Irrigated Agriculture in Egypt - notes of an external observer

Prof. Dr. Peter Wolff

Witzenhausen
Germany

Introduction

Agriculture is still an important economic activity of Egypt, and the sustainability of this sector is vital for the overall development of the country. Agriculture employs over 40% of the labour force and provides a noticeable source of the GDP with a share of 16%. Consequently, how to sustain the development of agriculture and thus the national economy is an important issue in Egypt. This issue is becoming ever more acute as the pressure on water, land and other natural resources increases. This papers intends to highlight some of the most important constraints irrigated agriculture is facing in Egypt.

Resource base and frame conditions

Soil resources

Egypt occupies a total area of about one million square kilometres, or 238 million feddans (99.17 million hectares), of which only a small portion (about 3.5%) is agriculturally productive. The agricultural land base of Egypt totals about 7.8 million feddans (3.25 million hectares) covering three different production zones. The first is the old irrigated land with an area of 5.4 million feddans (2.25 million hectares) lying within the Nile Valley and Delta. It represents the most fertile soils in Egypt, which is alluvial, level, deep, dark brown and heavy to medium in texture. Its organic matter content ranges from 1.1 to 2.3 % with pH values between 7.3 and 8.3. According to USDA soil taxonomy, the order Vertisols dominates the major part with the existence of the orders Entisols and Aridosols.

The second production zone is the "newly" reclaimed land, which is viewed as an opportunity for increasing the cultivated area by about 1.9 million feddans. This includes the newly reclaimed land of sandy, calcareous, and saline origin. Soils are poor in organic matter and in macro and micro nutrients.

The third zone is the rainfed area (about half a million feddans) located along the Northwest Coast and in North Sinai. On a per capita basis, Egypt's area of cultivated land, at 0.13 feddan per person, is among the lowest in the world. Despite the ever increasing cultivated area through the governments abuios land reclamation programs, land per capita has steadily declined over the years (Abdel Monem et al., 1998).

Water resources

Agriculture in Egypt is almost entirely dependent on irrigation; the country has no effective rain except in a narrow band along the northern coastal areas. Egypt has only one main source of water, the Nile River. The availability of the reliable water supply from Aswan High Dam is governed by the existing water-sharing agreement, under which 55.5 billion cubic meters are allocated to Egypt. Most of Egypt's water uses are within the agricultural sector, with 84% for agriculture, 8% for industry, 5% for municipalities, and 3% for navigation (Abu Zeid, 1994). Meanwhile, yearly about 4 billion cubic metres of agricultural drainage water is officially reused for irrigation. The groundwater aquifer underlying the Nile Valley and the Delta is entirely recharged from deep percolation from the Nile. The per capita share of fresh water resources is now below 900 cubic meters per person; it is expected to drop to 350 cubic metres per person by the year 2025. With the expected increase in population, not only demand for irrigation water will continue to increase in the next decade and beyond. This implies that the agricultural sector will have to adjust to a smaller amount of available water than previously.

Cropping system

Egypt's agricultural land is, on the average, highly productive and ideally suited to intensive agriculture. With good climatic conditions and a perennial source of irrigation water, agriculture is provided with excellent growing conditions, resulting in high crop yields. Crop productivity levels in Egypt are relatively high when compared to world standards. Productivity of wheat, corn and rice are 5.92, 6.21 and 8.26 tons per hectare (Gomaa, 1996). Due to intensive cropping, the total cropped area was estimated at about 12.1 million feddans, giving a cropping intensity of around 180% for the country as a whole. At present, it is estimated that cotton, wheat, rice, maize and clover (berseem) account for 80% of the cropped area. Wheat and berseem are the principal winter crops. In summer, cotton and rice are important cash crops while maize and sorghum are major subsistence crops. Livestock is an important and integrated part of the agricultural system, as 85% of all livestock is found on small farms.

Economic Policies

Egyptian agriculture is currently in a transitional period. The two decades of the 1960s and 1970s were characterised by heavy government intervention in agriculture. Output prices were controlled, inputs were subsidised, quota deliveries at fixed prices of the major food commodities, like wheat, maize, and beans, were compulsory, and land rent was controlled. Cropping pattern was influenced by area allotments required for the major crops like cotton, sugar cane, rice and wheat. Farmers decisions during that period were heavily influenced by those policies. In the late 1980s, as part of an economic reform program, agricultural market liberalisation policies were initiated. Output markets were liberalised and quota deliveries were eliminated. In addition, subsidies on inputs were reduced and crop area allotments were eliminated for most crops. The new policies have provided farmers with new flexibility in the cropping patterns and resource allocation that will affect the agricultural sector. Increasing wheat production in recent years following a dramatic rise in prices and improved technology gives an example of the impact of new policies.

