: 3x4.5 m*

Soil: *Texture Rocky Sandy loam , Available Moisture 80 %*

Irrigation : *Duration 1.5 hr , Frequency: every 3 days .*

Filter Type And Performance. *3 x Screen 4 in.-local .*

Pressure Inlet: 1.5 , Pressure outlet: , Loss:

Fertilizer Unit Characteristics. *Local- 150 liters .*

Emitter: *Make: Local ,Type: Microjet , Point Spacing 3 m .*

Rated Discharge per Emission Point *:24.3 l/h At Pressure: 0.5 bar*

Emission Points Per Plant : 1 , giving 18.23 liter/day
Laterals: *Diameter: 16 mm, Material : P.E , Length 50 m*
Spacing: *4.5 m.*
E.C.(if groundwater is used): 480 ppm

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l h
	A	**263**	**31.56**	**205**	**24.6**	**172**	**20.64**	**175**	**21**
Inlet end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**263**	**31.56**	**205**	**24.6**	**172**	**20.64**	**175**	**21**
	A	**310**	**33.72**	**140**	**16.8**	**170**	**20.4**	**210**	**25.2**
1/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**310**	**37.2**	**140**	**16.8**	**170**	**20.4**	**210**	**25.2**
	A	**281**	**33.72**	**175**	**21**	**162**	**19.44**	**125**	**15**
2/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**281**	**33.72**	**175**	**21**	**162**	**19.44**	**125**	**15**
	A	**259**	**31.08**	**217**	**26.04**	**225**	**27**	**150**	**18**
Far end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**259**	**31.08**	**217**	**26.04**	**225**	**27**	**150**	**18**
Pressure	inlet end	**0.8**		**0.4**		**0.5**		**0.4**	
	far end	**0.5**		**0.4**		**0.4**		**0.4**	
minimum rate of discharge	17.31								
average rate of discharge	24.2925	**EU= 71.26%**		**Ea=64.134 %**					

TRICKLE IRRIGATION EVALUATION

***Location**:Wady ElNatron South sector- ElMaha , Observer:Eng. Yasser , Date: 26 9/95*

***Crop**: Type Peaches , Age: 5 years ,Spacing: 4 x6 m .*

***Soil**: Texture Rocky Sandy loam , Available Moisture 80 %*

***Irrigation** : Duration 4 hrs , Frequency: daily .*

***Filter Type And Performance**. Stainless Steel-Helical .*

Pressure Inlet: 4.1 bar , Pressure outlet: 1.1 , Loss: 3 bar

***Fertilizer Unit Characteristics**. Local 150 liter.*

***Emitter**: Make:American ,Type:Rainbird (S.C.) , Point Spacing 4 m .*

***Rated Discharge per Emission Point** : 3.46 l/h At Pressure:0.6 bar*

Emission Points Per Plant : 2 , giving 27.7 liter/day

***Laterals**: Diameter: 16 mm, Material : P.E , Length 80 m*

***Spacing**: 6 m.*

***E.C.**(if groundwater is used): 307 ppm*

** This system contain pressure regulator .*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**14**	**1.68**	**24**	**2.88**	**21**	**2.52**	**24**	**2.88**
Inlet end	B	**23**	**2.76**	**21**	**2.52**	**22**	**2.64**	**23**	**2.76**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**18.5**	**2.22**	**22.5**	**2.7**	**21.5**	**2.58**	**23.5**	**2.82**
	A	**22**	**2.64**	**19**	**2.28**	**5**	**0.67**	**24**	**2.88**
1/3 down	B	**21**	**2.52**	**22**	**2.64**	**23**	**2.76**	**23**	**2.76**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**21.5**	**2.58**	**20.5**	**2.46**	**14**	**1.68**	**23.5**	**2.82**
	A	**22**	**2.64**	**279**	**33.48**	**21**	**2.52**	**23**	**2.76**
2/3 down	B	**22**	**2.64**	**23**	**2.76**	**21**	**2.52**	**24**	**2.88**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**22**	**2.64**	**151**	**18.12**	**21**	**2.52**	**23.5**	**2.82**
	A	**19**	**2.28**	**20**	**2.4**	**21**	**2.52**	**23**	**2.76**
Far end	B	**19**	**2.28**	**20**	**2.4**	**21**	**2.52**	**14**	**1.68**
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**19**	**2.28**	**20**	**2.4**	**21**	**2.52**	**18.5**	**2.22**
Pressure	inlet end	**0.7**		**0.6**		**0.6**		**0.6**	
	far end	**0.6**		**0.6**		**0.6**		**0.6**	
minimum rate of discharge	2.1								
average rate of discharge	3.46	**EU= 60.69%**		**Ea= 54.62 %**					

TRICKLE IRRIGATION EVALUATION

Location: *Wady ElNatron South sector-Aly Amer farm* .

