Alex. Eng. J., Alex. Univ., Volum 27 No. 2, pp. 19-36 *(1988)*

PRELIMINARY STUDIES TOWARDS EFFECTIVE WATER MANAGEMENT IN KAFR EL-SHEIKH GOVERNORATE

Dr. Ibrahim, M.A.M[1], Dr.S.A. El-Gohary[2]
and Dr. Mohamed Abd El-Razek, M.Rezk[3]

(1) Water requirements Res. Sec., Soil and Water Res. Inst., Agric. Rec. Cent. Cairo .

(2) Drainage Res. Sec., Soil and Water Res. Inst., Agric. Rec. Cent. Cairo .

(3) Lecturer, Faculty of Engineering, Alexandria University, Alex. Egypt.

ABSTRACT

Egypt is facing a serious crisis in water resources due to the drought in Africa. The country has to undertake serious measures to rationalize water use and a policy to optimise the use of available water resources should be carefully designed. About 90 % of Egypt water income is used for irrigation, and therefore, tremendous effort is needed to rationalize irrigation water use. This can be achieved by several means, one of which is to determine the water requirements for different crops at different growing stages and considering different agrometeorological conditions.

This will not only save tremendous amount of water, but will also increase land productivity.

The present paper gives an estimate for the irrigation water requirements for Kafr El-Sheikh Governorate based on the determination of consumptive use of different crops. A comparison study was then done with the actual irrigation water given by the Ministry of Irrigation. The study revealed the need of rearranging irrigation water requirment for different crops.

NOTATIONS

C	constant equal 20% which cover the conveyance lesses through the main and submain canals.
C.U.	consumptive use in cm/day, given by eq.(3).
D.W.	domestic water consumption including drnking human, and industrial
E_i	irrigation efficiency.
E_p	pan evaporation in cm/day.
ET_p	potential evapotranspiration in cm/day, given by eq. (4).
I.W.	irrigation water requirements for existing crops at different growth stages, given by eq.(2).
K_c	crop coefficients which depends upon the growth stages.
M.O.I.	ministry of irrigation.
P_{eff}	effective precipitation in cm/dey.
T.W.N.	total water needs, can be caleulated by eq.(1).

INTRODUCTION

The climate in Egypt differs from one area to another and according to the available meteorological data the country is divided into the following nine agroclimatic zones as distinguished by Rijtema and Abou Khalid [6]:

1. Coastal area
2. Central Delta area
3. Desert Delta area
4. Giza area
5. Area latitude 29^{o} - 27.5^{o}N
6. Area latitude 27.5^{o} - 26^{o}N
7. Dakhla area 26^{o}-25^{o}N
8. Kharga area 26^{o}-25^{o}N
9. Aswan area 25^{o} - 24^{o}N.

Kafr El-Sheikh Governorate lies in the Central Delta area, as shown in Fig. (1).

On the other hand, irrigation has been practiced by mankind for several thousands years, yet only in the present century extensive studies have been conducted in the general area of water-Soil-plant relationship. This relationship, commonly known as irrigation management, involves irrigation practice on the farm, or on individual fields.

Improper irrigation may waste large amounts of water, leaching soil nutrients, thereby impairing the productivity

Fig.(1) Agroclimatological Zones of Egypt.

1- Coastal area. 2-Central Delta area. 3-Desert Delta area.
4- Giza area. 5-Area Latitude 29°-27.5°N. 6-Area Latitude 27.5°-26°N.
7- Dakhla area 26°-25°N. 8-Kharga area 26°-25°N. 9-Aswan area 25°-24°N.

of the soil, or yields may be lowered if insufficient water is applied. Water for irrigation and other uses is becoming more and more valuable due to the increasing cost of irrigation projects and limited supply of good quality water. Therefore, we must learn how to prevent an excessive waste of irrigation water to preclude the degradation of the land and bring its improvement for maximum crop production.

