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The Rise of Large Scale Formal Smallholder Irrigation Schemes in Swaziland; An Appropriate Solution for Rural Livelihoods and Agricultural Production?

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Abstract

This paper argues that the dominance of estate sugarcane has caused, and is continuing to provide, an important 'political economy' to the development of smallholder irrigation in Swaziland; the lack of traditional, non-sugar smallholder irrigation in Swaziland is partly a product of the orientation of the lowveld towards irrigated sugar production. This relationship forms via a number of ways, explored in this paper. These factors, support services, and the agro-industrial farming environment combined with the high risks of successful development of small-scale irrigation in the middleveld, provide a momentum in capability that may considerably sustain new large-scale smallholder projects in the lowveld, which arguably may be the most sensible route for agriculture-related development. The key challenge is to ensure this confluence of endowments creates a wider spread of benefits than is currently being enjoyed by small farmers in Swaziland and at the same time, decision-makers also recognise that expanding formal large-scale smallholder is not without risks.

Introduction

This paper sets out some key issues for irrigation in Swaziland with a perspective upon the smallholder sector. It also comments on other issues related to irrigation and water resources in the country. In discussing smallholder irrigation is it important to appreciate the proportions involved of different land use types. Cultivated rainfed and irrigated land is estimated at 191 500 ha, which is 11% of the total area of Swaziland. Of this area, approximately 50 000 ha is irrigated, of which only about 1250 - 1500 ha is smallholder traditional irrigation. The majority is given to citrus and sugarcane irrigation, most of which is found in the lowveld of the country, supporting large-scale commercial sugarcane production. This paper argues that the dominance of estate-produced sugarcane has caused, and is continuing to provide, an important 'political economy' to the development of smallholder irrigation. In other words, the lack of traditional, non-sugar smallholder irrigation in Swaziland is a partly a product of the orientation of the lowveld towards irrigated sugar production. These links happen in a number of ways, as introduced in Figure 1. Firstly, access to smallholder irrigation in the non-sugar sector is currently relatively minor in extent and this historically can be traced to a past focus on large-scale irrigation schemes. Secondly, with exceptions, current and past smallholder development has been via formal irrigation schemes linked to a sugar industry that aims to increase total area and production, hence the emergence of government driven large-scale smallholder schemes (viz. LUSIP and KDDP) implemented as part of the government's poverty alleviation plan. Thirdly, support services for irrigation have been dominated by the sugar industry rather than by the Government - in a sense this has created good knowledge of water management in the lowveld, but a relative vacuum of capacity within Government Departments in the highveld capital city of Mbabane. In general, these support services, and the agro-industrial farming environment, have lead to a momentum in capability that sustains smallholder developments in the sugar sector. Fourthly, the area of combined land and water resources is restricted in the middleveld. Instead, in the lowveld, engineering works necessary to abstract water from large rivers create water delivery systems that can supply 'large-in-scale' smallholder schemes. These costly solutions then require sugarcane-based economic returns that make such interventions justifiable.

The conclusion of this analysis is that comparatively few farmers in rural areas currently depending solely on rainfed cultivation will gain any significant irrigation foothold. Therefore, in Swaziland, unless alternative models of smallholder support are very actively pursued, irrigation will be very much a privileged solution for those farmers offered plots on forthcoming smallholder schemes (two large schemes are being established over the next 5-10 years). This need not be perceived negatively, and indeed, as is explained, this policy may be the most appropriate for the foreseeable future. Leading on from this premise, is the question of how to settle and manage the forthcoming smallholder schemes in ways that a) extend the benefits of irrigation to a wider number of farmers; b) ensure sustainability and c) attend to food security issues prevalent in Swaziland.

The Irrigated Agriculture Debate

Irrigated agriculture uses approximately 95% of Swaziland's freshwater resources (WRI, 1997), much of which is utilised to produce sugarcane in commercially-owned estates in the lowveld. A review of the literature shows that for about 25 years commentators have documented the defining nature of development of Swaziland's water resources. Atkins (1999) argues the following logic:

> *"In the period 1990-1995, exports contributed some 79% to Swaziland's GDP with agriculture through sugar and citrus products accounting for over 56% of these earnings. These crops are fully dependent on irrigation, and thus it is clear that the strength of the economy lies in the effective and efficient development and sustainable management of its limited water resources." (Page 269).*

Atkins (*ibid*) goes on to point out that commercial farming dominates agricultural production, that most of the remaining 650 000 rural based population farm in

traditional rainfed ways and that the record of the comparatively few smallholder projects has been disappointing.
There are five constituencies that might benefit from agricultural development initiatives:

1. Rainfed farmers on Swazi Nation Land, growing maize. The estimated area is about 140 000 ha.
2. Farmers who have developed micro-scale and individual sources of water to irrigate plots of less than 0.5 ha found mainly in the middleveld and highveld on Swazi Nation Land, growing vegetables. The estimated area is about 250 to 500 ha in total.
3. Farmers who have organised themselves or have received external assistance to develop small-scale irrigation systems, mainly located in the middleveld on Swazi Nation Land, growing vegetables. The estimated area is about 800-900 ha in total.
4. Farmers who have been settled on large-scale smallholder schemes, found in the lowveld on Swazi Nation Land, growing mainly sugarcane and some vegetables. In the near future, this sector will be about 8000-15 000 ha in total (in two different developments).
5. Private large-scale commercial estates who irrigate only citrus and sugarcane. These are found on Title Deed Land in the lowveld. This sector is about 40 000 ha.

These five distil into two major irrigation classes; sugar and non-sugar. The sugar class involves types 4 and 5, i.e. the commercial growers and smallholders on relatively large formally designed irrigation schemes which tend to be found in the lowveld. The non-sugar class incorporates the first three; the rainfed farmers and those irrigated smallholders found on very small-scale systems that are more 'traditional' in design and ownership, and who tend to grow vegetables and other food crops.

Herein lies the debate; given a marked degree of rural poverty, how should Swaziland’s soil, land and water resources be best used to help farmers currently mostly reliant on unreliable rainfall to secure improved incomes and livelihoods afforded by access to irrigation? One answer, although not the only one, is as Terry (1997) suggests, to extend participation in the sugar industry to a wider number of small-scale farmers. After analysing the different dimensions related to irrigation in Swaziland, this paper then agrees with what seems to be the prevailing viewpoint - which is that the optimal route to smallholder development is via large-scale projects with Swazi farmers having some access to the sugar market. The critical issue is how best to deliver and design such initiatives so that they generate significant positive and long lasting impacts on rural poverty.

Geographical, economic and bio-physical introduction

Swaziland is a landlocked country of 17 400 km^2 (Figure 2) located between South Africa and Mozambique, with an estimated population of 960 000 (SSA 2001) and about 73 000 homesteads (FAO, 2001a). (N.B. Funnell in 1986 reported 60 000 homesteads). Formerly a British Protectorate, it became independent in 1968 and is now a constitutional monarchy compromising an extended royal family involved in wide-ranging economic activities and interests. (For example, the Royal family owns the parastatal development agency *Tibiyo*, which has compulsory shares in many agricultural projects, see Tibiyo, 2001). English and siSwati are official languages. Swaziland's trade and economy is characterised by its location within Southern Africa, and is particularly dominated by South Africa (see Atkins and Terry, 1995).

Economic and Social Data

Table 1 presents some basic social and economic data, some of them in comparison with indicators for Sub-Saharan Africa. Annual demographic growth rate is estimated at 3.1% and the current average population density is 55/km^2. Average real GDP grew at 3.6% between 1988 and 1998, and on average agriculture contributes approximately 13-14% to the GDP, though this has been declining in very recent years to 9.8 % according to the SADC Review (2001). (See various sources: Swaziland Business Yearbook, 2001; FAO, 2001, LUSIP, 2001). These sectoral figures hide the fact that "the majority of Swazi people continue to depend on agriculture as an important source of income and employment. The sector also plays a crucial role in providing raw materials for the largely agro-based manufacturing industries; particularly operations that use local sugar and wood" (SADC Review, 2001).

Figure 1. Schematic of linkages between the Swaziland sugar industry, sugar-sector irrigation and non-sugar smallholder irrigation systems

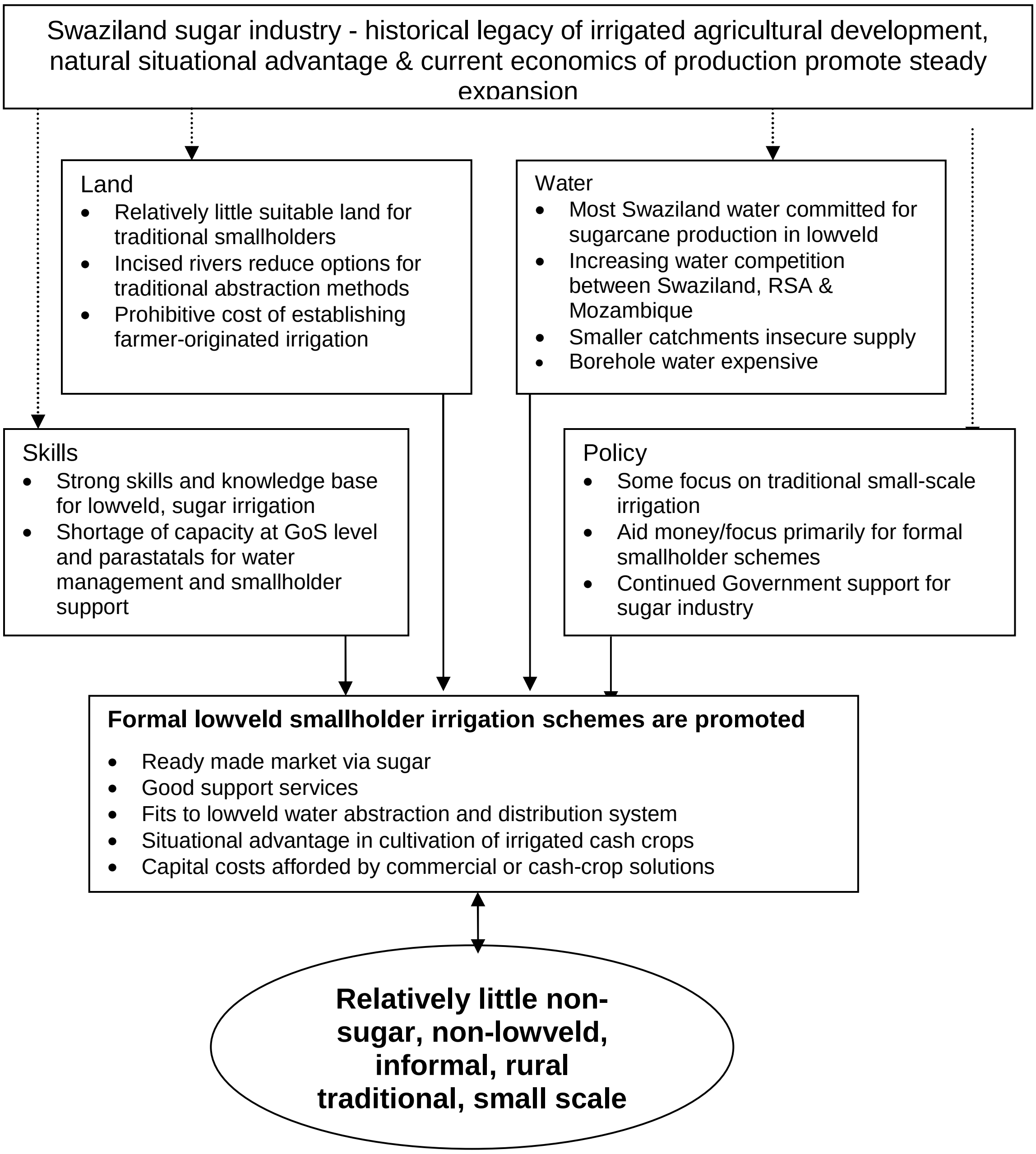


Table 1 Human, Social and Economic Data of Swaziland (and in comparison with Sub-Sahara)

