Concept of Integrated Water Management on the Command Areas of Irrigation Improvement Project (Case Study)

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Abstract

Water in Egypt is considered to be a commodity of a great strategic importance. It plays an important role in the different fields of development. The traditional irrigated areas in the old lands may not always continue to enjoy the fairly generous water allocations which they were used to receive since completion of the High Aswan Dam. The traditional style of water distribution, based on past experience and reactive management, although it has been very effective in the past in enabling most farmers to achieve high yields of major crops, it may not be well adapted to sharing out relative scarcity. Egypt's policy on cost sharing arrangements has been initiated by establishing Water Boards and by the promotion of Mesqa-level (tertiary) management. The operation and maintenance works have been evaluated by Water Users Groups, which is a major step forward in institutional reform. This helps in achieving decentralization which makes the Ministry of Water Resources and Irrigation (MWRI) get rid of some of the load that lays on its burden. It also changes its role from being operational to being more focused on the strategic and supervisory side as well as planning for national policy; this is the point that initiated the concept of Irrigation Improvement Project (IIP). The overall objective of (IIP) in Egypt is to improve the social and economic conditions of Egyptian farmers through development and use of improved irrigation water management towards increasing crop production. Also to promote the efficient use of water in irrigation and a more equitable distribution by establishing continuous flow and on-demand access to water resources. Water saving has come to be seen as one of the main objectives of IIP. It is expected that applying continuous flow will contribute to this by enabling and encouraging farmers to take water in a more rational way, without over-irrigation (although in the absence of conclusive evidence from a fully working example there has been a concern among operating staff that it might have the opposite effect).

Monitoring and evaluation (M&E) was established to measure some indicators related to water levels, flow discharges, cropping patterns, water requirements and to make calibrations in main and branch canals and drains within the studied catchment areas to observe the positive and negative findings of the system and the application of project's concept. The results of two indicators were presented in this technical paper to examine the concept of integrated water management; a- the ratio of using the drainage water and b- the average irrigation time as an indicator for fresh water availability (quantity & quality). Two catchments areas were selected to test this concept; a- El-Mahmoudia region in west delta for an area of about 12300 acre, and b- Meet Yazied region in middle delta for an area of about 9400 acre. The study areas cover all canals and drains to measure the overall water use efficiency and the optimum use of drainage water for irrigation over the command area. From the data obtained in El-Mahmoudia command area it is observed that, during summer season, the lowest ratio is from El-Emom drain and the highest ratio is from Ganbiet El-Emom drain according to water availability in these drains. So the quantities of water re-used from the sub-drains were more than the quantities from the main drains due to the quality of water and the accessibility to farmers. Farmers mentioned three reasons that forced them to use the drainage water, i.e.; the limited amount of the water in the canal that doesn't reach the end of meskas and the plugging of the canal with a lot of trash. For Meet Yazied command area it is observed that the lowest value was found in El-Bashier drain and the highest value was found in El-Ganien drain. From the findings the percentage of farmers who used drainage water for irrigation in the summer season before IIP were about 100% in both regions, the current percentage is about 80% in El-Mahmoudia area, and 73% in Meet Yazied area, the optimum value of this indicator should be 0%.

The M&E results show that, there is good evidence of reduced labour, time and cost for irrigation purposes in improved areas and also reduced cost for the maintenance of the Mesqas. Regarding the informal drainage reuse, it could be concluded that most of the farmers who have fields on the drains depend temporarily or permanently on the drainage water.

It is recommended to install flow meters in thee delivery pipes of the pumps to measure actual water supply in order to estimate the values of Water use Index WUI more accurately.

It is strongly recommended to control rice cultivation within the improved areas (the current percentages are about 70-75 %, where the allowed percentages are about 30-35 % of the total area). Also it is recommended to strengthen the institutional planning and implementation capacity within the irrigation sector in Egypt.

Keywords: Water Resources Projects, Monitoring and Evaluation, Water saving, water distribution, Reuse of drainage water and Operation costs.

Concept of Irrigation Improvement Project

Water is considered to be a commodity of a great strategic importance; it plays an important role in the different fields of development. The per capita share of water is currently used as an indicator for measuring the level of the country welfare and prosperity.

The main objectives of the irrigation improvement project could be summarized in the following points:

1. To increase the agricultural production and the farm income by improving the irrigation infrastructure, a more equitable distribution of water, and improving on-farm water management
2. To improve the long-term sustainability of irrigation through the assumption of responsibility for operation and maintenance at the tertiary level by farmers, cost sharing arrangement for tertiary level investment costs.
3. To strengthen the institutional planning and implementation capacity of the Ministry of Water Resources and Irrigation MWRI within the irrigation Sector; **(**Mott MacDonald & Sabbour Associates 2004).

The Irrigation Improvement Sector (IIS) of the Ministry of Water Resources and Irrigation (MWRI) in Egypt is currently finalizing the implementation of the first phase of the Irrigation Improvement Project (IIP). The project aims at improving of the old irrigation system in a total net area of about 248,000 feddans in the northern part of the Nile Delta. The project area is divided into three sub-projects: Mahmoudia (131,000 feddans) in Beheira Governorate and Manaifa (42,000 feddans) and Wasat (75,000 feddans) in Kafer EL-Sheikh Governorate (WMRI, 2005).

Regarding the informal drainage reuse, it could be concluded that most of the farmers who have fields on the drains depend temporarily or permanently on drainage water. The situation in El-Saeraniya canal is worse than in Mersya El-Gaml canal. The reasons behind using the drainage water are due to the lack of the water in the canal (Meskas), the plugging of the canal (Meskas) from the trash and the grass, and the filled up Meskas.

Experience from IIP and other projects shows that the introduction of On-Farm Water Management practices, on a pilot basis, resulted in significant yield increases and a reduction in the amount of water use by farmers, (IIS, 2006). Under the conditions of water shortage, the most important indicator of OFWM interventions is the water savings achieved while improving the crops yields and quality of produce, in addition to reduced negative impacts on the environment. The benefits to farmers stem from reduced production costs; particularly less water applied and hence reduced energy costs, but also less irrigation labor returns and marginal benefits to farmer. The water saving allows for horizontal expansion of the irrigated area and delays additional investments needed for mobilizing additional water resources. As the potential for mobilizing additional water resources is very limited in Egypt, water saving constitutes the most promising option for meeting increased water demands for agricultural expansion and for the agriculture sector to release water to other uses. Matching irrigation water application to meet crop requirements and the drainage necessary to control salinity levels in the soil limits drainage and conserves freshwater which is otherwise lost through excessive drainage water and pollution.

