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Environmental Sustainability of Egyptian Agriculture: Problems and Perspective
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Source: *Ambio*, Vol. 24, No. 1 (Feb., 1995), pp. 16-20
Published by: Springer on behalf of Royal Swedish Academy of Sciences
Stable URL: http://www.jstor.org/stable/4314279
Accessed: 15/07/2011 22:34

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Article **Asit K. Biswas**

Environmental Sustainability of Egyptian Agriculture: Problems and Perspective

With the lowest per capita arable land base in Africa, and with a rapidly increasing population, sustainability of agriculture in Egypt has now become a critical issue. This paper discusses the critical sustainability issues that need to be considered, and the important policy-related issues in the areas of land and water-resource management that merit urgent attention, if the sustainability of Egyptian agriculture in the 21st century is to be assured.

INTRODUCTION

Egypt, said Herodotus, is the gift of the Nile. More than two millennia after the Greek historian's visit, and in spite of extensive technological developments, it still is not an overstatement since life in Egypt would be impossible without the water of the Nile. Later Napoleon reconfirmed the observation of Herodotus during the French occupation. He said: "If I was to rule a country like Egypt, not even a single drop of water would be allowed to flow to the Mediterranean Sea". While, Napoleon was not aware of the importance of allowing some discharge of the Nile waters to the sea for salt balance and other environmental reasons, the general direction of his thinking was undoubtedly correct. In Egypt, the major constraint to agricultural development is water, not land. Even after the construction of the High Aswan Dam, which radically altered water-use patterns in Egypt, only about 7.49 million feddans (one feddan is almost equivalent to one acre or 0.40 ha.), i.e. less than 4% of the country's land area, is cultivated at present (1).

SUSTAINABLE DEVELOPMENT: CONCEPT AND ISSUES

The concept of sustainable development is not new. The general philosophy behind it has been recognized for many centuries. While the term "sustainable development" became fashionable around 1980, there is little difference between this and the concept of "ecodevelopment" that was prevalent during the early 1970s. There is no agreed definition of sustainable development. Currently, more than a hundred definitions exist, differing in some significant ways. In 1987, the World Commission on Environment and Development defined it as a process that "meets the needs of the present without compromising the ability of future generations to meet their own needs (2)."

Clearly, such definitions are somewhat simplistic, inconsistent, static, and too vague for use in policy formulation, planning and implementation of specific projects, except in a very general sense. Any development strategy that does not consider the achievement of a reasonable and equitably distributed level of economic well-being that can be perpetuated continually for many generations cannot be sustainable. This is not properly reflected in the WCED definition.

In spite of current rhetoric, it has to be admitted that operationally it has not yet been possible to identify a development process which can be planned and then implemented, and which would be inherently sustainable, however it is defined. We have had more success in identifying certain aspects of development which are unsustainable, and then taking appropriate remedial steps to reduce or even eliminate the undesirable effects than to devise a holistic approach that is intrinsically sustainable from the outset (3).

For example, if sustainable agricultural development is considered, we know that irrigation without drainage would contribute to waterlogging, which would reduce the yields of the irrigated area over a period of time. Since the main purpose of any irrigation project is to increase total agricultural yield, clearly any system that does not fulfil this objective over a long-term period can not be considered to be sustainable. Similarly, if extensive use of fertilizers increases the nitrate content of groundwater, impairing its use for drinking purposes, then this practice must be considered unsustainable (4).

While there are many issues that are important for sustainable agricultural development, from a policy point of view the following three factors are worth noting.

Short-term versus Long-term Considerations

The concept of sustainable development automatically assumes that the process selected would be viable over the long term, even though the issue of what constitutes "long-term" has neither been clarified nor been part of current discussions. The time factor either inadvertently, or because of its complexity, has been basically left fuzzy. Does sustainability cover 50 years, or 100, 500, 1000 or even more years?

