THE ROLE OF IRRIGATION IN THE SOUTH AFRICAN SUGAR INDUSTRY

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Abstract

Irrigation plays an important role in the South African sugar industry and in 1996-97 approximately 21% (87 000 ha) of the 412 000 ha under production was irrigated. In the northern areas irrigation is a prerequisite for growing sugarcane. These areas, comprising some 47 000 ha, typically produce more than 16% of South Africa's total production. In 1996-97 production in the northern irrigated areas was worth R0,6 billion in miller and grower revenues. The remaining 40 000 ha of irrigated areas fall in the coastal and midland regions of KwaZulu-Natal, where irrigation is generally supplementary to rainfall.

Selection and management of an irrigation system will affect water use efficiency. This is becoming especially important in catchments having limited water resources. In such catchments consideration is already being given to the economic return per unit water of competing land users.

Key operational and research areas will need to be addressed by the sugar industry to defend its use of scarce water resources.

Keywords: irrigation efficiency, water resources, catchment management

Introduction

Pressure is being placed on irrigated agriculture to justify its use of scarce water resources and substantiate the economic contribution of water used for irrigation. This is largely due to increased competition for finite water resources and the development of new water legislation and irrigation policy.

Following a request by the Department of Water Affairs and Forestry, the South African Sugar Association has prepared a report to assist in formulation of irrigation policy (Anon, 1997). This paper presents technical information from the report illustrating the importance of irrigation to the South African sugar industry and highlights the need for efficient use of water resources. Key operational and research challenges to improve irrigation water use efficiency are outlined.

Overview of sugarcane production and irrigation

In 1996-97 the area under sugarcane was 412 000 hectares, producing 20,9 million tons of sugarcane. Trends in area under sugarcane and production are given in Figure 1, which illustrates the marked variation in between-year sugarcane production. This variation is closely related to seasonal rainfall.

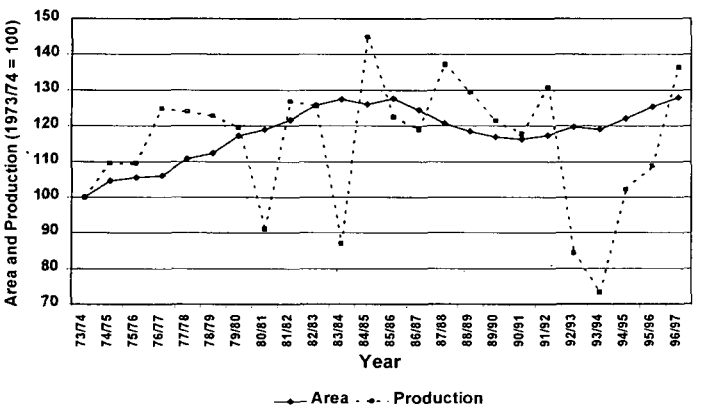

Figure 1. Area under sugarcane and production, 1973-74 to 1996-97.

The impact of seasonal rainfall on cane yield is illustrated in Figure 2, which compares industry average annual yield per hectare under cane and preceding 12 month rainfall. The potential role of irrigation to increase yields during dry years is evident.

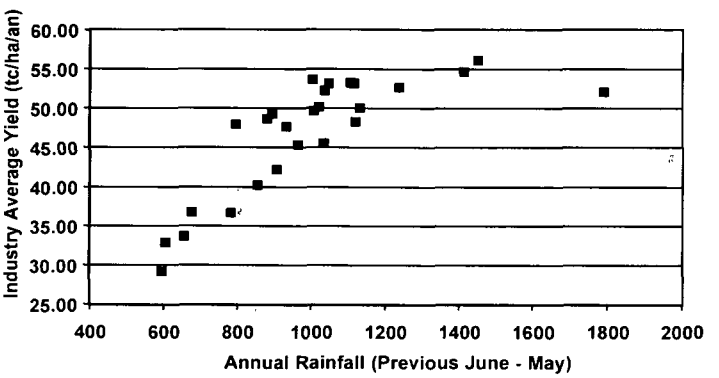

Figure 2. Industry average yield versus industry average rainfall.

