WORKING PAPER 3

Olifants River Irrigation Schemes

Reports 1 & 2

South Africa Working Paper No. 5

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International Water Management Institute

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OLIFANTS RIVER IRRIGATION SCHEMES

Report 1

Crop and Irrigation Data for Four Separate Irrigation Schemes

Richard Tren
and
Michael Schur

World Bank/International Water Management Institute

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Cover Photo: 'Olifants Basin' provided by Barbara van Koppen.

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Olifants River Irrigation Schemes

1. INTRODUCTION

This is the first of two reports on two separate projects funded by the World Bank and by the International Water Management Institute (IWMI). This report deals with the World Bank data requirements in order to generate economic models of the demand and supply of irrigation water. The second report covers the information required by IWMI for a study into the operation and management of different irrigation schemes.

The World Bank requirements allowed the researchers to choose any catchment in South Africa to conduct the research required to develop economic models for irrigation water supply and demand. It was decided therefore to combine this research with IWMI's required research on the Olifants River Basin.

1.1 Aim

The aim of the World Bank project is to develop an irrigation water-pricing model to describe supply-side and demand-side forces. The basic objective is to understand how these demand and supply forces come together to change the level of a policy instrument or cause the creation of new ones. The World Bank project will be examining data from five countries, namely Andhra Pradesh in India, China, Mexico, Morocco, and South Africa. The World Bank requirements are for detailed demand- and supply-side information for one irrigation region or scheme in South Africa. The Loskop Irrigation Scheme was chosen for this study, because of, among other reasons, the quality of data that is readily available.

1.2 Qualifications and Limitations

This report was compiled under strict time and budgetary limitations. The budget only allowed for limited site visits, which restricted the amount of primary data that could be collected. The report relies on secondary data and information collected from the Department of Water Affairs and Forestry (DWAF), the Loskop Irrigation Board and various extension officers and advisers from several cooperatives. Every effort has been made to ensure the quality and accuracy of the data and information by communicating with the most appropriate data sources and individuals. The authors cannot, however, take responsibility for any errors or inconsistencies in the secondary data that have been collected.

2. DESCRIPTION

2.1 Historical Perspective

When analyzing the agriculture and resource use in South Africa one must take account of the way in which resources were allocated under the apartheid system. Under apartheid, almost every economic activity was heavily regulated and the allocation of resources, subsidies, and state funds was politicized and based on racial classifications.

Since the early part of the 20th century, the white agricultural sector was favored politically and granted numerous grants and subsidies to secure a strong rural voter base. This allowed the white agricultural sector to construct dams and irrigation canals and to develop and expand irrigated agriculture, as well as many other forms of agriculture. Irrigation water was supplied to irrigation farmer at heavily subsidized tariffs, which

while frequently leading to the inefficient use of water allowed white farmers to develop a financially viable agricultural sector.

While white farmers were favored politically, black farmers and communities were actively discriminated against. The homeland policies of the successive Nationalist governments ensured that black communities were settled on marginal land with few resources and little or no access to water.

This political history has ensured that white farmers still enjoy relatively good levels of agricultural infrastructure, while black farmers in large part have poor infrastructure and limited prospects for obtaining finance to upgrade the infrastructure.

2.2 Physical Description

The Olifants River basin drains an area in excess of 54,000 km^2 and the river flows in an easterly direction from South Africa into Mozambique. There are five distinct topographical zones, namely escarpment, highveld, middleveld, bushveld, and lowveld. The river and its tributaries commence in the highveld region of South Africa and drops in altitude as it flows progressively eastwards. The altitudes range from 2,300 m above sea level in the Steenkamps Mountains near Lydenburg.

Along the highveld region, the main demands for water come from urban areas, industry and in particular, thermal power stations and agriculture. The major urban areas in the highveld region are Middelburg, Witbank, and Bronkhorstspruit.

This report deals with the area downstream of the Loskop Dam — the areas known as sub-catchment B320 and sub-catchment B500 according to the DWAF. The topography of sub-catchment B320, where large commercial white farmers have settled varies from mountainous with bushveld vegetation and narrow valleys to undulating terrain with thorn trees. Approximately two-thirds of sub-catchment B500 comprise the former homeland area of Lebowa. The area generally has lower agricultural potential than sub-catchment B320 and because of the settlement practices of the past is far more densely populated.

3. LOSKOP IRRIGATION SCHEME

3.1 Crop Descriptions

Table 1 below gives a breakdown of the major crops cultivated on the Loskop Irrigation Scheme, their water requirements, and the current crop prices. These figures have been estimated by the Loskop Irrigation Scheme management, the local cooperative and agricultural extension officers.

Table 1. Main crops grown on the Loskop Irrigation Scheme, irrigation requirements and crop prices.

Crop	Area (ha)	Irrigation level m^3/ha	Crop price
Tobacco	4,400	5,000	R 11.50/kg*
Cotton	6,000	4,500	R 2.65/kg
Wheat (winter)	9,000	5,500	R 1,150/tonne
Soya bean	3,000	4,000	R 1,300/tonne
Groundnuts	3,000	4,000	R 1,800/tonne
Peas	2,000	4,000	R 1,335/tonne
Maize	5,000	6,500	R 900/tonne
Citrus	4,000	10,000	R 1,500/tonne
Table grapes	250	7,000	R 8.80/kg

*The price refers to dried tobacco.
Source: Loskop Irrigation Board.

Winter wheat covers the highest number of hectares and is popular because the crop utilizes both capital and labor, while all the other crops are primarily summer crops. This improves the cash flow of the farming enterprises and allows farmers to use land that would otherwise lie fallow. The most water-intensive crop is maize, which requires 6,500 m^3/ha and has a relatively low return, only R 900/tonne.

The seasons during which farmers irrigate the various crops are given below as table 2.

Table 2. Irrigation seasons.

Crop	Irrigation season
Tobacco	October–March
Cotton	October–April
Wheat (winter)	May–early October
Soya bean	November–April
Groundnuts	October–March
Peas	May–early August
Maize	August–February
Citrus	12 months, peaks in September/October and December to February
Table grapes	12 months.

The above irrigation periods are based on the average or normal rainfall and weather patterns. There will be years when there is either lower or higher than normal rainfall when rainy season begins earlier or later than usual. In these cases, the periods during which irrigation takes place will change accordingly.

3.2 Major Inputs to Crop Production

The main inputs to the major crops and their respective prices are given in table 3. These inputs obtained from the local cooperative, extension officers, and the Irrigation Board however, may differ from official Department of Agriculture figures, which are based on a wide consensus of a number of farmers. Because these crop budgets have been compiled from numerous different sources, not every budget is identical in format. For example, the water cost for maize, wheat, groundnuts, and cotton includes electricity and maintenance of the irrigation equipment. For tobacco and citrus however, these cost features separately and the cost of the water itself is shown.

According to the local office of the OTK cooperative, the total cost of irrigation water, including the electricity and maintenance comes to R 21.6/m^3 of which the cost of the water itself is only R 0.07/m^3. The water cost for tobacco, greenpea, citrus, and table grapes as calculated in the crop budgets is approximately R 0.07/m^3.

According to the personnel at the Loskop Irrigation Board and the extension officers at the various cooperatives in Groblersdal, there are no constraints or restrictions to labor supply. The hiring of labor varies from farm to farm. Some farmers are able to employ full time staff throughout the year and others rely on temporary labor at harvest times. There is a ready supply of farm labor in and around Groblersdal and it appears that they require little training and are willing and capable to perform the required tasks.

Table 3. Main crop inputs.

