Irrigation Management Transfer: Development and Turnover to Private Water User Associations in Egypt

Yehia Abdel Aziz[1]

CONTEXT OF THE EGYPTIAN NILE IRRIGATION SYSTEM

THE GREAT NILE River System not only spans nine countries but drains one-tenth of the continent of Africa or 3.1 million square kilometers. Its most remote source is the Luvironza River in Tanzania which is 6,825 kilometers from the river's mouth in Egypt at the Mediterranean sea. The drainage and catchment area impinges upon Sudan, The Central African Republic, Zaire, Uganda, Rwanda, Burundi, Tanzania, Kenya and Ethiopia. The major riparian states are Ethiopia, Sudan and Egypt.(Waterbury, 1979). The Nile River System defines Egypt's long history, plays a central role in its economy and is a powerful influence on its social life and even political development. For example, Egypt, unlike most countries, depends almost solely on one river for its water for all uses. Egypt's land area is 995,450 square kilometers but its cropped land constitutes only about 2.6 percent of the whole while the remainder is desert. Figure 1 shows the Nile System in Egypt along which are the major cultivated areas which total about 2.8 million hectares. There are only 0.05 hectares of arable land per capita (World Resources Institute, [1992]).

Demands on the Nile waters are increasing at an accelerated rate. [The population] is almost 60 million today with a growth rate of 2.6 percent per year. Forty-five percent of the population live in urban areas and the remainder are located along the Nile River. Water demands were about 59.5 billion cubic meters (BCM) in 1985 and are projected to 72.4 BCM by the year 2000. [(ISPAN 1993)]. Rainfall is insignificant with about 20 millimeters at Cairo per year, and for a narrow rainfed band of land along the Mediterranean Sea rainfall averages about 150 millimeters. The average inflow at the Aswan High dam is about 84 milliard m^3 to Egypt and 18.5 milliard m^3 to Sudan with assumed reservoir losses of 10 milliard m^3 per year. While the Nile System used to be an abundant water supply system, a water crisis in 1988 and diminishing flows over a 16 year period illustrate that this is no longer the case. Population increases, industrial development and municipal water requirements are expected to rise from about 2.2 billion cubic meters to about 5.5 billion cubic meters by 1999 or 2000 AD. ([Abud Zeid] 1979).

These new demands and challenges drive irrigation improvement and require new roles for water users. They are as follows:

- Increased food production and food security.
- Improvement of total irrigation system performance.
- Financing of O&M, improvements and horizontal expansion.
- Reducing inequities and the wastage of water.
- Improved professional training and incentives.
- Applied action research, monitoring and evaluation.
- Organizational and legal changes for cost recovery and WUAs.
- Sustainable private water user associations (WUAs) and turnover of micro-systems to WUAs and creation of canal-level WUAs.
- Reduction of water losses in water conveyance and use.
- Mitigation of negative environmental impacts.

Positive aspects of the agricultural context of Egypt are cropping intensities of almost 200 percent and some of the highest average yields for some crops. The quality of crops is very high and increasingly horticultural crops are exported to the Middle East and the European Common Market. Fine-tuned crop and livestock farming systems are established and Egyptian farmers have high adoption rates for new technology.

EGYPT'S NATIONAL IRRIGATION IMPROVEMENT PROGRAM

Under the umbrella of the United States Agency for International Development's (USAID's) Irrigation Management System Project (IMS), the Irrigation Improvement Project (IIP) is a sub-project. It is based on the research findings of

[1]Undersecretary of Irrigation Improvement and Project Director of the USAID-assisted Irrigation Improvement Project, Ministry of Public Works and Water Resources (MPWWR), Cairo, Egypt.

the Egyptian Water Use Management Project (EWUP) assisted by USAID in the late 1970s and early 1980s. The stated goal of the IMS is:

"The effective control of Nile waters for their optimal allocation to and within agriculture as a means of helping increase agricultural production and productivity." (See USAID 1989.)

The IIP is the first prototype irrigation improvement project with active involvement of private WUAs. It will be completed in September 1995. Its specific objectives are:

1. To develop the institutional capability of the MPWWR for sustained irrigation improvement activities.

2. To develop a rational interdisciplinary team approach for identifying, testing and implementing solutions to priority system constrains for sustained efforts in irrigation system improvement.

3. To establish and empower an irrigation advisory service to provide water delivery and water use services, technologies and information to water users during and beyond the IIP.

4. To establish and strengthen formal private water user associations for playing an active role in planning, designing, implementing, operating, maintaining and regular monitoring of their micro-system during and after the IIP.

5. To assist in identifying policy alternatives and procedures for implementing a program of cost sharing for specified improvement costs from water users to be utilized for improving system operation and maintenance performance.

