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RICE WATER USE POLICY PHASE I: WATER MONITORING AND EVALUATION PROGRAM

Report No. 26

December 1999

Water Policy Program

International Resources Group **Winrock International** **Nile Consultants**

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Rice Water Use Policy Phase I: Water Monitoring and Evaluation Program

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Executive Summary

The extension of the policy package for the adoption of short duration varieties of rice as a means of saving water was accomplished in each of the six rice-growing governorates of the Nile Delta. A demonstration branch canal and a control branch canal were selected in each governorate. A policy "package," including the exclusive cultivation of short season rice varieties, coordinated planting dates, and changing from a rice water rotation to a standard rotation at the end of August, was implemented on the demonstration branch canals. Farmer free choice of both variety and crop calendar was permitted on the control canals. A water-monitoring program was implemented, consisting of the installation and calibration of automatic recorders and the collection of water diversion data throughout the 1999 summer cropping season. Results indicate that water savings of approximately 12% to 15% can be achieved by the adoption of the policy package, but failure to implement any part of the package will result in the absence of measurable water savings.

1. Introduction

1.1 Overview

The Agricultural Policy Reform Program (APRP) is a seven-year United States Agency for International Development (USAID) grant program involving several ministries. The Ministry of Agriculture and Land Reclamation (MALR) is the primary Egyptian governmental agency charged with support of agricultural production. The Ministry of Water Resources and Irrigation (MWRI) has the prime responsibility for management of Egypt's water resources. MALR, MWRI and USAID, under the umbrella of the APRP, jointly designed an agricultural and water policy package, which consists of integrated policy and institutional reforms. USAID supports the Ministries' efforts through annual cash transfers based on performance in achieving identified and agreed-upon policy reform benchmarks and technical assistance.

Technical assistance for the water policy analysis activity is provided through a task order (Contract PCE-I-00-96-00002-00, Task Order 807) under the umbrella of the Environmental Policy and Institutional Strengthening Indefinite Quantity Contract (EPIQ) between USAID and a consortium headed by the International Resources Group (IRG) and Winrock International. Local technical assistance and administrative support is provided through a subcontract with Nile Consultants.

1.2 Purpose of the Report

This report presents the actions to be taken by the MALR and the MWRI under the Tranche III, C.6 Benchmark, which states:

> ***The GOE (MPWWR [sic; now MWRI] and MALR jointly) will adopt policies for the substitution of short duration rice varieties for long duration rice varieties among private commercial growers and for changing water scheduling to achieve optimal use of water for rice production.***

The two Ministers adopted the Policy in June, 1998. The policy was to be implemented in two phases, as follows:

Phase I (1999). Demonstration and control areas in each of the six main rice-growing governorates:

A. Joint selection of demonstration and control canals (January)

B. MALR Activity

1. Training of national rice and local village extension staff (February and March)
2. Meetings with farmers (March)
3. Seed distribution (March and April)
4. Nursery establishment and transplanting (May and June)
5. Continued extension activities during growing season (April through October)
6. Completion of education/awareness/training package
7. Collection of production and economic data (October, 1999)

C. MWRI Activity

1. Training of district engineers and supervisory personnel in water measurement and monitoring (February through May)
2. Canal maintenance
3. Water rotation change (August)
4. Data analysis (October through December)

Phase II (2000). Extension of program nationally:

A. Joint evaluation of program (January)

B. MALR Activity

1. Review/disseminate information package (February and March)
2. Seed distribution (April and May)

C. MWRI Activity

1. Disseminate water rotation information (April through June)
2. Change water rotations (August)

This report evaluates water savings resulting from the implementation of Phase I of the joint policy for short duration rice variety adoption. The primary policy evaluation activities included monitoring irrigation water deliveries in six pairs of branch canal service areas (twelve branch canals), one demonstration canal on which the policy "package" was implemented and one control canal on farmers were free to chose either long-or short season rice as well as the crop calendar. The comparison of water deliveries, therefore, can confirm that the policy results in significant water savings.

1.3 Background

Egypt is dependent upon the Nile River for 98 percent of its water, and receives a fixed allocation from the High Aswan Dam of 55.5 billion cubic meters (bcm). Fresh water availability in Egypt is estimated to be about 950 cubic meters (cum) per capita, a level which is below the "water scarcity" threshold of 1,000 cum per capita, as reported by the FAO and other international agencies interested in water and its management. Moreover, the population is growing at a relatively rapid rate, claiming both municipal and industrial water and adding to the pollution of downstream flows.

Egypt's agricultural production, a dominant economic sector, is almost entirely based on irrigation. The overall efficiency of water use in Egypt's portion of the Nile Basin has been estimated to be nearly 75 percent, with outflows and evaporative losses of about 13.5 bcm, according to the annual water budget published by the MWRI Planning Sector. Further, the Government of Egypt (GOE) has targeted horizontal expansion of irrigation as a priority economic and social development activity. An additional 1.3 million feddans of irrigated cropland has been developed in the period from 1974 to 1997, and further expansion into the West Desert (Toshka) and the Sinai Peninsula of up to 1 million feddans is foreseen for the next decade. Clearly, water use efficiency and water management are of critical importance to the GOE.