The period of rapid adjustment, during which government revenues from the agricultural sector fell sharply, also provided an opportunity to adjust other prices to more appropriate levels. To some extent this was done - subsidies for farm inputs were as mentioned above reduced. But charges for water services to agriculture and to other

users were not introduced. Water still is provided free in bulk to all users by the Ministry of Public Works and Water Resources. Intermediate services of treating water for domestic consumption are charged for by the agencies concerned (Perry, 1996).

Threats to sustainability

Despite the fact that the use of high levels of inputs, developing improved varieties, using the agricultural land to its potential, and implementation of other cultural controls has resulted in historic increases in crop productivity, the sustainability of Egypt's agricultural system is endangered by a number of constraints. These constraints have been identified in part during inventory studies carried out by the Agricultural Research Centre of Egypt (ARC), the International Centre for Agricultural Research in the Dry Areas (ICARDA) within the EU financed Nile Valley and Red Sea Regional Program (Hamissa, M.R. et al., 1998).These constraints can be grouped into water management, agronomic, extension and institutional and policy constraints.

Water management constraints
Water management in Egypt faces the following constraints:

- Inequity of water distribution between the heads and tail ends of distributary canals and *mesqas*.
- Irrigation farmers are increasingly apathetic towards the operation of the irrigation system and seek to exploit localised solutions to obtain more reliable water supplies.
- The major problems in unlined canals are generally seen in weeds, seepage, and unstable cross-sections. But if one analyses the maintenance problems of the public irrigation and drainage infrastructure in Egypt it becomes obvious that this is a very complex issue. Under 4. the results of such an analysis are summarised.
- Removal of weeds and general maintenance of private *mesqas* is traditionally the responsibility of the farmers. However, in view of the excessive weed growth in some cases and the blocking of canal cross-sections caused by sediment, garbage materials, and debris in others, especially those running through or besides villages, farmers in many cases are unable to cope with this situation.

Agronomic constraints
Poor soil fertility, associated with salinity and alkalinity problems, represents a major limiting factor for the productivity of most field crops. About 500,000 feddans (210,084 hectares) of heavy soils, located in the northern part of the country, are highly saline, partly with poor internal drainage properties. The sodicity hazard of some of these soils is high and their permeability is low. Reclamation requires improvement of their physical and chemical properties through leaching, amendments, subsoiling, and deep plowing with good, appropriate drainage.

Other constraints are:

- Excessive freshwater loss to drains due to over-irrigation, poor land levelling etc.
- Poor plant stands, associated with hand seeding. The resulting low and uneven plant density cannot make efficient use of fertilisers.

- Poor management practices such as:
    - Poor seedbed preparation at planting.
    - Uneven seed depth and cover.
    - Late planting in some locations.
    - Fertiliser abuse, as a result of high application rates and low percentages of nutrient (nitrogen) utilisation.
    - Poor weed control in the field.
    - Disease damage in some field crops.
    - Insect damage, especially aphid, to food legumes, wheat, and barley.
    - Primitive methods of harvesting, threshing, transportation which might cause heavy yield losses.
    - Storage insects lead to grain loss and bad seed quality.

Extension constraints

Although there are constraints in any research program, the main problem in Egypt is how to transfer the already available research results to the farmers. Extension programs in Egypt face a variety of constraints.

These constraints are mainly:

- Lack of communication between research and extension.
- Inadequacy in delivering research results quickly and effectively to extension specialists and dissemination to farmers.
- Isolation of extension agents from each other.
- Farmer suspicion towards government personal.
- Shortage of well-trained extension workers.
- Engagement of extension personnel in many other governmental activities.

Institutional and policy constraints

The failure to deal effectively with the problems of farmers and their relationship to environmental degradation, to sustainability issues arises from numerous complex and interacting factors. Here institutional and policy constraints play an important role.

