IMPACTS OF SUGARCANE PRODUCTION ON WATER RESOURCES

EJ SCHMIDT

South African Sugar Association Experiment Station, P/Bag X02, Mount Edgecombe, 4300

Introduction

South Africa is a water scarce country. Based on current projections, South African water resources will be fully exploited by the year 2020. Changes to the way water resources are used and managed are thus required. To this end, proposed changes to South African water law will have far reaching effects on sugarcane growers. Increasingly, the crop will have to be justified against other land uses in terms of:

- water use under irrigation
- reduction in stream flow under rainfed conditions
- impact on water quality.

The new Water Act could affect irrigators significantly, as illustrated below in some of the proposed water law principles.

- Greater recognition will in future be given to the needs of the environment and basic human consumption in the apportionment of water.
- Boreholes and private dams in sensitive catchments will be subject to the same regulatory controls currently applied to public streams.
- Owners of land adjacent to a stream will not automatically be entitled to priority use of water as is currently the case through riparian rights.
- Water will be subject to national control with apportionment based on public interest, equity and efficiency of use.
- The pricing of water will reflect its scarcity and be guided by the efficiency with which it is used. Demand will thus be market driven, whereby low value users of water will cede rights to high value users.

The new Act could also affect rainfed growers:

- Land use has an impact on the water cycle, such as through rainfall interception. The new legislation proposes that land uses such as sugarcane should be regulated in sensitive catchments to manage scarce water resources. This is currently done for timber through a permit system.
- Economic incentives or penalties will be used to reduce pollution of water resources such as from soil erosion.

Increased focus will thus be placed on the impact sugarcane has on water resources.

Keywords: Water Act, water use, water legislation

Irrigation of sugarcane

In South Africa, approximately 21% of the total area under sugarcane is irrigated. Owing to high yields these areas typically produce 30% of the total crop, although this varies with season. Small scale growers account for approximately 13% of the irrigated area.

The table below gives a breakdown of irrigation on a sub-regional basis. Irrigation is a prerequisite in the northern regions (Mpumalanga and Pongola) where annual rainfall is typically 600 mm and class A pan evaporation is around 2 000 mm. Moving south, the difference between crop water requirement and rainfall decreases and supplementary irrigation is sufficient to augment rainfall, reduce risk and maximise yields during dry periods. South of Pongola, however, irrigation is a prerequisite in some areas of low rainfall or where soils have low moisture retention.

Region	Area (ha)	Irrigated area (%)
Northern irrigated	46 417	99
Zululand	107 005	27
North coast	114 134	7
South coast	70 197	2
Midlands	74 359	3
Total	412 112	21

Generalised plots illustrating trends in sugarcane yield under full irrigation and rainfed conditions are given in Figure 1. The plots were derived using the CANEGRO model, long term climatic records for a selected meteorological site in each region and an assumed deep soil with 20-30% clay content. A range in expected yield is presented to illustrate the likely difference in yields under optimum and average (70% of optimum) management practices. The plots are presented solely to illustrate macro trends and the higher yield improvement under irrigation in the northern areas.

From a water resources viewpoint it is important to consider the relationship between amount of water applied and corresponding increase in yield. The use of a crop model such as CANEGRO allows these aspects to be integrated and assessed. Figure 2 illustrates potential sucrose production, based on the model runs described above, as effective irrigation increases.

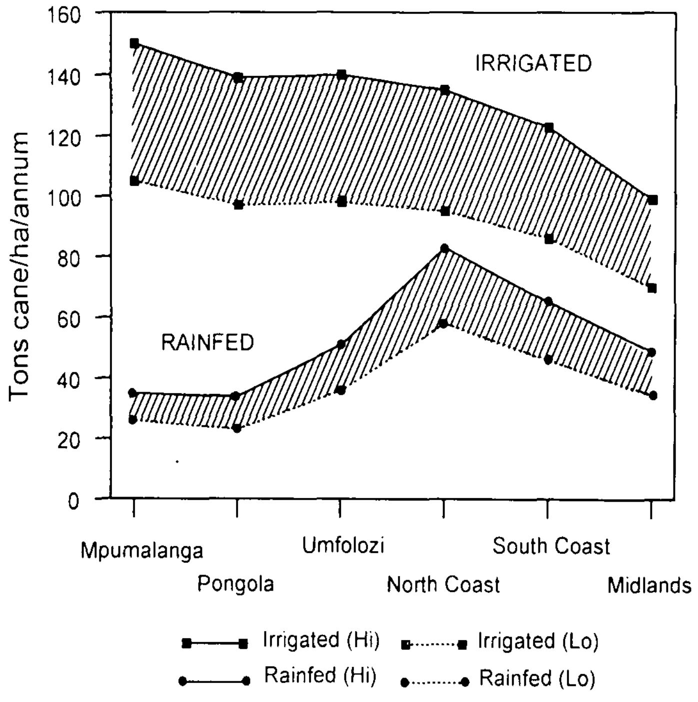

Figure 1. Sugarcane yield under irrigated and rainfed conditions in various regions of the South African sugar industry.

The larger yield increment with irrigation in the Mpumalanga and Pongola areas is again evident, as is the higher water demand in these areas. The curves illustrate a yield threshold that is a function of potential evapotranspiration, as well as a reduction in return per unit of irrigation water as the amount applied increases. This is due to a declining rainfall efficiency. The importance of knowing the optimum water requirement for a particular site and soil is thus critical to reduce water wastage and operating costs.

