HOLISTIC PERSPECTIVE FOR INVESTMENTS IN AGRICULTURAL DRAINAGE IN EGYPT

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ABSTRACT

During the last 30-40 years, Egypt has implemented one of the largest drainage networks in the world, consisting of surface drains, subsurface drains, pump stations and other related works. The target area to be provided with subsurface drainage in Egypt is 6.4 million acres out of which about 5.5 million acres is already implemented. Subsurface drainage systems in Egypt have reached the stage that more areas installed have, in theory, passed their economic lifetime and these areas need rehabilitation.

The overall cost of installation of subsurface drainage in Egypt is estimated at EGP 1600 per acre (year 2007), and about EGP 900 per acre for rehabilitation of old drainage systems. Maintenance costs are estimated at EGP 50 per acre per year. The pay back period of drainage is not more than 3-4 years. Incremental benefits of improved drainage on productivity amount to US $ 250 – 350, per hectare depending on location and soils.

Recently, a new role for drainage as a complementary part of the integrated water resources management has been recognized and the benefits of drainage went beyond reducing soil salinity and increasing crop yields. For that reason a new view for the drainage investment is needed which take into consideration all the benefits and impacts and the expected changes in all levels of planning, implementing, operating, maintaining and managing the new and old drainage systems.

The objective of this paper is to identify the current and future investments of agriculture drainage for a sustainable agricultural production in Egypt. In spite of the great achievements and benefits of drainage in Egypt, there is a huge potential for investments are needed to sustain agricultural drainage against the future challenges.

INTRODUCTION

Irrigated agriculture represents only 17 percent of total land cropped in the world, but provides 40 percent of the world's food. It is expected that irrigated agriculture will provide close to two-thirds of the additional food needed over the next 25 years. There is still some potential to expand irrigated area, which could be increased by up to 20 percent (40 million hectares) over the next 25 years.

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Poor irrigation and agronomic practices have led salinity, sodicity, and waterlogging to affect 40-50 percent of the world's 270 million hectares of land currently under irrigation. Proper management and provision for subsurface drainage in irrigation systems can address waterlogging and salinity problems and enhance productivity and sustainability of irrigation system. Drainage investments are needed to control waterlogging and salinity on 60-85 million hectares of currently irrigated lands. This investment can yield significant economic benefits (World Bank, 2006)

Drainage plays an essential part in food production while safeguarding the investments in irrigation and conserving land resources. During the second half of the 20th Century, drainage was implemented in about 150 million hectares of under-producing and naturally waterlogged or salinized lands, in many parts of the world.

Drainage has also contributed to agricultural intensification and diversification and as such has made the agricultural sector more competitive and financially sustainable. In global terms, however, drainage is still far of being adequate or sufficient. Out of the worldwide 1500 million ha of irrigated and rainfed cropped land, only about 14% is provided with some form of artificial drainage. In arid and semi-arid areas some 20 to 30 million ha suffer from irrigation induced degradation resulting in water logging and high soil salinity (ICID Statistics, 2003).

About US$20.7 billion has been spent by the World Bank for irrigation and drainage investments since 1980, but a reduced level of funding has been reported in recent years, dropping from US$1,040 million per year during 1994-96 to US$891 million per year in 1997-99, and US$490 million per year in 2000-02 (World Bank, 2006).

Since the 1970s about US$3 billion in Egypt has been invested to provide drainage for 2 million hectares for mitigation the effect of the irrigation-induced on water-logging and salinity. These investments lead to adopting appropriate technologies, improving irrigation systems, transferring management to water users associations, and adopting a well-functioning system of cost recovery. Egypt has a cropping intensity of 200 percent, and crop yields for wheat, rice, and cotton are among the highest in the world. Improved drainage accounts for 15-25 percent of crop yield increases (World Bank 2002).