ARRANGEMENTS AND PROCESSES FOR IRRIGATION MANAGEMENT TURNOVER OF IMPROVED SYSTEMS

The Irrigation and Drainage laws of Egypt, from the 1960s to the present 1984 law, have clearly defined the *mesqa* micro-system as private property of farmers for which they are responsible for maintenance, structures, repairs and the operation of water lifts. These mesqas range between 20 to 60 hectares with 30 to 60 farmers. They are further divided into *marwas* (off-takes) from the mesqa to farmers' fields. In addition, farmers in Egypt have had informal organizations for pumping water and managing their mesqas since perennial irrigation began with the first low Aswan Dam and other barrages. The operation of these informal systems based around traditional *sakia* pumping systems owned, operated and managed by groups of farmers is well document in several studies by the American University in Cairo Social Research Center (AUC 1984 and IIP 1990). In only one area of Egypt where water has traditionally been delivered by gravity flow at the great depression of Fayoum, the informal system, was found to be highly organized with leaders responsible for maintenance of the system, allocation of water using organized schedules with definite rules and sanctions. In the 1990 socioeconomic action studies which provided information on the existing system, it was found that there is in fact an informal system which is based on an Arab concept of *Haq ul Arab* (rights of the Arab) being used for decision making and settlement of conflicts related to water allocations and maintenance. Many of these informal principles have been built into the existing formal water user associations.

The MPWWR, based on research by the Egyptian Water Use and Management Project (EWUP) in 1984, made a policy decision to form private water user associations and to utilize them in future improvement projects (EWUP Report, 1984). The first initiative was to implement a small-scale Regional Irrigation Improvement Project (RIPP) assisted by USAID in 1985. A major contribution of the RIPP was the conceptualization of how to go about helping farmers to organize and the development of an Irrigation Advisory Service. A process of utilizing a cross section of irrigation and agricultural leaders was begun where several groups made tours to Sri Lanka, the USA and other countries. A management consultant facilitated the process of conceptualization. In one area of the RIPP Project, experiments were conducted in helping farmers form a few water user groups which were carefully monitored. By 1989, when the IIP began, there was a body of research and monitoring data and key concepts based on lessons learned. A process was evolved in early 1989 for building private water user associations and the first field work started on 11 canal commands in late 1989. The MPWWR issued a decree for formal water user associations and the establishment of a special Irrigation Advisory Service (IAS) in 1989 so that the work could begin.

The IAS of the IIP evolved a flexible but systematic process for helping farmers to form their private WUAs. This has been revised each year as lessons learned are fed back into the process for refinement. The focus is on finding ways in which water users are involved in each of the seven phases of the process. The process for establishing private WUAs has seven phases which build upon each other in a flexible time sequence. Figure 2 provides an overview of the phases and major activities under each phase. Figure 2 gives the name of each phase and specific activities under each in which water users and the Irrigation Advisory Service (IAS) are involved. The phases are entry, initial organization, preparation for planning and design of mesqas, participation in the improved mesqa implementation process and turnover, regular operations and maintenance and federation on the branch canals. [As shown in Figure 2, phase VII is process documentation with regular monitoring and evaluation of each phase for feedback. It also includes special impact evaluations.]

The IIP has been involved in intensive orientation of the MPWWR and legislators for a period of two years, in a process that has culminated in a special amendment to the 1984 Irrigation and Drainage Act making the first formal WUAs distinct legal entities. A legal base for resource mobilization from water users or cost recovery, and the establishment of a revolving fund for expanding irrigation improvement programs are included in this new Amendment of 17 June 1994. The MPWWR has prepared by-laws and decrees and the IIP has a definite strategy for the implementation of this significant amendment. To reach this stage has required much time in special studies, seminars and workshops, special overseas observation study tours to Spain, Indonesia and the Philippines. Custom-designed courses for IAS staff have been important preparations for reaching this stage. Numerous field trips arranged for politicians and officials and lobbying efforts by the IIP staff also helped to provide the bureaucratic orientation required. The importance of systematic bureaucratic orientation should never be minimized in efforts to establish sustainable WUAs. And it should be stated that with typical high turnover rates of officials in any public organization, it is imperative to continue bureaucratic orientation and training even after the policies and legal frameworks are in place.

PERFORMANCE RESULTS

Data indicating performance results comes from a number of important sources. These include: IIP Monitoring and Evaluation Data; IAS process documentation of organizational and financial aspects of WUAs; on-farm water management evaluations; three external evaluations, and the findings of a PhD. candidate from Denmark who completed some significant research in 1992-1993 on technology transfer of the new technologies and WUA acceptance of three of the 11 IIP canal commands. (Mr. Martin Hvidt of the Center for Contemporary Middle East Studies of Odense University of Denmark will be awarded his degree in October 1994.) (See Hvidt, 1994). In addition, there have been three major studies done for the IIP by Pacer Inc., a private firm in Cairo, related to the IAS and WUAs. (Pacer, Inc. 1993)

Water Reliability, Control, Adequacy and Fairness

Figure 3 provides data after and before turnover of the new mesqa systems from a sample of improved mesqas under the IIP. Note that mesqa conveyance efficiencies increased from an average of about 70 percent to about 90 and 95 percent. The overall irrigation efficiencies (conveyance x field application efficiencies) for 26 observations of sample mesqas averaged about 40 percent before improvements and ranged from 70 to 80 percent after improvements. Fairness or uniformity of water distribution on improved mesqas after improvements and turnover to WUA management are shown in Figure 4, for June through July in 1993, the peak summer month period. Though not presented in graphic or tabular form, Hvidt's data show that before improvements about one-third of 137 farmers interviewed reported serious problems of unequal deliveries. After the new technology and turnover none of the 137 sample water users reported unequal water deliveries between head and tail locations along the micro-system. Figure 5 shows that of 90 sample farms, before the turnover of new mesqas, about 65 percent reported that water was not adequate for good crop production in the Summer season of 1993. But after the turnover of new systems only about 10 percent reported these problems which were due to interruptions in continuous flow in the main canals while new down-stream control gates were being installed. No change was found for control mesqas where 60 percent of the farms reported summer season water problems.