Observer: Eng. Yasser , Date: 26/9/95

Crop: *Type Citrus , Age: 1.5 year Spacing: 3.5x3.5 m*

Soil: *Texture Sand , Available Moisture 60 %*

Irrigation : *Duration 2 hrs , Frequency: 2 days*

Filter Type And Performance. *3x Screen-Local -4 in* .

Pressure Inlet: 1.8 bar , Pressure outlet: 1.6 bar , Loss: 0.2 bar

Fertilizer Unit Characteristics. *Hydraulic fertilizer -Arkal -made in Israel*

Emitter: *Make: Local ,Type: Micro-jet , Point Spacing 3.5*

Rated Discharge per Emission Point : *27.4 l/h At Pressure: 0.4 bar*

Emission Points Per Plant : 1 , giving 27.4 liter/day
Laterals: *Diameter: 16 mm, Material :P.E , Length 30 m*
Spacing: *3.5 m.*
E.C.(if groundwater is used): 505.6 ppm

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**296**	**35.52**	**16**	**1.92**	**283**	**33.96**	**224**	**26.88**
Inlet end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**296**	**35.52**	**16**	**1.92**	**283**	**33.96**	**224**	**26.88**
	A	**460**	**55.2**	**274**	**32.88**	**160**	**19.2**	**386**	**46.32**
1/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**460**	**55.2**	**274**	**32.88**	**160**	**19.2**	**386**	**46.32**
	A	**355**	**42.6**	**165**	**19.8**	**73**	**8.76**	**162**	**19.44**
2/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**355**	**42.6**	**165**	**19.8**	**73**	**8.76**	**162**	**19.44**
	A	**223**	**26.76**	**215**	**25.8**	**192**	**23.04**	**168**	**20.16**
Far end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**223**	**26.76**	**215**	**25.8**	**192**	**23.04**	**168**	**20.16**
Pressure	inlet end	0.6		0.5		0.4		0.2	
	far end	0.5		0.4		0.4		0.3	
minimum rate of discharge	12.33								
average rate of discharge	27.39	EU=45.02%		Ea= 40.518%					

TRICKLE IRRIGATION EVALUATION

***Location**: ElSadat - Elmatar way- Aony Aou ElNawareg ,*

Observer: Eng. Yasser , Date: 19/11/95

***Crop**: Type: Citrus & Mango , Age: 7 years Spacing: 4x4 m.*

***Soil**: Texture: Sandy , Available Moisture : 60 %*

***Irrigation** : Duration: 4 hrs, Frequency: every 3 days.*

***Filter Type And Performance**. 3x Screen 4 in. -local*

Pressure Inlet: 4.2 bar , Pressure outlet: 4 bar , Loss: 0.2 bar

***Fertilizer Unit Characteristics**. Venturi 1 in.*

***Emitter**: Make: Local ,Type: Microjet , Point Spacing :4 m.*

***Rated Discharge per Emission Point** : 35.96 l/h At Pressure: 0.7 bar*

Emission Points Per Plant : 2 . giving 95.9 liter/day
***Laterals**: Diameter: 16 mm, Material : P.E , Length 35 m*
***Spacing**: 4 m.*
***E.C.**(if groundwater is used): 1203.2 ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**495**		**280**		**410**		**165**	
Inlet end	B	**340**		**170**		**310**		**125**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**417.5**	**50.1**	**225**	**27**	**360**	**43.2**	**145**	**17.4**
	A	**370**		**345**		**400**		**110**	
1/3 down	B	**240**		**475**		**295**		**100**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**305**	**36.6**	**410**	**49.2**	**346**	**41.5**	**105**	**12.6**
	A	**334**		**240**		**275**		**180**	
2/3 down	B	**334**		**255**		**400**		**165**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**334**	**40.08**	**247.5**	**29.7**	**337.5**	**40.5**	**172.5**	**20.7**
	A	**480**		**300**		**477**		**85**	
Far end	B	**565**		**294**		**325**		**255**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**522.5**	**62.7**	**297**	**35.6**	**401**	**48.1**	**170**	**20.4**
Pressure	inlet end	**1.4**		**1**		**1**		**0.2**	
	far end	**1**		**0.8**		**0.6**		**0.2**	
minimum rate of discharge	17.77								
average rate of discharge	35.96	**EU=49.4 %**		**Ea=44.46 %**					

TRICKLE IRRIGATION EVALUATION

Location: *El Sadat-ElMatar way- Taha Mohamed Abd ElMaksoud* ,

Observer: Eng. Yasser , Date: 19/11/95

Crop: *Type Cucumber , Age: 50 day Spacing:0.5*

Soil: *Texture Sandy loam , Available Moisture 80 m mm*

Irrigation : *Duration1 hr , Frequency:3 days*

Filter Type And Performance. *2 x Screen 3 in local*

Pressure Inlet: 1.2 , Pressure outlet: , Loss:

Fertilizer Unit Characteristics. *local - 200 liter*

Emitter: *Make:local ,Type: katif , Point Spacing : 0.5 M*

Rated Discharge per Emission Point : *3.96 l/h At Pressure: 0.15 bar*

Emission Points Per Plant : 1 , giving 1.32 liter/day

Laterals: *Diameter: 16 mm, Material : P.E , Length 34 m*

Spacing: *0.5 m.*

E.C.(*if groundwater is used*): *435 ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**47**		**30**		**41**		**53**	
Inlet end	B	**40**		**22**		**22**		**41**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**43.5**	**5.32**	**26**	**3.12**	**31.5**	**3.78**	**47**	**5.64**
	A	**29**		**27**		**50**		**39**	
1/3 down	B	**18**		**29**		**45**		**26**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**23.5**	**2.82**	**28**	**3.36**	**49.5**	**5.94**	**32.5**	**3.9**
	A	**27**		**35**		**25**		**19**	
2/3 down	B	**17**		**43**		**29**		**17**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**22**	**2.64**	**39**	**4.68**	**27**	**3.24**	**18**	**2.16**
	A	**40**		**59**		**32**		**14**	
Far end	B	**37**		**30**		**59**		**12**	
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**38.5**	**4.62**	**44.5**	**5.34**	**45.5**	**5.46**	**13**	**1.56**
Pressure	inlet end	**0.2**		**0.2**		**0.2**		**0.2**	
	far end	**0.1**		**0.1**		**0.1**		**0.1**	
minimum rate of discharge	2.29								
average rate of discharge	3.96	EU= 57.8%		Ea=52 %					

TRICKLE IRRIGATION EVALUATION

Location: *Sadat ElMatar way , Observer: Eng Yasser , Date: 2/11/95*

Crop: *Type : Pepper , Age: 14 month ,Spacing: 0.5 x 1.9 m.*

Soil: *Texture: sand , Available Moisture: 60 %*

Irrigation : *Duration: 2 hr , Frequency: daily.*

Filter Type And Performance. *3x Screen 3in.*

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics.*200 liter - local.*

Emitter: *Make: local ,Type: Katif , Point Spacing : 0.5 m.*

Rated Discharge per Emission Point : *4.05 l/h At Pressure: 0.2 bar*

Emission Points Per Plant : 1 , giving 8.1 liter/day
Laterals: *Diameter: 16 mm, Material : P.E , Length 30 m*
Spacing: *1.9 m.*
E.C.(*if groundwater is used): 435 ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	37		37		34		47	
Inlet end	B	34		15		39		29	
	Time	30	30	30	30	30	30	30	30
	Average	35.5	4.26	26	3.12	36.5	4.38	38	4.56
	A	57		46		9		19	
1/3 down	B	40		30		28		15	
	Time	30	30	30	30	30	30	30	30
	Average	48.5	5.82	38	4.56	18.5	2.22	17	2.04
	A	61		39		44		41	
2/3 down	B	70		17		32		30	
	Time	30	30	30	30	30	30	30	30
	Average	65.5	7.86	29	3.36	38	4.56	35.5	4.26
	A	42		20		18		26	
Far end	B	46		18		38		24	
	Time	30	30	30	30	30	30	30	30
	Average	44	5.28	19	2.28	28	3.36	25	3
Pressure	inlet end	0.3		0.2		0.2		0.1	
	far end	0.2		0.2		0.1		< 0.1	
minimum rate of discharge	2.38								
average rate of discharge	4.05	EU= 58.8%		Ea= 53 %					

TRICKLE IRRIGATION EVALUATION

Location: *Sadat - 2000 faddan area well 12 - Sherin Foaad Eskander ,*

Observer: Eng. A. Maher , Date: 15/11/95

***Crop**: Type: lemon , Age: 7 years , Spacing: 5x5 m.*

***Soil**: Texture : Sandy loam , Available Moisture: 80 %*

***Irrigation** : Duration: 2hrs , Frequency: every 2 days.*

Filter Type And Performance.

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics.

