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IRRIGATION IMPROVEMENT SYSTEM AND ITS EFFECT ON WATER MANAGEMENT IN BENI ADI VILLAGE (CASE STUDY)

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Irrigation Improvement System plays an important role in optimizing the use of the available water quantity from the River Nile; this will be achieved by saving some quantities of water which are lost in seepage from the water streams, evaporation from the surfaces of the open water streams and farmers' bad use of water. The major part of the Improvement System is the replacement of the existing earthen Mesqas with raised and lined Mesqas or buried pipeline Mesqas. These kinds of Mesqas are intended to eliminate the seepage of water through their cross sections; the end of these Mesqas is closed to prevent water losses to drains. Also, the area of the open water surfaces of the improved Mesqas will be less than the area of the open water surfaces of the earthen Mesqas. So, the amount of evaporation from the open water surfaces will reduce.

In Beni Adi el Bahariya Village (the study area) in Assiut Governorate, according to the Irrigation Improvement Management (IIM) in Assiut Governorate, June 1999 (end of the feasibility study in the study area), the area of the open water surfaces of the earthen Mesqas has been estimated to be about 19840 square meters. After finishing the improvement process; this area was reduced to be about 6250 square meters. So, the reduction in the amount of evaporation in Beni Adi el Bahariya Village (the study area) due to the Irrigation Improvement System is about 69 % of that was before improvement. The improved Mesqas are intended to eliminate the seepage of water through their cross sections, so; the amounts of water that are lost by seepage from the earthen Mesqas which are about 270000 m^3 annually are saved after the improvement.

In addition to the benefit of the Irrigation Improvement System in saving some quantities of water which led to increase the inflow discharge to the study area, there are other benefits (according to Monitoring and Evaluation Reports of IIM in Assiut Governorate, 2009). These benefits are land saving: where, there is about 3 % of the total area served by

Mesqas which is about 1 % of the total command area saved and made available for agriculture and roads. Also, irrigation time reduced by 50 % to 60 % of that was before improvement process which made water available all the time in the Mesqas with the adequate quantities, the cost of pumping reduced by 64 % which was a result of a single point lifting on the Mesqa and The increase in crop yields (according to agricultural association in Beni Adi el Bahariya village, 2009) due to the better conditions of water availability, Increase in wheat, cotton and maize were estimated at 10 %, 18 % and 9 %, respectively.

Irrigation Improvement System couldn't achieve increasing of on-farm efficiency because of farmers' bad use of water, where; they used to irrigate by high flow rates which lead to increase leakage from the farm land. Therefore, Field design and irrigation management practices have a significant impact on surface irrigation performance. Reductions in management variables such as irrigation time and design flow rate of the system can lead to improvements in irrigation efficiencies and water saving.

KEYWORDS: *Seepage, Evaporation, Mesqas and Irrigation Improvement Management (IIM).*

1. INTRODUCTION

There are many improvement projects had been done in many areas all over Egypt to increase the efficiency of using the available irrigation water quantity, and gain new reclaimed lands; in addition to increase the income of the agricultural sector in Egypt to meet the continuous increasing of the population and their needs.

So, the existing study is a trial to evaluate some of these projects in Upper Egypt to point-out the main observed advantages, their impacts and the main disadvantages to be avoided.

2. LITERATURE REVIEW

Agriculture in Egypt is depending on surface irrigation with water from the River Nile. The agricultural sector is the highest freshwater consumer, utilizing about 85 % of the available supplies. The traditional rotational irrigation system in Egypt was investigated by El-Alfy [3], 2003, El-Kholy [4], 2000, Gergis [7], 2003 and Zaki [16], 1998. This system has some disadvantages such as; severe shortage of water at the tail reaches; low conveyance efficiency; high operational cost; and excessive water losses to drains. Tremendous efforts should be implemented towards effective management for irrigation system, Ibrahim [8], 2003

To overcome the problems of traditional irrigation system and saving some quantities of water to optimize the use of the available water quantities from the River Nile, El-Alfy [3], 2003, El-Kholy [4], 2000, Gergis [7], 2003, Zaghlool [15], 1997 and Zaki [16], 1998, mentioned that Ministry of Water Resources and Irrigation (MWRI) took the decision to improve the irrigation system. Improved Mesqas (concrete lined or low pressure pipeline) is the major part of the improvement. There are other parts such as; down- stream control devices; single lifting points; Water Users' Associations

(WUAs); and Irrigation Advisory Services (IAS); Continuous flow in distributary's canals and their branches. Continuous flow means the existence of water in the irrigation system all the time and avoiding the periodical old system.

Gergis [7], 2003, studied the modernization of the irrigation system in the old lands and he showed that evaluation of the project in the first stages and any modifications will have significant impact on the project in the coming stages. Also, the problems of first stages have to be solved carefully in the coming stages, Zaki [16], 1998, examined the limitation and advantages of irrigation improvement in Beni Ebeid command area, which is located in El-Minia Governorate. Also, El-Kholy [4], 2000, investigated the improvement in on-farm management in Herz & Numania command area, which is located in El-Minia Governorate.

The evaluation of the improved irrigation system, in Al-Qahwagy command area that located in Kafr El-Sheikh Governorate, showed that the improved system has some problems related to management characteristics, El-Alfy [3], 2003 and Gergis [7], 2003 Also, it is indicated that there is still need for modification for efficient management. The increasing demands for irrigation water will coincide with raising concern about the environmental effects of the irrigation.

MWRI through the World Bank [12], 2007 and [13], 2008, studied the Environmental and Social Impacts Assessment and Framework Management Plan in the west Delta irrigation rehabilitation project (WDWCIRP) through: (i) cooperative arrangements to achieve economies of scale; (ii) on-farm water efficient technology demonstrations; (iii) irrigation advisory and production support services to improve productivity …etc.

3. RESEARCH PLAN

1. Selection of site for studying the Improved Irrigation System, the farmers' practices in their lands; as well as, the irrigation methods and estimation of the expected water saving.
2. Quantitative data collection concerning the on-farm water management.
3. After the collection of the above data and information, problems; an evaluation for the management efficiencies is identified.
4. After identifying the problems and evaluation of the irrigation system; suggestions are being reported to lead us to better water management.

Beni Adi el Bahariya village, in Manfalot District, in Assiut Governorate; was selected for the required study.