Item	Swaziland	Sub-Sahara
Population growth	3.1%	2.6%
GNP	US $ 1,440	US $ 480
Population density persons/km^2	55	*24*
Life expectancy (years)	60	51
Infant mortality (per 1000 births)	65	91
Illiteracy (% population +15 years old)	23	42
Access to safe water	60%	47%
Per capita freshwater resources, m^3/head	4900	8441
Urban population	34%	33%

Note: Data is mostly for 1997. Sources: LUSIP, 2001: World Bank 2001.

As Table 1 demonstrates, Swaziland fares well in comparison with much of Sub-Saharan Africa. However, there are significant problems with inequality and health. 60% of the population live below the poverty line (Matondo, 2001, pers. comm.), 48% of the population fall below the food poverty line (ACP-EU, 1999), while the poorest 40% share only 14% of the national income (1995 records quoted in IMF, 2000). The Gini Index[1] for Swaziland is 60.9 (data for 1994, HDR, 2001) demonstrating a marked degree of inequality. The following is a quote regarding poverty in Swaziland from the EU study of the background to the LUSIP project (2001):

> *However, there are disturbing anomalies which raise concerns about the ability of large proportions of Swaziland's population to obtain a basic standard of living. These are for instance:*
>
> - *Farm sizes, investment levels and productivity on Swazi commercial farms are far higher than on the smallholder farms from which the majority of rural households earn livelihoods;*
> - *Swazi communities identified between 53 to 80% of the local populations as poor;*
> - *Swaziland's HIV/AIDS infection rate is one of the highest in the world, rolling back advances in household welfare and capacity building investments;*
> - *The changes in South Africa have led to large declines in the regional demand for Swazi migrant labour and in foreign investment flows to Swaziland.*

As the EU summarise; there is an urgent need to "intensify the traditional farming sector – to improve food security, increase income-earning potential from off-farm

[1] The Gini index measures inequality over the entire distribution of income or consumption. A value of 0 represents perfect equality, and a value of 100 perfect inequality.

sales, reduce poverty and boost employment. However the structure of the rural economy and support given to traditional agriculture will not make this an easy task." (ACP-EU, 1999, page 45). It is within this context that the role of irrigation in agricultural productivity, livelihoods and equity is being debated. (Though this paper does not deal with larger issues such as the causes of poverty and inequality within Swaziland or the factors underlying production in predominantly rainfed Swazi Nation Land. See, for example Osunade, 1993 for this kind of analysis).

Geography

Four main physiographic units define the country. To the west is found the highveld, a range of mountains that extends into the Drakensberg of South Africa. The highveld occupies about 30% of the country and covers land between 1000-2000 metres in altitude. Precipitation is typically 800-1200 mm/yr. The capital city of Mbabane is found in the approximate centre of this unit. To the east of this unit, also running north-south, lies the middleveld, typically rolling and hilly land between 450-600 metres and also occupying 30% of Swaziland. Annual precipitation is somewhat less than the highveld, ranging from 500-1000 mm/yr. Manzini, Swaziland's second largest town is found here. Further to the east is the lowveld, with average elevations of 150-300 masl. This is a slightly larger area than the two other zones, occupying about 6,400 km^2 and receiving on average 500-750 mm of rain annually. Three towns, Mhlume, Simunye and Big Bend are found here, to the north, middle and south respectively. Lastly, the eastern Ubombo mountain range (average altitude of 600 metres), a relatively narrow zone, provides the border with Mozambique and Northern KwaZulu-Natal. Siteki is the major town found in this physiographic unit.

Agriculture and climate

The important agricultural zone of the lowveld has a semi-arid climate and only 20%-25% of the crop's water requirement is met by rainfall. The period of peak irrigation and growth is during the summer, from about mid November to March. During this period, the water deficit is usually in the region of 500 to 700 mm depending on rainfall. There is a trend towards higher temperatures and aridity moving south in the lowveld, as Table 2 demonstrates.

Table 2. Climate in the Lowveld

Location in the lowveld	North	Middle	South
Major sugar scheme	Mhlume	Simunye	Ubombo Ranches
River system	Komati	Mbuluzi	Great Usuthu
LTM rainfall	774 mm	635 mm	616 mm
LTM rainfall Dec to March	475 mm	373 mm	349 mm
LTM evaporation	2009 mm	2007 mm	2067 mm
LTM evaporation Dec to March	793 mm	803 mm	859 mm
LTM January mean temperatures (°C)	min = 20.4 max = 31.3		min = 21.2 max = 32.8
LTM June mean temperatures (°C)	min = 8.9 max = 24.4		min = 7.5 max = 25.0

Source: Lankford, 1998 a + b (based on estate meteorological records). LTM = long term mean.

The agricultural sector plays a vital role in the Swaziland economy (accounting for approximately 50-56% of the export earnings and 14% of GDP (NPDP, 1995; Atkins, 1999). It is the principle source of livelihoods for 70% of the population. Land is divided into two main types Swazi Nation Land (SNL) and Title Deed Land (TDL). The former covers 60% of the country and is about 9% cropped mainly for rainfed maize (NPDP, 1995; Osunade, 1994) – although Funnell (1986) argues that some farmers utilise some form of supplementary irrigation in the middle and highvelds (see later). Average SNL homesteads are 2 to 3.5 ha, about half being cultivated at any one time, supporting about 11 people (NPDP, 1995; Terry, 1997b), necessitating according to Terry (ibid) the sourcing of off-farm income to supplement agriculture. SNL is held in trust for the nation by the King and is disbursed to Swazis by chiefs (although women are not allowed to own land (Matondo, 2001, pers. comm.)). TDL land is primarily irrigated under commercial agriculture.

Water Resources

Total water resources are estimated at 4.5 km^3/year (4900 m^3 per capita), 42% of which originates from South Africa (Eales *et al*, 1996). It is estimated that consumptive water use is about 30 to 40% of that leaving the country (NPDP, 1995, adjusted figures). The within-border water endowment corresponds to a per capita supply of 2800 m^3 per person per year, nearly 1800 m^3 over the stated level of 1000 m^3 per person per year that defines water scarce countries (Falkenmark, 1989; Postel, 1992). All four largest rivers in Swaziland (the Komati, Mbuluzi, Great Usuthu and the Ingwavuma) are connected either upstream or downstream with South Africa and Mozambique. For example, the Komati and the Lomati begin in South Africa, flow through Swaziland and then back into South Africa before entering Mozambique. The Mbuluzi rises in Swaziland and flows into Mozambique. The Usuthu rises in South Africa and flows through Swaziland into Mozambique. The Ingwavuma is in the south of the country, which has a catchment solely within Swaziland and flows into South Africa and then Mozambique.

While Swaziland is relatively blessed with water resources, it should be recognised that except in flood conditions water resources are committed between riparian states that share the river basins. As Eales *et al*, (1996) point out;

> *"The Komati River hosts a number of impoundments on the upstream South African side. These are used for supply of cooling water for coal-fired power stations and water for irrigation. Historical agreements with South Africa have allocated a portion of the Komati River flow to Swaziland. This allocation has generally been more than could be used by Swaziland. However, the droughts of the 1980s and 1990s, coupled with increased irrigation abstractions upstream of Swaziland, have greatly reduced the flow in the Komati River as it returns to South Africa. This has partly been the motivating force behind the construction of the Driekoppies [and Maguga] Dams on the Komati/Lomati System."*

Table 3 presents some information on the main rivers. Their flow regimes are much the same with maximum flow occurring in February during the latter half of the rainy season, and minimum flow occurring in September at the end of the dry season. The much larger and more dependent flow of the Great Usuthu is one of the main reasons why the storage capacity of the Ubombo Ranches is lower than the other sugarcane estates. In summary, the sugar estates of the lowveld are relatively well provided with secure water resources. They are based on large river basins with predictable supplies, and are augmented by sizeable reservoirs with a total storage content of 215 million cubic metres. In addition to these larger reservoirs, it is estimated that there are approximately 500 small earth dams supplying villages and livestock (Matondo, 2001, pers. comm.). The Ministry of Agriculture and Co-operatives constructed these during the last 20 years, funded by the EU. With the addition of Maguga and Bovane reservoirs by the end of 2010, the total storage for use within Swaziland will be 457 million cubic metres, not counting many smaller reservoirs used for smaller farms and urban water use.

Another point worth mentioning is that most source rivers flow down from the well-weathered Precambrian massif of Southern Africa and have a low salt content (less than 150 mg/litre, NPDP; 1995). The observed pockets of salinity in the lowveld soils arise more from in-situ weathering of sodium feldspars found in the Karoo sediments rather than addition of salts from irrigation water (see for example Murdoch and Andriesse, 1964). However, surface waters are generally not safe for human consumption because of high coliform counts and bilharzia (NPDP, 1995).

Although groundwater is rarely used for irrigation in Swaziland, it is estimated that potential exists for the development of a total sustained flow of about 20 000 l/sec. To date it is estimated that only 6% has been tapped, principally for domestic and urban needs (information taken from NPDP, 1995).