***Emitter**: Make: local ,Type: Spaghetti , Point Spacing: 5 m.*

***Rated Discharge per Emission Point** : 26.73 l/h At Pressure: 0.25 bar*

Emission Points Per Plant : 1 , giving 26.73 liter/day
***Laterals**: Diameter: 16 mm, Material : P.E , Length 60 m*
***Spacing**: 5 m.*
E.C.(if groundwater is used): ppm

Outlet location on lateral		*Lateral location on the Manifold*							
		inlet end		*1/3 down*		*2/3 down*		*far end*	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	385	45.96	297	45.64	299	27.48	345	41.4
Inlet end	B								
	Time	30	30	30	30	30	30	30	30
	Average	385	45.96	297	45.64	299	27.48	345	41.4
	A	515	61.8	330	39.6	230	27.6	160	19.2
1/3 down	B								
	Time	30	30	30	30	30	30	30	30
	Average	515	61.8	330	39.6	230	27.6	160	19.2
	A	159	19.08	213	25.56	0	0	95	11.4
2/3 down	B								
	Time	30	30	30	30	30	30	30	30
	Average	159	19.08	213	25.56	0	0	95	11.4
	A	390	46.8	156	19.8	0	0	53	6.36
Far end	B								
	Time	30	30	30	30	30	30	30	30
	Average	390	46.8	156	19.8	0	0	53	6.36
Pressure	inlet end	0.3		0.3		0.3		0.3	
	far end	0.2		0.1		< 0.1		<0.1	
minimum rate of discharge	3.009								
average rate of discharge	26.73	EU= 11.22%		Ea= 10.09%					

TRICKLE IRRIGATION EVALUATION

Location: *ElSadat - 2000 feddan area- Mohamed Nour ElDean* ,

Observer: A. Maher , Date: 4/9/95

Crop: *Type: Gawafa. , Age: 3 years , Spacing: 2.5x5 m.*

Soil: *Texture: Sandy , Available Moisture : 60%*

Irrigation *: Duration: 1.5 hrs , Frequency: every 2 days*

Filter Type And Performance.

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics.

Emitter: *Make: local ,Type: Spaghetti , Point Spacing: 2.5 m.*

Rated Discharge per Emission Point *: 61.08 l/h At Pressure: 0.7 bar*

Emission Points Per Plant : 1 , giving 45.81 liter/day
Laterals: *Diameter:16 mm, Material : P.E , Length 30 m*
Spacing: *5 m.*
E.C. *(if groundwater is used): ppm*

Outlet location on lateral		*Lateral location on the Manifold*							
		inlet end		*1/3 down*		*2/3 down*		*far end*	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**760**	**91.2**	**632**	**75.84**	**616**	**73.92**	**452**	**54.24**
Inlet end	B								
	Time	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
	Average	**760**	**91.2**	**632**	**75.84**	**616**	**73.92**	**452**	**54.24**
	A	**744**	**89.28**	**176**	**21.12**	**489**	**58.68**	**582**	**59.84**
1/3 down	B								
	Time	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
	Average	**744**	**89.28**	**176**	**21.12**	**489**	**58.68**	**582**	**59.84**
	A	**342**	**41.04**	**467**	**56.04**	**461**	**55.32**	**504**	**60.48**
2/3 down	B								
	Time	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
	Average	**342**	**41.04**	**467**	**56.04**	**461**	**55.32**	**504**	**60.48**
	A	**510**	**61.2**	**489**	**58.68**	**445**	**53.4**	**469**	**56.28**
Far end	B								
	Time	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**
	Average	**510**	**61.2**	**489**	**58.68**	**445**	**53.4**	**469**	**56.28**
Pressure	inlet end	**1.5**		**0.8**		**1.1**		**1.1**	
	far end	**0.5**		**0.5**		**0.5**		**0.5**	
minimum rate of discharge	42.45								
average rate of discharge	61.08	**EU= 69.5%**		**Ea=62.55 %**					

TRICKLE IRRIGATION EVALUATION

Location: *Sadat - 2000 feddan - Shalabi ElSharbini ,*

Observer: Eng. A. Maher , Date: 13/5/95

Crop: *Type: Appel , Age: 5 years Spacing: 6x6 m.*

Soil: *Texture: Sandy loam , Available Moisture : 80 %*

Irrigation : *Duration: 1.5 hr , Frequency: every 3 days*

Filter Type And Performance.

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics.

Emitter: *Make: local ,Type: E2 , Point Spacing 6 m.*

Rated Discharge per Emission Point : *34.6 l/h At Pressure: 0.6 bar*

Emission Points Per Plant : 1 , giving 11.6 liter/day
Laterals: *Diameter: 16 mm, Material : P.E , Length 65 m*
Spacing: *6 m.*
E.C.(if groundwater is used): 256 ppm

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**581**	**64.72**	**155**	**18.6**	**115**	**13.8**	**245**	**29.4**
Inlet end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**581**	**64.72**	**155**	**18.6**	**115**	**13.8**	**245**	**29.4**
	A	**381**	**45.72**	**465**	**55.8**	**177**	**21.24**	**325**	**39**
1/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**381**	**45.72**	**465**	**55.8**	**177**	**21.24**	**325**	**39**
	A	**226**	**27.12**	**43**	**52.2**	**190**	**22.8**	**270**	**32.4**
2/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**226**	**27.12**	**43**	**52.2**	**190**	**22.8**	**270**	**32.4**
	A	**425**	**51**	**440**	**52.8**	**135**	**16.2**	**60**	**7.2**
Far end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**425**	**51**	**440**	**52.8**	**135**	**16.2**	**60**	**7.2**
Pressure	inlet end	**0.6**		**0.6**		**0.6**		**0.6**	
	far end	**0.6**		**0.6**		**0.6**		**0.6**	
minimum rate of discharge	13.95								
average rate of discharge	34.69	**EU= 40.22%**		**Ea=36.19 %**					

