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Monitoring and Evaluation of Irrigation Management Projects in Egypt

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Abstract

The fewer the water resources, the greater the demand and the more important water becomes. This applies in Egypt, where rainfall is rare and most of the country is desert, except for a narrow strip of cultivated land and urban areas along the Nile river course. Like other large rivers, the Nile Delta region is characterized by large tracts of rich fertile agricultural land, overpopulation and unique and delicate environmental conditions caused by mixing drainage and freshwater. Managing these unique natural resource areas has become increasing critical, given the threat to the ecological balance in these areas due to an increase in water exploitation to boost population and the development of resources. Accordingly, the performance of water-delivery systems, particularly irrigation systems, must be clearly defined and assessed under these current or expected stressed conditions. This paper highlights irrigation, drainage and water-management projects in Egypt and presents the positive and negative effects as well as the role of government and users in operating and maintaining the system. The objective is to identify significant research programs and projects carried out over the last three decades that have impacted on irrigated agricultural practices in Egypt. The study documents both successful and failed cases of direct and indirect research uptake. Specific recommendations for increasing the research uptake, improving the penetration of research results and taking corrective measures to strengthen and encourage research uptake to irrigation and drainage practices are highlighted.

Discipline: Irrigation, drainage and reclamation
Additional key words: canal, drainage, Nile, water resource

Introduction

Water scarcity is a growing global problem; challenging sustainable development and constraining efforts to produce enough food to meet increasing food needs (Molden 2007, 2010). Irrigation accounts for 70% of all water used on the globe; a percentage that approaches 85% when considering the rare water in the Near Eastern countries (FAO 2007). Egypt is one of the worst-affected countries, because of its aridity and a fixed share of limited Nile water. The Nile river ends in a unique delta region that extends over around 2.52 million ha of alluvial soil, while another batch of alluvial soil extends over about 1.05 million ha along the Nile stem upstream.

The total water used from various sources in Egypt is about 76.5 billion m^3, according to the latest estimates (MALR 2009). The Nile river supplies 73% of this demand directly, while the remainder mostly comes indirectly from the Nile (its groundwater aquifers, reusing agricultural drainage water and return flows from the river). High population growth over the past 30 years, and related industry and agriculture has increased the demand for water and will continue to do so in future. By 2017, total water demand is projected to reach about 93.5 billion m^3, which is almost double the fixed available supply. Climate change and global warming are further concerns exacerbating the severity of water shortages. This means the gap between available resources and water needs is getting wider over time and Egypt will soon face water scarcity (FAO 2007).

Irrigation canals are classified into main (first-level) canals, branch (second-level) canals, distribution canals (*mesqas,* or third-level canals which service areas from 15 to 50 ha) and irrigation ditches (*merwas*, which service areas up to 5 ha) as shown in Figure 1.

Irrigation of old lands in Egypt is currently confronted

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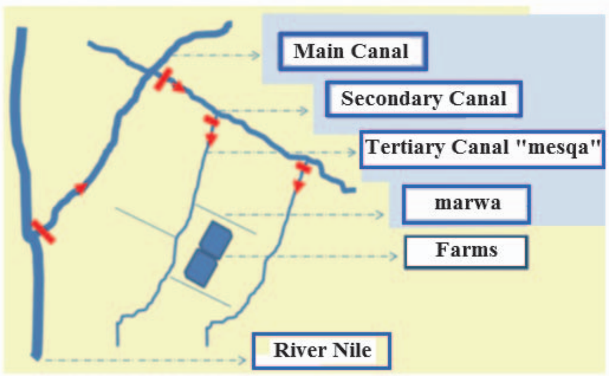

Fig. 1. Schematic layout for the irrigation system in Egypt

with pressing problems, including the inequitable distribution of water at *mesqas* and *marwas*, with most farmers at the tail ends receiving little water. There is also excessive water wasting and energy cost inherent to current system operations. Both issues mainly affect poorer farmers and cause their production and income potential to decline. This has led to losses of cultivated land and irrigation water, sub-optimal use of water, low yields, rigid cropping patterns, and low household food security and income. There are also considerable water losses at *marwas* level, where losses are reportedly between 9 and 17%.

