IRRIGATION OF SUGARCANE: PRELIMINARY ASSESSMENT OF ECONOMIC ADVANTAGE AT SELECTED SITES

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Introduction

The recent drought gave rise to increased interest in supplementary irrigation and many growers are investigating the installation of irrigation systems. Some have not considered long term economic viability.

Economic viability is dependent on a large number of factors, including:

- location and prevailing climatic conditions
- soil characteristics
- irrigation system characteristics and costs
- assurance of water supply.

The true test of economic viability is to compare the yield improvement under irrigation (hence increased revenue) against all the costs of purchasing and operating the irrigation system over its expected life cycle.

This short communication illustrates the use of a simple cane production and economic model to assist in irrigation planning.

It is important to emphasise that the results of this analysis should not be used as the criterion for irrigation feasibility at a particular site, as local conditions for a host of reasons (eg soils and management) may not fit assumptions made. However, the methods employed, together with grower specifics, may be used when considering scheme economics.

Estimating rainfed and irrigated cane yields

An irrigation/cane production model (Thompson and Harding, 1986) was used to estimate cane yield under rainfed and irrigated conditions over a 20 year period (1975-1994) at 10 sites covering the southern African sugar industry (Darnall, Amatikulu, Tongaat, Sezela, Riverview, Jaagbaan, Glenpark, Pongola, Ubombo and Tenbosch).

The model essentially keeps a daily account of soil moisture status and plant evapotranspiration based on daily rainfall and class A pan evaporation. Cane production is determined as 9,6 tons cane per 100 mm evapotranspiration. While not process based such as the CANEGRO model (Inman Bamber *et al.*, 1993), the irrigation/cane production model has been widely used over the years and is considered appropriate for preliminary planning. The figure of 9,6 tc/100 mm evapotranspiration reflects production in a research environment. In practise a management factor of between 70 and 90% should be used to reflect expected response under a commercially grown crop.

The aim of this analysis is to illustrate the impact of **location** and **water application strategy** on scheme economics. A single profile was used in the analysis and comprised a deep soil with total available moisture (TAM) to the plant of 120 mm. Soils in the industry are typified by TAMs ranging from 180 mm to 50 mm. Varying water application strategies were assumed:

- Rainfed conditions
- 50 mm applied to the crop every 10, 21 or 28 days
- 5 mm applied daily.

In the model, irrigation takes place only if the deficit exceeds the amount to be applied.

Estimates of average annual cane yield for the 10 sites over the 20 year record are given in Figure 1 for varying irrigation scenarios. Sites are arranged from left to right in order of decrease in mean annual rainfall. The results include a management factor of 70%. Where irrigation is applied daily (possible with a drip or centre pivot irrigation system), a factor of 85% is also used to reflect the effect on yield of better management capability under these systems.

For rainfed conditions the results indicate a yield increase as one moves from right to left (ie increasing mean annual precipitation, MAP). This limits cane production in Pongola, Ubombo and Tenbosch to irrigated conditions. Under daily irrigation (and therefore limited stress) yield is at a maximum and is dependent on potential evapotranspiration, which is related to mean annual class A pan evaporation (MAE, Figure 1). Thus, Jaagbaan has a substantially lower yield potential than Glenpark (which has a similar MAP) owing to higher altitude and lower temperatures and annual evaporation.

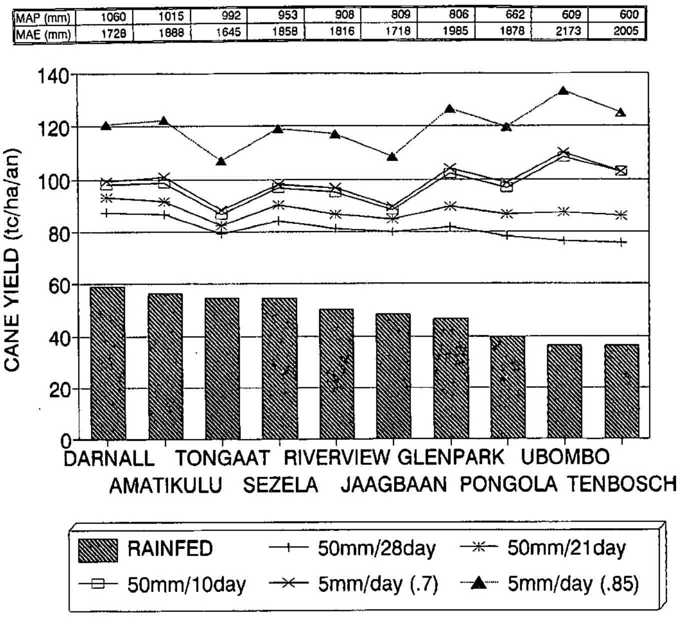

FIGURE 1: Estimates of average annual cane yield for varying irrigation scenarios

The gap between rainfed and irrigated yield potential is smaller in the wetter locations. Similarly, the improvement by moving from a long cycle (say 28 days) to a daily cycle is most marked at drier locations.

It is important to note that Figure 1 gives average yield for the 20 year time frame, but does not give an index of risk and variability between years. This aspect is illustrated later.

Economic assessment

An assessment of economic viability can be obtained by comparing the annual yield improvement under irrigation, and hence increased revenue, against the annual costs of purchasing and operating the irrigation system. These costs vary widely. Typical costs, used later for illustrative purposes, are given below.