Maize (white)		Tobacco	
Item	Cost (R/ha)	Item	Cost (R/ha)
Seed	100	Fertilizer	1,950
Fertilizers	870	Pesticides	
		Nematodes	1,600
		Herbicides	360
		Insecticides	550
		Succerides	530
Weed control	312	Seedlings	850
Pesticides	250	Curing	900
Machinery	150	Electricity	1,192
Hire services	440	Fuel	1,450
Water cost	1,404	Maintenance	1,400
Fuel	369	Miscellaneous	500
Repairs	353	Hail insurance	2,400
Insurance	198	Labor	7,830
Miscellaneous	48	Water cost	375
Labor	430	Total	21,887
Total	4,924	Yield(Kg/ha)	2,200
Yield (Kg/ha)	8 tonnes/ha	Margin(R/ha	4,800
Margin(R/ha)	2,276		

Soya bean		Wheat	
Seed	1,032	Seed	480
Fertilizers	-	Fertilizers	642
Weed control	175	Weed control	62
Pesticides	-	Pesticides	85
Machinery	150	Machinery	150
Hire services	168	Hire services	310
Water cost	864	Water cost	1,188
Fuel	350	Fuel	340
Repairs	300	Repairs	340
Insurance	380	Insurance	280
Miscellaneous costs	40	Miscellaneous costs	48
Labor	350	Labor	355
Total	3,809	Total	4,280
Yield(tonnes/ha)	3 tonnes/ha	Yield(tones/ha)	5.5(tonnes/ha)
Margin(R/ha)	90	Margin(R/ha)	2,045

Groundnuts		Cotton	
Seed	600	Seed	167
Fertilizers	-	Fertilizers	542
Weed control	240	Weed control	430
Pesticides	462	Pesticides	754
Machinery	150	Machinery	150
Hire services	90	Hire Services	200
Packaging	205	Packaging	-
Water cost	868	Water cost	972
Fuel	369	Fuel	369
Repairs	350	Repairs	353
Insurance	-	Insurance	780
Miscellaneous costs	48	Miscellaneous costs	48
Labor	900	Labor	1,445
Total	4,282	Total	6,210
Yield(tonnes/ha)	3.5 tonnes/ha	Yield(tones/ha)	3 tonnes/ha
Margin (R/ha)	2 018	Margin(R/ha)	1,740

Citrus – Orange		Table grapes	
Fertilizers	555	Fertilizers	4,000
Weed control	1,608	Weed control	-
Pesticides	1,208	Pesticides	15,000
Machinery	185	Machinery	1,500
Hire services	-	Hire services	-
Packaging	7,928	Packaging	18,000
Water cost	737	Water cost	540
Fuel	-	Fuel	1,000
Repairs		Repairs	-
Insurance		Insurance	-
Miscellaneous costs		Miscellaneous costs	-
Labor	990	Labor	25,000
Total	13,210	Total	65,040
Yield tonnes/ha	45	Yield Kg/ha	13,500
Margin R/ha	54,000	Margin R/ha	53,760

Peas	
Land preparation	450.81
Seed	1,020.80
Fertilizers	784.38
Chemicals	1,004.68
Water cost	242
Irrigation equipment	407.53
Electricity	598
Irrigation labor	360
Insurance	350
Overhead management costs	338
Overhead farm costs	312
TOTAL	5,868
Yield tonnes/ha	4.5
Margin R/Ha	137.43

Sources: OTK Cooperative, Groblersdal, Department of Agriculture COMBUD, Hereford Irrigation Scheme, I&J Groblersdal, and Meyer, F, Cape Span.

In consultation with the various Irrigation Boards (Loskop and Hereford) and with extension officers, it is apparent that there are no significant infrastructure constraints to agriculture. The agricultural infrastructure has been developed in conjunction with agriculture. There are several grain silos, tobacco-drying houses, cotton gins and packinghouses for citrus and grapes and cold storage rooms for grapes. At present there are no significant infrastructure constraints (van Strydt, J.; Tredoux, J.; du Plessis, H.; Roberts, M. personal-communication).

3.3 Land Prices

Land prices within the Loskop Irrigation Scheme vary according to the extent of irrigation rights and the type of irrigation equipment that has been invested in. It is not economically viable for a farmer to undertake dryland agriculture in the Loskop area. Consequently, grazing land is valued between R 1,000 and R 1,500 per hectare.

Land prices for irrigable land depends largely on the amount of infrastructure on the land and the amount of capital that has been invested. For an irrigation land with only drag lines, the average price would be between R 6,000 and R 7,000 per hectare, while land with irrigation pivots would fetch in the region of R 10,000 per hectare. Where deciduous crops such as citrus and grapes are cultivated and drip or micro irrigation has been installed, the land prices are likely to be in excess of R 10,000 per hectare. However, these prices depend largely on the type of crop planted, the age of the crop, and average yields of the crop as well as the investment in irrigation equipment (Viljoen, B., personal communication).

The land prices for tobacco farms are far higher than those for deciduous fruit crops and cash crops such as maize because of the amount of infrastructure that is required for tobacco farming. Depending on the number of drying and curing facilities on a farm, tobacco land is valued between R 25,000 and R 32,000 per hectare (du Plessis, H., personal communication).

There is very little leasing of land in the Loskop Scheme with the vast majority of land owned by farming enterprises. No data is available on the average cost of leasing land.

3.4 Farm Data

As mentioned above, it is not considered economically viable to undertake dryland irrigation along the Loskop Irrigation Scheme. The climate and rainfall are such that the majority of farming activity is under irrigation, with limited amounts of grazing and other agricultural activities. Irrigated agriculture remains the major economic activity along the Loskop Irrigation Scheme and there is no other significant activity, such as game farming or hunting that farmers engage in.

The average farm size is 35 hectares and with very few exceptions, each farm is allocated with water rights for 25.7 hectares at an allocation of 7,700 m^3 per hectare. Each farmer therefore is entitled to extract 197,890 m^3 of water per annum and the total scheme draws approximately 124 million m^3 of water from the Loskop Dam each year based on approximately 626 farmers.

The range of crops grown along the Loskop Irrigation Scheme is as detailed above, with small amounts of vegetables, such as beans and lettuce. The relative proportion of each crop grown depends largely on the market price of each product. The amount of tobacco, wheat, cotton, maize, and vegetables varies each year depending on the market price. However, the amount of land under tree crops, such as citrus and table grapes is more static as these crops are grown with a 25–30 year investment horizon.

Crop rotation is determined largely by the size of plots and available water. Most farmers on the Loskop Irrigation Scheme do rotate crops and crops are generally grown on the same plot of land once in every 3-4 years.

3.5 Water-Yield Relationships

The water-yield relationships are determined by dividing the crop yields by the water application (table 4). Although the amount of irrigation water sprayed on crops depends on rainfall, the rate of evaporation and other climatic conditions, these water-yield relationships are considered to be accurate (Crosby, C., personal communication).

Table 4. Water-yield relationships—major crops of the Loskop Irrigation Scheme.

Crop	Yield (Kg/ha)	Irrigation (m^3/ha)	Water-yield (Kg/m^3)
Tobacco	2,200	5,500	0.4
Cotton	3,000	4,500	0.6
Wheat (winter)	5,500	5,500	1
Soya beans	3,000	4,000	0.75
Groundnuts	3,500	3,800	0.92
Maize	8,000	6,500	1.23
Citrus	45,000	10,000	4.5
Table grapes	13,500	7,700	1.75

3.6 Water Supply Data

The water for the Loskop Irrigation Scheme is stored in the Loskop Dam, which is owned and managed by DWAF. The costs associated with this water supply are detailed below although it is important to note that at present, irrigation farmers are not required to pay the capital costs of the scheme. This, however, is set to change, with the new water pricing strategy, where full costs will be recovered from water users.

Almost all of the 124 million cubic meters per year is devoted to irrigation. The Loskop Irrigation Board does have some commitment to provide water to industries, municipalities and other nonagricultural water

users. The amount of water supplied to nonagricultural users is almost 4.4 million m^3. Table 5 below details the water use by the nonagricultural water users. In times of drought, the Loskop Irrigation Board is required to make allowance for the supply of a further 2.6 million m^3 to the former homeland of KwaNdebele. At present, the former homeland is provided with water from the Renosterkop Dam, which is currently at full capacity. However when water is not available from this dam, the Loskop Irrigation Board is required to supply water (Pretorius, K., personal communication).

Table 5. Nonagricultural water users.

Water user	Amount (m^3)
Municipality of Groblersdal	1,200,000
Municipality of Marble Hall	1,400,000
Hospital	30,000
Fisheries	600,000
Nature conservation	52,000
Lime mine	250,000
2 Schools	44,000
Police training college	800,000
Total	4,376, 000

Source: Loskop Irrigation Board.

3.7 Water Supply Costs

In addition to the charges made by the DWAF, the Loskop Irrigation Scheme incurs costs that are added to the price. At present, less than 30 percent of the costs paid by irrigation farmers relate to DWAF costs, with the remainder relating to the irrigation scheme costs.

The DWAF does not have any disaggregated cost data. The DWAF Finance Directorate has given broad guidelines as to whether costs are fixed or vary with the amount of water supplied. Cost items in the tables below have been divided between fixed and variable costs. According to DWAF, the only cost items that vary with the amount of water supplied are the operation and maintenance (O&M) costs. All other costs are independent of the amount of water supplied and therefore fixed. A breakdown of the O&M costs is not available from the DWAF (Hattingh, O; Willkinson, M., personal communication).

Catchment management costs are determined based on the programs that the catchment management agency (CMA) sets out. The total estimated cost of these programs (which in large part comprises the removal of alien plant species from watercourses and surrounding areas, afforestation permitting and abstraction control is divided by the total amount of water supplied. Should the total amount of water supplied increase, the unit cost will decrease; however, the total catchment management cost is independent of the amount of water supplied (Hattingh, O.; Willkinson, M., personal communication).

