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Policy options for irrigated food production in Southern Africa

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Southern African states irrigate about two per cent of their cropped area and they believe further irrigation development will enhance the food security of the region. This article reviews the levels of irrigation development in Botswana, Malawi, Tanzania, Zambia and Zimbabwe. The policy debate issues include an assessment of the potential for further irrigation development, large- and small-scale systems, complementarity and competition between irrigated and rain-fed agriculture, the weak farmer and government institutions, as well as official recognition of the importance of micro-scale irrigation. All SADC states have a limited number of people trained and experienced in the various fields of irrigation. It was found that there is little on-going research, though the need for it is growing, on the economics of irrigated food production to national and household levels, the possibilities of intensifying and diversifying agriculture into high-value crops and the effectiveness of irrigation as a catalyst for non-farm jobs in rural areas.

Irrigation is now a major force in world agricultural development. For instance, although only 20 per cent of the world's agricultural land is irrigated, this produces 40 per cent of the world's agricultural output (Kovda, 1977). India, China, Mexico, Sudan, Egypt and many other countries are using irrigation as the engine for agricultural production. Moreover, the World Bank, the Food and Agriculture Organization (FAO) and other international organizations regard irrigation as an important means of increasing food and agricultural production. So far, Southern African Development Community (SADC) states have been slow in developing irrigation. SADC irrigates only an estimated two per cent of its cropped area whereas sub-Saharan Africa irrigates five per cent and India 35 per cent. Even though SADC's Food Security Programme has launched project number 12 to improve irrigation management and development in the region, the knowledge necessary for solving the technical, social, economic and environmental problems surrounding irrigation in Southern Africa is woefully inadequate. To be successful, project number 12 needs updated records of areas currently under irrigation, the various types of systems, and the specific crops, yields, potential, problems and so on.

This article calls primarily for expanded applied research on irrigation and food security in the SADC region. If irrigation is to increase family and national food security, then research has to discover what needs to be done to facilitate cost-effective irrigation development.

Overview of irrigation in five SADC states: Botswana, Malawi, Tanzania, Zambia and Zimbabwe

With the exception of Zambia, few areas within the SADC countries receive rainfall amounts in excess of 1 500 mm — a minimum required for intensive cropping. Large parts of the region receive insufficient rainfall for settled agriculture. Botswana, on one extreme, is so arid that even in a good season, the country produces only about half its cereal requirements. The problem of aridity is worsened by the fact that, as total rainfall decreases, the distribution of the rainfall also deteriorates. Climatologists now estimate that droughts are a permanent feature of arid and semi-arid Africa, which includes almost all of SADC. Those areas receiving an average of 400 to 600 mm of rainfall per year can expect six droughts of two years or more in every 50 years (Harrison, 1987).

Drought is not the only reason why SADC countries are interested in irrigation. Irrigation is also perceived as having the potential for intensifying production as well as diversifying into high-value horticultural crops. However, countries are at different levels of irrigation development, with areas developed varying from about 2 000 hectares in Botswana to about 150 000 hectares in Zimbabwe (Table 1). The rest of this section will review current levels of development in the five SADC states, some differences in the potential for future development, and constraints on future development.

Botswana, after almost eight years of continuous drought in the 1980s, suggested plans to develop more irrigation. Of the existing 200 hectares under irrigation, about three-quarters are on large, privately-owned farms, located mainly in the north-eastern Limpopo Basin. About 100 hectares of this area is under intensive vegetable production. Since Botswana imports 80–90 per cent of vegetable requirements from South Africa, the market potential exists for expanding this area (Wiles, 1984).

In addition to officially recognized types of irrigation, about 2 000–3 000 hectares are under flood irrigation cultivation in the Okavango Delta and Chobe District (Sigwele, 1988). About 4 000 families rely on this type of agriculture.

In spite of Botswana's desire to increase the area under irrigation, water and soil potential is limiting. According to Sigwele, Botswana has the potential for about 33 000 hectares, where both soil and water are available and suitable. Further feasibility studies are underway in the Okavango Delta and Chobe enclave. These areas are difficult to assess because they have a fragile wildlife and riverine ecosystem.