Although part of drainage can be reused for agriculture, it results in lower yield because of its lower quality and requires subsequent pumping for its mobilization. As a direct impact on the project, inclusion of an OFWM component induces a higher internal rate of return, through increased benefits for farmers, and through reduced costs induced by reductions in the design of water transport and distribution networks, (WMRI, 2006).

Water Saving Strategy

Water saving has come to be seen as one of the main objectives of IIP. It is expected that continuous flow will contribute to this by enabling and encouraging farmers to take water in a more rational way, without over-irrigation (although in the absence of conclusive evidence from a fully working example there has been a concern among operating staff that it might have the opposite effect). So far as it is a pre-condition for implementing mesqa improvement, continuous flow also contributes indirectly to water saving by eliminating losses from traditional low-level mesqas. However, it should be noted that the aim of improving equity implies that at least part of any savings will pass directly to tail farmers who suffer from water shortages at present. Many of these farmers re-use water which is “lost” at present by irrigating from the drains. In some areas, there is also semi-formal re-use at secondary level, implemented by the Irrigation Districts. The overall saving at the branch canal level may therefore be rather limited. IIP interventions are relevant to all of these. The physical improvements should largely eliminate the possibility of direct losses from canals and meskas (especially tail losses). IIP may also contribute indirectly to reducing surface run-off and percolation losses both by avoiding over-irrigation by head farmers and by improving on-farm water management. Drainage re-use is not a core intervention of IIP, and it must be borne in mind that in general any increase in irrigation system efficiency reduces the scope for drainage re-use by a corresponding amount.

Water saving is a normal result from improved water use efficiency. There is a widespread expectation, reflected in the national media, that this will result in significant overall water savings. In the lower delta (unlike the Nile valley and some parts of the upper delta where drainage water is automatically recaptured by the main irrigation network), there are basically three possible strategies for achieving water savings:

- reducing the amount of irrigation water which flows to the drains, by reducing direct losses from canals and meskas, reducing surface run-off from fields and reducing percolation losses through the sub-surface drainage system ;
- increasing the amount of drainage re-use ;
- reducing total water consumption by crops, e.g. by modifying the cropping pattern, introducing new varieties with shorter growing periods or adopting irrigation methods and practices which reduce evapotranspiration.

IIP will not directly lead to reduced crop water consumption, but clearly any changes in agricultural systems can be more easily implemented in the context of a well-regulated irrigation system providing reliable, flexible and equitable water deliveries. The net overall effect of IIP in achieving water savings is difficult to predict. This is partly because the distribution of water losses in the existing system between the different components (e.g. canal tail losses, percolation losses etc...) is not well known. More importantly, the priority use for any savings due to localized increases in water use efficiency in IIP areas will be to improve canal supplies to water-short tail areas which at present rely on direct irrigation from drains for all or part of their supplies. This substitution of water previously lost to the drains for that taken from the drains for irrigation will be neutral in terms of overall water savings.

Methodology and Framework

The objective of this paper is to assess the extent of informal reuse of drainage water by farmers. For the two studied canals, a comprehensive survey of drainage reuse will be made for the whole area. This will be carried out as follows:

- a systematic reconnaissance was made along the banks of all main and secondary bordering or lying within the canal command areas covered by the pump operation studies, to identify all drainage reuse lifting points;
- a questionnaire survey was conducted of farmers using each lifting point to determine the extent of drainage reuse at each lifting point in terms of area served and crops irrigated and the proportion of the corresponding irrigation requirements met from drainage water.

1 Description of Study Areas

The research was conducted in two command areas, in Kafr El-Shiekh and In El-Behera. The command areas are described as follows:

1.1. Meet Yazied command area

Mersya El-Gaml canal

Mersya El-Gaml off-takes from El-Zawia canal (km 3.70). It is 16.35 km long and it serves around 9400 Feddan. The canal has three sub-branches, which are El-Mafroza, Kafr El-Morabeen and El-Bashair.

Mersya El-Gaml catchment drains

Mersya El-Gaml canal is surrounded by three secondary drains; El-Bashier drain, No 7 drain, and Faresh El-Ganien drain. Faresh El-Ganien drain is at the right side of the canal while No 7 drain is in the left side. El-Bashier drain is a short drain in the left side of the canal and it is between the canal and No 7 drain.

As a result, the locations the samples include the end of El-Bashier drain, the start of No 7 drain and at all locations (head, middle and tail) of Farsh El-Ganien drain.

Figure 1 Schematic lay-out of Mersya El-Gaml drains

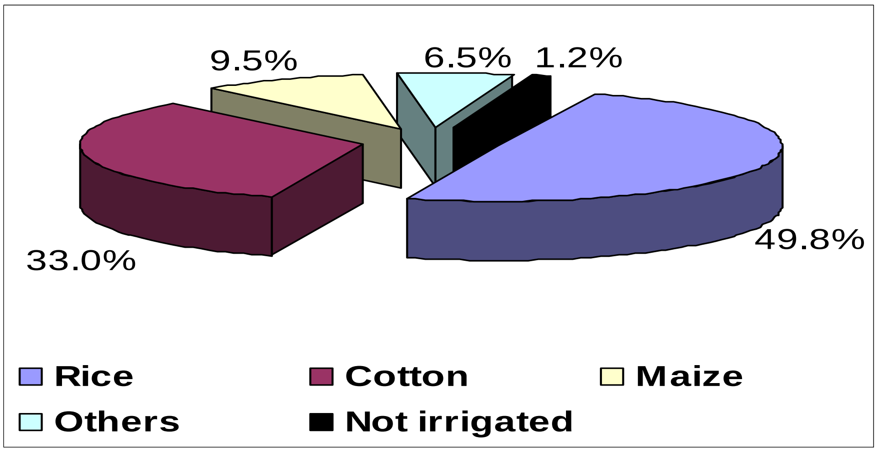

Figure 2 Cultivated area percentages on Mersya El-Gaml canal

Table 1 Summary of the selected drains on Mersya El-Gaml area

Drains	Farsh El-Ganain	Drain No.7	El-Bashair
No. of L.P.	21	11	14
No. of Pumps	30	12	14
No. of Farmers	21	11	14
Length (km)	15.13	15.50	8.14