Actual DWAF costs are available for the 1998/99 financial year, while budgeted estimates are available for the 1999/2000 year (tables 6 and 7). In addition, budget information for the 2000/2001 year is detailed below (table 8). This is of interest as it contains the costs as required by the new water pricing strategy. As detailed above, the annual irrigation quota available to farmers determines the total amount of water supplied to the Loskop Irrigation Scheme resulting in 124 million m^3 of water supplied every year. This figure is fixed except in drought years when the DWAF restricts the releases into the canal.

Table 6. Actual scheme costs of the Olifants River (Loskop Dam) and canals 1998/99.

Item	Fixed cost	Variable cost	Total
Scheme operation and maintenance cost		390, 459.47	
Management cost allocation from Area Office (Groblersdal)	49,000.00		
Management cost allocation from Regional Office (Pietersburg, Centurion)	6,000.00		
Betterments	19,866.19		
Total operation and maintenance costs			425,593.28
Catchment management costs:			
Abstraction control costs, afforestation permit control costs	55,000		
Eradication of invasive alien plants cost	515,000		
Total catchment management costs			570, 000
Total costs	605,133.81	390,459.47	995, 593.28
Income from water sales			
Domestic and industrial water			638,396.32
Irrigation water			217,583.55
Total income from water sales			855,979.87

Source: DWAF, Pretoria – Finance Directorate.

Table 7. Budget information, Loskop Dam and canals, financial year 1999/2000.

Item	Fixed cost	Variable cost	Total
Scheme operation and maintenance cost		460,000	
Management cost allocation from Area Office (Groblersdal)	357,100		
Management cost allocation from Regional Office (Pietersburg, Centurion)	59,300		
Total operation and maintenance costs			876,400
Catchment management costs			
Abstraction control costs, afforestation permit control costs	228,700		
Eradication of invasive alien plants cost	84, 600		
Total catchment management costs			313,300
Total costs	729,700	460,000	1,189,700
Total amount of expected water supply from dam (m^3)			170,021,730
Operation and maintenance unit cost(c/m^3)			0.52
Catchment management unit cost (c/m^3)			0.18
Total unit cost for water from dam (c/m^3)			0.70
Total unit cost for water from dam (R/ha)			53.88
Tariffs:			
Olifants River Irrigation Board			0.96 c/m^3
Loskop Government Water Scheme			R24.30/ha

Source: DWAF, Pretoria – Finance Directorate.

Table 8. DWAF water supply costs – Loskop Dam and canals, financial year 2000/2001.

Item	Fixed cost	Variable cost	Total
Return on Assets - Dams, weirs, buildings - Main and side canals Depreciation - Dams, weirs, buildings - Main and side canals Total NB. For 2000/01, irrigators will not be required to recover these costs			34,561 384
Scheme operation and maintenance cost:		500,000	
Management cost allocation from Area Office (Groblersdal)	149,000		
Management cost allocation from Regional Office (Pietersburg, Centurion)	19,000		
Betterments	670,000		
Total operation and maintenance costs			1,338,000
Catchment management costs:			
Abstraction control costs, Afforestation permit control costs	77,700		
Eradication of invasive alien plants cost	74,010		
Total catchment management costs			151,710
Total	35 ,551,094	500,000	36,051,094
Total amount of expected water supply from dam (m^3)			170,392,548
Operation and maintenance unit cost c/m^3			0.79
Catchment management unit cost c/m^3			0.09
Total unit cost for water from dam c/m^3			0.87
Total unit cost for water from dam R/ha			67.32
Tariffs: Olifants River Irrigation Board Loskop Government Water Scheme			Not finalized

Source: DWAF, Pretoria – Finance Directorate.

An explanation of the way in which the per hectare and cubic meter cost of water is calculated is given below:

? The unit cost of R 24.30/ha is the cost calculated for water from the dam and canals. These tariffs apply only to irrigators and not to any other water users.
The unit cost was calculated as follows:
Actual unit cost for 99/2000 financial year = R 53.88
Actual unit cost for 98/1999 financial year = R 16.20
Proposed unit cost is limited to an increase of 50 percent = 16.20x1.5 = R24.30

? The unit cost of 0.96 cent per cubic meter is the cost calculated for water directly from the dam. The unit cost was calculated as follows:
Actual unit cost for 99/2000 financial year = 1.27c
Actual unit cost for 98/1999 financial year = 0.64c
Proposed unit cost is limited to an increase of 50 percent = 0.64x1.5 = 0.96c

While the costs of supplying water from the Loskop Dam are high, for political and historic reasons, irrigation farmers were not required to meet many of these costs. Most significantly, they were not required to meet any capital costs. The Loskop Irrigation Scheme incurs a number of expenses relating to the maintenance and refurbishment of the canal systems, and the administration of the scheme. The estimated costs of the Loskop Irrigation Scheme for the 1999/00 financial year are given in table 9 below.

Table 9. Loskop Irrigation Scheme costs, 1999/2000.

Item	Amount (R)
Regular repair and replacement costs	800,000
Administration costs	700,000
Maintenance costs (including labor and materials)	8,026,000
Running costs (costs associated with diverting water And opening sluice gates)	1,500,000
Current investment project	2,300,000
Total	13,326,000

Source: Loskop Irrigation Scheme.

Based on the above costs, the DWAF at present charges the Loskop Irrigation Scheme 2c/m^3 for irrigation water. This cost is then passed on to the irrigators and a further 5c/ m^3 is added by the Loskop Irrigation Scheme to cover its costs. The current total cost for irrigation on the Loskop Irrigation Scheme is therefore 7c/m^3.

3.8 Income Distribution

There is a wide range of incomes between farmers on the Loskop Irrigation Scheme, depending on the size of the farm, efficiency of the agricultural methods and resources utilized, and type of crops grown. Along the Loskop Irrigation Scheme, there are no emerging black farmers as there are on several other irrigation schemes in the country.

Almost all farms have the same irrigation allocation of 25.7 ha; 15 farms have allocations of 30 ha and a few very small farms have allocations of only 2.8ha. The income distribution along the Loskop Irrigation Scheme is thought to be similar to the income distribution of the rest of South Africa (Loskop Irrigation Scheme).

4. HEREFORD IRRIGATION SCHEME

4.1 Background

The Hereford Irrigation Scheme was proclaimed in 1926 and lies on the left bank of the Olifants River, approximately 16 km downstream of the Loskop Dam. The scheme was established by private landowners after a small weir (known as the Meissner weir) and canal was built by Messers Miessner and Beukes on the Kameeldoorn Farm (71JS). The board acquired the weir on the Kameeldoorn farm and in return supplies irrigation water free of charge to this farm and the original Beukes farm (Kalkfontein 49JS).

Since the irrigation district was proclaimed under the Irrigation and Conservation of Water Act No. 12 of 1912, there has been no change to boundaries of the area. When the Board was established, the Water Court ruled that the total water allocation would be 29.9 percent of the normal flow of the Olifants River at De Wagendrift. Once the Loskop Dam was constructed in 1935, the Hereford Irrigation District was incorporated into the Loskop Government Irrigation Area (subsequently the Loskop Government Water Control Area).

In compensation for the reduction in normal flow as a result of the Loskop dam, the Hereford Irrigation District was allocated 0.85 m^3/s, or 26.8 million m^3 per annum free of charge from Loskop Dam. This has now been amended and the Hereford Irrigation Scheme pays the same rate for water to DWAF as the Loskop Irrigation Scheme.

Initially, very little land was cultivated under irrigation, with approximately 430 ha in 1930. However, by 1935 this had more than doubled to 1,540 ha. Currently, the scheme has a total of 3,426 scheduled hectares which is approximately half of the total area that falls under the scheme.

4.2 Crop Data and Irrigation Requirements

The major crops grown along the Hereford Scheme are similar to the Loskop Scheme. However, table grapes are more widely cultivated and citrus is a more prominent crop. Table 10 below details the approximate total number of hectares under each crop. The crop budgets are considered to be almost identical to those calculated for the Loskop Irrigation Scheme.

Before the 1960s, most of the irrigation along the scheme was by flood irrigation. This has now changed to sprinklers, center pivots, and an increase in drip irrigation. No flood irrigation is currently practiced along the scheme.

The majority of the water used in the Hereford Irrigation District is abstracted from the Olifants River via the Hereford canal, although most farms have small dams that are used to plan water use more effectively (table 10). According to DWAF, in 1988, there were 85 dams in the irrigation district with an estimated total capacity of 3.3 million m^3 or about 10 percent of the total water allocation of the board (DWAF 1991). This is contrary to the information supplied by the Irrigation Board, which estimates that there are between 50 and 52 dams on various private farms in the Irrigation District (Joppie Graham, personal communication).