In an effort to conserve as much water as possible, the GOE and APRP began to examine cropping patterns in Egypt, particularly for those crops which require high amounts of water. Rice and sugar cane were specifically targeted for analysis. Rice normally requires the application of about 8,000 cum per feddan and consumes about 4,700 cum per feddan. Other crops require much less water. For example, cotton requires about 5,800 cum applied and 3,680 cum consumed per feddan, while maize requires about 4,225 cum applied and 2,660 cum consumed.

The cultivation of rice as a summer crop has expanded dramatically from about 1,100,00 feddans in 1987 to about 1,566,000 feddans in 1997, an average annual increase of about 3.2 percent. Several causal factors can be cited: free farmer choice of cropping patterns introduced in the mid-1980's, the relative profitability of rice in the local markets, the attractiveness of rice as a home-consumption crop which reduces the risk of household food scarcity, and GOE support of rice prices relative to cotton, the competing summer crop, through import tariffs.

One of the potential ways to mitigate the increasing demand for water from expanding rice production is to reduce the amount of water required for cultivating rice. The Field Crops Research Institute

(FCRI) has devoted many years to developing varieties of rice which are both water conserving and income preserving. The culmination of the research has been the creation of three rice varieties: Giza 177, Sakha 101, and Sakha 102, which have about 25% shorter growing seasons (120 days) than the traditional longer duration rice varieties such as Giza 171 (160 days). Giza 178 is a more salt-tolerant variety that requires a 135-day growing season, which has about a 15% shorter growing season. In experimental plots, the FCRI was able to achieve both reduced water consumption and increased yields with these short season varieties. However, large-scale demonstration of the efficacy of these varieties required a more extensive field application in a commercial setting in order to evaluate both productivity and water savings.

The first report of the Rice Working Group (Report 6, EPIQ/WPRP, 1998) identified several short term policies regarding rice cultivation that would lead to more efficient use of water resources. Among these was the introduction of short duration rice varieties on a national scale. However, the implementation of such a policy without field tests on private commercial farms could have lead to significant problems. As a result, a pilot program of the policy "package" was conducted on the Sidi Gamme Branch Canal in Desouk, Kafr El Shiekh Governorate.

The short duration "package" consisted of:

1. exclusive cultivation of short duration varieties,
2. coordinated nursery establishment and subsequent transplantation, and
3. management of the water supply so that rice rotations ended upon maturation of the crop on or about August 31, 1998.

The substitution of short duration rice varieties for the more traditional varieties in order to achieve water savings is not as straight forward as might be thought. First, water for rice irrigation is provided to canals on a rotation basis, consisting of 4 days "on" (water in the canal) and 6 days "off" (no water in the canal) [4/6 rotation]. Non-rice rotations are 5 days "on" and 10 days "off" [5/10]. So long as some long season varieties are being cultivated on a canal, the MWRI is committed to providing a water rotation consistent with watering requirements for long season varieties. Otherwise, some farmers would suffer significant yield losses.

Moreover, the "package" involved coordination of the timing of establishment of rice nurseries and of transplanting among all farmers on the canal. If planting were spread over several weeks, the water rotation would have to be extended so that late plantings would receive adequate water. Only by coordinating planting can water rotations be switched from rice to non-rice rotations earlier to reduce water supply without jeopardizing farmer income.

The pilot program was undertaken during the 1998 summer cropping season on the Sidi Gamma and Sanhour El Gadida Canals in Desouk District, Kafr Elshiekh Governorate and a final report issued in June, 1999 (Report 22, EPIQ/WPRP). The results indicated that a water savings for applied water of about 12%, or about 1,280 cum/feddan of rice, was achieved.

The national extension of the short duration policy "package" was approved by the Ministers of MALR and MWRI in June, 1998, as a part of Tranche III Benchmarks. Phase I of that extension included the implementation of the "package" on one canal in each of the six rice-growing governorates in the Delta. The water monitoring and evaluation program was carried on by MWRI personnel in order to confirm the water savings from the package. This report presents the results of that water monitoring and evaluation program.

1.4 Organization of the Report

The report has four chapters. Chapter 1 includes the purpose and brief background information about the field study that is the subject matter of the report. Chapter 2 describes the design and field implementation of the water monitoring study, and the approach to data collection and analysis. Results from the analyses of the collected data are presented and discussed in Chapter 3. Conclusions are presented in Chapter 4. Appendices A through F present governorate-specific water monitoring data and analysis.

