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IRRIGATED AGRICULTURE IN BOTSWANA

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INTRODUCTION

Botswana's population was estimated at 1,212,000 in 1988 and is growing at around 3.4% per year. About 50% of the population is below the age of 15. The majority of the population live in rural areas. Many able-bodied men and women in both the rural and urban areas are either underemployed or unemployed. At present about 25% of Botswana's labour force (most of whom are in town) are unemployed.

Per capita agricultural production is lagging behind the population growth rate, and employment-generation in the sector is frustratingly low. The hostile physical environment is partly responsible for the poor performance of agriculture. The recent political decision to develop irrigated agriculture is linked to the disappointing performance of rainfed agriculture and the incapability of the livestock subsector, and the mining and manufacturing sectors to generate jobs and raise incomes of rural households.

Botswana's climate is semi-arid. Potential evapotranspiration is invariably higher than precipitation. As a result, available moisture is not always adequate for the development of plants to maturity. Average annual rainfall ranges from 250 mm in the southwest to over 650 mm in the north. Most livestock and arable crop production (including human settlement) is concentrated along the eastern edge of the country, largely due to the relatively better access to water and rainfall distribution. But rainfall reliability ranges from 20% in the south west to over 70% in the north. This rainfall pattern poses serious problems to the overall development of the economy and the agricultural sector. Botswana's rivers, except for the Chobe in the north, are seasonal and they flow between October and April. As a result, water for human consumption, livestock, and irrigated agriculture is obtained from underground sources.

Surface water sources are available only in the Chobe and Okavango areas. For almost all the urban areas, water is obtained from dams. Poor rainfall and water supply are some of the major bottlenecks to agricultural development. Drought is endemic to Botswana's agricultural production system.

The October to April growing season is dominated by high temperature. Average daily temperature ranges from 22°C in July to 33°C in January.

IRRIGATED AGRICULTURE

Over the past few years, the Government of Botswana has initiated studies to determine the area suitable for irrigation. Estimates of irrigation potential based

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on the availability of water and suitability of soil range from 33,211 ha to 255,150 ha. The country's total surface area is about 580,000 square km. The estimated irrigation potential is less than 1% of the country's physical areas. Two irrigation feasibility studies, recently undertaken in the Okavango Delta and Chobe Enclave, are being further analysed to enable the government to formulate cost-effective investment plans. The third potential area for irrigation is on the eastern side of the country in the Limpopo Basin.

The total area under irrigation by commodity is as follows: cereals, 1,560 ha; horticulture, 100 ha and cotton and other crops, 340 ha. About 3,000 people are employed in irrigated cereal production and 500 are employed producing irrigated horticulture crops (Botswana, 1988).

The private/freehold production system dominates irrigated agriculture in Botswana. Smallholders in the communal areas account for an insignificant area (30 ha) and they concentrate on vegetables and green mealies (maize). Cereal crops produced under irrigation are mainly maize, wheat, and sorghum. Freehold farmers also dominate the production of cash crops such as cotton and citrus. About 75% of the total areas under irrigation is on the eastern side of the country along the Limpopo Basin because of the availability of underground water from sand rivers.

Almost all the water for irrigation is obtained from diesel-powered engine boreholes. Few farmers depend on surface water to irrigate their crops. The sprinkler irrigation system is the most popular, but some farmers have started introducing drip irrigation. Unlike established large farmers, smallholders mostly use hand-made canals to water their vegetables.

Yield levels range from as low as 20 mt/ha (tomatoes) under smallholder vegetable production to over 40 mt/ha (tomatoes) in highly commercial systems. In fact, smallholder yields are about one-half of the large-scale ventures. Cereal yields range from 3 mt/ha to over 5 mt/ha, depending on the level of management, variety, water supply, etc.

Because of import controls, most farmers market their produce in the country at prices determined by market forces. Cotton is exported, mainly to South Africa, because of the lack of processing facilities in the country.

CONSTRAINTS ON THE DEVELOPMENT OF IRRIGATION

One of the major obstacles to the development of irrigated agriculture and the agriculture sector is the shortage of surface and underground water. Sizeable amounts of surface water are found in the Chobe and Okavango Delta, but evapotranspiration rates are high. Almost all the rivers are ephemeral. Although underground water continues to provide water for livestock, households, and irrigation, the source is risky because it largely depends on recharging from rain.

