# CHAPTER 5

## Water Availability and Cropping Pattern in the Gezira Scheme

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### 5.1 Water Availability from the Blue Nile

The Blue Nile is the source of irrigation water for the 2.1 million feddans of the Gezira scheme and some other 0.8 million feddans or so in other existing schemes. The present average annual consumption of irrigation water by these schemes is around 8.8 milliards cubic meters (Table 5.1). In addition to this, the Blue Nile flow is used for hydro-power generation and for drinking water supplies.

*Table 5.1. Existing schemes irrigated from the Blue Nile.*

| Schemes | Gross Area 1000 Feddans | Cropped Area 1000 Feddans | Water Use $10^3$ $m^3$ |
|---|---|---|---|
| Gezira | 2080 | 1600 | 5540 |
| Rahad | 300 | 304 | 1100 |
| Suki | 90 | 85 | 250 |
| Gunaid | 38 | 24 | 255 |
| N.W. Sennar | 32 | 36 | 355 |
| Abu Na'ama | 30 | 42 | 10 |
| Blue Nile Schemes | 235 | 162 | 540 |
| Private (U/S Sennar) | 25 | 22 | 230 |
| Private (D/S Sennar) | 55 | 52 | 512 |
| Total | 2885 | 2327 | 8792 |

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In spite of the fact that the present water consumption constitutes only around 18% of the average annual river yield of 49.2 milliard cubic meters, it is still water and not land which limits the expansion of the area irrigated from the Blue Nile. The reason for this is the lack of the required storage facilities that would allow a higher exploitation of the river flows.

The Blue Nile is characterized by a marked seasonality in its flow pattern. Of its 49.2 milliard cubic meters, 80% occurs in the four months from July to October and only 10% occurs in the seven months from December to June. The seasonality of the Blue Nile flow pattern has created a situation whereby the natural flow by far exceeds the water demand during the flood months from July to October and falls short from December to May. The primary objective of the two storage reservoirs constructed on the Blue Nile at Sennar and Roseires was to help in smoothing out the river flow pattern by storing some of the flood flows to supplement the natural flow during the low-flow months.

The present combined storage capacity of the two reservoirs is 2.62 milliards cubic meters (2.20 at Roseires and 0.42 at Sennar). Although this constitutes only 5.3% of the natural river flows, it contributes some 30% of the irrigation water demands on the Blue Nile. This limited storage facility is a major factor in determining the areas which can be placed under cultivation during the river low-flow period from November onwards.

The two reservoirs are usually kept at their minimum level during the flood season to allow the heavy silt laden flood water to pass downstream. Filling of the reservoirs is usually carried out during September and October. Abstraction from the reservoirs usually starts in late November or early December. The reservoirs contents are used to supplement the natural flows in satisfying the irrigation and other demands (such as hydro-power generation and maintaining a minimum flow downstream of Sennar) in such a way that the reservoirs contents are not to be exhausted before 10 June, the time by which the flood of the next year will start. The exact date of the start of filling and abstraction from the two reservoirs varies from one year to the other, depending on the flood magnitude and the rate at which the river is falling after the flood.

## 5.2 Water Availability for the Gezira Scheme

With the present cropping calendar, the irrigation season in the Gezira scheme starts by the beginning of June and continues to the end of March. During April and May, irrigation demands are small and canals are virtually closed for annual maintenance.

During the first 10-day period of June, the river flood will have usually started and some water could be made available for irrigation in the Gezira and other schemes. Preliminary analysis indicates that during 90% of the years, up to 15 million cubic meters per day can be made available for the Gezira scheme.

From the second 10-day period of June to late-November/early December (when abstraction from reservoirs starts), the river natural flow usually exceeds the water demands for all purposes. During this period, water is diverted to the scheme as run-of-the-river. The maximum amount which can be diverted is determined by the combined carrying capacity of its twin main canals. At present, this is equal to 31.05 million

cubic meters per day (14.52 in the Gezira old canal and 16.53 in the Managil new canal). However, during June, July, August, and sometimes early September, because the water level in the Sennar Reservoir is kept at its minimum level, the maximum discharge which can be passed into the headworks of the main canals is limited to 25 million cubic meters per day. From late September and onwards, the water level in the reservoir will be raised. This will enable the full main canals carrying capacity of 31.05 million cubic meters per day being diverted.