TRICKLE IRRIGATION EVALUATION

Location: *El Sadat- 2000 Fedan- Mohamed Abas ,*

Observer:Eng. Yasser , Date: 14/11/95

Crop: *Type: Olives , Age: 7 Years Spacing: 5x7 m.*

Soil: *Texture: Sandy loam , Available Moisture: 80 %*

Irrigation *: Duration : 1.5 hrs , Frequency: every 2 days.*

Filter Type And Performance.

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics.

Emitter: *Make: local ,Type: Spaghetti , Point Spacing : 5 m.*

Rated Discharge per Emission Point *: 17.92 l/h At Pressure: 0.15 bar*

Emission Points Per Plant : 1 , giving 13.44 liter/day
Laterals: *Diameter: 16 mm, Material : P.E , Length 40 m*
Spacing: *7 m.*
E.C.(if groundwater is used): 294.4 ppm

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**327**	**39.24**	**315**	**37.8**	**273**	**32.76**	**105**	**12.6**
Inlet end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**327**	**39.24**	**315**	**37.8**	**273**	**32.76**	**105**	**12.6**
	A	**160**	**19.2**	**210**	**25.2**	**140**	**16.8**	**183**	**21.9**
1/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**160**	**19.2**	**210**	**25.2**	**140**	**16.8**	**183**	**21.9**
	A	**217**	**26.04**	**88**	**10.56**	**190**	**22.8**	**30**	**3.6**
2/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**217**	**26.04**	**88**	**10.56**	**190**	**22.8**	**30**	**3.6**
	A	**151**	**18.12**	**Zearo**	**Zearo**	**Zearo**	**Zearo**	**Zearo**	**Zearo**
Far end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**151**	**18.12**	**Zearo**	**Zearo**	**Zearo**	**Zearo**	**Zearo**	**Zearo**
Pressure	inlet end	**0.2**		**0.2**		**0.2**		**0.1**	
	far end	**0.1**		**< 0.1**		**< 0.1**		**< 0.1**	
minimum rate of discharge	0.9								
average rate of discharge	17.92	**EU= 5.02 %**		**Ea= 4.52 %**					

TRICKLE IRRIGATION EVALUATION

Location: *ElSadat - 2000 Feddan Area- Dr. Ibrahim Seif ElNasr* ,

Observer: Eng. A. Maher , Date: 15/11/95

Crop: *Type : Olives , Age: 40 days , Spacing: 6x5 m.*

Soil: *Texture: Sandy loam , Available Moisture: 80 %*

Irrigation : *Duration: 1.5 hr , Frequency: every 2 days*

Filter Type And Performance.

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics.

Emitter: *Make: local ,Type: spaghetti , Point Spacing: 5 m.*

Rated Discharge per Emission Point : *30.9 l/h At Pressure: 0.25 bar*

Emission Points Per Plant : 1 , giving 23.18 liter day
Laterals: *Diameter: 16 mm, Material :P.E , Length 55 m*
Spacing: *6 m.*
E.C.(*if groundwater is used*): *ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**330**	**39.6**	**344**	**41.28**	**340**	**40.8**	**341**	**40.92**
Inlet end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**330**	**39.6**	**344**	**41.28**	**340**	**40.8**	**341**	**40.92**
	A	**404**	**48.48**	**240**	**28.8**	**370**	**44.4**	**90**	**10.8**
1/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**404**	**48.48**	**240**	**28.8**	**370**	**44.4**	**90**	**10.8**
	A	**394**	**47.28**	**310**	**37.2**	**297**	**35.64**	**69**	**8.28**
2/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**394**	**47.28**	**310**	**37.2**	**297**	**35.64**	**69**	**8.28**
	A	**340**	**40.8**	**155**	**18.6**	**96**	**11.52**	**zearo**	**zearo**
Far end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**340**	**40.8**	**155**	**8.16**	**96**	**11.52**	**zearo**	**zearo**
Pressure	inlet end	**0.3**		**0.3**		**0.3**		**0.3**	
	far end	**0.2**		**0.1**		**0.2**		**0**	
minimum rate of discharge	7.65								
average rate of discharge	30.9	**EU= 24.76%**		**Ea= 22.28%**					

