# AQUATIC WEEDS IN SUDAN'S GRAVITY IRRIGATION SYSTEMS: PROBLEMS, RESOLUTIONS AND FINANCIAL AND POLICY IMPLICATIONS

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## 1. THE PROBLEM

A major water management problem encountered by the Sudan Ministry of Irrigation is that of aquatic weeds. The authors interviewed senior hydraulic engineers and collected secondary data in Ministry of Irrigation (MOI) records to investigate the issue.

The presence of aquatic weeds was reported in the Gezira Canals in 1929, only four years after the irrigation system started to operate. The infestation gradually increased, and with the present intensification policy, weeds now constitute a major constraint to the irrigation system. The problem is particularly acute in the minor canals, Abu XXs[3] and drains.

Aquatic weeds can be classified into four groups:

(a) . **Emerged plants** anchored into the soil with most of their stem and leaf tissues above the water surface. Their height does not change with the water level;

(b) Submerged plants with most or all of their vegetative tissues below the water surface. They are often rooted or anchored;

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[3] Abu XX is a water stream irrigating nine fields of ten feddans each. Each Abu XX supplies nine Abu IVs which carry water into the fields.

(c) Floating plants free floating or anchored with most of their stem and leaf tissues at or above the water surface. They move up and down with the water level;

(d) Algae or unicellular

All aquatic weeds contribute to decreased efficiency of waterways. Their presence decreases water velocity and consequently the conveyance capacity of canals. The ultimate effect is a shortfall in delivery of optimal crop water requirements. In drainage ditches the growth of weeds increases the danger of flooding cultivated lands, resulting in crop damage or hindering land preparation. In lakes and irrigation headworks high evaporation rates of water is also a concern.

A survey of aquatic weeds by the Hydraulic Research Station in minor canals has revealed the presence of the first three categories of weeds. Potamogeton spp. and Echinochloa stagnima are the most common species and are responsible for most of the damage. Of the 52 canals surveyed, 60% were almost free of weeds, due to a recent manual/mechanical control operation; 15% were moderately infested while the remainder were heavily colonised. The tail sections of canals usually suffered most from blockage by weeds, because water there is almost stagnant. Weed presence in all canals was not uniform, indicating that clearance operations are selective and not made throughout the length of the whole canal in one operation. Hydraulic engineers believe that the practice of selective weed clearance is undesirable, as it allows for a faster re-growth of weeds.

Recolonisation of clean minors begins with emerged weed species, such as E. stagnima, I. aquatica and P. nodiflora. These species spread from the banks to the water, possibly as a result of poor mechanical desilting, manual pulling or raking of weed species rooted at the banks. The growth of emerged weeds decreases the flow velocity and provides favourable conditions for re-infestation by submerged weeds such as Potamogeton spp. N. pectinata and Ottelia spp.

Most of the drainage ditches are heavily infested, as a result of the insufficient machinery usually being employed for canal clearance which has priority.



## 2. WEED CONTROL METHODS

To combat weed problems and maintain the efficiency of irrigation canals MOI has adopted the following control methods:

(a) Manual Control

MOI employs teams of permanent workers to control weeds manually in heavily infested minor canals. The job is done by pulling, cutting, raking, chaining and harvesting weeds at intervals of 2-3 weeks. The method used to be effective and feasible. However, with the existing extensive canal and drainage system, the shortage in labour supply and reluctance of recruits to work under hazardous conditions, manual control has become expensive and less effective than it used to be.

(b) Mechanical Control

This entails the continuous desilting of minor canals using mechanical grabbers. Weeds are uprooted and placed on the banks. This method has the advantage of serving the dual purposes of desilting and weed control. The small number of available machines and shortages in spare parts means the operation cannot be repeated in the same year in any one area.

Agricultural engineers at the Gezira Scheme have developed a mechanical device to do the job more effectively. It is a steel bar with long hooks which extend into the bottom of the canal. When the device is pulled by two tractors, one on each bank, submerged as well as emerged weeds are cut and shredded. However, plant material needs to be manually removed. The trial has shown considerable promise in controlling weeds. In addition, a selection of machines have been ordered from the Netherlands, but their efficiency and effectiveness remains to be tested.