Land prices within the Hereford scheme depend largely on the amount of physical investment on the land and the existing crop mixture. On average, however, according to the Hereford Irrigation Board, leased land is valued between R1,500 and R 2,000 per hectare while purchased land is valued around R 15,000/ha.

Table 10. Crop pattern in the Hereford Irrigation District.

Crop	Hectares	Percentage of total
Wheat (winter)	1,000	25
Citrus	760	20
Table grapes	135	4
Cotton	700	18
Tobacco	700	18
Vegetables	600	15
Total	3,895	100

The total water allocation for the scheme members is 7,700 m^3/ha per annum which is identical to the allocation for the Loskop Irrigation Scheme. Unlike the Loskop Irrigation Scheme, the number of irrigable hectares per farm is not fixed and varies from 5 ha on some small farms to 900 ha on the largest farm.

Limited data are available on the budget and expenditure of the Hereford Irrigation Scheme. According to the Irrigation Board, the total scheme cost is approximately R 400,000. Around one half of this cost is in the form of salaries and wages and around R 100,000 is spent on the maintenance of the scheme. A further R 100,000 is spent on administration costs. No regular contributions are made by the scheme members in order to provide for the refurbishment of the canal or for future investment. Currently, an investment of about R 12 million is to be made to cement the canal. The Irrigation Board will borrow a significant portion of this amount and the costs will be recouped from the scheme members (Joppie Graham, personal communication).

The Hereford Irrigation Scheme charges irrigation water users R 150 per hectare per annum, which at an allocation of 7,700m^3/ha translates to 1.9c/m^3. In addition to the Hereford costs, the DWAF costs of 2c/m^3 are levied which results in a total irrigation water charge of approximately 4c/m^3.

5. COETZEESDRAAI AND HINDOSTAN

5.1 Background

The Coetzeesdraai and Hindostan Irrigation Schemes are located along the Olifants River downstream of the Mokgoma Matlala and Buffelsdoorn Dams in the southern section of the Northern Province. The two schemes fall under the Olifants River Irrigation District, which was started in 1946/47 when flood irrigation was used. Prior to the democratic elections in South Africa in 1994, the area formed part of the nominally self-governing homeland of Lebowa. After 1994, the area was reincorporated into South Africa and now falls in the Northern Province (Mahlase, E.; Mahilwane, T., personal communication).

The area is semiarid with an average rainfall between 350 and 500 mm per annum and has poor groundwater and surface water potential. With the exception of the Zebediela Citrus estates, the majority of crops planted in the Olifants River Irrigation District are cash crops such as wheat, maize, cotton, and tobacco.

Both the Coetzeesdraai and Hindostan Irrigation Schemes fall within tribal trust land and fall under the jurisdiction of Kgosi (Chief) Matlala. Although the land is owned by the tribe and administered by the Kgosi and his Indunas (Headmen) individual farmers and their families have rights to the use the land and this right can be passed from one member of a family to another.

5.2 Crop Data and Irrigation Requirements

The main crops grown on the Coetzeesdraai and Hindostan schemes are maize and winter wheat although at one time a certain amount of coriander is cultivated on Coetzeesdraai. Although the Northern Province government agricultural extension officers considered the gross margins achieved on these irrigation schemes to be similar to those achieved by the large commercial farms on the Loskop Irrigation Scheme, information from the Agricultural and Rural Development Corporation (ARDC) suggests otherwise. Table 11 below describes the crop budgets for wheat and maize for both the Coetzeesdraai and Hindostan schemes.

Table 11. Crop budgets—maize and winter wheat (R/ha).

Wheat	Hindostan	Wheat	Coetzeesdraai
Seed	413.35	Seed	413.35
Fertilizers	940.51	Fertilizers	940.51
Weed control	133.98	Weed control	133.98
Pesticides	-	Pesticides	-
Machinery	356.52	Machinery	356.52
Hire services	280	Hire services	280
Water cost	1.7	Water cost	1.7
Transport	300	Fuel	300
Repairs	-	Repairs	-
Insurance	-	Insurance	-
Miscellaneous		Miscellaneous	
Labor	184.50	Labor	184.50
Total	2,610.56	Total	2,610.56
Yield(tonnes/ha)	2.5 tonnes	Yield(tonnes/ha)	1.5
Gross sales @ R 1,050/tonne	R 2,625	Gross sales @ R 1,050/tonne	R 1 575
Gross margin(R/ha)	R 14.40/ha	Gross margin(R/ha)	- R 1,035.56/ha

Maize	Hindostan	Maize	Coetzeesdraai
Seed	168.82	Seed	413.35
Fertilizers	1,216.38	Fertilizers	940.51
Weed control	143.83	Weed control	133.98
Pesticides	431.60	Pesticides	-
Machinery	653.43	Machinery	356.52
Hire services	-	Hire services	280
Water cost	1.7	Water cost	770
Transport	266.50	Fuel	300
Repairs	-	Repairs	-
Insurance	-	Insurance	-
Miscellaneous	-	Miscellaneous	
Labor	471.50	Labor	184.50
Total	3,353.76	Total	3,378.86
Yield(tonnes/ha)	8 tonnes	Yield (tonnes/ha)	6 tonnes
Gross sales @ R 900/tonne	R 7,200	Gross sales @ R 900/tonne	R 5,400
Gross margin (R/ha)	R 3,846.24/ha	Gross margin (R/ha)	R 2,021.14/ha

Crop budget information is available from the ARDC for the Veeplaats Irrigation Scheme, which is situated downstream of Coetzeesdraai and Hindostan. As Veeplaats operates on a similar basis to these two irrigation schemes, the author is of the opinion that these crop budgets are considered to be more accurate. The budgets have however been adjusted to cater for the lower yield that is achieved on Coetzeesdraai and Hindostan.

These crop budgets are provided for illustrative purposes only and show that wheat is a marginal crop with a gross yield of only R 14/ha and a loss of over R 1,000/ha for Coetzeesdraai. It is likely that many of the items, such as fertilizers and pesticides may not feature and that labor costs will be zero as the farmers would use family members as laborers and they would not receive direct wages. However, the use of family labor on the fields represents an opportunity cost and should therefore be included in some form. According to the ARDC crop budgets and the potential maize yields supplied by Department of Agriculture extension officers stationed at Nebo, maize should be a highly profitable crop. The crop is mainly produced for household consumption and is not generally sold in market. For reasons relating to the efficiency of irrigation water use and farming practice, which will be expanded upon below, it is likely that the yield is below the 8 tonnes/ha (which is the same as that yielded by the large commercial farmers on the Loskop Irrigation Scheme).

6. CONCLUSION

The above data serve to highlight the dramatic differences in agricultural practices between large commercial white farmers and black farmers in South Africa. South Africa's political history ensured that white farmers had access to numerous subsidies, ready finance, and state assistance in numerous fields and that black farmers were undeveloped, had little access to finance and were financially and economically unsustainable.

Emerging black farmers are still burdened by the historic apartheid policies with many unable to generate sufficient income or raise money to improve agricultural infrastructure. It is unlikely that many black emerging farmers will ever receive the state assistance and subsidies that the white farmers received in the past. The present government has removed almost all the state agricultural subsidies and is attempting to ensure that the full costs of water supply are recovered from all water users.

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OLIFANTS RIVER IRRIGATION SCHEMES

Report 2

Irrigation Management Structures for Four Separate Irrigation Schemes

World Bank/International Water Management Institute

Olifants River Irrig ation Schemes

1. INTRODUCTION

The work contained in this report and the previous one comprises a synthesis of two separate projects, funded by the World Bank and the International Water Management Institute (IWMI), respectively. This report deals specifically with the requirements of IWMI, namely to investigate the management and operations of the various irrigation schemes in question. This report should be read in conjunction with Report 1, which deals with the requirements of the World Bank and gives details on crop budgets and water supply costs.

The World Bank requirements allowed the researchers to choose any catchment in South Africa within which to conduct the research required to develop economic models for irrigation water supply and demand. It was decided therefore to combine this research with IWMI's required research on the Olifants River Basin.

1.1 Aim

The aim of the IWMI study is to improve the understanding of effective local management of irrigation by users. The project looks at several different types of schemes, namely a government-run scheme, a private commercial scheme, and small black-run irrigation schemes. The two core hypotheses of the research are:

- the potential of a scheme for performance and impacts is determined by exogenous variables, such as design, infrastructure, etc; and

- the actual here-and-now performance and impacts of a scheme relative to its potential are determined by the quality and effectiveness of its governance and management, other things remaining the same.

This report aims to gather data and information required in order to undertake and test the above hypotheses.

