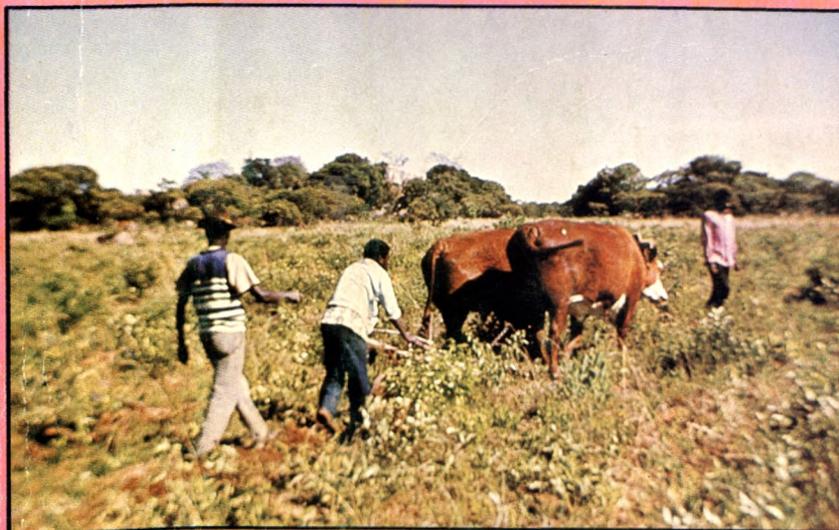


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# HOUSEHOLD AND NATIONAL FOOD SECURITY IN SOUTHERN AFRICA

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Edited by  
Godfrey D. Mudimu & Richard H. Bernsten  
*University of Zimbabwe UZ/MSU Food Research in Southern Africa*

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# IRRIGATION RESEARCH PRIORITIES FOR SOUTHERN AFRICA

Mandivamba Rukuni<sup>1</sup>

## INTRODUCTION

Irrigation is a major force in world agricultural development. For instance, 20% of the world's agricultural land is irrigated and it produces 40% of the world's agricultural output (Kouda, 1977). India, China, Mexico, Sudan, Egypt, and many other countries are using irrigation as the engine of agricultural production and production stability. The World Bank, the Food and Agriculture Organization (FAO), and many other international organisations regard irrigation as an important means of increasing food and agricultural production. But so far, SADCC states have been slow in developing irrigation. For example, Southern Africa has an estimated 2% of its cropped land under irrigation--compared with 5% in Sub-Saharan Africa and 35% in India. SADCC's Food Security Programme has launched Project Number 12 to improve irrigation management and development in the region; but the knowledge base on the technical, social, economic, and environmental issues surrounding irrigation in Southern Africa is woefully inadequate. For each type of system, Project 12 needs updated records of areas, crops grown, yields, and irrigation potential.

This paper primarily calls for expanded applied research on irrigation and food security in the SADCC region. If irrigation is to play an increasing role in family and national food security, then research has to indicate what needs to be done to facilitate cost-effective irrigation development.

## OVERVIEW OF IRRIGATION IN SADCC STATES

Before I turn to an overview of irrigation in individual SADCC countries, I would like to draw attention to a recent FAO (1986) study of irrigation in Africa. The study reviewed food production in eight countries: Senegal, Burkina Faso, Niger, Mauritania, Mali, Somalia, Botswana, and Kenya; and reported that irrigation is an essential element of future food production in both the short and medium term. The study concluded that in the remaining countries on the continent, at least one-half have some of their land in drought-risk zones where small scale irrigation based mainly on small dams and groundwater could do much to reduce rural hardship and the need for costly disaster relief.

I would now like to turn to irrigation in the SADCC region and begin by commenting on the difficulty in determining how much land is potentially available for irrigation.

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**Botswana**

Botswana currently has an estimated 1,500 ha under irrigation while the World Bank (Olivares, 1987) estimates the national potential at around 57,000 ha. But the FAO (1986) has estimated that Botswana has a potential of 100,000 ha that can be brought under irrigation--a figure that is 94% higher than the World Bank's estimate. The FAO estimates are based mainly on water availability, but when other factors are taken into consideration such as suitable soils, present and potential technologies, and the cost of developing irrigation, the irrigation potential falls sharply.

Howard Sigwele (1989) has noted the difficulty in measuring irrigation potential in the Okavango Delta, one of two large sources of surface water in Botswana. The Okavango River enters Botswana from Angola in the north-west and flows into the Okavango Delta, a 1 million ha terminal swamp/floodplain. The Okavango Delta is rich in wildlife, but the soils are of unknown cropping quality. Both agricultural and environmental concerns are of strategic importance in deciding on what public action to take on this potential 1 million ha scheme.