In Egypt such constraints to irrigated agriculture are:

- Top-down centralised state-controlled institutions and minor official role of traditional local institutions in areas such as conflict resolution and the regulation and maintenance of the irrigation system.
- Inflexibility of state-controlled irrigation systems management.
- Inability of national institutions to exercise authority effectively at the local level and the lack of empowerment of local institutions to co-ordinate activities at their level.
- Land losses and low land/population ratio: Due to urbanisation expansion, it is estimated that about 30,000 feddans are lost annually (El Belassy, 1992). The per capita share of land declined from 0.5 feddan in 1897 to 0.1 feddan in 1992 (Abu Zeid, 1994).
- Division of various research and production efforts on the same crop between various institutes and sections.
- Gap between research and extension.
- Nonavailability of inputs in quantity, quality and in time.
- Lack of dynamic administrative and management systems.

Maintenance - the bottleneck of Egypt's irrigation and drainage system

General remarks

Maintenance is defined simply by Ostrum (1993) as "any activity that slows the deterioration of a facility, whether caused by use or ageing." Carruthers and Morrison (1994) provide according to Svendsen (1994) a somewhat more operational specification of maintenance as

> *.... a management response to the deterioration of the physical condition of irrigation and drainage systems that threatens to make it impossible to achieve operational targets.*

The above definition contains several notable features. The most important being that maintenance is described as a management response. This suggests that, for effective maintenance at least, the responsible institution must have objectives related to maintenance and make real-time decisions regarding maintenance in response to changing conditions. In short, it must be a managing agency and not an administrative one.

Four basic categories of maintenance can be identified in the O&M of irrigation and drainage systems:
(1) desilting, (2) weed control, (3) maintenance of structures, (4) maintenance of mechanical equipment such as pumps and engines. To this list can be added, according to Svendsen (1994), (5) maintenance of decision support facilities. The category comprises the measurement, communication, and decision support systems which allow the intelligent and responsive control of water in the irrigation and drainage system. Together the condition of these system facilities constrains or enables the ability of the system to deliver or drain water by affecting canal carrying capacity, water storage capacity, and regulatory capacity. A sixth category of maintenance usually carried out by irrigation and drainage agencies comprises of maintenance of appurtenant structures and facilities such as project buildings and access roads.

Maintenance of open canals and drains is not just the physical part of deweeding and desilting operations. It is a management undertaking requiring a high degree of flexibility in decision making on the spot, at the local level.

Maintenance problems observed in Egypt

Weed problems are generally severe on the Egyptian canals and have been attributed to the closure of the High Aswan Dam which reduced the annual silt load of the Nile enhancing the penetration of light through the water and increasing the growth of submerged species like *Potamogeton pectinatus* and *Potamogeton nodosus*. It is according to Barbben and Bolton (1988) reported by maintenance engineers that weed growth was not a problem in the period before regulation of the Nile. Whether this also applies to the then relatively sparse open drainage system is not known.

The irrigation and open drainage system in Egypt consists mainly of unlined earth canals to distribute or collect water. Canal velocities are low. Drains often contain stagnant or very slow moving water. Together, with favourable climatic conditions, make ideal habitats for aquatic plants. The increase in fertiliser application most probably increased the nutrient content of the drainage water and encouraged even more the

growth of weeds. All types of aquatic weeds are common in the open drains that is submerged, ditch bank, emergent and floating weeds. It seems to depend on the site conditions whether one or the other type is dominant. Because of the weed infestation the roughness is sufficiently high to decrease the flow of the irrigation canals and open drain system.

The maintenance of the irrigation and drainage infrastructure in Egypt is, as in other countries, a very complex issue. Therefore no simple solutions can be found. The following reasons for poor maintenance are most commonly found in Egypt:

(1) technical problems
- inadequate physical operation of maintenance works
- oversized canal sections through over excavation
- missing service road network
- bridges and pipelines as obstacles
- difficult mechanical removal of biomass (especially submersed weeds)
- mechanical maintenance makes large amount of specialised equipment necessary

(2) management problems
- lack of strategic vision in relation to maintenance
- inadequate long range conceptual planning capability
- staff availability unsatisfactory
- training of staff insufficient
- contracts for annual instead for several years maintenance
- no preventive maintenance
- lack of comprehensive operational plans
- lack of accountability and incentives
- lack of liaison between irrigation or drainage authority and water users

(3) financial problems
- dependency attitude of farmers upon free services from the state
- no well developed direct cost recovery system
- system for assessment and collection of O+M costs missing
- inadequate budget
- underpayment of contractors
- bureaucratic financial procedures