Nowadays a new role for drainage has been recognized as an complementary part of the integrated water resources system. An integrated approach (DRAINFRAME), addressing all positive and negative impacts of drainage has been introduced by Abdel-Dayem et al 2004, which shows how a participatory planning methodology looking at every aspect of the resource system and all the stakeholders can untangle the multiple impacts, costs, and benefits; prioritize investments; and begin to locate benefits and mitigate side effects.

The objective of this paper is to identify the current and future investments of agriculture drainage for sustainable agricultural production in Egypt.

Drainage in Egypt

Egypt's Nile Valley and Delta, one of the oldest agricultural areas in the world, has been under continuous cultivation for at least 5000 years. Egypt has an arid climate, characterized by high evaporation rates (1500-2400 mm/year) and little rainfall (5-200 mm/year), thus agriculture mainly depends on irrigation from the river Nile (Fig 1). In the 1960's, the Egyptian Government started an ambitious programme to implement drainage system in approximately 2.5 million ha of agricultural land with an annual implementation capacity of about 70 000 ha and it is expected to be completed around 2012 (Nijland et al 2005).

The implementation of drainage systems involves the following steps:

- Construction of open main drains or the remodeling of the existing main surface drains
- Construction of drainage pumping stations to keep the water level in the main surface drains at 2.5 m below field level so that the pipe systems can discharge by gravity in these main drains;
- Construction of pipe field drainage systems consisting of field drains and pipe collector drains.

The overall cost of installation of subsurface drainage in Egypt is estimated at EGP 1600 per acre (year 2007), and about EGP/900/ acres for rehabilitation of old drainage systems. Maintenance costs are estimated at EGP 50 per acre per year. Assuming that 2/3 of incremental income can be attributed to drainage; this would mean that the payback period of drainage is not more than 3-4 years. Drainage is one of the most important investments for raising agricultural productivity in a country with limited water resources and high population growth. Drainage is estimated to have an economic rate of return of 19 percent. The annual contribution of drainage to the Gross Domestic Product was estimated at US$0.9 billion or 8 percent of agricultural value added (Ali et al 2001).

Cost recovery for drainage investments and maintenance has improved, as is reflected in a 25-year time frame for full recovery of capital costs, shared between government (50-55 percent) and beneficiaries (40-45 percent) (World Bank, 2006).

DRIVERS FOR INVESTMENT IN EGYPT

The pressure of fast growing population

The growing population of Egypt and related industrial and agricultural activities has increased the demand for water and land to a level that reaches the limits of the available supply. The population of Egypt has been growing in the last 50 years from 19 million in year 1947 to about 38 million in the year 1977 to 66 million in 2002 and 70 million in the year 2005, with an annual increase of about 1.4 million. It is expected to grow to 83 million in the year 2017 and to be about 95 million by the year 2025 (see fig. 2).