(c) Chemical Control

Herbicides are used to eliminate the growth of weeds. In Sudan both Roundup and Pasta herbicides are used, although the effectiveness has not been evaluated. A major concern is environmental pollution and the cost involved. Opponents to the use of chemicals have campaigned to influence policy, claiming a number of drawbacks to chemical control:

(a) Chemicals effect only submerged weeds, at only a specific stage of plant development. If chemicals are not applied at that stage control is not achieved;

(b) Even effective chemical control needs to be supplemented by a manual or mechanical operation to remove the dead plant material. This implies both additional cost and an environmental hazard facing follow-up workers;

(c) It has been technically established that chemicals are most effective when the canals are dry or the water is stagnant. However, weeds grow and hinder irrigation mid-season when canals are full of water;

(d) There is a risk that operating chemical companies will use an over-dose to produce short-term results on submerged weeds in order to promote their chemicals' performance. This practice has been encouraged by the evaluation method MOI uses for chemical companies, whereby irrigation engineers assess chemical effectiveness by the results as seen immediately after operations. The risk are excessive costs, long term failure and environmental hazard;

(e) Management of the chemicals is often not optimum. Chemicals are stocked for long periods at the risk of spoilage and loss of effectiveness;

(f) Chemicals pose an environmental hazard to farmers and their families, agricultural workers and the operations' staff of the chemical companies.

## 3. FINANCIAL IMPLICATIONS

Currently, there is no reliable economic data to compare relative costs and impacts of different weed control methods. Some data from the commercial chemical companies is available from the author on request. However, this type of information is often biassed in the direction of promoting the company's product. MOI keeps budget records on all three control methods in their campaign to fight aquatic weeds. However, interpretation and usefulness of these records is limited as discussed here. Expenditure for each method for the period 1985/86 to 1990/91, in comparison to the total irrigation expenditure, was very variable. In this period, on average, about



60% of total MOI expenditure (operation and maintenance, and minor development) was for weed control, with a range of 40% to 87%. However, the records of MOI annual expenditure do not give an accurate reflection of the true cost of each control method. Some of the apparent variation in expenditure between years may be explained as follows:

(a) In MOI accounts there is no stock-taking procedure to account for opening and closing chemical stocks for each year. The chemical purchases in any one year are recorded as if wholly consumed in that year;

(b) A major increase of the budget item 'mechanical works' took place from 1989/90, due to a huge programme of earth-moving operations fighting both siltation and weed problems. Expenditure on this programme will give benefits in years to come, although accounts attribute the expenses only to the year of operation.

Consequently, expenditure on manual control appears not to have a wide variation (ranging from 9-18% of total expenditure); whereas annual percentage expenditure for mechanical (35-79% of total), and chemical (3-51% of total) methods of control appear to have varied noticeably.

An exceptional decrease in the percentage expenditure on chemical control from 1989 to 1991 was due to the decrease in foreign support in the form of grants and soft loans. This raises a further issue of the sustainability of chemical control in terms of supply and high recurrent budgets required for purchase.

It is not just the total annual expenditure on weed control, or the percentage of total expenditure which is important, but the cost-effectiveness of each method. Cost-effectiveness calculations must take the following factors into consideration:

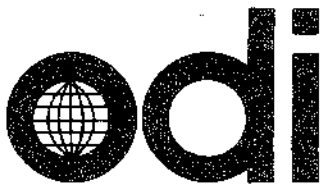
(a) How long does a treatment under each method last and, therefore, over what period is the expense borne? It is scientifically proven that methods vary in this respect;

(b) The mechanical and chemical methods need to be supplemented by a further manual operation to remove dead weeds which otherwise block the waterways;

(c) Mechanical control removes both weeds and silt in one operation, so rendering a valuable side service. Although, on average, the percentage expenditure for the total study period was recorded as highest for mechanical weed control, this was not necessarily the dominant method. Some of the costs should be attributed to desilting benefits.

## 4. POLICY **IMPLICATIONS AND FUTURE RESEARCH**

Government policy on aquatic weed control in Sudan's gravity irrigation systems has emphasised the use of chemicals as a replacement for manual and mechanical methods. However, experience is showing that use of chemicals also has disadvantages, especially in environmental terms. There is no concrete evidence in Sudan to show that chemical control is superior to mechanical or manual, either theoretically, economically or environmentally. Little objective data is available to show that the real economic cost (e.g. including the cost of removal of dead weeds) for effective weed control is lower for chemical than other methods. It is clear that the subject needs further research, with accurate financial recording, including cost-benefit analysis of the different control methods and environmental investigation of the hazards of chemical use for humans, livestock and wildlife.



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