4. DESCRIPTION OF THE STUDY AREA [9]

Location: Beni Adi el Bahariya village lies in Manfalot District, which lies about 22 km. North of Assiut Governorate (358 km. South of Cairo).

Command area: About 1100 feddan, the total cropped area is about 1024 feddan.

Topography: Beni Adi el Bahariya area has a flat surface and it slopes very gently towards the Northwest. Its average land level (Altitude) is (49.2 m), Beni Adi el Bahariya village, its coordinates is 27 19 N, 30 58 E

Climate: The area is characterized by a warm and dry climate. The mean daily temperature ranges from a minimum of 9.4 (in centigrade) in January to a maximum of

45.8 (in centigrade) in August with a mean annual of 27.2 (in centigrade). The mean annual rainfall is almost negligible.

Soil: Soil in Beni Adi el Bahariya area is mainly fluvial deposits derived from Nile silts (silty clay) without significant influence of desert deposits. Studies and investigations in this area showed that this type of soil restricts 80 % of the plant root to the upper 40 cm layer of the soil. Water table in most of the area is 150 cm or more below the ground surface.

Main Crops: The main grown crops in summer include Cotton and Maize, which cover about 98 % of the cultivated area, while the main crops in winter include Wheat and Berseem (Clover) that occupy about 79 % of the cultivated area.

Water source: The only source of water supply to the area is the River Nile that provides 100 % of the water demand to the command area. Nile water is delivered to the area through a major canal called Beni Adi which off-takes from west Naga Hammadi canal that takes, in turn, from the River Nile upstream Naga Hammadi Barrage. Water is distributed in the area through 14 Mesqa.

The Discharge: MWRI [11], 1993 estimated the peak water duty in July for the command area. It was 39.9 cubic meters per feddan per day. This means that the designed discharge is 0.47 cubic meters per second for the command area.

Irrigation Rotation: Beni Adi canal takes its water from west Naga Hammadi canal on a rotational schedule, then water is delivered to the area through the 14 Mesqa. The rotational periods are typically a three-turn rotation with 5 days on & 10 days off in winter and a two-turn rotation with 5 days on & 5 days off in summer.

Irrigation methods: Beni Adi el Bahariya area is characterized by surface irrigation method. Basin or Furrow irrigation is practiced in this area based on the crop type. Micro irrigation systems such as sprinkler or drip irrigation are not practiced in the old lands in Egypt.

Energy Source: Diesel fuel constitutes the main energy source to operate the pumps that are installed at the head of Mesqas to divert water from branch canal to Mesqas. Water is then made available to farmers' fields, through openings along the Mesqa, which flows by gravity to fields.

Water Rights: Water rights system did not exist before the improvement. Farmers were allowed to take water from canal or Mesqa to irrigate their lands. Although the irrigation interval of the system before the improvement was fixed to be 15 days, Farmers particularly those at Mesqas' tails, used to complain from lack of irrigation water or were deprived from irrigation during the on-period of the canal. The improved system in Beni Adi el Bahariya village guarantees water availability on time for each farmer where his location is from the Mesqa, head or tail. The problem of inadequate water at Mesqas' tails has been solved.

5. IMPROVEMENT'S BENEFITS

The main benefits of the improvement process were as follows:

- Water saving,
- Increasing of conveyance efficiency in Mesqas,
- Adequate and dependable water delivery to users,
- Increasing on farm efficiency,

- Reducing irrigation labor requirements, costs and time,
- Improved yields and quality of crops
- Land saving,
- Better scheduling and timing of irrigation
- Increasing co-operation between water users' and operators, and finally
- Decreasing water born diseases

6. DESIGN OF MESQAS

Improvement of Mesqas constitutes the major part of the Irrigation Improvement System. It includes replacement of the existing earthen Mesqa (Private canal operated by farmers) as shown in photo (1) with an elevated and lined Mesqa as shown in photo (2) or buried pipeline Mesqa as shown in photo (3).

Photo (1) Earthen Mesqa before improvement

Photo (2) Elevated Mesqa after improvement

Photo (3) Buried pipeline Mesqa

6.1. Elevated and lined Mesqas

By applying Manning equation, the Mesqa dimensions are calculated as follows:

$Q_{md} = 1/n * R^{2/3} * I^{1/2} * A$ (1)

$R = A/P$ (2)

Where; $A = b*d + z*d^2$ and $P = b+2*d*(1+z^2)^{1/2}$

For a rectangular cross section: z (side slopes) = 0

By assuming: $b = X\ d$ (3)

$d = [Q_{md} * n * (X + 2)^{2/3}/(X^{5/3} + I^{1/2})]^{3/8}$ (4)

In which;

b Bottom width of a Mesqa (m),

d Water depth in Mesqa (m),

X Ratio between b and d, it was assumed = 1.5

I A Mesqa bed slope (cm/km),

n Roughness coefficient of a Mesqa, it was assumed 0.016 for concrete lined Mesqas

Q_{md} Design discharge of a Mesqa (m^3/sec.).

Bouwer [1], 1969, estimated the bed slope of a concrete lined water stream as follows:

$I = 15 * Q^{-0.2}$ (5)

In which;

I A bed slope (cm/km)

Q Discharge in m^3/sec.

By assuming a free board equal to 0.25 m, yields:

$d_1 = d + 0.25m$ (6)

Where, d_1 is the depth of a Mesqa (m).

6.2. Buried pipeline Mesqas

As shown in figure (1) Low-pressure PVC pipeline Mesqa includes a pump station at Mesqa head in addition to a reservoir to provide low head for pipeline Mesqa. The pipeline sets approximately at one meter below ground level, its slope is the same as the ground slope and provides with risers at spacing of about 100 meters. Flow from each riser is controlled by an Alfa Alfa valve. The pressure head at the last riser in the Mesqa should be equal 1 m.

The pipe Mesqa is recommended when land capacity for constructing open Mesqa is difficult and expensive. In addition, Pipe Mesqa is recommended when Mesqa runs through villages and subjects to pollution and blocking by villagers garbage.