Annual fixed costs

- Interest (17% of capital cost)
- Depreciation (10% of capital cost)
- Maintenance (5% of capital cost)
- Management cost (say R10 000 per annum).

Annual variable costs

- Labour (R20 per day – 20 ha per labourer)
- Water (varies widely – say R100 per hectare per annum)
- Power (line fee R3 600 pa and 15 c/kWh)
- Transport of additional cane (R0,30 per ton per km)
- Additional fertiliser and crop husbandry costs (not included).

Figure 2 indicates incremental profit/loss due to irrigation over the 20 year period for the sites with the lowest and highest MAP (Tenbosch and Darnall respectively). Nett profit/loss in Figure 2 is based on the yield improvement (after applying 50 mm of irrigation every 28 days using a dragline system), a cane selling price of R100 per ton, less all irrigation costs.

Annual costs are based on the figures given above assuming a 20 km haul to the mill. The capital cost of the irrigation system is assumed for illustrative purposes to be R5 000 per hectare. Irrigation costs will be dependent on the volume of water pumped and power costs, which are related to seasonal rainfall and head pumped against. Both these factors are accounted for in the analysis. The average annual variable costs at Tenbosch and Darnall in this analysis were R1 921 and R1 514 respectively, reflecting greater water application rates at Tenbosch.

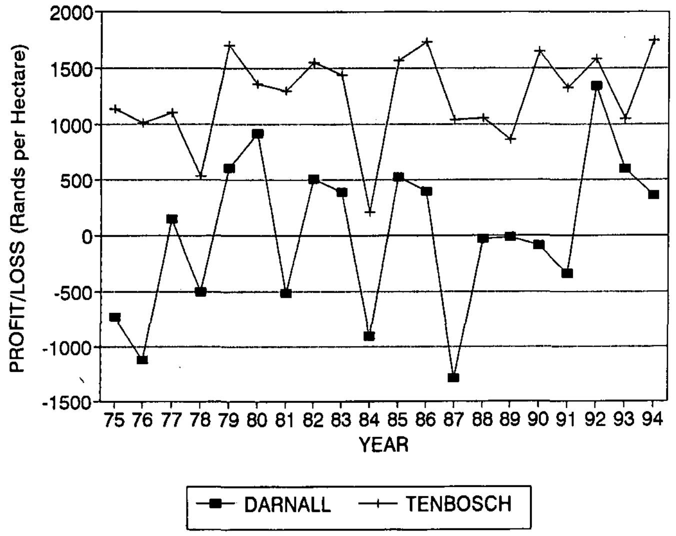

FIGURE 2: Nett profit/loss due to irrigation

Profit/loss is clearly dependent on seasonal rainfall. Figure 2 illustrates the significant differences between sites and between years. For Darnall, the scheme would show a positive return only over dry periods (eg 1992-1994). For Tenbosch, the scheme would show a positive return over the entire period.

Figure 3 indicates the average profit/loss over the 20 year period for the two sites, based on a range of capital costs and annual variable costs, for a system applying 50 mm every 28 days. This provides useful guidelines on the amount that should be spent to ensure profitability. For example, at Tenbosch, investing R5 000/ha on a system with R1 921 annual operating costs would yield an average of R1 100/ha profit (see also Figure 2). At Darnall, spending R5 000/ha for a system, with R1 514 annual operating costs, it is clear that the investment is unlikely to produce long term benefits.

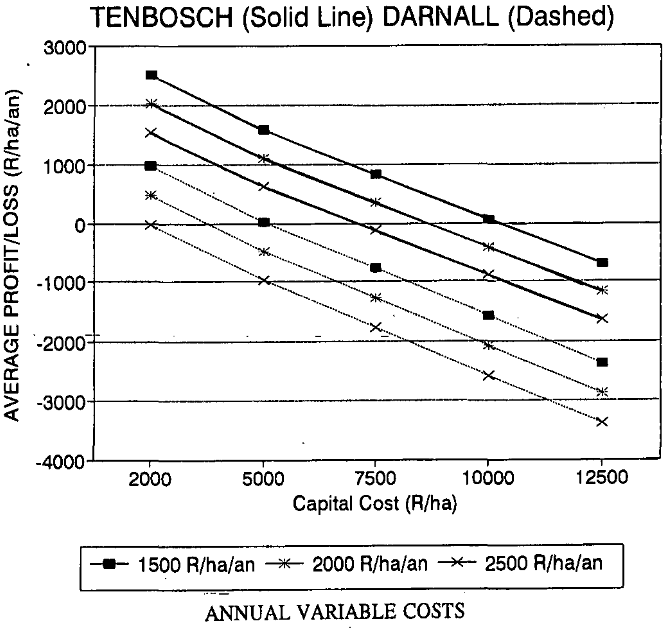

FIGURE 3: Average profit/loss based on a range of capital costs and annual operating costs

Similar economic assessments can be undertaken for each site and any selected water application strategy.

Summary and conclusions

An irrigation model has been used to determine yield improvement under irrigation for a range of sites and water application strategies. A simple economic model has been used to determine incremental profit/loss due to irrigation for a range of fixed and variable annual costs. The model allows determination of average returns over the period of record and, more importantly, cash flow implications between years and over a sequence of bad (or good) years.

Based on historical climatic records the model produces an assessment of what should be spent on an irrigation system. While inputs to the model have been generalised in this analysis, the technique allows detailed analysis of site specifics in terms of climatic records, soils, management capabilities, expected system costs and tax implications.

REFERENCES

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