TRICKLE IRRIGATION EVALUATION

Location: *Sadat city - 2000 feddan area- Ibrahim Eleraky,*

Observer: Eng. A.Maher , Date: 7/11/95

Crop: *Type : Olives , Age: 3 years , Spacing: 6x5 m.*

Soil: *Texture: Sandyloam , Available Moisture: 80 %*

Irrigation : *Duration : 1 hr , Frequency: every 3 days.*

Filter Type And Performance. *No Filter exist.*

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics. *No Fertilizer unit exist.*

Emitter: *Make: local ,Type: E2-without cover , Point Spacing : 6 m.*

Rated Discharge per Emission Point : *53.92 l/h At Pressure: 04 bar*

Emission Points Per Plant : 1 , giving : 18 liter/day
Laterals: *Diameter: 16 mm, Material : P.E , Lenght 75 m*
Spacing: *5 m.*
E.C. *(if groundwater is used): 492.8 ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**875**	**105**	**765**	**91.8**	**675**	**81**	**686**	**82.32**
Inlet end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**875**	**105**	**765**	**91.8**	**675**	**81**	**686**	**82.32**
	A	**560**	**67.2**	**315**	**37.8**	**440**	**52.8**	**550**	**66**
1/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**560**	**67.2**	**315**	**37.8**	**440**	**52.8**	**550**	**66**
	A	**412**	**49.44**	**175**	**21**	**161**	**19.32**	**193**	**23.16**
2/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**412**	**49.44**	**175**	**21**	**161**	**19.32**	**193**	**23.16**
	A	**403**	**48.36**	**190**	**22.8**	**385**	**46.2**	**404**	**48.48**
Far end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**403**	**48.36**	**190**	**22.8**	**385**	**46.2**	**404**	**48.48**
Pressure	inlet end	**0.7**		**0.7**		**0.7**		**0.6**	
	far end	**0.2**		**0.1**		**0.2**		**0.2**	
minimum rate of discharge	21.57								
average rate of discharge	53.92	**EU=40 %**		**Ea= 36 %**					

TRICKLE IRRIGATION EVALUATION

Location:*Sadat city -2000 feddan area- Alaa Ibrahim Zaid farm ,*

Observer:Eng. A. Maher , Date:6/11/95

Crop*: Type: Appel , Age: 3 years , Spacing: 6x6 m.*

Soil*: Texture : Sandy loam , Available Moisture: 80 %*

Irrigation *: Duration: 3/4 hr , Frequency: every 3 days.*

Filter Type And Performance*.No filter exist.*

Pressure Inlet: , Pressure outlet: . Loss:

Fertilizer Unit Characteristics*. No Fertilizer unit exist.*

Emitter*: Make: local ,Type: spaghetti , Point Spacing: 6 m.*

Rated Discharge per Emission Point *: 74.34 l/h At Pressure: 0.4 bar*

Emission Points Per Plant : 1 , giving 18.6 liter/day
Laterals*: Diameter: 16 mm, Material : P.E , Length 75 m*
Spacing*: 6 m.*
E.C.*(if groundwater is used): ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**1240**	**148.8**	**1260**	**151.2**	**685**	**82.8**	**682**	**81.84**
Inlet end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**1240**	**148.8**	**1260**	**151.2**	**685**	**82.8**	**682**	**81.84**
	A	**904**	**108.5**	**1083**	**129.9**	**540**	**64.8**	**208**	**24.96**
1/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**904**	**108.5**	**1083**	**129.9**	**540**	**64.8**	**208**	**24.96**
	A	**556**	**66.72**	**825**	**99**	**241**	**28.92**	**505**	**60.6**
2/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**556**	**66.72**	**825**	**99**	**241**	**28.92**	**505**	**60.6**
	A	**370**	**44.4**	**500**	**60**	**170**	**20.4**	**143**	**17.16**
Far end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**370**	**44.4**	**500**	**60**	**170**	**20.4**	**143**	**17.16**
Pressure	inlet end	**0.7**		**0.6**		**0.6**		**0.6**	
	far end	**0.3**		**0.3**		**0.2**		**0.2**	
minimum rate of discharge	20.36								
average rate of discharge	74.34	**EU= 27.39 %**		**Ea= 24.65 %**					

TRICKLE IRRIGATION EVALUATION

Location:*Sadat city - 2000 feddan - Adel farm.*

Observer: Eng. Yasser , Date: 7/10/95

Crop: *Type: Olives , Age: 8 month , Spacing: 6x6 m.*

Soil: *Texture: Sandyloam , Available Moisture: 80 %*

Irrigation *: Duration : 1 hr , Frequency: every 2 days.*

Filter Type And Performance. *No Filter exist.*

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics.*No fertilizer unit exist.*