7. SYSTEM PERFORMANCE

Analyzing the Irrigation Improvement System in Beni Adi el Bahariya Village (the study area) will be at the following parameters:-

7.1. Water Saving

The quantities of water that are saved as a result of the improvement process; will be studied in the following parameters:

1. Evaporation from the open water surfaces.
2. Seepage from the water streams (Mesqas).

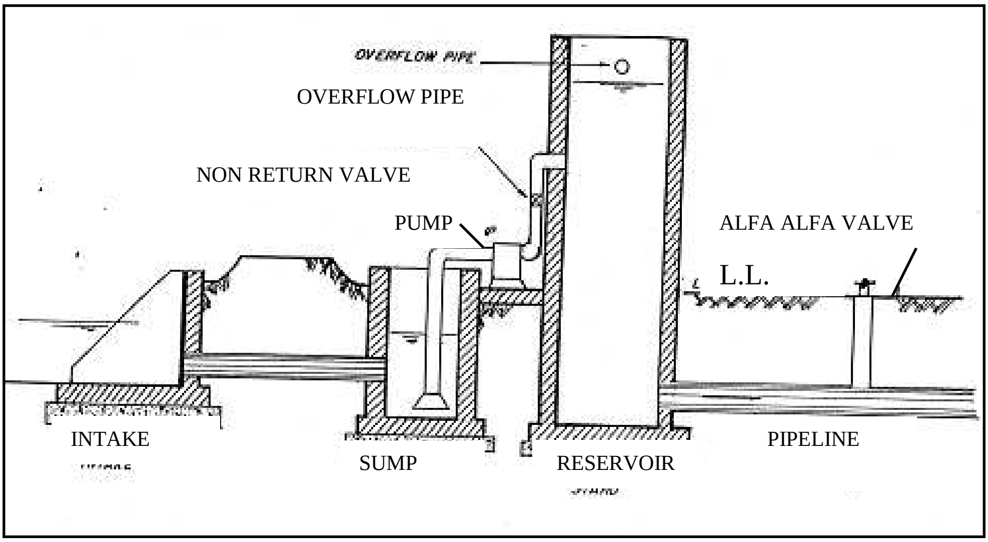

Figure (1) Low pressure pipeline Mesqa

Evaporation (E):

Evaporation is the losses of water from the open water surfaces of the water streams. (According to IIM in Assiut Governorate, June 1999); the area of the open water surfaces of the earthen Mesqas has been estimated to be about 19840 square meters. After finishing of the improvement process; this area reduced to be about 6250 square meters.

So, the reduction in the amount of Evaporation in Beni Adi el Bahariya Village (the study area) due to the Irrigation Improvement System is about 69 % of that was before improvement.

The evaporation rate varies with temperature (Higher temperature = more evaporation), wind speed (Higher wind speed = more evaporation), and relative humidity (Lower humidity = more evaporation).

Evaporation from surfaces is one of the most significant forms of the losses of water from the water streams. Ashour and others [10], 2009, estimated the evaporation (E) from the open water surfaces as the following:

$$E = 0.14 * (e_o - e_{200}) * [1 + (0.72 * U_{200})] \quad (7)$$

In which;

E Evaporation from the open water surfaces (mm/day)

e_o The average maximum elasticity of water vapor calculated on the surface temperature of water (mb)

e_{200} The average value of elasticity of water vapor over the body of water at a height of 200 cm (mb)

U_{200} The average value of wind speed over the body of water at a height of 200 cm (m/s)

The relation between t_o and e_o is illustrated in figure (2) and the relation between t_{200} and e_{200} is illustrated in figure (3)

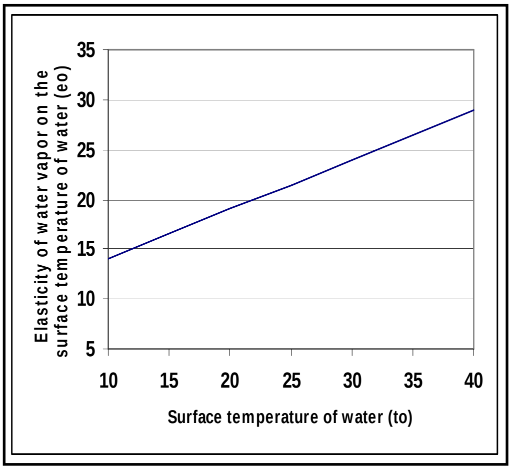

Figure (2) Relation between t_o and e_o

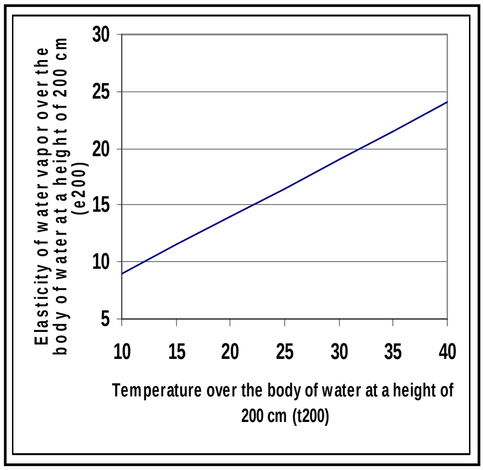

Figure (3) Relation between t_{200} and e_{200}

Where; t_o is the surface temperature of water, and t_{200} is the temperature over the body of water at a height of 200 cm.

Volume of evaporation (m^3) = 0.001 * E * A * n (8)

In which;

A Area of the open water surfaces (m^2)

n The number of days in the current interval of time (month)

From equations (7) and (8), the amount of evaporation from surfaces due to the meteorological data for the study area in the year 2008 was calculated and given in table (1). According to the calculations, figure (4) illustrates a comparison between the evaporation before and after improvement.

Table (1) calculated the amount of Evaporation

Year	Month	Air temperature °C			e_o	e_{200}	U_{200}	E
		Max.	Min.	Average				
2008	Jan.	23	5	14	16	11	3.2	2.31
	Feb.	25	7	16	17	12	3.6	2.51
	March	29	11	20	19	14	4.3	2.87
	April	34	16	25	21.5	16.5	4	2.72
	May	38	20	29	23.5	18.5	3.7	2.56
	June	40	23	31.5	24.75	19.75	3.5	2.46
	July	41	24	32.5	25.25	20.25	3.2	2.31
	August	43	26	34.5	26.25	21.25	3	2.21
	Sep.	37	22	29.5	23.75	18.75	2.6	2.01
	Oct.	35	17	26	22	17	2.8	2.11
	Nov.	28	12	20	19	14	3	2.21
	Dec.	24	8	16	17	12	3	2.21