Production and income losses at farm level have been estimated to be even higher and range between 6 to 40% (IFAD 2012). Poor management has been cited as the most frequent irrigation problem (Jensen et al. 1990, El-Agha et al. 2011) leading to sub-optimal use of limited water. Improving irrigation efficiency has long been an important water management goal to reduce waste and save water.

Egypt, in cooperation with many international donors, has commenced some projects to manage and improve water resources. To bridge the gap between the limited water supply and the increasing demand, the Egypt Water-Use Project (EWUP) conducted and financed by the United States agency for international development (USAID) as a research project, took place during the period between 1977 until 1983.

According to the projects' results, the Egyptian government, represented by the Ministry of Water Resources & Irrigation (MWRI), has started a national program to improve irrigation management in old areas located within the valley and Delta. This national program sets up a well-identified framework, including major project requirements and specific items to improve system management; covering an area of 1.47 million ha by 2017. A physical system started in 1984 through a USAID-financed improvement project covered an area of 27,300 ha, including at branch-canal and tertiary levels, and was finished by 1996 (MALR 2009).

The second stage began physically in 1997 and comprised investment to improve the existing irrigation system over 104,160 ha of the northern Nile Delta in Behira and Kafr El-Sheikh Governorates. Physical work on reconstruction and development had been completed by the end of 2005 (JICA 2011).

The Integrated Irrigation Improvement and Management Project (IIIMP) is the third stage of the irrigation-improvement program, which was started in 2007. It is a multi-donor program featuring new approaches, including integrated water management and full user involvement from the planning stage. It was completed in two phases and five irrigation command areas in the delta and Upper Egypt. The first IIIMP phase included the command areas of two main canals, Mahmoudia and Meet Yazid, with gross areas of 120,000 and 111,000 ha or covering about 10% of the irrigated areas in the Nile Delta. There are no data found for the second phase (El Kashef 2012, Kotb & Boissevain 2012).

A new stage, which began in 2010/2011, was called "Sustainable Use of Agricultural Resources Program" with five subprojects; one of which the On-farm Irrigation Development in Oldlands (OFIDO). Some subprojects were already started, while others remained within the preparatory phase. The main goal of this program is to improve on-farm irrigation systems in 2.1 million ha in the Nile Delta and Valley during the action plan period (2011-2021) to save water for reclaiming the targeted areas in the 2030 strategic plan. Also, on-farm irrigation in the newly reclaimed land (0.88 million ha) will improve and be managed during the first action plan 2010-2017 (El-Gendy 2011).

Performance assessment in irrigation and drainage supports when planning and implementing any improvement project, and its process is defined as the systematic observation, documentation and interpretation of activities related to irrigated agriculture, ultimately targeting the efficient and effective use of resources by providing relevant feedback to scheme management at all levels (Bos et al. 2005).

The main objective of this paper is to clarify the positive and negative impacts for the Egyptian irrigation improvement program and introduce some specific recommendation to improve and manage irrigation water for real water savings. Many recommendations were also provided for corrective measures to strengthen and encourage the uptake of research results and findings to irrigation and drainage practices.

Methodology

A desk-based assessment using evaluation studies and projects carried out by government, donors, regional organizations and research institutions was supplemented with information from national partners. In addition, using a combination of field studies and surveys of relevant literature as well as the authors' observations, monitoring and early interviews with stakeholders, the authors built up a picture of the positive and negative impacts of the irrigation-improvement projects.

The monitoring was performed by the authors and the working team at the Agricultural Engineering Department at the Faculty of Agriculture in Benha University, Egypt by visiting many project locations. Considerable data were measured and collected; many positive and negative points were monitored at the field; and the accuracy of the data introduced in the project reports was also ensured.