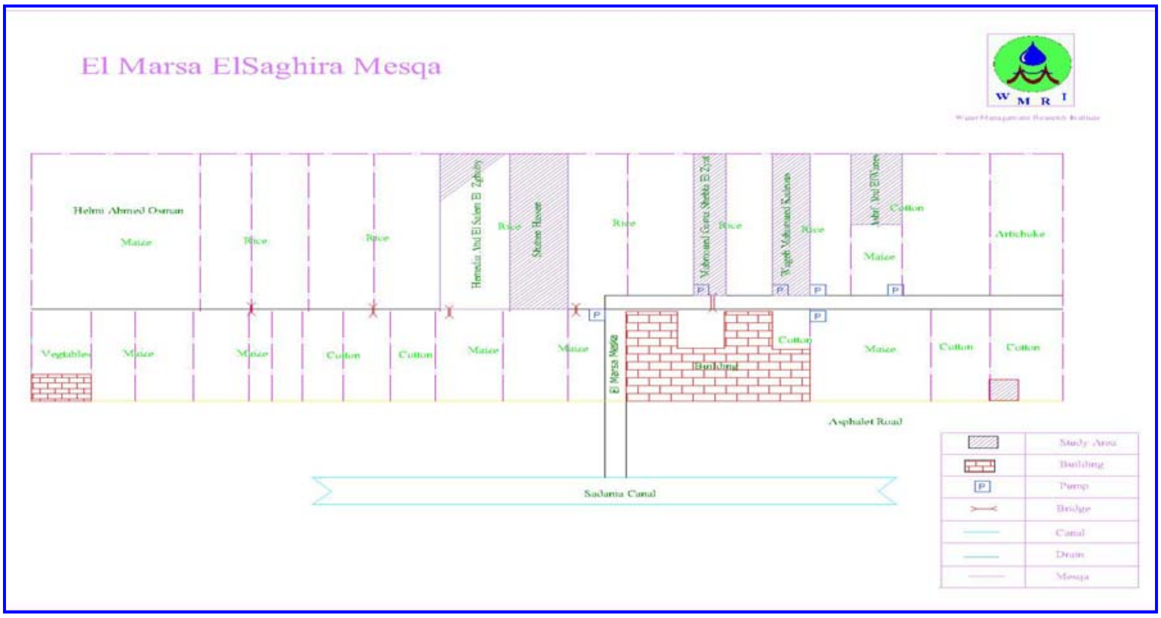

Figure 3 Schematic lay-out of meska El-Mersya El-Saghira

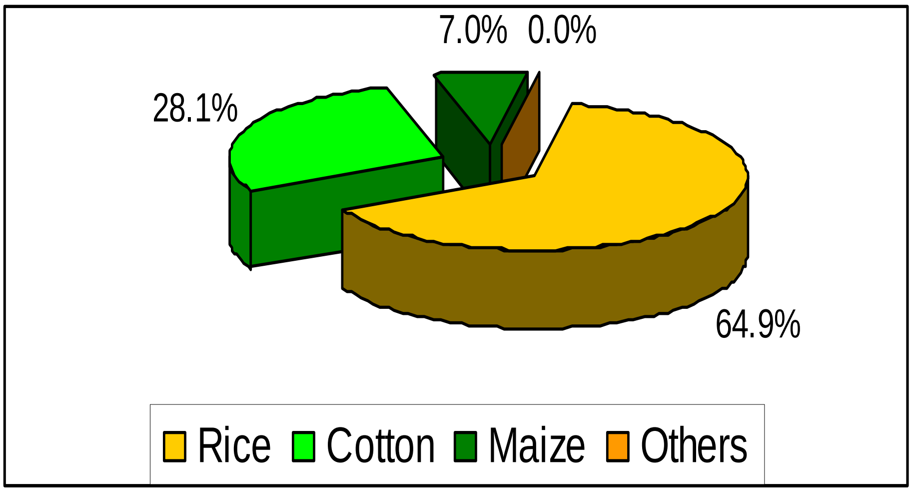

Figure 4 Summer cropping pattern for Zahran meska

Table 2 Inventory of lifting points for El-Bashair drain**.**
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1.2. El-Mahmoudia command area

El-Saeraniya Canal

El-Saeraniya off-takes from El-Mahmoudia canal (km 44.375). It is the first canal downstream Kafr El-Dawar regulator. It is 7.10 km long and it has an extension that is 8.67 km long. It has three sub-branches besides the extension. The total served area for El-Saeraniya and its extension is 12306 Feddan. The canal is covered for 1.2 km from the intake. It has two small open parts through this length; one at the beginning of the canal and one after around 400 m from the intake.

El-Saeraniya catchments drains

There are five drains that serve El-Saeraniya canal, which are El-Deshody drain, El-Emom drain, Ganbiet El-Emom drain, El-Baslakon drain and Sidi Gaze drain. El-Deshody drain is on the right side of El-Saeraniya canal. Both El-Emom and Ganbiet El-Emom drains are perpendicular to the end of the canal. El-Baslakon and Sidi Gaze drains are on the left side of El-Saeraniya canal and Sidi Ghaze branch.

Table 3 : Summary of the selected drains on Saerania area

Drains	El-Deshodi	Part of El-Omom	Part of Ganabiat El-Omom	Part of Baslakoun	Sidi Ghazi
No. of L.P.	21	3	7	12	4
No. of Pumps	36	6	8	20	12
No. of Farmers	36	6	8	20	12
Length (m)	16.4	11.8	4.6	5.35	1.4

2. Data collection

There were two ways for data collection. The first way includes the data that are measured directly, which are the calibration of different pumps, irrigation durations, irrigation time and cropping pattern of the selected fields. The other way includes the data collected from farmers through questionnaires and this includes number of irrigations, time of irrigations (day or night) and pump operations data, area served and labour requirements.

Pump calibration

Sixty-three pumps were calibrated; 36 pumps on Mersya EL-Gaml canal and 27 pumps on El-Saeraniya canal. Calibration includes defining different items. The calibration includes pumps discharges, pumping head, fuel consumption rates and pump speed.