Therefore, a much better approach for an effective irrigation water management is achieved by the calculation of crops water requirements under different agrometeorological conditions. This can be achieved by identifying a more accurate method for determining of crops consumptive use (c.u). The calculation of c.u. must be carried out for the nine different zones and not only for the three ones of Delta, Middle and upper Egypt distinguished by ministry of Irrigation. In the same line, Delta can't be considered as one area but three ones. They are : Coastal, Central Delta and Desert Delta areas. For each area, determination of c.u. and consequently water requirements for different crops must be done, in a proper way.

So, to achieve an effective water management in Kafr El-Sheikh Governorate, a comparison study has been made between the present policy of irrigation water applied by the Ministry of Irrigation (M.O.I) and the method adopted by the present study and which is based on the determination of c.u. of different crops in the Central Delta area. This area consist of : kafr El-Sheiekh, Gharbia, Dakahlia and a port

of Sharkia Governorates.

Water Yield

Irrigation water is conveyed to Kafr El-Sheikh Governorate by: Abasi Rayah, Monofi Rayah and Nile-Rashid branch, Fig. (2). Water yield for each branch including those for submain canals were recorded daily by the M.O.I. Column 2, Table (1) shows the total quantities of water in Million M^3/day feeding Kafr El-Sheikh Governorate during the months of year which are taking from the actual readings of the M.O.I.

Materials and Methods

Total water needs (T.W.N.) were calculated twice. Firstly by applying the method that followed by M.O.I. and secondly by the method adopted in the present study.

According to the M.O.I. method, the T.W.N. during any month are calculated from the following Eqn.:

$$T.W.N. = (I.W. + D.W.)\ (1 + C) \qquad (1)$$

where:

I.W. = irrigation water requirements for the existing crops at the different growth stages, values of I.W for different crops are given in table A-1, Appendix A.

El-Sheikh Governorate, Ei is taken 50 % for rice and 60 % for the other different crops [3].

P_{eff} = effective precipitation (Rainfall) in cm/day, and

C.U. = consumptive use in cm/day, the value of which depends upon the type of crop, its growth stage, and the meteorological conditions of the area. According to the field experiments conducted by Ibrahim [4], the following Eqn. can be used to calculated C.U. for the central Delta area:

$$C.U. = K_c . ET_p \quad \text{(cm/day)} \qquad (3)$$

$$ET_p = 0.1642 + 0.8\ E_p \quad \text{(cm/day)} \qquad (4)$$

in which:

K_c = crop coefficients which depends upon the growth stage,

ET_p = potential evapotranspiration in Cm/day as given by Ibrahim [4] and represented by eq. (4), and

E_p = pan evaporation in cm/day.

Table (A-2), appendix (A) shows the values of P_{eff}, and ET_p during the months of the year [5]. It also shows the values of K_c for the different crops during their growth seasons according to the FAO report [1].

Results and Discussions

Differences in T.W.N. between the adopted method and that followed by the ministry of irrigation are listed in table 1-Column 5 and showed that there are slightly difference except for Oct., Mar., Apr., May, Jul., Aug. and Sept. the corresponding values are + 4.263, + 4.56, + 2.422, + 5.577, + 6.89, - 2.238 and - 3.274 Mil. M^3/day respectively. This can be attributed to that for the adopted method, planting irrigation equals 600 M^3/fed/month was taken into consideration in October and visa versa regards M.O.I. for other months, variation between both methods are due to the differences in irrigation duties for rice specially for months May, Jul., Aug. and Sept. as shown in tables (A-1 and A-3) Appendix.

From the obtained results that tabulated in Table (1) and shown in Fig. (3) which indicates the balance between water yield or water income and the calculated water needs which consists of irrigation, domestic and industrial purposes. The balance is in Mil. M^3/day for Kafr El-Sheikh Governorate. It is shown that the differences between both sides were + 3.593, + 5.29, + 4.354, - 1.976, - 2.061 , - 1.537 , - 3.28, - 11.469, - 7.502 and - 0.564 Mil. M^3/day for months of Oct., Nov., Dec., Feb, Mar., Apr., May, June, Jul., Aug., and Sept. respectively. These differences were equivalent to a percentage of + 53.23, + 98.69, + 84.61, -21.49, -14.47, -12.12, -23.19, -39.51, -38.83, -29.95 and - 3.61 respectively. In January, there is no watering due to

Table (1): Balance of Water for Kafr El-Sheikh Governorate during different months.