Roughly 21% of the area under cane is irrigated. Table 1 shows the irrigated area supplying each mill (1996-97 data). Irrigation plays the most important role in the northern areas of Malelane, Komati, Pongola, Umfolozi and Nkwaleni (supplying the Felixton mill). In these areas, due to low rainfall and high evaporation, irrigation is a prerequisite for sugarcane production. In other areas supplementary irrigation is used to boost yield during dry periods.

The northern irrigated areas of Malelane, Komati and Pongola comprise 12% of the area under cane, and in 1996-97 pro-

duced 16% of the total crop. In an average year, given reliable water supplies, this contribution is above 20%.

Table 1. Irrigated area for each mill supply region (1996-97).

Mill	Area under sugarcane (ha)	Irrigated area (ha)	Percentage irrigated
Malelane	18 177	18 177	100
Komati	12 812	12 812	100
Pongola	15 428	15 428	100
Umfolozi	18 562	8 267	45
Felixton	36 680	11 374	31
Amatikulu	39 824	9 352	23
Glendale	11 075	2 003	18
Maidstone	48 521	5 086	10
Union Co-op	19 036	1 573	8
Darnall	29 874	794	3
Sezela	42 364	886	2
Noodsberg	31 376	511	2
Umzimkulu	27 834	312	1
Entumeni	11 938	145	1
Gledhow	24 666	202	1
Eston	23 947	351	1
Total	412 114	87 261	21

The contribution of irrigation to production in supplementary irrigation areas is not available from records. However, based on irrigation area data (Table 1) and estimates of yield under rainfed versus irrigated conditions, it is estimated that in an average year some 30% of industry production can be attributed to the 21% of the industry under irrigation.

Figure 3 illustrates the potential increase in yield when irrigating at selected sites in the industry. The yield estimates were based on the CANEGRO crop model (Inman-Bamber, 1995) and are given for poor (shallow) and good (deep) soils as well as rainfed and fully irrigated conditions for an average year. A range in yield estimates is given to reflect management variations.

The large increase in yield when irrigating in the northern areas is evident. The impact of soil type is illustrated by the larger yield improvements when irrigating poor soils. Supplementary irrigation of poor soils in southern areas is thus often economically viable. In this regard it should be recognised that supplementary irrigation, provided at critical periods of crop stress, can provide a disproportionate increase in yield per unit of water applied.

Factors affecting irrigation water use

Climate factors

The reliance on irrigation in the northern areas is a function of climatic patterns in the sugar industry. Annual rainfall is generally in excess of 900 mm in the coastal areas of KwaZulu-Natal, exceeding 1 250 mm in places. Rainfall declines to less than 700 mm in river valley inland areas and in the northern irrigated areas. Class A pan evaporation increases from 1 500 mm in the south to more than 2 000 mm in the north. Based on these climatic patterns and taking into account crop, climate and rainfall efficiency factors, nett irrigation water required to meet full crop water demand typically ranges from less than 500 mm/year in the KwaZulu-Natal coastal areas to up to 1 200 mm/year in the northern areas (Figure 4).