Even if one considers the lower figure of 50 years, there is a fundamental dichotomy as to its use in the real world. For example, generally, the economic planning horizon of farmers in Egypt, or in any other country for that matter, generally extends to one cropping season or to at most three. In the newly reclaimed areas of Egypt, the time horizon could extend from 2 to 3 years, but certainly no more than 5 years. The philosophy of nearly all farmers has been to maximize economic returns from agricultural activities within this time horizon. Thus, the mind-set is inherently based on maximizing profits over a continual series of short-term periods. If the short-term benefits result in long-term costs to themselves (e.g. in terms of soil erosion, salinity development, etc.), generally short-term considerations have won over the long-term implications. While in some cases this outlook of "short-termism" could be due to a lack of knowledge or understanding of the potential long-term impacts of activities, it has to be admitted that for financial reasons, small farmers, who are mostly poor, are forced to consider only the short-term economic implications for their own survival.

Accordingly, even if the societal and/or governmental goal is to achieve long-term sustainable development, in reality the major objective of a vast majority of farmers normally is short-term survival. Thus, any plan for sustainable agricultural development, which does not specifically consider this fundamental conflict and then attempt to identify realistic alternatives to overcome the problem, is doomed to fail.

Externalities

Externalities occur when private costs or benefits do not equal social costs or benefits. Farmers and large agricultural estates operate primarily on the basis of their own private costs and benefits. If opportunities which can reduce costs and/or increase potential benefits are perceived, actions are taken which can be beneficial, but are unlikely to serve the common good. Examples include use of excessive irrigation water by farmers in the headreaches of canals which means tail-enders have insufficient and/or unreliable water supplies. This may substaniitally decrease yields, and thus incomes, of tail-enders. Similarly, wastes from agro-processing industry may be discharged to canals and rivers, impairing the existing water-use downstream.

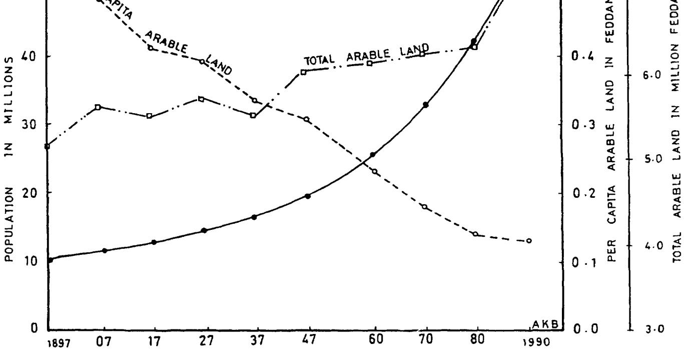
Such costs could be internalized through taxes, subsidies and regulations; but in reality, even in developed countries, it has not been easy to internalize the externalities for four important reasons. (i) Methodologically, calculation of the precise value of externalities has been a very difficult task. (ii) Frequently politically powerful individuals and organizations vociferously defend their own private advantages, even though they also may be experiencing additional costs somewhat indirectly. (iii) Externalities could develop steadily over time and, thus, there could be a time gap before those affected realize the true costs. (iv) Regulations to control such externalities have proved to be ineffective and expensive in nearly all developing countries.

Risks and Uncertainties

A major issue confronting sustainable agricultural development are the risks and uncertainties inherently associated with complex systems. With the increasing population base in Egypt, the country's land and water resources are used intensively to maximize agricultural productivity. But, to what level can Egypt's agricultural production system be intensified without sacrificing sustainability? What early warnings would indicate a transition process from sustainable to nonsustainable? What parameters need to be monitored to show that a transition is about to occur or occurring? Our present knowledge is inadequate, even to identify the parameters that would indicate transition from one stage to another. We cannot accurately detect, much less predict, the transition of a sustainable system to a nonsustainable one. In addition, agricultural systems are variable by nature. Fluctuations may be so great that statistically significant data would be very expensive or even impossible to obtain in order to state categorically that such variations are natural or signs of unsustainability. If additional factors like potential climatic changes are superimposed on these complex issues, the degree of uncertainty increases manifold (5). One is confronted with the difficulty of identifying the direction of change, let alone the degree of change.