Mali's experience with a similar scheme is instructive. In 1929, the French proposed to develop a 1 million ha irrigation scheme. Although they had predetermined that cotton was the most profitable crop, because of unforeseen soil problems, rice turned out to be a more profitable crop. Nevertheless, the scheme has failed to attract settlers and after 60 years, only 40,000 ha are under irrigation.

**Zambia**

Zambia has a large potential for both rainfed and irrigated production. The government and commercial farmers feel that part of the answer to recurring drought lies in irrigation. An estimated 6,000 ha are under irrigation in Zambia, compared with the World Bank's (1987) estimate of 423,000 ha and the FAO's (1986) estimates of 3.5 million ha of irrigation potential. A large number of irrigation projects are in various stages of preparation, but detailed plans for development have not been drawn up. Action-oriented research on soil and water relationships is needed to further project-level planning.

Recently attention has been focused on the "draw-down" areas of Lake Kariba and the need to improve the livelihood of about 36,000 people who were displaced when the dam was constructed at Kariba. Rainfall is unreliable in the Kariba Basin and people regularly run short of food. Policy guidelines for smallholder irrigation surrounding Lake Kariba include the use of simple irrigation methods, usually matched with low capital costs. Self-help by the local population is encouraged in allocating public funds.

**Malawi**

Malawi has an estimated 20,000 ha of developed irrigation, of which about 80% is large-scale private and estate schemes, 15% government, and 5% self-help (Hunting Technical Services, 1981). Between 1968 and 1979, an estimated 3,200 ha was developed for irrigated rice by smallholder farmers in 16 schemes around Lake Malawi, Lake Chirwa, the Phalombe Plain, and the Shire Valley (Makato, 1984). These self-help schemes were characterized by Stoutjesdirk (1984) as farmer-initiated

diversion schemes to supplement dry season production. Summer rice, vegetables, and pulses are grown during dry spells and the vegetables are consumed locally. The impact of such schemes on nutrition and household food security is still to be quantified.

### **Tanzania**

Tanzania is probably the only SADCC country where traditional irrigation was practiced in pre-colonial days (Hekstra, 1983) on the lower slopes of Mount Kilimanjaro, the Kilombero Valley, Sukumaland, and Tukuya. Large-scale schemes were initiated by the government in the 1950s at Kalenga, Mlali, Kitivo, Ikona Utengule, and Uru-Chivi. The government subsequently stopped constructing these schemes because of their poor performance. In 1974, the government adopted a policy of investing in schemes for smallholders.

The FAO (1986) recently estimated that there are 140,000 ha of irrigation in Tanzania, which represent about 6% of potential and about 3% of total cultivated area (Mgonja, 1983). About 80% of all irrigation is farmed by smallholders (Mrema, 1984) and/or small groups commanding areas rarely exceeding 5 ha. These schemes use water from rivers, springs, and flood plains.

### **Zimbabwe**

Zimbabwe has an estimated 150,000 ha under irrigation, 30% of the estimated potential of 500,000 ha. Virtually all wheat and sugarcane, about 70% of all coffee and tea, and 45% of cotton are grown under irrigation. Sizeable areas of citrus, other fruit, maize, and soyabeans are also grown under large-scale private irrigation.

A World Bank (1987) study concludes that small projects are generally more profitable, because they contribute more to the permanent employment of rural people. Zimbabwe, for instance, has a backlog of identified schemes where water and soil potential has been surveyed for smallholder development. Yet, development has been slow because of a variety of policy reasons, some common in other SADCC countries as we shall discuss later.

## **POLICY ISSUES**

### **The Development of irrigation potential**

SADCC states have exploited a small amount of the existing potential (Table 1). Water is probably the most limiting factor on irrigation development. Most SADCC states have not assessed the soil potential adequately and the extent to which soils curtail water potential is largely unknown. The costs of irrigation development are rising and now range from US\$4,000 to US\$8,000 per ha (Table 2). Despite the increasing cost of development, irrigation can still achieve over 10% economic return to investment (Table 3).

### **Type of systems**

With the exception of Tanzania, most of the irrigated area in SADCC is in large-scale, private schemes. Smallholders farm a small portion of the total land under

**Table 1. Current irrigated area and potential of nine SADCC states.**

Country	Current irrigated area ('000 ha)	FAO estimate of irrigation potential ('000 ha)	Potential developed (%)	World Bank's estimate of potential ('000 ha)
Angola	10	6,700	< 1	na
Botswana	12	100	12	57
Lesotho	1	8	13	na
Malawi	20	290	7	na
Mozambique	70	2,400	3	na
Swaziland	60	7	< 1	na
Tanzania	140	2,300	6	na
Zambia	16	3,500	< 1	523
Zimbabwe	130	280	46	460

na indicates no estimate available.

Sources: FAO (1986); Olivares (1987).