Irrigation time

An irrigation time sheet is collected from the farmers who own the selected fields in each Meska. It is used to calculate the water use index (WUI). It is also involved in calculating irrigation cost per feddan, average irrigation time, labour requirements, and the incident of night irrigation.

Average irrigation time per feddan

The average irrigation time is the ratio between total irrigation time and the number of irrigations. This average will be calculated for the selected crops during summer and winter seasons. Average irrigation time for each crop at each Meska considered all fields cultivated by that crop on the Meska. It is calculated for different Meskas and locations.

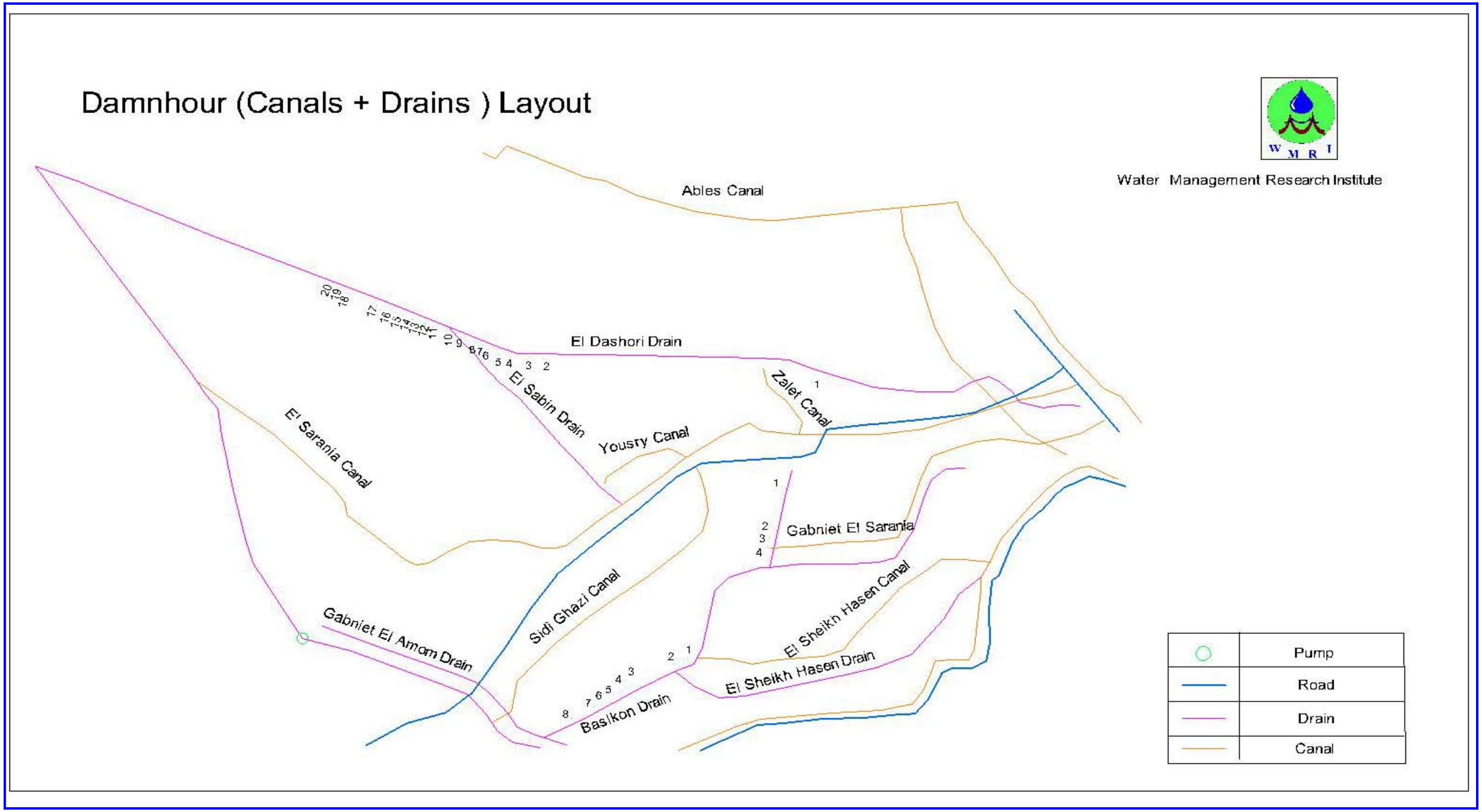

Figure 5 The schematic lay-out of Saerania canal.

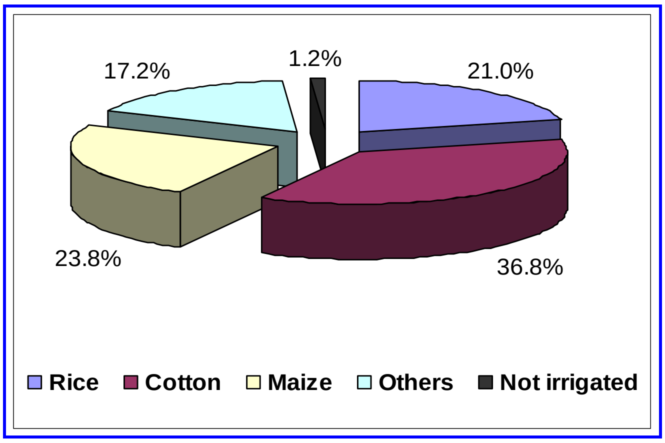

Figure 6 Cultivated area for each crop on Saerania canal.

Figure 7 The typical style of local farmer pump on Sa'rania catchment area

Pump operation

Pump operation sheet is used to collect the data regarding the selected pumps. All pump operations, even for the selected fields or other fields are considered. The data contains the duration of each pump operation, suction and delivery heads, fuel consumption, cropping pattern and the served area of the fields irrigated by the current operation.

Results and Discussions

1 Meet Yazied command area

The following figure presents the ratio of using the drainage water from each drain during summer 2005. From the figure, the average ratios are between 63% and 71%. The lowest value was found for El-Bashier drain and the highest value was found for Faresh El-Ganien drain. The results of Farsh El-Ganien drain presented in the previous table are the average of the three locations Details about these three locations are presented in the following figure (10). From the figure, the average value of depending on the drainage water increases from 68% at the head to 75% at the tail.