These fundamental issues need to be successfully resolved, before the concepts of sustainable agricultural development can be holistically conceived and implemented. Unfortunately, while lip service is given to sustainable agricultural development, most of the literature is either general or a continuation of "business or usual" which has been given the latest trendy label of "sustainable development". If sustainable agricultural development is to become a reality, national and international organizations need to address the real issues. Unless the rhetoric is effectively translated into reality, "sustainable development" will remain a trendy catchword for a few years, and then gradu-ally fade away like the earlier concept of ecodevelopment.

Figure 1. Population and arable land (total and per capita) in Egypt, 1897–1990.



LAND RESOURCES

For a very arid country like Egypt, the prime factor for land productivity is water. An analysis of arable land can best be divided into the pre-and post-High Aswan Dam (HAD) periods. The increased and reliable water availability made possible by the construction of the dam, and assisted by other technological developments, has made it possible to intensify cultivation in the old lands and to expand agricultural activities in to new areas. Construction of the HAD basically confirmed the fact that the supply of arable land in Egypt is not necessarily inelastic, as was previously assumed.

Between 1970 and 1980, total arable area in Egypt increased by only c. 700 000 feddans, while population increased nearly fourfold, from 11.2 million to 42.1 million. Thus, the area of arable land available per person declined by 71% during this 73-yr period. The changing patterns of population, total arable land and per capita arable land available are shown in Figure 1. However, the rate of increase of total arable land during the past decade is highly unlikely to be maintained in the future.

Loss of Productive Land

Not much has been written on the loss of productive land in Egypt, except in a very general fashion. Estimates of land loss available at present range from a low of 20 000 feddans (6) to a high of more than 100 000 feddans (7) per year.

The problem of calculating land loss is compounded by four complex factors. (i) At present net area of cultivated land can only be estimated, since the last agricultural census was carried out in 1961. (ii) As mentioned later in this paper, land reclamation statistics refer only to gross areas; reliable data are unavailable on areas that are not fully reclaimed, unproductive, and abandoned. (iii) No information is available on land losses due to the urbanization process, even for very specific years. (iv) Current estimates of land loss due to waterlogging and salinity development are so vague that they are literally meaningless.

The literature on Egyptian environmental aspects is full of anecdotal or superficial estimates on land loss, masquerading as realistic data. For example, one World Bank report (7) quotes annual loss of "agricultural land to topsoil skimming and urban encroachment" to 100 000 feddans in 1983, which anyone knowledgeable of Egyptian conditions will find absurd. Haas (8) claims that by 1972, "One-third of Egyptian irrigated land was estimated to be salinized or was threatened by salinization," a meaningless statement. Similarly, Kishk's (9) statement that at least 50% of the land was salinized is equally meaningless. Neither Haas nor Kishk indicate what is meant by salinized land: for example does it mean decline in agricultural productivity due to salinity by 1%, 5%, 10%, 50% or 80%, or land completely withdrawn from agricultural activities? A loss of 1% is not a problem, but 20% is. For scientific planning or decision-making purposes, one must have a clear idea of the level of salinization. Lumping 1% salinization with 90% salinity is a useless exercise.

From a policy viewpoint, it is essential that Egypt should give urgent attention to reducing the loss of arable land due to urbanization for three reasons. (i) With growing population, existing agricultural land areas should not be allowed to be lost. (ii) Land reclamation is an expensive process, and it is desirable not to lose any productive land areas, and then to try to compensate loss by reclamation. (iii) Land lost due to urbanization is often more productive than reclaimed land.

Currently, laws exist which are expected to prevent the loss of arable land due to urbanization, but such laws have been basically ineffective since they are not properly formulated, and their implementation leaves much to be desired. However, the prevention of loss of agricultural land, due to urbanization, has not been possible in nearly all developing countries and in many developed countries.

WATER RESOURCES

As mentioned earlier, the most important natural resources constraint for Egypt for any sustainable agricultural development strategy is water. In spite of this critical importance of water for the future development of the country, unfortunately, up to now reliable estimates of water balance at the national level are not available. Equally, reliable estimates of current water requirements for various sectors like agriculture, industry, municipal, navigation and hydropower generation are also not available. Without such estimates, rational planning for agricultural water availability and its efficient use for the medium- to long-term is not an easy task.