Source of Meteorological data: Journal of the Egyptian Meteorological, 2008

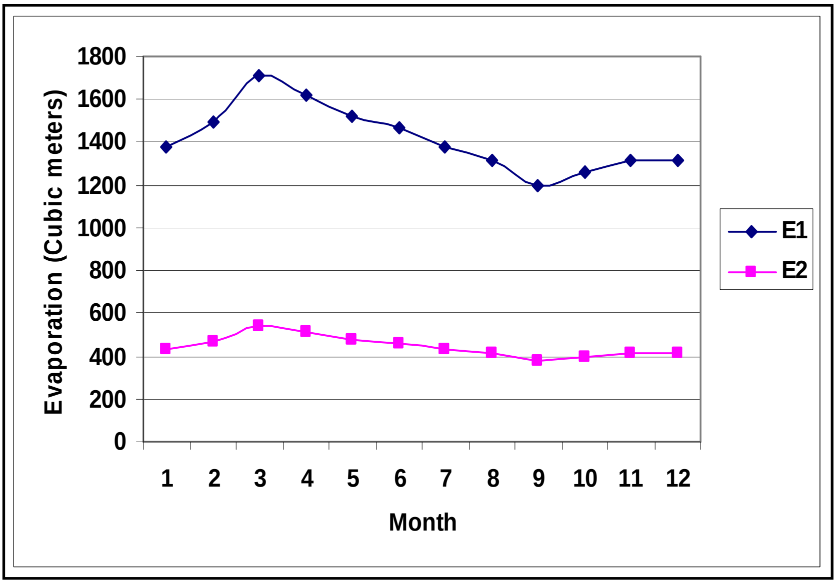

Figure (4) Comparison between the evaporation before and after improvement

Where; E1 is the monthly evaporation before the improvement process in m^3, and
E2 is the monthly evaporation after the improvement process in m^3.

Figure (5) illustrates the actual saving in evaporation due to the improvement process.

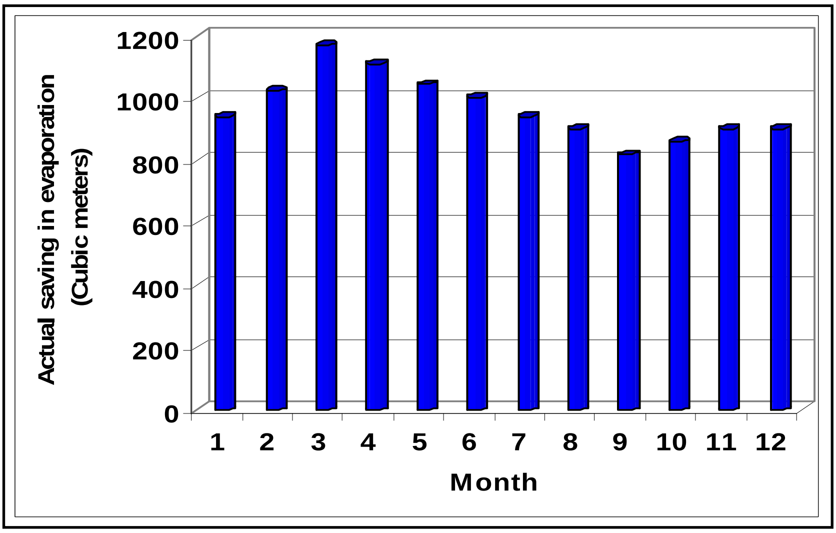

Figure (5) Actual saving in evaporation due to the improvement process

Seepage (S):

In Upper Egypt, the losses of water by seepage are about 35 % of the water taken from the River Nile. This value can be distributed as the following: 20 % for Main and Branch canals, 10 % for Distributary's canals and 5 % for Mesqas in the average. MWRI [6], 1982.

As the seepage rate from the earthen Mesqas is a percentage of the water taken from the canal that is feeding the Mesqas. So, by applying the average value (5 % for Mesqas), the calculations of the average monthly seepage rate from the monthly inflow discharge for Beni Adi el Bahariya Command Area are given in Figure (6).

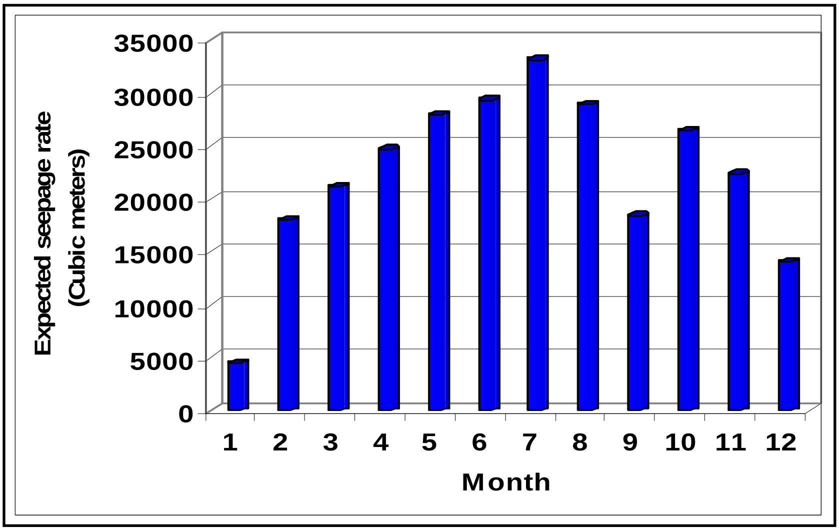

Figure (6) Expected seepage rate from the earthen Mesqas

The improved Mesqas are intended to eliminate the seepage of water through their cross sections. Also, the end of the Mesqas is closed to prevent water losses to drains.

Finally; the Irrigation Improvement System in Beni Adi el Bahariya Village (the area under study) contributed to save some quantities of water to use them positively in the present days and in the future. So, the actual monthly inflow to Beni Adi el Bahariya command area increased as illustrated in figure (7) by the amount of seepage that is eliminated and also due to the reduction in evaporation from the open water surfaces.

7.2. Conveyance efficiency in Mesqas

Preventing seepage and weed growth increases conveyance efficiency in Mesqas to reach about 95 % instead of about 60 % before the improvement process (according to Monitoring and Evaluation Reports of IIM in Assiut Governorate, 2009). The losses are only due to evaporation from free water surface, which was also reduced by reducing Mesqas' cross sections.

The conveyance efficiency reflects the ratio between the farm's water deliveries to the amount of water enters the Mesqa. Measurements of this efficiency were made by Irrigation Improvement Project (IIP) team through installing water level automatic recorders along the Mesqa and using the flow meters to quantify the flow running along the Mesqa and deliveries to farms.