(4) legal problems
- use of chemicals banned since Dec. 1991
- legal framework for drainage associations and engagement in maintenance is non-existent or not in operation

(5) sociocultural problems
- attitude of society in respect to preventive maintenance is underdeveloped
- lack of interest of farmers in participating or collaborating in maintenance work
- poverty and maintenance
- over fishing of grass carp
- maintenance lacks the prestige of construction among professional staff
- low social status of maintenance work

(6) ecological problems
- maintenance interferes with ecosystems of canals
- solid waste disposal at canal banks
- disposal of sewage into irrigation and drainage canals

(7) health problems
- increase of vector borne diseases through poor maintenance (Schistosomiasis)

The Fayoum Water Management Project (1996) in studying different weed control methods came to the conclusion that:
- mechanical weed control, using the mowing buckets is an efficient method, as it prevents any further expansion and deepening of the water channels resulting from the use of the traditional excavation buckets;
- mowing buckets can be installed on various equipment available in Egypt;
- mowing buckets are cost efficient and can operate with high performance, if carefully used by the operators and if the labourers carry out the necessary maintenance works systematically with the required efficiency.

Despite these facts deweeding of irrigation and drainage channels in Egypt is still done in most cases by using the traditional excavation buckets. The single most important issue constraining a shift from this traditional method of channel excavation to weed mowing are the contracts for annual maintenance. The problem concerns the design of contracts, the duration of contracts, the tendency to follow an established maintenance system, the imprecise specifications for contracted work items and the structure of the unit rates.

A new strategic thinking is required

There is a broad consensus among irrigation and drainage professionals that present maintenance standards are a crucial impediment to the efficiency and sustainability of irrigation and drainage systems. In many ways the irrigation and drainage maintenance problem is not unique. It is perhaps but a visible example of a general infrastructure maintenance problem provading education, health, transport and other elements of the public sector in the developing world (Carruthers and Morrison, 1994).

The recurrent cost problem has been identified by Carruthers and Morrison et al. (1994) as a major constraint on even the best designed maintenance organisations. However, throwing more money at the maintenance problem is very unlikely to resolve it. It is much more than likely that without other changes any additional resources will be wasted. More precision in diagnosis and clear criteria by which improvements can be judged will be required. The norms for rehabilitation and maintenance of drainage systems being developed by the M&E Project of the Egyptian Public Authority for Drainage Projects (EPADP) leads in the right direction and should be consequently implemented.

One has to be aware that in the maintenance of irrigation canals and open drains no general solution exists. This is because site conditions, especially weed growth conditions differ across Egypt, requiring different maintenance measures. This is why site specific maintenance strategies have to be developed and a high flexibility of the organisation responsible for maintenance and in management of the irrigation and drainage system is required.

Much maintenance presents arduous tasks and the potential returns are often not perceived by those involved especially in irrigation and drainage system management. This failure to recognise the value of maintenance is true for governments, for irrigation and drainage agencies and farmers. All these groups must be encouraged to participate in all aspects of planning, construction and implementation. Participation, especially of farmers, seems to be missing in Egypt. Especially drainage is seen by the beneficiaries in Egypt to be solely a government undertaking. In order to reach a high degree of sustainability of the irrigation and drainage system practical maintenance issues have to be high on the agenda at each stage in development. Beneficiaries have to become aware of the value of well functioning drainage systems.

The increased effective participation of farmers in maintenance is seen as one solution to its neglect. There is a general understanding that beneficiaries of the drainage systems installed by EPADP have to finance and execute its upkeep in the future, most likely through ”drainage associations”. It is not clear whether this general call for greater participation of beneficiaries in all aspects of drainage management can be applied in Egypt at present or in the near future, especially since drainage does not seem at present to be very high on the agenda of the farmers all over Egypt. This is particularly valid for the sugarcane farmers in the Nile Valley. To encourage optimal participation, the valid incentives must be clearly evident to all the players. But what are the incentives for the farmers for example? What can EPADP do to deliver these incentives? What organisational structure is appropriate to deliver these incentives? Under which conditions is it beneficial for farmers to participate?