From mid-November/early-December, the river natural flow falls below the water demands and abstraction from the storage reservoirs is usually started. The Gezira Scheme has to compete with other schemes and other water uses in the available water resource. The water available for the Gezira Scheme then depends on the expected river flows, storage volume, and the competition from other uses during the particular season. Preliminary analysis using the present demand pattern indicated that in 80% of the years it is possible to make available 31.05 millions cubic meters per day for the Gezira scheme until the end of January, 25 millions per day throughout February and then 21, 15 and 10 millions per day during the first, second and third 10-day periods of March.

To operate the hydro-power facilities of the Roseires Dam during April and May a minimum of 17 million cubic meters per day have to be discharged. Preliminary analysis indicated that, after satisfying the minimum flow requirements downstream from Sennar Dam and N.W. Sennar Sugar and other small private schemes, some 5 million cubic meters per day could be made available for the Gezira Scheme.

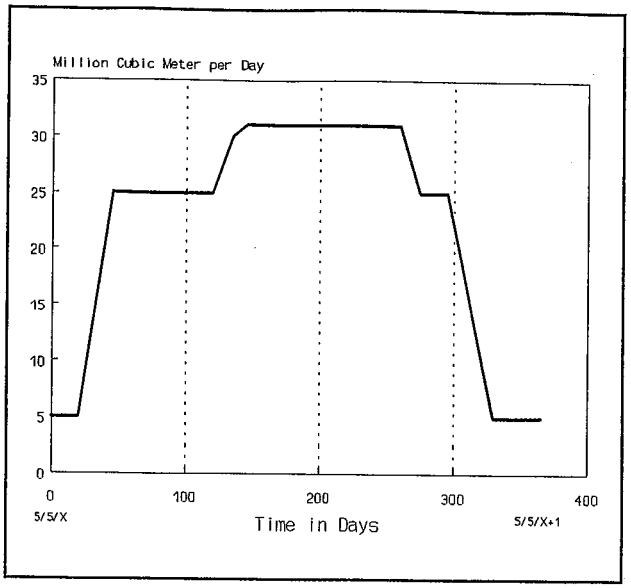
The above account shows that the water availability for the Gezira scheme can be taken to be as shown in Figure 5.1 and Table 5.2 in four out of five years.

The heightening of the Roseires Dam is expected to make available additional water for the period from February to early June if required.

*Table 5.2. Water availability for the Gezira Scheme in million cubic meters per day.*

| Month period | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1st | 15 | 25 | 25 | 25 | 31 | 31 | 31 | 31 | 25 | 21 | 5 | 5 |
| 2nd | 25 | 25 | 25 | 25 | 31 | 31 | 31 | 31 | 25 | 15 | 5 | 5 |
| 3rd | 25 | 25 | 25 | 30 | 31 | 31 | 31 | 31 | 25 | 10 | 5 | 5 |

*Figure 5.1. Water availability pattern for the Gezira Scheme.*




## 5.3 Water Use in the Gezira Scheme

### 5.3.1 Calculations of the Scheme Water Use

To calculate the water use in the Gezira Scheme, a micro-computer based model was prepared in Lotus-123. The model calculates the crop water demands of the scheme for each 10-day period throughout the year. The idea was to use the model for planning purposes at the scheme-wide level. The same model can be used at the major or minor level for the same purpose.

The use of the model does not require a knowledge of computers. The user needs only to input the area for each crop and the model automatically calculates and plots the pattern of water demand variation with time throughout the year. In addition, the model calculates the following: (i) total seasonal demand; (ii) abstraction from the storage reservoirs; and (iii) abstraction during the heavily silt laden flow (This is the period from July 10, to August 20. Abstraction in this period is particularly undesirable as, on average, 65% of the silt entering the scheme is diverted during this period).

The model described above was used for calculating the water use pattern for three scenarios of cropping patterns and intensities. The next subsections show the results and compare the water use pattern with the water availability.