To address traditional irrigation failings, Egypt has adopted an ambitious target to improve irrigation over about 1.47 million ha, some 70% of which are located in the Delta, by 2017 (NWRP 2005). Most improvement projects also include many subprojects and here, the authors focused on subprojects related to water and irrigation management. According to the review, the main aim of all projects was to improve the water-delivery system ("*mesqa* and *marwa*" branch canals).

Improving *mesqa* is key to enhancing overall irrigation performance and includes upgrading existing models with new replacements. The old *mesqa* are usually earthen and low-level ditches with non-organized water withdrawals via multiple pumping points along their lengths. Two types were recommended for improvement: open elevated *mesqa* and buried low-pressure pipes. Elevated *mesqa* comprise an open ditch, but one which is lined and elevated, while the normal water level in the elevated *mesqa* was set to allow gravity flow to fields at 15 cm above the field level. Alternatives for elevated *mesqa* included a rectangular concrete cast-in place section and precast concrete shaped as a "U" section as shown in Figure 2. Low-pressure PVC pipeline *mesqa* are a further choice for replacing the old *mesqa*; set about one meter below grade and equipped with risers at intervals of about 100 meters. The flow from each riser is also controlled by an alfalfa valve. Such *mesqas*, elevated or pipeline, are intended to minimize the seepage of water. The end of the *mesqa* is also closed to prevent water losses into drains.

Monitoring and Evaluation Results

The Irrigation Improvement Project (IIP) package includes both technical and social modifications to the irrigation system. The fundamental change introduced by the IIP involved replacing individual farmer pumping at many points along the *mesqa* with collective pumping at a single point. Accordingly, the IIP organized farmers in *mesqa*-level Water Users' Associations (WUAs), introduced a continuous water supply to branch and sub-branch canals, installed a pump station at each *mesqa* and replaced the open *mesqa* canal with a subsurface piped system. The IIP packages also included improving branch canals by installing downstream control gates; targeting on-demand irrigation, and establishing an Irrigation Advisory Service (IAS).

1. The Project Achievements

(1) Improved delivery system for main and secondary canals:

Within the project term, delivery designs for 68 main and secondary canals (134 km long) serving 88,200 ha were completed. This included 116 downstream control gates and 39 discharge control distributors, with associated regulators; requiring around 39,000 m^3 for masonry pitching, and 190,000 m^3 of earthworks for canal modeling.

The irrigation system in the old lands of project governorates implies considerable losses through tail escapes, excess irrigation at canal heads, and water shortages and irregular supply at tail ends. Many individual mobile pumps are costly to operate and maintain, while pump owners may overcharge for pumping fees. The main canals are operated based on continuous-flow and upstream-control systems,

Fig. 2. Mesqa improvement using a precast concrete "U" section (IFAD 2012.)

while the secondary and tertiary canals are operated on a seasonally adjusted rotation schedule. The main irrigation and drainage systems, particularly in Mahmoudia and Meet Yazid command areas, are in good working condition, thanks mainly to investments under IIPs and IIIMP since 1989. The rotational system of water distribution in branch canals serving 29,274 ha has been converted to continuous flow for "on-demand" delivery of water to the *mesqas*. This is also linked to *mesqa* improvement, i.e. tertiary canals are being raised, pipelines to distribute water installed, and individual pumps replaced with single point pumps to improve operations and reduce pumping costs. To date, tertiary canals (*mesqas*) serving 70,390 ha have been improved and their farmers are organized in 2,600 *mesqa* WUAs. Quaternary canal (*marwa*) improvements (piped or lined) have been low (2,465ha), covering about 1% of the irrigation command areas. Under IIIMP, *mesqa* and *marwa* improvements are expected to extend the scope by an additional 78,000 ha, which will bring the total *mesqa* coverage to 64 and *marwa* to only 34% of the irrigation command areas. To date, branch-canal WUAs have been formed on 66 branch canals serving about 100,800 ha and an additional 78,000 ha is expected to be covered when IIIMP is complete in 2013.