Effects on Costs for O&M and Farmer Satisfaction, after Turnover of New Mesqa Technology.

Table 1 provides a summary of 90 farmers, which compare a number of dimensions of the new versus the old mesqa systems after turnover to them for operation, maintenance and management. This includes maintenance and operational costs, increases in yields, savings to farmers, water control and the reduction of conflicts. Figure 6 shows the average cost per hour for pumping water before and after the introduction of the new technology. It should be pointed out that the before situation refers to the cost per hour for hiring pumps while the after situation cost of US$0.65 per hour also includes fuel, oil, maintenance, payments to the pump operator and guard and an increment for the reserve fund for major repairs and pump replacement. Hvidt (1994) found in his sample of 137 farmers on improved mesqas at three IIP canal commands, that seasonal pumping costs per hectare ranged from about US$68 to US$79 [LE] before the IIP and were only about US$45 to US$50 per hectare after the new technology and its turnover to the WUA (see Figure

7). Hvidt (1994) also found that the time to irrigate one hectare for five main crops was reduced from an average of about 15 to 17.5 hours, to about 5 to 7.5 hours per hectare after the turnover of the new systems.

A major savings is shown in Figure 8 of sample mesqas on five IIP canal commands. Where low pressure buried pipelines with alfalfa valves were installed, land savings ranged from 0.4 to 2.0 percent with an average of 1.0 percent of the total irrigated command area on mesqa service systems. It has been found that there are from 0.2 to 0.4 hectares of valuable land saved per km of buried pipeline on improved mesqas on five canal commands with an average of about 0.28 hectares. Figure 9 shows a dramatic reduction in maintenance costs after turnover. Before improvements and turnover, average maintenance costs were about US$67 [LE] per one hectare due to the costs of labor and tractor backhoes. These costs dropped to only about US$0.75 after improvements. But this is a premature low cost because the new mesqas with fixed cross-sections have been in operation only for about one-to-two years. It must also be realized that the old mesqas ranged from about 1 to 2.5 meters in depth below field level with cross sections of 2.0 to 4.0 meters which were progressively enlarged from the design standard with each cleaning by hired labor or machines. It is much too soon after improvements and turnover to fully evaluate mesqa maintenance costs.

Not shown in graphical form are substantial water saving potential and the almost complete elimination of night irrigation after improvements, which is a great convenience for farmers of whom 65 to 100 percent irrigated at night during the peak summer season water demand months using the old mesqa technology without formal WUAs.

Financial Viability and Collection of Fees

Feasibility studies and two recent evaluations of the ability of farmers to pay for the costs of pumps and mesqa improvements show that the average increases in incremental income per hectare per year is about US$300. It has been determined by these studies that farmers on new systems have the ability to pay for the physical costs over 20 years with no interest charges. Continuous process documentation studies of WUA finances from 1992 show that WUAs are building up surplus funds in their WUA accounts, most of which, are typically deposited in local banks (see IAS Special Studies, 1992-94). Figure 10 provides data as to the status of WUA finances. To date, there are three basic methods of fee collection for mesqa O&M and repair/replacement of pumps: fee collection on an hourly basis, fees per irrigation, and a method of water users depositing funds at the beginning of each crop season to cover fuel, repairs and maintenance costs. The predominant method is one based on collection prior to each irrigation. The WUA treasure collects the fees and issues a voucher which is turned over to the pump operator before an irrigation starts. This is recorded by the pump operator or the record keeper and deposited in the bank account of the WUA by the WUA treasurer. Intensive financial training of WUA council members and mesqa leaders is given by the IAS. Regular monitoring of the financial status of WUAs is an important part of process documentation. Data to date indicate that local WUA management is positive as well as the methods of charges by time and per irrigation. The IAS staff are helping WUAs to move away from advance payments to a system of either hourly charges or charges per irrigation. The hourly method especially is very close to the volumetric method of payment for irrigation water and services. This method and the per irrigation method provide records of time the pumps are operated making it possible to estimate energy costs and the efficiency of pumps.

Physical Sustainability of Local Management

It is early in the life of the new technology and WUAs to draw hard conclusions, but to date the potential for physical and organizational sustainability appear to be very good. This is based on the operation of some improved systems for three years and the fact that the technology, though more sophisticated, is similar in nature and function to the technology which was replaced. Egyptian farmers have been operating pumps for about 20 years on a vast scale replacing the old methods of sakia pumping rings using animal power and the *tambour* (archimedes screw water lift) which is now a museum piece. The private pumps broke the old time barrier for irrigations which resulted in farmers moving water directly from the canals and across mesqas. Farmers hired pumping services at a very high cost before the IIP. Now farmers have a central mesqa pumping system around which they are organized into WUAs. Farmer acceptance and satisfaction is very high as indicated earlier in Table 1. To date there have been no major problems with the buried pipelines with alfalfa valves and the maintenance of these and raised lined mesqas.

Though we do not have solid data on the mitigation of serious environmental problems, field observations and farmers' reports suggest that in some sugar cane areas especially, before the IIP the water table was so high that crops could not be grown. Another definite positive impact is that where stagnant water provided a breeding ground for malarial mosquitos and bilharzia before the IIP, with buried pipelines and raised lined gravity micro-systems water does not stand in the mesqas. Where the new mesqas pass through or near village areas, water no longer stands in stagnant pools in the large cross sections of old mesqas. It is hoped that in future WUA and IIP evaluations, focus will be given to a study of the impact of the new technology on the environment. It is interesting to note from Table 1 that all farmers interviewed about the old versus the new mesqas reported that there are definitely fewer water conflicts than in the past.