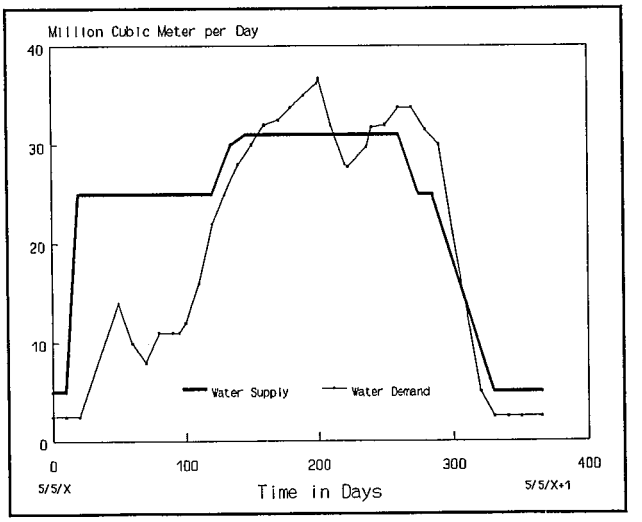
### 5.3.2 Last 4-Course Rotation

The last 4-course rotation (3-course rotation in the Managil extension) was adopted in the scheme in the 1975/76 season. The design cropping pattern and intensity for the whole scheme was as follows:

| | |
|---|---|
| ELS Cotton | 608333 feds. |
| Wheat | 608333 feds. |
| Dura | 304167 feds. |
| Ground Nut | 304167 feds. |

Figure 5.2 shows a comparison between the water availability and demand patterns. Clearly, the water demand exceeds the water availability for a large part of the irrigation season. In fact, the designed cropping pattern and intensity had never been achieved in the 15 years during which the rotation was adopted. Areas for all crops fluctuated considerably below their potential, with the exception of dura (sorghum), which in some years exceeded its design area.

*Figure 5.2. Water supply and demand pattern based on 4-course rotation.*



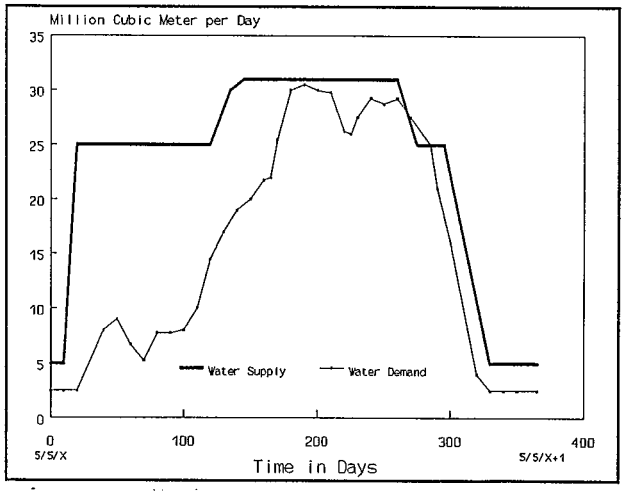
### 5.3.3 Original Proposed 5- Course Rotation

The original proposed 5-Course rotation was as follows:

| | |
|---|---|
| ELS Cotton | 420000 feds. |
| Wheat | 420000 feds. |
| Dura | 185000 feds. |
| Ground Nut | 185000 feds. |
| Rot. Gardens | 50000 feds. |
| Mixed fodder | 210000 feds. |
| Serial Fodder | 210000 feds. |

Figure 5.3 depicts the relationship between water demand and availability. Clearly, the match is better than the previous 4-course rotation with demand exceeding supply in only one decade in the first period of February. However, there is a large quantity of water unused during the first half of the season.

*Figure 5.3. Water supply and demand pattern based on the original 5-course rotation.*



### 5.3.4 The Proposed 1994/95 Season Pattern

For various reasons, the originally proposed 5-course rotation was not adopted as designed during the last few seasons. The proposed 1994/95 season cropping pattern is as follows:

| | |
|---|---|
| ELS Cotton | 100000 feds. |
| MS Cotton | 192995 feds. |
| Dura | 425717 feds. |
| Ground Nut | 228952 feds. |
| Wheat | 500000 feds. |
| Sun Flour | 10000 feds. |
| Rot. Gardens | 50880 feds. |

Officials of the agricultural administration of the scheme indicated that the cropping pattern in the scheme will follow this norm at least in the foreseeable future. Figure 5.4 shows the water demand and availability patterns for this season. The match is clearly better than in the originally proposed 5-course rotation. However, there is still a large quantity of available water unused during July and August and again during December and January. In practice, the unused excess water in July and August is reflected in the large areas which are usually unofficially cultivated with dura and irrigated using the scheme water. The December - January excess is reflected in the large quantity of water usually drained during this part of the season.

*Figure 5.4. Water supply and demand pattern under the new 5-course rotation.*