Upper Egypt is located at the top of the Nile irrigation system, where water in the main system is generally accessible in all project governorates, but with limited distribution equity. Investments in irrigation and water management in project governorates remain low to date and only 55 mesqas in Qena and 14 in the Assiut Governorate, covering 1,773 and 1,122 ha respectively, have been improved and spawned private *mesqas*. Similarly *marwa* improvements have progressed only slowly. To date, *marwa* improvement has covered about 5,880 ha, or less than 1.5% of the irrigation command areas. The concept of branch-canal WUAs has also been restricted to Qena Governorate, where 225 WUAs have been formed, covering 97% of the irrigation command areas in the governorate.

(2) Irrigation Advisory Services (IAS)

This was established as one of the IIP items to provide technical support and training for the WUAs at *mesqa* and branch-canal level when operating and maintaining improved *mesqas*. The main objective of the IAS is to promote WUA participation at different work levels as well as solving conflicts among farmers. IAS with the WUAs successfully performed more than 3,500 improved *mesqas*. IAS creates about 65 branch canals and WUAs cover all the improved branch canals.

(3) Modified drainage system

Studies from 1977 to 1988 focused on the validity of the modified drainage concept from the perspective of conserving water for rice irrigation (DRI 2007). This is based on dividing the total drained area to sub-areas served by sub-collectors and one collector. An investigation program was conducted from 1977 until 1979, while the modified drainage was developed and tested during the period of 1980-1988 in the experimental fields at Balakter pilot areas, Behira Governorate.

In general, it was noted that modified drainage saves about 32-48% of the irrigation water. Applying irrigation improvement could save 21% through lining *mesqas*, using one lifting point, and irrigation scheduling for every farmer. The studies of Drainage Research Institute (DRI) during the period from 1996 to 2000 confirmed the application of controlled drainage with IIP could save about 1000 m^3/ha of Rice irrigation water (DRI 2007), while irrigation time savings were 32% in the area with IIP during the rice season of 1997.

(4) Modern irrigation systems

The West Noubaria Rural Development Project (WNRDP) has significantly boosted the advancing national effort to improve the irrigation system in Egypt, by promoting water saving for irrigated agriculture in the Project area (modernized irrigation is applied because the soil is characterized by relatively higher permeability). Support provided to small farmers and WUAs (training, capacity building, and credit) to change irrigation techniques used for fruit trees plantations have allowed a total area of 11,986 ha to be equipped with drip irrigation in 2011(IFAD 2012). The area equipped with drip irrigation represents 51% of the total farmland area in Tiba and Al-Entelak and is estimated at 23,529 ha. The project successfully created 117 registered WUAs, and serviced 8,403 ha.

The impact on the protection of natural resources and water has been satisfactory. The water saved by converting from sprinkler-based to drip irrigation amounts to 24 m^3/ha, due to higher efficiency and less wetted area (MALR 2009). In other words, for the added 11,986 ha with drip irrigation, a total volume of 285,270 m^3 of water was saved. The total water saved makes it possible to irrigate residual farmland areas in Tiba and Al-Entelak (3,786 ha), given that 60 m^3 are needed to irrigate 1 ha through drip irrigation.

2. Positive impacts on irrigation management:

+ At the *mesqa* level, the IIP has effectively reduced the problem of water inequity and supply shortages, by a combination of technical and institutional interventions. These include replacing rotational with continuous flow in combination with gravity flow in raised open *mesqa* canals or buried pipes operated at low-pressure. Although continuous-flow conditions have not yet been attained, building lined canals and burying pipes has increased the conveyance efficiency. The irrigation improvement package has also improved conveyance efficiency at tertiary level by 30%, which includes improving head-tail equity and reduction in irrigation time by 50-60%, land saving of 2%, and crop yield by 10-15% (Kotb & Boissevain 2012).