Table 3. Water resource development on the main Swaziland rivers

River	Komati	White Mbuluzi	Great Usuthu
Main tributaries	Mphofu, Mzimnene	Black Umbuluzi	Mkhondvo, Ngwenpisi
Position in Lowveld	North	North-central	South
Average flow annual flow	397.3 million cu. metres	213.3 million cu. metres	1534.77 million cu. metres
Month of minimum flow	September	September	September
Average monthly min flow	9.0 million cubic metres	7.98 million cu. metres	48.72 million cu. metres
Expressed as flow rate	3.5 cumecs	3.1 cumecs	18.8 cumecs
Month of maximum flow	February	February	February
Average monthly max flow	75.5 million cubic metres	32.07 million cu. metres	248.65 million cu. metres
Expressed as flow rate	29.1 cumecs	12.4 cumecs	95.9 cumecs
Name of dam	Sand River	Mnjoli	Van Eck, Sivonga
Total size of storage	47,330,000 m^3	150,000,000 m^3	17,300,000 m^3
Major sugar estate and mill	Mhlume, est. 1960	Simunye, est. 1980	Ubombo Ranches, est. 1956
Approx. mill catchment area	12,600 ha	11,000 ha	15,000 ha
FUTURE DEVELOPMENT			
	Maguga dam	(No further large-scale development)	Bovane Reservoir
Estimated smallholder area	6000 ha, near Bordergate		11 500 ha
Estimated storage	302 million cubic metres		160 million cubic metres
Adj. volume for Swaziland	83 million cubic metres		

Sources: Lankford 1998 a+b; Komati Basin Development Project, 2001, LUSIP 2001. SKPE, 2001.

Water resources management in Swaziland

A number of recent droughts and rising demands for water have raised awareness of water resources and of the need to manage water more carefully. The main indicator of this is the new Water Act introduced in 1998 and currently being debated in Parliament (- which arose out of concerns during the eighties and nineties).

The National Physical Development Plan (1995) identifies that "there is no overall policy to develop water use", and that "in order for Swaziland to be effective in negotiations with neighbouring countries regarding international rivers a National Water Master Plan should be prepared". Apart from the recent development proposals for the Komati basin with the proposed construction of the Maguga Dam, the other river basins now require updated information.

Furthermore, a strategic planning workshop held in 1996 by the Swaziland Sugar Association determined the need for an expansion in water management skills to meet: (1) future challenges arising out of the introduction of the Water Act in 1998; (2) increased competition for water from industry within Swaziland; (3) increased sugar production; and (4) further demand from Mozambique and South Africa which share Swaziland's water resources. Following development of the Maguga reservoir in the Highveld, large increases in payment for water were predicted (SSA 1996).

Figure 2. Schematic map of Swaziland, with location of major rivers, storage and irrigated areas

KEY

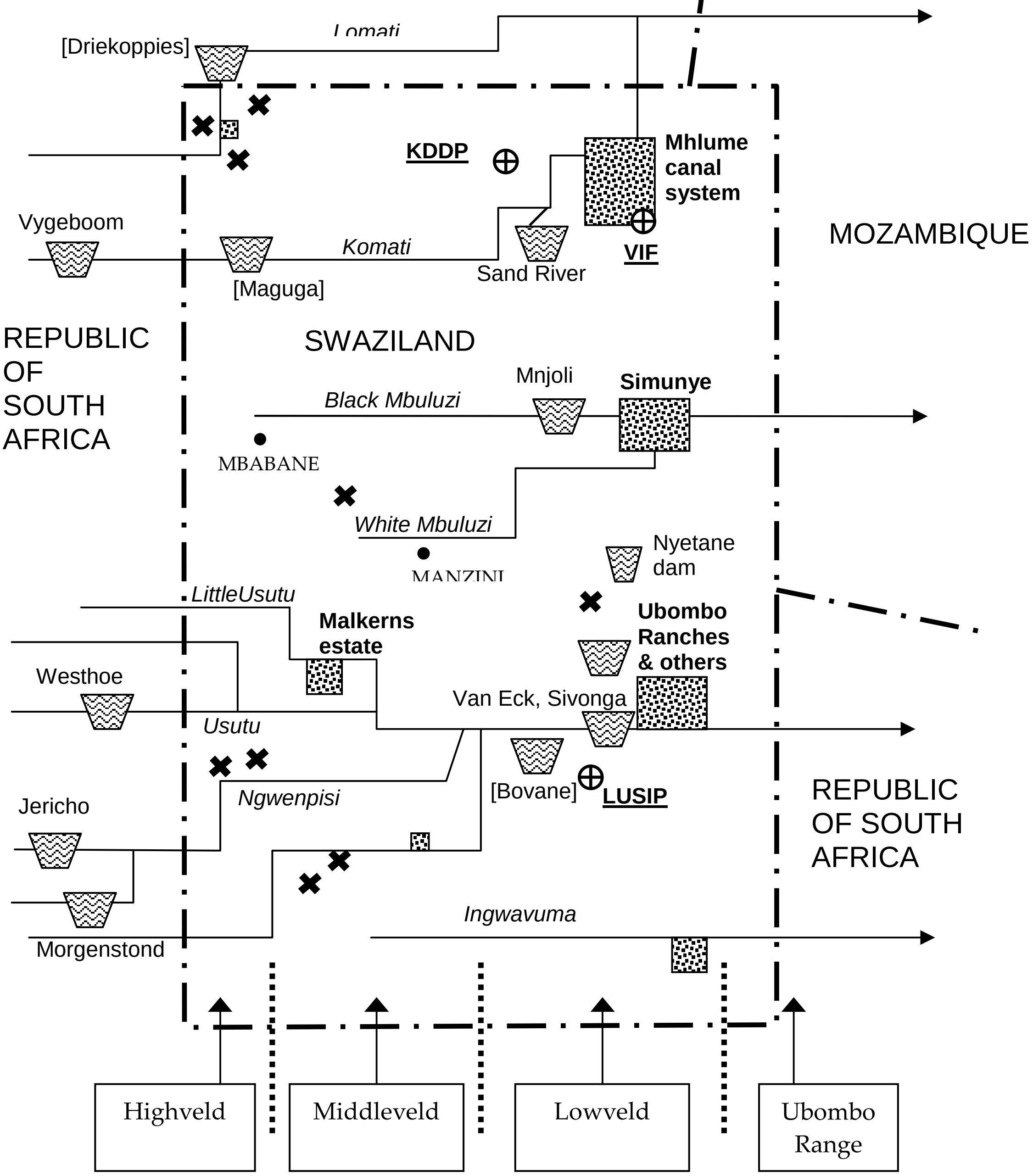
(VIF = Vuvulane Irrigated Farmers, KDDP = Komati Downstream Development Project [sometimes referred to as SKPE, Swaziland Komati Project Enterprise], LUSIP = Lower Usuthu Smallholder Irrigation Project)

Water storage [being planned or recently constructed]

Irrigated land - predominantly estate

⊕ **Large scale smallholder schemes - current and planned**

✖ Areas with small scale smallholder



Swaziland has four main water institutions, described as follows:

The Water Resources Branch, within the Ministry of Natural Resources and Energy, has few powers and resources. Its main activity is managing water for irrigation, though as discussed later, this responsibility is diminished because of the compensating abilities of the lowveld irrigators. Also within the Ministry of Natural Resources is the Komati Project Co-ordination Unit.

In addition, there is a small Irrigation Section (also referred to as a Unit) within the Ministry of Agriculture catering for small-scale farmers, providing design work and extension mainly on irrigated vegetables. It is only recently that it has started assisting small-scale sugarcane growers in collaboration with the Sugar Association. (J. Mamba, 2001, pers. comm.; Dlamini, 2001, pers. comm.).

The Rural Water Supply Branch (RWSB) has responsibility for rural water supply and falls under the Ministry of Natural Resources but relies heavily on external funding. It was set up with donor funding and NGO support during the United Nations Decade of Water and Sanitation.

The Water Services Corporation was privatised in 1994 to facilitate better planning, budgeting, and overall management of urban water supplies. It is an Agency remaining answerable to the Ministry of Housing and Urban Development.

These four are located in Mbabane in the highveld, and while officially charged with water resources management, the list ignores the fact that the lowveld of Swaziland is an important location of institutions involved in water management. The sugarcane irrigators and the Swaziland Sugar Association (based in Simunye) have contributed towards the development of water resources legislation and together have built up considerable levels of expertise in water resources management. In addition, the Swaziland Komati Development Project (SKPE) office is located in Tshaneni, in the northern part of the lowveld. The sections below help explain why the lowveld has come to be so important in terms of irrigated agriculture.

Irrigation in Swaziland

Cultivable land in Swaziland is estimated at nearly 200 000 ha (Funnell, 1988, taken from a study conducted by the US Corps of Engineers and quoted in NPDP, 1995). However, based on both water and land resources, the potential for irrigation development drops to 90 000 ha, which is 40-65% of the total cultivated land depending on variability in rainfed production. Although the FAO (2001b) estimates there is currently 65 000 to 69 000 ha irrigated land in Swaziland, (and this is quoted widely elsewhere) this figure is difficult to arrive at by totalling up the amounts of land under different types of crops and growers. This author estimates that irrigated land in Swaziland is currently about 50 000 ha. Apart from citrus and sugarcane, which total about 47 000 ha there is little substantial irrigation found elsewhere. This tallies with the figure of 42 000 ha found in the National Physical Development Plan, which albeit uses slightly old data (NPDP, 1995).

A simple typology of Swaziland irrigators is found in Table 4. As mentioned above, the key characteristic of irrigation in Swaziland is that it is dominated by the lowveld irrigation systems that cultivate sugarcane. Together the Mhlume, Simunye and Big Bend mills have a total catchment area of 43 000 ha, nearly 85% of Swaziland's total irrigated area. The SSA record that the three millers and four large growers produce 77% of the sugarcane crop, while the number of growers over 1000 ha (including the three millers) is only seven. There are 15 growers cultivating between 50 ha and 1000 ha and only 295 cultivating below 50 ha. The sugarcane grown in the Malkerns area in the middleveld is for seedcane as well as some milling.

Each of the sugar estates in the lowveld grows sugarcane on medium to heavy textured soils making them ideal (if over 600 mm in depth) for efficient irrigation. Climatic and evaporative conditions of 1700 mm per annum promote good growing conditions. Irrigation needs to provide about 1200 - 1500 mm gross each year. These growing conditions give yields of 90 to 120 tonnes cane per hectare (TCH) resulting in a water productivity of 8.3 kg cane/m3 water. In the lowveld, cane is harvested every 11 to 12 months with sucrose contents of 11% to 17%. This contrasts with rainfed cane in Natal, South Africa, where yields of 80 to 100 TCH are harvested every 15-18 months.

