Information Sheet

5.15 Irrigation costs estimates

Introduction

Irrigation is economically viable when the income from an increase in RV yield (relative to rainfed cultivation) is sufficient to cover the capital and operating costs of irrigation. In this information sheet, approximate cost estimates are presented for an array of irrigation systems commonly used on sugarcane farms in South Africa. This information sheet highlights:

- the components that contribute to irrigation costs,
- the range and cost differences amongst the irrigation systems, and
- the balance between capital and operating costs.

The cost estimates presented in this information sheet are based on a number of realistic and representative assumptions, but actual costs can vary depending on contextual and site specific factors such as distance from the water source, topography (slope) or system design capacities. For this reason, the costs presented in this information sheet are for approximate comparison of irrigation systems and should not be relied on as an absolute. In addition, costs are time sensitive and the costs presented in this information sheet reflect the tariffs and rates of the various components (e.g. water, electricity and labour) in **August 2020**. Use of the figures in this information sheet long after the published date must be adjusted accordingly. Updated costs of the various components can be found from the sources listed in the references at the end of this information sheet.

Capital Costs

The capital costs for the different types of irrigation systems shown in Table 1 consists of infield equipment only. The cost of pump stations, main lines, filters and valves are highly variable and, therefore not included. Equation 1 is used to translate the total capital cost to an annual repayment amount, when the system is financed via a loan. The loan interest rate was assumed to be 10%.

$$T = K \times \frac{i(1+i)^n}{(1+i)^n - 1} \qquad \text{[Eqn 1]}$$

Where, T = payment per annum (R/annum)
K = total capital costs (R)
i = loan interest rate (fraction)
n = Term of repayment (years), taken as the life span of the system

Table 1: Capital costs for infield equipment for a selection of irrigation systems

Irrigation System	Total capital costs[a] (R/ha)	Interest rate (%)	Life Span (years)	Annual capital costs (R/ha per yr)
Dragline Sprinkler	14 000	10%	10	2 278
Semi-Permanent Sprinkler	15 000		12	2 201
Permanent Sprinkler	27 000		15	3 550
Centre Pivot	22 000		15	2 892
Drip - Subsurface	26 000		10	4 231
Drip - Surface	24 000		10	3 906

[a]Capital cost only include infield equipment. The pump station, filter and mainline costs are not included.

Operating Costs

The main components of operating costs in irrigation are water, electricity, maintenance and labour. In Table 2, the nett irrigation requirement (NIR) for the Pongola region is used as an example to depict how systems with different efficiencies, require different volumes of water (gross irrigation requirement (GIR)) and, therefore, incur different water costs to meet the same crop water requirement.

Table 2: Water costs estimates for a given Nett Irrigation Requirement (NIR)

Irrigation System	NIR[a] (Pongola)	System Efficiency (η)	GIR[b] (Pongola)	Unit Water[c] Cost	Total Cost of Water
	(m^3/yr)	(%)	(m^3/yr)	(c/m^3)	(R/ha/year)
Dragline Sprinkler	8 450	83	10 181	23.43	R 2 385
Semi-Permanent Sprinkler		83	10 181		R 2 385
Permanent Sprinkler		90	9 389		R 2 200
Centre Pivot		90	9 389		R 2 200
Drip - Subsurface		98	8 622		R 2 020
Drip - Surface		95	8 895		R 2 084

[a] NIR – Nett irrigation requirement, [b] GIR – Gross irrigation requirement, $GIR = \frac{NIR}{\eta}$

[c] Water tariffs as published by the DWS (http://www.dwa.gov.za/Projects/WARMS/Revenue/charges2020.aspx).

The water tariffs for the main sources of irrigation water are shown in Table 3. The water costs in Table 3 reflect a scenario when the total water allocation (quota) for that specific source is to be used in a year.

Table 3: Water tariffs and costs for the range of irrigation water sources in SA sugarcane industry

Water Source	Water Allocation	Unit Water[a] Cost	CMA[b] Charge	Water Tariff	Water Costs
	(m^3/yr)	(c/m^3)	(c/m^3)	(c/m^3)	(R/ha/year)
Lomati River	8 500	9.13	1.93	11.06	940
Komati River	9 950	9.13		11.06	1 100
Crocodile River (below Gorge)	13 000	6.02		7.95	1 034
Crocodile River (above Gorge)	8 000	6.02		7.95	636
Pongola River	10 000	21.54	1.89	23.43	2 343
Jozini Dam/Makhatini flats	10 000	22.98		24.87	2 487
Umhlatuze River	7 000	23.31		25.2	1 764

[a&b] Water tariffs as published on the Department of Water and Sanitations website (http://www.dwa.gov.za/Projects/WARMS/Revenue/charges2020.aspx) (July 2020)

[b] CMA charge – Catchment Management Agency Charge

Electricity costs are linked to the volume of water pumped, the associated flow rate and pumping time, plus the specific power requirements for each irrigation system. Sprinkler systems with higher pressure requirements at the nozzle typically require more power (0.9 kW/ha), compared to lower pressure systems such as pivots (0.8 kW/ha) or drip (0.6 kW/ha).