Second, predominantly sandy, low-humus and phosphorus-deficient soils are a major constraint on irrigation. The water-holding capacity is low and would require heavy fertilizer investments to sustain productivity. The distribution of irrigable soils is spotty.

Third, the major source of water for irrigation is deep aquifers. In almost all cases, water is drawn through diesel-powered engines because electricity prices are high. For instance, in South Africa farmers pay about 9 thebe per kilowatt, compared with 24 thebe in Botswana.

Given the high tariffs and foreign exchange requirements for the current energy sources available to irrigation farmers, the viability of irrigation is uncertain. It remains to be seen whether the vast coal resources that are also converted to electricity will relieve both consumers and farmers of the escalating energy cost. Surprisingly, electricity consumers at the copper and nickel mine (BCL) in Selebi Phikwe pay 50% less than other non-BCL consumers (World Bank, 1986). Technically, the coal project should make Botswana almost self-sufficient in her energy requirements.

Bio-chemical and mechanical technology to support irrigated agriculture in the country is regrettably lacking. Attention has been paid to rainfed agriculture, since most farmers will remain in this system for decades to come.

The institutionalization of irrigated agriculture in the long run depends on the number and quality of human resources. At present, Botswana has only two local irrigation specialists. Horticultural farmers have expressed concern over the acute shortage of qualified irrigation specialists. Experience elsewhere in the world shows that the success of irrigation partly depends on the number and quality of human resources, including farmers. Generally this takes decades to achieve.

Thus, the lack of physical infrastructure, inputs, and access to profitable markets are serious constraints on the development of irrigated agriculture.

PLANS TO DEVELOP IRRIGATED AGRICULTURE

The government's policy toward the development of irrigation is part of a multipronged development strategy with the following goals:

- o increasing and improving household and national food security;
- o generating employment opportunities for the fast-growing labour supply;
- o reducing dependency on the mining and livestock (cattle) sectors through diversification; and
- o conserving natural resources.

The agricultural sector has performed poorly in helping to achieve household and national food security goals (Appendix 1). There is growing dependency on food imports, including food aid. It is hoped that the development of irrigation will contribute to food security through increasing employment and food production in designated potential areas, including flood recession agriculture.

The government has launched several initiatives to promote irrigated agriculture. The flood recession agriculture practiced in the Okavango Delta is a gradualistic approach, designed to improve water conservation and management techniques. Smallholders normally plant less than 2 ha under flood recession and obtain yields of 1-2 mt/ha if floods are timely and adequate. The government hopes to improve the productivity of smallholders through better water and crop husbandry techniques. Several projects are helping farmers in the region develop improved farm practices.

However, the risks associated with flood recession are still high. Sometimes, only a very small portion of the potential area is flooded.

Second, two feasibility studies in the Okavango Delta and Chobe Enclave have been undertaken to determine the potential for viable irrigated agriculture. The results of the two investigations are being studied in detail in order to formulate cost-effective, long-term investment plans that are environmentally sound. These areas also cover a very sensitive ecology and include a sizeable wildlife population.

Third, a long-term master plan for water development is being developed by Botswana to harness the available water resources to benefit the various sectors of the economy, including irrigated agriculture. Already, 70 dam sites have been identified and plans are underway to tender for dam designs. The dam sites designated for irrigation will be developed after finalising soil and infrastructural supportive systems. Most of the sites are on the eastern side of the country since this is where most rivers are found. Road infrastructure is being developed alongside the water master plan. In addition, a rural electrification programme is underway.

To encourage the development of irrigated agriculture, in 1982 the government introduced a Financial Assistance Policy (FAP), and a capital and labour grant assistance programmes to encourage investors to generate jobs for the economy. Irrigated agriculture is eligible for five-year grants under the scheme. But the failure rate among the small-scale entrepreneurs (ventures up to P20,000) has been very high.

The demand for irrigation personnel is growing, yet Botswana has only two qualified irrigation specialists. Plans are underway to strengthen the Irrigation Unit in the Ministry of Agriculture through training. Farmers will also be trained in irrigation management.