Elsewhere, formal commercial irrigation is rather more minor in extent, but is found in the middleveld, again for mostly agro-industrial use, such as irrigating seed cane, citrus and pineapple under commercial conditions. The methods used here are mostly sprinkler and trickle (drip). Added to this, is a small rice and mixed vegetables irrigation scheme near Matsapa, Manzini supported by Taiwan aid (ICDF 2001).

Table 4. A simple typology of Swaziland irrigation systems

Type and unit size	Other names for sector	Examples of typical systems	Location in Swaziland	Approximate Numbers (and area, ha)
Sugar and Citrus Estates (> 1000 ha)	Commercial irrigation scheme	Mhlume, Simunye estates Swazican, Malkerns	Lowveld and Middleveld	10-12 (approx 45 000 ha)
Smallholder sugarcane scheme (>1000 ha)	Formal smallholder scheme	E.g. VIF	Lowveld	Approx 300 farmers (approx 1500 ha)
Other sugarcane private farmers (10 - 200 ha)	Small-scale Swazi farmers & private growers	(Various, scattered)	Lowveld and Middleveld	Approx 30 farms (approx 2000 ha)
Non-sugar mixed cropping smallholder & micro systems (0.2 to 100 ha)	Rural irrigation systems	E.g. Nkwene irrigation garden Matsapa	Middleveld	Approx 1000 households on (800-900 ha)
Mixed cropping watered plots and gardens (0.01 to 0.5 ha)	"Individual farmers" (Funnell, 1986)		Middleveld and highveld (highly scattered)	Approx 4000 householders (250-500 ha)
Private growers using borehole water (< 10 ha?)			Middleveld	Difficult to estimate

Sources: Carr 1987b; SSA, 2001; Matondo, 2001; Author's own estimate; ICDF 2001; Funnell 1986, 1988 & 1994; FAO 2001a. With the exception of the last type, all cultivators use surface water resources.

In addition in the lowveld, there is the formal smallholder scheme of Vuvulane Irrigated Farmers (VIF) which is an irrigated smallholder scheme in the northeast of Swaziland. VIF obtains its water from the same Mhlume canal system that provides water to most of the Mhlume Mill catchment. VIF was founded in 1963 to fulfil "developmental" aims of the Commonwealth Development Corporation (CDC) who wished a more "direct involvement of the Swazi Nation" (VIF, 1995 and see Carr 1987b). In 1983, CDC handed over the scheme to the Swazi Nation under a new company, VIF Limited, owned by the King. Many of the existing farmers are those who originally settled. They grow sugarcane for Mhlume mill, providing 10% of its total requirement. The area on each farm under sugarcane varies from 70% to 95%, though this has risen in recent years due to higher prices. Other crops include vegetables, cotton and maize. Because VIF is situated on deep red basalt-derived soils, and provides its farmers to with extension advice, yields are adequate, ranging around the 90 to 120 TCH mark. This is slightly less than the lowveld average principally due to lower levels of fertilisers applied. The layout of VIF is structured and formally designed reflecting the original engineers' aim of providing a transparent way of distributing land and water (Morling, 1994, pers. comm.). There are a total of 302 farms ranging from 3.0 to 7.0 ha plots, plus a commercial, nucleus estate of 100 ha, giving a total area of about 1470 ha.

The mixed cropping and non-sugarcane smallholder sector is very minor in area, but is found in some of the smaller streams in the middleveld throughout Swazi Nation Land (SNL). This sector is only thought to amount to approximately 1300 - 1500 ha (author's own estimate) consisting of about 800 ha of smallholder schemes and about 250 to 500 ha of scattered watered micro-plots or gardens (see below). The main irrigated crops are vegetables, fruit and sugarcane (for whole stick consumption). Carr (1987b) found that 820 ha of irrigation fell under smallholder irrigation, including 13 irrigation projects developed within Rural Development Areas (RDAs). This included the 12 irrigation projects totalling 300 ha labelled 'Farmer Co-operatives' or 'Farmer Associations'. These communal, smallholder projects are characterised by individual family holdings of around 0.3 to 0.6 ha in schemes averaging 20 ha. In the last 15 years many of these are been supported and funded by the Swazi Bank, the King's Enterprise Fund and some international institutions (mostly EU and IFAD). Funnell (1994) analysed some of these and found them, in the absence of any tangible Government support, to be survivors and "quiet innovators", utilising a range of technologies to water crops including buckets, furrows and in some instances "ingenious DIY sprinkler systems supplied from self-built storage tanks."

During the late eighties and early nineties, 3 or 4 of these micro-irrigation schemes were first supported through the Smallholder Credit and Marketing Project of IFAD (though 12 were identified in the project memorandum). Following a review in 1993, this work was consolidated and expanded via the Smallholder Agricultural Development Project (SADP) also funded by IFAD. SADP intended to develop 185 ha of new irrigation and rehabilitate 257 ha of existing irrigation. Central support to the Ministry of Agriculture and Co-operatives was envisaged to consolidate irrigation services into a single Small-Scale Irrigation Unit (though progress on the latter has not occurred).

In turn, SADP lead to part funding and part-implementation via an NGO – the Swaziland Farmer Development Foundation (SFDF) - (see IFAD 2001 and SFDF 1998) which has also received funding from the EU Microprojects Section (SFDF 1998). Irrigation systems supported by this project are founded upon traditional communal tenure. The purpose of the schemes is the development of micro-scale schemes (2-10 ha) garden groups, usually consisting of women, to produce vegetables. SFDF provides capital and technical assistance, while the group provides free labour for installation and contribute to the operating costs. After two years, the group aims to be entirely responsible for the operation of the scheme. The most common source of supply is pumping water from a perennial stream to a reservoir, which then supplies the downstream fields through a buried PVC pipe system. The National Agricultural Marketing Board (NAMBOARD) assists further in crop marketing, by advising the farmers and occasionally purchasing their produce.

Finally, as Table 4 shows, approximately 4000 households in the 1993 census (FAO 2001a) recorded some form of watering of vegetable crops, as Funnell, (1986) and Atkins (1999) state probably using a mixture of technologies. Extrapolating from the analysis by Funnell in 1986, one can surmise the following; that the plot areas cultivated here are probably in the 0.01 to 0.5 ha range and that the total area of this type of irrigation is probably no more than about 250-500 ha. Most of these farmers are located in the middle and highveld, utilising local streams for supplementary irrigation either by using a simple furrow or more rarely by transporting barrels or buckets. It appears that farmers generally develop small offtakes near the headwaters of streams, and are thus dependent on adequate river flow and are susceptible to shortages of rain. According to Funnell (1986) these are unconnected to the "officially recognised [smallholder] schemes" (as reviewed above) and therefore generally omitted by the Government when the latter conducts surveys of irrigators. Certainly, in the literature there appears to be little mention of them, or of their role in meeting rural and urban vegetable demand.

In summary, private Swazi farmers utilising their own sources of water or managing small communal schemes are relatively minor part of the irrigation production pattern. However, small farmers on networked formal irrigation schemes are a principal growth area and for example Big Bend will be relying more on surrounding smallholder farmers to deliver sugarcane. The expansion plans of both LUSIP and KDDP are examples of the future manifestation of this type of grower.

Agriculture and the sugar industry in Swaziland

To understand the context of smallholder irrigation, it is necessary to emphasise the place that sugar has in Swaziland and the place that irrigation has in supporting the milling capacity of three large mills. As outlined in the introduction and in Figure 1, developments associated with irrigation have supported this crop and its institutional infrastructure to the relative neglect of non-lowveld and non-sugarcane smallholder irrigation.

The sugar industry is a major player in the Swaziland economy. (A good summary of the sector can be found in Terry, 1997a+b, and Atkins and Terry, 1995.) Swaziland's annual production is around the 547 000 metric tonnes level (SSA 2001) produced from about 43 500 ha (2.3% of Swaziland's total area). These production rates (12.5 tonnes sucrose/ha) make it one of the most productive in Africa. Indeed, it is the second largest exporter of sugar in Africa after RSA, which is first at 800 000 metric tonnes.

Within Swaziland, it is the biggest single foreign currency earner (about 150-210 million US dollars sterling annually depending on the price of sugar), providing about 17-22% of total export revenue (USAD, 2001). It is the single largest employer directly employing 16 000 people and 80 000 indirectly (Colhoun, 1994; B & T Directories, 1995, SSA, 2001). "Sugarcane contributes more than 50% of the total agricultural output and 30% agricultural employment as well as providing an industrial base; milling alone has an annual contribution of about 20% to the total manufacturing output and about 27% to the total manufacturing wage employment" (USAD, 2001). Interestingly, Terry (1997b) analysed that every hectare of smallholder irrigation in Swaziland generates of 0.4 of a permanent job in comparison with 0.2 of a permanent job accruing with the development of a hectare of estate irrigation.

Furthermore, the Swaziland Sugar Association (SSA, 2001) point out: "Contributions to public revenues in the form of company tax, sugar levy, sales tax and personal income tax from employees makes the Sugar Industry by far the largest contributor to fiscal revenue. When this is taken together with the savings associated with those social services provided by the industry which would otherwise have had to be provided by government, it makes the total contributions enormously important for the country". In the lowveld, the sugar industry has in the past taken responsibility for the provision of housing, medical care, clinics, schools, education, the funding of training and the provision and maintenance of a network of secondary roads. It is, arguably, the "Green Gold of Swaziland" though its location in the lowveld restricts participation by middleveld smallholders in this success (Matondo, 2001, pers. comm.).

As Table 5 shows, sugarcane produces nearly 10 times the value of maize and cotton on a per hectare basis, and because of its area, it produces nearly 7 times the total value of citrus - another important irrigated crop in Swaziland. Table 5 reveals that maize production area is more than sugarcane area, but the former varies around this mean depending on the prevailing climate and rains, whereas the latter is more stable because of the provision of irrigation. Maize is mostly grown via traditional farming at a subsistence level on Swazi Nation Land (SNL). Thus, this sector plays a small but significant role in the economy by supplying some of the staple food crop maize (see also Wessels-Bayer and Smith, 1996). On the contrary, the bulk of sugarcane is mostly grown on estates situated on Title-Deed Land (TDL) held on freehold or concession basis. The estates are nearly all joint internationally and Government owned systems (through the parastatal development company *Tibiyo*). The ratio of crop-originated GDP by type of land is approximately 1:7 in favour of TDL (figures taken from IMF 2000). This division into different types of land and farming systems is the principle marker of Swaziland's dualistic agricultural sector.

Rice cultivation is still very minor with production around the 300 tonne mark for the whole country. (Central Bank, 2000). This inactivity is said to be due to a very weakly developed local market.