Month	Water yield (income) Mil.M^3/day	Total Water needs Mil. M^3/day		Differ. between the two methods Mil. M^3/d	Balance Mil.M^3/day (2)-(4)	Percent of Balance (6)/(4)*100
		M.O.I method	the a dopted method			
(1)	(2)	(3)	(4)	(5)	(6)	(7)
Oct.	10.342	2.486	6.749	+ 4.263	+ 3.593	+ 53.23
Nov.	10.650	4.109	5.360	+ 1.251	+ 5.290	+ 98.69
Dec.	9.500	5.795	5.146	- 0.649	+ 4.354	+ 84.61
Jan.	5.371					
Feb.	7.217	10.597	9.193	- 1.404	- 1.976	- 21.49
Mar.	12.183	9.684	14.244	+ 4.560	- 2.061	- 14.47
Apr.	11.140	10.255	12.677	+ 2.422	- 1.537	-12.12
May	10.867	8.570	14.147	+ 5.577	- 3.280	-23.19
June.	17.133	26.824	28.325	+ 1.501	-11.192	-39.51
Jul.	18.067	22.646	29.536	+ 6.890	-11.469	-38.83
Jul.	18.067	22.646	29.536	+ 6.890	-11.469	-38.83
Aug.	17.550	27.290	25.052	- 2.238	- 7.502	-29.95
Sept.	15.050	18.888	15.614	- 3.274	- 0.564	- 3.61
Average	12.089	13.377	15.095			

Column No. 2 represents water yield (income) as recorded in the documents of the ministry of irrigation, Kafr El-Sheikh.

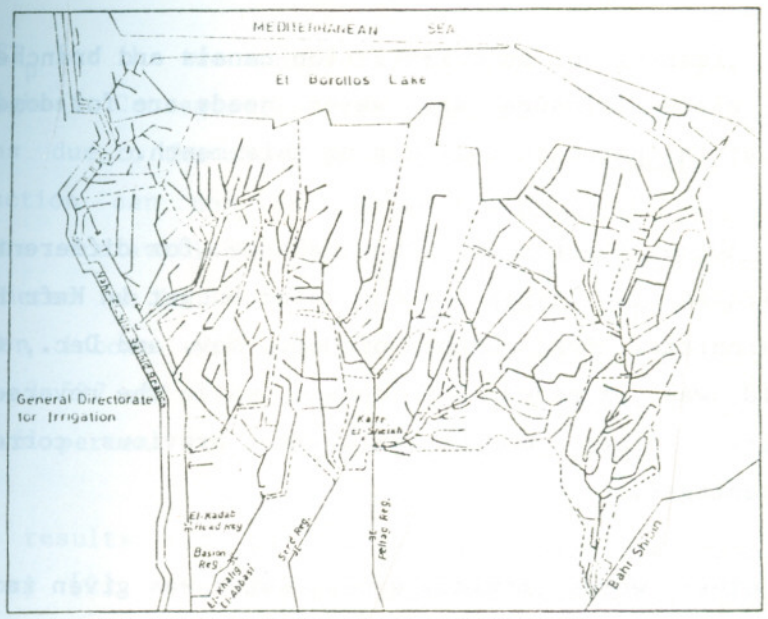

Fig.(2) Main Water Resources in Kafr El-Sheikh Governorate.