1.2 Qualifications and Limitations

This report was compiled under strict time and budgetary limitations. This allowed for very limited site visits, which restricted the amount of primary data that could be collected. The report therefore relies on secondary data and information collected from the Department of Water Affairs and Forestry (DWAF), the Loskop Irrigation Board and various extension officers and advisers from several cooperatives. Every effort has been made to ensure the quality and accuracy of the data and information by communicating with the most appropriate data sources and individuals. The authors cannot, however, take responsibility for any errors or inconsistencies in the secondary data that have been collected. Furthermore, it should be noted that the secondary data does not always permit a rigorous assessment of scheme performance based on orthodox measures. It has therefore been necessary in some instances to rely on anecdotal evidence, from which inferences had to be made.

2 DESCRIPTION

2.1 Historical Perspective

When analyzing the agriculture and resource use in South Africa, the way in which resources were allocated under the apartheid system must be taken into account. Under this system, almost every economic activity was heavily regulated and the allocation of resources, subsidies and state funds were politicized and based on racial classifications.

Since the early part of the 20th century, the white agricultural sector was favored politically and in order to secure a strong rural voter base was granted numerous grants and subsidies. This allowed the white agricultural sector to construct dams and irrigation canals and to develop and expand irrigated agriculture, as well as many other forms of agriculture. Irrigation water was supplied to irrigation farmers at heavily subsidized tariffs that, while frequently leading to the inefficient use of water, allowed white farmers to develop a financially viable agricultural sector.

While white farmers were favored politically, black farmers and communities were actively discriminated against. The homeland policies of the successive nationalist governments ensured that the majority of the population was confined to approximately 13 percent of the total land area of South Africa. These black communities were settled on marginal land with few resources and frequently had little or no access to water.

The nominally autonomous homeland governments were able to develop their own agricultural policies and in many cases, ambitious and economically inefficient communal agricultural schemes were developed. Since the democratic elections in South Africa in 1994, the homelands fell away and the land was re-incorporated into South Africa. The dissolution of the homeland governments and the gradual changes in agricultural policy in South Africa has left many of the black irrigation projects in disarray.

The differences between white and black irrigation farmers in South Africa are highlighted in table 1 below. The small-scale and micro-scale irrigation farmers are almost entirely made up of black farmers with little access to financial resources or technical expertise. By far the greatest irrigated area falls under the medium and large-scale irrigation schemes, which are almost entirely made up of white commercial farmers. These schemes benefited over the years from numerous government subsidies and other state assistance. This political history has ensured that white farmers still enjoy relatively good levels of agricultural infrastructure, while black farmers in large part have poor infrastructure and limited prospects for obtaining finance to upgrade the infrastructure.

This report examines small-scale irrigation schemes, a private irrigation scheme, and an irrigation board scheme that was previously government-managed. As will be apparent, the ability of an irrigation scheme to gain access to financial and other resources determines not only the state of the infrastructure, but the management of the scheme and the overall efficiency and profitability of the farmers.

2.2 Physical Description

The Olifants River basin drains an area in excess of 54,000 km^2 and the river flows in an easterly direction from South Africa into Mozambique. There are five distinct topographical zones, namely escarpment, highveld, middleveld, bushveld, and lowveld.

The river (and its tributaries) commences in the highveld region of South Africa and drops in altitude as it flows progressively eastwards. The altitudes range from 2,300 m above sea level in the Steenkamps Mountains near Lydenburg.

Along the highveld region, the main demands for water come from urban areas, industry and in particular, thermal power stations and agriculture. The major urban areas in the highveld region are Middelburg, Witbank, and Bronkhorstspruit.

Table 1. Categories of irrigation farming in South Africa.

Category	Irrigated area	Main characteristics
Micro-scale Home food gardening Community gardening Foodplots on smallholder schemes	5 – 20,000?	The least information is available for this category. However, it is an important source of food security in rural, peri-urban and even urban environments, and increasingly a basis for augmenting family income among the poor.
Small-scale		On-farm product processing and packaging, and direct retail selling are important features.
Smallholder schemes	? 47,500	There are about 202 of these schemes. Institutional arrangements and inappropriate technology has hampered their management.
Private small-scale farmers	Unknown	These farmers have access to land through tribal authorization, and have developed without access to financial or agricultural support services.
Medium and large-scale		
Government water schemes	346,000	These were built as public works programs for white farmers since the 1920s to promote irrigation development and increase agricultural production.
Irrigation boards (IB)	397,000	There are currently 294 irrigation boards countrywide, the third of which is located in the Western Cape.
Private irrigation development	457,000	These are privately owned irrigation works, where farmers developed their own infrastructure to extract water directly from rivers, boreholes or farm dams.

Source: Department of Water Affairs and Forestry (DWAF) and Department of Agriculture (DA) (1998).

This report deals with the area downstream of the Loskop Dam in the areas known as sub-catchment B320 and sub-catchment B500 according to the DWAF. The topography of sub-catchment B320, where large commercial white farmers have settled varies from mountainous with bushveld vegetation and narrow valleys to undulating terrain with thorn trees. Approximately two-thirds of sub-catchment B500 comprise the former homeland area of Lebowa. The area generally has lower agricultural potential than sub-catchment B320 and because of the settlement practices of the past is far more densely populated.

3. LOSKOP IRRIGATION SCHEME

The Loskop Irrigation Scheme is notable as a case study as it was constituted by the government in 1935 and was operated by the Department of Water Affairs until July 1992 when it was taken out of government hands. The scheme members now undertake the management and operation of Loskop Irrigation Scheme and it is run as a nonprofit organization.

3.1 Scheme Infrastructure

The current state of the infrastructure along the scheme (as described above) is considered to be good with regular maintenance and upgrading of the scheme works. The irrigation scheme has a five-year plan that aims to constantly replace and repair the infrastructure. The main canal is said to be in need of repair in some places. However, this will take place under the five-year plan.

No water metering takes place along the canal or on private farm property. The amount of water supplied to individual farmers is regulated by the degree to which the various sluice gates along the canal are opened. Depending on the size of the sluice gate opening, water can be delivered at 17 m^3/hour, 34 m^3/hour, 51 m^3/hour, 68 m^3/hour, 102 m^3/hour, 151 m^3/hour, and 200 m^3/hour. The amount of water that has actually been delivered to farmers can be monitored by comparing the amount of water ordered from the Loskop Dam with the water that is returned to the Olifants River. The percentage of water lost can then be calculated and the scheme administrators will also know if any farmer has taken more than his or her allocation.

3.2 Scheme Members

The Loskop Irrigation Scheme is made up mainly of irrigation farmers. However, several industries and the Marble Hall and Groblersdal municipalities, schools and hospitals are also members of the scheme.[1] The only significant non-commercial agricultural member is the state research farm in Groblerdal.

The irrigation scheme is made up of 624 farms. However, because there are numerous farmers who own more than one farm, the total number of farmers who are members stands at approximately 400. The number of votes that any one farmer is allocated is dependent on the number of hectares that he or she owns. Each farmer is allocated 1 vote for every 6 hectares up to a maximum of 10 votes per property. The breakdown of the number of votes per farmer is not available.

Irrigation farming is the main economic activity for almost all of the members of the Loskop Irrigation Scheme. While some farms may operate small bed and breakfast facilities and certain other farmers have livestock in addition to the irrigation crops, these activities are not considered to be significant when compared to irrigation farming (Johan van Strydt personal communication).

3.3 Scheme Management and Board

The Loskop Irrigation Board employs 67 full time employees (i.e., technicians and managers numbering 16 and 51 unskilled laborers) and oversees the day-to-day management of the Loskop Irrigation Scheme. The management is responsible for ensuring that water is efficiently and effectively delivered to the appropriate farmers. A number of employees are involved with processing the water requirements and requesting the correct amount of water from the DWAF in Groblersdal. Others are responsible for administrating the billing and fee collection and monitoring the amount of water that is conveyed along the irrigation canal. Records of

[1]Table 5 of Report 1 details the nonagricultural water users.

the total amount of water supplied to each individual farmer have to be kept so that a farmer is not permitted to exceed his or her annual water allocation. Monitoring the water levels in the balancing dam and measuring the amount of water returned to the Olifants River and therefore the amount of water lost are also the responsibility of the irrigation scheme employees.

The unskilled laborers who are employed by the scheme perform day-to-day maintenance and upkeep of the canal and perform any construction if deemed necessary. The laborers are also responsible for opening and closing the various sluice gates to the required level (which is determined by the farmers request for water) for each irrigation farmer.

The Loskop Dam is operated and managed by the DWAF based in Groblersdal and it is the Department's responsibility to determine the annual water quota based on the amount of water in the dam. This total annual quota for the water year, which runs from April to March, cannot exceed the total allowable irrigation rights (of 124 Million m^3), but can be set at a lower level than this in the case of extreme weather conditions, such as drought.