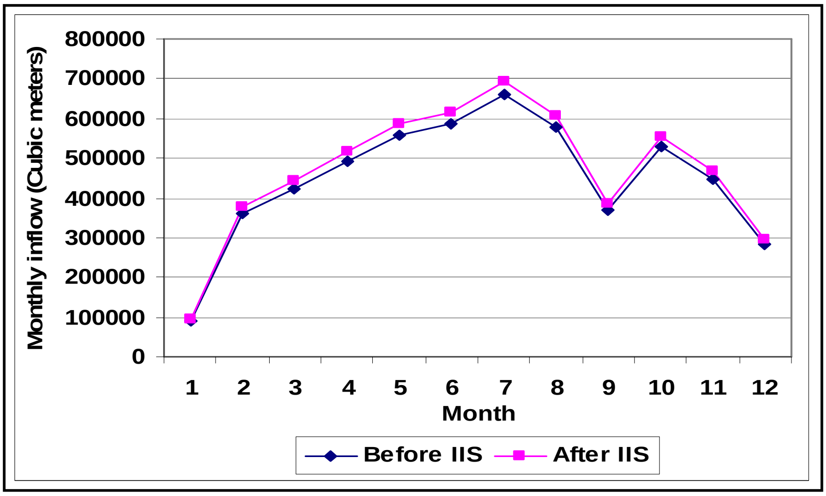

Figure (7) Monthly inflow before Irrigation Improvement System (IIS) and monthly inflow after (IIS)

In addition to the benefit of the Irrigation Improvement System in saving some quantities of water which led to increase the inflow discharge to the study area, there are other benefits that had been reported (according to Monitoring and Evaluation Reports of IIM in Assiut Governorate, 2009). These benefits are adequacy of water supply in winter and summer before and after the improving process as shown in figures (8) and (9), the fairness in water distribution along Mesqas before and after the improvement as shown in figure (10), economical benefits and agricultural benefits.

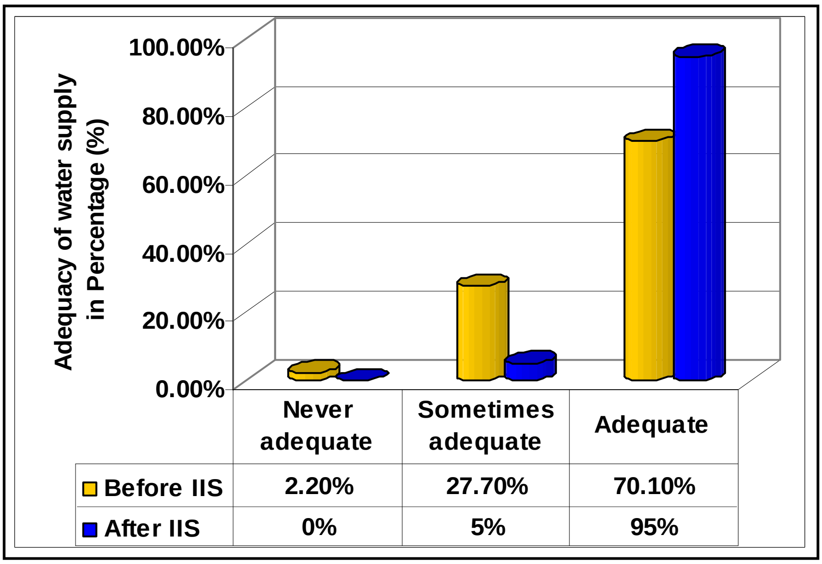

Figure (8) Estimated adequacy of water supply before and after IIS in winter

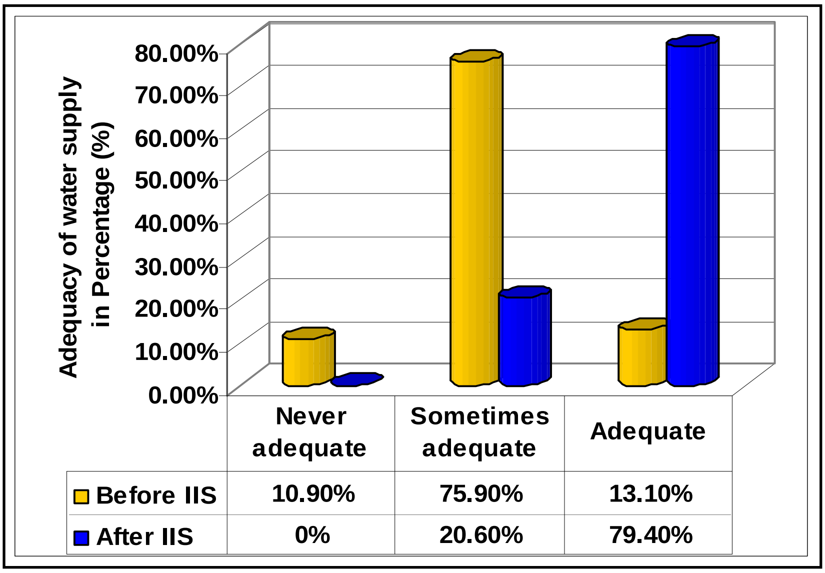

Figure (9) Estimated adequacy of water supply before and after IIS in summer

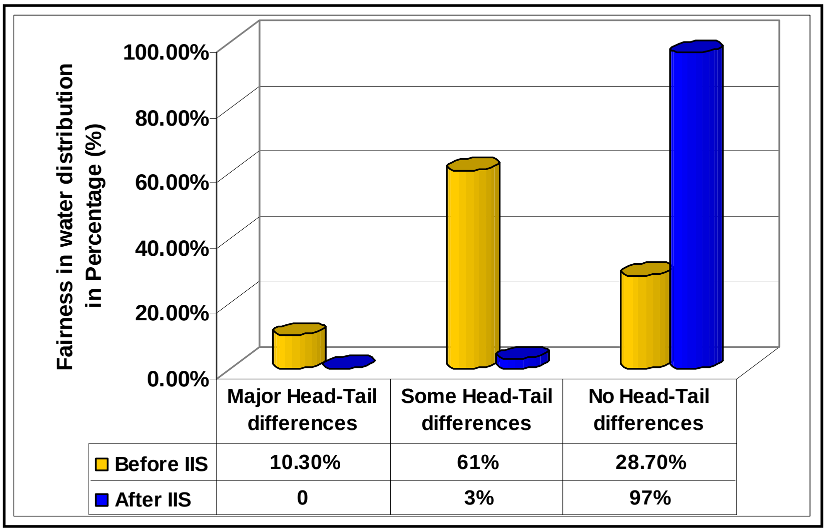

Figure (10) Estimated fairness in water distribution along Mesqas before and after improvement

7.3. Cost of pumping

The cost of irrigation (pumping) includes different items such as salary of the pump operator and guard, cost of pump fuel and oil, and cost of waiting time until the water is being available at the head of the field. After improvement, these costs have been reduced thanks to the single point lifting and better irrigation schedule that minimized the waiting time as shown in table (2).

