3.14 IRRIGATION STUDIES IN THE GEZIRA SCHEME (SUDAN) BY A.H. EL RAYAH AND A.H. EL NADI

The Gezira Scheme was started in 1925, primarily for cotton growing. It has expanded so that sorghum, lubia, wheat, groundnuts and vegetables are now important crops. These are grown in a definite rotation so as to provide for efficient use of land and water.

The soils of the area are relatively uniform. They are cracking clays which usually have a relatively favourable granular structure on the surface, form wide cracks on drying, have high clay content (40-65 %), high cation exchange capacity, and pH values ranging from 7.2 to 9.6. There is a considerable proportion of sodium among its exchangeable bases. This high sodium exchange capacity has a pronounced influence. The water holding capacity is high and permeability is low and little water passes below the roots (0-60 cm). The high amounts of sodium are not likely to influence yields except for very sensitive crops. The permanent wilting point determined on cotton seeding is 20 %. The storage capacity of the soil is poor.

The soil has a self-regulating effect, i.e. too much watering means less water absorbed at the next irrigation and vice versa. Cotton, which is traditionally the major crop, is known to tolerate a wide range of moisture conditions. Irrigation of the crop early in the season is confused by rains. But the general practice is to water lightly in order to reduce the risks of waterlogging although waterlogging for short periods during growth has little effect on cotton.

The main purpose of water economy in the Gezira is to obtain maximum production per unit of irrigation water. This can be achieved by increasing the yield per unit area or increasing the area of crop irrigated. The latter approach has been preferred so far.

In the past increase in area of crop irrigated was limited by water available at:

(a) period of peak demand (October, November);

(b) stored water period (January - March).

However, storage has no longer been a limiting factor since the completion of Roseiris Dam. At present the primary concern is to economise in water use at the peak period of demand (October-December), particularly since the cropping system was intensified.

Various methods have been experimentally used for estimating crop water requirements.

(a) Evapotranspiration

As there is no through drainage in the heavy clays of the Gezira scheme the total amount of irrigation water applied has to be a measure of total evapotranspiration apart from minor losses in conveyance. The theoretical patterns of water use are always characterized by a very marked mid-season peak associated with high leaf area indices. This implies the use of differential irrigation, in contrast with the fixed irrigation schedules which provide for a uniform rate of water application over the whole season. Attempts have also been made in the past to estimate water requirement, using Penman formulae and other methods, but the estimates appear rather low.

The range in daily water losses from cotton fields in October-December varies from 18-32 cubic metres per feddan. The range of Penman Eo for the same period covers only 20-23 cu. m.f. per day. The crop factor, however, varies between 0.9 for poor cotton to 1.4 for vigorous cotton.

(b) Water Duty Experiments

A very large number of irrigation experiments have been carried out at the Gezira Research Station (Fadda 1962, Farbrother 1969). Combination of water duties (light, medium and heavy) at different seasons have been used, assumed to be nominally 300, 450 and 600 cubic metres per feddan. Intervals in watering cotton have varied between 7 and 28 days. The results have been inconsistent, indicating that a wide variation in irrigation schedules has little effect on yield levels. But, generally, heavy water duties give good yields. As a result of these experiments, a medium watering (450 cu.m.f.) at 14-day intervals is usually given for cotton in the Gezira. The crop is usually sown in early August and the season extends until March. Many experiments have been made by varying the date of water closure to economise in water use. Watering after February has been shown to have negligible effect on yield. Interseasonal variability has been so great that there is not enough evidence to modify the present standard practice. Length of the growing period varies from season to season so that controlling water use on a calendar basis has little meaning. In any case, with the Roseiris Dam, water economy late in the season is no longer necessary.

(c) Soil Moisture Determinations

The present policy of research, adopted primarily by Hack (1969) and Farbrother (1969), is to seek a full understanding of the sequence of wetting and drying cycles that result from traditional irrigation.

Soil moisture determinations at very frequent intervals within irrigation cycles have been made gravimetrically at full plant cover in order to measure actual water loss.

Recent research has disclosed two defined stages in the process of wetting a field plot. First the surface accepts water readily and rapidly through cracks (within 1 hour) to bring the 0-60 cm horizon up to a closely reproducible upper level of soil moisture. The quantities required vary inversely with amount already there (800 cu.m.f. to zero). The second stage is that of filling up the furrow with free standing water. This involves only 100/150 cu.m.f.

The state of soil prior to watering plays the dominant rôle in water duty. At a fixed watering interval of 14 days during the cotton season the actual duties are likely to be no more than 250 cu.m.f. during early and late season, rising to 450 cu.m.f. during mid-season peak. This self-regulating effect also explains why actual field intervals in experiments have had little effect on total water use, or on growth or on yield. Experimental work has shown that the optimum interval at the peak of the season was 12 rather than 14 days.

Evidence available indicates that the effective depth of the rechargeable zone varies with root behaviour and efficiency. Effective depth of wetting for cotton is 0-60 cm but increases with a well fertilized crop. Current programmes of work on water requirements of groundnuts and wheat (El Rayah, 1970) have shown that the depth of soil involved in irrigation cycles is strictly limited to about 40 cm because of the shallow depth of rooting. Soil moisture contents less than the permanent wetting point are commonly observed at 0-20 cm depth before the end of a 14 days cycle of irrigation, which suggests the use of a shorter interval for these crops. Sugar cane at the Gezira Research Scheme, however, appears to utilize some 80 cm depth of soil (Farbrother, 1969).