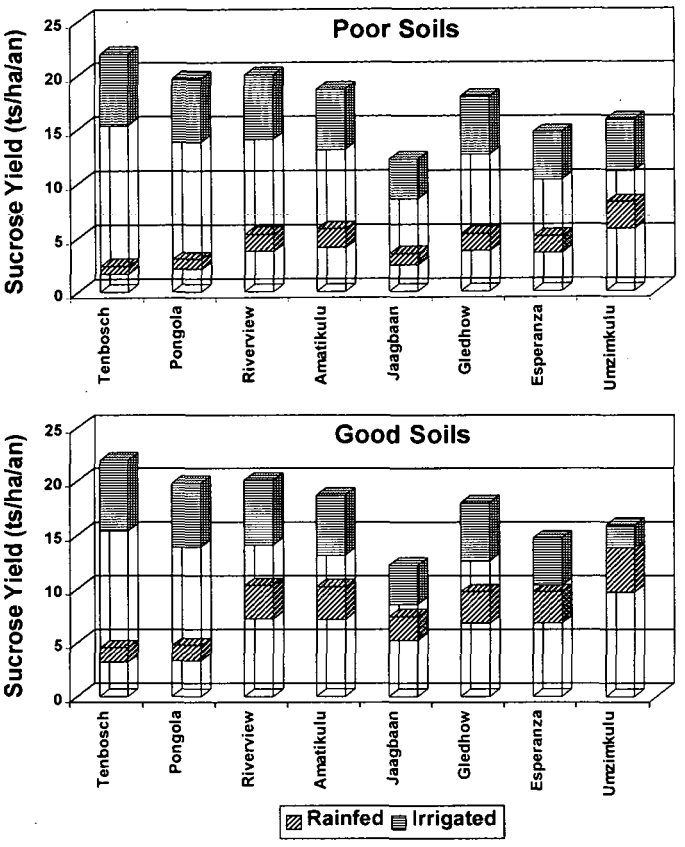

Figure 3. Potential increase in yield when irrigating at selected sites.

System Factors

Irrigation system efficiency will determine how much water must be extracted from the water source in order to meet crop requirements. Approximately 91% of irrigation is in the form of overhead dragline or portable pipe sprinkler systems. These systems generally have 60 to 80% efficiency depending on system management and local wind and evaporation conditions. Approximately 6% of irrigated lands are currently under centre pivot which has an advantage of higher application efficiency, low labour requirement and flexible scheduling. Approximately 3% are under drip irrigation, which typically has an application efficiency of above 90%. Use of drip and centre pivot systems is on the increase in water scarce areas. However, careful consideration has to be given to the improved yields and lower operating costs relative to the high capital cost of these systems to ensure profitability (Schmidt, 1996).