**Table 2. Cost per hectare<sup>a</sup> of irrigation development in selected SADCC countries, 1985.**

	Botswana US\$/ha	Zambia US\$/ha	Zimbabwe US\$/ha
All projects analysed	5,886	2,032	9,460
Projects with <sup>b</sup> :			
IRR > 20%	916	1,840	3,957
IRR 10% - 20%	4,869	2,640	9,908
IRR < 10%	11,964	8,808	9,483
Area analysed (10 <sup>3</sup> ha)	35	13	63
Percent of potential	60	3	14

<sup>a</sup>Exchange rates per US\$ are Pu 2; Zk 11 and Z\$1.59.

<sup>b</sup>IRR = internal rate of return.

Source: Olivares (1987)

irrigation. Much of the smallholder irrigation was developed in arid areas during colonial periods. More recent developments concentrate on large schemes.

Smallholder schemes tend to grow a wider range of food crops, including cereals and vegetables. Women are more involved in smallholder irrigation than large-scale schemes. Siakantu (1988) reports that, following the rehabilitation of smallholder irrigation in a dry zone in Zambia, women made up 44% of farmers irrigating small plots of 0.1 to 0.2 ha. A similar trend was recorded in Zimbabwe where women are more actively involved in "comma-hectare" schemes, tilling 0.1 to 0.3 ha of irrigated vegetables (Rukuni, 1984).

**Table 3. Profitability of irrigation in selected SADCC countries.**

Internal rate of return (IRR)	Botswana	Zambia	Zimbabwe
20% or greater			
% of projects	27	65	40
% of irrigable area	15	89	7
10% to 20%:			
% of projects	15	13	33
% of irrigable area	54	10	89
Less than 10%:			
% of projects	58	22	27
% of irrigable area	31	1	4

Source: Olivares (1987)

A recent World Bank (1987) study of irrigation concludes that small-scale schemes in Africa have higher economic returns than large-scale schemes and generate more employment per hectare than large schemes. But both SADCC governments and donors have great difficulty in conceptualizing, designing, and implementing schemes that benefit a large number of small farmers. Research is urgently needed on the technical, economic, social, and environmental impacts of proposed small, medium, and large schemes.

#### **Complementarity of rainfed and irrigated agriculture**

The traditional view of irrigation as a separate farming system is compatible with large-scale but not small-scale, irrigation. The literature shows that smallholder (small-scale) irrigation is often more profitable when it is integrated with rainfed farming. Conflict and/or competition, especially for family labour, usually leads to poor returns from irrigation. Small farmers tend to plan and use rainfed and irrigated land conjointly, as a total production system, using common family resources to achieve common objectives. Food availability for the family, day in day out, is usually the top family priority.

The issues of complementarity and conflict have not been well addressed by researchers in Africa. For example, few studies of smallholder irrigation generate information on both rainfed and irrigated production. Both issues can be addressed at the national, as well as the household levels, through properly designed research studies.

SADCC states should take the lead in studying and debating the proper role of irrigation in agricultural and national development plans. Many of the current debates on irrigation in the SADCC region are unencumbered by facts and figures. For example, we know that the cost of irrigation per hectare is several times higher in Africa than in Asia. But to date, economists have proposed few concrete ideas on how to drive down the cost of bringing land under irrigation in Africa. For arid countries such as Botswana, and arid parts of SADCC states, the question is more

pressing since there are no foreseeable promises of rainfed technologies that will raise family incomes and food production.

### Farmer and government institutions

Commentators from inside and outside SADCC identify weak irrigation institutions as a major obstacle to further development. The common situation at the national level is the absence of a central authority responsible for planning and executing further development. The tasks are usually split between separate ministries of water and agriculture. And within those ministries, irrigation is usually located in the departments with primary responsibility to another agency, such as extension and water supply. These sections are often poorly staffed; SADCC states are acutely short of people with the technical, professional, and managerial skills required to make irrigation successful. One university in SADCC has recently started training agricultural engineers. Botswana, with ambitious plans for irrigation development, has only one trained national with post-graduate training in irrigation.

If smallholder farmers were to improve their technical and managerial skills, then the pay-off to irrigation investment would rise substantially. Most of the literature already cited concludes that, after switching from rainfed to irrigated farming, it takes a long time, maybe a whole generation, for farmers to adjust to new work routines, increased risk, and technical requirements. Presently, there is almost no on-going research on the sociological and managerial issues in farmer irrigation associations. There is a need for several universities in the SADCC region to set up multi-disciplinary research groups to bring together national researchers to carry out research on the tough institutional problems surrounding smallholder irrigation.

