Study of the Effect of Crop Patterns on Farm Water Losses at North and West Nile Delta, Egypt

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ABSTRACT

Egypt is considered as semi arid region, therefore, water is the limiting resource to maximize the agricultural production. To maximize the benefit of water resource, it is necessary to identify the causes of irrigation water losses through the system of irrigation on the farm level and water budget studies were conducted during summer season, 2005 on four branch canals. Dakalt and El Kahawagy branch canals represented Kafr El Shiekh Governorate (North Nile Delta), while Besntway and El – Hamamy branch canals represented, El Behera Governorate (West Nile Delta). Two improved mesqas were selected at Kafr El Shiekh, and four at El Behera, were selected at different locations. The cropped areas for the selected mesqas in Kafr El Sheikh Governorate ranged from 71.43 to 100% for rice, 0.0 to 28.34% for cotton and 0.00 to 0.23 % for maize. While in El Behera governorate, the cropped area ranged from 11.83 to 75.61% for rice, 4.59 to 58.93% for cotton, 0.96 to 3.76% for maize, 1.03 to 36.09% for fruits and 0.54 to 4.88% for vegetables. The conveyance efficiency average values ranged from 78.64 to 83.56 % for Kafr El Sheikh and from 78.12 to 86.57 % for El Behera. Water conveyance losses in earth marwas were found to be 18.9% and 16.76% for Kafr El Shiekh and El Behera, respectively.

Field irrigation efficiency was a minimum value for El Naira mesqa (55.81%) because all area cultivated with rice, but it was 80.26% in Sharf El Den mesqa when rice occupied 35.73% of the total area.Total benefit values could be arranged as following ascending order: El Shemy & El Taweel mesqa > Ganab 1 mesqa > Sharaf El Den mesqa > Om Henesh C mesqa >El Deeb & Abd Ella mesqa >El – Naira mesqa. The most efficient utilization of water unit was achieved when rice area ranged between 11.8 and 66% of the total mesqa area to maximize the return of water unit and minimize water conveyance and field losses. The crop pattern should be adopted with mesqa water supply to ensure higher on – farm irrigation efficiency and reduce water losses.

Key words: Cropping pattern on farm water losses , and efficiencies.

INTRODUCTION

In the arid and semi arid areas of the world, the limiting resource to maximize agricultural production is water. The River Nile is the main water sources. In Egypt, 85% of the available water supply (55.5 billion cubic meters annually) is consumed by the agriculture sector. The water conservation and maximize water use efficiency is a crucial issue that represents the keystone for agriculture extension. . To maximize the benefit of this resource, it is necessary to recognize and identify where water loss are occurring, its magnitude and how control it. Water budget is a tool can used to solve this problem.

Ley et al (1984) indicated that 40% of water might be lost from unimproved filed ditches. Water conservation could be fulfilled through better management where water balance studies on different levels are the main foundation for the conservation process. The average overall irrigation efficiency in Nile Delta is about 50%. Most of water losses occur in mesqas, marwa and in field (Shawky and El - Kashef, 2004).

The main aspect of water resources system is the economic usage of water. About 50 percent of the total water available for irrigation in India is diverted to rice crop alone with the assumption that the water requirement of rice is very high, without any basis for the assumption. Out of this 50 percent water is consumed by rice; 60 – 70 percent quantity is lost by deep percolation and evaporation (Kumar Raj et al 1999).

In Egypt, a large percentage of agricultural land is suffering from water logging and salinity problems (Up to 33% of the delta affected). Also, farmers complain of shortage in specific locations along canals, or at particular times within the irrigation cycles (Metawi, 1989). This is a result of the inefficient of water at the local level. Therefore ,the objectives of this study are aimed to estimate the existing water losses on earth marwa under different actual cropping patterns and the suitable cropping pattern to minimize water losses and maximize crop return per unit of water.

MATERIALS AND METHODS

Water balance studies were conducted during summer season of 2005 in two locations i.e.; one location in Kafr El Sheikh governorate, which include two sites. The first site is located at Dakalt branch canal (Om Henesh C, mesqa) with cropping pattern 71.43% rice and 28.34% cotton of total area. The 2nd site is located at El Kahwagy branch canal (El Naira mesqa) at which the rice crop occupied all area (100%).

Another location was at El Behera Governorate and included four sites: two sites at Besentway branch canal i.e.; Sharf El Den and El Deeb & Abd Ella mesqas, (35% rice, 65% cotton) and (75% rice, 25% cotton), respectively. And two sites at El Hamamy branch canal; Ganab, 65% rice, 25 % fruit and 10% maize and El Sheemy & El Taweel 12% rice , 48% cotton , 36% fruit and 4.0% maize.