2. Description of Phase I Activities

2.1 General Description

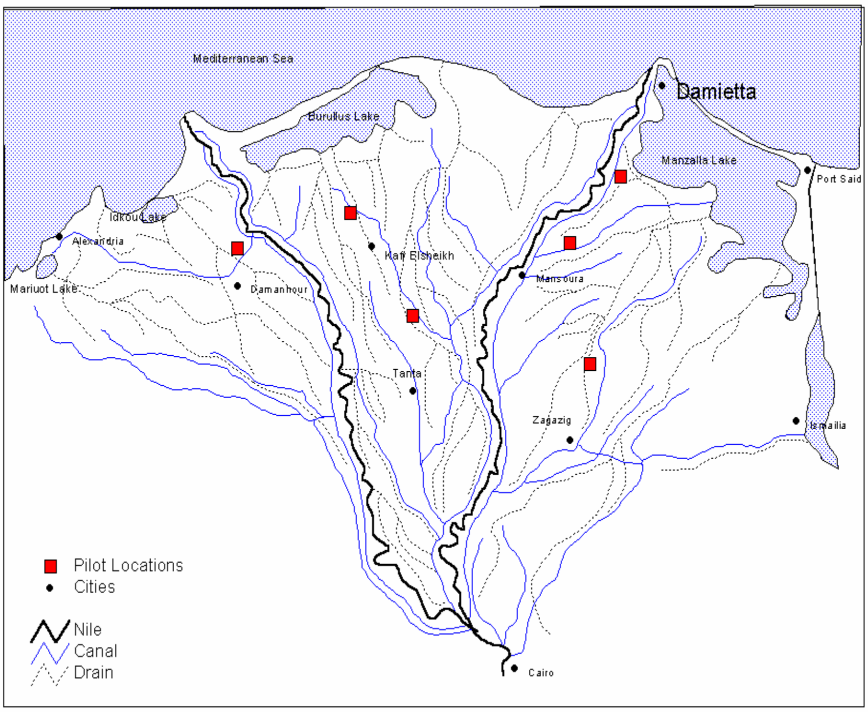
The implementation of Phase I of the short duration rice policy package involved several steps. First, the MWRI and MALR selected one pair of branch canals in each of the six rice-growing governorates in the delta to serve as the demonstration and control canals. The selection was based on the availability of an effective agricultural extension program, the potential for continuous water monitoring, and the comparability of the two branch canals. The location and characteristics of the selected branch canals are found in Table 1 and Figure 1.

Table 1. Characteristics of Demonstration and Control Canals

Governorate	Demonstration Canal			Control Canal		
	Name	Area (fed)	Length (km)	Name	Area (fed)	Length (km)
Gharbia	Khadiga	1540	3.800	Nesheil	1058	3.700
Kafr Elsheikh	Dakalt	6300	11.400	Kom Elwahal	1600	4.300
Beheira	Nekla	3014	9.800	Hamad Meneis	1917	5.500
Sharkia	Moralia	5022	10.775	Elserw	5000	11.820
Dakahlia	Mit Taher	4961	5.700	Elnazl	6187	9.980
Damietta	Elshoka	1417	5.000	Haggaga	2791	5.500

Prior to the summer cropping season, MWRI personnel who worked on or supervised the activity attended a one-day workshop on the short duration rice variety package and they received on-site training in water measurement and water monitoring procedures. Measuring and monitoring devices were installed on the selected canals prior to the date of the establishment of rice nurseries to ensure that accurate and reliable data on water savings were available for Phase I of the program. Schematics showing the locations of the automatic water level recorders for each of the canals is given in the appropriate appendix.

Figure 1. Location of Demonstration and Control Canals



MWRI personnel completed all necessary branch canal improvements and maintenance prior to rice nursery establishment. A second workshop was held for MWRI personnel to ensure that water delivery procedures would be consistent among the canals, with the exception of the early rotation shift on the demonstration canals.

MWRI personnel were also responsible for developing accurate maps of the cropping patterns on both canals in each governorate for both the summer and following winter seasons, including the proportions of long and short duration varieties of rice on the control canals. The cropping pattern maps for each governorate can be found in the appropriate appendix. These maps were used to compile data regarding the cropping patterns for summer, nili and winter seasons.

Water delivery data were collected through the planting of winter crops to ensure accurate estimates of water savings for the entire crop rotation. Measured water savings were then determined for each of the branch canals by comparing the difference in seasonal water deliveries between the demonstration and control canals.

2.2 Data Collection

MWRI directorate measurement teams were established in each of the six govenornates to collect field data over the period from May 1 to October 31, 1999. Several types of field data were collected by these teams as part of the water-monitoring program: canal physical characteristics, water level data, canal flow measurement data and crop data. Daily reference evapotranspiration data was obtained from MALR.

2.2.1 Water level data

Continuous water level measurements were made using automatic water level recorders installed at the head and tail of both the demonstration and control branch canals. Main canal water levels upstream of the branch canal head regulators were recorded manually at regular intervals using the main canal staff gauges. Branch canal regulator gate openings were also recorded by MWRI staff each time gate adjustments were made.

2.2.2 Stage-discharge calibration data

To develop stage-discharge relationships, canal flow rates were measured using current meters at least two times during each on rotation period in each branch canal. The flow rates were taken at all branch canal head locations and at tail locations only if there was outflow. At the same time water level observations were taken upstream and downstream of the branch canal head regulator, and at the tail end of the canal. The branch canal regulator gate openings were also recorded.

2.2.3 Crop data

Crop data was compiled by MWRI field staff from information provided by MALR district extension personnel. This included types and area of crops grown, planting dates, and harvest dates. For each branch canal, the areas under production by crop were compiled on a daily basis. Crop maps showing the location and extent of the areas planted under short duration rice for the demonstration canals were also prepared by the MWRI field staff.