Table 5. Relative production figures for crops in Swaziland

Crop	Maize	Cotton	Citrus	Sugar (sucrose)
Main production systems	Rainfed, farmer	Rainfed, farmer	Irrigated, estate	Irrigated, estate
Area (ha)	60-80 000	17 000	3000	40 - 45 000
Value (E, million)	70-95	15-31	95-132	400-500
Total metric tonnage (5 yr average)	97 000	5000 – 15 000	81 000 – 100 000	547 000
National consumption (metric tonnes)	123 000	14 000	Approx 30 000	Approx 200 000
Av. yield (t/ha)	1 – 1.5	0.4 – 0.8	10 – 35	12 to 13
E/ha	1200	882	25000	12500

Notes: Spanning 1996 to 2000 data. Values in emalangeni. The South African Rand has parity value with the Swaziland lilangeni. Eight Rand to 1 US $, sugar price about $250 to $310/tonne sucrose. Crop yields vary depending on climatic conditions and farming system. Cotton area doubled in 1995/96. Sources: Lubombo Spatial Development Initiative, 2001, Cotton SA, 2001. SSA 2001. FAO 2001a. FAO 2001b. SADC Review, 2001. IMF 2000. Central Bank of Swaziland, 1998.

Swaziland's sugar production is expanding at about 3% each year mainly from increased area (SSA, 2001). For example, the sugar industry is expecting an expansion of about 6000 hectares over the next few years when the Maguga dam irrigation project comes on stream – termed the Komati Downstream Development Project (KDDP – see Terry 1997a and KDDP, 2001, for further information). There are also plans to add nearly 12 000 ha of smallholder irrigation in the Usuthu basin via an EU funded project - the Lower Usuthu Smallholder Irrigation Project (LUSIP). Although the cropping patterns of these areas will not be totally sugarcane, these projects have important implications for the expansion of sugarcane smallholder irrigation, and means that it is possible to project that by 2010 there will be about 55 000 ha of sugarcane in the country. This dwarfs the size of the non-sugar small-scale sector which is estimated by the author to be no more than about 1300-1500 ha (see the next section).

In summary, provided irrigation is well managed and water is adequate, the advantageous position for sugarcane is due a number of favourable factors: a strong selling environment including protected prices and markets; relatively low labour costs; and good growing conditions. Crop diversification on the estates is not often economic when the capital element of the sugar mill is accounted for. The next section helps explain the lowveld's natural endowment for sugarcane.

Irrigation management on the estates in Swaziland

It is argued that the sugar industry in Swaziland dominates irrigation, and that this includes a dominance of skills in water management. These two factors eclipse the technical capacity of Government irrigation personnel and extension officers. The know-how for irrigation arises from necessity; irrigation is one of the most important agricultural operations in the sugar industry accounting for approximately 25% of production costs (SSA 1996) and for two thirds of the cane yield.

A number of other attributes contribute to an in-depth understanding of water management. Within each estate, and across the whole industry, managers are exposed to different types of irrigation. For example, the current distribution of area under each type of irrigation is as follows: furrow is 36%; sprinkler: 50%; drip: 8%; and centre pivot: 6% (SSA 2001). This provides fertile ground for comparative monitoring of operation, costs and benefits (see also Pollok and Geldard, 1990; Carr 1987a; Atkins, 1999). Almost all estates conduct scientific and carefully controlled crop-based irrigation scheduling in order to maximise returns to water and land. Water supply is mostly from large-scale reservoirs maintained by river supply. Gravity supply to tertiary canals takes place via a conveyance network of canals utilising a variety of adjustable or on/off gated turnouts. Within the schemes, no additional rainwater harvesting is found, and rarely are drains used as canals or vice-versa. Furthermore, in the cooler off-peak season, drying-off (ripening), fallow land and slower growth rates of sugarcane during the stalk elongation phase allows considerable savings of water to be made through deficit irrigation (e.g. see Ellis and Lankford, 1988). All this encourages the careful planning of when and where water will provide the best economic returns.

A combination of hot climates, variable rainfall, localised salinisation and heavy-textured soils with relatively low readily available moisture capacity and poor drainage gives little room for water management error. High-performance scheduling is needed on all types of irrigation (furrow, drip and overhead) in order to provide, during the summer, irrigation once every 7 to 12 days, applying 50-85 mm of water. The means to achieve this kind of control on furrow systems is explored more by Lankford (1992).

The future should see increasing investment in skills and technology in irrigation. All the estates employ technical advisers and have access to the SSA’s expanding irrigation services, which include:

- Technical information on irrigation methods
- Evaluation of irrigation systems
- Checking designs and commissioning systems
- Advice on water measurement devices
- Irrigation economics
- Drainage design guidelines
- Irrigation scheduling software (CANESCHED)
- Potential yield forecasting with the model CANEGRO (see SSA, 2001).

Technology changes will probably focus more on drip, floppy and centre-pivot than on improvements to furrow irrigation (although this is not to say that changes in the latter are possible - see below). For example, Ubombo Ranches has installed over 500 ha under centre-pivot in the last three years, and Simunye has changed 5000 ha of sprinkler to drip in recent years. All estates continue to invest in micro-computing facilities for data capture on irrigation.

These skills and practices conducted on the estates trickle down to smallholders and help provide a environment of support. The lowveld has the air of close-knit agro-industrial zone where observation and information provide ready reminder of common and best practices. More specifically, there is a healthy environment of knowledge transfer between the estates and personnel of the SSA. In turn, the Extension Service of the SSA provides training on agronomy and budgeting for smallholders (Terry 1997a), plus links with the extension service specifically provided by VIF for its own smallholders.

Sustainability and natural resource management

Here, sustainability in the context of irrigated agriculture refers to the system's ability to maintain comparatively appropriate productivity in the long run under existing management and cultivation methods. There is evidence from a productivity angle that the cultivation of sugarcane on both estate and smallholder schemes is sustainable in the long term and within its context (though it might be tendentious to argue otherwise). Many fields have now been growing cane for nearly 40 years and while there has been a recorded initial drop-off from 120-150 TCH, yields have stabilised at around 95-105 TCH. On some R set soils, over 20 ratoons have been achieved, with no distinct decline in yields within the ratoon cycle (SSA, 2001). It would not necessarily be sensible to argue for a switch to low input-low output methods of production to meet notions of sustainability suggested for production systems elsewhere in Africa (e.g. Pretty 1995). The norm for these types of lowveld production systems is high input - high output. Although Terry (1997a+b) raises the spectre of depleted soils, the fact remains that many growers invest successfully in fertilisers and carefully controlled crop management regimes. The topography, soil types, cultivation cycle, added value of the processed product, and high capital investment enables this kind of farming system. The economics of sugarcane production, and the activities organised by managers, agronomists and extension services promote a strong sense of scientific inquiry and continuous monitoring of estate operations resulting in judicious applications of inputs including water.

There appears to be a distinct case for arguing for the situational advantage of sugarcane in the lowveld. By comparison elsewhere, sugarcane production in Swaziland is one of the most efficient in the world, and a concentration of environmental conditions fit with the physiology of the crop. Another C4 crop, maize, would grow well, but the economics would be categorically different. Maize is successfully grown in the cooler rainfed parts of central South Africa, hence Swaziland can import cheaper maize than maize grown under rainfed or irrigated conditions in Swaziland. There is also the argument that efficient producers should be allowed to produce enabling a 'global sustainability' and providing sources of "virtual water" when sugarcane is imported into other countries.

Smallholder irrigation at the crossroads - key issues

There remain essentially two main options for smallholder irrigation in Swaziland; whether to continue to provide and support formal smallholder irrigation able to cultivate cash crops, or to support traditional small-scale irrigation focussed towards food cultivation by rural people in the middleveld. Funnell (1986, 1988) raised concerns over the types of irrigation development in Swaziland, finding that 38% of TDL but only 9% of SNL was irrigated. He believed: "The Government has an ambivalent attitude towards the question of most appropriate investment strategy for expanding irrigation".

As is argued in this section, the first of the two options has important advantages to it, while the second is only plausible in certain circumstances (and so far the track record of this sector's performance has not been encouraging – see Funnell 1988 and IFAD, 2001). It is argued that some of the key issues for smallholder irrigation are inevitably wrapped up with the political economy of sugar cane production in the country. In addition to the question of which smallholder irrigation format is most appropriate, there are also secondary issues related to the sugar industry.

As Matondo (2001) points out, a successful sugar sector and increasing area under irrigation does not necessarily imply a healthy food security situation. Each year Swaziland imports maize to the tune of approximately 40 000 tonnes, and there are significant proportions of the rural population in the middleveld who suffer food shortages regularly. Plus there is no direct linkage between their food security and sugar production. Three issues exist here: one is the need to promote crop diversification where sensible, the second is to highlight the risks attached with over-reliance on an exported cash crop and the third is the need to increase access to irrigation. Since farmers make a cropping choice reflecting 'farm gate' prices, the first two are closely interconnected, and cannot necessarily be centrally controlled. All three are discussed below.

Crop diversification and reliance on one sector

The near future will see farmers on the large-scale smallholder schemes being encouraged to undertake mixed cropping rather than monocropping sugarcane. This follows on from two reasons; the need for farmers to reduce risk associated with reliance on one crop, and the second is the need for food for the Swaziland domestic market.

Over the period 1990-96, sugar exports comprised 22% of total exports. The corollary to this is that an adverse change in any aspect of the industry will have significant negative impact on the rest of the economy. Recent drops in the sugar price have been felt, but the quota system to the European (170 000 MT) and American market (20 000 MT) accounting for 40% of the total sold ensures preferential pricing and some protection against declining world prices.

Planned expansion of the sugar industry, the bulk of which will occur via smallholder irrigation, means an increasing amount sold on the world market (for example, during 2000, SSA exported a total of 39,000 tons of bulk raw sugar to world markets). This does add sensitivity to world prices, but this exposure is not borne by smallholders alone, rather it is shared among all growers. As Terry (1997b) points out past expansion up to 1995 has safely occurred because of an increase in quotas ("from 120 000 to 170 000 tonnes").

On balance, the near future looks difficult to predict; Swaziland's sugar industry stands to benefit from the EU's 'everything-but-arms' plan, which will allow the world s 48 poorest countries to export all goods, except arms, freely to the EU starting in 2009. Under an EU-ACP agreement signed in Benin, June 2000, the EU pledged to continue to import 1,305-billion tonnes of raw sugarcane at a guaranteed price, equivalent to that paid to EU farmers which is higher than the world price. (USDA Reports On Swaziland Sugar Production, 2001). On the negative side, world prices continue to stay low. South Africa absorbs much production, and in the last five years has been increasingly sensitive about this (e.g. see Terry, 1997a), preferring to favour its own producers.