+ Individual pumping has been replaced by a centrally operated pumping system managed by WUA members. Notably, the shift from individual to collective pumping has resulted in considerable cost savings of about one-third (IFAD 2012).

+ According to the preliminary findings of IIP's monitoring and evaluation item, unofficial reuse of drainage water has largely been eliminated along improved *mesqas*, while water losses at the tail ends of the *mesqas* into open drains were also significantly reduced. The positive effect of irrigation efficiency gains at the *mesqas* may be countered by the loss of the "multiplier effect" of unofficial water reuse at that level; thus paving the way to expand official reuse (World Bank 2012).

+ Assessing farmers' acceptance of the continuous flow indicated that about 85% of the farmers preferred the pipeline as an improved *mesqa* rather than raised-lined *mesqa*, which resulted in around 2% of land being saved for cultivation. Moreover, the investment-cost recovery mechanisms at *mesqa* level are being widely accepted by farmers and increasingly applied through the land tax-collection system (According to our survey in Kafr El-Sheikh (n=60)).

+ The first IIIMP phase has spawned crop-yield increases of 20% and drainage is thought to have accounted for 15-25% of this increase (El Kashef 2012).

+ In new areas in the fringes of the Nile Delta and Valley, modernized irrigation (sprinkler or drip) is applied because the soil is characterized by higher permeability (mostly sandy soil). The area under modern irrigation is about 400,000 ha; i.e. about 11% of the total irrigated area (MALR 2009). Modernized irrigation is now becoming a must, by law, in newly reclaimed land in Egypt. The shift in irrigation techniques from mobile sprinkler to drip irrigation is a positive impact of the improvement project, which allowed water savings of 10% (irrigation efficiency increased from 80% for the sprinkler to more than 90% for drip irrigation).

+ The project helped enhance environmental conditions in the improved areas and reduce water-related diseases (Human diseases resulting from insects and bacteria living in stagnant water and weeds) following the shift to pipelines *mesqas* instead of open uncovered ones and since reducing the informal reuse of drainage water for irrigation (IFAD 2012).

+ The project helped reduce poverty among the beneficiary population by increasing the farmers' income. This was achieved by increasing the agricultural production, saving land and reducing the cost of irrigation and maintenance. Yields varied between improved and unimproved areas between 6-12% depending on the crop and variety (e.g. rice yield increased by 8.8% and cotton yield by 4.5%) (MALR 2009).

3. Negative impacts on water management:

-All project assessments and/or evaluation reports assume there a lack of means to monitor improvement effects on agricultural benefits, operational gains for farmers, and changes (increase or decrease) in water use and equity (fairness) of water distribution.

-Setting up IIP has elicited higher level irrigation system improvements, regardless of the fact that ignoring the reduction in system supplies will limit project effectiveness and impact on farmers. Improving the main, secondary and tertiary irrigation canals without attention to the need for *marwa* and on-farm improvement will decrease the potential benefits. Similarly, *mesqa*, *marwa* and on-farm improvement packages without higher system-level interventions will also fail to yield desirable results. In addition, minor incremental investments in on-farm water management and irrigation improvements elicit substantial incremental benefits for farming income thanks to higher yields, improved water distribution, equity for tail end users and higher water-use efficiency.

-The on-farm improvement component showed a lack of awareness of the importance of spreading results on the part of MWRI and excessive focus by the Ministry of Agriculture and Land Reclamation (MALR) on land-leveling in the demonstration program, which hindered intended interventions to improve irrigation management. It failed to achieve the expected on-farm impact.

-Introducing continuous flow is still lagging significantly behind other improvement interventions. Continuous flow has been effectively applied only to 18% of Mahmoudia samples, which indicates the deficiencies in project planning.

-However, the effects of IIP's technical interventions on performing and functioning of existing land drainage are not fully understood. It is assumed that the expected effect of improved *mesqa* design, via IIP interventions, would trigger decreased seepage losses, and hence lower water tables and reduced drain discharge of laterals. It was reported that water tables in the improved area rendered the discharge capacity of drainage systems less effective (IPTRID 2007).