2.2.4 Evapo-transpiration data

Reference evapo-transpiration data is needed to estimate crop water requirements. These values are usually determined empirically for a reference crop such as alfalfa from climate data such as wind, temperature humidity, and pan evaporation. MALR Agriculture Research Center has an extensive national agro-climatic data collection network where this type of climate data is collected. The Central Lab for Agriculture Climate uses this data to prepare daily estimate on reference evapotranspiration that it publishes monthly for over 30 locations. This reference evapotranspiration was compiled on a daily basis from the following agro-climatic stations:

- Kafr ElZayat (Beheira)
- Abu Kabir (Sharkia)
- Kotour (Gharbia)
- Sidi Salem (Kafr ElSheikh)
- Aga (Dakahlia)
- Kafr Saad (Damietta)

2.3 Data Analysis

Data analysis was carried out by the Central Administration for Water Distribution, MWRI, with assistance from the EPIQ WPRP team. Water levels at branch canal upstream and downstream locations were tabulated on a 24-hour daily basis at two-hour intervals. Using the discharge-water level calibrations for each branch canal and regulator, water level-discharge equations were developed. The field data were fit to three different types of equations: the orifice equation based on flow relationships through the intake gate, the Manning equation using water slope estimates, and on an exponential water level-discharge relationship. The analyses for each governorate can be found in the appropriate appendix. The two-hour water level data were converted to two-hour discharge flow data using the most appropriate equation. These data can also be found in the appropriate appendix. The results were summed to determine the daily, monthly, and seasonal volumetric flows delivered to each of the branch canals.

Daily estimates of crop water requirements were determined using the following equation (FAO, Irrigation and Drainage Paper 24, 1984):

$ET_{crop} = Kc*ET_o$

Where:

ET_{crop} = crop water requirement, mm/day

Kc = experimentally derived crop coefficient

ET_o = reference crop evapotranspiration, mm/day

(The crop Kc values were obtained from MWRI [Nile Water Resources Management Final Report, 1991]. The values for Et_o were obtained from the Central Lab for Agricultural Climate in the Agricultural Research Center, Cairo. This information was calculated by crop for the served area for each branch canal and is presented in the appendices.)

Branch canal water delivery efficiencies were calculated using the following equation:

$$\text{Efficiency (\%)} = \text{Total seasonal } ET_{crop}/\text{Total seasonal water delivery X } 100$$

This definition of efficiency is somewhat arbitrary and conservative, as it does not include percolation or other losses which might normally be included.

3. Results and Discussion

In theory, short duration rice should require 15% to 25% less water compared to the long-season rice, simply because the growing season is 15 % to 25% shorter – 135 to 120 days compared to 160 days. In practice, however, actual difference would be less than the theoretical prediction. Land preparation for rice cultivation, for example, may consume as much as 1/3 of the total water delivery and is common to both short and long-duration varieties. Also, crop consumptive use in the period from June to August period is much higher than in September and October, the period in which short season varieties are harvested.

3.1 Expectations Based on Previous Studies

Based on the 1999 EPIQ study, the long-season rice would be expected to require about 12% more water than the short duration rice. However, the savings occurs only if the water rotation is appropriately changed from the rice to non-rice rotation earlier than with long-season varieties.

3.2 General Observations

Table 2 summarizes information on rice cropping and water deliveries for the demonstration and control branch canals in the six governorates. The results appear to confirm the findings of the previous EPIQ study.

Rice is clearly the main summer crop and covers about from 50 to over 90% of the service areas. Cotton and maize are the other major summer crops. In the demonstration branch canals all farmers grew short duration varieties. In the control branch canals, farmers were free to choose the variety cultivated. Many farmers in three of the governorates voluntarily chose short duration varieties. Strictly speaking, therefore, all of the control canals do not contrast short duration and long-season rice water delivery. However, even though short duration varieties were planted on some of the control canals, planting dates on those canals were not coordinated and water was delivered on the traditional seasonal basis (June through mid-October).

Table 2. Rice Cropping and Water Deliveries

Governorate	Demo Canal Name	Area (fed)	Rice Area (fed)	Rice %	Control Canal Name	Area (fed)	Rice Area (fed)	Rice %	Differ-ence in Rice%	Difference In Delivery m^3/fed
Gharbia	Khadiga	1,540	866	56%	Nesheil	1058	874	83%	26%	-1
Kafr Elsheikh	Dakalt	6,300	4,472	71%	Kom Elwahal	1600	1183	74%	3%	1177
Beheira	Nekla	3,014	1,780	59%	Hamad Meneis	1917	1086	57%	-2%	1607
Sharkia	Moralia	5,022	2,514	50%	Elserw	5000	2572	51%	1%	984
Dakahlia	Mit Taher	4,961	3,489	70%	Elnazl	6187	5202	84%	14%	658
Damietta	Elshoka	1,417	1,284	91%	Haggaga	2791	1871	67%	-24%	656
TOTALS		**22,254**	**14,405**	**65%**		**18,553**	**12,788**	**69%**		

Both short- and long-duration rice varieties are generally planted in May. The crop consumptive use is high for the months of June, July and August. Harvest for short duration varieties starts at the end of August and continues in the month of September. Contrary to expectations, however, farmers often did not plant the next crop (berseem, wheat, etc.) until the end of October. The crop data (Tables 3-8) indicate a significant amount of fallow land in September and October. However, the term "fallow," as reported, applies to any land not requiring water delivery, including drying rice paddies, rather than the traditional definition of land not supporting a standing crop.