Ultimately, one must conclude that the sugar industry is building considerable forward momentum and that current and future smallholder systems will be geared towards supplying sugar mills. It is not easy to predict eventual smallholder cropping patterns because they reflect changes in crop prices. As has been observed on VIF, farmers alter the area under sugar according to its profitability from between 75% to 95% of their farm area. Terry (1997b) reminds us that inter-cropping, though rarely seen in lowveld sugar fields, is a way of managing food and cash crops simultaneously. Summarising, and paraphrasing Tiffen's (1990) analysis of plantation agriculture; "the [Swaziland sugar industry] has proved to be an adaptable institution in the face of major changes in its global environment".

Access of smallholders to irrigation

It is a tenet of this paper that access to irrigation will mainly happen to those who are invited cultivate on the forthcoming large-scale formal irrigation schemes LUISP and KDDP, and not via the growth of small communal systems. According to Atkins (1999), various authors believe that the Government of Swaziland has not supported smallholder irrigation. He writes;

> *"until recently, smallholder irrigation schemes were not actively supported by Government (Funnell, 1991 and Levin, 1997) and it is noticeable that the comparatively few formal smallholder irrigation developments in the country have performed relatively poorly (Glover 1984 and Williams & Karen, 1985). In consequence, a major problem now facing Swaziland is how to follow a cost-effective route to smallholder irrigation development and management while ensuring that the basic tenets of environmental sustainability are followed."*

This concern should probably be clarified. A number of recent projects in Swaziland funded principally by IFAD have supported smallholder schemes but have not reached more than about 250 ha. This is in comparison to the donor/GoS intention of reaching over 500 ha of smallholders and can also be compared to the 40 000 ha of large-scale irrigation present in the country. In addition, there has been no formalised or documented technical support for the 4000 scattered and individual (or small group) householders who water plots and gardens of less than 0.5 ha of mixed cropping.

Swaziland is relatively unique in Southern Africa in combining a number of factors that restrict low cost access to smallholder irrigation. So, while this paper argues alongside Atkins and others in agreeing that Government assistance to non-sugarcane smallholder irrigation has been minimal, the lack of traditional smallholder irrigation is not the Government's fault. Unlike other places in Southern and Eastern Africa, few smallholder irrigation systems have arisen out of farmers' own initiatives. This is mainly due to the small amounts of suitable land available for farmers to spontaneously and cost-effectively develop land.

The total cultivable irrigable area in Swaziland is relatively small, under 100,000 ha, which itself precludes extensive smallholder irrigation. Added to this is the fact that in the lowveld the perennial rivers are large with widely varying flows. Such rivers require substantial and costly engineering infrastructure (weirs or pumps) to abstract water. Indeed the ideal offtake sites and available water have already been 'taken' or committed, leaving little for small-scale yet reliable points of water abstraction using traditional intake construction methods that are found in other parts of Sub-Saharan Africa.

Related to the previous points, the large rivers are incised both in the lowveld and middleveld, making it difficult to tap water without significant infrastructural intervention. The hilly topography in the middleveld also constrains the area of suitable commandable land for small-scale irrigation. This situation is even further accentuated in the highveld, where additional cool and wet agro-meteorological conditions favour rainfed maize cultivation rather than the need to meet moisture needs with irrigation. In addition, smaller sized catchments found in the middleveld feature smaller streams more seasonal in nature creating unpredictable supplies for irrigation and unattractive conditions in which to co-ordinate labour, land preparation, weeding, canal forming, and other inputs associated with communal irrigation. Atkins, (1995) makes the salient point that: "Smallholder irrigation in Swaziland is limited to the extent that adequate supplies of water can be made available. With irrigation water being at a premium there is a need to maximise returns to the irrigated area for a given crop on specific soil types."

Bearing in mind that the irrigated farming system in Swaziland is associated with sugarcane, an additional factor restricting access to irrigation are the quotas available from the industry for procuring and selling on the raw material as processed sugar. Although expansion via smallholders is now the preferred route, it has to be controlled through the three main mills, cognisant of the quotas[2] operated according to the 1967 Sugar Act (SSA, 2001; Terry 1997b) and of the export markets available to the industry.

A pro-poor irrigation imperative or a sustainable privilege for the few?

Given the fact that nearly 75% of Swazi people live in rural areas and that most rely on some form of rainfed agriculture for food, one may conclude that improving agriculture is a priority. The argument for expanding access to irrigation is even stronger when records show that maize importation is required in most years due to a highly variable climate affecting home maize production. Furthermore, Matondo (2001, pers. comm.) makes the salient point that *food self-sufficiency* rather than food security is under threat as farmers switch more and more to sugarcane. Terry, (1997b) questioning the expansion of irrigation to the poorest, demonstrates that recent sugar quota allocation to Swazi nationals “indicates the ability of already relatively resource-rich individuals to take advantage of the new opportunities created…” In addition, Eales *et al*, (1997) also point to greater security against droughts that a more pervasive system of rural water irrigation, boreholes, storage and reticulation might bring. Thus non-lowveld, non-sugarcane, traditional, *small-scale* smallholder irrigation appears to be a right and necessary solution.

[2] Smallholders provided with recent quotas are also termed Schedule “D” growers – see Terry, 1997b.

However, a rational analysis shows that the solution to food security via formal irrigation smallholder schemes is a *de facto* compromise - or certainly one that needs scrutiny. This is concluded from four points of view. Firstly, from a bio-physical and hydrological point of view, there are shortages of land and water. Second; sugar and high value-orientated smallholder irrigation in the lowveld necessarily demands the kinds of developments that promote economic success and scale efficiencies; in other words, reasonably large schemes with formalised, structured water delivery methods. Thirdly; the lowveld-wide farming system has promoted a skills, knowledge and services infrastructure which can efficiently be used to support new Swazi irrigators both in terms of inputs, (including water) and in marketing outputs (citrus and sugar mainly). Fourthly, new developments being planned (LUSIP and KDDP) will be on Swazi Nation Land, thus re-addressing the imbalances noted by Funnell in 1988.

One could also argue for a 'livelihoods approach' where it is not water that becomes central to rural development, but the values, resources and secondary benefits that non-local water development brings. In other words, either rural people in Swaziland often provide their own labour to the large-scale sugarcane sector or they benefit because families on smallholder systems remit money to their original homestead elsewhere in Swaziland. This creates a livelihood diversification for these 'other-located' families. This is particularly important for women who provide large amounts of labour for the lowveld sugar estates (Matondo, 2001, pers. comm.). The 'privileged solution' of irrigation (Moris, J. 1987) is more defensible when viewed in this 'benefit-spreading' manner. As said above, the contribution of the sugar industry to the Swaziland economy cannot be underestimated.

Of course, there is room for a twin-track approach. As well as supporting settlement on large smallholder schemes, rural Swaziland could benefit from well-planned and delivered micro irrigation projects, much as the IFAD projects aimed to do. Although here the track record points to some institutional sustainability problems (IFAD, 2001), such design remains a possibility. With small catchments comes risky production systems with less secure water supplies, or a costly dependency on borehole water or unforeseen second generation problems such as poor maintenance or problematic water sharing protocols between smallholders. Such rural irrigation projects become unsustainable because they are neither truly farmer originated and owned systems (with inherent social sustainability) nor are well supported and serviced smallholder schemes built into a larger production and water supply/storage system such as is found in the lowveld. The problems of non-lowveld smallholder irrigation recorded in Swaziland may be precisely because their physical and institutional design does not suit the 'endowments' found in the middleveld.

Combining both a livelihoods perspective and a twin-track approach, one might argue that micro-plots for sugar-growing smallholders might extend benefits to a wider section of the public and be much more pro-poverty focussed. Currently, the new LUSIP and KDDP projects intend to provide 3 hectares per smallholder family (Matondo, 2001, pers. comm.) or 2 ha irrigated with 1 ha rainfed (English, 2001, pers. comm.). Yet evidence from research conducted by the author in Tanzania indicates that 0.2 to 0.5 hectares (between 0.5 and 1 acre) of irrigated farming helps keep a family from sliding into poverty. Plus, evidence from within Swaziland (Funnell, 1986) indicates that plots of less than 0.5 hectares of mixed cropping are seen as valuable livelihood assets; "the revenue from winter cropping [i.e. vegetables] could generate an income that is reasonably commensurate with unskilled water employment" (page 119). The feasibility plan for KDDP involved displacing 1900 homesteads yet providing access to irrigated farming for 1150 homesteads, with the balance of homesteads choosing not to become cane growers needing re-settlement in other areas (English, 2001, pers. comm.). Simply reducing the irrigated land per family down to 1.75 ha would give all homestead owners the choice to become irrigators. A simple calculation using data from 1991 (collected by the author in 1998) shows the comparisons between income from growing sugarcane on VIF and a basic salaried wage (see Table 6). This demonstrates that a smallholding could be as low as 1 ha (to allow for fluctuations in sugar price) and yet support a family. (Interestingly, and perhaps predictably, many VIF farmers interviewed in 1998 declared that their farms of between 3 to 6 ha were too small). However, settling larger numbers of people does however increase organisational burden and construction costs both during settlement and on-going management, and can give rise to a more influential rural constituency.

Table 6. Calculations of sugar-based income for an average farm in VIF

Item	Figures
Average yield	112 tonnes/ha
Average sucrose %	13%
Average sucrose yield	14.64 tonnes/ha
Average size of farm (cane)	3.67 ha
1991 Sugar price recompensed to VIF farmers	496.89 R/tonne
Average total growing, harvest and haulage costs	3975 R/ha
Average net paid to farmers	2994 R/ha
Average net annual income	10978 R
Average basic salaried wage (monthly)	130 to 170 R
Average basic salaried wage (annual)	1560 to 2040 R
Size of sugarcane farm to equal basic annual wage	0.5 to 0.7 ha approximate

All data are for 1991. Rand and emalangeni are equal. Note slight discrepancies are involved because "other crops" are involved in costs accrued to farmers. Exchange rates in 1991 approximated to 5 rand to one US dollar. Calculated size of farm is based on net income not gross income.

National water decision making

However, of importance to future trends affecting smallholder irrigation in the country is the capacity, experience and structure of water resources management at the local and national levels. The capacity within the Ministry of Natural Resources to manage projects and programmes related to smallholder irrigation appears limited. The 1982 drought in the country particularly revealed weaknesses in the Government's ability to control water usage. Interviews with Ministry staff in 1997 showed them over-stretched yet under-resourced and unsure of developments occurring in the lowveld (Lankford 1998b). Carr (1987b) noted only one qualified engineer and 7 other staff in the Irrigation Section of the Ministry of Agriculture and Co-operatives. A participant on a JICA Training Course in 1999, Japan, entitled "Water Resources Development and Environmental Impact Assessment in Arid Areas" listed the constraints that hinder irrigation development in Swaziland: "The lack of irrigation policy and strategy to guide irrigation development; limited institutional capacity; fragmented sections of the Ministry of Agriculture responsible for water development." (Anon, 2001). And writing in the mid 1990's, Eales *et al* (1997) wrote of the delays and frustrations within various departments regarding water and irrigation.