Every irrigation farmer submits a request to the scheme administrators every Thursday for the water requirement of that week. It is the responsibility of the scheme administrators to add up all the irrigation requests and then submit a request to the Department of Water Affairs who then release the total required amount of water into the canal on a Friday. The scheme employees then open each farmer's sluice gate to the appropriate height according to the request for water.

The Loskop Irrigation Board is made up of eight members, one chosen from each of the eight sub-districts that make up the Loskop Irrigation Area. The members of the irrigation scheme elect the Board members every three years. As explained above, the number of votes that an individual member has depends on the number of properties that he or she owns, with a maximum number of votes of 10. The Board is in turn accountable to the members who elect them and are required to meet with the members at least once a year at an annual general meeting (AGM). The function of this meeting is to report back to the scheme members and for the members to raise issues with the Board. The Irrigation Board, particularly the Chairman of the Board, is however at the members' disposal at any time and, therefore, if there are pressing issues that a farmer, or group of farmers wish to discuss, they are not required to wait until the AGM.

In addition to the AGM, the Board is required to meet with and report to the local Department of Water Affairs in Groblersdal once a month. The purpose of these meetings is to discuss management and operational issues and to ensure the efficient running of the irrigation scheme.

Although the scheme was privatized in 1992, de jure authority over the scheme still rests with DWAF. Although DWAF has these de jure rights to intervene in the management of the scheme, to date no intervention has taken place and, according to the Chairman of the Loskop Irrigation Board, intervention is unlikely to take place.

No other government department or nongovernmental organization exerts any influence over the management of the scheme, nor do they have any de jure rights to do so. Apart from the commitments to supply water to the farming community, the irrigation scheme is obliged to supply 2.6 million m^3 of water per annum to the communities in the former homeland of KwaNdebele. This water is only supplied when water is unavailable from the Renosterkop Dam, which was built specifically to supply water to these communities. In times of drought when the level of the Renosterkop Dam is low, water is conveyed along the Loskop Irrigation Scheme canal to the communities. The Loskop Dam supplies additional water should it be required for the communities.

According to the National Water Act (Act No. 36 of 1998), an ecological reserve is required to be set aside for the sustainable maintenance of ecosystems along a particular water course. As yet little progress has been made along the Olifants River with regard to the calculation of the reserve and, therefore, this has not yet made an impact on the Loskop Irrigation Scheme. The calculation of the ecological reserve is the function of the DWAF, who will then be required to inform the scheme of any changes to their abstraction rights as a result of the reserve.

3.4 Performance of the Scheme

It appears that the management and operation of the scheme has become more efficient since its privatization. This is evidenced in the percentage of water loss, which averaged 30 percent when the scheme was managed by DWAF and since privatization has fallen to between 21 percent and 24 percent. The main reasons for this drop has been the increase in the level of maintenance and repairs on the canal. According to the Board, the billing system and the collection of fees have become more efficient since privatization. Under the present system, farmers who do not settle their accounts within 90 days risk having their sluice gates closed and will not receive any further irrigation water. In addition, an interest is charged on any account that is not paid within a 90-day period.

Although the scheme administrators reserve the right to impose these penalties, farmers are rarely cut off from the water supply. This is because the administrators prefer to negotiate and discuss potential problems with individual farmers and in reality are relatively flexible over the recovery of their costs.

It is apparent that the individual members of the scheme observe and comply with the regulations of the scheme. There are very few cases where the scheme members abstract more than their allocation or not comply with the scheme rules. (Johan van Strydt, personal communication). It is thought that the efficient monitoring of the scheme and the fact that the scheme employees regularly monitor the canal and the sluice gates ensure the high level of compliance.

The financial management of the scheme appears to be sound. The financial statements of the scheme were not available for review. However, according to the Loskop Irrigation Board, the scheme has never been in financial deficit. Any financial surpluses that are generated by the Board are channeled into improvements and upgrading of the scheme and are not returned to the members.

The view that the performance and efficiency of the irrigation board has improved since it became an Irrigation Board Scheme is confirmed by DWAF. An example of how the scheme has become more efficient is evidenced in the way in which the canal is maintained. While the scheme was a government scheme, the local DWAF would employ approximately 300 laborers to remove grass from the sides of the canal. This task would take 3?4 months and once the laborers had progressed to the end of the canal, they would frequently be required to begin again at the start of the canal. Under the current management, however, the Irrigation Board works with the members of the scheme, and each farmer dedicates a number of his or her own laborers on selected days to remove grass from the canal for a particular section. This ensures that the task is completed at a far lower cost, more effectively and in a shorter time (Pretorius, K., personal communication).

It is also apparent that the members of the Loskop Irrigation Scheme are satisfied with the management and operation of the scheme. This is evidenced by the fact that the annual meetings of the Board are attended by 10–15 farmers. When the scheme was state-run however, almost all the farmers would attend the annual meetings. According to DWAF, the management of the scheme is now closer to the members and better placed to respond to any issues that may arise. (Pretorius, K., personal communication).

4. HEREFORD IRRIGATION DISTRICT

The Hereford Irrigation District has, since inception, been run as a private non-profit irrigation scheme. As detailed above, the Miessner weir and the irrigation canal were constructed in 1926 and the Irrigation District is still reliant on this infrastructure. The releases from the Miessner weir into the canal is controlled by the Hereford Irrigation Board and in general, the sluice gates are set to release the maximum possible amount of water into the canal. Therefore, when the weir is full, the only limiting factor to the amount of water that can be conveyed is the size of the canal. There are no balancing dams in the Hereford Irrigation District as there are on the Loskop Irrigation Scheme. As would be expected, however, almost every farm along the Hereford Scheme has its own storage dam.

As with the Loskop Irrigation Scheme, the volume of water supplied to the individual farms is controlled by the height to which each sluice gate is opened. Each farm has its own sluice gate and the amount of water delivered to each farm is also dependent on the water pressure, in other words on the height of water in the canal. The sluice gate apertures therefore have to vary in accordance with the varying amount of water in the canal.

4.1 Scheme Members

The members of the Hereford Irrigation Scheme are all farmers. Unlike the Loskop Irrigation Scheme, there are no municipal or industrial members. There are 42 members on the scheme; almost all the members are white commercial farmers. Although there are 33 black emerging farmers on the scheme, there is only one member representing these farmers. This is because all 33 farmers use the same sluice gate and farm that previously had been a white-owned commercial farm.

Irrigated agriculture is the main economic activity for all of the members of the Hereford Scheme. According to the Irrigation Board, there are no other activities (such as tourism or livestock agriculture) that contribute significantly to the farmers' income.

Each of the small-scale black farmers farms an area of 3?9 hectares and cultivate ground nuts, maize, cotton, tobacco, and vegetables. Each farmer decides independently on what to produce based on the expected demand for his or her products. There is little or no central control among the farmers to conform to certain crop patterns. Although the yields achieved by these small-scale farmers are lower than those achieved by the commercial white farmers, they are said to be higher than the yields of small-scale black irrigators in the former homeland areas. The reason behind this higher yields is said to stem largely from the fact that the Hereford small-scale farmers are better organized, have greater access to information and arrange training workshops.

None of the small-scale Hereford farmers has any irrigation equipment, such as overhead pivots, drip or micro irrigation equipment. All the farmers rely on flood irrigation to deliver the water and there is no control over the quantities of water that each individual farmer receives. The availability of water is good, and the small-scale irrigators are very seldom without adequate irrigation water.

Marketing the produce from the small-scale Hereford farmers does appear to be problematic. One small-scale farmer stated that the quality of their produce was equivalent to that of the white commercial farmers. However, they are unable to sell the produce at markets because of prejudice against them (Sefolose, J., personal communication). However, this has not been confirmed.

There is a clear breakdown in communication between the Hereford Board and the small-scale farmers. According to the Board, the commercial farmers and the Board itself provide advice and non-financial

assistance to the small-scale farmers. This is denied by the small-scale farmers who are reportedly unhappy with the management of the Board. It is not clear what the actual situation is.

4.2 Scheme Management and Board

The Hereford Irrigation Scheme employs nine full time staff (seven unskilled laborers and two water management technicians),whose responsibility is the management of the scheme. The duties of the full time staff are to ensure that sufficient water is released from the Miessner weir, to open the sluice gates for the various scheme members, and to monitor the levels of water losses. The amount of water entering the Hereford canal is controlled entirely by the Hereford Irrigation Scheme staff. However, in times of water shortage, the releases into the river from the Loskop Dam are regulated by DWAF. Billing and the collection of fees have been outsourced to a firm of bookkeepers who perform the function for a fee.