The metrological data for Kafr El Sheilh and El Behera Governorates were recorded. The average maximum temperature for summer months were 34 ^{o}C in July and 32.8 ^{o}C in August , respectively at Kafr El Shiekh and El Behera. While, the minimum temperature were 10.3 and 12.3 ^{o}C in April , respectively at Kafr El Shiekh and El Behera. The relative humidity varied from 59 to 75% in Kafr El Shiekh and from 54 to 65% in El Behera . The average wind speed was 1.3 Km/h in both locations .The average of solar radiation were 518.5 580.9 Cal. /cm^2 /min. and average values of evapotranspiration were 6.03 and 5.45 mm/day, respectively at Kafr El Shiekh and El Behera..

In each site, the crop pattern was surveyed, the amount of water applied for each crop was measured within an area served by a distributary canal (mesqa) and their private canals(marwas) which deliver water to farmers fields.

The measurements and calculations:

1-Water conveyance efficiency: It was calculated in the selected earth marwas as the ratio of discharge at the second cutthroat flume (application point at 100 m distance from the first cutthroat flume) to the flow rate at the 1st flume (lifting point).

$$\text{Conveyance efficiency} = \frac{\text{Flow at flume (2)}}{\text{Flow at flume (1)}}$$

2-Irrigation water losses: It consists of seepage from the earth canal into the underlying groundwater and spills, which occur from leaky banks, overtopping the banks of the canals. A method of reporting the loss is the percent loss and expressed as follow:

Losses = 1 - Conveyance efficiency

3-Amount of irrigation water applied: Amount of irrigation water applied was measured for different summer crops by using a cutthroat flume (20 x 90 cm) according to early, (1975).

4-Water utilization efficiency: It was calculated by dividing crop yield (kg)on applied water (m^3)

5-Crop eavapotranspiration: Crop eavapotranspiration for different summer crops was calculated using Penman Monteith equation and crop coefficient

(FAO Irrigation and Driange Technical Paper No. 56).

6-Water losses at on- farm level: The general equation of continuity for a fluid dynamic (Daily and Harleman, 1966; Daugherty and Franzini, 1977).

7-Hydrologic studies: For hydrologic studies a simplified form of the equation for a fixed control volume and a specific period of time may be used:
$I_T - D_T = \Delta \, ST$

Where,

I_T = Total inflow volume of water into the control volume during time period T, (m^3)

D_T = Total outflow volume of water during time period T, (m^3)

$\Delta \, ST$ = Total change in volume of water during time period T, (m^3)

8-On farm irrigation efficiency obtained by divide water consumptive use on the amount of water applied.

9-The field water losses equal 100 – on farm irrigation efficiency.

10- Total crop return: It is equal to water utilize efficiency x % of crop area of the selected mesqa x average of unit price. The total benefits were obtained by summation of crop return on mesqa and it depends on the kind of crops and relative area of which crop cultivated.

RESULTS AND DISCUSSION

A.Crop patterns:

The crop patterns for the selected mesqas are given in Table 1. Data show that the relative rice areas ranged between 11.83 and 100% for El Sheemy & El Taweel and El Naira mesqas, respectively of the Total area served by these mesqas. Cotton crop occupied the secondorder which recorded the ratios varied from 4.59 to 58.93% for Ganab and sharf El Den mesqas, respectively. In this respect, the third order was fruits which represent 1.8 to 36.09% for Sharaf El Den and El Sheemy & El Taweel mesqas, respectively. Also, maize and tomato crops occupied small areas.

B.Conveyance losses in earth marwas:

On- farm water delivery is accomplished through a system of marwas. These marwas are difficult to be maintained in good conditions due to the cracks, this cracks cause direct seepage of irrigation water through it, change the cross sections, and prevents successful compacting of marwa banks.

Significant On–Farm conveyance losses have been observed between outlet of valves and point of application along marwas ,these water losses might be due to leakage and dead storage.

Table 1. Crop patterns in summer, 2005 for selected mesqas located at Kafr El – Sheikh and El – Behera Governorates

Branch Canal	Selected mesqas	Rice %	Cotton%	Maize %	Fruits %	Tomato%
		Kafr El- Shiekh				
Dakalt	Om Henesh C	71.43	28.34	0.23		
El - Kahwagy	El - Naira	100	-	-		
		El – Behera				
Besntway	Sharf El -Den	35.73	58.93	3.76	1.03	0.54
	El Deeb & Adb Ella	75.61	19.51	-	-	4.88
El - Hamamy	Ganab 1	66.78	4.59	0.96	23.18	4.49
	El –Sheemy & El -Taweel	11.83	48.61	3.49	36.09	-

.Data in Table2. show the conveyance losses of earth marwas that located on selected mesqas in the studied area.