> *"There is no single institution outside the monarchy with the power to co-ordinate water policy in Swaziland. Authority is dispersed among several government departments, each of which seems eager to cede responsibility. Despite much discussion and an agreement in principle taken 6 years ago, the proposed National Water Authority, with the powers to gather information, formulate policy, plan development, and oversee implementation, has still not been set up. Development planning falls primarily under the Ministry of Economic Planning, whose priorities do not necessarily address resource management and sustainable water delivery.*

The situation appears to have improved since the failure of the 1988 draft water act to go through Parliament. Renewed efforts are now underway to revive the water act to include new water and irrigation developments in the country. These revisions will take a river-basin approach utilising basin authorities, consider water boards at the local level and strengthen water management (e.g. by defining water duties for altitude/aspect and crop type, plus by compelling users to record flows). A Water Sector Committee with members drawn from SSA and various water users are helping to steer this revival.

Technological choice

Four main types of irrigation technology are used in Swaziland; furrow, drip, sprinkler and centre pivot. After more than 30 years of management, it is clear that each is suited to particular circumstances, and that it is not easy to generalise about complexity of operation or inefficiency of water application of any given technology. Therefore, when considering the appropriateness of technology for smallholder schemes it is extremely important not to accept at face value the kinds of generalisations that are often applied to these technologies. For example, Atkins (1999) states that "while [furrow or surface] is relatively simple to manage, the system is comparatively inefficient and thirsty". However, tests of surface irrigation by the author during the 1980's found efficiencies as high as 90% in some secondary systems. Counter to this, specialists in the lowveld know how easy it is to mismanage drip and sprinkler resulting in over-application or poor distribution of water (Clowes, 2001, pers. comm.; Dodsworth *et al*, 1990.). Nonetheless, it is extremely important that on the new smallholder schemes, design and choice carefully considers individual farmer and group needs as well as factors that enable main system management and promote efficiency. For example, operation will be affected by 12 or 24 hour irrigation; the degree of intermediate storage; costs of water (either directly through payments or indirectly through pumping charges); and the ability to divide, share and cycle water at the secondary and tertiary level in transparent ways. For example, research at VIF during 1997 showed that farmers preferred fixed modular turnouts to variable screw-operated undershot gates, believing them to be a fairer way of allocating water, (Lankford, 1998b).

Writing in 1995, Atkins saw that; "The irrigation technologies reviewed require very different management systems to make them sustainably profitable. The choices have to be well assessed before promoting one system above another to smallholders, and from the outset it is clear that new irrigators will need much managerial support". Later, in 1999, Atkins cautioned; "While future smallholder developments could well see an increase of some 21,500 ha of irrigated land in the next five or six years (Booker Tate, 1996 and CDC, 1997), planners and managers need to be sure of the costs and benefits each irrigation technology represents". Perhaps the test will be ability to apply the lessons learnt from the different technologies used, rather than utilise a text book approach that dictates that certain types of irrigation technologies have certain qualities. Therefore, a critical question for smallholder irrigation in Swaziland is whether the evaluation systems are in place to deliver the correct technological choice initially or to be able to refine and refit systems once established to users evolving wishes. The approach taken by LUSIP seems to indicate that these matters are carefully being considered, as the following quote shows:

> *"Water will be delivered to blocks of 50 to 100 hectares that will be managed by WUG* [water user groups]. *On-farm irrigation will be provided by furrow irrigation and dragline sprinkler systems. Sprinklers are the system of choice for smallholder farmers who have already organised themselves into Associations and are drawing irrigation water direct from the Usuthu River."* (LUSIP, 2001)

Even so, there are doubts at the long run success of ideas submitted by the design and contracting engineers, as Magwenzi points out (2001, pers. comm.):

> *"This process needs to be taken a stage further such that once an irrigation method has been selected, the irrigation system is designed to suit the management skills of the farmers (design for management) and to ensure that a life cycle cost approach is used in system selection. Presently, the tendency is to select the cheapest system based on initial capital outlay. This can compromise sustainability of the scheme when farmers fail to provide adequate funds for of O&M. The life cycle cost approach is particularly prudent in view of the fact that it is easier to secure finance for initial capital at project initiation than it is to secure funds for recurrent expenditure.*

International water management and demand management

Changes in water laws and increased competition for water from RSA and Mozambique further define the context in which future smallholder irrigation development is planned. On the face of it, water is largely committed, even including for the fact that Maguga Dam is nearing completion and will increase supplies. Another problem reducing water availability entering Swaziland is the storage and abstraction of water on the three main rivers, with six dams on these rivers upstream of Swaziland's western border. Eales *et al*, (ibid) concluded that: "Government officials maintain that flows through Swaziland are declining because of South Africa's dams" and "Because of Swaziland's size and location, government officials in Swaziland feel relatively impotent in asserting the nation's right to a more equitable share of river flows. Response has been correspondingly limited".

Without increases in supply, the Swaziland irrigators will have to rely more and more on demand management. Since demand management has already been in place in the lowveld for approximately 15 years on some estates, the skills to implement improved delivery and scheduling already exist (Lankford, 1992). However, a law of diminishing returns is operating here, lowveld irrigators already tend to work conservatively retaining water in their storage dams because of experience with droughts in the eighties and nineties. They have also been exploring ways of improving climate forecasting to manage water (Bohn, 2000 & 2001). Eales *et al* (ibid) on the contrary feels that a "lack of demand-management strategies" characterises Southern African (including Swaziland) water management. This is probably incorrect if one considers the practices in the lowveld account for between 75 to 80% of freshwater used in the country. It is the author's view that the industry could extract some 10-20% additional savings without necessarily moving wholesale to drip irrigation or to expensive refitting of delivery systems. This could come a number of changes; a) from refinements in measuring the irrigation deficit by moving from Open Pan methods to the Penman-Montieth equation (Clowes, 2001, pers. comm.); b) by employing severe cuts to winter irrigation of cane as pioneered in the Zimbabwe lowveld (Clowes, *ibid* and Lankford and Ellis, 1990); and c) by considering improvements to canal water control and scheduling which includes the use of measured water flows to match supply with demand (e.g. as suggested in Lankford, 1992). However, and as a footnote, it remains to be seen whether water usage and technology will respond to increases in water charges arising from the establishment of the Maguga dam on the Komati River.

Secondary issues

There is an array of secondary issues associated with various options of smallholder design. Initially, two environmental issues; effects of highveld soil erosion and ecological change in the lowveld are mentioned. This is followed by brief discussions on issues related to the benefits, performance, participation and sustainability of smallholder irrigation.

Highveld soil erosion

Mushala *et al*, (1997) point to high rates of erosion in the highveld occurring in saprolitic soils. Not only is this hazardous for upland rainfed agriculture, but the effects can be seen in high sediment loads in river waters tapped for lowveld irrigation schemes. SSA (2001) raised concern over dam siltation and Eales *et al* (1996) also identifies the sedimentation of rivers and reservoirs. "For example the main water-supply catchment for the greater Manzini area (the industrial hub of the country, with rapidly growing informal settlements) lies in badly degraded communal lands. The combination of steep slopes, erodible granitic soils, overgrazing, and high-intensity rainfall has led to major sedimentation. The silting of dams and reservoirs is, therefore, a serious problem, particularly in the Matsapha-Manzini area".

Ecological change

Aside from the categorical change in ecology from bushveld to monocrop sugarcane, there is little evidence of major secondary damage to the environment in the lowveld arising from the change from natural vegetation to commercial agriculture. However, some secondary ecological change in the lowveld environment is evident. Local moisture and hydrological changes are also observed, for example previously seasonal streams are now supplied with runoff throughout the year resulting in changes in the composition of faunal and floral assemblages dependent upon water (Culverwell, 2001, pers. comm.).

Sustainability - issues for concern

Resonant with the tone and findings of the proceedings by Mazungu (2000) and also of the First National Irrigation Conference of Tanzania (DANIDA, 2001), there are a number of concerns regarding the sustainability of rural water and irrigation projects in Swaziland. These sustainability and performance problems are considered to stem from a variety of reasons as expressed by a number of commentators:

- A lack of funds allocated for O&M, while others stem from problems with inappropriate tariff structures, poor cost recovery, and problems in getting users to pay for the water supplied (Eales *et al*, 1996). Clowes (2001, pers. comm.) also highlighted the difficulty in accessing finance for recurrent costs as compared to capital finance for the establishment of KDDP and LUSIP. He suggested that funded by more direct links to water and irrigation charges.
- The non existence of water laws and water associations; production sites located too far from markets, unavailability of water permits denying farmers water abstraction rights, lack of credit facilities both for capital investment in small scale irrigation development and seasonal inputs (Anon, 2001).
- The lack of success on government-initiated irrigation schemes on SNL has been due to a lack of planning, poor skills and a lack of participation by farmers involved (Terry, 1997b, quoting Mushala 1995).
- Technological choice, discussed above, has important longer-term impacts on farmer-level water management, group-level water management and therefore on system-wide water control. The move towards complete or partial pressurised delivery for farmers on KDDP and LUSIP belie the fact that pressurised delivery systems do require from smallholders more skill and maintenance. A recent evaluation of the only smallholder subsurface drip scheme by SSA has called in to question the sustainability of this method of irrigation under smallholder conditions without management support for the farmers (Magwenzi, 2001, pers. comm.).
- Similarly, there are concerns about the agreements needed to schedule and cycle water between farmers. The mechanisms, source and degree of support for smallholders, particularly when water is in short supply or when hardware ages, have not yet been fully formulated. It is unlikely that these post-project management issues will be adequately addressed by the donor agencies or by private irrigation contractors or by the SSA which does not have and will not have the requisite irrigation management function. It is the view of SSA that this is an urgent matter needing attention at the national level (Clowes, 2001, pers. comm.).
- Lack of government realisation, policies, or actions regarding the need for water-supply education and training focused on rural women, even though women's community ties are strongest and their benefits from improved water-supply schemes would be the most significant. (Eales *et al*, ibid).
- A lack of feeling of community on the outside funded and constructed smallholder schemes (as evidenced by difficulties at VIF, see Terry 1997b, who quotes many other commentaries on the history of VIF). For example, research by the author in 1998 revealed discrepancies between VIF management and farmers in terms of who should maintain and clean tertiary canals. Furthermore, splits in membership of VIF reveal underlying institutional problems, some of which were related to establishment of the long-term leasing system for cultivating land at

VIF. In addition, a sense of community and ownership seemed to be undermined by the absence of a reticulated domestic and potable water supply at VIF, mentioned by most farmers interviewed as being one of their main problems (Lankford, 1998a).