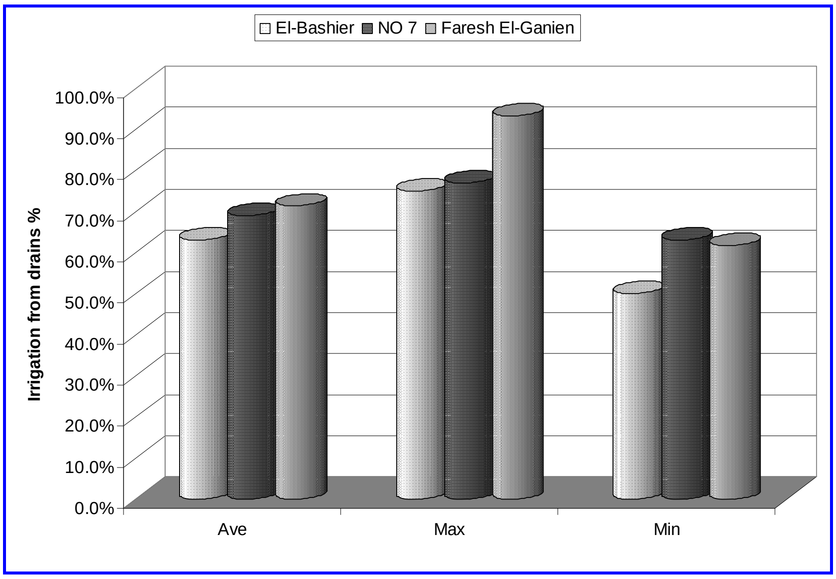

Figure 8 Ratio of irrigating from secondary drains of Mersya El-Gaml catchments area

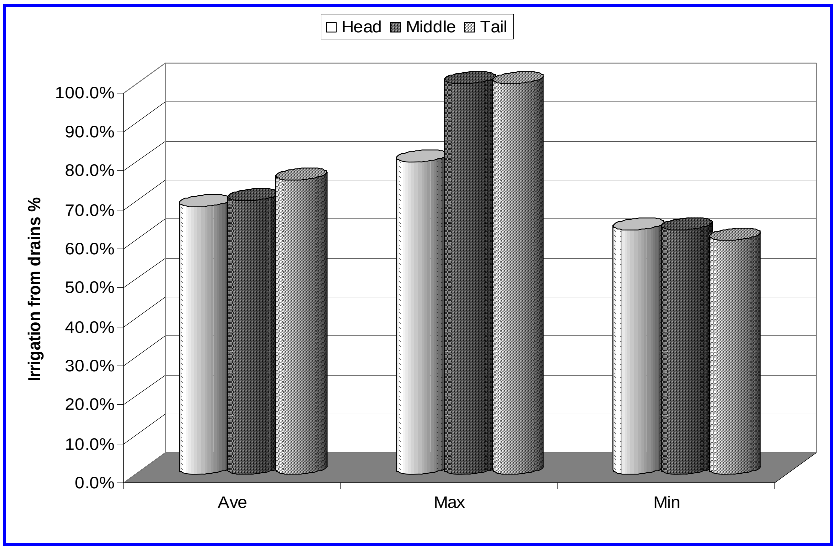

Figure 9 Ratio of irrigating from Farsh El-Ganien drain

Regarding the irrigation time from the canal (Meskas) and the drains, the following figures present average irrigation time for the main summer crops from both sources. For rice crop; average irrigation time for rice crop from the canal is between 1.4 and 2.3 hours. Average irrigation time from drains is between 2.5

and 3.3 hours. The ratio between irrigation time from canals and drains in different location on Farsh El-Ganien drain are close to average value presented above.

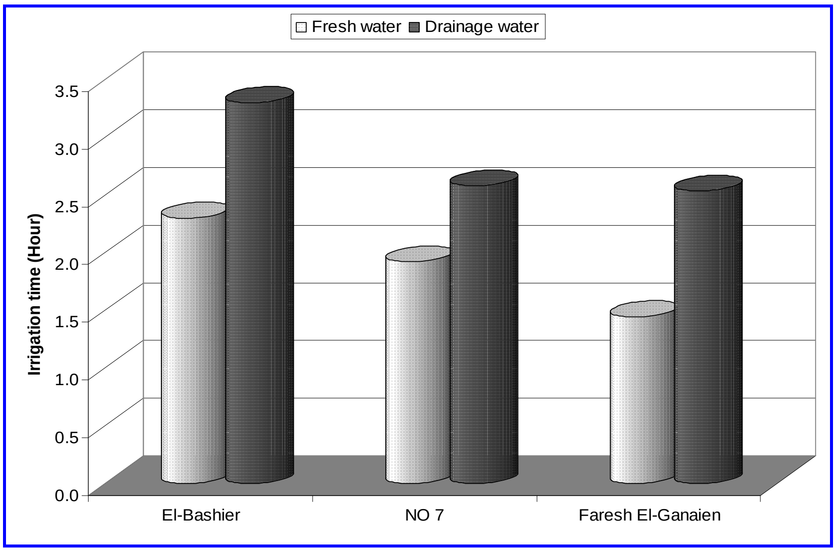

Figure 10 Average irrigation time (Rice crop) from Mersya El-Gaml command area

Regarding cotton crop, the average irrigation time from the canal is between 3.0 and 3.6 hours. From drains, the average irrigation time is between 3.9 and 4.6 hours. The ratio between average irrigation time from the canal and the drain is 77~78% for all drains. Regarding different locations on Farsh El-Gainen drain, the ratio is between 75% and 84%. The highest value is in the middle.