3.3 Measured Water Saving from Variety Substitution

Table 2 presents the difference in the amount of water delivered per feddan to the demon-stration and the control canals. Note that for the canals in the Gharbia governorate, there was no difference between the two canals. Excluding the Gharbia, the seasonal total for short duration rice canals varies from 5,500 m^3/feddan to 7,700 m^3/feddan, with an average of 6,850 m^3/feddan. The corresponding values for the control canals are 6,700 m^3/feddan to 8,700 m^3/feddan, with an average of 7,870

m^3/feddan. The difference in the amount of water delivered ranges from 600 m^3/feddan to1,600 m^3/feddan, with an average of 1,020 m^3/feddan. That is, the demonstration canal deliveries were about 12.9 % lower than that of the control canals. These results compare well with the 1998 water monitoring study of one location where the difference was estimated to be about 12%.

Some of the results may appear counter-intuitive. In particular, note that for most of the canals, the calculated consumptive use and the delivered water are greater in October than in September, even though normally October is a much cooler month than September. The increased water demand is due to two factors: first, rice harvest occurs primarily in early September for short duration varieties and in later September and early October for long duration varieties. Berseem, as the most frequent crop following rice, is planted in October following rice harvest and requires considerable water application during planting and establishment.

A second anomaly in the data appears in the Damietta Governorate results. In particular, for the month of October the delivered water is significantly less than calculated consumptive use for the control canal. The apparent insufficiency of water deliveries was due to two unusually long periods of canal closure during the month which were related to high flows in the drains.

Table 3. Cropping Pattern, Consumptive Use and Water Delivery: Beheira Governorate

Nekla Canal: Demonstration

Crop Area (fed.)	May	June	July	August	Sept	October
Cotton Area (fed.)	1060	1060	1060	1060	1060	681
Maize Area (fed.)	22	87	98	83	80	59
Berseem Area (fed.)	0	0	0	0	270	1213
Others Area (fed.)	112	79	75	72	107	147
S. Rice Area (fed.)	233	1591	1780	1750	531	0
Long Rice Area (fed.)	0	0	0	0	0	0
Fallow Area (fed.)	1587	197	1	49	967	915
Total Service Area (fed)	3014	3014	3014	3014	3014	3014
% Rice	8%	53%	59%	58%	18%	0%
Consumptive Use (MCM)	1.12	1.34	1.92	1.41	0.77	0.82
Delivery (MCM)	3.13	3.86	4.46	4.23	3.18	2.69
Seasonal Consumptive Use (MCM)						7.38
Seasonal Delivery (MCM)						21.55
Water Use Efficiency (%)						34
Average Seasonal Delivery Per Feddan (m3/Season)						*7149*
Average Seasonal Delivery Per Feddan (mm/day)						*9.3*

Hamad Meneis Canal: Control

Crop Area (fed.)	May	June	July	August	Sept	October
Cotton Area (fed.)	645	645	645	645	645	405
Maize Area (fed.)	66	109	110	42	38	28
Berseem Area (fed.)	0	0	0	0	145	787
Others Area (fed.)	75	76	76	84	155	180
S. Rice Area (fed.)	56	620	702	701	264	0
Long Rice Area (fed.)	86	383	384	384	347	40
Fallow Area (fed.)	989	84	0	60	324	478
Total Service Area (fed)	1917	1917	1917	1917	1917	1917
% Rice	7%	52%	57%	57%	32%	2%
Consumptive Use (MCM)	0.70	0.87	1.21	0.92	0.56	0.53
Delivery (MCM)	2.24	3.88	3.96	3.38	2.29	1.04
Seasonal Consumptive Use (MCM)						4.79
Seasonal Delivery (MCM)						16.78
Water Use Efficiency (%)						29
Average Seasonal Delivery Per Feddan (m3/Season)						*8755*
Average Seasonal Delivery Per Feddan (mm/day)						*11.3*

Table 4. Cropping Pattern, Consumptive Use and Water Delivery: Damietta Governorate

Elshoka Canal: Demonstration

Crop Area (fed.)	**May**	**June**	**July**	**August**	**Sept**	**October**
Cotton Area (fed.)	65	65	65	65	65	65
Maize Area (fed.)	0	0	0	0	0	0
Berseem Area (fed.)	0	0	0	0	25	408
Others Area (fed.)	0	56	68	68	68	68
S. Rice Area (fed.)	93	1089	1284	1048	22	0
Long Rice Area (fed.)	0	0	0	0	0	0
Fallow Area (fed.)	1259	207	0	236	1237	876
Total Service Area (fed)	1417	1417	1417	1417	1417	1417
% Rice	7%	77%	91%	74%	2%	0%
Consumptive Use (MCM)	0.87	0.90	1.18	1.03	0.73	0.05
Delivery (MCM)	1.43	1.77	2.01	1.75	1.51	1.40
Seasonal Consumptive Use (MCM)						4.76
Seasonal Delivery (MCM)						9.87
Water Use Efficiency (%)						48
Average Seasonal Delivery Per Feddan (m3/Season)						*6964*
Average Seasonal Delivery Per Feddan (mm/day)						*9.0*