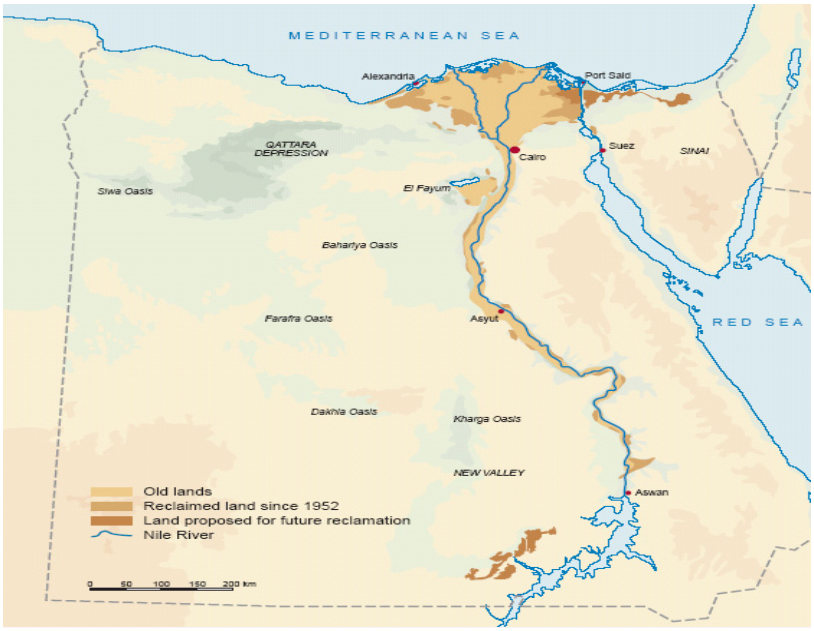

Figure 1. Agricultural land in Egypt

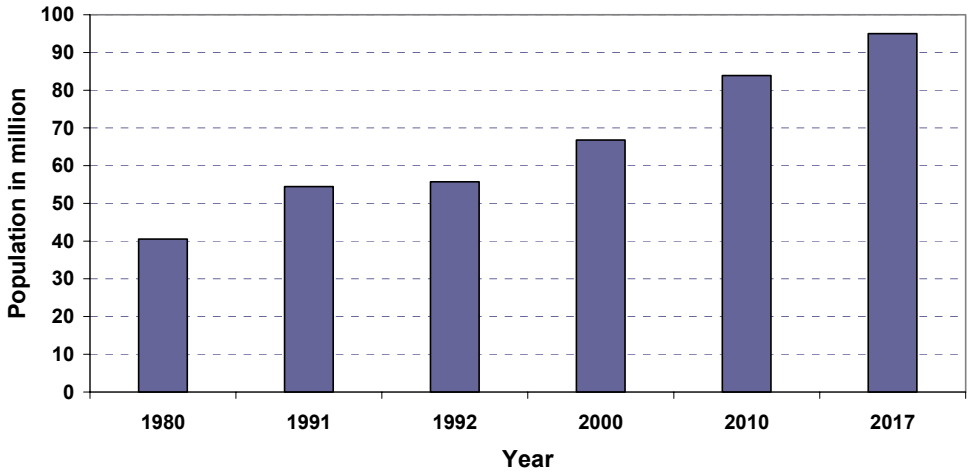

Figure 2. Population growth

The present population of Egypt is strongly concentrated in the Nile Valley and the Delta and 97% of the population lives on 4% of land of Egypt. To relieve the pressure on the Nile Valley and Delta the government has embarked an ambitious programme to increase the inhabited area by means of horizontal and vertical expansion projects in agriculture. All these developments require water and reclamation of both old and new lands. Population Growth and related industrial developments have resulted in a severe pollution of the water either in canals or drains. This pollution is threatening public health and reducing the amount of good quality water either surface or drainage water even further. The government of Egypt has to face these challenges.

Limited Land Resources

The total area of Egypt is 1.001,450 km^2, the majority of which is desert lands representing 96%. Most cultivated lands are located adjacent to the Nile banks, its main branches and canals. Currently the inhabited area is about 12.5×10^6 acres and the cultivated agricultural land is about 7.85×10^6 acres. The per capita cultivated land declined from about 0.4 acres in 1960 to about 0.2 acres in 1996. The sharp decline of the per capita of both cultivated land and crop area resulted in the decrease of the per capita crop production. This affects directly the food security at the individual, family, community and country levels.

The need for drainage development

In Egypt there is a long history of irrigation. During last decades there has been a development in irrigation in conjunction with the construction of reservoirs. Aside from huge benefits of the irrigation projects they have also resulted in water logging and salinization. Therefore drainage systems are required at a large scale to enable irrigated agriculture on a sustainable basis. It is the role of drainage community to provide policy makers with tools that allow consideration of all aspects regarding production and resources preservation.

The need for drainage is generally determined to increase and/or rationalize food production or to prevent lower production levels due to problems induced by irrigation. In other words there is a direct link between the investments to be made and the benefits to be expected. These benefits generally include the increase in yields or in the case of land reclamation the opening up of new areas resulting in new agriculture production potential. Because of an increase in population and in consumption per head, it is necessary to increase food production. This may be obtained by realizing higher yields at existing agricultural lands and/or reclamation of new land.