Table (2) Reported cost of irrigation in L.E. before and after improvement

Cost	Before Improvement	After Improvement
	Hired pump	WUA pump
One irrigation/feddan	50	18
Yearly for an average size farm	3300	1287

*** WUA = Water User's Association

7.4. Irrigation time

Reduction of irrigation time ranged from 50 % to 60 % of that was before improvement on the improved Mesqas as shown in figure (11). Improvement process made water available all the time in the Mesqa. Better scheduling of irrigation and higher flow rate at the field level has also contributed to reduce the irrigation time. The irrigation time does not only include the time when the pump is actually operating, but also the time to transport the water to the land.

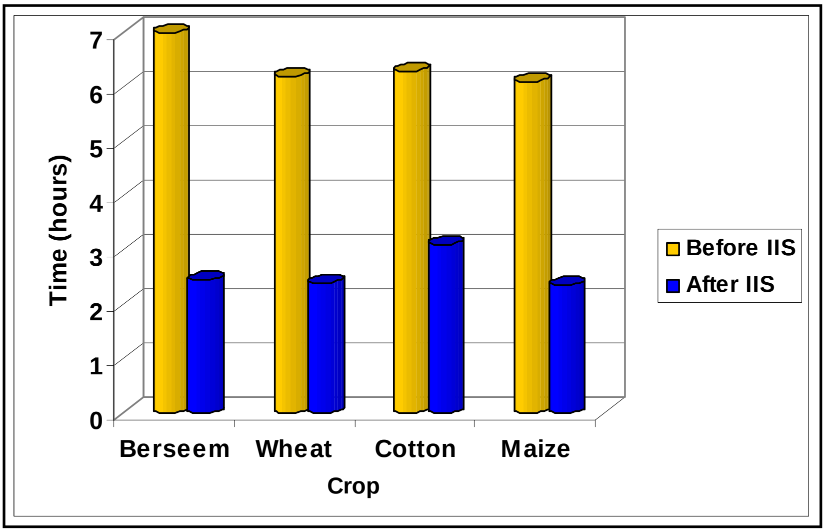

Figure (11) Average time of irrigation before and after improvement (hours/feddan)

7.5. Agricultural benefits

The improvement process has two main agricultural benefits. Both of them cause increasing of farmers' income. The first benefit is land saving or land increase; which is a result of the construction of improved Mesqas as compared to areas occupied by old Mesqas. There is about 3 % of the total area served by Mesqas which is about 1 % of the total command area saved and made available for agriculture and roads (according to Monitoring and Evaluation Reports of IIM in Assiut Governorate, 2009) as shown in table (3).

Table (3) saving in land following improvement of Mesqas

Type of Mesqa	Total area saved, in feddan	Saving in % of total area served by Mesqas	Average saving in feddan per 1000 m Mesqa	No.
Pipeline Mesqa	3.55	2.10	1.31 feddan	No. = 3
Raised lined Mesqa	4.65	1.15	0.49 feddan	No. = 11

The second benefit is the increase in crop yields due to the better conditions of water availability. The increase in crop yields (according to agricultural association in Beni Adi el Bahariya village, 2009); increase in wheat, cotton and maize were estimated at 10 %, 18 % and 9 %, respectively.

8. ENVIRONMENTAL IMPACTS

The improved system prevents weed growth in concrete Mesqas, consequently decreasing water born diseases.

9. THE DISADVANTAGES THAT COULDN'T BE SOLVED BY THE IMPROVEMENT

There are some disadvantages couldn't be solved by the improvement projects such as:

1. The expected increase of on farm efficiency couldn't be achieved because of farmers' bad use of water. Where; they used to irrigate by high flow rates which lead to increase leakage from the farm land.
2. The expected increase of co-operation between water users' and operators couldn't be achieved because of the conflict between operators of the system and water users'.
3. Cost of improvement is still high and needs to be reduced. The capital costs of improved Mesqas are very high and the farmers are complaining from this. The costs of construction of the open elevated and pipeline Mesqas are L.E. 3680 per feddan and L.E. 5850 per feddan; respectively (according to Monitoring and Evaluation Reports of IIM in Assiut Governorate, 2009).
4. The improvement system didn't deal with the drainage system. Poor drainage and saline conditions can affect the agricultural production. So the solution is to construct furrows and field drains that will prevent crop damage.

10. USING SIMULATION MODELING TO IMPROVE THE DESIGN AND MANAGEMENT OF FURROW IRRIGATION

Field design and irrigation management practices have a significant impact on surface irrigation performance. Clemmens [2], 1981. Amongst surface irrigation methods, furrow irrigation is the most commonly used method for irrigating crops around the world. Improper design and management of furrow irrigation systems may lead to water wastage.

One potential for improving the efficiency and performance of furrow irrigation systems (application efficiency, storage efficiency and distribution uniformity) lies in the use of simulation models to predict furrow irrigation performance and evaluation of changes in management variables, which can lead to improvements in irrigation efficiencies and water saving.

10.1. The NRCS_SURFACE model

NRCS_SURFACE is a software package designed to simulate the hydraulics of surface irrigation (border, basin and furrow) at the field level, and to optimize the irrigation system parameters to maximize application efficiency. Walker [14], 1997

A field in Beni Adi el Bahariya village (the study area) was selected to achieve the simulation methodology. This field was selected from the different farms across the cotton growing areas. Data collected from the field are as given in table (4)

Table (4) Data collected from he field

Parameter	Value
Field length	100 (m)
Field width	82.5 (m)
Design flow rate for one furrow	1 (l/s)
Irrigation time (T)	240 (min.)