Table 4: Electricity cost estimates for the different irrigation systems

Irrigation System	Volume H_2o (GIR)[a]	Flow rate per ha	Pumping time	Pump Power	Elect. use	Active Elect. Tariff[b]	Active Elect costs	Fixed Elect costs[c]	Total Elect cost
	(m^3/yr)	(m^3/hr)	(hrs)	(kW/ha)	(kW.h)	(R/kW.h)	(R/ha/yr)		
Dragline Sprinkler	10 181	3	3380	0.9	3042	1.42	4 320	719	5 039
Semi-Perm. Sprinkler	10 181	3							
Permanent Sprinkler	9 389	2.8							
Centre Pivot	9 389	2.8		0.8	2704		3 840	575	4 415
Drip - Subsurface	8 622	2.6		0.6	2028		2 880	431	3 311

[a] GIR for Pongola region brought through from Table 2

[b] Active electricity tariff for Landrate option was used, as published in the ESKOM Tariff booklet (July 2020)

[c] Fixed electricity costs are based on the Landrate tariff option for a 50 KVA transformer. Fixed costs differ across systems, because systems have different power requirements per ha and can irrigate larger or smaller areas from the same supply size (50 KVA transformer).

The difference in annual maintenance costs for the range of irrigation systems is reflected in Table 5

Table 5: Cost estimates for maintenance of the different irrigation systems

Irrigation System	Annual maintenance cost[a]	Capital Costs	Annual maintenance cost
	(% of capital cost)	(R/ha)	(R/ha/year)
Dragline Sprinkler	4	14 000	560
Semi-Permanent Sprinkler	2	15 000	300
Permanent Sprinkler	1	27 000	270
Centre Pivot	5	22 000	1 100
Drip - Subsurface	3	26 000	780
Drip - Surface	5[b]	24 000	1 200

[a] Annual maintenance costs (% of capital costs) as published in the ARC Irrigation User's Manual (updated in 2020).

[b] Surface Drip Maintenance Costs can be as high as 30% from damage when removing before burning/harvest, especially for thin walled pipes.

The labour requirements and associated labour cost for each irrigation system is reported in Table 6. Drip irrigation systems are attributed with similar labour requirements to dragline sprinkler systems. While drip systems have no need to move equipment across a field, labour is still required to open or close valves at block inlets, flush laterals, clean filters and perform other regular maintenance activities.

Table 6: Estimated labour requirements and costs

Irrigation System	Labour requirements		Shifts per day	No. of irrigation days	Man-days/ ha per year	Unit Cost (R/ man-day)[b]	Total labour costs (R/ha/year)
	(ha per labour units)[a]	(labour units/ ha per shift)					
Dragline Sprinkler	25	0.04	2	144	11.52	168	1 935
Semi-Perm. Sprinkler	25	0.04	2	144	11.52		1 935
Permanent Sprinkler	50	0.02	1	144	2.88		484
Centre Pivot	100	0.01	1	144	1.44		242
Drip - Subsurface	25	0.04	2	144	11.52		1 935
Drip - Surface	20	0.05	2	144	14.4		2 419

[a]Labour requirements (ha per labour units) as published in the ARC Irrigation User's Manual.
[b]Unit costs (R/man-day) – industry standard as published in SASRI mechanisation (costs) report no.2 (2020).

In Table 7, all of the above cost components are brought together to provide an overview of the capital, operating and total costs of the respective irrigation systems. Apart from the annual capital costs, electricity is the largest cost component in most irrigation systems.

Using the RV price of R 4 677.41 in July 2020, the increase in RV yield must be ±3 tons/ha above rainfed yields to cover irrigation costs for most irrigation systems.

Table 7: Cost breakdown of irrigation systems typically used the SA sugarcane industry

	Dragline sprinkler	Semi-permanent sprinkler	Permanent sprinkler	Centre Pivot	Subsurface Drip	Surface Drip
Capital (R/ha)	R 14 000	R 15 000	R 27 000	R 22 000	R 26 000	R 24 000
Capital (R/ha per year)	**R 2 278**	**R 2 201**	**R 3 550**	**R 2 892**	**R 4 231**	**R 3 906**
Operating (R/ha per yr)	**R 9 919**	**R 9 656**	**R 7 992**	**R 7 957**	**R 8 047**	**R 9 014**
Water	R 2 385	R 2 385	R 2 200	R 2 200	R 2 020	R 2 084
Electricity	R 5 039	R 5 039	R 5 039	R 4 415	R 3 311	R 3 311
Maintenance	R 560	R 300	R 270	R 1 100	R 780	R 1 200
Labour	R 1 935	R 1 935	R 484	R 242	R 1 935	R 2 419
Total (R/ha per year)	**R 12 198**	**R 11 861**	**R 11 542**	**R 10 849**	**R 12 278**	**R 12 920**
RV yield equivalent (tons RV/ha)[a]	2.6	2.5	2.5	2.3	2.6	2.8

[a] RV yield equivalent is the RV yield above rain fed yields required to match the costs of irrigation, assuming an RV price of R 4 677.41 (July 2020).

Finally, Table 8 depicts the balance between the capital and operating costs. The operating costs over the life span of the system far outweigh the capital costs. For this reason, any individual must consider more than just the capital cost when selecting a new irrigation system.

Table 8: Comparing capital and operating costs over the life span of an irrigation system

	Dragline sprinkler	Semi-permanent sprinkler	Permanent sprinkler	Centre Pivot	Subsurface Drip	Surface Drip	Average
Capital	19%	19%	31%	27%	34%	30%	**27%**
Operating	81%	81%	69%	73%	66%	70%	**73%**

References/Acknowledgements

ARC Irrigation User's Manual. WRC report number TT 819/2/20, available by email from orders@wrc.org.za or as a download from www.wrc.co.za
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