Pollution and Environmental Degradation

Although Egypt's efforts in birth control have been acknowledged by the international community, the population still will continue to grow. The population growth has put more stress on both water and land resources. Degradation of these resources, due to heavy socio-economic exploitation, adds up to the water scarcity problem. This situation has brought water quality as a milestone in water resources management. Over the last 30 years applied research has been facilitating the soft shift from water quantity based to water quality based management.

The need for a holistic perspective

No doubt that drainage is an important and complementary part of integrated water resource management and many benefits from drainage are invisible to decision makers, managers, users, stakeholders, private sector and civil society. But in recent years these invisible benefits of drainage have been recognized and the role of drainage went beyond controlling water logging and salinity such as:

- The Economic benefits from drainage include improved crop productivity, greater sustainability, and opportunities for crop diversification for higher income and also from incremental revenues from horticulture or benefits from improved education, health, and family income.
- Social benefits primarily relate to poverty reduction, reduction of mosquito-breeding areas, improved storm water control, and improved access to fields.
- Environmental benefits can include elimination of barren saline areas, and minimizing the movement of chemical and herbicide to drainage water.
- Drainage can improve public health and sanitary conditions in villages, lower maintenance costs of rural roads, enhance the durability of foundations and mud-based houses, and reduce flooding-related infrastructural damage and disruption.

With this new holistic perspective for the benefits from agricultural drainage, a huge potential for investments is available. This new perspective requires a better documentation of the negative and positive impacts of drainage and an assessment of what has worked in the different drainage environments.

POTENTIAL INVESTMENT IN DRAINAGE IN EGYPT

Opportunities for profitable new investments are more difficult because of increasing costs, such as materials, machines, labors, equipments; new environmental and social costs not previously recognized in drainage projects; a growing need for drainage investments; and falling commodity prices. There are, however, significant opportunities for investments in drainage as following:

Investment in public awareness

As mentioned above the role of drainage still invisible for decision makers, managers, users, stakeholders, private sector and civil society. The first step in encouraging the investment in agricultural drainage is to have national public awareness program. The Investment in this program can include preparing television programs, establishing of information centers, organizing workshops and meeting at local and high level, and publishing of newsletters for all communities in the Nation. When the potential benefits from drainage agricultural and the potential investment are known for the hole Nation, the situation will be suitable for creating more drainage projects at different levels.

Investment in existing drainage system utilization

Monitoring and evaluation of existing drainage system is very important for the sustainability of irrigated agricultural to avoid the degradation in soil, crop, and water resources. Adequate financing is essential for such monitoring to correct problems that can be detected. Decisions on when to undertake drainage work require realistic information from baseline studies, projections, or models, especially for newly irrigated land (World Bank 2006).

The expansion of irrigated area slowed from two percent a year in the 1960s and 1970s to hardly one percent in the 1990s, and water is increasingly unavailable for irrigation. Given present land and water resource constraints and the shortage of potential areas for new development, most production gains must come from better utilization of existing irrigated areas (World Bank 2006). This is a great challenge, and for that reason the utilization of existing irrigation and drainage system is a must.

During the last 30-40 years, Egypt has implemented one of the largest drainage networks in the world, which consist of surface drains, subsurface drains, pump stations and other related works. The target area to be provided with subsurface drainage in Egypt is 6.4 million acres and about 5.5 million acres has already been implemented. Subsurface drainage systems in Egypt have reached the stage that more areas installed have, in theory, passed their economic lifetime and these areas need rehabilitation which gives more potential for investments.

Wahba et al 2005 showed a new concept of management for existing subsurface drainage systems in Egypt and a large opportunity for irrigation water can be saved by proper management of these existing systems. For that reason with a low investment in utilization of existing drainage system more benefits can be gained. The investment here includes monitoring and evaluation, management of existing system, development of tools for management, training and public awareness.