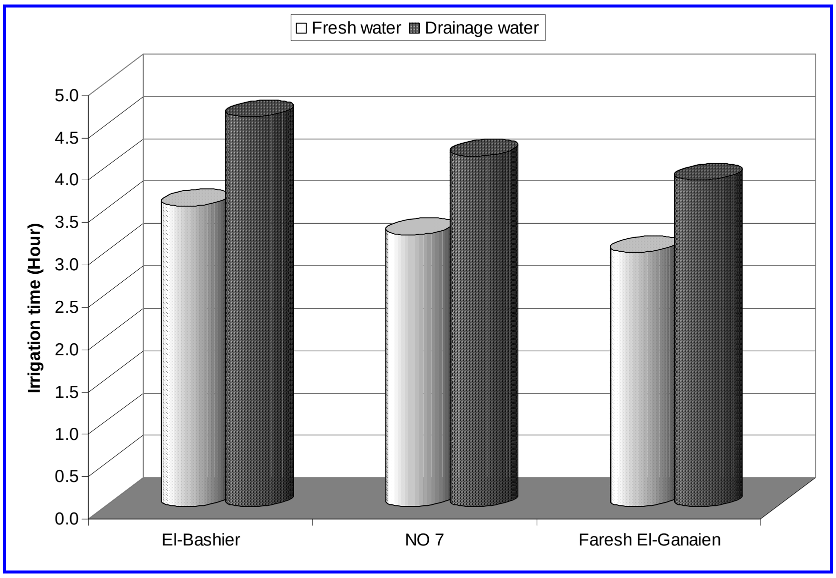

Figure 11 Average irrigation time (cotton) from Mersya El-Gaml command area

Regarding the reasons that force the farmers to irrigate from the drains, the results could be summarized as follows:

- According to the farmers, the water shortage in the canal is the main reason. 100% of the questioned farmers in El-Bashier and No 7 drains see that.
- The second reason is the trash or the grass in the canal. All farmers put this as the second and the third reasons with ratios that differ from a drain to the other.

During the winter season, the use of drainage water decreases. In reality this value of average water reuse indicates that some problems in the canal system that leads farmers in winter to depend on drainage water, not the assumed available fresh water in the irrigation canal system in winter season.

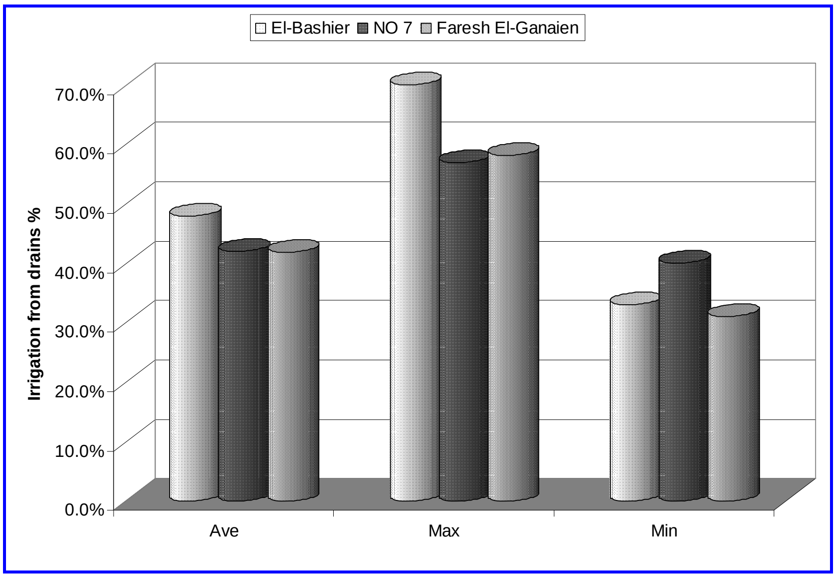

Figure 12 The ratio of irrigating from drains of Mersya El-Gaml canal during winter season

Sugar-cane was found only close to drain No 7 and El-Bashier drains (where water is available). The average irrigation time from drains is between 3.7 and 3.8 hours. The average irrigation time from the canal close to El-Bashier drain is 2.8 hours. For fields close to No 7 drain, the average irrigation time is 3.2 hours.

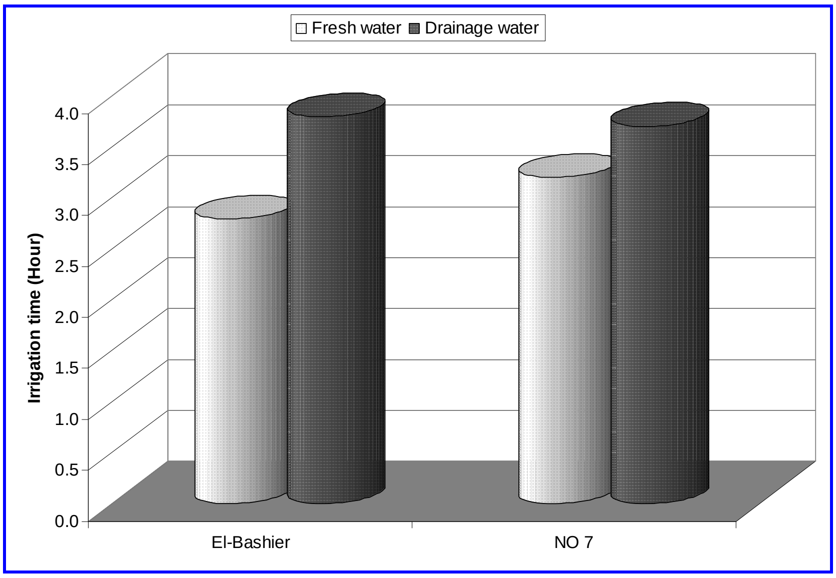

Figure 13 Average irrigation time (suder-cane) on Mersys El-Gaml command area

In this catchment area, the reasons force the farmers to use the drainage water could be the limited water in the canal and the trash or the bad situation on the canal system (rubbish) that don't allow water to reach the till end of the canal.

2 El-Mahmoudia command area

The ratios of using the drainage water from each drain are presented in the following figure. From the figure, the ratio of using the drainage water is between 79% and 88%. The lowest ratio is in El-Emom drain and the highest ratio is in Ganbiet El-Emom drain. For El-Deshody drain, there is some fields that did not use the drainage water during summer season. For other drains, the minimum ratio is between 45 and 50%. Regarding the average irrigation time from the canal (Meskas) and drains, the following figure presents the average irrigation time for rice crop from different drains. From the figure, there is no specific trend for all drains. In El-Deshody drain, average irrigation time for a unit area of rice crop from the canal is 2.0 hours. From the drain, the average irrigation time is 2.7 hours. For El-Emom drain, average irrigation time is 1.0 hour from the canal while it is 2.3 hours for the drain. In Ganbiet El-Emom drain, the situation is different. The average irrigation time from the canal (2.4 hours) is higher than the average irrigation time from the drain (2.1 hours). There is no relationship could be obtained between the average irrigation time from the canal and the average irrigation time from the drain for maize crop as well.