### Micro-irrigation

Irrigated gardening, or what is commonly known as micro-irrigation, is a promising but uncharted type of irrigation. (Lambert and Hotchkiss, 1987). The use of shallow groundwater represents a widespread form of irrigation by small farmers. These treeless wetlands are also termed *dambo* in Zambia and Malawi, and *vlei* or *bani* in Zimbabwe. Dambos usually have dark soils and are found at headwaters of river systems and also in alluvial river beds.<sup>2</sup> Alluvium extends over several million hectares. Alluvial aquifers recharge on a continuous basis, even when no rain occurs. Work in Botswana shows that even when no surface flow occurs, the aquifer is largely recharged (Nord, 1985)

Watermeyer (1987) describes Zimbabwe's experiences with water abstraction from sands. Typical of most of Africa, environmental degradation has led to siltation of rivers and dams. But river sands are capable of holding up to 40% of their volume in water. Such water is being used for irrigation in drier parts of Zimbabwe. To be able to abstract the water, a rock bar is used to impede the slow but steady movement of water held in the sand. Watermeyer concludes that it is regrettable

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<sup>2</sup>In Zimbabwe, *dambos* cover an estimated 1.28 million ha, with more than a quarter of a million hectares in communal areas (Whitlow, 1984).

that this great water potential is not being exploited. After all, the loss of such water through evaporation is minimal.

The main attraction of micro-irrigation is that the water source can be sited in or near the irrigated plot. This obviates the need for expensive pumping, and legal problems of obtaining water rights. But the development of micro-irrigation is still fraught with problems. Since the 1930s, farmers in Zimbabwe have been forbidden by law to cultivate *dambos* because of fear of soil erosion and depletion of water tables which maintain river flows in dry seasons. Farmers were encouraged to graze these areas. This conventional wisdom has been challenged over the decades with research results showing that crop cultivation can be carried out safely on these *dambos* and, in fact, that grazing may pose a greater risk (Rattray *et al.*, 1953; Thiessen, 1972). Current research by the Faculty of Engineering, University of Zimbabwe (in collaboration with Loughborough University) indicates that the threat from crop cultivation has been overstated and with proper safeguards, the exploitation of *dambos* for micro-irrigation is compatible with good environmental management.

The lack of energy sources for pumping is another problem. There is a limit for hand-pumping and there are no existing pumping technologies suitable for such small-scale irrigation in SADCC states. The Department of Civil Engineering, University of Zimbabwe, is working on an animal-driven pump which can produce two to three litres per second which is adequate to irrigate up to two hectares. It will take time to develop a prototype that can be mass-produced or made available to smallholder farmers at affordable prices.

## NEED RESEARCH IN SADCC STATES

The inventory of needed research on irrigation is considerable. Research is needed on surface water potential, soil analysis, potential for shallow groundwater-based micro-irrigation, pumping techniques, water-use efficiency, and the effectiveness of government and farmer institutions. I would like to propose a general conceptual framework to assist SADCC states identify priorities for research and development. SADCC nations need to analyze the appropriate role of irrigation in enhancing national and family food security. The key question is: what are cost-effective irrigation systems to complement rainfed food production? And, given the irrigation potential, what are the options and priorities in developing irrigation to fulfil national and household food security goals in SADCC States? These questions have to be addressed at national as well as family levels.

### Irrigation and national food security

Although irrigation is a permanent feature of the strategic plans of all SADCC countries, most countries have great difficulty in drawing up policies and investment guidelines. Answers to some of these questions can be found by examining the experience of existing schemes. But recent World Bank and FAO studies in Africa have shown that returns to rehabilitating poorly designed schemes are not necessarily higher than new investments. So research has to focus on the economics of

rehabilitating existing schemes and the cost of opening new schemes. I consider this research to be of top priority for countries with arid zones and smallholder farmers.

Since governments are still the main facilitators of smallholder irrigation, the analysis will largely be within the realm of public investment appraisal. Irrigation for food security is therefore not a simple question of investment to make financial profits, but a hard question of determining whether irrigation schemes are more cost-effective for famine relief than, say, food for work and other food transfer programmes.

### **Household food security**

To understand how families secure their food needs, research has to focus on the rural household as a production and consumption system. In some schemes, researchers should examine how the household uses both rainfed and irrigated lands. But the analysis has to go beyond local activities and examine regional and international market potential. For example, what are the opportunities for horticultural and other high-value crops for regional and international markets? A better understanding of irrigation for casual work, food for work and other employment opportunities should shed light on the food security impact of irrigation schemes on surrounding areas.

At the rural household level, there is also a need to analyze the productivity of inputs, crop diversification, and the cultivation of high-value crops. Parallel to production analysis is a need to study consumption patterns and the nutritional status of irrigators and nonirrigators to understand family strategies for coping with food insecurity, including the sale of family labour in off-farm employment.

Researchers should also try and understand the impact of irrigation on the rural economy. By studying the market relationships between irrigation schemes and surrounding areas, we may understand the multiplier effects of irrigation.

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