These problems associated with small-scale irrigation, including those at VIF, were also found by Carr over 15 years ago (1987b) in his analysis of the sector in Swaziland. It appears that the generic delivery and support problems that are faced by countries with small-scale irrigation sectors also apply in Swaziland. However, as a corollary to this one should perhaps recognise the relevant support infrastructure that can be found in Swaziland from the SSA (and various donor agencies) as they prepare to face the formally established and large-scale smallholder schemes with considerable in-house and locally-derived expertise. The problem here is that these alternative routes to smallholder settlement are not without risks. For example, the kinds of social conflict seen on VIF during the eighties and early nineties could be repeated if the conditions and agreements of settlement are not resolved in ways which promote their sustainability. The decision mechanism for who gets land on the KDDP may be at the King's discretion, assisted by local chiefs and dictated by the availability of good soils (one reason the area was dropped from 7400 ha to 6000 ha was to ensure equitable access to deeper soils. Clowes, 2001, pers. comm.). While there is perhaps sufficient respect for royal decision-making for this mechanism to function, other options for greater public consultation were initially at least ignored (English, 2001, pers. comm.). At the heart of some these issues appears to be the question of land tenure, and the mechanisms for legally transferring, selling and dividing land between owners. The contentious issue of land tenure and its close association with the political structures within Swaziland is too large a topic for this paper (e.g. see Chapter 5 of McDermott, 1995 or Levin, 1988) but it is inevitably wrapped up with the formulation of settlement mechanisms.

Expansion of irrigation in the future

Already part way through planning and construction are the two major smallholder projects of LUSIP and KDDP. Next in line for a gradual expansion appears to be the Ngwempisi Reclamation Project (the full command area is estimated to be approximately 9000 ha) for funding by Taiwan, which has committed itself to a pilot project of 160 ha (ICDF, 2001). Planners in Swaziland have continued to identify potential sites as the following list shows, taken from the Swaziland National Development Plan, 1995:

- *"along the Black and White Mbuluzi Rivers in the Lowveld east of Vuvulane and along the Nkhalashane River in the Lubombo region north of the Mbuluzi;*
- *in the lower Mtilane basin and the lower Little Usuthu basin;*

- *in the Mkhondvo basin in the middle reaches of the Mkhondvo River and along the Ndlotane River;*
- *the lower Great Usuthu basin (potentially the largest area of irrigable land) particularly in the Mabopheni area;*
- *south of the Ngwavuma River in the eastern Lowveld region (having the largest tracts of good to excellent soils) and also in the vicinity of the Ngwavuma's confluence with the Nsongweni River and upstream from its confluence with the Mantambe River."*

With regard to the last one, planners working for the Lubombo Spatial Development Initiative have proposed further expansion of the lowveld's premier crop under the 'Ngwavuma Sugar Project'. "This project has the potential for irrigated farming of sugar cane (predominantly) in Swaziland and South Africa for delivery of cane to a [fourth] mill located strategically in Swaziland at Nsoko." (LSDI, 2001, see also ACP-EU, 1999). This would require the development of water storage or transfer from the Usuthu given the insecurity of flow of this river (NPDP, 1995).

It is unlikely that all of these will be fully developed mainly because of shortages of water, costs associated with adding further water storage (a conclusion echoed by Terry, 1997b), availability of sugar quotas for farmers, and as Atkins and Terry (1995) imply, constraints on milling capacity (page 245). Although it is difficult to guess the future growth of irrigated land, this author estimates that by 2020 there will be approximately 65-70 000 ha of irrigation in Swaziland. The majority of this will be probably be 'large-scale' (> 1000 ha) smallholder schemes developed by international agencies.

Lastly, one should perhaps not underestimate the profitability of vegetable production (re: Funnell, 1986) for urban markets utilising the relatively untapped potential of groundwater. Only the more appropriate sites will be used, and because of the cost of establishment, this option is only open to certain kinds of private growers. Cumulatively, it is likely that this sector will grow by no more than 1000 ha in the next 10 years.

Key issues to be addressed in future smallholder schemes

Before concluding it is appropriate to summarise the key issues that need to be addressed to improve the viability of smallholder irrigation. Three subject areas are highlighted here as priorities:

Technology selection and design for management

Critical to long term sustainability and ability to share and manage water will be the correct choice of irrigation technology, and the ability to evolve that technology in response to individual, irrigation system, strategic and water resource needs. Of particular concern is the proposed use of piped systems for smallholder irrigation despite the fact that even the well-resourced commercial schemes have had difficulties with water management, operation and maintenance costs associated with this choice of technology. A critical observer would argue that the cost saving advantages of establishing piped systems negating the need to grade and lay canal networks is probably driving such decisions. However, cautiously questioning the use of pressurised technology is not for the faint-hearted; many irrigators, engineers and policy-makers see this as the natural route to modern and efficient water management.

Institutional support for small holder irrigation

This analysis shows (a viewpoint supported by SSA (Magwenzi, 2001, pers. comm.)), that there is a need for a single institution to oversee support for smallholder farmers. It is surprising given the predicted increase in irrigation expansion that such an authority has not been established. Without such rationalisation, support is likely to be insufficient and fragmented amongst the SSA, estates, donor agencies and the small irrigation unit in the Ministry of Agriculture, leading to real risks of flaws in system design, construction, institutional development and management. The question should be posed - would not an expanded SSA be best placed to co-ordinate such responsibilities?

Economic analysis of irrigation schemes

Central to the analysis of short and long term viability of smallholder irrigation is the appropriate economic evaluation of different models of production and support. As the SSA points out (Magwenzi, 2001, pers. comm.):

> *"There is a need to formulate a comprehensive economic model that can assess the economics of irrigation with capacity to do what-if analyses including the effect of markets, milling capacity and similar strategic variables. This would help to ensure that the viability of schemes and in particular assessing costs and benefits of new technology before committing large sums of money."*

Conclusion

This paper has argued that unlike other countries in Sub-Saharan Africa, Swaziland does not have an extensive traditional smallholder irrigation sector. Rather, either the commercial sugar estates dominate irrigation or the smallholder sector is relatively formalised, having been established via high-profile settlement schemes. VIF and forthcoming Lower Usuthu and Maguga Dam projects are a good example of these. This lack of broad smallholder constituency provides the Government of

Swaziland with a problem; the lack of access to irrigation by the majority of farmers, and simultaneously a dilemma. Should Swaziland be encouraging small-scale irrigation projects for the rural poor, either through Government funding or outside development aid, with attendant risks of delivery and low performance, or should it continue to delegate formal smallholder settlement to the mechanisms and processes associated with the sugar industry? The former model may provide solutions for the poorest of rainfed farmers and the latter model tends to settle few numbers of farmers each with a plot of land large enough to support a family. Pressure to achieve expansion is high, stemming from Government and the Sugar Industry; so some form of balance should possible. Perhaps the solutions lie in a range of options; to use the skills base, research, support services and economic rewards of the sugar industry to support smallholder irrigation; and yet also to consider tenure market arrangements that create micro-irrigation plots within lowveld schemes to allow a larger numbers of settlers. Each plot might be sized to provide for a reduced but core income within a diversified rural livelihood portfolio. Conditions are ripe; the sugar industry has already achieved some track record in community irrigation; and is willing to see more in 'new area' development.

In a sense, the Government of Swaziland has already embraced these principles in their sanction of LUSIP, the objective of which is:

> *"Increase of agricultural productivity through irrigation on SNL in order to raise smallholder incomes by integrating the productive smallholder agriculture into the existing dynamic commercial market-oriented environment."* (LUSIP, 2001)

LUSIP has identified the special conditions applicable here:

> *"Two things make this project different from many irrigation projects:*
> - *highly developed private sector in the project area that is able to handle input supply, marketing and processing*
> - *presently successful smallholder irrigation already taking place, and acting as a visible demonstration of the income benefits that result from its adoption.*
>
> *The challenge of LUSIP is to replicate the already existing successful smallholder irrigation schemes*
> - *on a much larger scale and*
> - *with a wider range of crops than just sugar".* (LUSIP, Resumé, 2001)

However, these challenges also contain many other attendant issues related to smallholder performance and sustainability. Some of these have been mentioned in this paper, and are paralleled elsewhere in Sub-Saharan Africa. Concerns such as allocation of land; environmental impacts; erosion of community participation; inclusion of women; technology choice; poor cost recovery and sporadic government response to other specific problems that arise such as conflict management and maintenance of systems. The solutions to these problems are not forthcoming, particularly when Government resources to do so are so constrained. Given the momentum for sugar industry-supported smallholder irrigation in the lowveld, one cannot dismiss the economies gained if this remains the main route for the Government to provide for sustainable expansion of smallholder irrigation. This begs the question as to whether and how this support system could be altered to improve this delivery, particularly as "this support is bound to show signs of strain as the number of Schedule D growers expands" (Terry 1997b). Deciding the format of a viable institutional support framework remains critical to the water management, technology, economic and social factors that help encourage and steer smallholder irrigation towards success. Further, this support would not only benefit sugarcane grown on smallholder plots, but also, importantly, food and fibre crops for the domestic market.

One should not finish without mentioning that a second route also exists for irrigation expansion; that of private vegetable production using groundwater – which may increasingly be within the reach of farmers, and be found outside of the gravity, networked small-scale systems. The scale of expansion may not be great, amounting to no more than several hundred hectares in the next 5 years – but its role in helping to meet urban food security might be vital. Commentators suggest GoS has largely ignored this sector (e.g. see Funnell, 1986). However, as long as the economically viable producer-to-urban market conditions sustains such production GoS intervention may not be necessary, enabling the Government to concentrate its efforts in more cost-effective co-ordination and regulatory activities elsewhere.

A key question remains: how might the Government and sugar industry extend the benefits of irrigation to a wider populace in a more equitable and transparent manner, in a way that recognises the risks of sugar price fluctuations and related terms of trade, and a relatively narrow domestic food production base that sugar expansion subtracts from? The answer appears to be not in delivering projects itself, but in formulating and regulating agricultural and water development occurring in the lowveld. Perhaps the nexus of these issues lies in the wider access of householders to a partial (but vital) livelihood gain from irrigated micro-plots together with an appropriate land tenure system and co-ordinate support mechanisms.

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