Malawi has an estimated 20 000 hectares of developed irrigation, of which about 80 per cent is large-scale private and estate schemes, 15 per cent government and 5 per cent self-help (Hunting Technical Services, 1981). Between 1968 and 1979, 16 schemes covering an estimated 3 200 hectares were

Table 1: Current irrigated area and potential of nine SADC states

Country	Current irrigated area (000ha)	FAO estimate of irrigation potential (000 ha)	Potential development (per cent)	World Bank's estimate of potential (000 ha)
Angola	10	6 700	less than 1	—
Botswana	12	100	12	57
Lesotho	1	8	13	—
Malawi	20	290	7	—
Mozambique	79	24 000	3	—
Swaziland	60	7	less than 100	—
Tanzania	140	2 300	6	—
Zambia	16	3 500	less than 1	523
Zimbabwe	130	280	46	460

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

developed for smallholder farmers to produce irrigated rice. The schemes are spread around Lake Malawi, Lake Chirwa, Phalombe Plain and Shire Valley (Nakato, 1984). These are self-help schemes, diverting water from the rivers to supplement dry-season production. Summer rice, vegetables and pulses are grown during dry spells. Vegetables are consumed locally. The impact of such schemes on nutrition and household food security is still to be quantified.

Tanzania is probably the only SADC country where traditional irrigation was practised significantly in pre-colonial days (Hekstra, 1983). This was done on the lower slopes of Mount Kilimanjaro, in the Kilombero Valley, and in Sukumaland and Tukuya. The development of large-scale irrigation was initiated by the government in the 1950s with schemes such as Kalenga, Mlali, Kitivo, Ikona Utengule and Uru-Chivi. The government subsequently stopped constructing these schemes because of their poor results, and has, since 1974, invested mainly in smallholder schemes.

In 1986 FAO estimated that 140 000 hectares were under irrigation in Tanzania. This represents about six per cent of the estimated potential and about three per cent of the total cultivated area. About 80 per cent of all irrigated land is farmed by smallholders and small groups commanding areas rarely exceeding five hectares (Mrema, 1984). These schemes use water from rivers, springs and flood plains.

A number of large and small river basins have the potential for further irrigation development. The Rufiji Basin has the greatest potential of all, for hydroelectrical power as well as for irrigation (Sisila, 1988). The Rufuji Basin comprises the Great Ruaha, Kilombero, and the Luwegu–Luhombero river systems, which altogether have a potential for about 700 000 hectares of irrigation. However, Sisila (1988) cites lack of finance and limited manpower as major bottlenecks to further the development of irrigation. Typical of all SADC countries, Tanzania has no enunciated policy on the development of irrigation.

Zambia has a large potential for both rain-fed and irrigated crop production. The government and commercial farmers feel that part of the answer to recurring drought lies in irrigation. An estimated 6 000 hectares are under irrigation in Zambia. Olavares (1987) estimated that Zambia has the potential for 423 000 hectares. A large number of irrigation projects are in various stages of preparation but detailed plans for their development have not yet been drawn up. Action-oriented research on soil and water relationships is needed to determine future planning.

Recently attention has been on the 'drawn-down' areas of Lake Kariba and the need to improve the livelihood of about 36 000 people who were displaced when the lake was constructed (Siakantu, 1988). Rainfall is unreliable in the Kariba Basin and people run short of food regularly. The government hopes to develop the potential of smallholder irrigation surrounding Lake Kariba by making available simple, inexpensive irrigation methods. The local communities are also encouraged to supply matching funds.

Zimbabwe has an estimated 150 000 hectares under irrigation – the largest irrigated area in SADC. This is 30 per cent of its estimated potential of 500 000 hectares. Virtually all wheat and sugarcane, about 70 per cent of all coffee and tea and 45 per cent of cotton are grown under irrigation on privately-owned farms. These farms also grow large quantities of citrus and other fruits, maize and soyabeans.

Zimbabwe has a backlog of identified schemes where water and soil potential have been surveyed for the development of smallholder irrigation schemes. Unfortunately, development has been slow for a variety of policy reasons, some common in other SADC countries, as discussed later in this article.