Investment in Drainage of the New Lands

The population in Egypt is expected to reach 85 million within two decades. Unemployment runs between 11 to 20 percent of the population. For this reason horizontal expansion is being one of the main policies of the Egyptian Government to provide food, all manner of jobs and long-term investment opportunities for the increasing population. El-Salam project (585,000 acres) and Toshka project (540,000 acres) are examples for the new reclaimed area in Egypt.

The main characteristics of the new lands differ from the old Delta lands with regard to soil and crop types, water quantity and quality and availability, infrastructure, irrigation types, mentality of farmers, users, stakeholders, and economic levels. Based on these differences, the investments in drainage in the new lands will be absolutely different than in old land with regard to source of funds, the way for paying infrastructure, cost recovery, and maintenance service The investment in the new lands may include, infrastructure (open drains, pump stations, drainage structures), water user associations, and water boards, drainage materials, machines and maintenance equipment, consultation work for monitoring and evaluation of water tables, water quality, and soil quality, changes in cropping systems, water supply, seasonal water variation, and environmental assessments,

Investment in drainage of Oasis and closed basins

The New Valley is a large depression located between the Nile Valley and Libya. In this depression there are five main Oasis which are Paris, Kharaga, Dakhla, Farafra and Bahariya.

The future cultivated land will amount to 152,370 acre by year 2010 (Nialnd et al 2005). Also there is Siwa Oasis in the North West of delta with an agricultural area about 30.000 acre. Generally drainage problems are created from excess irrigation water discharged from free flowing springs and uncontrolled wells. This causes increases in subsurface water level and soil salinity of top soil layers

The drainage in such Oasis is not like the conventional system in old land due to the topographic features of the depressions and the investment here will include non-conventional drainage systems, integrated water management, utilization and protection of ground water, utilization of drainage water, multiuse of drainage water, utilization of sunshine power for desalinization of drainage water, and safety disposal of drainage water. In recent years a lot of investors have started reclamation of new lands in these areas and at the same time these Oasis are famous with high value crops like dates and olives which give more potential for higher economic return from drainage investment in these areas.

Investment in Bio-drainage

Bio-drainage has not been used extensively in large-scale projects, although it is promising under the right conditions. Bio-drainage removes excess groundwater through transpiration by vegetation with high water use, such as eucalyptus trees. This maintains groundwater levels below the root zone of crop plants. Other advantages are wind erosion control, elimination of drainage water disposal problems, low investment cost, and ecological benefits. Disadvantages are that bio-drainage areas use potential cropland, do not remove salts, and may interfere with water use by crops (World Bank 2006).

An integrated irrigated system with shelterbelts trees as a bio-drainage in Egypt's South Valley Project is investigated by Amer and Wahba 2005 for enhancing sustainable communities in the area has been proposed and multi benefits with sand dunes fixation have been shown. The proposed system is recommended to be applied in an integrated way with the irrigation and drainage system. Bio-drainage still new in Egypt and with the consideration of potential benefits from it, so investment in bio-drainage can be in the first priority in the future of drainage investment in Egypt.

Investment in Controlled Drainage

Controlled drainage is a technique for regulating the water table level, which allows harvesting “more crop per drop” in both the scheme and the basin. The technique can be part of new drainage systems and retrofitted in existing ones. It is particularly suitable in irrigated regions threatened by water scarcity. Applying controlled drainage will help in regulating drainage and preventing ‘over drainage’. The economic instruments that are advocated to address the overuse of irrigation water have their equivalents in drainage, but again there is a need to build up a critical mass of knowledge in this field.

In response to rising water tables in the Nile Delta, a free-flowing subsurface drainage system has been installed across most of the agricultural sector of the Nile Delta. Recent controlled drainage pilots in rice growing areas showed water savings of up to 40 percent (DRI 1998). Research work was done in small field plots planted to corn and wheat. Farmers can recoup the costs of controlled drainage in two or three seasons, owing to increased crop yield. In circumstances where high water savings can be achieved, the internal rate of return is 100 percent, meaning that the investment is recouped within one year (Abbott et al. 2001; Abdel-Gawad 2002).