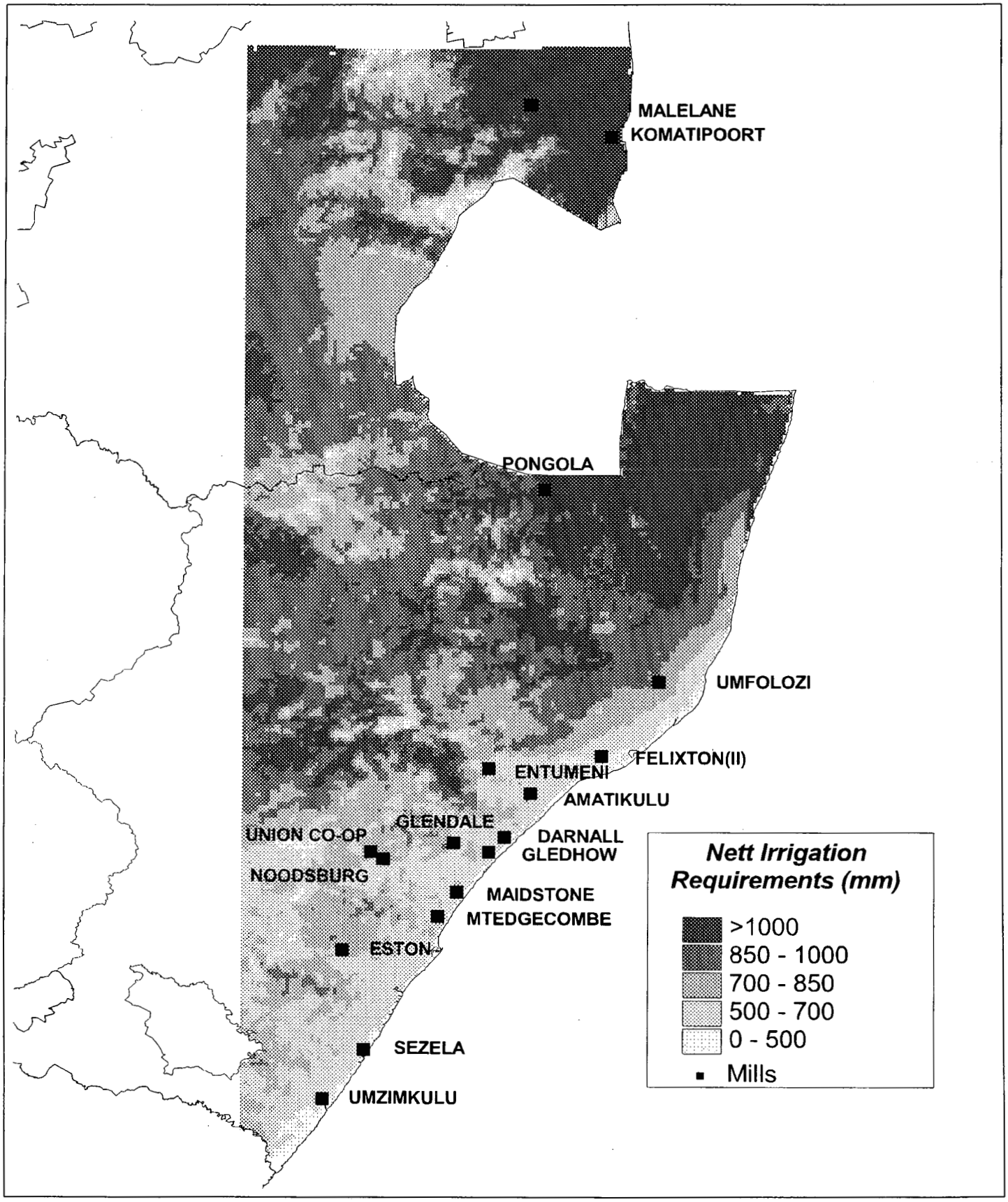

Figure 4. Nett irrigation water requirement for sugarcane under full irrigation.

Management factors

Many other factors also impact on water use efficiency, particularly scheduling of irrigation (i.e. ensuring the right amount is applied at the right time). The South African Sugar Association Experiment Station (SASEX) has promoted scheduling as a means to save water, cut operating costs and increase yields. Scientific scheduling methods based on use of evaporation pans and automatic weather stations to estimate crop water use are in use as well as direct measurement of soil water status. While the majority of growers rely on practical experience in scheduling irrigation, in the northern areas there is a significant increase in the use of scientific scheduling methods. For example in the Onderberg area of Mpumalanga, 8 250 ha (25% of total cane area) is irrigated based on neutron probe scheduling methods. Automatic weather station based scheduling is also being implemented.

Economic contribution of irrigation

In 1996-97 the sugar industry's gross revenue directly attributable to sugar and molasses sales was R3,6 billion, of which R0,6 billion was attributable to the fully irrigated areas of Mpumalanga and Pongola.

Through its activities the South African sugar industry generates direct income and employment. The economic impact of the sector extends beyond these direct effects, to the generation of indirect employment and income. This is due to the backward linkages that exist between the sugar sector and the many businesses that serve the sugar industry, as well as the forward linkages associated with processing of sugar and its by-products (e.g. molasses and bagasse).

Total employment generated by the sugar industry in 1994-95 was estimated to have been 238 000 (95 000 through direct employment) of which 32 000 was attributed to the northern irrigated areas. It is thus likely that over 150 000 people are dependant on the sugar industry in the northern irrigated areas. An important point to note is that, because of its agricultural base, the sugar industry contributes disproportionately to employment and income in poorer rural areas.