NEEDED RESEARCH

While Botswana is committed to developing irrigated agriculture to complement rainfed agriculture, several policy issues require more analysis at both the micro and macro levels. Failure to do so could cost the country a lot in both political and economic terms. Below is a brief summary of some of the major research needs for the development of technically feasible, cost-effective, socially relevant, and environmentally sound irrigation.[2]

Socioeconomic viability.

Data are needed to determine how to reduce the cost of developing and implementing alternative irrigation systems under field conditions. For large-scale schemes (> 300 ha) in Botswana, investment costs (both capital and recurrent) to irrigate field crops (maize, etc.) under sprinkler systems drawing water from 9 dams

[2]An agricultural sector assessment is currently in progress by the Ministry of Agriculture. The final report will include a discussion of irrigated agriculture.

are P12,296[3]/ha (1987 prices). For small-scale schemes (< 30 ha) using the same irrigation system, the investment costs are a staggering P91,749/ha. Certainly these investment costs are very high. In fact, to develop 50,000 ha under sprinkler irrigation to meet Botswana's annual cereal requirements of around 200,000 mt from large-scale schemes, would cost about P560 million in capital and P55 million in recurrent costs (1987 prices), respectively. In fact, the annual cost of irrigation to meet Botswana's cereal requirements is over three times the cost of the total annual food import bill over the indicated period.

Appendix 2, 3, and 4 display capital and recurrent costs/ha by size of scheme, source of water, irrigation system, and type of crop. Although there is disagreement over these estimated investment costs/ha, the figures indicate that the cost of developing irrigated agriculture in Botswana could be very high. More information needs to be generated for policymakers and planners on what needs to be done to develop cost-effective, but sustainable irrigation development projects. At present, available information is inadequate to determine the economic viability of irrigation under different levels of management, operation, etc. As earlier indicated, the opportunity cost is high, since resources allocated to the development of irrigated agriculture could probably be efficiently used for housing or industrial activities. Such information would assist the government to resolve equally important issues such as what type of crops to produce; who should produce them (*i.e.*, small or large-scale entrepreneurs); what type of irrigation system to use by crop, scale, and source of water. Each of these questions and many others require detailed research for policymakers to formulate long-term investment plans for irrigated agriculture. Further, since several governments aim to be self-sufficient in basic cereals, should the production of crops such as cotton, sunflower, be encouraged under irrigation since they are not cereals? What research and extension services would be required to promote the production of these noncereal crops since, historically, these organizations have been preoccupied with cereal grains under rainfed conditions. In summary, tough questions need to be studied and resolved to enable policymakers to formulate long-term investment plans to determine whether irrigated agriculture can improve food security and cost-effectively create jobs.

Agricultural marketing and pricing policies.

Assuming it is found that irrigated agriculture can be viably developed for different scales of production, more information is required for policymakers on how the marketing of such commodities should be undertaken. In particular, should the private sector continue to purchase produce from farmers and distribute them? What type of commodities should be marketed by the private sector or by parastatal bodies? Presently, most produce is marketed predominantly by the private sector. The Botswana Agricultural Marketing Board, for instance, only serves as a residual buyer. Do policymakers wish to continue such a marketing policy when irrigated agriculture is developed? Such questions require further research. Also related to

[3]1 Pula = about US$0.50

marketing, are what storage policies and strategies should be developed to promote irrigated agriculture?

Policymakers also require information on how the input and output prices for irrigated crops should be determined. Presently producer prices for the basic staples (maize, sorghum) are based on import parity or landed cost. For oil seeds like sunflower and groundnuts without local processing facilities, their prices are largely based on export parity. The government sets only guaranteed minimum producer prices, but the farmers are still free to sell at the market-determined prices. Under irrigated agriculture, does the government wish such a policy to continue? If not, what are the trade-offs? At present, information needed by policymakers to resolve these issues is inadequate. More research is required for in-depth analysis of both marketing and pricing policies to enable long-term but sustainable irrigation projects to be undertaken.