The individual members of the scheme do not have the authority to request a specific volume of water and are forced to abstract water while it is available. It is for this reason that there is such a high number of storage dams among the scheme members as they are forced to store water for future use.

The Board of the Hereford Irrigation Scheme is made up of seven members who are elected by all the members of the scheme. The number of votes that any particular member has depends on the quota of water rights that he or she possesses. Each member is entitled to one vote for every 10 hectares or land, or part thereof. There is no maximum number of votes that an individual can accrue. As is the case with the Loskop Irrigation Scheme, the Board members of the Hereford Scheme are re-elected every three years.

The Irrigation Board is required to meet with the head of the regional department of DWAF at least once a year and report to them on the functioning and management of the scheme. The Board is also required to meet at lease twice a year with the members, where the Board is expected to report back to its members on the management and finances of the scheme and the members are free to raise any issues or problems.

Although the members have the right to request that a particular Board Member be removed if they feel that he or she has not been fulfilling his or her functions satisfactorily, this has never happened and such an event was deemed to be highly unlikely according to the Board (Joppie Graham, personal communication). The members of the scheme have direct access to the Board members and to the irrigation scheme staff and are able to raise any issues or concerns that they may have at any time.

The Hereford Irrigation Board has allowed the trading of water rights along its scheme for some time. Should a particular farmer not require his or her full water allocation at a particular time, he or she is permitted to transfer these rights to another farmer. This transfer has to be approved by the Irrigation Board, which will assess the transfer based on its practicality and any impact that it may have on other water users. No permanent transfers of water rights have been effected and all the trades to date have been temporary trades, with the water rights reverting to the original owner after a fixed period of time. The purchaser of the water rights is expected to pay R 1,000/ha/annum, plus R150/ha/annum of water tax, resulting in a total price of R 1,150/ha/annum.

Apart from the requirements to meet with the head of the regional department of DWAF once a year, the Hereford Irrigation Scheme has very few external influences. As a private scheme, it is answerable only to its members and although the DWAF can restrict the amount of water that the scheme uses in times of drought and sets the tariffs for raw water charges, it has no influence over the running or management of the scheme. No other government department such as the Department of Agriculture or nongovernmental organization has ever imposed any regulations or standards on the scheme.

4.3 Performance of the Scheme

In recent years, there has been an improvement in the efficiency of the management and operation of the Hereford Scheme. The Hereford Scheme has a history of very high water losses. About 30 years ago, water losses were as much as 60 percent of the irrigation water. As the Hereford canal is not lined with concrete, the water losses are inevitably higher than the water losses experienced by the Loskop Scheme. The Hereford Scheme management has, however, improved the way in which the scheme is administered, the upkeep of the canal, and the monitoring of water delivery.

Today, the losses from the system are estimated to be between 25 percent and 30 percent. However, these figures are likely to drop once the scheme undertakes its investment program and the canal is lined (Graham, J., personal communication)**.** According to DWAF, the fact that the Hereford Scheme has always been privately owned and managed meant that they did not have access to the range of grants and subsidies that the Loskop Scheme had. This would have resulted in inferior infrastructure and the subsequent higher water losses.

The improvements in the efficiency of the Hereford Scheme and the reduction in water losses could in part be due to pressure from DWAF. The new water-pricing strategy of DWAF is aimed at ensuring that water is used by the highest value users. The recognition of the economic value of water and the projected increases in water tariffs have meant that both the DWAF and water users have become more conscious about the efficiency of water use. In the past, the DWAF was relatively unconcerned by the water losses of the Hereford Scheme. Now they are far more vigilant in ensuring that water losses are minimized (Kobus Pretorius, personal communication).

As detailed above, the cost to the Hereford Irrigation Scheme of conveying water, managing and operating the scheme is 1.9c/m^3 or R150/ha/annum. This cost is significantly lower than the cost of 5c/m^3 imposed on irrigators along the Loskop Irrigation Scheme. The fact that the Hereford Scheme has been privatized since inception may in some way explain the lower unit cost of water as the scheme is likely to have been operating purely on the interest of its members and with more direct local control than the Loskop Irrigation Scheme. It must be pointed out though that the Hereford Scheme does not make any provision for future improvements or investment in the scheme, which is done by Loskop. This may mean that the unit price of water could spike upwards if and when new investment projects are undertaken.

At present there are very few violations of the rules and regulations of the Hereford Scheme. In the past, however, there were several cases where individual farmers were abstracting more than their allocation. According to the Board however, this problem has been reduced and there is almost complete compliance with the regulations (Joppie Graham, Hereford Irrigation Board personal communication).

Theoretically, the members of the scheme can make formal complaints to the chairman of the Board if they feel that any particular member is not representing their interests adequately or are not performing their functions correctly. To date, however this has not happened and the prospect of it happening in the future did not appear to be realistic according to the Board(Joppie Graham, personal communication).

At present there are no performance evaluation procedures for the Board and no formal mechanism or body that objectively assesses the function that the Board plays. The Board meets three or four times a year. However, there is regular communication between the board members and members of the scheme have direct access to the Board members. As mentioned above, there appears to be a breakdown in communication between the Board and the small-scale irrigators. The small-scale irrigators have stated that they are unhappy with the management of the board and do not feel they are adequately represented by it (Jerry Sefolose, personal communication).

Although few members of the scheme contravene its regulations, the Board does have the right to withdraw abstraction rights from members should such contraventions take place. Should irrigation water accounts not be settled, the Board retains the right to charge interest on outstanding amounts and non-paying members can be prohibited from abstracting water. Such cases are very rare and most disputes are discussed and negotiated with the Board and are usually resolved before such actions are deemed necessary.

5. HINDOSTAN AND COETZEESDRAAI IRRIGATION SCHEMES

Both the Hindostan and Coetzeesdraai Irrigation Schemes are located downstream of the Loskop and Hereford Irrigation Schemes and fall within in the Middle Olifants River sub-catchment. The farms are both located on Tribal Trust land in an area formerly known as the homeland of Lebowa. Lebowa was a nominally independent state created by the Nationalist Government as part of the homeland scheme, which was a fundamental pillar of the apartheid system. Under the homeland scheme, separate governments were set up in the nominally independent republics with responsibility for all internal affairs, such as security, education, agriculture, and water policy. Since the democratic elections of 1994, the homeland of Lebowa was re-incorporated into the Republic of South Africa and all self-governance fell away.

Agricultural development in the former Lebowa is limited partially by the relatively low rainfall, which limits dry-land agriculture and also by a lack of financial resources and expertise to develop irrigation systems. Because of the dense settlement practices in almost all of the previous homelands, overgrazing, poor land practices, and soil erosion are common and this is a notable feature of the former Lebowa.

Part of the agricultural policy of the former Lebowa was to support subsistence agriculture and to subsidize many of the agricultural inputs, as was the case in South Africa. Since the homeland government system fell away, much of this subsidization and support has been removed and this has negatively affected the ability of homeland farmers to produce agricultural produce.

Hindostan and Coetzeesdraai are typical of the small-scale subsistence agriculture that exists on tribal land in the former Lebowa. Although the schemes are located adjacent to each other and produce the same agricultural products, differences in the management structures affect the total output and efficiency of the schemes.

5.1 Hindostan Irrigation Scheme

Hindostan covers an area of 56 ha with approximately 45 farmers each cultivating 1.25 ha of land. Water is conveyed from the Buffelsdoorn Dam using a 3-kilometer long canal and irrigation equipment consists of motherline pipes and center pivots overhead sprays. Most of this equipment is in a very poor state with a high number of leaks and consequent wastage. There are no current plans to upgrade the canal or the irrigation equipment. However, government officials based in Nebo did refer to the Arabie- Olifants upgrading scheme which was tabled in 1996 and was destined to invest approximately R12 million in new equipment. This plan was never acted upon, however, and its current status is not known. (Pelasi, M., personal communication)

The majority of the subsistence farmers are elderly and their primary source of income is the state pension of R550 per month. The agriculture is seen as a way of augmenting this income and providing household food. Most of the farmers make use of younger household members to assist as laborers. However, they perform much of the agricultural work themselves. No water meters are available to measure the total amount of water used by the scheme, nor the amount of water used by individual farmers within the scheme.

5.1.1 Scheme Management and Board

All of the 45 subsistence farmers are members of the Hindostan Irrigation Scheme and every three years they elect a nine-member management committee whose responsibility is the management of the irrigation equipment. The committee collects the funds required to pay for the electricity used by the irrigation pumps and they liase with agricultural extension officers and, together with these officers, provide advice to farmers. In addition to these responsibilities, the management committee manages the irrigation scheduling, which determines which area is irrigated at any one time.