Small scale grower contribution in irrigated areas

Of the 412 000 ha under sugarcane in 1996-97 approximately 22% (93 000 ha) was farmed by the industry's 56 000 registered small scale growers. In the irrigated areas 13% of the 87 000 ha can be attributed to small scale growers. Of the 3,4 million tons of cane produced in the northern fully irrigated areas in 1996-97, small scale growers produced 14%.

Small scale growers thus contribute a significant and increasing part of irrigated sugarcane production. For many small scale growers sugarcane has provided a stable income, allowed the development of irrigation management expertise and, in many cases, ultimately diversification into other crops and enterprises. It should be noted that sugarcane has a lower risk exposure relative to other crops such as subtropical fruits, based on:

- Lower climatic risk (not as markedly affected by water shortages at critical periods of [fruit] development, nor to hail damage).
- Smaller fluctuations in market price.
- Faster positive cash flows owing to lower establishment costs and earlier cash inflows.
- Less exposure to exchange rate fluctuations given an average 70% domestic market.
- An established marketing and service structure once milling facility has been assured.

Competition for water resources

The important role that irrigation plays in the South African sugar industry has been highlighted above. Increased water demand from all sectors of the economy is resulting in greater competition for limited water resources. Pressure is being applied on the sugar industry to justify its use of irrigation water on the basis of the economic wealth generated per kilolitre of water used. This pressure will be most acute where irrigation is a major consumer of local water resources. Table 2 summarises the potential maximum irrigation water demand of sugarcane, relative to catchment mean annual run-off for selected major catchments. The information is based on broad estimates of:

- Irrigated sugarcane area per catchment.
- Typical gross irrigation required to meet full crop water demand.
- Catchment mean annual run-off (Anon, 1994).

Table 2. Estimated potential irrigation water demand of sugarcane relative to catchment mean annual runoff (MAR).

River catchment	Catchment area (ha)	Sugarcane irrigation area (ha)	Sugarcane irrigation (% of MAR)
Hluhluwe	90 997	1 500	30
Lomati	147 000	6 100	30
Pongola	608 525	14 500	27
Amatikulu	95 346	7 400	17
Komati	970 229	12 400	17
Mhlatuzi	387 435	11 700	16
Umzunduzi	117 600	560	16
Krokodil	1 043 818	12 500	15
Mzinene	72 789	330	13
Tongati	42 186	2 100	11
Mkuze	480 138	2 000	9
Mdloti/Ohlanga	59 638	1 800	8
Mlazi	96 889	1 270	6
Umfolosi	99 933	4 200	4
Umlalazi	49 792	1 300	4
Mtwalume	55 201	370	3
Mvoti	273 444	2 700	3
Fafa	26 101	160	2
Mhlali	29 000	300	2
Mgeni	443 553	860	<1
Lovu	94 424	70	<1
Mkomazi	438 515	300	<1

It is evident that in many catchments irrigation of sugarcane plays a small role in water usage. Assessment of the geographic position of sugarcane production also illustrates that most production is at the lower end of the river, which has less impact on other water users than if it were in the headwaters of the catchment. In some cases, however, irrigation of sugarcane could have a significant impact on catchment water resources. In such catchments the need to improve the efficiency with which irrigation water is used is greatest.

In key areas such as the Onderberg/Nkomazi portion of Mpumalanga (Krokodil, Lomati and Komati rivers), consideration is already being given to the economic return per unit of water used for competing crops (eg sugarcane, citrus and subtropical fruits) and timber plantations. While sugarcane does not always look favourable on a Rand generated per kilolitre of water used basis, the faster positive cash flows, reduced establishment costs, lower risk exposure and established markets and support structures make sugarcane a dominant irrigated crop in the Onderberg.

Key areas to improve irrigation water use efficiency

Given the importance of water resources to the sugar industry and the external forces shaping how water is used, we need to be mindful of how irrigation efficiency can be improved in the industry. Key measures to improve water use efficiency are summarised below.