Policy issues

The irrigation potential

Estimating irrigation potential has always been a problem in Africa. Governments have always explicitly or implicitly included irrigation in their development plans. There is a general feeling present in the thinking of African governments that irrigation has a role to play in agricultural development. This feeling is also present within the donor community. For instance, FAO estimated that Botswana has a potential of 100 000 hectares – a figure 94 per cent higher than that of Olivares. As discussed earlier, Sigwele (1988) has noted the difficulty of measuring irrigation potential in the Okavango Delta, one of the two large sources of surface water in Botswana.

Water is probably the factor most limiting the development of irrigation in SADC states. Most SADC states have not assessed the soil potential adequately, and the extent to which soils curtail water potential is largely unknown. This lack of information is a serious handicap because, though the costs of irrigation development are rising, well-researched, well-planned projects still pay more than ten per cent return on investment (Table 2).

Type of systems

With the exception of Tanzania, most of the irrigated area in SADC is large-scale, private schemes. Smallholders farm only a small portion of the total land under irrigation, and much of that portion was developed in arid areas during periods of colonial rule. More recent development has also concentrated on large schemes. However, evidence is supporting the view that small-scale irrigation schemes in Africa have higher economic returns than large-scale irrigation schemes. They also generate more employment per hectare, partly because more women are involved in smallholder irrigation than in large-scale irrigation. Siakantu (1988) reports that in Zambia, following the rehabilitation of smallholder irrigation schemes in a dry zone, women made up 44 per cent of farmers irrigating small plots of 0,1 to 0,2 hectares. A similar trend was recorded in Zimbabwe where they till 0,1 to 0,3 hectares of irrigated vegetables (Rukuni, 1984). Smallholder irrigation schemes also grow a wider range of food crops, including cereals and vegetables, both of which are important to the nutrition and food security of households.

In spite of these advantages of smallholder irrigation schemes, however, SADC governments and donors have great difficulty in conceptualizing, designing and implementing irrigation schemes that benefit a large number of small farmers. For this

Table 2: Cost per hectare of irrigation development in selected SADC countries, 1985

	Botswana US$/ha	Zambia US$/ha	Zimbabwe US$/ha
All projects analysed	5 886	2 032	9 460
Projects with:			
IRR 20 per cent or larger	916	1 840	3 957
IRR 10–20 per cent	4 869	2 640	9 908
IRR below 10 per cent	11 964	8 808	9 483
Area analysed (10^3 hectares)	35	13	63
Per cent of potential	60	3	14

Note: IRR = Internal Rate of Return.
Exchange Rates per US$ are Pu 2; Zk 11 and Z$1,59

Source: Olivares (1987)

reason, research is urgently needed on the technical, economic, social and environmental impact of proposed small, medium and large irrigation schemes. In addition, the results should be widely disseminated, particularly to government policy makers.

Complementarity of rain-fed and irrigated agriculture

Small-scale irrigation is often more profitable when it is integrated with rain-fed farming (Rukuni, 1984). Competition between the two, especially for family labour, usually leads to poor returns from irrigation. Smallholder farmers tend to plan and use rain-fed and irrigated land conjointly, as a total system of production using common family resources to achieve common objectives. Food availability for the family, day in, day out, is usually the top family priority. Unfortunately, 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 rain-fed and irrigated production. Both issues can be and should be addressed at the national as well as the household level.

SADC states should take the lead in studying and debating the proper role of irrigation in agricultural and national development. There has been a general lack of facts and figures for arid countries such as Botswana, and for arid parts of other SADC states. The question is pressing since there are no foreseeable rain-fed technologies that will raise family incomes and food production.

Farmer and government institutions

Commentators from inside and outside SADC identify weak irrigation institutions as a major obstacle to the further development of irrigation. A common situation at national level is the absence of a central authority responsible for planning and implementing the further development of irrigation. The tasks are usually split between separate ministries of water and agriculture, and within those ministries, the responsibility for irrigation is usually located in departments such as extension and water supply. In addition, these sections are often poorly staffed. SADC states are acutely short of people with the technical, professional and managerial skills required to make irrigation successful. Only one university in SADC has recently started training agricultural engineers. Botswana, though it has ambitious plans for irrigation development, has only one or two nationals with postgraduate training in irrigation.