One has to be aware that there might also be another side of the picture. The expectation that the farmers in Egypt are to execute and to finance the work that needs to be done on the drainage and partly on the irrigation systems could turn out to be wishful thinking of those remote from the field level problems, a reaction to shortages of government revenue, or simply a switch of tactics from centralised planning approaches to devolved participative mechanisms in line with a widespread current political fashion. If this is the case a different strategy has to be developed to improve the maintenance situation of the irrigation and drainage systems in Egypt on a sustainable basis. At least it is necessary to change from the present more or less schematic maintenance operations to more situation-conforming management of the maintenance works. It seems to be necessary to develop a respective strategy or concept which increasingly involves the beneficiaries in operation and maintenance of the irrigation and drainage system.

The maintenance of watercourses and especially open drains is in Egypt as in other countries increasingly discussed from an ecological point of view. The Research Institute of Weed Control and Channel Maintenance of Egypt's Water Research Centre besides others are considering weed growth in channels to some degree desirable for ecological reasons. It was found also to be of some advantage for water quality improvement. Such changing attitudes have to be considered when developing a maintenance strategy.

Conclusions

Egypt's highly productive irrigated agriculture is subject to unprecedented expansion in area and intensification, while competition with industrial and domestic sectors for fixed supply of Nile water continues to increase. Salinization, heavy use of inputs, and pollution all threaten the health of the soils. At the same time, developing newly reclaimed desert soils and rainfed areas to possess economically sustainable productive capacities is seen as a major challenge. To achieve a sustainable development of Egypt's irrigated agriculture it takes more than just solving the technical and agronomic problems. Among others the the sustainable solution of legal, sociocultural, ecological, health and financial problems have to be considered. Furthermore, limited resources and threatened production sustainability call for an efficient resource-management strategy and farming-system approach for agricultural development and research in Egypt. Such an research approach is followed within the EU financed Nile Valley and Red Sea Regional Program by the Agricultural Research Centre of Egypt and the International Centre for Agricultural Research in the Dry Areas (ICARDA). The approach should by extended to all agricultural research in Egypt. Such approaches have to be holistic, taking into account the socio-economic requirements of all sectors of the economy, of Egypt's society.

Literature

Abu Zaid, M.A., 1994: Egypt's efforts towards management of agricultural water demand.- Proceedings of VIII IWRA World Congress on Water Resources, Cairo, 21 - 25 November 1994.

Abdel Monem, M.H.S.; Khalifa, H.E. and M. B. Solh, 1998: Building and sustaining the high production capacity of Egypt's irrigated lands: A long-term research program.- Journal of Sustainable Agriculture 11 (No. 2/3), 7 - 17.

Brown, L.R., 1999: Feeding nine billion.- In: Brown, L.R., 1999: State of the World. A Worldwatch Institute report on progress toward a sustainable society.- W.W. Norton & Company, New York and London.

Carruthers, I.; Morrison, J., 1994: Maintenance in Irrigation: A review of strategic issues.- MAINTAIN Project, GTZ, Frankfurt a. M., Unpublished report.

El Belassy, A.O., 1992: Some problems in utilizing agricultural land resources and their effects on development.- Egyptian Journal of Agricultural Economics 5, 22 - 28.

Fayoum Water Management Project (FWMP), 1996: Findings of operational research on different aquatic weed control methods applied in Fayoum 1989 - 1996.- Proc. Seminar on Improved Aquatic Wed Control, Fayoum 19. - 20. June, 1996.

Gomma, A.A., 1996: Current and future global situation of grains: The Egyptian case.- Paper presented at the International Seminar on Grains, Water, and the Political Decisions (in Arabic), Cairo, 30 - 31 March 1996.

Hamissa, M.R.; Elenein, R.A.; Solh, M.B. and A. M. Abdel Shafi (Ed.), 1998: Inventory Studies. Vol. 1. Old irrigated lands of Egypt. No. 5. Synthesis.- Resource Management Series. Nile Valley Regional Program, Cairo/Egypt.

Ostrum, E., 1993: Institutional incentives and sustainable development, infrastructure policies in perspective.-

Perry, C.J., 1996: Alternative approaches to cost sharing for water service to agriculture in Egypt.- Research report No. 2. International Irrigation Management Institute (IIMI), Colombo, Sri Lanka.

Radwan, L.S., 1997: Farmers responses to inefficiencies in the supply and distribution of irrigation requirements in Delta Egypt.- The Geographical Journal 163 (No. 1), 78 - 92.

Svendsen, M., 1994: Improving maintenance in irrigation - external roles in strategic and operational change.- MAINTAIN Project, GTZ, Frankfurt a. M., unpublished report.