-The survey performed by authors showed that 45% of farmers reused drainage unofficially due to inadequate distribution of canal water in some regions.

Conclusion

The irrigation improvement package began with uncomplicated tertiary level improvement and has been expanded over the years. The improvement embraces a single-lifting point at tertiary level, subsurface drainage, quaternary level improvement, laser land-leveling, improvements to the delivery and main canals, and strengthening efforts to allow water users to get involved in operating and maintaining the improved facilities. The irrigation improvement package has successfully improved distribution efficiency at tertiary level, including head-tail equity, irrigation time, land saving, and crop yield. The current irrigation improvement package has successfully improved conveyance efficiency at tertiary level by 30%, which includes improving head-tail equity, reducing irrigation time by 50-60%, land saving of 2%, and crop yield by 10-15%. In new areas on the fringes of the Nile Delta and Valley, modernized irrigation is applied because the soil shows relatively higher permeability. The present area covered by a modern irrigation system comprises about 11% of the total irrigated area. Modernized irrigation is now becoming a must, by law for newly reclaimed land in Egypt.

Recommendations and the Way Forward for Improvement

Under conditions where water is scarce, real water savings, which may increase water-use efficiency, can come from many sources. If the Egyptian government wants to achieve its overall goals of increasing the efficiency and sustainability of water use, it should focus more closely on the following points:

-Increase the field irrigation efficiency from 45 to 60%, which means saving on irrigation water (6,000 m^3/ha/season when cultivating the short-period span rice). It is strongly recommended to continue implementing the full irrigation improvement package in Egypt's old lands, which are served by old irrigation systems. This may result in considerable water saving of up to 5 billion cubic meters per year.

-All previous and current activities to improve old land concentrate on increasing only distribution efficiency by applying continuous flow, replacing old earthen *mesqa* by PVC pipelines and later replacing earthen *marwa* by PVC pipelines. However, on-farm management activities such as land-leveling, agronomic practices, modified cultivation methods and training will help improve application efficiency. Whether this leads to real water savings depends on whether that water is reused.

-Using geographic information systems (GIS) and other modern information systems in association with real data and obtaining real feedback of cropping patterns in advance from farmers via WUAs opens up great opportunities to improve the management of natural resources. Besides, applying an on-demand water supply will enhance the reliability of water delivery, which can be achieved using a rotation-flow or continuous-flow system. The key is receiving real data about cropping patterns in advance to facilitate planning of a good irrigation schedule that would help reduce the gap between demand and supply.

-The irrigation and water-management portion would include: (a) improvement of farm-level irrigation systems to use irrigation water more rationally; (b) enhanced water-management practices to distribute available water more equitably; and (c) greater and more effective participation of users and stakeholders in water management for sustained irrigation and improved crop production.

-The main risk to the efficient and sustainable use of land and water resources is price signals that persuade farmers to grow crops that are water intensive, such as rice. This can be mitigated by introducing high-value crops that offer viable alternatives. In addition, the lack of financial resources could limit the introduction of technologies to use land and water more efficiently, such as farm-level irrigation improvement, laser land-leveling, the use of improved inputs, etc. This may be mitigated by introducing financial services as a key part of the current strategy.

-According to farmers surveys conducted by the authors, several farmers are aware of the importance of land-leveling using laser equipment and its effect in terms of saving water and time required for irrigation. However, even when they are willing to apply it, they are unable to do so, because as well as cost, coordinating details among neighboring farmers and arranging crops are both difficult. Traditional techniques still prevail in IIP areas and few farmers are aware of improved irrigation practices. We recommend establishing a visionary plan to increase agricultural mechanization stations that serve farmers at affordable prices, as well as encouraging the private sector to invest in this area.