Haggaga Canal: Control

Crop Area (fed.)	**May**	**June**	**July**	**August**	**Sept**	**October**
Cotton Area (fed.)	35	35	35	35	35	33
Maize Area (fed.)	0	0	0	0	0	0
Berseem Area (fed.)	0	0	0	0	156	831
Others Area (fed.)	144	515	786	786	786	305
S. Rice Area (fed.)	0	0	0	0	0	0
Long Rice Area (fed.)	360	1404	1871	1871	1639	395
Fallow Area (fed.)	2253	837	99	99	175	1226
Total Service Area (fed)	2791	2791	2791	2791	2791	2791
% Rice	13%	50%	67%	67%	59%	14%
Consumptive Use (MCM)	1.69	1.65	2.13	2.04	1.29	1.44
Delivery (MCM)	3.98	5.23	4.41	4.61	2.28	0.75
Seasonal Consumptive Use (MCM)						10.24
Seasonal Delivery (MCM)						21.27
Water Use Efficiency (%)						48
Average Seasonal Delivery Per Feddan (m3/Season)						*7620*
Average Seasonal Delivery Per Feddan (mm/day)						*9.9*

Table 5. Cropping Pattern, Consumptive Use and Water Delivery: Dakahlia Governorate

Mit Taher Canal: Demonstration

Crop Area (fed.)	**May**	**June**	**July**	**August**	**Sept**	**October**
Cotton Area (fed.)	205	267	334	280	0	0
Maize Area (fed.)	82	369	595	472	0	0
Berseem Area (fed.)	0	0	0	0	875	1234
Others Area (fed.)	201	232	233	218	569	698
S. Rice Area (fed.)	532	2382	3464	3489	769	0
Long Rice Area (fed.)	0	0	0	0	0	0
Fallow Area (fed.)	3941	1711	335	503	2748	3029
Total Service Area (fed)	4961	4961	4961	4961	4961	4961
% Rice	11%	48%	70%	70%	16%	0%
Consumptive Use (MCM)	2.95	2.97	3.92	3.23	2.37	2.59
Delivery (MCM)	5.26	7.06	9.81	7.75	4.11	3.40
Seasonal Consumptive Use (MCM)						*18.04*
Seasonal Delivery (MCM)						37.39
Water Use Efficiency						48
Average Seasonal Delivery Per Feddan (m3/Season)						*7537*
Average Seasonal Delivery Per Feddan (mm/day)						*9.8*

Elnazl Canal: Control

Crop Area (fed.)	**May**	**June**	**July**	**August**	**Sept**	**October**
Cotton Area (fed.)	267	369	267	267	26	0
Maize Area (fed.)	50	369	528	534	50	0
Berseem Area (fed.)	0	0	0	0	875	1234
Others Area (fed.)	108	141	112	114	276	450
S. Rice Area (fed.)	0	0	0	0	0	0
Long Rice Area (fed.)	714	2776	5041	5202	2561	162
Fallow Area (fed.)	5048	2531	239	70	2400	4341
Total Service Area (fed)	6187	6187	6187	6187	6187	6187
% Rice	12%	45%	81%	84%	41%	3%
Consumptive Use (MCM)	3.75	3.81	5.06	4.69	3.08	3.43
Delivery (MCM)	10.20	9.40	9.74	8.12	7.89	5.36
Seasonal Consumptive Use (MCM)						*23.81*
Seasonal Delivery (MCM)						50.70
Water Use Efficiency (47)						47
Average Seasonal Delivery Per Feddan (m3/Season)						*8195*
Average Seasonal Delivery Per Feddan (mm/day)						*10.6*

Table 6. Cropping Pattern, Consumptive Use and Water Delivery: Gharbia Governorate

Khadiga Canal: Demonstration

CROP AREA (FED.)	May	June	July	August	Sept	October
Cotton Area (Fed.)	320	320	320	320	285	81
Maize Area (Fed.)	354	354	354	354	332	113
Berseem Area (Fed.)	845	506	0	0	5	205
Others Area (Fed.)	0	0	0	0	0	0
S. Rice Area(Fed.)	21	360	866	866	854	593
Long Rice Area (Fed.)	0	0	0	0	0	0
Fallow Area (Fed.)	0	0	0	0	64	548
Total Area (Fed.)	1540	1540	1540	1540	1540	1540
% Rice	1%	23%	56%	56%	55%	39%
Consumptive Use (MCM)	0.59	0.75	1.16	0.98	0.59	0.78
Delivery (MCM)	2.09	2.08	2.66	2.19	1.26	1.56
Seasonal Consumptive Use (MCM)						4.86
Seasonal Delivery (MCM)						11.84
Water Use Efficiency (%)						41
Average Seasonal Delivery Per Feddan (m3/Season)						*7769*
Average Seasonal Delivery Per Feddan (mm/day)						*10.1*

Nesheil Canal: Control

CROP AREA (FED.)	May	June	July	August	Sept	October
Cotton Area (Fed.)	101	101	101	101	96	42
Maize Area (Fed.)	83	83	83	83	75	27
Berseem Area (Fed.)	838	347	0	0	0	70
Others Area (Fed.)	0	0	0	0	0	0
S. Rice Area(Fed.)	0	0	0	0	0	0
Long Rice Area (Fed.)	36	527	874	874	869	607
Fallow Area (Fed.)	0	0	0	0	19	313
Total Area (Fed.)	1058	1058	1058	1058	1058	1058
% Rice	3%	50%	83%	83%	82%	57%
Consumptive Use (MCM)	0.45	0.59	0.86	0.83	0.51	0.59
Delivery (MCM)	1.10	1.55	1.94	1.64	1.30	0.65
Seasonal Consumptive (MCM)						3.84
Seasonal Delivery (MCM)						8.19
Water Use Efficiency (%)						47

Average Seasonal Delivery Per Feddan (m3/Season)	7768
Average Seasonal Delivery Per Feddan (mm/day)	10.1