Since the agricultural sector is the major user of water, sustainable agricultural development strategies need a clear idea of the quantity of water that is likely to be available to this sector in the future, and the modes of its utilization. Current estimates (10) available from the Ministry of Public Works and Water Resources indicate that agriculture accounts for the lion's share of water use, 49.7 billion m^3 per year, which is 84% of the total water use in the country. This amount does not include an annual estimated loss of 2 billion m^3 from the main, lateral and sub-lateral canals mainly due to evaporation.

Annual evapotranspiration losses in Egypt are estimated at 34.8 billion m^3, accounting for the bulk of the agricultural water use. This estimate includes not only crop-consumptive water use, but also any other "unaccounted" for water uses (1). On the basis of the analyses carried out by the author, the following sustainability and environmental issues need to be considered for any realistic formulation of agricultural strategy in terms of water quantity considerations.

Percentage Share of Water Available for the Agricultural Sector Will Decline in the Future

This trend is likely to accelerate in the post-2000 period, primarily because of sharply increasing demand from the industrial sector. MPWWR estimates of industrial-water use in 1990, based on extrapolation of very limited field surveys carried out in 1980, was 4.7 billion m^3. It is expected to increase to 7.6 billion m^3 by the year 2000. In the absence of any reliable studies on industrial water use, any forecast can only be considered very preliminary even for the near-term projection for the year 2000. Thus, this estimate is most likely to be adjusted quite significantly as more and more reliable data become available.

On the basis of studies in other similar developing countries, the general trend, however, is likely to be accurate (11). Water requirements for the domestic sector will continue to rise because of increasing population, and a higher per capita demand from population sectors which attain better living standards. Industrial water demands would increase significantly. However, since domestic and industrial water demands would continue to receive higher priority, the amount of water available for agriculture will decline. Thus, sustainable agricultural strategies for Egypt must be based on declining percentage shares of available water.

Water Conservation Must Play an Increasingly Important Role in the Future

Since the agricultural sector will have to get used to the concept of doing more with reduced water in the future, water conservation must be considered a priority for agricultural strategies. All the major policy options to increase water-use efficiency need to be pursued: e.g. water pricing, improved operation, maintenance and rehabilitation of irrigation systems, reduction of all types of water losses, development of water-conserving varieties of crops, substitution of high water-using crops with those requiring less water per unit of output, etc. The agricultural sector is the major user of water and, therefore, has the highest potential for water saving.

Clear Strategy Is Necessary on Groundwater Use

Serious and extensive studies of groundwater availability is of comparatively recent origin in Egypt. Accordingly, information on groundwater is less reliable than that for surface water.

Current estimates indicate that the total groundwater available in the Nile Valley and Delta is about 500 billion m^3. The existing annual rate of abstraction in this region for domestic, industrial, and agricultural purposes is estimated at 2.6 billion $m^3\ yr^{-1}$. This can probably be increased on a sustainable basis to about 4.9 billion m^3, which is estimated to be equivalent to the annual recharge rate (1).

The policy issues are more complex for groundwater use in the Western Desert, New Valley, and Sinai, since this is fossil water and not a renewable resource. For example, preliminary estimates indicate that total groundwater storage in New Valley is of the order of 40 000 billion m^3, with salinity levels varying between 200 and 700 ppm.

Use of this or any other fossil water would depend on its quality, cost of pumping, and economic return over a fixed time period. Consideration has also to be given to potential socio-economic implications for the area when water can no longer be economically abstracted. While use of fossil groundwater has already started in Egypt, there is no clearly enunciated policy. It is essential that a clear government policy is needed, after careful consideration of all the benefits and risks.