Emitter: *Make: local ,Type: spaghetti , Point Spacing: 6 m.*

Rated Discharge per Emission Point *: 91 l/h At Pressure: 0.55 bar*

Emission Points Per Plant : 1 , giving 45.5 liter day
Laterals: *Diameter: 16 mm, Material : P.E , Length 78 m*
Spacing: *6 m.*
E.C. *(if groundwater is used): ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l h
	A	**1091**	**130.9**	**885**	**106.2**	**830**	**99.6**	**1125**	**135**
Inlet end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**1091**	**130.9**	**885**	**106.2**	**830**	**99.6**	**1125**	**135**
	A	**1045**	**125.4**	**660**	**79.2**	**730**	**87.6**	**660**	**79.2**
1/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**1045**	**125.4**	**660**	**79.2**	**730**	**87.6**	**660**	**79.2**
	A	**770**	**92.4**	**790**	**94.8**	**680**	**81.6**	**697**	**83.64**
2/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**770**	**92.4**	**790**	**94.8**	**680**	**81.6**	**697**	**83.64**
	A	**360**	**43.2**	**496**	**59.52**	**585**	**70.2**	**723**	**86.76**
Far end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**360**	**43.2**	**496**	**59.52**	**585**	**70.2**	**723**	**86.76**
Pressure	inlet end	**0.6**		**0.6**		**0.6**		**0.6**	
	far end	**0.5**		**0.5**		**0.5**		**0.4**	
minimum rate of discharge	63.03								
average rate of discharge	90.95	**EU= 69.3 %**		**Ea=62.37 %**					

TRICKLE IRRIGATION EVALUATION

Location: *Sadat city - 2000 feddan -Saaid ElFouly ,*

Observer:Eng. Yasser , Date: 12/11/95

Crop: *Type : Olives , Age: 1 year , Spacing: 6x5 m.*

Soil: *Texture: Sandyloam , Available Moisture: 80 %*

Irrigation : *Duration: 1 hr , Frequency: weekly.*

Filter Type And Performance. *No Filter exist.*

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics. *No Fertilizer unit exist.*

Emitter: *Make: local ,Type: Spaghetti , Point Spacing : 5 m.*

Rated Discharge per Emission Point : *57.7 l/h At Pressure: 0.45 bar*

Emission Points Per Plant : 1 , giving : 8.24 liter/day
Laterals: *Diameter: 16 mm, Material : P.E , Length 60 m*
Spacing: *6 m.*
E.C.(*if groundwater is used): 1523.2 ppm*

Outlet location on lateral		Lateral location on the Manifold							
		inlet end		1/3 down		2/3 down		far end	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A								
Inlet end	B								
	Time	30	30	30	30	30	30	30	30
	Average								
	A								
1/3 down	B								
	Time	30	30	30	30	30	30	30	30
	Average								
	A								
2/3 down	B								
	Time	30	30	30	30	30	30	30	30
	Average								
	A								
Far end	B								
	Time	30	30	30	30	30	30	30	30
	Average								
Pressure	inlet end								
	far end								
minimum rate of discharge									
average rate of discharge		EU= %		Ea= %					

TRICKLE IRRIGATION EVALUATION

Location: *Sadat City -2000 Feddan- Galal Manaa farm* .

Observer:Eng. A. Maher , Date: 31/10/95

Crop: *Type : Olives , Age: 5 years , Spacing: 6x6 m.*

Soil: *Texture: Sandy loam , Available Moisture: 80 %*

Irrigation : *Duration : 2.5 hrs , Frequency: every 3 days.*

Filter Type And Performance. *No Filter exist.*

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics. *No Fertilizer unit exist.*

Emitter: *Make: Local ,Type: E2 , Point Spacing: 6 m.*

Rated Discharge per Emission Point : *30.78 l/h At Pressure: 0.2 bar*

Emission Points Per Plant : 1 , giving: 25.65 liter/day

Laterals: *Diameter: 16 mm, Material : P.E , Length 36 m*

Spacing: *6 m.*

E.C.(if groundwater is used): 294.4 ppm

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**410**	**49.2**	**340**	**40.8**	**198**	**23.76**	**385**	**46.2**
Inlet end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**410**	**49.2**	**340**	**40.8**	**198**	**23.76**	**385**	**46.2**
	A	**135**	**16.2**	**350**	**42**	**194**	**23.28**	**313**	**37.56**
1/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**135**	**16.2**	**350**	**42**	**194**	**23.28**	**313**	**37.56**
	A	**215**	**25.8**	**303**	**36.36**	**201**	**24.12**	**60**	**7.2**
2/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**215**	**25.8**	**303**	**36.36**	**201**	**24.12**	**60**	**7.2**
	A	**430**	**51.6**	**280**	**33.6**	**zero**	**zero**	**263**	**31.56**
Far end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**430**	**51.6**	**280**	**33.6**	**zero**	**zero**	**263**	**31.56**
Pressure	inlet end	**0.3**		**0.3**		**0.2**		**0.2**	
	far end	**0.3**		**0.2**		**0.1**		**0.2**	
minimum rate of discharge	11.79								
average rate of discharge	30.78	**EU= 38.3 %**		**Ea= 34.47 %**					

TRICKLE IRRIGATION EVALUATION

Location: *ElSadat- ElMatar Way- Helmy Mohamed Mowafak ,*

Observer:Eng. A.Maher , Date: 15/11/95

Crop: *Type : Olives , Age: 11 month Spacing: 4x4 m.*

Soil: *Texture : Sandyloam , Available Moisture: 80 %*

Irrigation *: Duration: 1 hr , Frequency: every 2 days.*

Filter Type And Performance.