The obtained results revealed that the mean values of conveyance losses across different locations are ranged from 13.43% to 21.88% at sharaf El Den mesqa and El Sheemy & El Taweel mesqas.The conveyance efficiencies were 78.64 and 83.56 % for Om Heneesh (C) and El-Naira mesqas at kafr El - Sheikh, respectively.While the 2nd location at El-Behera Governorate the conveyance efficiencies were 86.57, 84.69, 83.57 and 78.12%, for Sharf El Den,ElDeb&Abd Ella ,Ganab1 and El Shemy&El Taweel mesqas, respectively.It is important to mention to that the greater conveyance losses the greater the areas of rice crop The water losses ranged from 13.43 to 21.88% under different conditions. The obtained results are in agreement with those obtained by Ley et al. (1984) and Shawky and El-Kashef (2004). Also, data indicated that the mean values of conveyance efficiency were 81.07 and 84.53% for Dakalt and El – Kahwagy branch canals respectively in Kafr El Shiekh governorate. While the corresponding values were 85.11 and 81.3% for Bsentway and El – Hamamy branch canals respectively

in El Behera governorate. These results are in agreement with those reported by Shawky and El Kashef, (2004).

C. On Farm water losses and irrigation efficiency:

Applied water, crop water consumptive use, water losses and on - farm irrigation efficiency for the selected mesqas are presented in Table3.

The results indicate that rice crop recorded the highest values of on - farm water losses and lowest on - farm irrigation efficiency in different selected locations It's clear that rice crop recorded the highest value of on - farm water losses which ranged from 40.98% in Sharaf El Den for Bsentway branch canal to 45.83% in Om Henesh (C) for Dakalt branch canal. Data also showed that the percentage of on - farm water losses increased by increasing the area occupied by rice crop.. Results revealed that the mean values of farm water losses varied in wide range from 12.85% in cotton crop at El Deeb & Abd Ella mesqa to 21.57% at Sharaf El Den mesqa. Cotton crop area ranged from 4.59 to 58.93% of the total area of Ganab, and Sharaf El Den, respectively. Minimum efficiency was (55.81%) when all area cultivated with rice in El Naira mesqa, but reached to 80.26% when rice occupied 35.73% of the total area in Sharaf El Den mesqa.

Table 2. On-farm marwa conveyance efficiency and their losses during individual irrigations on some mesqas located in Kafr El-Sheikh and El-Behera Governorate

Governorate	Branch Canal	Mesqa Name	Conveyance Efficiency, %	Conveyance Losses %
Kafr El - Shiekh	Dakalt	Om Heneesh (C)	78.64	21.36
	El-Kahwagy	El-Naira	83.56	16.44
	Bsentway	Sharaf El-Den	86.57	13.43
		El-Deb & Abd Ella	84.69	15.31
El-Behera		Ganab 1	83.57	16.43
	El-Hamamy	El-Sheemy & El-Taweel	78.12	21.88

Table 3.Water losses and on farm irrigation efficiency for selected mesqas located at Kafr El Sheikh and El –Behera Governorate during summer season 2005

Branch Canal	Selected mesqas	Cultivated crops	Total Area (fed.)	Amount of water applied (m³ / Area)	Water consumptive use (m³ / Area)	On-farm water losses%	On farm irrigation efficiency %
				Kafr El – Sheikh			
Dakalt Canal	*Om Henesh C*	*Rice*	76.48	430878.92	233422.94	45.83	54.17
		Cotton	30.34	102279.77	85305.75	16.6	83.4
		Maize	0.25	793.03	597.77	24.62	75.38
El – Kahwagy	*El – Naira*	*Rice*	42.27	234581.02	130931.37	44.19	55.81
				El –Behera			
Bsentway	*Sharf El Den*	*Rice*	8.64	49093.3	29034.03	40.98	59.02
		Cotton	14.25	50314.46	38908.49	21.57	78.43
		Maize	0.91	2668.93	2366.2	11.34	88.66
		Fruits	0.25	1043.25	919.17	11.89	88.11
		Tomato	0.13	390.46	339.99	12.93	87.07
	El Deeb & Adb Ella	*Rice*	23.25	134805.92	78130.14	41.74	58.26
		Cotton	6.0	18160.24	16382.52	12.85	86.15
		Tomato	1.5	4825.43	3923.01	18.7	81.3
El – Hamamy	*Ganab*	*Rice*	20.08	117112.36	67477.24	42.53	57.47
		Cotton	1.38	4764.89	3767.98	20.92	79.08
		Maize	0.29	892.86	754.06	15.53	84.47
		Fruits	6.67	30689.87	25626.46	14.66	85.34
		Tomato	1.35	5182.94	4564.92	12.12	87.82
	El – Sheemy & El – Taweel	*Rice*	7.22	42403.89	24262.23	42.13	57.8
		Cotton	29.67	100929.36	80981.56	20.08	79.92
		Maize	2.13	6256.99	5538.47	11.83	88.17
		Fruits	22.03	96775.94	80997.26	14.24	85.26

Therefore, the optimum state was recorded by 35% rice as in Sharaf El Denmesqa. Maize crop occupied small areas different from 0.23% to 3.76% with water losses ranged between 11.34% to 24.62%, respectively with mean value of 15.8% under different studied locations. This may be due to the opportunity of water evaporation and deep percolation. D. Water utilization efficiency and total relative benefits.