Treated Wastewater Could Be an Important Source of Irrigation Water By the Year 2000 and Beyond

Even though reliable estimates are not available for the treated wastewater that is likely to be available by the year 2000 and beyond, some preliminary estimates can be made on the basis of the current plan for wastewater treatment for the Greater Cairo area. Assuming an average unit wastewater production of 340 liters per capita per day, the total amount of wastewater that could be available from the Greater Cairo area would be of the order of 1.9 billion $m^3\ yr^{-1}$ by 2010. Treated wastewater could, thus, become an important new source of water by 2000 and beyond. This factor should be considered in agricultural development strategies.

From the environmental and resource viewpoint, treated wastewater has both benefits and constraints. On the benefit side, treated wastewater contains fertilizers like nitrogen, phosphorus and potassium, and some micronutrients like metals. Hence, in terms of agricultural productivity, treated wastewater is normally more beneficial than normal irrigation water. However, they do not contain the required major nutrients in optimal proportions for crop growth, nor in large amounts (12). In addition, on the basis of the data available, wastewater contains less N, P and K in Egypt than in developed countries. While precise reasons for this anomaly cannot be given, the P-content could be less, due to comparatively low use of synthetic detergents in Egypt.

On the constraints side, use of treated wastewater could pose some environmental and health problems. Hence, it is necessary to ensure that all treatment plants function properly, and appropriate monitoring is carried out regularly.

The use of treated wastewater in Egypt has been somewhat limited. Some time ago, an interdepartmental committee on this subject was established under the leadership of the Academy of Scientific Research and Technology. This Committee, has made very little progress, and has been basically inactive. From the viewpoint of agricultural strategies, some major pilot irrigation projects need to be established, as and when treated wastewater becomes available from the Greater Cairo project.

Water Quality Issues

For any agricultural strategy, it would, however, not be enough to consider only issues related to water quantity without any reference to water quality. Water quality has major implications in terms of agricultural water use, and agricultural activities could affect water quality, reducing water availability for other sectors.

On the basis of current water-quality data, for both surface water and groundwater, no reliable statement can be made for Egypt. This situation, however, is similar in other developing countries. It is clear that water pollution is a serious problem in many canals and drains, as well as in parts of the Nile.

Some fundamental problems need to be addressed promptly. First, no national strategy exists on proper collection, analysis, review and dissemination of water-quality data. Nor is there a rational comprehensive water-quality management plan that can be implemented. While efforts are being made to address these issues, it will be some time before a realistic plan is prepared, let alone implemented. Second, the important issue of the institutional arrangements for water-quality data collection and data-management plans have received scant attention. Within MPWWR, water quality data are being collected primarily by the three institutes under the Water Research Center (WRC): Nile Research Institute (NRI, formerly High Aswan Dam Side Effects Research Institute); Drainage Research Institute (DRI); and Research Institute on Groundwater (RIGW). On a long-term basis, MPWWR needs to develop a functional division responsible for collection of routine water-quality data. Research institutes should not have long-term responsibility for routine data collection.

Existing water-quality data-management systems should become compatible in terms of the hardware and software used. At present, the systems used by NRI, DRI and RIGW are not compatible, and a clear picture of water-pollution problems is not available—even if the appropriate data are available—without significant additional work. Since water-quality data-collection systems have only recently been initiated, the compatibility of the various systems need urgent attention.

Third, there are serious shortcomings in terms of the present practice of taking one or two samples per year on limited but a fixed number of water-quality parameters along the Nile, and a few selected canals and drains. Even the proposed plan to take four sampling runs per year would be of very limited use for proper water-quality management.

Water-quality monitoring programs must be more flexible, in terms of frequency of sampling, sites where samples are taken, and parameters sampled. In some highly-polluted areas, daily samples may be necessary for certain parameters since it is well-known that diurnal variations could be significant. However, for certain parameters, at the same site, sampling at three-monthly intervals may be enough. Similarly, certain parameters need to be measured at specific sites, but may be unnecessary at other locations. Furthermore, parameters that need to be measured may vary over time, depending on the types of industry, process modifications, etc. which might change effluent quality. Thus, a flexible water-quality monitoring program has to be prepared, and then implemented. This program needs to be reviewed periodically, and changes should be made when necessary.