Table 7. Cropping Pattern, Consumptive Use and Water Delivery: Kafr Elshiekh Governorate

Kom Elwahal Canal: Demonstration

Crop Area (fed.)	May	June	July	August	Sept	October
Cotton Area (fed.)	823	900	1004	1093	279	0
Maize Area (fed.)	366	454	552	601	194	0
Berseem Area (fed.)	274	128	0	0	772	1648
Others Area (fed.)	366	231	117	128	690	1262
S. Rice Area (fed.)	607	4163	4472	4472	2066	0
Long Rice Area (fed.)	0	0	0	0	0	0
Fallow Area (fed.)	3865	425	154	6	2299	3389
Total Service Area (fed)	6300	6300	6300	6300	6300	6300
% Rice	10%	66%	71%	71%	33%	0%
Consumptive Use (MCM)	3.51	3.82	4.50	3.35	2.08	2.02
Delivery (MCM)	7.12	7.39	7.23	5.85	2.67	4.79
Seasonal Consumptive Use (MCM)						19.27
Seasonal Delivery (MCM)						35.05
Water Use Efficiency (%)						55
Average Seasonal Delivery Per Feddan (m3/Season)						*5564*
Average Seasonal Delivery Per Feddan (mm/day)						*7.2*

Kom Elwahal Canal: Control

Crop Area (fed.)	May	June	July	August	Sept	October
Area (fed.)	188	191	206	209	76	0
Maize Area (fed.)	83	93	134	158	157	0
Berseem Area (fed.)	63	41	0	0	180	458
Others Area (fed.)	83	66	35	50	169	376
S. Rice Area (fed.)	103	816	950	950	477	0
Long Rice Area (fed.)	25	203	233	233	233	119
Fallow Area (fed.)	1055	190	43	0	308	648
Total Service Area (fed)	1600	1600	1600	1600	1600	1600
% Rice	8%	64%	74%	74%	44%	7%
Consumptive Use (MCM)	0.91	0.95	1.15	0.94	0.53	0.51
Delivery (MCM)	1.27	1.69	1.75	1.93	1.16	2.99
Seasonal Consumptive Use (MCM)						5.00
Seasonal Delivery (MCM)						10.79
Water Use Efficiency (%)						46
Average Seasonal Delivery Per Feddan (m3/Season)						*6741*
Average Seasonal Delivery Per Feddan (mm/day)						*8.7*

Table 8. Cropping Pattern, Consumptive Use and Water Delivery: Sharkia Governorate

Moralia Canal: Demonstration

Crop Area (fed.)	May	June	July	August	Sept	October
Cotton Area (fed.)	932	932	932	761	0	0
Maize Area (fed.)	451	1255	1268	1232	23	0
Berseem Area (fed.)	0	0	0	0	0	576
Others Area (fed.)	175	308	308	308	360	748
S. Rice Area (fed.)	214	2118	2514	2280	220	0
Long Rice Area (fed.)	0	0	0	0	0	0
Fallow Area (fed.)	3250	409	0	441	4419	3698
Total Service Area (fed)	5022	5022	5022	5022	5022	5022
% Rice	4%	42%	50%	45%	4%	0%
Consumptive Use (MCM)	3.34	3.14	3.49	1.91	2.36	2.71
Delivery (MCM)	6.11	7.33	7.97	6.12	3.96	3.89
Seasonal Consumptive Use (MCM)						16.95
Seasonal Delivery (MCM)						35.38
Water Use Efficiency (%)						48
Average Seasonal Delivery Per Feddan (m3/Season)						*7046*
Average Seasonal Delivery Per Feddan (mm/day)						*9.1*

Elserw Canal: Control

Crop Area (fed.)	May	June	July	August	Sept	October
Cotton Area (fed.)	1147	1147	1147	905	0	0
Maize Area (fed.)	309	1089	1074	1070	68	0
Berseem Area (fed.)	0	0	0	0	0	0
Others Area (fed.)	27	115	130	130	172	756
S. Rice Area (fed.)	34	304	344	333	0	0
Long Rice Area (fed.)	217	1767	2228	2228	2228	482
Fallow Area (fed.)	3266	577	77	335	2532	3762
Total Service Area (fed)	5000	5000	5000	5000	5000	5000
% Rice	5%	41%	51%	51%	45%	10%
Consumptive Use (MCM)	3.38	3.18	3.50	2.17	2.37	2.77
Delivery (MCM)	6.63	7.91	8.92	7.75	5.05	3.90
Seasonal Consumptive Use (MCM)						17.35
Seasonal Delivery (MCM)						40.15
Water Use Efficiency (%)						43
Average Seasonal Delivery Per Feddan (m3/Season)						*8030*
Average Seasonal Delivery Per Feddan (mm/day)						*10.4*

The results for the Gharbia Governorate demonstrate the necessity of implementing the entire policy package to obtain water savings. Many farmers in the Gharbia Governorate were not convinced to plant short duration rice varieties exclusively until well after the coordinated planting dates in May. Transplanting was delayed into July. Thus, those farmers would have experienced a severe water shortage during the months of September and October had the MWRI adhered to the policy package and changed the rotation from 4/6 to 5/10 at the end of August. The MWRI delivered water for rice through mid-October to meet farmers' needs. Thus, even though short duration rice was grown exclusively, the water savings did not materialize. Clearly, cooperation among the farmers, MALR, and MWRI is essential in order to fully implement the "package" to reduce applied water.