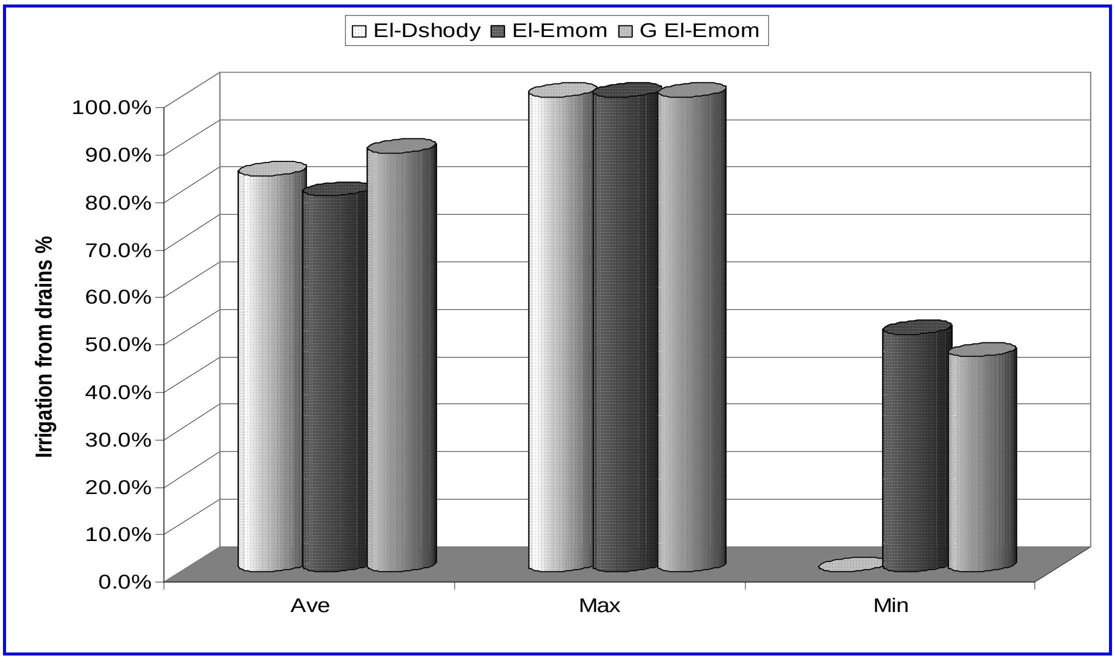

Figure 14 The ratio of irrigating from secondary drains of El-Saeraniya canal

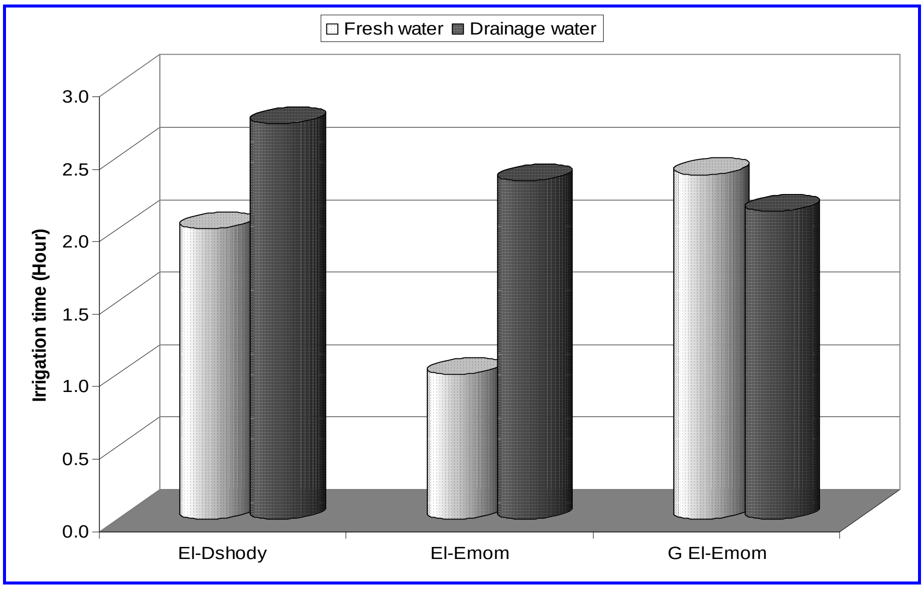

Figure 15 Average irrigation time (Rice crop) from El-Saeraniya catchment area

The average irrigation time for cotton (figure 18) is the same as for rice and maize crops, where there is no trend between the average irrigation time from the canal and average irrigation time from drains. The average irrigation time from the canal is lower regarding El-Deshody and El-Emom drains. In Ganbiet El-Emom drain, the average irrigation time from the canal is higher than the average irrigation time from the drain. Considering the same drain for all crops, it could be concluded that the average irrigation time from Ganbiet El-Emom is less than the average irrigation time from the canal regarding all crops. The opposite is in El-Emom drain. In El-Deshody drain, the situation is different from one crop to the other.

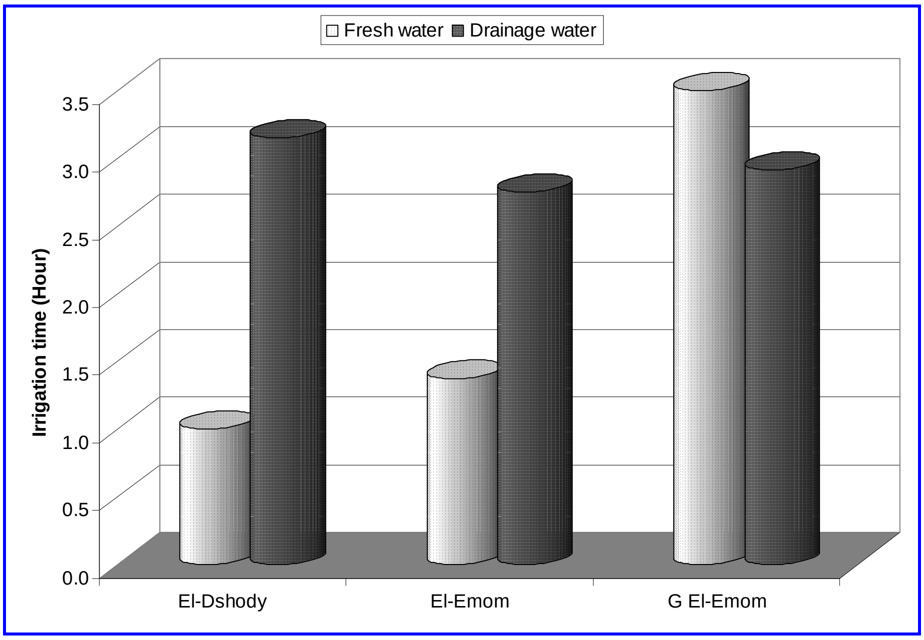

Figure 16 Average irrigation time (Cotton) from El-Saeraniya catchment area.