Impacts on Crop Yields and Quality of Crops

Given the almost 200 percent cropping intensities in the old lands of Egypt, significant increases were not expected. But there are increases in yields and changes in cropping patterns. Hvidt's 1992 study (See Hvidt, 1994) of three improved canal commands one to three seasons after mesqa improvements shows that farmers' estimates after two seasons of operation were about a 10 percent increases in cotton, about a 14 percent for maize and about a 16.5 percent in sugar cane yields per hectare (See Figure 11). Crop yields are not expected to change immediately after improvements because crop yield changes also result from changes in crop and input prices, climatic conditions, pest infestations, etc. We are now moving from sample and control farmer-reported data to crop cutting experiments which will provide us more than an indication of changes in crop yields. Though not shown in tabular or graphic form, the Hvidt study of 1992 shows that 35 percent of the farmers on new systems expected to change to higher quality crops because water control resulting from continuous flow and the new technology now make this possible. Presently the market prices for high quality crops are positive and most of these require increased water control for applying moisture to short rooted crops.

Changes in Profitability of Irrigated Agriculture

Changes in profitability have definitely taken place as indicated by data presented earlier under cost recovery and cost effectiveness. For example, it was shown that the incremental increase in net income per hectare under the improved systems averages about US$60 per year. This is expected to increase as farmers move to higher-value crops under the free market situation which now prevails throughout Egypt. But farmers' costs of fertilizer, insecticides, energy and other inputs and services are also increasing. As shown, land savings are substantial for a country with inadequate arable land, therefore, this must be included in the estimation of profitability along with other savings including pumping costs, maintenance costs, time to irrigate and mitigation of negative environmental impacts made available with the new technology. Figure 12 shows that with the new mesqa technology and WUA organization, the time to irrigate a hectare of land is reduced to more than one-half the time required before the new mesqa turnover.

This description of the Egyptian experience within the context of a large public gravity system, which formerly was administered in a highly centralized manner, suggests that recent changes have been significant. The process is underway and the IIP prototype project is now providing lessons and data for future projects which are expected to come on line in early 1995. The task of the IIP is to refine the process, help establish the policy and incentive environment for such projects and to continue to monitor and refine the processes for long-term sustainability. There is now a momentum in the IIP as indicated by the recent legal changes and policy decisions for WUAs, cost recovery and the establishment of an improvement revolving fund. There is much work to do before the end of this prototype project in late 1995. We are planning an international workshop on irrigation improvements with active farmer involvement for late 1995, and in 1996 the ICID meetings will take place in Cairo. A major question to be addressed in the 1996 ICID meetings is how to achieve sustainable irrigated agriculture with active participation of farmers. [We invite you to Cairo to share with us your experiences. Thank you very much.]

References

[Abu-Zeid,] Mahmoud. 1979. Strategy for irrigation development in Egypt. Water Supply and Management Journal, Vol. 3.

American University in Cairo (AUC) Social Research Center. 1984. Irrigation and society in rural Egypt. Cairo, Egypt: AUC papers in social sciences. Volume 7. Monograph Number 4.

Egyptian Water Use and Management Project (EWUP). 1984. Improving Egypt's Irrigation System in the old lands. Findings of the EWUP reported in the final report, Cairo: Ministry of Public Works and Water Resources, Water Research Center.

Hvidt, Martin. 1994. Water, technology and development. Unpublished Ph.D. dissertation. Odense. Denmark: Odense University.

Irrigation Advisory Service (IAS). 1992-1994. Unpublished reports on rapid appraisals of WUAs and WUA financial studies. Cairo. MPWWR/IIP Documentation.

Irrigation Improvement Project (IIP). 1990. Socio-economic study of Egypt's Irrigation Management Improvement Challenge Report (seven volumes). Cairo: MPWWR.

Irrigation Improvement Project (IIP). 1993. Monitoring and Evaluation Report. Cairo: MPWWR/IIP.

North Sinai Committee for the preservation of cultural heritage. 1989. Customary law in North Sinai. Cairo: American University Press.

Pacer, Inc. [1993.] Appraisal of completed fully operational WUAs review of cost recovery potential from water users for the IIP. Cairo. (Unpublished reports). Irrigation Improvement Project.

Saleh, Heba. 1990. The politics of water. The Middle East. August 1990 Issue.

USAID/Cairo. 1989. Agricultural briefing paper. Cairo. USAID.

World Resources Institute. 1992. World resources: 1992-1993. New York: Oxford University Press.

Waterbury, John. 1979. Hydro-politics of the Nile Valley. Syracuse, New York: Syracuse University Press.

World Bank. 1992. Arab Republic of Egypt public sector investment review, Report No. 11064-EGT. Washington, D.C.: The World Bank. Volume I.

World Bank. 1993. Arab Republic of Egypt: An agricultural strategy for the 1990s. Washington, D.C.: The World Bank

USAID/Cairo. 1993. Evaluation of the irrigation management project component of the Irrigation management systems project (Project No. 263-0132). Cairo: USAID.

Table 1. Sample farmers' comparison of old versus new mesqas showing percentages reporting "agree" and "strongly agree" (1992-1993).