Operational challenges

Measurement

Insufficient measurement of water use is a restricting factor in many irrigation schemes. Without information on the amount of water being abstracted from a water source and applied to individual fields, water resources cannot be adequately managed. Poor design of the scheme and the high cost of water metering devices are often blamed for this situation. Short-term savings in this area, however, generally result in long term losses over the schemes life cycle.

Water pricing

Inappropriate pricing structures have sometimes encouraged misuse of irrigation water. Charging the full cost for water will encourage efficient usage. Appropriate pricing structures, for example charging on a per kilolitre basis rather than per hectare basis, or using escalating charge rates as usage increases, can improve water utilisation.

System maintenance

Irrigation schemes can only function properly if they are maintained to ensure operation is as originally specified. Regular measurement of system performance in the form of an annual audit should be seen as an integral part of scheme operation.

Training and extension

Knowledge and skill levels of many irrigators need improving. Training and extension plays an important role in maintaining or lifting the standard of irrigation. The cost of this support should ultimately be built into the cost of the water being used.

Flexible supply schedule

In some cases a growers best plans to schedule irrigation are negated by an inflexible supply schedule from the water distributing agency. A system whereby water can be ordered in advance and water not used can be carried over into the season would encourage the use of on-farm scheduling. Lack of assurance of supply often constrains investment in more efficient but expensive irrigation systems.

Water management agency

Management of water resources should be seen as an integral part of management of the catchment as a whole. Water management agencies must thus represent all stakeholders and must operate in accordance with clear catchment management plans. Decentralised decision making by local representatives will improve management.

Irrigation scheduling.

Much research has been focussed on developing irrigation scheduling methods. These range from direct measurement of soil water content and measurement of crop water status to use of automatic weather stations to undertake a soil water budget. Adoption of these methods is often slow and there is a need to make them more user friendly and to promote their use.

Research challenges

Crop production and water use

Better data on crop production and water use is required for each crop and land use competing for water in the various regions and catchments. Reliance is often placed on a few years' data from isolated field trials to determine crop production and water use. Robust and widely verified models such as CANEGRO for sugarcane will in future play an important role in providing answers to decision makers. The extent to which alternative irrigation schedules can improve water use efficiency will have to be assessed. The role of whole farm/region optimisation to ensure best return from limited water resources will become more important.

Economic return on water use

Much effort needs to be placed in the area of resource economics. The net returns per kilolitre of water used by say irrigated crops versus timber plantations, could in future be the basis for establishing water tariffs, determine water allocations and making policy decisions. Methods of calculation and underlying assumptions for each enterprise must however be comparable. The broader impacts of each land use on related industries, the environment and socio-economic issues must be evaluated.

Varieties and agronomic practices

Focus will increasingly need to be placed on selecting varieties that provide higher yields with less water. Similarly planting and harvesting programmes will need to be developed to achieve maximum water use efficiency. Improved cultural practices to increase infiltration and storage need to be developed.

Conclusions

Approximately 21% of the area under sugarcane in South Africa is irrigated, producing some 30% of the crop in an average year. Irrigation water use varies from less than 500 mm/year in the coastal areas of KwaZulu-Natal to up to 1 200 mm/year in the northern fully irrigated areas of Pongola and Mpumalanga, which comprise 12% of the total area.

In 1996-97 the fully irrigated areas contributed 16% of the sugar industry's gross revenue. Some 150 000 people were dependent on sugar production for their livelihood in this region. Expansion of small scale grower sugarcane under irrigation has been marked. Small scale grower areas currently comprise 13% of total irrigated areas.

Competition for water resources in certain catchments is forcing the industry to justify its use of irrigation water on the basis of economic return per kilolitre of water used. Key operational and research challenges face the industry to ensure water is used optimally.

Acknowledgements

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