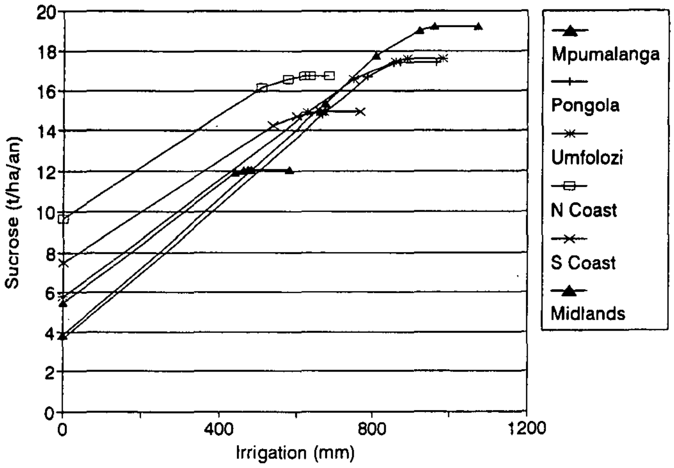

Figure 2. Relationship between water applied and increase in cane yield in selected areas of the South African sugar industry.

Another important consideration is the irrigation system efficiency, which represents the effective water applied to the root zone divided by gross water brought to the field edge. An overhead system typically has a low efficiency of between 60 and 80% owing to wind and evaporation losses, whereas a subsurface drip system can have an efficiency nearer 95%. Low efficiencies imply high wastage and a low yield return per unit of water abstracted from the river. A move towards more efficient irrigation systems can be expected as competition for water and water prices increase. Efficient systems generally have a high capital cost, and a site specific cost benefit is required to compare expected yields with capital and operating costs.

The above illustrates the need to improve irrigation management by using efficient systems and through appropriate scheduling of water application.

Impact of sugarcane on stream flow

Proposed changes to the Water Act could also see regulation on rainfed sugarcane, due to its interception of rainfall and reduction of stream flow. This could take the form of a levy paid on intercepted rainfall or a permit system to limit expansion of production in sensitive catchments. It must be recognised that the impact of a crop on run-off depends on its location in the river catchment as well as soil and slope conditions, stage of crop growth, management practices and local climate conditions.

It is thus worth noting that, of the 412 000 ha currently under cane, about 293 000 ha (70%) occur along the coastal belt of KwaZulu-Natal near the lower end of catchments and within 30 kilometres of the sea. Most of the run-off entering streams in these areas flows directly into the Indian ocean with fewer competing water users which comprise primarily ecological usage. Nevertheless, decisions on land use and its impact on water resources are required in sensitive catchments such as those of the Krokodil and Umgeni rivers, where there are many competing water users. In such cases an integrated view has to be taken of the catchment, and the hydrological impact of different land uses has to be quantified.

Run-off has been monitored at four sugarcane research catchments at La Mercy (mean annual rainfall = 1 000 mm) since the mid-1970s. The catchments were kept under bare fallow conditions from 1978 to 1984, when cane under various management practices was introduced. The records indicate that annual run-off as a percentage of rainfall is less than 5% in dry years when rainfall is less than 850 mm, but increases to 25% during wet years (rainfall >1 200 mm). Run-off is closely related to rainfall intensity, with levels of up to 50% run-off during high intensity storms. The influence of management practices is difficult to determine from available records since other factors such as different slopes and soils disguise trends. The impact could, however, be marked when sugarcane is planted in wetland areas or adjacent to a river channel.

Observed run-off records are site specific, and hydrological models provide a useful tool to extrapolate to ungauged catchments. The Agricultural Catchments Research Unit (ACRU) model, which has been widely used and verified for a range of land uses, has been successfully used with La Mercy data to improve the ability to model hydrological processes from sugarcane catchments. This has allowed the model to be used to compare the impacts of sugarcane on stream flow relative to other land uses such as grassland and timber. The results of this work are reported separately (Smithers *et al.,* 1997).

Soil erosion

It is generally regarded that, with sound management practices, the sugarcane crop does not contribute to soil erosion. Sugarcane ratoons perennially, with planting being undertaken on a 10 to 15 year rotation. Thus only about 8% of the area is exposed at any one time during replanting. It is during the bare fallow period that a field is most vulnerable to erosion.

Records from the La Mercy catchments illustrate a sharp decline in soil loss, from an average of 50 t/ha/annum under bare fallow conditions to less than 5 t/ha/annum under crop cover. Generally a large portion of annual soil loss occurs when one or two rainfall events coincide with bare conditions or low canopy cover. During such storms as much as 30 t/ha soil loss has been measured, which represents a loss of 3 mm topsoil.

Minimum tillage planting operations are becoming more widespread in the industry, and are an important step in reducing erosion. In rainfed areas, soil exposure during harvesting is also being significantly reduced by the adoption of strip cropping and trashing.

Conclusions

All stakeholders in a catchment are linked through the hydrological cycle. Water resources management must recognise the specific characteristics of each catchment, and all should be addressed in an integrated way. The sugar industry is a major stakeholder in KwaZulu-Natal and Mpumalanga and brings enormous socio-economic benefit to the region. However, cane production must take place mindful of potential impacts on the environment. The relationship between sugarcane production, irrigation water usage, stream flow and soil erosion has been introduced in this paper. Through careful management negative impacts can be minimised.

REFERENCE

Smithers, JC, Schulze, RE and Schmidt, EJ (1997). Modelling the impacts of grassland, forestry and sugarcane run-off at the Umzinto research catchments. *Proc S Afr Sug Technol Ass* 71 (in press).