New mesqa vs old mesqa	"Agree"	"Strongly agree"
A. Maintenance labor less		
1. Own labor	28.6	71.4
2. Hired labor		100.0
3. Maintenance		100.0
B. Operational labor less		
1. Own labor	66.7	33.3
2. Hired labor	18.2	81.8
C. Increased crop yields and new crops expected		
1. From old crops		6.7*
2. Introduce new crop		100.0
D. More savings to farmers		
1. Pumping costs less		100.0
2. Land savings	100.0	
3. Less time to irrigate		100.0
4. Less maintenance costs		100.0
E. Better water control		
1.Timing of irrigation	23.5	76.5
2.Irrigation flexibility	23.5	76.5
3.Delivery efficiencies		100.0
4.Field applications	11.8	88.2
5.Less complexities		100.0
6.Less pump break downs		100.0
F. Less water conflicts between farmers		100.0

N = 90

Note: Questions asked about each of these items had four responses from which sample farmers responded with either "strongly disagree," "disagree," "agree" or "strongly agree."

Denotes that many of the improved mesqas at the time of data collection had been operating for only one season. Yield changes are dependent on many factors other than improved water supplies.

Figure 1. Irrigation improvement project.

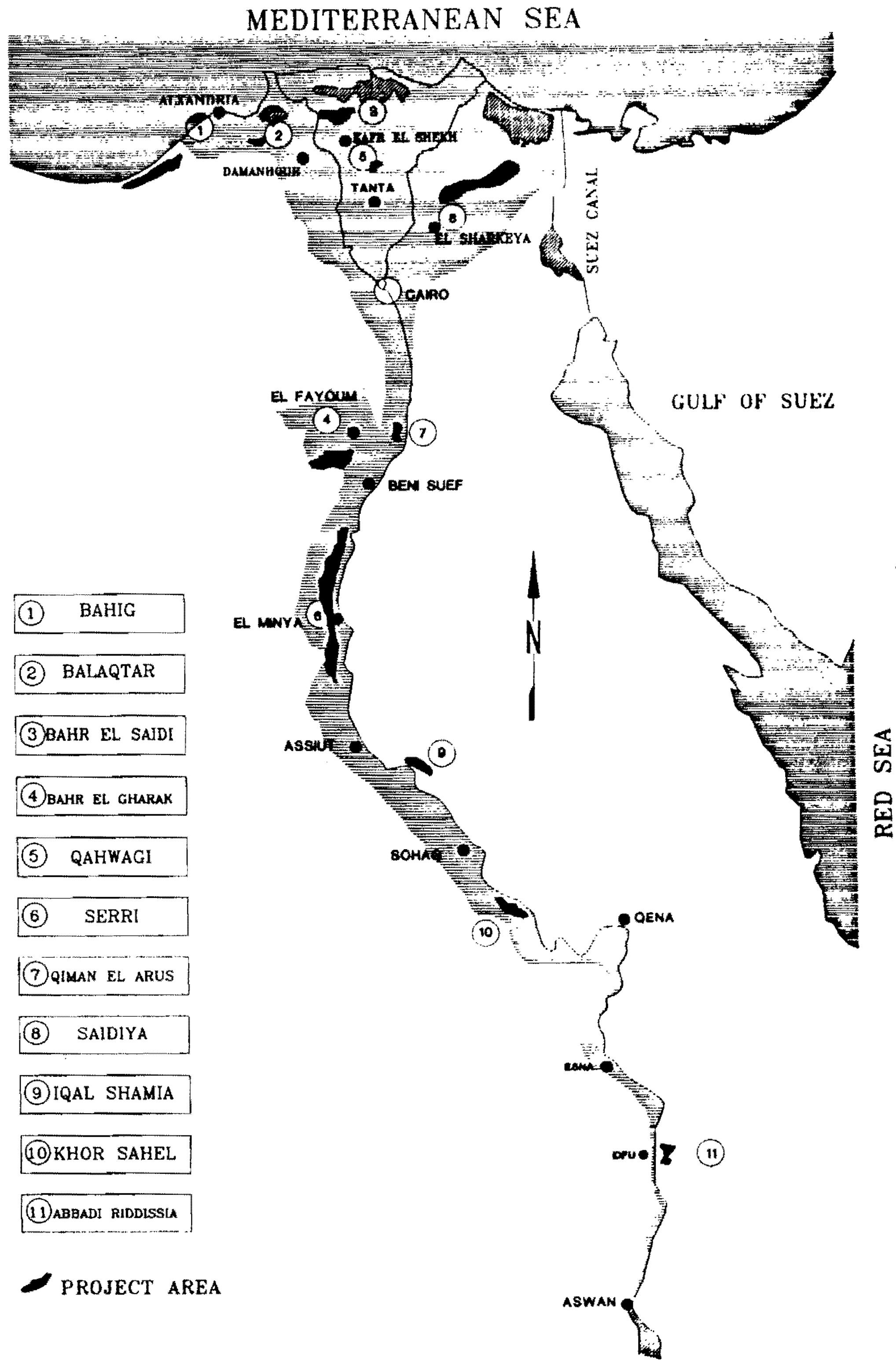

Figure 2. Flexible IAS for assisting water users to form WUAs.