Fourth, progress is needed in the quality control and quality assurance of water-quality laboratories to ensure consistently reliable analyses. Proper training of an adequate number of water-quality analysts is essential. Until and unless an experienced cadre of analysts is available, water-quality data are unlikely to be reliable.

Control of Sources of Pollution

There are three major sources of pollution in Egypt: domestic; industrial (including agro-processing); and agricultural. Domestic wastewater requires at least primary treatment, and where necessary, secondary and tertiary treatment. Without treatment facilities, that are operationally functional, water pollution from domestic sources cannot be controlled.

The pollution of the Nile canals and drains, by industrial effluents, is a more complex problem compared to domestic and agricultural pollution. The Egyptian government currently owns and operates 367 industrial facilities, the majority of which are related to the agricultural sector, even though individual facilities may be owned by a ministry other than the Ministry of Agriculture and Land Reclamation (MALR). The Ministry of Industry is the major owner (72%), followed by Ministry of Economics (9%), Ministry of Supplies (8%), and the remainder (11%) owned by the Ministries of Defense, Electricity, Agriculture, Housing and Health. Of these industries, some 35% discharge effluents directly to the Nile or through agricultural drains, 15% discharge to the canals which are sources of water for irrigation as well as for drinking, and the rest to coastal lakes, the Mediterranean, or through land application, deep wells and irrigation.

For private industries, very little data are available on effluent quality and quantity. Pollution from private industry is currently underestimated, and is considered as a rapidly growing problem sector.

In the absence of reliable information, little can be said on the present status of industrial-water pollution in Egypt. However, the trends are clear. Industrial-water pollution is a rapidly growing problem, and in parts of Egypt waterbodies are already seriously contaminated and violate WHO guidelines for drinking water.

With respect to nonpoint sources of pollution from the various agricultural chemicals, very little data are available on nitrate and pesticide contamination. The limited data available are somewhat suspect, since many of the measurements are in parts per billion. No time series data are available on pesticide and nitrate contamination that could indicate a trend. However, if the levels of fertilizer and pesticide application increase, it is likely that leaching to surface water and groundwater could increase.

From the viewpoint of water-quality management, the optimal solution is to control pollution at the source. Thus, for the agricultural sector, consideration should be given to more efficient use of pesticides (including integrated pest management) and fertilizers.

Legal Implications

The legal basis of controlling water quality has been the Public Law 48 of 1982 on the "Protection of the River Nile and Waterways from Pollution (Water Act)". The law established very stringent effluent standards for various organic and inorganic pollutants. It also provided strict sanctions against polluters. Unfortunately, this law was poorly drafted, and standards stipulated were too strict and rigid allowing no flexibility, exceptions or possible recourse. No serious studies were carried out to determine the potential problems for implementing the law in terms of economic, technological and social conditions, e.g. availability of adequate funds, trained manpower, sophisticated laboratories and transportation facilities for analyses, monitoring, inspection and enforcement. Not surprisingly, the law has been basically ineffectual. Ironically, some public sector companies are the worst offenders. Shortly after the law was promulgated, the Egyptian government was forced to grant dispensations to polluters because of their inability to comply with the legal requirements.

Public Law 48 needs to be amended significantly, and amendments cannot be made on the basis of theoretical considerations only. Serious studies are necessary if any new law is to have a sound techno-economical basis, which would improve its implementation potential.

CONCLUSION

To meet population growth and to provide higher standards of living, Egypt must use all available land, water, and related resources intensively, efficiently, and sustainably. The real question is not whether these resources should be used intensively and extensively, but rather how such use can be achieved in an environmentally-sound way to ensure that the development process can remain sustainable over the long term. While no one would argue with this goal, the real problem arises when decisions have to be made on how to design, implement and maintain an intrinsically sustainable agricultural-development project. Admittedly, some progress has been made during the past two decades, but we still do not know enough about how the aspects of a project, plan or program should be handled and coordinated to ensure long-term survival.

There is often a tendency to blame development specialists for environmental ills, irrespective of why they occurred, including serious constraints like our present status of knowledge and data availability, just as the ancients often blamed astrological conjunctions for their failings.

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