Note also that there were two of the "conforming" five Governorates (Dakahlia and Damietta) in which the percentage of cultivated area growing rice differed substantially between the demonstration and control canals (+14% and –24%, respectively). For the three remaining Governorates, the average difference between water delivered to the demonstration and control canals was 1,256 m^3/feddan, almost identical with the previous years' pilot results.

The results from the Dakahlia and Damietta governorates are not easily explained. As might be expected, when the demonstration canal contains a significantly greater percentage of rice, as is the case for Damietta, the difference in delivered water per feddan is smaller than the average of the three governorates with similar rice percentages. However, for Dakahlia, the smaller percentage of rice in the demonstration canal would intuitively suggest that the difference in delivered water between the demonstration and control would be, which is not the case. It should be noted, however, that in these governorates, the demonstration canals which were selected were in fact only the first reach of the canal, which means that long duration rice rotations were provided to lower reaches. While the inflows and outflows were accurately measured, it is likely that farmers on the demonstration area used more water than would have been the case had the rice rotation been ended at the end of August on the entire canal.

Finally, it should be noted that these results are based on the actual measured system delivery of water. Theoretical water savings for rice plantations only may differ. However, as the short duration rice variety policy is adopted nationally, it is the actual system delivery that will determine the water savings.

Nevertheless, implementing the policy package for short duration rice varieties, including ending the rice rotation early, would appear to save approximately 12% to 15% of the water deliveries compared to traditional water deliveries when the policy package is fully and correctly implemented.

There an indication that the policy of ending rice rotation early may provide an opportunity to save additional water if water management based on actual demand is implemented. One source of reduced demand stems from the fact that during the period following harvest (September to October), water deliveries were reduced but were still much higher than the crop requirement – about 6.5 mm/day compared to the requirement of about 4 mm/day. A second source is that a relatively large amount of fallow land followed the harvest of short duration varieties, as indicated above (and in Tables 3 - 8). Even given that the definition of "fallow land" may be somewhat misleading, there still may be a significant amount of land not supporting a standing crop. For example, a farmer planning to grow wheat would likely not plant his wheat early because of ripening requirements in the spring. Thus, water deliveries could be reduced by the amount of water delivered to bare land. However, the large-dimensions of canals in the Delta system require relatively large minimum levels of flow to ensure delivery of water to the end of the canal. Reducing volumetric delivery may be limited even if demands are reduced. Still, managing water based on actual demands (demand-based management) should provide many opportunities for reducing the amount of water released from the traditional rotation-based releases.

3.4 Potential Water Saving from Efficiency Improvement

Tables 3-8 compare the monthly water deliveries (system input) and calculated crop consumptive use (system output), and present the calculated efficiencies for the short duration rice branch canals.

For the summer season, water use efficiency varies between about 30 to 50%, with an average close to 40%. Seasonal average consumptive use is about 4.5 mm/day, whereas about 9 mm/day of water is delivered. The same pattern of water use efficiency is observed on monthly basis. These results suggest a potential for water conservation within the service areas, through programs that encourage better on-farm management and water use. Note, however, that the water deliveries during the high-water year of 1999 were probably somewhat greater than in a normal year and that seepage and percolation losses are not included as “legitimate” consumptive uses in these calculations. If 2 mm/day for seepage and percolation are included as legitimate, the calculated efficiency would be 66%. Finally, the efficiency measures for larger systems may be significantly higher, due to reuse of drainage water. Thus, while increased on-farm efficiencies may provide opportunities for saving water, the amount of savings is unknown.

Reducing water application rates in the northern Delta may have consequences on salt-water intrusion. The MWRI has indicated that from 700,000 to 1,000,000 feddan of rice are optimal in the Delta to prevent salt-water intrusion from the Mediterranean Sea into the Nile Delta groundwater aquifers. Studies are needed to determine the impact of introducing short duration rice varieties on salt-water intrusion.

4. Summary and Conclusions

The measured water delivery for cultivating short duration rice was less than that necessary for long-season rice by about 12% to 15%. A fundamental question, however, is whether this difference can be translated into water saving on a national level. That depends on the two Ministries' ability to jointly implement the policy appropriately.

In all the demonstration areas except one the field engineers were able to reduce water deliveries in accordance with the policy package. In the exception, the policy package was not fully implemented. Specifically, establishing nurseries and transplanting the short duration varieties was delayed, and did not permit changing from the rice to the traditional crop water rotations until October. Therefore, in order for short duration varieties to provide savings of applied water, the entire "package" must be implemented. Clearly, cooperation and coordination between the MALR and the MWRI is essential to achieve the predicted water savings.

Another possible option for water conservation is to improve water use efficiency. While the water monitoring activity was not designed to provide details about this option, results indicated that water deliveries were about twice the crop water requirements, indicating a system efficiency level of 50%. This relatively low efficiency may suggest that further study of on-farm efficiency improvement is warranted.

5. References

Rice Working Group, *Assessment of Egypt's Rice Policy and Strategies for Water Management*, Report No. 6, EPIQ/WPRP, June, 1998.

Rice Working Group, *Short Duration Rice Variety Pilot Program Results*, Report No. 22, EPIQ/WPRP, June, 1999.