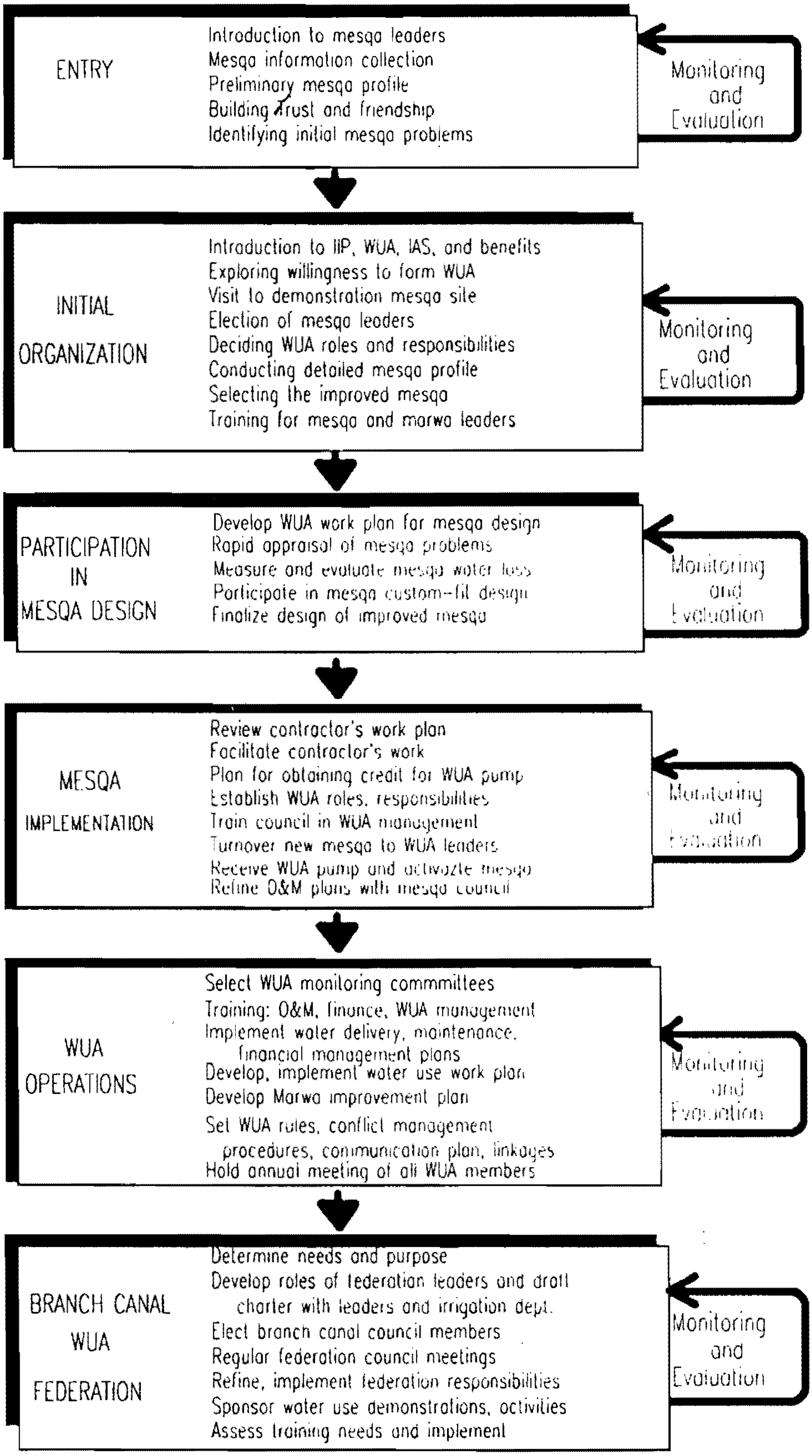

Figure 3. Conveyance efficiency in mesqas, before and after improvements.

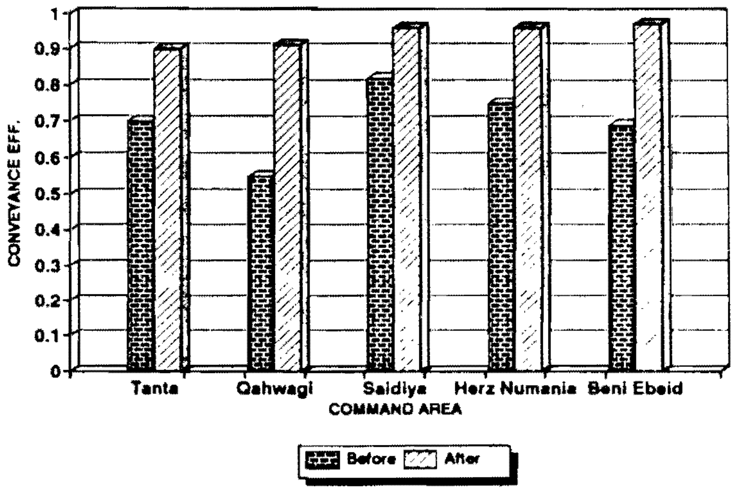

Figure 4. Uniformity of water distribution among users (1993).