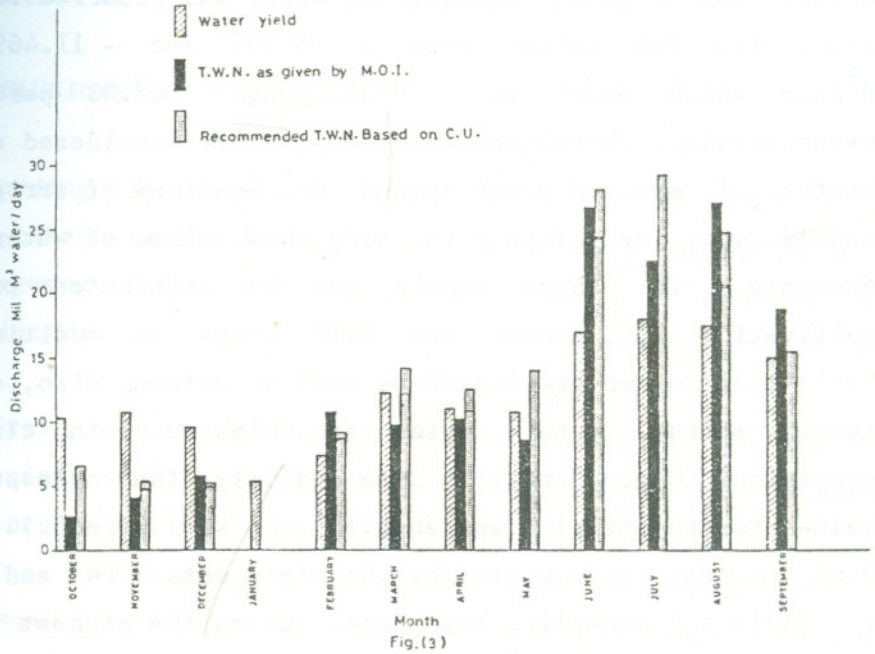

Fig.(3)

the cleaning of both irriagtion canals and branches during the winter closure and water needs are for domestic and industrial purposes only during this month.

The above figures of the balance for different months, indicates two types for the water budget in Kafr El-Sheikh Governorate. For months of Oct., Nov. and Dec., the water yield was exceeded the demand while the reverse occured during other months with the previous corresponding percentages.

On other words, maximum excess water was given in Nov. The water income was exceeded the water need by + 5.29 mil. M^3/ day which equals to + 98.69 percent. The value considered as waste of water should be directed to other area in the country suffering from shortages of water. While, the highest shortage of water was occurred in June and July. The values were - 11.192 and - 11.469 Mil. M^3/day which equal to - 39.51 and - 38.83 percent respectively,. Therefore June and July are considered as the months of maximum water demand. So, Sections of irrigation canals must be designed to carry this volume of water. The shortage in these months can be attributed to the cultivation of summer and Nili crops in addition to irrigating other growing crops such as cotton. Also, during summer months, water duties are high due to climatic condition. Concerning with June and July, the corresponding values for potential evaptranspiration (ET_p) were 0.74 and 0.68 cm./day as computed by Ibrahim's method [4] and shown in table A-2 Appendix. Therefore, due to the highest values

of ET_p for the two months, irrigation water duties should be highest. Consequently, the crops will suffer during these months due to the shortage of water. So, maximizing of crop production can not be achieved although other suitable factors are available. Months of April and September can be considered as in between. In other words, there is equality between income and computed water demand. The differences are - 1.537 and - 0.564 mil. M^3./day equal to - 12.12 and + - 3.61 percent for the previous months respectively.

These results are in the same line with that reported by El-Quosy [2], who stated that in the Delta, three turn rotation is applied throughout the year 5 days on (or working) and 10 days off (or closed). An exception is made during the period of peak demand (16 th May to 15 th September) where the rotation is converted into two turn rotation of 7 days (on) and 7 days (off).

CONCLUSIONS AND SUGGESTIONS

According to the present study, the following points should be taken into consideration to achieve effective water management and consequently the goal of maximum crop production.

1. Irrigation water duties should be determined for the nine regions that distinguished before instead of the three present regions classified by the Ministry of Irrigation. For each area, the consumptive use for different crops should be determined practically. Hence, Water duties can

be obtained.

2. In irrigation policy, prepared by the Ministry of Irrigation , no planting watering were recorded which equal to about 600 M^3/Fed. and 650 M^3/Fed. for winter and summer crops respectively as listed in the adopted method.