10.2. Prediction of furrow irrigation performance (Actual irrigation simulation):

- Model (1): The simulation was done by using actual design flow rate for furrow (1 l/s) and actual irrigation time (T = 240 min.). The results are as shown in table (5).

Table (5) irrigation performance under actual irrigation simulation

(Ea)	(Er)	(DU)	Volume balance in cubic meters for one furrow per irrigation		
			Inflow (m^3)	Outflow (m^3)	Infilt (m^3)
39.87 %	99.67 %	98.78 %	14.4	7.1	7.3

The irrigation simulation produced an estimate of its performance with three indicators, as given in table (5):

1. ***Application efficiency (Ea)*** is the ratio of the average depth or volume of the infiltrated water stored in the root zone to the average depth or volume of irrigation water applied to the field. Inefficiencies are caused by deep percolation and tail water losses.
2. ***Storage or requirement efficiency (Er)*** is the ratio of the amount of water stored in the root zone during irrigation to the amount of water needed to fill the root zone to field capacity. Inefficiencies are caused by under-irrigating

part of the field. For the best conditions for crops, *the requirement efficiency should be greater than 90 %.* Elliot [5], 1982

3. ***Distribution uniformity (DU)*** is the ratio of the depth or volume infiltrated in the least irrigated quarter (sometimes called the low quarter) of the field to the average depth or volume infiltrated in the entire field.

10.3. Evaluation of changes in management variables:

Scenario No. (1): reduction of irrigation time (T) and using the actual design flow rate for furrow (1 l/s).
Scenario No. (2): reduction of design flow rate for furrow and using the actual irrigation time (T = 240 min.).
Scenario No. (3): reduction of irrigation time (T) with the design flow rates in scenario no. (2).
The above scenarios with their models are given in table (6).

Table (6) Scenarios to evaluate changes in management variables of surface irrigation

	Scenario No. (1)		Scenario No. (2)			Scenario No. (3)					
Model	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Design flow rate (l/s)	**1**	**1**	**0.5**	**0.6**	**0.4**	**0.5**	**0.5**	**0.6**	**0.6**	**0.4**	**0.4**
Irrigation time “T” (min.)	**210**	**180**	**240**	**240**	**240**	**210**	**180**	**210**	**180**	**210**	**180**

The simulation was done for the above models. The results are as shown in Figure (12).

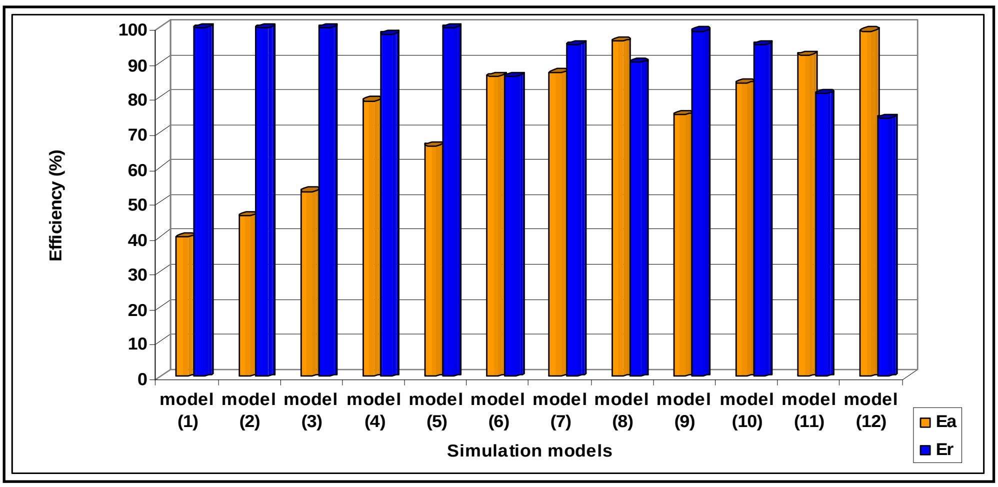

Figure (12) Furrow irrigation performance for the simulation models

Analysis and discussion

From Figure (12), we can obtain the following:

1. Simulation model (1) is the actual irrigation simulation, and; simulation models from (2) to (12) are the possible models to achieve improvements in irrigation efficiencies and save water.
2. Simulation models (6), (11) and (12) are not recommended as the requirement efficiency (Er) < 90 %. But; the remainder models are recommended
3. Simulation model (8) "Design flow = 0.5 l/s & Cutoff time (T) = 180 min." is the best model which achieves application efficiency greater than 90 %.

Figure (13) shows the percentages of water which can be saved for the possible simulation models with changes in management variables.

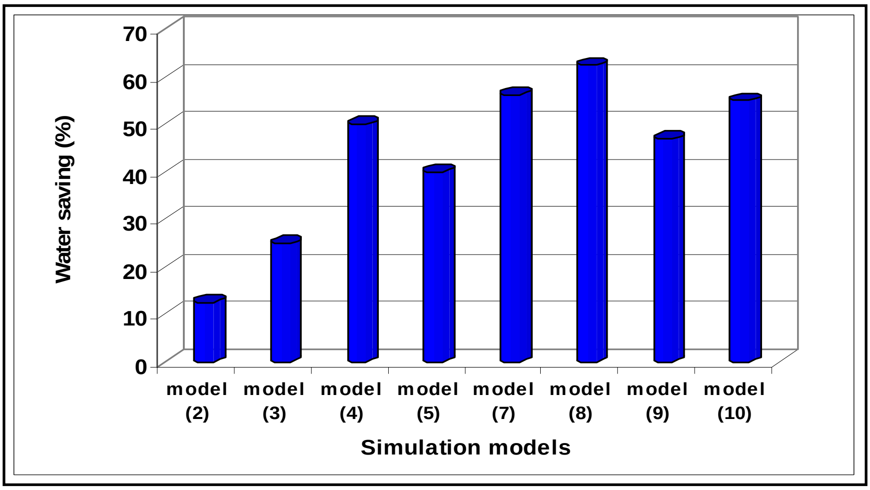

Figure (13) Expected water saving in furrow irrigation for the simulation models

11. SUGGESTIONS

The suggestions to achieve the maximum benefits from the Irrigation Improvement System in optimizing the use of the available water quantities for Assiut Governorate from the River Nile; especially in the area under study can be as follows:

1. To achieve high water use efficiency and a high production, the water supply schedules must be adjusted according to the changes in crop water requirements over the growing period.
2. Rehabilitation of the water structures along the canals such as intakes, cross regulators and tail escapes to minimize water losses from canals' ends to drains.
3. Replacement of the old structures with new ones with radial gates to provide automatic control for the downstream water levels to match with the farmers' demands.
4. Good land leveling should be introduced to the study area to achieve water application uniformity in the field.
5. Downstream control gates such as AVIO and AVIS should be installed in the main delivery system to achieve the best controlling of water levels and to

respond to water level fluctuations in the downstream. The gates are opened to bypass more flow when farmers' demands increase in the downstream and are closed when water withdrawal is stopped. The first (AVIO) is recommended for relatively higher upstream water levels while AVIS is for smaller upstream levels.