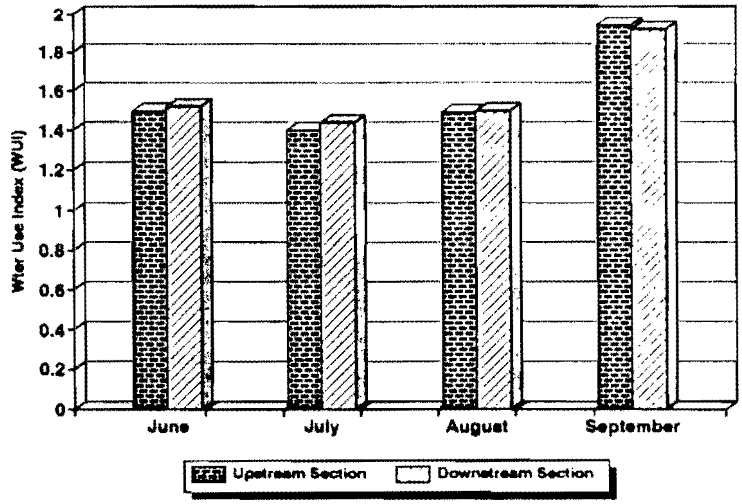

Figure 5. Farmers' reports about water adequacy for good productivity for summer season 1993.

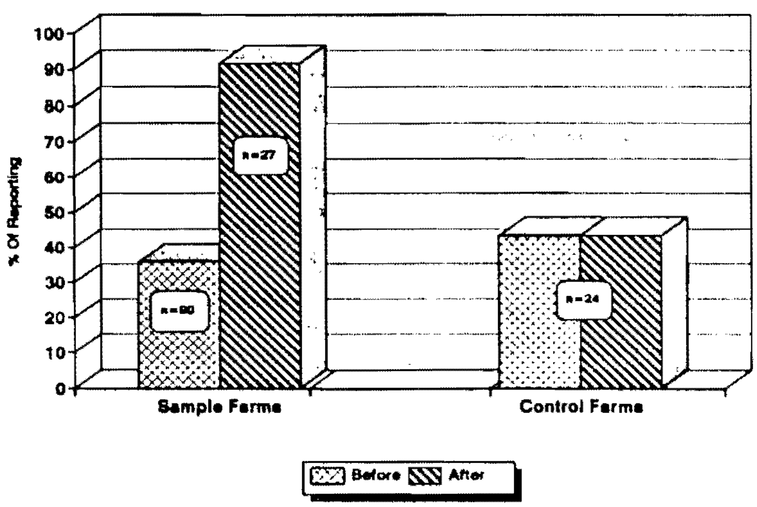

Figure 6. Comparison of average cost per hour for pumping water before and after IIP.

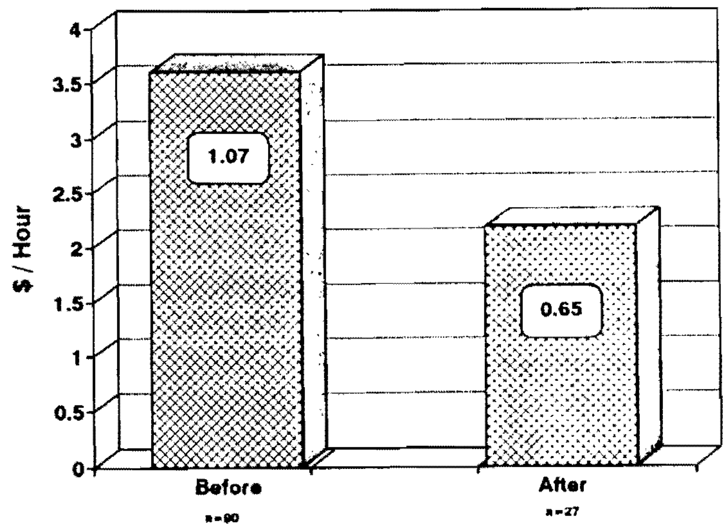

Figure 7. Estimated total cost of pumping water/hectare for two cropping seasons, before (1992) and after (1993) the IIP new mesqa technology.

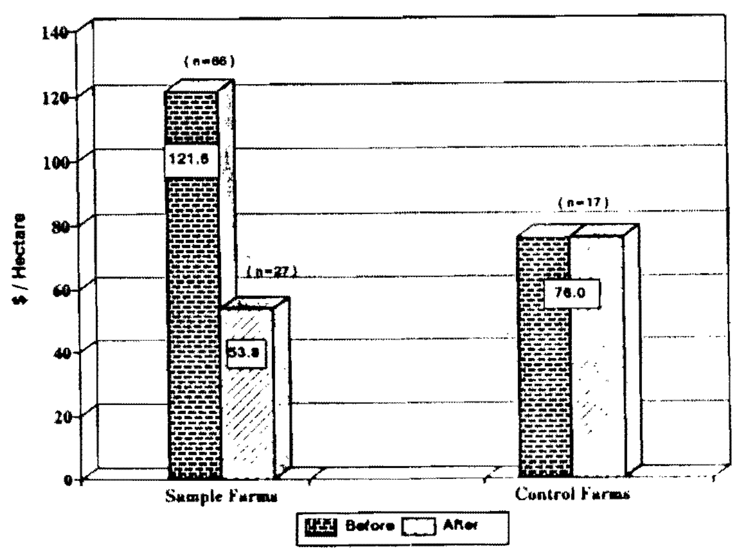

Figure 8. Estimated land savings from new pipeline mesqas (percentage of service area).