If smallholder farmers were to improve their technical and managerial skills, the pay-off to irrigation investment would rise substantially. After switching from rain-fed 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. Unfortunately, little is being done to speed up this adjustment. For instance, almost no research is being carried out on the sociological and managerial issues facing smallholder irrigation associations.

Micro-scale irrigation

One promising but uncharted type of irrigation is gardening irrigation, increasingly being referred to as micro-scale irrigation (Lambert and Hotchkiss, 1987). Micro-scale irrigation generally refers to small gardens, usually growing high-value vegetable crops. These gardens are usually small and found on wetlands, where the water-table is high. Among smallholders, probably its most widespread form is the use of shallow groundwater on treeless wetlands. These wetlands usually have dark soils and are found at the headwaters of river systems and alluvial river beds. Some alluvial aquifers recharge on a continuous basis even when there is no rainfall. Work in Botswana showed that even when no surface flow occured, the aquifer generally recharged (Nord, 1985).

Watermeyer (1987) describes Zimbabwe's experiences with water abstraction from sands as another promising source. In most parts of Africa, environmental degradation has led to the siltation of rivers and dams. These river sands can hold up to 40 per cent of their volume in water, and in some drier parts of Zimbabwe such water is being used for irrigation. To be able to abstract the water a rock bar is used to slow down the movement of water held in the sand. Watermeyer concludes that this great water potential should be exploited, especially since the loss of such water through evaporation is minimal.

The main attraction of micro-scale irrigation is that the water source can be sited in or near the irrigated plot. This makes expensive pumping unnecessary and in some cases there are no legal problems of obtaining water rights. But the development of micro-scale irrigation still faces severe legal limitations. Since the 1930s, farmers in Zimbabwe have been forbidden by law to cultivate wetlands owing to fears 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 (Rattray *et al.*, 1953; Thiessen, 1972), with research results showing that crop cultivation can be carried out safely on these wetlands and, in fact, that grazing may pose a greater risk. Research also indicated that danger from crop cultivation has been overstated (Lambert and Hotchkiss, 1987). With proper safeguards, the exploitation of wetlands for micro-scale irrigation is compatible with good environmental management.

Another problem is that there are no water pumping technologies suitable for such small-scale irrigation in SADC states (Nhando, 1987). Hand- and animal-driven pumps that can produce one to three litres per second would be adequate to irrigate up to two hectares. However, it will take time to develop prototypes that can be mass-produced and made available to smallholders at affordable prices.

An important first goal is to change the old law that restricts the cultivation of wetlands. That alone will help tremendously in the development of micro-scale irrigation.

SADC states' irrigation requirements

The inventory of research needed on irrigation is considerable. Research is needed on the potential of surface water, the potential for shallow groundwater-based micro-scale irrigation, pumping techniques, the efficient use of water, soil characteristics, and the effectiveness of government and farmer institutions. In this section, a general conceptual framework is proposed to help SADC states identify priorities for these.

Nations need to analyse the appropriate role of irrigation to enhance the food security of both the family and the nation. The key questions are: In what way can irrigation be used, in a cost-effective manner, to complement rain-fed food production? Given the irrigation potential, what are the nation's options and priorities in developing irrigation to fulfil that food security goal?

Irrigation and national food security

Although irrigation is a permanent goal of all SADC countries, most countries have great difficulty in drawing up policies and investment guidelines. However, answers to some of these questions can be found by examining experiences with existing schemes. For instance, returns on the rehabilitation of poorly designed schemes may not necessarily be higher than new investments. So research has to focus on both existing schemes and new schemes. The research must be of top priority for those arid zones occupied by smallholders.

Since there are many demands on government funds, and since governments still pay the major costs of developing irrigation for smallholders, the decision to invest or not to invest in irrigation is a difficult one. For instance, will food-for-work or other food transfer programmes relieve famine more effectively and at a lower cost than irrigation schemes? Only research can give answers.

Family 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 rain-fed and irrigated lands. But the analysis has to go beyond local activities and examine regional and international markets. A better understanding of how irrigation creates additional jobs such as casual work, food-for-work and other employment opportunities should shed light on the value of irrigation for food security, local as well as regional.