Human resource and technology development

Presently, Botswana has two professional irrigation specialists. Irrigated agriculture requires well-trained researchers, extension staff, social scientists, environmentalists, and farmers. If scarce resources are allocated to human resource development, to what extent would that affect rainfed agriculture and other sectors of the economy? Equally important for Botswana is the lack of a technological resource base to support irrigated agriculture. High-yielding but pest-resistant crop varieties will have to be found. Appropriate irrigation equipment will need developing. Technology development, like training, is long term. As a result, policymakers will require in-depth information to formulate investment plans to develop irrigation, as the opportunity cost of resources for technology and human resource development to institutionalise this production system is also high. Future policies for the development of irrigation would need research on the broader implications of these initiatives to improve both food security and employment creation.

Health and environmental aspects

Quite often the development of irrigated agriculture, although intended to improve the standard of living of the population, causes serious health and environmental problems. Economically important diseases such as malaria and bilharzia, which could adversely affect the productivity of labour, require research for policymakers and planners to minimise potential human suffering. Similarly, the careless use of agro-chemicals such as pesticides and fertilizers could disturb the ecology of the area. Long-term interventions to redress the potential hazards of chemicals on the environment are required.

Other research policy issues, such as fiscal and monetary aspects, require in-depth analysis for policymakers and planners to formulate long-term cost-effective but sustainable irrigation projects.

In summary, there are numerous research topics that require further investigation. Failure to thoroughly address these issues could create serious dislocations in the overall economy.

REFERENCES

Botswana Government. Ministry of Agriculture. 1988. *Agriculture sector assessment.* Gaborone, forthcoming

----------. ----------. 1987. *Import substitution for national development: the case for the agricultural sector.* Gaborone.

----------. ----------. 1986. *Botswana's agricultural policies and food strategy.* Paper presented to the SADCC Agricultural Ministers. Harare, Zimbabwe.

----------. ----------. various years[a]. *Botswana agricultural statistics*, Gaborone.

----------. ----------. various years[b]. *Agricultural statistics: domestic production and area planted.* Gaborone.

----------. Ministry of Finance and Development Planning. 1985. *National development plan 1985-91.* Gaborone

----------. ----------. Central Statistics Office. various years. *Cereal, trade, and population statistics.* Gaborone.

----------. ----------. various years. Department of customs and Excise. *External trade statistics,* Gaborone

----------. Ministry of Mineral Resources and Water Affairs. 1987a. *Limpopo water utilization study.* A consultancy report by MacDonald and Partners, Cambridge, England. Gaborone.

----------. ----------. 1987b. *Southern Okavango integrated water development phase I.* Gaborone

----------. Ministry of Works and Communication, Department of Meterological Services. various years. *Annual rainfall.* Gaborone.

Eicher, C. K. and D. C. Baker. 1982. *Research on agricultural development in Sub-Saharan Africa: A critical survey.* MSU International Development Paper No. 1. Department of Agricultural Economics, Michigan State University, East Lansing, MI.

Lipton, M. 1987. Botswana's agriculture in the light of Asian experience. IDM Public Lecture.

World Bank. 1986. *Public expenditure and development in Botswana.* Washington, D.C.

World Food Programme, Botswana. various years. *Aid imports.* Gaborone.

Appendix 1. Cereal production, area planted, imports, population, and rainfall, Botswans 1978 to 1986.

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Production (mt)[a]	50,000	10,000	46,000	55,000	19,000	15,800	8,400	20,000	22,200	21,300
Area planted (ha)	260,000	80,000	87,000	90,000	204,000	29,000	203,000	11,000	243,000	310,000
Total cereal imports (mt)[b]	79,861	161,938	109,288	79,423	111,020	173,600	171,462	187,200	200,000[f]	220,000[f]
Aid imports (mt)[c]	6,819	11,101	13,462	9,248	4,906	24,278	25,639	46,225	32,110	46,000
Population ('000)[d]	821	859	906	941	976	1,012	1,049	1,088	1,128	1,168[e]
Average annual rainfall (mm)	622	312	513	577	359	340	325	310	329	368

[a]Domestic production covers maize, sorghum, millet, beans/pulses, and wheat. [b]Cereal imports cover maize, sorghum, rice, millet and wheat together with their processed products. [c]Food aid imports excludes noncereal food such as milk power. [d]De facto population projections (medium variant growth rate). [e]National averages. [f]Preliminary estimates, Central Statistics Office for External Trade still processing the data.
Source: Central Statistics Office (various years); World Food Programme, Botswana (various years); Ministry of Agriculture (various years[a]); Department of Meteorological Services (various years).