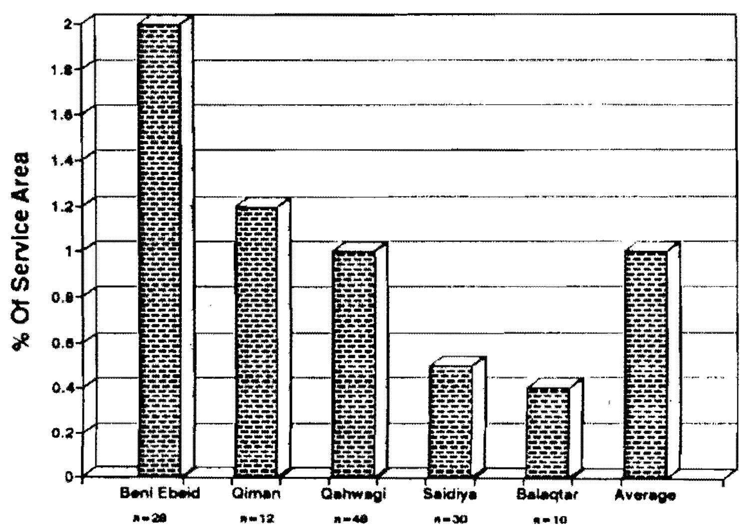

Figure 9. Mesqa maintenance costs per hectare, before and after the new mesqa technology.

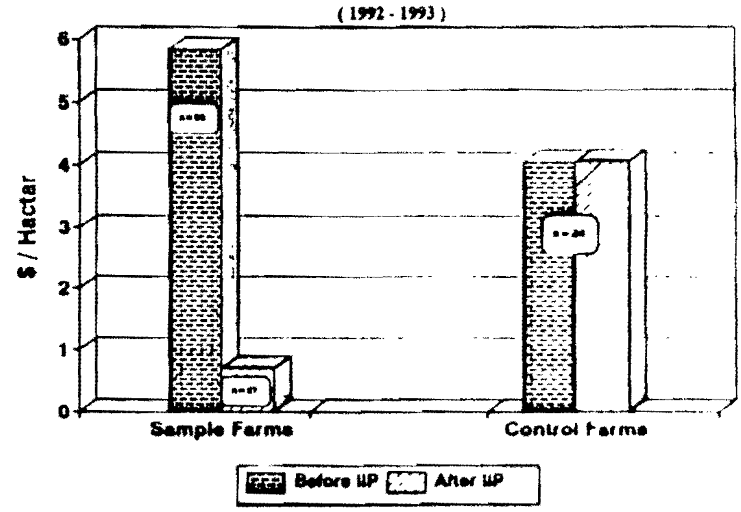

Figure 10. Balance on hand, summary of 31 WUAs.

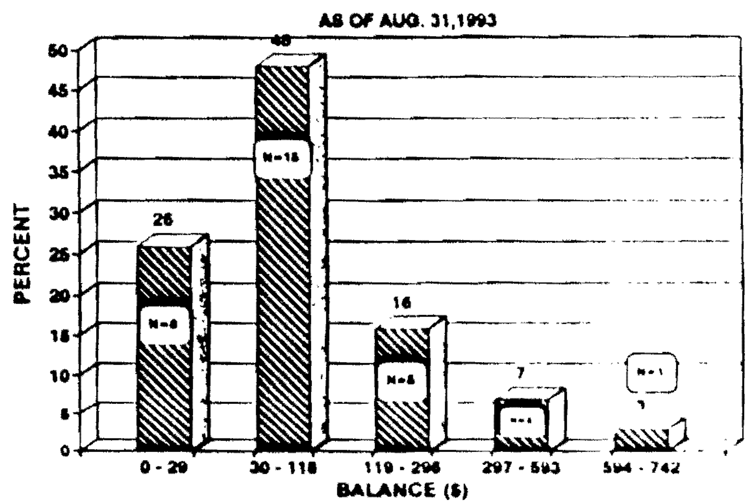

Figure 11. Yield increase after IIP (Herz Numaniya Command Area).

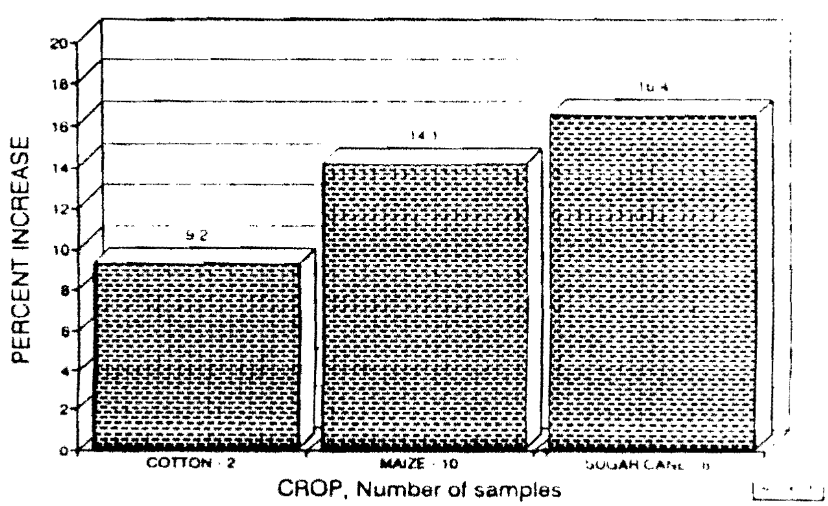

Figure 12. Average time to irrigate one hectare of selected crops before and after IIP (1992-1993).