At the rural household level, there is also a need to analyse the productivity of inputs, and the economic returns from diversifying and cultivating high-value crops. At the same time, to understand family strategies for coping with food insecurity, including use of family labour in off-farm employment, there is a need to study the consumption patterns and the nutritional status of those who irrigate their crops and of those who do not.

Researchers should also try to understand the impact of irrigation on the rural economy. By studying the market relationship between irrigation schemes and surrounding areas, it may be understood to what extent irrigation is a catalyst for non-farm jobs and higher incomes in rural areas.

REFERENCES

FAO 1986 *Irrigation in Africa South of the Sahara* (Rome, Food and Agriculture Organization, Investment Centre Technical Paper No. 5).

Harrison, P. 1987 *The Greening of Africa* (London, Paladin, Grafton Books).

Hekstra, P. 1983 *Prospects for small-scale irrigation development in East Africa: An inventory made in Burundi, Kenya, Malawi, Tanzania and Uganda* (Rome, Food and Agriculture Organization, Land and Water Development Division).

Hunting Technical Service 1981 *National and Shire Irrigation Study* (Blantyre, Ministry of Agriculture and National Resources).

Kovda, V. A. 1977 Arid land irrigation and soils' fertility: Problems of salinity, alkalinity and compaction, in Worthington (ed), *Arid Land Irrigation in Developing Countries).*

Lambert, R.A. and Hotchkiss, P 1987 Shallow groundwater for micro-scale irrigation (Paper presented at the Second Intermediate Seminar on Irrigation Farming in Kenya and Zimbabwe, Juliasdale, Zimbabwe).

Nakato, C. J. A. 1984 Smallholder rice irrigation in Malawi: The role of the farmer in irrigated rice. M.J. Blackie (ed),. *African Small-Holder Irrigation Symposium* (Wallingford, Hydraulic Research Limited).

Mrema, G. C. 1984 Development of smallholder irrigation in Tanzania: Problems and prospects, in M.H. Blackie (ed.) *African Smallholder Irrigation Symposium,* Wallingford, Hydraulics Research Limited.

Nhando, E. W. 1987 Power sources for pumping (Paper presented at the Second Intermediate Seminar on Irrigation Farming in Kenya and Zimbabwe, Juliasdale, Zimbabwe).

Nord, M. 1985 *Sand Rivers of Botswana* (Gaborone, Government Printers).

Olivares, J. 1987 Shallow alluvial aquifers in Zimbabwe and their relevance for irrigation development (Paper presented at the Second Intermediate Seminar on Irrigation Farming in Kenya and Zimbabwe. Juliasdale, Zimbabwe).

Rattray, J. M. 1953 The vlei areas of Southern Rhodesia and their uses. *Rhodesia Agricultural Journal* **50**: 465–85.

Rukuni, M. 1984 An Analysis of Economic and Institutional Factors Affecting Irrigation Development in Communal Lands of Zimbabwe (Harare, Univ. of Zimbabwe, Ph. D. thesis).

Siakantu, J. B. 1988 Experiences of smallholder irrigation schemes at the Lake Shores draw down areas of Lake Kariba in the Gwembe South District (Paper presented at the Workshop on Irrigated Agriculture in Africa, Harare).

Sigwele, H. 1988 Irrigation and food security in Botswana (Paper presented at the Fourth UZ/MSU Conference on Food Security Research in Southern Africa, Harare).

Sisila, S. 1988 The impact of irrigation on food security: Current status and research priorities in Tanzania. (Paper presented at the Fourth UZ/MSU Conference on Food Security Research in Southern Africa, Harare).

Theisen, R.J. An investigation into the declining natural resources problems (Salisbury, unpublished report).

Watermeyer, J.M. 1987 Water use efficiency and development in Zimbabwe. (Paper presented at the Second Intermediate Seminar on Irrigation Farming in Kenya and Zimbabwe, Juliasdale, Zimbabwe).

Wiles, G.C. 1984 Irrigation for small-scale irrigated vegetable production in Botswana in M. J. Blackie (ed.) *African Smallholder Irrigation Symposium* (Wallingford, Hydraulics Research Limited).

Whitlow, R. 1984 A survey of dambos in Zimbabwe. *Zimbabwe Agricultural Journal* **81** No. 4.

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