As observed from farmers, the reasons that force farmers to use drainage water, based on their opinions, could be summarized as follows:

- All the farmers mentioned that the amount of the water at the canal in not enough and it does not reach them.
- Some farmers mentioned that their Meskas were dried up and so they depend totally on the drainage water.
- Some farmers mentioned the pluging of the canal with a lot of trash (Sidi Gaze branch).

It should be mentioned that 50% of the questioned farmers at the head of El-Deshody drain did not use the fresh water during the summer, in El-Emom drain, the ratio is 33%. In Ganbiet El-Emom drain, between 55% and 82% of the farmers depend on drainage water during summer season. The data was collected from four drains. These drains are El-Deshody drain, El-Baslakon drain, Ganbiet EL-Emom drain and Sidi Gaze drain.

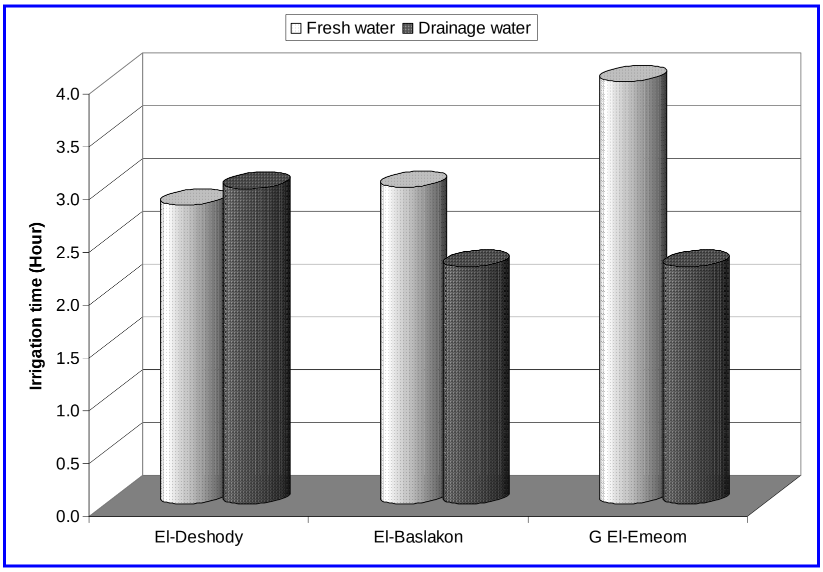

Figure 17 Average irrigation time (Wheat) from El-Saeraniya catchment area.

The reasons that force farmers to use the drainage water in the winter season are the same as in summer such as the farms locations (easy use) and the inadequacy of water in the canal.

3 General findings

It could be concluded that:

1. Most of the farmers close to the drains use the drainage water, either occasionally or permanently. This could also be found at some locations at the head of the canal. However, there is no estimation about the ratio of the cultivated area of the canal that depends on the drainage water.
2. Average irrigation time for different crops while using the fresh water or the drainage water was also calculated. Irrigation time is affected by the availability of the water and the water level in both sources (suction head at the pump). These data (irrigation time) should be considered as approximate data as it is not measured. It is just the estimation of the questioned farmers. However, these data also indicate that the situation in El-Saeraniya canal is worst that it in Mersya El-Gaml canal as the irrigation time from the canal (Meskas) is always lower than the irrigation time from the drain in Mearsya El-Gaml canal. This is not the situation in El-Saeraniya canal.
3. According to the farmers, the main reasons for using the drainage water are:

   - The limitation of the water in the canal or the short application period
   - The existence of the trash or the grass in the canals or the Meskas
   - Some Meskas were dried up and so there is no other source for irrigation rather than the drain dried.

Conclusions

The traditional irrigated areas in the Old Lands may not always continue to enjoy the fairly generous water allocations which they have become used to receiving since completion of the High Aswan Dam. The traditional style of water distribution, based on accumulated experience and reactive management, although it has been very effective in the past in enabling most farmers to achieve high yields of major crops, may not be well adapted to sharing out relative scarcity. Thus, for some, the changes associated with the introduction of continuous flow are also seen as a preparation for coping with a future situation of tighter water availability. In this view, continuous flow is not just about efficiency and equity of water distribution within branch canals, but also about equity between branch canals and management of the main system.

A reduction in water deliveries to branch canals cannot be taken in isolation as an indicator of water saving due to IIP; taking into account parallel developments in cropping patterns, varieties, drainage system, it is probably never going to be possible to directly measure or quantify any actual water saving due specifically to IIP. Nevertheless, if a reduction in water deliveries takes place in conjunction with an improvement in equity and an increase in yields; in this case we can say that with IIP and other changes such as new crop varieties.

From the M&E results there is good evidence of reduced labour, time and cost for irrigation purposes in improved areas and also reduced cost for the maintenance of the mesqas. Egypt’s policy on cost sharing arrangements, establishing Water Boards and promotion of mesqa-level management concerning operation and maintenance works by Water Users Groups is a major step forward in institutional reform as it helps achieving decentralization which lets the MWRI gets rid of some of the load that lies on its burden and changes its role from the operational role to the strategic and supervision one represented in planning for national policy.

- Most of farmers whose fields are on the drains depend temporarily or permanently on the drainage water.
- The situation in El-Saeraniya canal is worse than in Mars El-Gaml canal. This could be observed from the ratio of using the drainage water and the average irrigation time.
- The reasons behind using the drainage water are the limitation of the water in the canal (Meskas), the plug of the canal (Meskas) due to the trash and the grass, and the drying up of some Meskas.

Regarding the informal drainage reuse, it could be concluded that most of the farmers who have fields on the drains depend temporarily or permanently on the drainage water (mainly when they decided to cultivate rice). The situation in El-Saeraniya canal in Damanhour is worse than in Mersya El-Gaml (Kafr El-Shikh) canal regarding the dependency for drainage water for irrigation.

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