6. Canal tail escape should be rehabilitated to prevent water losses from canal end.

12. CONCLUSIONS

From the present study; it is clear that, the main irrigation improvement system factors which are contributing in the increasing of the inflow discharge to Beni Adi el Bahariya village are:

1. Elimination of the seepage from the Mesqas after the improvement process.
2. Decreasing the amount of evaporation from the open water surfaces by 69 % of that was before the improvement process.

The increasing of the inflow discharge to the area under study can be achieved through optimizing use of the available quantities of Nile water belongs to the study area. And at the same time, the increasing of the inflow discharge to the study area can be achieved through minimizing the losses of water by seepage, percolation and evaporation.

According to the monitoring and evaluation reports of IIM in Assiut governorate, 2009; the main achieved goals from the carried out improving system can be summarized in the following main points:

1. The problem of inadequate water at Mesqas' tails has been solved.
2. The adequacy of water supply improved to reach about 95 % in winter and about 80 % in summer.
3. Fairness in water distribution along Mesqas improved to reach about 97 %.
4. The pumping cost decreased (about 18 L.E./one irrigation/feddan instead of 50 L.E./one irrigation/feddan "before improvement")
5. Reduction of irrigation time ranged from 50 % to 60 % of that was before improvement.
6. Land saving: There is about 1 % of the total command area has been saved and made available for agriculture and roads.
    1) 40 % for agricultural
    2) 60 % for roads
7. Improvement of farm income: There is an increase in crop yields ranges from 9 % to 20 % depending on the type of crop (according to agricultural association in Beni Adi el Bahariya village, 2009).
8. Farmers became very keen with their water application, as they are paying for the cost of operation and maintenance. They do their best to minimize the operating hours and consequently optimize the use of water.

So, the main aim of the Irrigation Improvement System had been achieved successfully in the area under study and it's recommended to be replicated in all other governorates.

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نظام الرى المطور و تأثيره على ادارة المياه فى قرية بنى عدى (دراسه حالة)

نظام الرى المطور يلعب دورا هاما فى الاستخدام الامثل لكمية المياه المتاحه من نهر النيل، و هذا سوف يتحقق بتوفير بعض كميات المياه المهدرة التى تفقد عن طريق التسرب من المجارى المائيه الغير مبطنه وايضا البخر من المسطح المائى للمجارى المائية.

ويعتبر الجزء الاساسى لنظام التطوير هو استبدال المساقى الترابيه الحاليه بمساقى مبطنة و مرفوعة أو مواسير مدفونة. وهذه المساقى المطوره تعمل على انهاء التسرب الذى يحدث من المساقى الترابيه، كما أن مساحة المسطح المائى للمساقى المطورة أقل بكثير من المسطح المائى للمساقى الترابيه مما سيؤدى الى تقليل الفاقد الذى يحدث بسبب البخر من المسطح المائى.

وبدراسة هذا الموضوع بالنسبه لقرية بنى عدى البحرية الواقعة فى مركز منفلوط فى محافظة اسيوط وهى تمثل المنطقة تحت الدراسة فى هذا البحث: تبين أن النقص الحادث فى كمية الفاقد نتيجة البخر قد يصل الى حوالى ٦٩ % بعد عملية التطوير، حيث أن المسطح المائى للمساقى الترابيه والتى حدث لها استبحار (تغيير فى شكل قطاع المسقى) تم تقديره بحوالى ١٩٨٤٠ متر مربع. هذا المسطح المائى أصبح حوالى ٦٢٥٠ متر مربع وذلك بعد عملية التطوير.

فبعد عملية التطويرازداد التصرف الشهرى لزمام قرية بنى عدى البحرية وذلك بعد توفير كمية المياه التى كانت تفقد عن طريق التسرب من المساقى الترابيه القديمه، وايضا بعد تقليل كمية البخر من المسطح المائى للمساقى المطورة عن الذى كان يحدث من المساقى الترابيه القديمه. كل هذا سيعمل على تحقيق افضل استخدام لكمية المياه المتاحة لقرية بنى عدى البحرية فى الوقت الحاضر وايضا فى المستقبل.

نظام الرى المطور لا تقتصر فائدته على توفير بعض كميات المياه فقط ولكن هناك فوائد اخرى أدت الى رفع مستوى معيشة الفلاح امكن رصدها من خلال تقارير المتابعه والتقييم بعد عام من انتهاء عملية التطوير. هذه الفوائد كالتالى:

١. النقص فى زمن الرى ٥٠ % : ٦٠ % عن الزمن الذى كان قبل التطوير بسبب توافر المياه طوال الوقت فى المسقى.
٢. النقص فى تكاليف الرى حوالى ٦٤ % عن التكاليف التى كانت قبل التطوير.
٣. الزيادة فى انتاجية المحاصيل، بالنسبه للقمح ، للقطن وللذرة على النحو التالى ١٠%، ١٨% و ٩% على الترتيب.
٤. الزيادة فى مساحة الزمام بحوالى ١% بعد عملية التطوير. هذه الزيادة سوف تستغل فى الزراعة وفى عمل الطرق.

وبالرغم من ذلك فان نظام الرى المطور لم يتمكن من رفع كفاءة التطبيق داخل الحقل وذلك بسبب الاستخدام السئ للماء من جانب الفلاحين الذين اعتادوا على الرى بتصرفات كبيرة مما يؤدى الى زيادة

فاقد المياه. من اجل ذلك فان تصميم وادارة ممارسات الرى داخل الحقل له تاثير كبير على اداء الرى السطحى. فعلى سبيل المثال: تقليل زمن الرى أو تقليل التصرف التصميمى من الممكن أن يؤدى الى رفع كفاءة الرى وتوفير المياه المهدرة بسبب سوء الاستخدام.