The management committee reports to and is in constant liaison with the 45 farmers because of the proximity in which they live and cultivate their fields. The committee reports directly to the local Headman or Induna who has the authority to oversee and to intervene in the running of the irrigation scheme. If any disputes arise or it is felt that the members of the irrigation scheme are not complying or cooperating with the scheme committee, the matter will be brought before the Induna.

Should the Induna not be in a position to resolves disputes or to take particular decisions, the matter is usually taken before the local Chief or Kgoshi. As the traditional leader of the area, the Kgoshi commands a great deal of authority among most communities, particularly the elderly. Apart from the advice given by the agricultural extension officers and from the district office of the Department of Agriculture, no other significant external influences occur.

A significant change in the way in which agricultural practices take place (and indeed in the structure of the entire society) is the move toward freehold ownership of land by individuals. Currently, the land in question is owned in trust by the tribe. However, Proclamation R188 of 1969 makes provision for title deeds to be issued to individuals to facilitate private ownership of farmland. Although the provision for title deeds to be issued has been in place for many years, the recent democratic and political changes in the country are likely to have increased awareness of the right to individual land ownership (Madale, J.; Mahilwane, T., personal communication)

The community that farms at Hindostan differs from many of the surrounding communities in that they moved to the area relatively recently due to the apartheid government's policy of forced removals. As the community is relatively a newcomer, it does not have the same strong traditional links to and reliance on the Kgoshi. Although the community is said to respect and abide by the rulings and decisions of the Kgoshi, it does not consult him on every matter, such on agricultural practice. As will be explained below, this differs with the neighboring farming community at Coetzeesdraai.

5.1.2 Performance of the Scheme

According to the district office of the Department of Agriculture based at Nebo, the Hindostan Irrigation Scheme is well run and is relatively productive. Every year, the community manages to harvest a significant crop and the yields are higher than many of the farms in surrounding areas.

The electricity bill for the irrigation pumps is regularly paid and the irrigation scheme is said to be well organized in raising funds and ensuring the financial viability of the scheme. As no fees are paid for the irrigation water itself, it is not possible to compare a per hectare price for water with the other schemes.

5.2 Coetzeesdraai Irrigation Scheme

Coetzeesdraai is situated immediately south of Hindostan and adjacent to the Arabie Dam. Coetzeesdraai covers an area of 158 ha and supports 126 farmers, each on 1.25 ha plots. A 2015 km canal conveys water from the Buffelsdoorn dam, as is the case with Hindostan. However, the canal is said to be in very good condition as it is concrete lined and has a low leakage rate (Mahlase, E., personal communication). The

branches of this canal are reported to be in poor condition, however, and in need of repair. The irrigation equipment consists of pumps, motherlines and overhead irrigation sprays. As with Hindostan, this equipment is in a poor state and funds are required to repair and/or invest in new equipment.

No meters or any other type of technology is in use to measure the amount of water use on the Coetzeesdraai and no fees are paid to the Department of Water Affairs or any other body for the water use.

5.2.1 Scheme Management and Board

The operation and management of the irrigation scheme are in many respects identical to that of the Hindostan Scheme, where the farmers elect a nine-member committee every three years to manage and operate the irrigation equipment. The function of the committee is much like that of the Coetzeesdraai committee, in other words to ensure payment for electricity and to determine the irrigation schedules. As with Hindostan, the management committee is readily accessible to the farming community as the committee is chosen from the farmers themselves.

The Coetzeesdraai committee reports directly to a Headman or Induna, in this case, a different Induna to the Hindostan Scheme. The Kgoshi in both the Hindostan and Coetzeesdraai Schemes is the same, however the relationship that the Coetzeesdraai community has with the Kgoshi is quite different. The Coetzeesdraai community has been settled in the area for a far longer time than the Hindostan community and also has stronger ties and reverence for the traditional system of leadership and government.

Because of the stronger ties that the Coetzeesdraai community has with the Kgoshi, many decisions concerning day-to-day management of farming are not taken until the committee has consulted with the Kgoshi. Decisions on when to plough, when to sow, the amount and timing of fertilizer and pesticide applications and decisions on when and how to irrigate are more often than not left for the Kgoshi to take.

The result of this system of management is considerably lower yields, with the potential for negative gross margin on wheat. The crop budget given in the other report should only be used as an indication of the possible crop budget on Coetzeesdraai based on similar practice elsewhere. While the crop is not necessarily a cash crop that is sold at market, and one for which the farming community might not recognize a net loss on the crop, it is an indication of the inefficiency of the farming practice.

5.2.2 Performance of the Scheme

Despite the fact that the yields of the Coetzeesdraai Scheme are far lower than the yields of the Hindostan Scheme, it appears as though the commitments to pay the electricity supplier, Eskom is regularly met and that the financial aspects of the scheme are well managed. Both schemes face similar difficulties with the age of the equipment, leakages, and breakdowns.

The fact that the average yields of both wheat and maize are considerably lower than those of Hidostan shows the overall bad management of the scheme. It is likely though this is due to the outlook of the management committee as well as the community as a whole and not necessarily because the management structure of the irrigation committee is inefficient.

6 TESTING THE HYPOTHESES

As detailed above, IWMI aims to test two core hypotheses. The first hypothesis is that the potential of a scheme for performance and impacts is determined by exogenous variables, such as design, infrastructure

created, etc. The second hypothesis is that the actual here-and-now performance and impacts of a scheme relative to its potential are determined by the quality and effectiveness of its governance and management, other things remaining the same.

What is notable of all the irrigation schemes is that the basic management structure is very similar. All the irrigation schemes elect a board or committee to either manage or oversee management for a limited period of time (in each case 3 years). The boards or committees are all fairly small and have intimate knowledge of the farming community and the area as they are chosen directly from the community. The boards or committees are all obliged to report back to the members of the scheme at least once a year, however in practice there appears to be regular contact between some if not all members of the boards and the members of the scheme that elected them.

The two black-run irrigation schemes are perhaps the most cumbersome in management structure with clearly defined hierarchies and reporting structures that, at least in the case of Coetzeesdraai, are required for as much traditional reasons as for practical management reasons. There are many reasons for the black-run irrigation schemes to function less efficiently than the commercial run white-run schemes. The historical disadvantages and lack of access to capital are only two of the many difficulties facing these farming communities. It is notable that the community that relies less on the traditional leadership structure and relies more upon its own initiative and knowledge is more efficient and achieves far greater yields under very similar farming and climatic conditions.

In order to test these hypotheses, values are given on a scale of 1–5 for the levels and quality of infrastructure, the quality and effectiveness of management and the efficiency and productivity of agriculture. Table 2 below allocates values for these three issues, where 1 is the highest value and 5 is the lowest.

Table 2. Performance of the schemes.

Scheme	Infrastructure	Management	Agricultural performance
Loskop	1	1	1
Hereford	2.5	2	1 (2 for small-scale farmers)
Hindostan	4	3	3.5
Coetzeesdraai	4	5	5

The above analysis shows that the scheme that has both the most advanced infrastructure and the best scheme management, namely the Loskop Irrigation Scheme, has the best agricultural performance. The agricultural yields, however, are very similar for those farmers on the Hereford Scheme, where the state of the infrastructure is poorer and the level and quality of management is also worse. For the small-scale black farmers on the Hereford Scheme however, the agricultural performance is weaker. There could be a number of reasons for these small-scale farmers under-perform. For example, their relative inexperience in commercial agriculture and inability to raise capital for structural improvements. The fact that these farmers feel that the Hereford Irrigation Board does not adequately represent them could play a significant part in their under-performance. It cannot, however, be the only reason.

Both the Hindostan and the Coetzeesdraai Irrigation Schemes have poor infrastructure and both are in need of upgrading. This clearly negatively influences the ability of the farmers to farm effectively. While the

standard of the infrastructure in both cases is similar, there are marked differences in the management of the schemes. It is in larger part due to the more effective and efficient management of the Hindostan that this scheme achieves higher yields than are evidenced on Coetzeesdraai.

7. CONCLUSION

The above analysis makes comparisons of farming and irrigation practices between four different irrigation schemes within the same area. Differences in farming and irrigation practices are starkly evident and enormous variations in yields exist. However, this should come as no surprise, especially in a country like South Africa where the variations in wealth and access to resources are so marked.

The similarities in management structure are therefore contrasted with the significant differences in cultural and traditional practices. Changes in land tenure systems and challenges to traditional leadership, which is taking place throughout the country, is therefore likely to impact greatly on the management of irrigation schemes and on communal agriculture as a whole.

As stated above, the budgetary and time limitations on this report have precluded any more in-depth investigation into the management and functioning of the various schemes. Both infrastructure and management play vital roles in the performance of the various irrigation schemes. However, it is likely that effective and efficient management, particularly for small-scale irrigation schemes, is marginally more important than infrastructure.

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