The results from an experimental field to investigate the effects of controlled drainage on the quality of subsurface drainage outflows in Egypt showed the potential environmental and economic benefits with the application of controlled drainage in semi-arid regions (Wahba et al 2001).

North America and Northern Europe have invested millions of dollars in research and development on controlled drainage to combat non-point source pollution by nitrates. The field scale results were quite rewarding through reduced drainage flows and pollutant loads, and increased crop yield (World Bank, 2005). Controlled drainage with it's huge benefits for old and new subsurface drainage system will be in the main drainage investments agenda in Egypt

Investment in Capacity Building

A great deal of water is being misused or mismanaged owing to weak institutions and poor water policies. The solution entails taking human and institutional processes and capacities more into account in the design and operation of hydraulic devices and infrastructure. Training and technical assistance are required for building capacity of individuals and institutions, such as local governmental bodies and public sector, board members, WUA personnel, and water staff agencies. Establishing leadership and ownership and building capacity (organizational and managerial skills, and databases) in agricultural water projects, and related reforms of policies and organizational structures, are Important for sustainability of investments.

Investment in water quality

Environmental concerns need to be mainstreamed into all aspects of water management and agricultural policy. Nowadays the deterioration of water quality in the drainage networks in Egypt is a major concern. Almost of villages in rural areas in Egypt do not have access to sanitary system and sewage water from these areas is going direct or indirect to drainage water which affects the quality of this water. More work is needed in the Investment of low cost wastewater treatment, controlling pollution from the source, public and best agricultural management practice. Improving drainage water quality will lead to protecting the public health and this is one of the main investment opportunities for companies and private sector to take into consideration.

Investment in operation and maintenance

Egypt's Ministry of Water Resources and Irrigation, took a successful process approach in which it gradually built support for reform. Egypt's Public Authority for Drainage Projects (EPADP) brought massive and rapid drainage development soon after its establishment, but the way it operates is outdated by today's rapidly changing environment and the mounting costs of operation, maintenance, and replacement.

The O&M plan should be based on an inventory of all the infrastructure work and include an asset management plan defining the frequency of routine maintenance and life of the work. This plan should be the base for assessing the annual maintenance budget. The benefits expected from the above actions for effective O&M include:

- Better drainage service to users
- More benefits can be gained
- Positive impacts on the environment and on saline and water
- Increased life of drainage infrastructure.
- Better utilization of the drainage system

The agency needs to shift from construction to maintenance, tailor designs to users as well as to sites, decentralize water management, and privatize service delivery. There is a need to plan drainage systems in such a way that maintenance is the key element, easy to handle, relatively inexpensive and can be done locally. There is moreover much work to be done in documenting the different options in maintenance and the type of maintenance organization required. All of these are open large area for investment in the operation and maintenance of drainage system.

Investment in GIS and Remote Sensing application

Recent research breakthroughs in remote sensing enable the quantification of water consumption and crop production without agrohydrological ground data. These measurements provide a vehicle for assessing farm management in terms of land productivity, water productivity, irrigation efficiency, environmental degradation, and farmer income (World Bank, 2005).

Drainage issues should be assessed through remote sensing, combined with geographic information system (GIS) and modeling technologies that facilitate applying integrated approaches in drainage system planning and management. These technologies are useful when assessing how drainage interventions will change the natural (agro) hydrological conditions in the resource systems, how the social and environmental values may change, and which benefits and losses may materialize. The application of such techniques in Egypt is still very limited and so there is a great potential of investments in using these technologies the near future.

Investment in drainage water and treated wastewater reuse

Egypt's freshwater supply is constant at 55.5 billion m^3 a year, but the country faces a double challenge. It has to supply water to newly reclaimed areas, which means it has to increase crop production on all new and existing irrigated areas using the same total water supply. For that reason the reuse of agricultural drainage water became national policy in the 1980s, currently, 5 billion m^3 of drainage water, with an average salinity of 1.8 dS/m, is reused each year. The policy of the (MPWRI) is to re-use as much as 7.0 billion cubic maters by the year 2010. The realization of this target depends on the management approaches which ensure safe environmental impact on soil, crop and human health.