Data of water utilization efficiency are presented in Table 4.

It is clear that tomato crop recorded the highest values water unit productivity, follow by fruits crops. While the cotton crop recorded the lowest values of water unit productivity.

It could be ranking the different cropping patterns according to their total benefit values as follows: El Shemy & El Taweel mesqa > Ganab 1 mesqa at El Hamamy branch canal > Sharf El - Den mesqa > Om Henesh C mesqa >El Deeb & Abd Ella mesqa >El – Naira mesqa. On the other hand, El Naira mesqa takes the last ranking when all area cultivated with rice crop.

Conclusion

It is necessary to make arrangement between the farmers, ministry of agricultural and ministry of water resources to plan crop pattern and best management of water resources. It could be concluded that the best utilization benefit of water unit was achieved when rice area ranged between 11.8 and 66% of the total mesqa area to maximize the return of water unit and minimize water conveyance and field losses.

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الملخص العربي

دراسة اثر التركيب المحصولى على الفواقد المائية على مستوى الحقل فى شمال و غرب دلتا النيل

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تقع مصر في حزام المناطق شبه الجافة لذلك تعد المياه العامل الاساسى المحدد لتعظيم العائد من وحدة المياه لذلك كان من الضروري تقدير الفواقد المائية على مستوى الحقل.

تم دراسة الميزان المائي في الموسم الصيفي لعام 2005 على مستوى أربعة ترع فرعية حيث تم اختيار ترعتي دقلت و القهوجي ليمثلا محافظة كفر الشيخ (شمال الدلتا) و كذلك اختيار ترعتي بسنتواى و الحمامى ليمثلا محافظة البحيرة (غرب الدلتا). كما تم اختيار عدد اثنين من المساقى المطورة فى بداية كل ترعة لدراسة التركيب المحصولى الفواقد المائية وكفاءة الري على مستوى الحقل.

ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلي:

يشغل محصول الأرز من 71.43 إلى 100% من اجمالى المساحة المنزرعة من زمام المساقى المختارة في محافظة كفر الشيخ بينما يشغل القطن 28.34 % ويشغل الازرة 0.23 % . أما بالنسبة المساقى المختارة بمحافظة البحيرة فان الأرز يمثل من 11.83 إلى 75.61 % من اجمالى المساحة المنزرعة والقطن يشغل من 4.59 إلى 58.93 بينما يشغل الازرة من 0.96 إلى 3.76 % و من 1.03 إلى 36.09 على التوالي وتشغل الخضر مساحة من 0.54 إلى 4.88% من المساحة الكلية على المسقى.

تراوحت كفاءة نقل المياه في المراوي الترابية في المساقى المختارة بكفر الشيخ بين 78.64 و 83.56 % بينما تراوحت الكفاءة بين 78.12 و 86.57 % بمحافظة البحيرة.

كانت نسبة فقد المياه فى المراوي الترابية لكل من محافظتي كفر الشيخ والبحيرة هي 18.9 و 16.76 % على الترتيب.

وصلت القيمة المتوسطة لكفاءة الري على مستوى الحقل إلى حدها الأدنى في مسقى النايرة (55.81%) وذلك عندما كانت المساحة بأكملها منزرعة بالأرز بينما وصلت قيمتها إلى 80.26% في مسقى شرف الدين عندما شغل محصول الأرز 35.73% من اجمالى المساحة الكلية.

ازدادت قيمة الفواقد المائية بينما قلت قيمة كفاءة الري على مستوى الحقل وذلك مع زيادة المساحة المنزرعة بمحصول الأرز والعكس.

يمكن ترتيب العائد الكلى من المساقى المختارة تصاعديا كما يلي: الشيمى والطويل > جناب 1 > شرف الدين > ام حنيش > الديب وعبد اللاه > النايرة .

> الديب وعبد اللاه > النايرة .

أمكن الحصول على أعلى عائد لوحدة مياه الري عندما شغل محصول الأرز من 11.8 إلى 66 % من المساحة الكلية للمسقى وذلك نتيجة لتقليل نسبة الفواقد على مستوى الحقل.

وبذلك يمكن التوصية انه لابد من التنسيق بين كل من اجهزة وزارة الزراعة ووزارة الموارد المائية والري لتحديد مساحات الأرز المستهدفة على زمامات المساقى واختيار التركيب المحصولى الأنسب لضمان عدالة توزيع المياه على طول المسقى و تعظيم الاستفادة من وحدة مياه الرى.