-Without more definite information concerning actual changes in water-use quantities, on-farm irrigation efficiencies, and future expansion of projects, researchers will find it difficult to make any substantive predictions on the projects' impact on the quantity and quality of surface and subsurface drainage water and its reuse, drainage requirements, and replenish-able groundwater sources. For this reason, we propose establishing a specialized unit, supervised by both MWRI and MALR, to provide integrated databases with project results constantly updated to help researchers.

-Integrated water resource management should be introduced at all appropriate levels from field to basin level. Current efforts to improve irrigation supply management must be accompanied by improved water demand management measures. There is a need to integrate agricultural improvement technologies into IIIMP and exploit improved water-control technology such as controlled drainage. Moreover, educating farmers on where IIIMP water savings are intended to go will become increasingly important at the farm as well as on the *mesqa* level.

-Broad institutional development should be introduced; based on stakeholder participation and streamlined within a national water resource policy. Currently, existing water user organizations at branch-canal level lack legal recognition. If such institutions are to be operational, their legal and financial status should be clarified and likewise their collaboration with the lowest level public authorities.

-The IIIMP should include a campaign to increase awareness of the importance of functions and stakeholder values and focus on the skills required for both water and financial management.

-A centrally operated pumping system has replaced individual pumping, managed by water users who have formed water user associations. We have to support this technique more in coming projects to apply it in the most cultivated areas. Notably, the shift from individual to collective pumping has allowed in considerable cost savings of about one-third.

-Twinning and partnerships between all water and irrigation departments and authorities will create an environment to facilitate the successful transfer of interactive research output to field implementation. Currently, uncertainty over communication channels among research institutes and universities as well as government may trigger misunderstanding in roles and constrain overall progress of the irrigation improvement project. Accordingly, the actual cooperation between them must be considered. This means all details related to the research project agenda can be discussed and their views and comments carefully considered. In many cases, their operational experience alters the research agenda dictating ideas for pressing research topics.

-Documentation is one of the main tools in research uptake. Some studies previously discussed were financed by foreign and international donors, whereby most of their documentation was written in English and is difficult for engineers or farmers to understand and adapt. Moreover, occasionally limited documentation material obstructed the research uptake.

-A comprehensive database for all water and irrigation-improvement projects, findings and recommendations must be established. This database should be accessible by all research staff for their benefit and education. It might also be advisable to put it on a special and known website.

-Small (1/2 to 1 acre) drip-irrigation systems should be tested, modified and adopted to cater for horticultural and other crops and perform the relevant financial and economic analyses for adaptation by smallholders. Drip irrigation would reduce the water added by up to 50%, while simultaneously boosting yields by 30-50%. These indicative improvements suggest that it would be economically viable for smallholders to upgrade their irrigation systems.

-The first step toward saving irrigation water and improving the efficiency of current systems comes in the form of projects to manage water and improve irrigation under a single umbrella, as well as coordination roles. Here, the first priority is to expand the improvement and development of irrigation systems. Subsequently, simulation models can be used to calculate the estimated values lost in drainage. This information can then be used in drainage and reuse water projects by leveraging the calculated quantities. Where the current situation does not allow for efforts to expand existing water-reuse projects and improved irrigation systems to help reduce drainage losses, these projects will fail to meet their objectives.

-When planning improvement projects, it is important to bear in mind a long-term plan to maintain and follow-up matters with responsible authorities, particularly after the original project timeline and therefore maintained on the results obtained. It is recommended that the government encourage the development of financial service projects to address the above investments.

Finally, a new mindset is required when managing irrigation water. Firstly, performance across scale must be considered. The second priority is to focus more on quality considerations. Most irrigation management projects have been deployed in the same regions in Delta (Kafr El-Shekh & El –Behaira governorates) and Upper Egypt (El Menia & Asiut governorates) and these regions only need to maintain the improved irrigation system, not launch new ones. For that purpose, the new improvement projects have to be established elsewhere, where irrigation water savings will be more effective.

Finally, tangible water savings must be pursued if irrigation improvement is to become a reality.

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