Pressure Inlet: , Pressure outlet: , Loss:

Fertilizer Unit Characteristics.

Emitter: *Make: local ,Type: Spaghetti , Point Spacing: 4 m.*

Rated Discharge per Emission Point *: 36.23 l/h At Pressure: 0.3 bar*

Emission Points Per Plant : 1 , giving 18.11 liter/day

Laterals: *Diameter: 16 mm, Material : P.E , Length m*

Spacing: *4 m.*

E.C *(if groundwater is used): ppm*

Outlet location on lateral		***Lateral location on the Manifold***							
		inlet end		***1/3 down***		***2/3 down***		***far end***	
		volume collected ml	discharge l/h	volume d ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	**535**	**64.2**	**390**	**46.8**	**385**	**46.2**	**135**	**16.2**
Inlet end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**535**	**64.2**	**390**	**46.8**	**385**	**46.2**	**135**	**16.2**
	A	**98**	**11.76**	**300**	**36**	**325**	**39**	**455**	**54.6**
1/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**98**	**11.76**	**300**	**36**	**325**	**39**	**455**	**54.6**
	A	**290**	**34.8**	**175**	**21**	**307**	**36.84**	**210**	**25.2**
2/3 down	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**290**	**34.8**	**175**	**21**	**307**	**36.84**	**210**	**25.2**
	A	**542**	**65.04**	**305**	**36.6**	**239**	**28.68**	**140**	**16.8**
Far end	B								
	Time	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**
	Average	**542**	**65.04**	**305**	**36.6**	**239**	**28.68**	**140**	**16.8**
Pressure	inlet end	**0.5**		**0.3**		**0.3**		**0.3**	
	far end	**0.2**		**0.2**		**0.2**		**< 0.1**	
minimum rate of discharge	16.44								
average rate of discharge	36.23	**EU=45.37 %**		**Ea= 40.84%**					

TRICKLE IRRIGATION EVALUATION

Location: *El Sadat* , *Observer: Eng.A.Hossam* , *Date: 4/9/95*

Crop: *Type Gawafa* , *Age: 3 years* *Spacing: 2.5x5 m*

Soil: *Texture Sandy* , *Available Moisture 60%*

Irrigation : *Duration 1.5 hr* , *Frequency: 2 days*

Filter Type And Performance. *gravel 28 in.+ screen*

Pressure Inlet: , *Pressure outlet:* , *Loss:*

Fertilizer Unit Characteristics. *No fertilizer exist .*

Emitter: *Make: Local* ,*Type: Spaghetti* , *Point Spacing 2.5 m*

Rated Discharge per Emission Point : *50 l/h At Pressure: 0.5 bar*

Emission Points Per Plant : 1 , *giving 50 liter/day*

Laterals: *Diameter: 16 mm, Material : P.E* , *Length 30 m*

Spacing: *5 m.*

E.C.*(if groundwater is used): ppm*

Outlet location on lateral		Lateral location on the Manifold							
		inlet end		1/3 down		2/3 down		far end	
		volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h	volume collected ml	discharge l/h
	A	760	91.2	632	75.84	616	73.92	452	54.24
Inlet end	B								
	Time	15	15	15	15	15	15	15	15
	Average	760	91.2	632	75.84	616	73.92	452	54.24
	A	744	89.28	176	21.12	489	58.68	582	59.84
1/3 down	B								
	Time	30	30	30	30	30	30	30	30
	Average	744	89.28	176	21.12	489	58.68	582	59.84
	A	342	41.04	467	56.04	461	55.32	504	60.48
2/3 down	B								
	Time	30	30	30	30	30	30	30	30
	Average	342	41.04	467	56.04	461	55.32	504	60.48
	A	510	61.2	489	58.68	445	53.4	469	56.28
Far end	B								
	Time	30	30	30	30	30	30	30	30
	Average	510	61.2	489	58.68	445	53.4	469	56.28
Pressure	inlet end	1.5		0.8		1.1		1.1	
	far end	0.5		0.5		0.5		0.5	
minimum rate of discharge	42.45								
average rate of discharge	61.08	EU= 69.5 %		Ea= 62.55 %					