3. Further study, should be directed towards the solution of the excess water in the Governorate of Kafr El Sheikh during winter months and to get a suitable usage for this waste of water. On other hand, area of summer and Nili crops should be related to the water yield during the maximum demand period (June, July and other shortage months). Other Solution, to regulate the water intake in relation to water demand.

4. In policy of irrigation duties prepared by the Ministry of Irrigation, there is no figures for sugar beet and Soya bean crops. Although they are considered as main crops cultivated in the Governorate. The areas were 31897 and 4421 Feddan during 1986 for the two crops respectively. The reason for this large area cultivated by sugar beet is to meet the requirements of Delta sugar beet factory in the area.

5. Regarding to rice, which is considered as the crop occupied the largest cultivated area in the Governorate (about 216477 Feddan) with the highest irrigation duties of about 9000 m^3/fed. during the growing season. Therefore, further studies should be carried out to reduce the irrigation duties of rice by:
   - Reducing the area cultivated by rice in the Governorate especially after the present long drought

facing the sources of River Nile.

- Reducing the depth of irrigation water to about 7 cm. instead of the present one of 10 cm. approximately.
- Extending the irrigation interval to 6 days instead of 4 days.

REFERENCES

[1] Doorenbos, I., Kassan, A.H., Bentvelson, C.L.M., Branscheid, V., Plusjé, J.M.g.a., Smith, M., Uittenbagaard, G.O., and Van der Wal, H.K., "Yield respanse to water", Irrigation and Drianage paper, 33 FAO, Rome, 1979.

[2] El-Quosy, D.E., "A method of Saving irrigation water in the Arab Republic of Egypt by modifying irrigation rotation", Water Sci. Mag., Water Res. Center, 3rd Issue, Nov., 1987.

[3] Hansen, V.E., Israelsen O.W., and Stringharm , G.E., "Irrigation Principles and Practices," 4th Edition, John Wiley & Sons, 1979.

[4] Ibrahim, M.A.M., "Evaluation of different methods for Calculating potential evapotranspiration in North Delta Region," Ph.D. Thesis, University of Alexandria, Egypt, 1981.

[5] Ibrahim, M.A.M., El-Gohary, S.A., and Eid, H.M., "Climatological studies of Sakha area with special reference to potential evapotranspiration", Conf. of Agric. Sci. on food defeciency overcoming through outonomous efforts in Egypt. Fac. of Agric. Mansoura Univ., 22-24 June, 1987.

[6] Rijtema, P.E., and Abou-Khalid, A., "Research on Crop water use, salt affected soils and drainage in Arab Republic of Egypt," published by FAO., Cairo, 1975.

[7] Yaran, B., Danfors, E., and Vaadia, Y., "Arid zone Irrigation," Springer Verlag Berlin, New York, 1973.

[8] Yonan, N.A., "Engineering Irrigation," 2nd Edition, Alexandria University, Egypt, 1976, PP. 24-40.

APPENDIX A

Table (A-1): Irrigation Water Requirements (I.W.) for The different crops in Kafr El-Sheikh Governorate in m^3/fed/month according to the M.O.I. data (*).

Crop	Area Cultivated fed.	MONTHS Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.
a) Winter crops													
Bersim	183193	55	300	380		685	680	750	210				
Wheat	93519		180	400		345	348	527					
Barley	2754		385	400		335	280						
Beans	9546			510		300	450	90					
Flax	15476		120	275		225	230	220					
Suger beet	31897	55	300	380		685	680	750	210				
Vegetables	11985	530	710	790		585	85						
other Crops	11847	260	320	383		204	340	290					
b) Summer and Nili Crops													
Cotton	104505					350	325	305	420	655	750	375	
Rice	216477								180	2260	1780	2630	1950
Mazie(sum).	96625								555	740	940	465	
Maize(Nili)	4000	380								345	655	615	705
Veget.(Sum.)	27137					330	650	700	790	665	125		
Veget.(Nili)		1125										945	1190
Orchards	6146	735										805	740
Suger Cane	1263	550	510	480		270	260	340	380	400	520	620	670
Soy bean	4421								555	740	940	465	
other crops	16248								595	780	860	615	250
Irrigation duties(I.W.) Mil. M^3/day		1.888	3.24	4.645		8.647	7.886	8.362	6.958	22.169	18.688	22.558	15.556

(*) Documents collected from ministry of irrigation, irrigation office, Kafr El-Sheikh.