Reuse of drainage water holds great potential for saving valuable freshwater resources for competing prime uses that require more stringent water quality standards. It can provide a reliable supply of irrigation water and rich nutrients to cropped fields. Furthermore, reuse may alleviate drainage disposal problems in rivers and streams by reducing the volume of drainage water as well as helping in the restoration of natural wetlands.

To encourage the investment in drainage and wastewater reuse a new policy should be considered to give the private sector a right to water which they can treat.

Role of private sector

A new role for private sector participation is needed. The private sector (farmers labors, small contractor, and stakeholders), can offer a wide range of products and services which can promote sustainable irrigated agriculture. Many poor smallholder farmers and holders of small enterprises do have access to some funds, though limited, and are willing to invest in agricultural activities with the appropriate incentives and investment conditions. Encouragement of such participation requires changes in the direction of efforts by public sector actors and donors. Public sector actors including donors can prime such investments and facilitate the investment process through training, demonstration, information centers, adequate legislation, and setting up institutions to empower farmers and enterprises, quality control of drainage installation, transfer of management of drainage systems to empowered farmers, arranging for credit schemes, among others. Private sector requires an investment climate providing security for investment.

Role of government

Creating an investment climate must be the top priority for governments to promote private sector participation in investments in drainage and integrated water resources management in order to eliminate household food insecurity, rural poverty and achieve economic growth.

The role of government is changing, and investment will be needed to strengthen core government functions, such as: establishing the policy framework within which the private sector can function; regulation of land and water rights and markets; integrated water resources management; environmental protection; research and technology transfer; and rural

infrastructure. Governments need also to set an incentive structure that incorporates principles of equity within the context of customary rights and that provides for recovery of operation and maintenance costs as the basis for quality water service and scheme sustainability.

Financing of drainage projects

Drainage projects can either be partly or wholly financed by a government from public funds as part of a public task to improve the production potential and/or to arrest further deterioration of the production potential and environment. The national benefits are expected to be an increase in local and, hence, national income. This can be translated into an improved tax base, better living conditions and perhaps reduced health costs. Private initiatives for construction and financing of large-scale drainage systems are rare. Organizing the financing and recovery of the cost is largely dependent on the national customs and policies. It can range from being completely financed by government funds with the expectation that costs will be recovered through taxes, to being completely financed by the direct beneficiaries, either directly or through loans (Nijland et al 2005). An approach often used is as follows:

- The main infrastructure which include the main surface drains, the outlets and/or pumping stations, is considered a public good and is entirely financed by the government with public funds either directly or though loans. Repayment is eventually expected to come from an increased tax base or payment for maintenance service.
- The on-farm works, which include field drainage systems, are considered to be the direct benefit of the land owner/user. Therefore, the landowners have to finance these works, either fully or partly. Partly, because in some cases government subsidizes these works and expects repayment of their subsidies through additional tax revenues in the future.
- Landowners finance their part with a loan with a commercial loan or a subsidized loan. The repayment conditions of the loans can be made on the basis of projected yield improvements.

CONCLUSIONS

- In spite of the great achievements and benefits of drainage in Egypt, there is a huge potential for investments that are needed to sustain agricultural drainage against the future challenges.
- The potential investments include public awareness, existing drainage system utilization, drainage of the New Lands, drainage of Oasis and closed basins, bio-drainage, controlled drainage, capacity building, drainage water quality, operation and maintenance of drainage system, GIS and Remote Sensing application, and drainage water and treated wastewater reuse.
- A new role for private and governments sector is needed. The private sector can offer a wide range of products and services which can promote agriculture production and growth. To encourage the investment in drainage and wastewater reuse a new policy should considered to give the private sector a right to water which they can treat.
- Creating an investment climate must be the top priority issue for governments to promote private sector participation in investments in drainage.

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