Appendix 2. Capital and annual costs for large schemes (pula/ha), Botswana, 1987.

Type/Crop	Capital	Annual[a]	Type/crop	Capital	Annual[a]
Large Dam					
Surface irrigation			Drip irrigation		
Field crops	8,087	60	Field Crops	19,736	1,062
Citrus	8,457	66	Citrus	14,245	910
Hand move sprinkler			Centre pivot		
Field crops	11,201	1,095	Field crops	11,398	1,084
Citrus	12,626	946	Field crops[b]	16,299	826

[a]Costs of water source and electrical power transmission are excluded.
[b]Summer cropping limited to 70% of net irrigated area.
Source: Ministry of Mineral Resources and Water Affairs, p. 29 (1987).

Appendix 3. Capital and annual costs for medium schemes (pula/ha), Botswana, 1987.

Type/Crop	Capital	Annual[a]	Type/crop	Capital	Annual[a]
Multi-use dam			Direct river abstraction		
Surface irrigation	23,060	135	Surface irrigation		
Vegetables	27,871	157	Field Crops	24,517	360
Citrus	29,126	170	Vegetable	29,329	372
			Citrus	29,884	355
Hand move sprinkler			Hand move sprinkler		
Field crops	22,911	825	Field crops	20,337	245
Vegetables	24,973	1,200	Vegetables	22,399	1,374
Citrus	28,192	785	Citrus	25,619	917
Drip irrigation			Drip irrigation		
Field crops	28,230	866	Field crops	29,906	926
Vegetables	29,273	876	Vegetables	27,836	1,246
Citrus	24,724	736	Citrus	23,162	846
Centre pivot			Centre pivot		
Field crops	22,802	783	Field crops	20,854	957
Field crops[a]	18,724	607	Field crops[a]	16,950	734
Vegetables	23,509	799	Vegetables	21,650	981

[a]Summer cropping limited to 70% of net irrigated area.
Source: Ministry of Mineral Resources and Water Affairs, p. 29 (1987).

Appendix 4. Capital and annual costs of small schemes (pula/ha), Botswana, 1987.

Type/Crop	Capital	Annual[a]	Type/crop	Capital	Annual[a]
Small dam			Ground water		
Surface irrigation			Surface irrigation		
Field crops	122,066	631	Field Crops[1]	29,178	2,769
Vegetables	132,250	680	Vegetables[1]	32,549	2,644
			Citrus[1]	23,251	2,172
Hand move sprinkler			Hand move sprinkler		
Field crops	90,808	941	Field crops	17,588	1,830
Vegetables	95,734	1,170	Vegetables[1]	27,641	2,988
			Citrus	19,059	1,878
Drip irrigation			Drip irrigation		
Field crops	83,174	981	Field crops	23,260	1,588
Vegetables	88,198	1,156	Vegetables[1]	29,888	2,427
			Citrus	16,484	1,365
Centre pivot			Centre pivot		
Field crops	67,951	816	Field crops	16,073	1,639
Field crops[1]	38,944	558	Field crops[1]	13,298	1,210
Vegetables	72,308	846	Vegetables	16,073	1,671
Direct river abstraction			Sand river extraction		
Surface irrigation	8,788	443	Surface irrigation		
Vegetables	12,821	461	Field Crops[1]	21,725	1,177
			Vegetables[1]	25,259	1,127
			Citrus[1]	17,345	896
Sprinkler irrigation			Hand move sprinkler		
Field crops	8,834	690	Field crops	15,146	1,042
Vegetables	9,609	1,089	Vegetables[1]	22,921	1,663
			Citrus	16,618	1,006
Drip irrigation			Drip irrigation		
Field crops	17,489	766	Field crops	29,906	926
Vegetables	17,489	1,002	Vegetables[1]	27,836	1,246
			Citrus	23,162	846
Centre pivot					
Field crops	9,356	696			
Field crops[1]	8,904	534			
Vegetables	9,356	710			

[a]Summer cropping limited to 70% of net irrigated area.
Source: Ministry of Mineral Resources and Water Affairs, p. 30 (1987).