Table (A_2): Values of Potential evapotranspiration ET_p in (cm/day), effictive precipitation P_{eff} in (cm/month), and crop coefficients K_c for Kafr El-Sheikh Governorate.

	Oct.	Nov.	Dec.	Jan.	Feb.	Mar	Apr.	May	Jun.	Jul.	Aug.	Sept.
ET_p	0.47	0.36	0.3	0.31	0.34	0.42	0.55	0.66	0.74	0.68	0.62	0.55
P_{eff}	0.148	0.517	1.342	1.444	1.465	0.655	0.251	0.085	0.00	0.00	0.00	0.00
					Crop Coefficients (K_c)							
Bersim		0.35	0.74	0.74	0.74	0.74	0.74	1.13				
wheat			0.30	0.70	1.05	1.05	0.65	0.2				
Barley			0.30	0.70	1.05	0.85	0.65					
Beans		0.30	0.65	0.95	0.90	0.55	0.25					
flax		0.30	0.70	1.05	1.05	0.85	0.65					
Suger beet		0.40	0.75	1.05	1.05	0.9						
Vegatbles		0.38	0.68	0.99	0.84	0.62	0.4					
Orchards	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75				
Other Crops		0.41	0.61	0.87	0.93	0.79	0.58					
Cotton							0.21	0.41	0.8	0.96	1.10	0.54
Rice								1.10	1.10	1.10	1.10	0.95
Corn(Sum.)									0.50	0.72	1.05	0.77
Corn(Nili)	1.05	0.77									0.5	0.72
Vegt.(Sum.)						0.41	0.50	0.80	1.05			
Vegt. (Nili)										1.10	0.90	0.98
Orchards						0.83	0.83	0.83	0.83	0.83	0.83	0.83
Suger cane	1.05	1.05	1.05	0.80		0.40	0.75	0.95	1.00	1.05	1.05	1.05
Soy bean	0.83								0.61	0.80	1.11	1.01
other crops						0.40	0.57	0.82	0.84	0.94	0.96	0.86

Table (A-3) : Irrigation Water Requirements (I.W.) for the different Crops in Kafr El-Sheikh Governorate in m^3/fed./ month according to the adopted Method.

Crop	Area cultivated Fed.	MONTHS											
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sept.
a) Winter crops:													
Bersim	183193	600*	243	425		432	650	846	521**				
wheat	93519		600	139		644	936	745	92**				
Barley	2754		600*	139		644	754	493***					
Beans	9546	600*	205	373		538	480	279					
Flax	15476	600*	205	399		644	754	745					
Suger beet	31897	600*	281	438		644	793						
Vegetables	11985	600*	268	386		503	532						
Orchards	6089	762	545	438		444	663	859	1081				
other crops	11847	600*	293	347		562	689	657					
b) Summer and Nili crops:													
Cotton	104505						650*	241	586	1247	1419	479**	
Rice	216477								1888(1)	2054	1953	1771	1323
Maize (sum.)	96625								600*	781	1068	1419	447(2)
Maize(Nili)	4000	1068	290(2)								600*	677	832
Veget. (Sum.)	27137					600*	363	569	1146				
Veget.(Nili)										600*	1628	1211	1172
Orchard	6146						741	947	1185	1224	1120	958	
Suger Cane	1263	1061	772	634		650*	350	859	1367	1550	1549	1419	1210
Soy bean	4421								600*	945	1185	1497	586(2)
Other Crops	16248						600*	645	1172	1310	1380	1289	983
Irrigation duties (I.W.) Mil. M^3/day		5.440	4.283	4.104		7.477	11.686	10.380	11.605	23.420	24.429	20.693	12.828

* Planting irrigation, ** for 10 days , *** for 20 days,

(1) for the seedling area = 1/6 rice area, (2) for 15 days.